University of Alberta

An overview of sodium, calcium, and vitamin D dietary-related behaviors of

Chinese Canadians in Edmonton

by

Yan Han Yu

A thesis submitted to the Faculty of Graduate Studies and Research

in partial fulfillment of the requirements for the degree of

Master of Science

in

Nutrition and Metabolism

Department of Agricultural, Food, and Nutritional Science

Spring 2012

Edmonton, Alberta

ABSTRACT

The sodium, calcium, and vitamin D intakes and their respective food sources were assessed in a convenience sample of 81 Canadian-born and foreign-born Chinese adults from the University of Alberta in Edmonton. The mean intakes of sodium, calcium, and vitamin D were 3,623 ± 1,406 mg/day, 794 ± 351 mg/day, and 4.4 ± 3.7 μg/day, respectively. Participants were at high risk for calcium and vitamin D inadequacies and excessive sodium intake. Commercially-processed foods (condiments included) were the main source of sodium (54%). Milk and dairy were the primary sources of calcium (42%) and vitamin D (53%). The findings imply that Chinese adults, Canadian-born and foreign-born alike, are consuming foods typical of Western diets. Western foods are thus important to target to optimize intakes of vitamin D and calcium and to reduce sodium intakes in Chinese Canadians. The study findings can be used to improve future nutrition messaging for each group.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AI: Adequate Intake

ANOVA: Analysis of Variance

BMD: Bone Mineral Density

CBC: Canadian-born Chinese

CCHS: Canadian Community Health Survey

CHMS: Canadian Health Measures Survey

CVD: Cardiovascular disease

DRIS: Dietary Reference Intakes

EAR: Estimated Average Requirement

FAO: Food and Agriculture Survey

FBC: Foreign-born Chinese

FFQ: Food frequency questionnaire

FSA: Food Standards Agency

IOM: Institute of Medicine

MSG: Monosodium Glutamate

NAHSIT: Nutrition and Health Survey in Taiwan

NHANES: National Health and Nutrition Examination Survey

RDA: Recommended Daily Allowance

UL: Tolerable Upper Intake Level

USDA: U.S. Department of Agriculture

WHO: World Health Organization

1. INTRODUCTION

In 2006, Canada's five million immigrants made up 16.2 % of the population. Among all the visible minority groups, Chinese Canadians are the second largest, representing 3.9% of the total Canadian population and 24% of the total visible minority population (Statistics Canada, 2008). In 2006, there were about 1.2 million residents of Chinese ethnicity in Canada, with 74.5% being foreign-born (first-generation) (Statistics Canada, 2010). The People's Republic of China (Mainland China) and Hong Kong (special administrative region) were the top two birth places among the foreign-born Chinese visible minorities, at 52.9% and 24.2%, respectively, while Taiwan (7.4%) and Viet Nam (5.7%) represented two other countries where a large proportion of the foreign-born Chinese came from (Statistics Canada, 2008).

In 2006, 3.7% of the population of the Province of Alberta identified as being of Chinese descent and most of them (94.3%) resided in Alberta's two largest census metropolitan areas (Statistics Canada, 2008). In 2006, there were approximately 47,200 Chinese people living in Edmonton and 66,375 in Calgary (Statistics Canada, 2008). Adults who self-identified as Chinese and participated in the research project outlined in this thesis, were recruited from the University of Alberta campus in Edmonton, Alberta. The research included Chinese individuals originating from Canada, China, Taiwan, and Hong Kong.

Immigration to a new country can lead to a substantial shift in a person's lifestyle and environment and numerous changes can occur as a result, including access to health care, physical activity, and diet. These changes can result in modifications in chronic disease risk and management (Satia et al., 2002). Diverse health outcomes among the Chinese population in Canada have arisen partly due to the effects of dietary acculturation whereby Chinese immigrants adopt the dietary practices of the mainstream culture (that is, Westernized food habits) while still retaining their own (Satia et al., 2000 & 2001). A substantial shift to a Western lifestyle appears to result in modified (both adverse and

improved) morbidity and mortality for many chronic diseases (Satia et al., 2002). For instance, adoption of Westernized diets that are high in fat and low in vegetables and fruits is of concern because this dietary pattern is a risk factor for several chronic conditions such as cardiovascular diseases and certain digestive tract cancers (American Institute for Cancer Research, 1997; WHO, 2003), while increased dairy consumption can be a positive behavior modification in Chinese immigrants living in North America (Lee et al., 1994; Lee et al., 1999; Satia et al., 2001; Lv & Cason, 2004; Lv et al., 2007). For this reason Chinese Canadians, both Canadian and foreign born, may require development of nutrition messaging that targets their specific nutritional needs and cultural factors that influence their dietary intake (Satia et al., 2000; 2001 & 2002). Health promotion strategies that are culturally appropriate and tailored to differences in food intake patterns in Chinese Canadians are therefore required (Heaney, 2000; Satia et al., 2000; 2001 & 2002).

Studies show that among ethnic groups, Chinese immigrants in North America have a high risk of low bone mineral density and osteoporosis, especially for women and older immigrants (Lau, 1997; Siris et al., 2001; Lauderdale et al., 2003; Babbar et al., 2006). Adequate calcium and vitamin D intakes are needed to maintain optimal bone health (Holick, 2007; Major, 2008). However, information for calcium and vitamin D is so far still limited for Chinese Canadians. It is necessary to provide nutrition education that is tailored to Chinese Canadians because many dietary focused osteoporosis-prevention efforts in Canada and the United States are aimed at the general population and do not consider cultural influences on dietary intake (Kittler and Sucher, 2004; Lv & Brown, 2011).

In addition, there is a significant relationship between Asian immigrants' length of residence in Canada and blood pressure increases (Kaplan et al., 2002; Steffen et al., 2006). This may be the result of changes in both dietary practices and physical activity and stressors associated with cultural change. High levels of

dietary sodium intakes are etiologically associated with elevated blood pressure (prehypertension/hypertension) and adverse cardiovascular health (Havas et al., 2004; Kearney et al., 2004; Hajjar et al., 2006). The Canadian Health Measures Survey estimated that hypertension affects nearly one-fifth (19%) of Canadian adults aged 20-79 years (Wilkins et al., 2010) and almost 30 % of hypertension among Canadians may be attributed to excess dietary sodium (Joffres et al., 2007). However, the Chinese diet consumed in Asian countries differs from the Canadian diet for sources of sodium (James et al., 1987; Mattes et al., 1991; Brown et al., 2009; Fischer et al., 2009) and yet, little is known whether these sources change when Chinese individuals immigrate to Canada.

For dietetic practitioners and nutrition educators to better understand and educate Chinese Canadians on their major food sources of sodium, calcium, and vitamin D and to inform them of food choices for heart and bone health, more research is required to identify common dietary sources of sodium, calcium, and vitamin D for Chinese Canadians. The research project, conducted on Chinese adults in Edmonton, was developed to meet the following objectives with two studies.

Study 1

- To report the average and differences in sodium intake of Canadian-born Chinese (CBC) and Foreign-born Chinese (FBC) individuals.
- To report the prevalence of excessive sodium intake of Chinese men and women.
- To identify primary food sources of sodium consumed by CBC and FBC.

Study 2

- To report the average and differences in calcium and vitamin D intake of CBC and FBC.
- To report the risks for calcium and vitamin D inadequacy of Chinese men and women.
- To identify primary food sources of calcium and vitamin D consumed by

CBC and FBC.

It was anticipated that study findings may be used to improve nutrition messaging for the Chinese Canadian population, Canadian-born and foreign-born alike.

1.1 LITERATUE CITED

Babbar RK, Handa AB, Lo CM, et al. Bone health of immigrant Chinese women living in New York City. *Journal of Community Health. 2006; 31(1): 7-23.*

Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *International Journal of Epidemiology. 2009; 38(3): 791-813.*

Hajjar I, Kotchen JM, Kotchen TA. Hypertension: trends in prevalence, incidence, and control. *Annual Reviews of Public Health. 2006; 27: 465-90.*

Havas S, Roccella EJ, Lenfant C. Reducing the public health burden from elevated blood pressure levels in the United States by lowering intake of dietary sodium. *American Journal of Public Health. 2004; 94(1): 19-22.*

Heaney RP. Calcium, dairy products and osteoporosis. *Journal of American College Nutrition. 2000;19(2 Suppl): 83S-99S.*

Holick MF: Vitamin D deficiency. *New England Journal of Medicine. 2007; 357(3): 266-81.*

James WP, Ralph A, Sanchez-Castillo CP. The dominance of salt in manufactured food in the sodium intake of affluent societies. *Lancet. 1987; 1(8530): 426-9.*

Joffres MR, Campbell NR, Manns B, Tu K. Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada. *Canadian Journal of Cardiology. 2007; 1;23(6): 437-43.*

Kaplan MS, Chang C, Newsom JT, McFarland BH. Acculturation status and hypertension among Asian immigrants in Canada. *Journal of Epidemiology & Community Health. 2002; 56(6): 455-6.*

Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review. *Journal of Hypertension. 2004; 22(1): 11-9.*

Kittler PG & Sucher KP. Food and Culture. 4th ed. Toronto, ON: Wadsworth; 2004.

Lau EM. Epidemiology of osteoporosis in urbanized Asian populations. *Osteoporosis International. 1997; 7(Suppl 3): S91-5.*

Lauderdale DS, Kuohung V, Chang SL, Chin MH. Identifying older Chinese immigrants at high risk for osteoporosis. *Journal of General Internal Medicine. 2003; 18(7): 508-15.*

Lee MM, Wu-Williams A, Whittemore AS, et al. Comparison of dietary habits, physical activity and body size among Chinese in North America and China. *International Journal of Epidemiology.1994; 23(5): 984-90.*

Lee SK, Sobal J, Frongillo EA. Acculturation and dietary practices among Korean Americans. *Journal of American Dietetic Association.1999; 99(9): 1084-9.*

Lv N, Brown JL, Liu B. Enhancing nutrition consumption in the American diet: Factors influencing dairy product consumption of Chinese Americans in Pennsylvania. *Topics in Clinical Nutrition. 2007; 22(3): 258-71.*

Lv N, Brown JL. Impact of a nutrition education program to increase intake of calcium-rich foods by Chinese-American women. *Journal of American Dietetic Association. 2011; 111(1): 143-9.*

Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *Journal of American Dietetic Association. 2004; 104(5): 771-8.*

Major GC, Chaput JP, Ledoux M, et al. Recent developments in calcium-related obesity research. *Obesity Reviews. 2008; 9(5): 428-45.*

Mattes RD, Donnelly D. Relative contributions of dietary sodium sources. *Journal of American College Nutrition. 1991; 10(4): 383-93.*

Potter J, ed. World Cancer Research Fund and the American Institute for Cancer Research, Food, Nutrition, and Prevention of Cancer: a Global Perspective. Washington, DC: American Institute for Cancer Research; 1997.

Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and

Chinese-Canadians. *Journal of American Dietetic Association. 2001; 101(5): 548-53.*

Satia JA, Patterson RE, Neuhouser ML, Elder J. Dietary acculturation: Applications to nutrition research and dietetics. *Journal of American Dietetic Association. 2002; 102(8): 1105-18.*

Satia JA, Patterson RE, Taylor VM, Cheney CL, Shiu-Thorton S, Chitnarong K, Kristal AR. Use of qualitative methods to study diet, acculturation, and health in Chinese-American women. *Journal of American Dietetic Association. 2000; 100(8): 934-40.*

Siris ES, Miller PD, Barrett-Connor E, Faulkner KG, Wehren LE, Abbot TA, Berger ML, Santora AC, Sherwood LM. Identification and fracture outcomes of undiagnosed low bone mineral density in post-menopausal women: Results from the National Osteoporosis Risk Assessment. *Journal of American Medical Association. 2001; 286: 2815-22.*

Statistics Canada. Provinces and Territories, 2006 census of population. Visible minority groups, percentage distribution, for Canada. http://www40.statcan.gc.ca/l01/ind01/l2_30000-eng.htm Accessed September 8th, 2011.

Statistics Canada. Canada's Ethnocultural Mosaic, 2006 Census. Ottawa, ON: Ministry of Industry; 2008.

Steffen PR, Smith TB, Larson M, Butler L. Acculturation to Western society as a risk factor for high blood pressure: a meta-analytic review. *Psychosomatic Medicine. 2006; 68(3): 386-97.*

Wilkins K, Campbell NR, Joffres MR, et al. Blood pressure in Canadian adults. *Health Reports. 2010; 21(1): 37-46.*

World Health Organization. Global Strategy on Diet, Physical Activity and Health Chronic Disease - key risk factors include high cholesterol, high blood pressure, low fruit and vegetable intake. Geneva, Switzerland: WHO press; 2003.

2. LITERATURE REVIEW

2.1 DESCRIBING IMMIGRATION IN CANADA AND DIETARY ACCULTURATION

a. Canadian Mosaic: Chinese Immigration to Canada and Edmonton

Canada has long been a country that accepts people with various ethnic backgrounds to enrich its multicultural diversity and welcomes proportionately more immigrants than any other country in the world (Perez, 2002). One of the goals of Canada's Immigration Act is "to permit Canada to pursue the maximum social, cultural and economic benefits of immigration" and defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in color" (Immigration and Refugee Protection Act, 2001). Canada now receives an average of approximately 200,000 immigrants annually (Perez, 2002). It is very likely that the Canadian population would start to decrease in 30 years without the population input of immigrants to Canada, which now represents close to 60 % of total Canadian population growth (Edward et al., 2005).

According to the Statistics Canada (Statistics Canada, 2008), the increasing number of recent non-European immigrants has significantly contributed to the growth of the visible minority population. If current immigration trends continue, members of visible minority group will gradually grow much more quickly than the non-visible minority population and could account for almost one-fifth of the total Canadian population by 2017 (Statistics Canada, 2006).

From the results of the 2006 Population Census (Statistics Canada, 2008), 16.2 % of the Canadian population consisted of Canada's 5 million immigrants with ethnic Chinese representing the second largest minority group. For the first

time, South Asians[1] have outnumbered Chinese as the largest visible minority group in the history of Census of population. In 2006, Chinese accounted for about 24% of the visible minority population and 3.9% of the total Canadian population. During the period of 2001 and 2006, the number of individuals who identified themselves as Chinese increased 18.2% from 1,029,400 to 1,216,600 for Canada in general and 21.4% for Alberta. In 2006, 3.7% of the Albertan population (120,275 people) were of Chinese descent and most of them (94.3%) resided in Alberta's two largest census metropolitan areas; there were approximately 47,200 Chinese people living in Edmonton and 66,375 in Calgary (Statistics Canada, 2006).

Although the Chinese visible minority population has had a long history in Canada, recent immigration has also fuelled their growth. Among the Chinese visible minority 25.5% are Canadian-born (Statistics Canada, 2008). The People's Republic of China (Mainland China) and Hong Kong (special administrative region) were the top two birth places among the foreign-born Chinese individuals, at 52.9% and 24.2%, respectively. Followed by Taiwan (7.4%) and Viet Nam (5.7%) (Statistics Canada, 2008).

Chinese living in Canada are a diverse group with a variety of countries of birth, mother tongues, languages spoken at home and religious affiliation but they are linked by a common ethnicity[2]. Given the diversity within this group, it is a great challenge and important to gain a better understanding of the dynamics underlying any changes in Chinese immigrants' health. This information informs public policy about potential risks confronting this increasingly important component of the Canadian society. Numerous changes can occur with immigration, including access to health care, physical activity, and diet (Satia et

[1] A majority of the foreign-born South Asians came from countries in the Indian subcontinent, such as India (48.8%), Pakistan (14.6 %), Sri Lanka (11.7 %), and Bangladesh (3.6 %) (Statistics Canada, 2006 census of population).

[2] Unlike national origin or race, ethnicity is a social identity associated with shared behavior patterns, including food habits, dress, language, family structure, and often religious affiliation (Kittler & Sucher, 2004).

al., 2002). A substantial shift to a Western lifestyle appears to result in modified (both adverse and improved) morbidity and mortality for many chronic diseases among different ethnic groups (Satia et al., 2002). For instance, adoption of Westernized diets that are high in fat and low in vegetables and fruits is of concern because this dietary pattern is a risk factor for several chronic conditions such as cardiovascular diseases and certain digestive tract cancers (American Institute for Cancer Research, 1997; WHO, 2003). On the other hand, a reduction in preserved foods has reduced the risk of stomach cancer in some Asian populations (Korean and Japanese) in the United States (Chyou et al., 1990; Yang et al., 2007). An important public health objective would be to encourage different ethnic groups to retain their traditional healthful eating patterns while adopting healthful dietary practices of their host country. To meet this objective, it is necessary to understand the process by which immigrants adopt the dietary practices of the host country, called "dietary acculturation", determine if there are in fact any dietary changes made as a result of dietary acculturation and, identify the factors that enable it to occur.

b. Overview of Acculturation

"Acculturation is the concept used to represent adaptation to sociocultural change" (Trimble, 2003). The term "acculturation" is commonly used to describe the process by which a racial/ethnic group, usually a minority, adopts the cultural patterns and traits such as beliefs, religion, or language of a dominant/host group (majority) (Satia et al., 2003). When people from one culture move to a region with different cultural norms, adaptation to the new host society begins (Kittler & Sucher, 2004).

Many research disciplines such as anthropology, sociology, psychology, public health, and others are involved in the study of acculturation. Even though there is no either a standard definition of acculturation or a standard method of its measurement that social scientists all agree on (Satia, 2003; Marger, 2000), there are two generally accepted models that discuss the psychological aspect of

acculturation in general (Padilla & Perez, 2003; Satia, 2003). John Berry (1980) describes a model on acculturation which includes varieties of adaptation and specifically identifies the following four views: assimilation, integration, rejection, and deculturation (Berry, 1980). Berry's model recognizes the importance of multicultural societies, minority individuals and groups, and the fact that individuals have a choice for how far they are willing to go in the acculturation process (Padilla & Perez, 2003). During this process, an individual is acquiring, retaining, and/or abandoning behaviors and values of both his or her original culture and the host culture (Berry, 1980; Marger, 2000; Satia, 2003).

The other well-accepted model, proposed by Robert Park (Persons, 1987) describes acculturation as a series of distinct, irreversible stages (contact, competition, accommodation, and assimilation) where completion of one stage is required before moving to the next. According to this model, contact between peoples from different cultures forces them to seek ways to accommodate to each other to minimize conflict. Thus, contact shapes intergroup relations between different ethnic communities. Park's model is a better model in reflecting the experience of many European immigrants. However, it has been criticized by many social scientists as a weak model as immigrants who are especially physically and culturally unique such as immigrants from Africa and Asia, fail to follow the irreversible stages of acculturation and do not merger with the new host culture completely (assimilation) (Marger, 2000; Satia, 2003). Also, Park's model is not accurate to describe the behaviors of more recent immigrant groups (Satia, 2003). Compared to Park's model, Gordon's is more accepted when studying Asian immigrants because they do not pass through irreversible stages of acculturation as Park's model describes (Satia, 2003).

Regardless of which theory is used to describe the process, it has been hypothesized that the most adaptive and healthiest type of acculturation is having the desire to maintain one's original cultural identity, as well as seeking to interact with the new culture. It is believed that acculturation occurs at both the

micro (individual) and macro (social/group) levels. Acculturation at the individual level is referred to as "psychological acculturation" and refers to changes in attitudes, beliefs, behaviors, and values in individuals due to acculturation (Szapocznik & Kurtines, 1980; Satia, 2003). At the macro level, acculturation results in physical, biological, political, economic, and cultural changes in the acculturating group or in the society as a whole (Berry, 1980; Szapocznik & Kurtines, 1980; Marger, 2000).

The acculturation process takes place along a continuum of behavior patterns that can be very fluid, moving back and forth between traditional practices and adopted customs (Kittler & Sucher, 2004). Typically, first-generation immigrants often remain emotionally attached to their country of birth. They integrate into their new society by adopting some majority culture values and practices, but generally surround themselves with a group of family or friends who are from their ethnic background (Kittler & Sucher, 2004). Other immigrants become bicultural. It happens only when the new majority culture is viewed as complementing, rather than competing with, an individual's ethnicity (Kittler & Sucher, 2004). In this case, the positive aspects of both cultures are retained and the individual learns the skills required to live successfully within either culture (Brookins, 1993). Eventually, assimilation occurs when people from one cultural group shed their ethnic identity and fully merge into the majority culture. Most often assimilation takes place in subsequent generations despite the efforts of first-generation immigrants to strive toward assimilation to survive in a foreign country, Overall, very few immigrants exist at the two extreme edges of acculturation continuum, either maintaining total ethnic identity or rejecting their culture of origin and accepting only that of the majority culture (Meleis et al., 1992).

Several factors affect the speed of an individual or group to assimilate into a new society, be it a new country or a different area within the same country (Satia, 2003). Evidently, the greater the contrast between the

immigrant's original and host cultures, the more obstacles the immigrant groups will experience in order to acculturate. For example, highly skilled or educated immigrants from urban areas are less likely to experience cultural isolation or major changes in lifestyle upon immigration to a developed country (Satia, 2003). On the other hand, immigrants who locate in ethnic enclaves (i.e., an area which retains some cultural distinction of people of the same ethnic group, such as Chinatown-type settlements in the North America) or who migrate involuntarily (e.g., refugees) may acculturate with considerably less speed and facility (Pan et al., 1999; Satia et al., 2000; Satia, 2003).

c. Introduction to Dietary Acculturation

"While acculturation pertains to adopting cultural characteristics, "dietary acculturation" specifically refers to the complex process that occurs when a minority group learns to adopt the eating patterns and food choices of the mainstream culture and chooses to retain some of their own" (Satia et al., 2002). Immigration to a new country can lead to a substantial shift in a person's lifestyle and environment and many changes can occur as a result, including access to health care, physical activity, and diet. Yet, diet, particularly culturally based food habits, is often one of the last traditions people change after immigration through acculturation (Kittler & Sucher, 2004). Eating is usually considered a private behavior without the public observation of the main stream society, unlike speaking a foreign language or wearing traditional clothing (Kittler & Sucher, 2004). Research shows that the consumption of new food items is often independent of traditional food habits (Pelto et al., 1981; Dewey et al., 1984; Szathmary et al., 1987). Therefore adoption of new food habits does not generally progress from traditional diet to the diet of the majority culture. Often, the lack of native ingredients (less accessibility), convenience or cost factors may force immediate acculturation and speed change (Kittler & Sucher, 2004).

Differently from some dimensions of acculturation in which the immigrant group unilaterally adopts the traits of the host culture, dietary

acculturation is a more reciprocal process, as the host group may also adopt some of the foods and dietary practices of the minority group(s). As an example, there is a large influence of Chinese culture on the food industry in the North America. The fast growing Chinese population has led to increased selection of traditional Chinese foods in Western grocery chains (e.g., Superstore and Walmart) and influenced the accessibility and cost of these foods in general (Peng, 2005). Also there are a variety of ethnic supermarkets and restaurants available throughout most of North America (Heise, 2002; Satia, 2003). As a result of these changes persons of Chinese ethnicity might choose to retain many of their traditional Chinese food ways despite having many of the conditions predictive of dietary acculturation.

Similar to other forms of acculturation, dietary acculturation is multidimensional, dynamic, and complex and does not appear to be a simple process in which a person moves linearly from one end of the acculturation continuum (traditional) to the other (acculturated) (Berry, 1980; Szapocznik & Kurtines, 1980; Satia et al., 2001; Satia, 2003). Rather, research shows that as part of the acculturation process, immigrants may retain traditional foods, exclude others, find new ways to use traditional foods, and/or adopt the diets of the host country (Yang & Fox, 1979; Lee et al., 1999; Pan et al., 1999; Satia et al., 2000; Satia et al., 2001). For instance, among many Chinese immigrants living in the United States, rice typically remains an important staple, while other traditional foods may be replaced by cereal, bread, sandwiches, and dairy foods (Yang & Fox, 1979; Pan et al., 1999; Satia et al., 2000). In addition, as part of dietary acculturation, people of Chinese descent may replace “Bao Zi” (a steamed bun stuffed with chopped meat and/or vegetables) with meat sandwiches to which they add mayonnaise (Satia, 2003). Immigrants may also incorporate the foods available in the host country in preparing traditional meals (Satia, 2003). For example, a study of 102 first-generation Chinese immigrants in Nebraska by Yang and colleagues (Yang et al., 1979) reported that the

participants used canned and frozen American vegetables to prepare Chinese dishes. Some studies have also shown that evening meal changes the least of the three meals and remained the most traditional meal (i.e., immigrants are more likely to consume traditional foods at the evening meal) and breakfast and lunch change the most. It is probably because they eat the evening meal with other family members, while they have more accessibility to "Westernized" foods (such as pizza and sandwiches) for breakfast and lunch (Pan et al., 1999; Satia, 2003). Finally, some immigrants may fully adopt (i.e., acculturate) to the dietary patterns of the new environment, however, when compared to first-generation immigrants, this is more often observed in subsequent generations (Kittler & Sucher, 2004).

Dietary acculturation is influenced by a number of factors which can result in considerable change in dietary intake (Satia, 2003). Figure 2-1 shows a proposed model of dietary acculturation by Satia et al (2002), which is the only model of dietary acculturation found in the literature. The model identifies socio-economic, demographic, and cultural factors interacting with exposure to the host culture. This exposure, in turn, may influence the extent to which immigrant's change in their attitudes, beliefs about food, taste preference as well as food purchasing and preparation behaviors. According to Satia's model, there are three classifications of resulting dietary patterns including 1) retention of traditional food habits, 2) adoption of host country's food habits, or 3) bicultural eating patterns including retention of certain traditional food habits (at certain meals or occasions) and incorporation of host country's food habits (at other meals or occasions). Although Satia's acculturation model describes the detailed and comprehensive interactions among various influencing factors and immigrants' dietary behavior change, so far, this model, has never been empirically validated for use. The fact that the model is so comprehensive and includes all possible contributing factors to dietary change of immigrants limits its wide utility and application. Both qualitative approaches (for measuring

changes in psychosocial factors and taste preferences) and quantitative approaches (for measuring socioeconomic and demographic factors) may be required to evaluate all the contributing factors, changes in these factors, and dietary outcomes in the model. Perhaps partial use of the model focusing on one contributing factor at a time might improve its applicability in research.

Many studies have shown that some socio-demographic characteristics such as age, gender, longer length of residence in the new host country, fluency with the host language, high education and income, employment outside of the home, being married, and having young children result in increased exposure to mainstream culture, and consequently, dietary acculturation (Yang & Fox, 1979; Berry, 1980; Szapocznik & Kurtines, 1980; Negy & Woods, 1992; Lee et al., 1999; Pan et al., 1999; Satia et al., 2000; Satia et al., 2003). Health literacy also has an impact on a variety of skills related to food preparation and shopping such as reading labels and budgeting (Kwok et al., 2009).

Exposure to a new culture is through local food supply, which can lead to substantial changes in food procurement and preparation. For instance, the lack of traditional foods and ingredients such as certain types of vegetables or spices will result in increased consumption of the common foods of the host country (Satia et al., 2000). Similarly, if traditional foods are less available or more expensive and time-consuming to prepare, it may be more convenient and affordable to eat prepackaged dinners or to frequent fast food restaurants (Pan et al., 1999; Satia et al., 2000).

Exposure to host culture through media (television, radio, books, magazines) may change attitudes, knowledge and, beliefs about the diet and disease risk (Satia, 2003). For example, a slim model in fashion magazines in the North American culture may influence the perceptions of body image among teenage immigrant girls (Taylor et al., 1998); and exposure to nutrition and health messages can modify beliefs about the relationship between diet and chronic disease risk (Satia et al., 2002; Satia, 2003). Studies conducted in

immigrant populations show that these daily environmental factors and exposures are among the most commonly cited reasons for dietary acculturation (Pan et al., 1999; Satia et al., 2000; Satia, 2003).

d. Dietary Acculturation of Chinese Immigrants in North America

"Cross-cultural researchers stated that for new arrivals to North America, consumption of traditional foods formed a link with the past, eased the shock of entering the new culture, and served to maintain ethnic identity" (Brown & Mussell, 1984). Researchers have noted that certain traditional dietary practices remained intact, whereas some foods from other cultures were incorporated (Grivetti & Paquette, 1978).The study of culturally-based foods and food habits of immigrants has specific applications in determining nutritional status and implementing dietary changes in an ethnic group. This information can be very useful for dietitians who work with clients from diverse ethnic groups because dietary acculturation can result in both healthy and less healthy dietary changes. Among Chinese immigrants in the U.S., for example, decreased consumption of seafood and increased intake of red meat (which results in significant alterations in saturated fat and sodium intake) are unhealthful changes resulting from dietary acculturation, while eating a greater variety of fruit and vegetables can be a positive behavior modification (Yang et al., 1979; Pan et al., 1999; Satia et al., 2000). Therefore, although dietary acculturation can have negative health consequences, not all dietary changes are necessarily detrimental.

Eleven cross-sectional studies that investigated and measured both "diet" and "acculturation" have been reviewed in this thesis. Most selected studies were conducted in Chinese Americans (mostly first-generation) as relatively less information was available for Chinese Canadians. In these studies, several acculturation indicators were used, such as length of residence, English proficiency, age, and education. Both quantitative and qualitative approaches such as food frequency questionnaires, 24-hour dietary recalls, household food inventory, and qualitative interviews were used to examine the diet and nutrient

intakes of Chinese immigrants. A summary of findings of these selected studies (Table 2-1) that examined associations between diet and acculturation in Chinese in the United States and Canada between 1978 and 2009 is presented below.

In 1978, Grivetti et al (1978) set up a pilot project on food choices among first generation Chinese immigrants who settled in northern California. The results showed that there was a decline in diversity of animal products regularly consumed by those living in the United States when compared with previous dietary patterns in China. Animal products that showed sharp decreases in consumption frequency were primarily seafood (crab, oysters, prawns, shark fin, and squid) and duck. When researchers compared the intake of participants in the US to previous dietary patterns while living in China, they found that most dairy products were used more frequently when living in US; the frequency of rice consumption declined after immigration; and, the use of cold and hot breakfast cereals was increased sharply. They also pointed out several changes in vegetable and fruit use to include the consumption of broccoli, lettuce, potato, squash, and zucchini increased significantly, while the consumption of bok choy, green onions, lotus roots, mushrooms, tree ear fungi, and water chestnuts decreased. Apples and peaches were consumed more frequently whereas the use of lychee, mandarin orange, persimmon, pineapple, and watermelon decreased. The researchers stated that the decreases in certain Chinese food choices may have been due to the effects of dietary acculturation as those foods were readily available and accessible in California. This study has shown that non-traditional foods play major dietary and nutritional roles in Chinese-American families.

Yang and colleagues (1979) developed a questionnaire to assess food habits, prior practices, and changes in food consumption pattern of Chinese living in Lincoln, Nebraska. They found a great proportion of Chinese were eating an American lunch (e.g., fast food and salad). Lunch was the most changed meal

of the day while dinner was the least when compared to prior practices. The researchers explained that participants who ate more American-style dinners (e.g., bread, sandwiches, and fast food) were mostly University students living in dormitories, where the meal plans were provided by the institution and they were unable to choose their meal patterns (i.e. students ate only what was served). Interestingly, in this study American foods were usually not accepted or eaten in their natural style, instead they were modified or "re-cooked" to be more Chinese-like foods according to the flavor and texture preferences of the Chinese participants.

In 1994, another study confirmed the higher consumption of meat (especially beef) and dairy products in North American Chinese (Lee et al., 1994) compared to Chinese living in China. In 2004, Lv et al (Lv et al., 2004) surveyed 399 first-generation Chinese Americans in Pennsylvania. They found that participants with better English proficiency and more congenial American friends were more acculturated. Approximately half of the participants reported ordering traditional Chinese foods when eating out, with the belief that Chinese foods were healthier than American foods (especially fast food), and the taste preference was for Chinese foods. One-third of the participants reported choosing American-style meals when eating out for the following reasons: American foods were convenient, fast, inexpensive, safe, and easy to find.

Satia et al conducted qualitative interviews with Chinese American women to study diet, acculturation, and health (Satia et al., 2000). They found that breakfast appeared to be the first meal to be "Westernized", largely for reasons of convenience. Food quality, cost, and availability were the most important predictors of dietary change after immigration to the U.S. In the following year, Satia and colleagues used information from the interviews to develop a household food inventory tool using American household foods for dietary acculturation assessment in Chinese immigrants. The household foods on the inventory list were major contributors of fat and/or were useful indicator

foods of dietary change such as butter, lunchmeats, snack chips and milk. Satia explored a dietary acculturation scale as well (Satia et al., 2001) that measured some dietary changes and the degree of Western or Eastern dietary preference. In their study, greater acculturation to American food habits in Chinese women was associated with a younger age, higher education, marriage, employment outside the home, and longer residence in America.

Over the years, a few studies of Chinese immigrants were conducted on specific age groups ranging from adolescents to the elderly. In 1985, Hrboticky & Krondl surveyed first- and second-generation Chinese adolescent males living in Toronto, Canada (Hrboticky & Krondl, 1985). They found that second- generation Chinese Canadians adolescents used Canadian food items (mainly highly processed foods) such as cake, processed meats, potato chips, and cold breakfast cereals more frequently than their first generation counterparts. The researchers indicated that all Canadian food items used in high frequency by second-generation Chinese Canadians were consistently consumed by their Caucasian counterparts, showing an acculturation effect on the use of these items.

In 1999, Pan et al examined the adaptation to American dietary patterns in Asian students, mainly Chinese (90%) from Taiwan and China attending Pennsylvania State University. Immigration of these students to the U.S. was found to be significantly associated with increased consumption frequency of fats/sweets, salty snacks, dairy products, and fruits and decreased consumption frequency of meats and vegetables. Due to financial constraints, students tended to eat out less often, but they were selecting cheaper American-style fast foods when they did eat out. Lastly, elderly Chinese Canadians living in Toronto, Canada (Kwok et al., 2009) were surveyed about their dietary habits and health beliefs. A high percent (over 70%) of participants reported eating a Western-style breakfast, Chinese-style lunch such as rice with stir-fry, noodles, or soup, and almost all participants (98%) consumed a traditional Chinese dinner. Green

leafy vegetables (e.g., bok choy) and fruits were regularly consumed by elderly Chinese Canadians while lettuce salads and potatoes were eaten less. Sixty percent of participants preferred eating Chinese foods because they thought that a traditional Chinese diet is healthier than the typical Western diet.

In summary, data on the dietary acculturation of Chinese-Canadians is limited compared to their American counterparts. However, given the similarities of dietary patterns and lifestyles across North America, it is very likely that the acculturation process observed in the U.S. resembles that in the Canadian context.

The eleven selected studies used several acculturation characteristics such as age at immigration, education level, language preference, and length of time in host country to measure immigrant's level of overall acculturation. Dietary measures including household inventory, food frequency questionnaire, and 24-hour dietary recall were used to assess immigrant's dietary intakes. These study findings were broadly accepted as the following: The North American Chinese immigrants keep dinner as the most traditionally Chinese meal, although breakfast, lunch, and snacks tend to become more Westernized (Yang et al., 1979; Satia et al, 2000; Kwok et al., 2009). North American Chinese prepare Chinese dishes at home but prefer American foods more while eating out (Bojanic et al., 2006). Traditional fruits and vegetables may be replaced by more commonly available North American items, such as potatoes, lettuce, broccoli, apples, and peaches (Grivetti & Paquette, 1979). Meat and poultry intake increases, while some traditional protein items like pig's liver and bone marrow soup often remain popular (Lee et al.,1994). Sugar intake also increases, mainly through consumption of soft drinks, candies, and pastries (Peng, 2005). Even though milk is not a familiar item in the typical Chinese diet, several studies suggest that milk consumed by Chinese Americans is increased in the United States (Lee et al., 1994; Lee et al., 1999; Satia et al., 2001; Lv et al., 2004; Lv et al., 2007). Other dairy products such as cheese, yogurt, and ice cream have also

been found to be well accepted by North American Chinese (Peng, 2005). Several Chinese foods remain regularly consumed, such as rice, soybean products, cooked vegetables, and fruit (Grivetti & Paquette, 1979; Lee et al., 1994; Pan et al., 1999; Nan et al., 2004). Researchers noted that rice continued to be an important staple, but other traditional grain foods were replaced by cereal, bread, ham burgers, and sandwiches; salt intake therefore increased (Pan et al., 1999; Peng, 2005).

e. Measurement of Dietary Intake in Immigrant Populations

Determining an individual or group's usual dietary intake is essential when the relationships between diet and health are being assessed (Gibson, 2005). Food records, dietary recalls, and food frequency questionnaires are the most commonly used assessments for evaluating dietary intake of individuals and groups (Gibson, 2005).

Food diaries or food records are a method (Nelson et al, 1997) in which subjects are taught to describe and give an estimate of the portion size or weight of all foods and beverages consumed for a specific time frame (Food and Agriculture Organization, 1996). Information about the weight of food eaten may be obtained either by requesting individuals to physically weigh the food or to describe portions of food in terms of household measures, pictures, food models, or package sizes. A weighted food record is the most precise and accurate method available for estimating usual food and nutrient intakes at the individual level (Gibson, 2005). This method does not rely on memory and allows for a relatively easy means for quantifying amounts consumed (FAO, 1996). Nevertheless, it does require a high level of participant burden, literacy, and most importantly, may alter intake behavior due to the workload required to do the measurement, which may contribute to its ineffectiveness in some populations (FAO, 1996).

Another method to assess dietary intake is the food frequency questionnaire (FFQ). The FFQ consists of the structured listing of individual foods

or food groupings (FAO, 1996; Gibson, 2005). For each item on the food list, the respondent is required to estimate the regularity of consumption based on specific frequency categories which indicate the number of times the food is usually consumed per day, week, month or year (FAO, 1996). Food frequency questionnaires are designed to estimate a large number of nutrients and generally include between 50 and 150 food items (FAO, 1996). Specifically, some combinations of foods can be used as predictors for intakes of certain nutrients or non-nutrients, provided that the dietary components are concentrated in a relatively small number of foods or specific food groups. Examples include the consumption frequency of fresh fruits and fruit juices as predictors of vitamin C intake and dairy products as predictors of calcium intakes (Gibson, 2005).

The 24-hour recall method may be an interview or written information concerning the previous day's intake. The 24-hour dietary recall consists of the listing and quantification of foods and beverages consumed in the previous 24 hours. Food types and their amounts are recalled from memory with the aid of a trained interviewer (FAO, 1996). In this approach, there is little respondent burden, no literacy requirement, and it is not likely to alter intake behavior (FAO, 1996). However, its weaknesses are due to its reliance on the subject's memory, its requirement for a trained interviewer, and the difficulty in estimating amounts consumed (FAO, 1996). Estimating the amount of food consumed is a complex cognitive task. Common foods and main course items are more easily recalled than less common foods, although visual aids and non-directive prompts have been shown to be vital in gaining maximum recall of dietary intake (Livingstone, Robson, & Wallace, 2004). Multiple 24-hour recalls on non-consecutive days are required to estimate the habitual intake of nutrients (Gibson, 2005).

Overall, the food diary and 24-hour recall methods depend on the ability of the participant to provide accurate information. Nelson et al. (1997) reported the reliability or repeatability of 24-hour recalls to generally be good.

Typically, both dietary recalls and food diaries should include weekdays and weekend days. The variability of daily intakes may be high because of different intakes during the days of the week and weekend days. The inclusion of one weekend day when using these methods may prove to be beneficial as weekend consumption has been shown to differ from weekday intake for some respondents and specific nutrients (Larkin, Metzer, & Guire, 1991). Typically, the consumption descriptions from 24-hour dietary recalls and food diaries are incorporated into computer programs to obtain information on nutrient intake (Nelson et al, 1997).

Whichever method is chosen to estimate dietary intakes of individuals or groups, special considerations are always encouraged when using these methods with immigrant populations. Chinese immigrants, for example, have a unique system of cuisines and dining habits that are culturally unique from other cultures. Cultural knowledge and awareness of eating habits should be considered by health professionals when collecting the dietary information from Chinese respondents because usually they eat and share a meal from common plates placed in the center of the dining table at home. This may pose difficulties to both participants and researchers when it comes to measuring and estimating individually consumed amounts of food. To overcome some of these problems, visual aids such as 3-dimensional food models and eating utensils are therefore often complementarily used for this purpose (Lee et al., 1994; Lancaster et al., 2006). Also, the Chinese diet is usually composed of many stir-fried side dishes (with a carbohydrate staple, usually rice, noodles, or steamed buns) using oils and condiments as ingredients during cooking rather than as an added fat/condiments at the table. For this reason, respondents may find it difficult to estimate the amount of these items that were consumed (Kelemen et al., 2003). In the development and evaluation of cultural food frequency questionnaires for several immigrant groups in North America, Kelemen and colleagues assumed that the fat added to a Chinese stir-fry recipe was entirely consumed and did not

adjust for amounts that may have remained in the pot with cooking liquids (Kelemen et al., 2003).

Lastly, Chinese immigrants are a linguistically diverse ethnic group. In order to better facilitate the dietary assessment and ensure that consent is informed consent, the instructions and measurement tools (such as FFQ) are often translated into Chinese (traditional or simplified) (Lee et al., 1994; Lv & Cason, 2003; Lv & Cason, 2004; Kwok et al., 2009) and face-to-face interviews (such as 24-hour dietary recall) are usually conducted by bilingual (Mandarin-English or Cantonese-English) interviewers (Satia et al., 2000; Satia et al., 2001) for respondents with limited ability to read, write, and speak English. Even with these efforts, translation may sometimes pose challenges for the interviewers as there is not always an equivalent English word for a Chinese word or vice versa.

2.2 SODIUM-RELATED DIETARY BEHAVIOURS IN CANADA

a. The Global Burden of Hypertension

Globally, the reported prevalence of hypertension in the adult population varies widely, but the overall number of adults with hypertension worldwide was recently predicted to exceed 1.5 billion by 2025 (Kearney et al., 2004; Hajjar et al., 2006). Hypertension affects approximately 1 billion individuals worldwide (Bakris et al., 2008). Globally, hypertension is of great public health concern because hypertension is the single most important cause attributable to mortality (Ezzati et al., 2002). It is a key factor contributing in the development of cardiovascular and cerebrovascular diseases, and a major cause of stroke, myocardial infarction, heart failure and kidney diseases (Mohan, Campbell & Willis., 2009). Approximately two-thirds of all strokes and one half of all ischemic heart diseases are directly attributable to hypertension (Lawes et al., 2006). The high and rising rate of cardiovascular diseases (CVD) coupled with the aging population calls for a closer examination of how we study and control salt consumption.

In economically developed countries, the prevalence of hypertension ranged between approximately 20% and 50 % (Hajjar et al., 2006; Brown et al., 2009). According to the data from the National Health and Nutrition Examination Survey (NHANES) 1999-2000, the prevalence of hypertension was 27.1% in men and 30.1% in women in the U.S. general population. The 1986-1992 Canadian Heart Health Survey (Kearney et al., 2004) reported a similar prevalence of hypertension as the NHANES 1999-2000 and estimated that 4.1 million Canadian adults aged 18-74 years had hypertension (Kearney et al., 2004). The most recent survey data, the 2007-2009 Canadian Health Measures Survey (CHMS) estimated that hypertension affects nearly one-fifth (19%, 4.6 million) of Canadian adults aged 20-79 years (Wilkins et al., 2010). The overall prevalence of hypertension was nearly the same in males (19.7%) and females (19.0%) and rose with age in both sexes (Wilkins et al., 2010).

In China, the prevalence of hypertension has increased dramatically during the past decades. The emergence of CVD, over-nutrition, and overweight caused by the rapid economic growth and associated socioeconomic and dietary changes has in large part been a result of this phonemonen (Gu et al., 2002). According to The International Collaborative Study of Cardiovascular Disease in Asia (InterAsia), 27.2 % of the Chinese adult population age 35-74 years old had hypertension, representing 129,824,000 persons (Gu et al., 2002). The prevalence of hypertension was higher in northern compared to southern China (Kearney et al., 2004).

According to the World Health Organization, interventions to reduce population-wide salt intake have been shown repeatedly to be highly cost-effective (WHO, 2006). In Canada, it has been estimated that if the average sodium intake is decreased by 1,840 mg/day (from the current average 3,400 mg/day)-roughly equivalent to bringing it down to the Adequate Intake (AI) of 1,500 mg/day (IOM, 2004)-hypertension prevalence would be decreased by 30% (Joffres et al., 2007; Health Canada, 2010). This would result in approximately

one million fewer hypertension patients and direct annual cost savings of $430 million due to fewer physician visits, laboratory tests and drug use (Joffres et al., 2007). It is also estimated that such a decrease in sodium intake would prevent 23,500 cardiovascular disease events per year in Canada, representing a decrease of 13% over current numbers (Joffres et al., 2007). Overall, using the most recent (1998) data available, it is estimated that the direct costs associated with cardiovascular diseases at that time were $6.82 billion and the indirect costs were $11.65 billion, for a total of $18.47 billion (Health Canada, 2010).

As a result of the high salt intake around the world, in 2003, the World Health Organization (WHO) set a worldwide target of 5g or less of salt (<2,000 mg sodium) per day, per person (Whitworth, 2003). Following release of the WHO recommendations, a number of countries launched initiatives to reduce the sodium intake of their populations. Finland started a successful salt reduction campaign as part of a comprehensive strategy to lower the high incidence of CVD in 1979. The strategy sought to improve the overall nutritional quality of the Finnish population's diet and increase physical activity levels. Work is still ongoing nationally in Finland and, in the case of sodium reduction, focuses on informing the public through extensive media campaigns and the mandatory labeling of high salt foods, as well as working with the food industry to reformulate foods on a voluntary basis. It is estimated that Finnish industry has reformulated a variety of product groups to reduce their salt content by about 20% to 25% (World Action on Salt and Health, 2009). This comprehensive approach has resulted in reduction in average sodium intake, from over 5,000 mg per day in 1980 to about 3,300 in 2002, which contributed to a significant decrease of more than 10 mm Hg in the Finish population average systolic and diastolic blood pressure, along with a 75% decrease in both stroke and coronary heart disease mortality (Reinivuo et al., 2006).

In the United Kingdom, the Scientific Advisory Committee on Nutrition set a target to reduce sodium intake in 2003 from a population average of 3,800

mg sodium per day to 2,400 mg sodium per day by 2012 (Food Standards Agency, 2009). The average daily intake of sodium decreased from 3,800 mg in 2001 to 3,440 mg in 2008 (FSA, 2009).The strategies to achieve the goal include a public campaign to raise consumer awareness of high salt intake and its bad influence on health and how to reduce intake; working with the food industry to reduce levels of salt in processed foods; and front-of package labeling to provide additional information to consumers on the levels of salt (and other nutrients) in food (FSA, 2009). Following Finland and the U.K., the U.S. and European Union have also undertaken initiatives to limit salt consumption with general approaches to reduce sodium intake at the population level to achieve the Institute of Medicine (IOM) or WHO recommendations (Health Canada, 2010).

In Canada, Health Canada established the Sodium Working Group to develop a population health strategy for reducing sodium intake among Canadians in 2007. As a result, the Sodium Reduction Strategy for Canada was released in 2010 and an interim sodium intake goal of a population average of 2,300 mg of sodium per day has been set to be achieved by 2016 (Health Canada, 2010). The strategy proposed is comprehensive and includes partnership with the food industry and restaurant and foodservice sector to set sodium reduction targets for processed foods in Canada.

Hypertension continues to remain a top public health concern. Some studies of immigrants have observed and demonstrated that residence in increasingly industrialized societies is associated with graded increases in the prevalence of hypertension (Marmot et al., 1976; Steffen et al., 2006; Yang et al., 2007). In a recent study, Kaplan et al found that there was a significant relation between Asian immigrants' length of residence in Canada and hypertension and suggested that different patterns in the prevalence of hypertension may be a result of changing of dietary practices, including meal patterns and food choices based on degrees of adaptation (Kaplan et al., 2002). The relationship of acculturation to the burden of hypertension draws the attention of public health

due to the fact that there are rising numbers of Asian immigrants, especially Chinese coming to Canada (Kaplan et al., 2002; Statistics Canada, 2008).

b. Impact of Dietary Sodium on Health

Epidemiologic, clinical, and experimental studies all suggest that ingestion of a diet habitually high in salt plays a role in the etiology and pathogenesis of elevated blood pressure and further hypertension (Brown et al., 2009). A causal relationship between dietary sodium intake and high blood pressure has been known since the first scientific evidence was published in 1960 showing a positive linear association (Brown et al., 2009). High levels of dietary sodium (consumed as common salt, sodium chloride) are considered to be established risk factors for the raised blood pressure and adverse cardiovascular health, which accounts for about 7.6 million deaths, or 13.5% of deaths, annually worldwide (Loria et al., 2009). Sustained reduction in dietary sodium is associated with favorable cardiovascular outcomes such as cardiovascular events (Cook et al., 2007).

Hypertension (high blood pressure) is one of the most common risk factors for cardiovascular and renal diseases (Brown et al., 2009). It is shown to be associated with increased risk of developing coronary heart diseases, stroke, congestive heart failure, and renal insufficiency (Loria et al, 2009). In addition to high sodium intake, other contributing risk factors to hypertension include high body weight, smoking, stress, sedentary life styles, physical inactivity, alcohol intake, and dietary patterns (Lee & Nieman, 2010). A number of studies have identified the beneficial effects plant-based diets have on blood pressure (Appel et al., 1997; Kotchen & McCarron, 1998). These study findings showed that blood pressure was significantly reduced with an eating plan that is low in saturated fat, cholesterol, and total fat and rich in fruits, vegetables, fat-free or low–fat milk and milk products. In other words, people consuming vegetarian diets tend to have a lower blood pressure than non-vegetarians. The vegetarian diet has been proven to be beneficial to reduce blood pressure because of its rich content of

potassium, calcium, magnesium, and dietary fiber (Appel et al., 1997; Kotchen & McCarron, 1998).

Restricting dietary sodium intake lowers blood pressure among individuals with and without hypertension, with larger effects in reducing blood pressure in people with hypertension (Sacks et al., 2001). Results from the 2004 Canadian Community Health Survey (CCHS) 2.2 Nutrition (Garriguet, 2007) indicate that over 85% of men and 60% of women had sodium intakes exceeding the recommended upper limit with an average intake of 3,092 mg[3]; estimates are that 15,000 Canadians are dying every year due to morbidity caused by excessive sodium consumption (Cassels, 2008). Interestingly, the CCHS data also show that a diagnosis of hypertension did not significantly affect the average sodium intake of adults over 30 years of age. People with hypertension had significantly higher average sodium intake compared to those who were normotensive (Shi et al., 2011). In Canada, reducing sodium consumption to the recommended levels would likely decrease the prevalence of hypertension by 30 %, reduce hypertension-related events by 8.6 % and save about 2 billion dollars annually in health care costs (the most recent data) even without considering the impact of other sodium-related health risks (Joffres et al, 2007). Also, Cook et al examined the implications of small reductions in diastolic blood pressure and estimated that a population-wide decrease of 2 mm Hg diastolic blood pressure would be estimated to lower the prevalence of hypertension by 17%, coronary artery disease by 6% and the risk of stroke by 15%, with many of the benefits occurring among people with normal blood pressure. The World Health Organization (2003) (Whitworth, 2003) has therefore estimated that reducing dietary sodium intake by 2.9 g salt from current daily intakes would lead to a 22% reduction in the number of deaths from strokes and a 16% reduction in the deaths from coronary heart disease worldwide.

[3] Actual sodium consumption is estimated to be approximately 3,400 mg per day since the survey did not include discretionary salt added at the table (6%) and during cooking of homemade meals (5%), which could increase the intakes by approximately another 11%.

However, despite abundant scientific evidence showing the positive association between high levels of sodium intake and adverse cardiovascular health, there have been disagreements about sodium reduction and its overall benefits to general public health. Controversies have arisen from related research showing that genetic influences could also play a role in causing hypersensitivity to salt consumption and that there are populations who are more salt-sensitive than others such as African American, elderly, and overweight people. These studies argue that population-wide sodium reduction would be more beneficial to salt-sensitive individuals and therefore is not an appropriate recommendation for the entire population (Siani et al., 2000; McCarron, 2007; Taylor et al., 2011). These disputes continue although it is not yet clear as to what defines a salt-sensitive response and nor is there a standard way to detect salt sensitivity (Strazzullo, 2001; McCarron, 2000).

A more recent study also reported controversial findings about sodium reduction on CVD mortality (Stolarz-Skrzypek et al, 2011). Stolarz-Skrzypek and colleagues found that among 3,681 subjects, those who excreted the least sodium in their urine (the standard measure of sodium intake, as sodium consumed in a day is mostly excreted in that day's urine) (Wilson et al, 2001) were more likely than those with the most sodium in their urine to experience adverse cardiovascular events. They concluded that excess sodium consumption might not raise risk of CVD. Many immediately criticized the study and argued that it had too few subjects and only accounted for a few cardiovascular events. The study results shouldn't be used to suggest any solid conclusions (Huget, 2011).

Given continued efforts to institute public health policy regarding sodium reduction throughout the years, it is of great concern whether controversial information such as studies mentioned above actually offers a true perspective to health professionals and to the population at large regarding the prevention and treatment of hypertension. Extra cautions should always be taken when

interpreting conclusions of any future studies in this area as mixed messages disseminated by media may easily confuse the general public.

c. Canadians' Sodium Consumption: Results from the 2004 Canadian Community Health Survey Cycle 2.2-Nutrition

i. Dietary Recommended Intakes (DRIs) for Sodium

Canada and the United States collaborated to establish nutrient reference levels that optimize health, prevent risk of chronic diseases, and avoid deficiencies (Gibson, 2005). The Dietary Reference Intakes (DRIs) were established to reduce the risk of chronic and degenerative diseases, establish an upper level of intake designed to avoid risk of adverse health outcomes, and to include components of food not conventionally considered to be essential nutrients but which may have a possible health benefit (Gibson, 2005). The DRIs consist of four components: Estimated Average Requirement (EAR), Adequate Intake (AI), Recommended Dietary Allowance (RDA), and Tolerable Upper Intake Level (UL) (IOM, 2004). The EAR is based on a specific criterion of adequacy, defined specifically by the biochemical measurement or function, which varies with the nutrient (Gibson, 2005). The UL describes the highest continuous daily intake of a nutrient that does not appear to carry risks of adverse health effects in most members of a given group, defined by stage of life and sex (Gibson, 2005). The ULs represent total intake from food, water, and supplements. The RDAs are the average daily dietary intake levels which are sufficient to meet the nutrient requirements of nearly 97%-98% of healthy individuals in a specific age and sex group (Gibson, 2005). Reaching or exceeding the AI denotes a low probability of inadequacy; AIs are used when the EARS are not defined for a specific nutrient (Gibson, 2005). It is important to note that DRIs do not have the ability to identify a single person as being at risk for inadequacy because the actual nutrient requirement of an individual is not known (Gibson, 2005). For this reason, a comparison of dietary intake with the DRI values can only be used to assess the quality of the intake of a group (Fitzgerald, 2002). With a group of

people, we can use the average intake in relation to the DRIs to assess whether there is risk of inadequacy in the respective group.

The IOM recommends the following AIs per day for sodium (Table 2-2):

- 1000 milligrams (mg) for children (both genders) aged 1 to 3 years
- 1200 mg for children (both genders) aged 4 to 8 years
- 1500 mg for people (both genders) aged between 9-50 years
- 1300 mg for adults (both genders) aged 51-70 years
- 1200 mg for seniors (both genders) over 70 years of age

Because no sufficient scientific evidence is available to establish an EAR, and thus calculate a RDA, only AIs for sodium are defined. The IOM has also established a UL which ranges from 1500 mg to 2200 mg of sodium per day for children and adolescents aged 1 to 13 years, up to 2300 mg per day for people aged 14 years. Consumption exceeding these limits increases the risks of adverse health effects, especially those linked to hypertension (IOM, 2004).

ii. Canadians' Overall Sodium Intakes

Information on Canadians' sodium consumption was gathered as part of the 24-hour dietary recall component of the 2004 CCHS 2.2 Nutrition (Garriguet, 2007). Survey respondents were asked to list all foods and beverages consumed during the 24 hours before the day of their interview; specifically, from midnight to midnight. A sub-sample of the population responded to second 24-hour recall a few days later to help assess the day-to-day variation in an individual's food/beverage intake. The proportion of the population exceeding the UL for sodium was estimated from the data collected during the two interviews using the Software for Intake Distribution Estimation program (Dodd et al., 1996; Nusser et al., 1996). However, it is important to note that the amount of salt people added to their food was not actually measured by the CCHS, and it was not included in daily sodium intake. Actual sodium consumption is estimated to be about 3,400 mg with another 11% from the discretionary salt added at the table and during cooking counted (Health Canada, 2010).

Adequate sodium is needed for normal blood volume control and helps cells function properly. Yet, according to the 2004 CCHS, most Canadians consume far more sodium than is recommended (IOM, 2004). The 2004 CCHS (Figure 2-2) (Garriguet, 2007) shows that, regardless of their age, Canadians' average daily intake of sodium is far beyond the recommended ULs beyond which health risks increase. Males consume more sodium than females, with intakes above 4000 mg/day (d) for those aged 14-30 years and intakes between 3300-3600 mg/d for those aged 31-70 years. The average sodium intakes are slightly less for seniors over 70 years of age at approximately 2800 mg/d for males and 2300 mg/d for females. Among people aged 19-70, over 85% of males and approximately 60-80% of women have usual sodium intakes that surpass the recommended ULs, with the average being 3092 mg/d. That high figure does not take into account salt added at the table and stove and does not adjust the tendency of underestimation by survey respondents. Also, the survey reported that by age 9, children were beginning to adopt the dietary behavior of adding salt to food.

Sodium consumption exceeds the recommended levels throughout the country, but two provinces stand out. In Quebec and British Columbia, the average daily intake for residents aged 1 or older in 2004 was more than 3300 mg compared to the population mean of 3092 mg for Canadians l (Garriguet, 2007). The average sodium intake for Alberta, of 3041 mg, was slightly above the Canadian average (Garriguet, 2007).

iii. Methods to Measure Dietary Sodium Intakes

There are many challenges to measuring sodium in the diet. Some specific problems include: quantifying accurately the amount of salt added during cooking (including at restaurants) and at the table given that there is variation in the proportion of salt added during cooking that is retained by the food (i.e., salt left behind on the plate or in the cooking water) and variation in the sodium content of manufactured foods. Common measurement approaches

for dietary sodium intakes range from objective measures such as a 24-hour urine sodium to subjective ones such as dietary self-report through 24-hour recall or food diaries and food records.

The most objective indicator of dietary sodium intake currently available is measuring urinary excretion of sodium. In a healthy individual, skin losses of sodium are very little and therefore 24-hou urine is the typical route (account for as much as 95% to 98% of dietary sodium intake) of sodium excretion (Wilson et al., 2001; Bentley; 2006). However, the within-person variance in sodium excretion can be as high as 30% making it difficult to precisely estimate sodium intake on a consistent basis (Wilson et al., 2001; Bentley, 2006). Therefore, multiple observations can help assist in increasing precision in the overall mean for individuals. Depending on the study, the smaller the sample size the more days the 24-hour urine collection is required to achieve better precision (Bentley, 2006). Data from studies with standardized methods, such as INTERSALT (International Study of Electrolyte Excretion and Blood Pressure), INTERMAP (International Study of Macro-/Micro-nutrients and Blood Pressure), and national surveys demonstrate that sodium excretion estimates are reproducible at the population level, though there is well-known marked intra-individual variability (reflecting day-to-day variation in a person's sodium intake) at the individual level (Brown et al., 2009).

The 24-hour urine may be used to validate the accuracy of dietary assessment methods (Bentley, 2006). However, the 24-hour urine is expensive and cumbersome in terms of sample collection (Nelson, 1997; Herbert et al., 1997). Incomplete collections may be especially problematic. Collections known to be incomplete become even more expensive and time consuming when they have to be repeated. Even more costly are collections not identified as incomplete because they can alter study results (Bentely, 2006).

Another method used to assess dietary sodium intake is a food diary or food record (Nelson et al, 1997). In this method, subjects are taught to describe

and give an estimate of the portion size or weight of all foods and beverages consumed for a specific time frame (FAO, 1996). Information about the weight of food eaten may be obtained either by requesting individuals to physically weigh the food or to describe portions of food in terms of household measures, pictures, food models, or package sizes (Bentley, 2006). One advantage of the food record is that it is prospective. A weighted food record is the most precise and accurate method available for estimating usual food and nutrient intakes at the individual level (Gibson, 2005).This allows direct observation of the current diet, and lengths of recording can be varied to suit study needs (Gibson, 2005). An advantage of the multiple-day food diary is that it allows evaluation of within-subject variation (Bentley, 2006). The primary disadvantages include the need for a high degree of motivation. Misreporting of foods and portion sizes consumed is common (Nelson, 1997; Hebert et al., 1997; Kristal et al., 1998; Espeland et al., 2001). These methods do not rely on memory and allow for a relatively easy means for quantifying amounts consumed (FAO, 1996). Nevertheless, it does require a high level of participant burden, literacy, and most importantly, may alter intake behavior, which may contribute to its ineffectiveness in some populations (FAO, 1996).

The third method that will be described is the 24-hour recall. This method may be an interview or written information concerning the previous day's intake. The 24-hour dietary recall consists of the listing and quantification of foods and beverages consumed in the previous 24 hours. Food types and their amounts are recalled from memory with the aid of a trained interviewer (FAO, 1996). The primary advantages of the 24-hour recall are its speed and ease of administration (Gibson, 2005).Large numbers of participants may be interviewed at a manageable cost (Espeland et al., 2001). Compliance is usually good because only a small amount of information is required from each subject (Gibson, 2005). The 24-hour recall is appropriate for measuring current diet in groups of subjects and is therefore well suited to studies where differences between group means

will be assessed (Gibson, 2005; Bentley, 2006). Multiple 24-hour recalls on non-consecutive days are required to estimate the habitual intake of nutrients (Gibson, 2005; Bentley, 2006). The 24-hour recall may be administered by telephone or face-to-face interview. In this approach, there is little respondent burden, no literacy requirement, and it is not likely to alter intake behavior (FAO, 1996).

The 24-hour recall also has several disadvantages when measuring nutrient intake. The primary disadvantage is that the 24-hour recall does not provide a reliable estimation of intake because of day-to-day variation (Bentley, 2006). Another disadvantage is cost. This method may be expensive because the wide variety of food consumed requires estimation of portion sizes and individual computer coding. Estimating the amount of food consumed is a complex cognitive task (Bentley, 2006). Common foods and main course items are more easily recalled than less common foods, although visual aids and non-directive prompts have been shown to be vital in gaining maximum recall of dietary intake (Livingstone, Robson, & Wallace, 2004). The 24-hour recall becomes even more expensive if multiple 24-hour recalls are required. In addition, this approach it heavily relied on the subject's memory and interviewers must be adequately trained in the technique, as it may be easy to bias responses through ill-judged or leading questions or by failing to probe adequately for food consumption not spontaneously mentioned (Bentley, 2006). The interviewer must be able to speak the subject's native language and be familiar with the food habits of the population from which the sample has been drawn (Nelson, 1997; Gibson, 2005; Bentley, 2006)

Overall, both dietary recalls and food diaries should include weekdays and weekend days. The variability of daily intakes may be high because of different intakes during the week and weekends. The inclusion of one weekend day when using these methods may also prove to be beneficial, as weekend consumption has been shown to differ from weekday intake for some

respondents and specific nutrients (Larkin, Metzer, & Guire, 1991). Typically, the consumption descriptions from 24-hour dietary recalls and food diaries are then incorporated into computer programs to obtain information on nutrient intake (Nelson et al., 1997). Because a large proportion of the population tends to eat away from home, restaurant and processed foods are highly represented (Champagne & Lastor, 2009). It is crucial to recognize differences or changes in the sodium content of the dietary databases on nutrient composition of foods. Although knowing the variability of sodium content in foods is essential, it does not seem feasible to capture the sodium content of every food and beverage in the market in the nutrient databases (Champagne & Lastor, 2009). However, updates need to be made if sodium is the nutrient of interest. The food diary and 24-hour recall methods depend on the ability of the participant to provide accurate information. Nelson (Nelson et al., 1997) reported the reliability or repeatability of 24-hour recalls to generally be good. However, a valid external measure would be ideal to assess the validity of these measurements. A 24-hour urine, if correctly collected, is often used as an external measure to validate these measures (Caggiula et al, 1985; Espeland et al., 2001).

iv. Sodium Food Sources in the Canadian Diet

Sodium is primarily consumed in the form of sodium chloride (Garriguet, 2007). A US study that examined the relative contributions of dietary sodium in 62 participants using seven-day food records estimated that 90% of sodium intake comes from sodium chloride, which is typically obtained from table salt (Mattes & Donnelly, 1991). Study results show that processed foods are the main sodium source, contributing to 77% of average daily sodium intake. The remaining 23 % comes from both sodium naturally occurring in foods (12%) and salt added during cooking (6%) or at the table (5%) (Mattes & Donnelly, 1991).

The 2004 CCHS (Figure 2-3) (Garriguet, 2007) showed that 19% of all sodium that Canadians consume comes from pizza, sandwiches, submarines, hamburgers and hotdogs. The key food group contributors of sodium in the

Canadian diet are breads (13.4%), processed meats (8.9%), soups (7.4%), tomatoes (vegetables) and vegetable juice (7.6%), pasta dishes (5.7%), cheese (5.4%), liquid milk/milk-based beverages (4.0 %), potatoes (3.4%), and sauces (2.9%) (Fischer et al., 2009). It is important to note that the 2004 CCHS did ask respondents about "salt added to their foods", but did not quantify the intakes. Although it is estimated that approximately 6% of sodium is added at the table as salt and 5% of sodium is added during cooking of home-made meals (Mattes & Donnelly, 1991), the actual discretionary table salt added in the home was not measured in the survey.

For males aged 19 years and older, their important sodium sources were breads (508 mg/d), processed meats (355 mg/d), and pasta dishes (185 mg/d). For females aged 19 years and older, breads again were the leading contributor (379 mg/d), followed by vegetables (191 mg/d), and processed meats (184 mg/d) (Fischer et al., 2009). Breads are the major source of sodium, providing 14.2% for males older than 19 years and 14.1% for females older than 19 years. For males aged 19 years and older, this is followed by processed meats (9.8%, 10.2%, and 9.9%, respectively), whereas for females aged 19 years and older, this is followed by vegetables (6.9%). Pasta dishes (5.2%) and processed meats (6.9%) rank third respectively for males aged 19 years and older and for females aged 19 years and older (Garriguet, 2007).

Although, breads are found to be major contributors of sodium, this is mainly because of the large number of servings consumed, rather than a high concentration of sodium in each serving of bread. Higher-sodium foods such as processed meats are eaten in smaller quantities but, because of their sodium density, contribute significant amounts of sodium to the diet of Canadians. Some very high sodium foods, such as frozen dinners, are eaten by only a small portion of the population, but for those consuming these products, the sodium could contribute a significant portion of the UL just from a single meal.

Salt is added to foods primarily as a flavour enhancer. It also serves as a preservative, dough conditioner, and solid carrier for spices. In addition, it helps maintain the texture and improve the enzyme activity (in the maturation of cheese) and water-holding capacity of certain products (Man, 2007). However, more people in Canada are consuming commercially-processed foods because of the increased availability, accessibility, and convenience of these foods. Today , more than half of dietary sodium in the Canadian diet derives from commercially-prepared foods. To remove excess sodium from the diet, the U.S. National Heart, Lung, and Blood Institute suggests levels of sodium content of commercially processed products must be reduced and that a 50% reduction of sodium in these foods would save up to 15,000 lives per year (Havas et al., 2004). Individual efforts to reduce salt intake are limiting and it is impossible to avoid processed foods such as fast foods and prepackaged foods entirely from their current diet in order to meet the sodium recommendations (Anderson et al., 2010). Because of this, a public health approach involving restaurants and food industry sectors plays a major role in determining levels of salt in foods.

d. Cultural Differences in Sources of Sodium in the Northern American and Chinese Diets

In the typical European and Northern American diets, an estimated 75% of sodium intake comes from processed or foods eaten away from home (restaurant-prepared); 10-12% occurs naturally in foods; and a similar proportion is from discretionary use at home or at the table; salt added during cooking (6%) or at the table (5%) (James et al., 1987; Mattes & Donnelly, 1991; Fodor et al., 1999). In other words, the largest quantities of salt now consumed in North America originate from industrially-processed foods. Only 13-15 % of total dietary sodium consumption is discretionary or consumer-controlled through the addition to food after its preparation. The rest is derived from naturally occurring sources and or commercial processes. According to the 2004 CCHS - Nutrition (Garriguet, 2007; Fischer et al., 2009) more than half (55%) of dietary

sodium Canadians consume is derived from commercially-prepared foods such as breads (13.4%), processed meats (8.9%), soups (7.4%), tomatoes (vegetables) and vegetable juice (7.6%), pasta dishes (5.7%), cheese (5.4%), liquid milk/milk-based beverages (4.0 %), potatoes (3.4%), and sauces (2.9%). Therefore, sodium is often "hidden" in foods and individuals are unaware of the amount of sodium they consume. Personal efforts to reduce salt intake may be difficult because of the large quantities of salt found in processed foods. However, a quite different picture with regard to dietary sources of sodium is apparent for the traditional Chinese food environment, where sodium in the diet mainly comes from discretionary use of salt, that is, salt added through cooking or from sauces (Brown et al., 2009).

In China, discretionary use of salt which refers to sodium-rich condiments such as cooking salt, soy sauce, and monosodium glutamate (MSG), has been identified as the major source of dietary sodium in traditional Chinese food (Tian et al., 1996). The percentages of sodium coming from discretionary salt were reported to be 88% and 63% for rural and urban China respectively (Tian et al., 1996). In rural farming populations in China, salt is still used traditionally for preservation and storage of foods (e.g., salting of vegetables, eggs, and meats) where home refrigerators are not widely available (Anderson et al., 2010). However, widespread acquisition of home refrigerators is making these practices dispensable. The INTERMAP study found extensive use of salt (75.8%) in home cooking and at the table in the People's Republic of China. Soy sauce accounted for about 9.9% and 5.5% of total sodium intake in Southern and Northern China, respectively (Anderson et al., 2010). Mustard, turnip greens, and cabbage (3.6%), sodium bicarbonate/carbonate (tenderizers) (2.5%), noodles and buns (such as mantou) (3.8%), and salted eggs (0.8%) were minimal contributors to dietary sodium. From the results of Nutrition and Health Survey 2001-2002 (NAHSIT) in Taiwan, discretionary use of salt (29.7%), seasoning spices and pickles (11.3%), and soy sauce (8.7%) accounted for almost 50% of

sodium intakes coming from food sources showing that the discretionary use of salt (which refers to sodium-rich condiments such as cooking salt, soy sauce) was the major source of dietary sodium in traditional Chinese eating practices (Wu et al., 2007). Similar to the 2004 CCHS data, noodles/steamed buns/wheat products (11.5%) and soups (9.6%) were moderate contributors to total sodium intake in both typical traditional Chinese and North American diets (Wu et al., 2007; Garriguet, 2007; Fischer et al., 2009).

Overall, these sodium studies of Chinese living in Asia indicate that the Chinese diet consumed in Asian countries differs from the Canadian diet for sources of sodium. Primarily it is because the Chinese diet (consumed in Asia) has notably higher sodium intake from discretionary consumption (e.g., salt or soy sauce added during cooking) and a lower portion of dietary sodium from processed or restaurant-prepared foods than what is observed in the typical North American diet. Yet, little is known whether these sources change when Chinese individuals immigrate to Canada and start incorporating Canadian foods in their diet and while still retaining some of their own. Extensive research indicates that reduced sodium intake lowers cardiovascular events and is the most efficient strategy for both preventing and treating hypertension (Chang et al., 2006; Cook et al., 2007). Given there is little information about food sources of sodium consumed by Chinese in Canada, more research is required in this area to enable dietetic practitioners and nutrition educators to better educate Chinese Canadians about healthy food choices.

2.3 CALCIUM- AND VITAMIN D-RELATED DIETARY BEHAVIOURS IN CANADA

a. Calcium and Vitamin D nutrition

Calcium and vitamin D are essential nutrients that are needed throughout the life cycle to promote bone health by increasing peak bone mass during childhood and adolescence, minimizing age-related bone loss, and

thereby decreasing the risk of osteoporosis, bone fractures, and other health problems (Heaney, 2007; Holick, 2007). A low intake of these nutrients may increase the risk for osteoporosis, bone fracture and other health problems. It is clear that inadequate calcium intake may impair skeletal integrity, nerve impulse transmission, maintenance of membrane potential, and muscle contraction (Leachman-Slawson et al., 2001). Long-term calcium and vitamin D deficiency can lead to rickets and in the case of a menopausal woman, it can lead to osteoporosis, in which the bone deteriorates and there is an increased risk of fractures (Jackson et al., 2001). While a lifelong deficit can affect bone and tooth formation, over-retention can cause hypervitaminosis D (elevated levels of vitamin D in the blood) and hypercalcemia (elevated levels of calcium in the blood), impaired kidney function and decreased absorption of other minerals (Nicklas, 2003). Inadequate calcium intake has also been found positively associated with obesity, colon cancer, and hypertension (Nicklas, 2003).

It is important to note that the causes of osteoporosis are so far not completely understood by science. Although calcium and vitamin D are essential nutrients for optimal bone health, low intakes of these nutrients do not necessarily increase one's risk of developing osteoporosis. In addition to low calcium intake and poor vitamin D status, other contributing factors to osteoporosis include ethnicity, family history, insufficient weight-bearing exercise, smoking, high alcohol consumption, and low levels of estrogen in women and testosterone in men (National Institute of Health, 2011). Among ethnic groups, Chinese people have a comparatively higher risk of low bone mineral density (BMD) and osteoporosis (Lau, 1997; Lauderdale et al., 2003; Babbar et al., 2006) possibly due to their overall low calcium intakes (Pun et al., 1997; Pan et al., 1999; Lu, 2000; Ma et al., 2007). Studies on Chinese immigrants in Chicago and New York have found high rates of low BMD and osteoporosis especially among the elderly and Chinese immigrant women (Lauderdale et al., 2003; Babbar et al., 2006). Data from the National Osteoporosis Risk Assessment

Initiative in 1990s in the U.S. (Kittler & Sucher, 2004) indicated that almost 8% of Asian American women, 7% of whites, and 4% of blacks had osteoporosis. At every age group, Asians had the lowest BMD and blacks had the highest.

However, when adjusted for weight, age, and other risk factors, the researchers reported the relative risk factors for fracture was lowest in Asians and highest in whites. Among Asians, Chinese Americans had the lowest incidence of hip fracture compared to whites. Overall, the U.S. Asian women have high rates of low BMD and osteoporosis but fewer hip fractures than U.S. white women, with Chinese Americans having the lowest incidence compared to whites (Lauderdale et al., 1997; Ross et al., 1991; Kittler & Sucher, 2004). Moreover, in a recent study, Bow and colleagues further confirmed that, although the risk of hip fractures in Asian men and women was low (less than half of that in Caucasians), Asian men do however have a vertebral fracture risk similar to Caucasian men, and Asian women have an even higher clinical vertebral fracture risk than Caucasian women (Bow et al., 2011). The study followed up 4,112 Southern Chinese people (56% women) aged 50 years and older, who were participating in the Hong Kong Osteoporosis Study, for a mean period of 4 years. From this evidence, it is controversial to draw solid conclusions about the association between low calcium intake, low BMD, osteoporosis, and low hip fracture rates as observed in Chinese population since other factors, such as genetic and lifestyle factors seem to also play a critical role in their relations to one and another (Lau, 1997).

Vitamin D deficiency is common in situations when cutaneous production and dietary intake are compromised (Gozdzik et al., 2008). In the past years, there has been an increasing interest in the function and role of vitamin D in health and disease. This includes many functions beyond its role classically associated with bone health and extends to other perspectives in chronic disease, inflammation, and the immune system. Vitamin D plays a critical role in many cellular and immunological pathways (Nicklas, 2003). Low levels of vitamin D

have been associated with various chronic diseases including cancers, autoimmune diseases, diabetes, osteoporosis, cardiovascular disease, and microbial infections (Vieth et al., 2002; Rucker et al., 2002; Roth et al., 2005; Gozdzik et al., 2008). Vitamin D nutrition is unique among vitamins and minerals because it varies by environment. Its status is affected by latitude, culture, and food fortification legislation (Holick, 2007). Therefore, it is difficult to define the source of vitamin D because vitamin D is synthesized in the skin through a photolytic process upon exposure to the sun's ultraviolet light or is obtained from dietary sources (Vieth et al., 2002). The determinants of vitamin D status can be multifactorial but the most important factor affecting endogenous vitamin D synthetic levels is sunlight exposure and skin's susceptibility to form endogenous vitamin D. This effect is constantly demonstrated by seasonal variations in vitamin D levels.

Several other factors can affect vitamin D concentrations, including: 1) skin pigmentation (melanin, the major natural pigment in the skin, interferes with cutaneous production of vitamin D) (Gozdzik et al., 2008; Mathal et al., 2009); 2) age (the skin loses the ability to synthesize vitamin D with increased age) (MacLaughlin et al., 1985; Ginde, Liu & Camargo, 2009); 3) weight (higher adiposity has been associated with lower vitamin D levels) (Holick, 2007; Mithal et al., 2009); 4) deliberate avoidance of sun exposure and/or use of sunscreen, being indoors, and clothing coverage (due to sun safety or cultural reasons) (Holick, 2007); 5) mal-absorption disorders which affect the body's ability to absorb vitamin D (including celiac disease, Crohn's disease, and cystic fibrosis) (Lo et al., 1985); 6) diseases and disorders of the kidneys and/or liver that affect vitamin D metabolism (Holick, 2007) and 7) seasonal variation is exhibited among many races, ages, and countries (Rucker et al., 2002; Roth et al., 2005). For many people, exposure of their skin to ultra violet B is the primary source of their vitamin D. However, at latitudes far from the equator, such as Canada, the

amount of UVB available from sunlight during the winter months is inadequate to allow cutaneous vitamin D synthesis (Rucker et al., 2002).

b. Vitamin D status of Canadians

Circulating plasma 25-hydroxyvitamin D concentrations are the best clinical indicators of overall vitamin D adequacy and represent the combined contributors of cutaneous synthesis and oral ingestion of dietary sources of vitamin D, including vitamin D_2 (ergocalciferol) from plants and fungi and vitamin D_3 (cholecalciferol) from animal sources (Langlois et al., 2010). There is some evidence that vitamin D_2 may not be used in the body as efficiently as vitamin D_3 (Hanley et al., 2010). In Canada, both vitamin D_2 and D_3 can be found in fortified foods and over-the-counter supplements with vitamin D_3 used most often in vitamin D supplements (Hanley et al., 2010). Although there is an emerging controversy over the exact serum concentrations distinguishing vitamin D sufficiency from vitamin D insufficiency (Langlois et al., 2010; Slomski et al., 2011), it is clear that health professionals are becoming more aware of the link between low concentrations of 25-hydroxyvitamin D and increased risks of chronic diseases, including diabetes mellitus, cancer, autoimmune disorders, and osteoporosis (Dawson-Hughes et al., 2005; Holick, 2007; Vieth et al., 2007).

Many studies have identified a high prevalence of vitamin D insufficiency in healthy adults living in Canada (Vieth et al., 2001; Rucker et al., 2002; Roth et al., 2005; Lappe et al., 2007; Holick, 2007), particularly during the winter when skin synthesis of vitamin D is severely limited or non-existent. Hence, the population is reliant on dietary sources of vitamin D (Vatanparast et al., 2009). However, it is important to note that these studies did use several different cut-off values to assess the prevalence estimates of vitamin D insufficiency (Calvo et al., 2003). In 1999, Rucker et al (Rucker et al., 2002) examined the serum 25-hydroxyvitam levels in 188 Canadian adults (men and women aged 27-89 years) in Calgary throughout four seasons. Prevalence of vitamin D insufficiency (defined as serum 25-hydroxyvitamin D levels below 50

nmol/L) was found among more than 60 subjects during the spring, fall, and winter seasons. In another more recent Canadian study, Vieth and colleagues (Vieth et al., 2001) assessed the vitamin D status (through the serum 25-hydroxyvitam levels) in 796 women (89.7% were white). They found, for non-white women, primarily Asian (10.3 %), there was a much higher prevalence of vitamin D insufficiency (defined as serum 25-hydroxyvitamin D levels below 40 nmol/L) during winter (32%) and summer (17%) than for their white counterparts. Vieth and colleagues also reported that participants' vitamin D intake from fortified milk was not enough to maintain their vitamin D status in winter when skin production of vitamin D was compromised.

The results from the 2007-2009 Canadian Health Measures Survey (CHMS) (n=5,306) (Poliquin et al., 2009) showed that about 4% of the Canadian population aged 6 to 79 years (5% of men and 3% of women) had serum 25-hydroxyvitamin D levels indicating vitamin D deficiency (defined as serum 25-hydroxyvitamin D levels below 27.5 nmol/L), and more than 10% did not have adequate concentrations (defined as serum 25-hydroxyvitamin D levels over 37.5 nmol/L) for optimal bone health based on the 1997 IOM standards. However, 35% were found above the cut-off (serum 25-hydroxyvitamin D concentrations over 75 nmol/L) suggested in some studies as desirable for overall health and disease prevention (Poliquin et al., 2009). Women were found more likely than men to have adequate concentrations. Serum 25-hydroxyvitamin D concentrations measured in the winter and spring (between November and March) were lower than those measured in the summer and fall (between April and October) (Poliquin et al., 2009). White racial background and frequent milk consumption were found significantly associated with higher serum 25-hydroxyvitamin D concentrations (Poliquin et al., 2009).

The importance of ethnicity has also been demonstrated by other reports on vitamin D status, where persons with darker skin color (i.e., higher skin melanin levels) had lower vitamin D status (Holick, 2005; Giovannucci, 2005;

Gozdzik, 2008). Individuals of European ancestry have a lower risk of vitamin D insufficiency because they have low cutaneous melanin levels (Holick, 2005; Giovannucci, 2005). It is well known that melanin interferes with the production of vitamin D in the skin and that individuals with darker skin pigmentation are at increased risk of vitamin D insufficiency (Holick, 2005; Giovannucci, 2005). In a recent study, Gozdzik et al indicated that the mean total vitamin D intake from food and supplements in individuals of East Asian ancestry was lower than the current Health Canada recommendation for young adults of 15 micrograms (µg)/day (Gozdzik, 2008; IOM, 2011). The study results also suggested that those at greatest risk of vitamin D insufficiency were consuming the lowest amounts of vitamin D in their diet and/or supplemental sources (Chen et al., 2007).

A recent Institute of Medicine's report (Ross et al., 2011) on calcium and vitamin D indicates that the prevalence of vitamin D inadequacy in the North American population has perhaps been overestimated because of the inappropriate use of serum 25-hydroxyvitamin D cut-off points. The cut-off points used in several studies have exceeded the levels identified in this report. According to the report (Ross et al., 2011), the EAR is 10 µg/day for ages older than 1 year and the RDA is 15 µg/day for ages 1 to 70 years and 20 µg/day for 71 years and older, corresponding to serum 25-hydroxyvitamin D levels of 40 nmol/L for EARs and over 50 nmol/L for RDAs. Higher serum 25-hydroxyvitamin D levels are stated to not be consistently associated with greater overall health benefits. There has been emerging evidence that observes health risk when serum concentrations of 25-hydroxyvitamin D are exceeding 375 nmol/L (Holick, 2007; Langlois et al., 2010). Elevated levels of vitamin D in the blood can cause hypervitaminosis D or vitamin D intoxication, whereby calcium is over-absorbed and retained in the body (hypercalcemia) (Nicklas, 2003). Prolonged hypercalcemia eventually leads to calcification of soft tissues (such as kidney, lungs, and blood vessels) and damages nervous, renal, and cardiovascular functions (Holick, 2005). Loss of appetite, nausea, vomiting, kidney stone, and

plaque formation are commonly seen clinical health outcomes associated with hypervitaminosis D (Holick, 2005). In order to prevent both under-treatment and over-treatment, there is an urgent need for evidence-based consensus cut-off points for serum 25-hydroxyvitamin D for deficiency and inadequacy.

c. Calcium status of Canadians

Adequate intake of calcium is essential to overall health. However, a study (Vatanparast et al., 2009) that examined Canadians' overall calcium intake from various nationwide and provincial survey data suggests that many adult Canadians are not meeting current calcium recommendations from food and supplement use. Vatanparast and colleagues have investigated and determined trends in calcium intake from foods of Canadian adults from 1970-1972 to 2004 using data from the Nutrition Canada Survey (1970-1972, n=7,036); 9 provincial nutrition surveys (1990-1999, n=16,915); and the 2004 Canadian Community Health Survey-nutrition (n=20,197) (Vatanparast et al., 2009). They found, calcium intake increased from 1970 to 2004. Yet, the increases in calcium intake were not significant with the calcium-fortified beverages being lawfully permitted to the market in the late 1990s. Also noting that calcium intake of males in every age category was greater than that of females. Calcium intakes across provinces were mostly similar in the 1990s and in 2004.

Overall, the mean calcium intake from foods from these surveys remained below the RDA value of 1000 mg/d for all adult age groups, except for young men (19-30 years). Young adult men were the only age group to have mean calcium intake (from food and supplements) exceed the RDA. However, only about half of them actually met the recommendation of 1000 mg/d for calcium. Because of the higher calcium intake from supplements in older females (over 50 years), there was a large increase in the percentage of older adults meeting the RDA when calcium intake from supplements was added to calcium intake from food sources (Vatanparast et al., 2009).

The latest survey data available on calcium intake from the CCHS indicates that national mean intakes from foods in 2004 were below the RDA recommendation (IOM, 2011) for women, especially those older than 51 years. The RDA for women over 50 years of age is higher than for younger women at 1200 mg/d. Overall, men had higher intakes (from foods only) than women in most age groups. However, the only exception was observed among older adult women (over 50 years) when their calcium intake from supplements was added to the total calcium intake. In sum, the calcium intake of Canadians needs to be improved because the (population) mean for calcium intake (from both food and supplement) fell below the recommended RDA. Older male adults are also at higher risk of calcium inadequacy because their calcium intake from supplements is lower compared to older women and their need for calcium is higher compared to other age groups.

d. Methods to Measure Dietary Calcium and Vitamin D Intakes

Dietary calcium and vitamin D intakes can be estimated through the use of various tools, which differ depending on study objectives, design and resources (Pritchard et al., 2010). Common measurement approaches for dietary calcium and vitamin D intakes include objective measure such as biochemical indicator, 25-hydroxyvitamin D for assessing vitamin D status and subjective measures such as food frequency questionnaires (FFQ), 24-hour recall, and food diaries or food records.

Whether vitamin D is produced in the skin or ingested, vitamin D is subsequently circulated and metabolized in liver and kidney to form its biologically active form in the blood, calcitriol (1, 25-dihydroxyvitamin D). Calcitriol is the hormone regulating the homeostasis of calcium and phosphorus in the human body (Hanley et al., 2010). However, the levels of 1,25-dihydroxyvitamin D are not the best indicator of vitamin D status due to its short half-life (about 15 hours) and the fact that it is tightly regulated by parathyroid hormone and is therefore easily affected by many metabolic disorders (e.g.,

disorders in calcitriol synthesis and calcium/phosphorus metabolism). Instead, serum 25-hydroxyvitamin D, the intermediate metabolite of vitamin D, is most commonly used to determine an individual's vitamin D status. It has a longer circulating half-life (about 60 days) than 1,25-hydroxyvitamin D and reflects vitamin D synthesized in the skin and obtained from food sources and supplements (Hanley et al., 2010; NIH, 2011). In addition, the serum 25-hydroxyvitamin D levels may also be used to validate the accuracy of dietary assessment methods of vitamin D (Hanley et al., 2010).

A blood sample taken from a non-fasting individual at any time of day is required for the measurement of 25-hydroxyvitamin D (Hanley et al, 2010). The 2007-209 Canadian Health Measures Survey (CHMS) was a large-scale (n=6016) study that examined the serum 25-hydroxyvitamin D concentrations in the Canadian population aged 6 to 79 years to assess their vitamin D status (Langlois et al., 2010). However, the serum 25-hydroxyvitamin D method is expensive and may be problematic given that there is variability in results of laboratory analyses and techniques available for measuring serum 25-hydroxyvitamin D. Falsely low or high values might be obtained depending on the particular test or laboratory used (Hanley et al., 2010).

There is not yet an ideal biochemical indicator for dietary calcium intake of wide use in epidemiological surveys (Sato et al., 2005; Chung et al., 2009). The chemistry analysis of a duplicate meal consumed by each study subject gives an accurate estimate of calcium intake, but is not feasible in large scale epidemiological surveys (Sato et al., 2005). However, data from national surveys with standardized methods, such as The National Health and Nutrition Examination Survey (NHANES) in the United States and Canadian Community Health Survey (CCHS) rely on the 24-hour recalls for measuring total calcium and vitamin D dietary intakes from all sources (foods and supplements) along with other nutrients (IOM, 2011). The 24-hour dietary recall consists of the listing and quantification of foods and beverages consumed in the previous 24 hours. Food

types and their amounts are recalled from memory with the aid of a trained interviewer (FAO, 1996). However, the interviewer must be able to speak the subject's native language and be familiar with the food habits of the population for which the survey targets (Nelson, 1997; Gibson, 2005). The primary advantages of the 24-hour recall are its speed and ease of administration (Gibson, 2005). Large numbers of participants may be interviewed at a manageable cost (Espeland et al., 2001). Multiple 24-hour recalls on non-consecutive days are required to estimate the habitual intake of nutrients (Gibson, 2005; Bentley, 2006). In this approach, there is little respondent burden, no literacy requirement, and it is not likely to alter intake behavior (FAO, 1996). However, its weaknesses lie upon its reliance on the subject's memory, its requirement for a trained interviewer, and the difficulty in estimating amounts consumed (FAO, 1996). Common foods and main course items are more easily recalled than less common foods, although visual aids and non-directive prompts have been shown to be vital in gaining maximum recall of dietary intake (Livingstone, Robson, & Wallace, 2004).

Another method to assess dietary calcium and vitamin D intakes is the food frequency questionnaire (FFQ). Food frequency questionnaires are designed to estimate a large number of nutrients and generally include between 50 and 150 food items (FAO, 1996). For each item on the food list, the respondent is required to estimate the regularity of consumption based on specific frequency categories which indicate the number of times the food is usually consumed per day, week, month or year (FAO, 1996). Specifically, some combinations of foods can be used as predictors for intakes of certain nutrients or non-nutrients, provided that the dietary components are concentrated in a relatively small number of foods or specific food groups. Examples include the consumption frequency of dairy products as predictors of calcium intake (Barr et al., 2001) and margarine (mandatorily vitamin D-fortified in Canada), milk (both fluid and powdered forms), and plant-based beverages as predictors of vitamin D

intake (Pritchard et al., 2010). In addition to food items, information on calcium and vitamin D supplement use (frequency and amount) is also often collected from the FFQ in order to examine the total intake of these nutrients (Barr et al., 2001; Wu et al., 2009; Taylor et al., 2009; Poliquin et al., 2009; Pritchard et al., 2010). The 2004 CCHS (Brulé, 2010) survey shows that there is a high frequency of supplement use with 48% to 82% of Canadians reported taking a calcium supplement within the previous 30 days of the survey. In recent years, dietary supplements containing calcium and vitamin D have become more common and have been more frequently consumed (IOM, 2011). Typically, FFQ are used in a clinical screening setting or in epidemiologic studies to assess dietary intakes, often in relation to the development of a disease (Pritchard et al., 2010). The dietary information obtained from FFQs assists the examination of the relationships between diet and disease and biochemical and functional measures (Cade et al., 2002; Langsetmo et al., 2010). Regardless of the setting or purpose, the questionnaire should be validated and compared to a gold standard of evaluative protocols (i.e., a weighted food record). In particular, it should be country-specific, age-specific and include a comprehensive list of food items to capture the study population's eating patterns, food choices and diet variability (Wu et al., 2009; Taylor et al., 2009; Pritchard et al., 2010).

The fourth method that will be described is a food diary or food record. In this method, subjects are taught to describe and give an estimate of the portion size or weight of all foods and beverages consumed for a specific time frame (FAO, 1996). Information about the weight of food eaten may be obtained either by requesting individuals to physically weigh the food or to describe portions of food in terms of household measures, pictures, food models, or package sizes. A weighted food record is the most precise and accurate method available for estimating usual food and nutrient intakes at the individual level (Gibson, 2005). This allows direct observation of the current diet, and lengths of recording can be varied to suit study needs (Gibson, 2005). This method does not

rely on memory and allows for a relatively easy means for quantifying amounts consumed, therefore is accepted as the gold standard diet analysis technique (FAO, 1996). However, it does require a high level of participant burden, literacy, and most importantly, may alter intake behavior, which may contribute to its ineffectiveness in some populations (FAO, 1996). An advantage of the multiple-day food diary is that it allows evaluation of within-subject variation (Bentley, 2006). The primary disadvantages include the need for a high degree of motivation. Misreporting of foods and portion sizes consumed is common (Nelson, 1997; Hebert et al., 1997; Kristal et al., 1998; Espeland et al., 2001).

Overall, both dietary recalls and food diaries should include weekdays and weekend days. The variability of daily intakes may be high because of different intakes during the week and weekends. The inclusion of one weekend day when using these methods may also prove to be beneficial, as weekend consumption has been shown to differ from weekday intake for some respondents and specific nutrients (Larkin, Metzer, & Guire, 1991). Typically, the consumption descriptions from 24-hour dietary recalls, food records, and food diaries are then incorporated into computer programs to obtain information on nutrient intake (Nelson et al, 1997). The food diary and 24-hour recall methods depend on the ability of the participant to provide accurate information. Nelson (1997) (Nelson et al, 1997) reported the reliability or repeatability of 24-hour recalls to generally be good.

e. Canadians' Calcium Consumption: Results from the 2004 Canadian Community Health Survey Cycle 2.2-Nutrition

i. Dietary Recommended Intakes (DRIs) for Calcium

Health Canada is now recommending that Canadians follow new Dietary Reference Intakes (DRIs) for calcium, which are outlined in a recent report published by the U.S. Institute of Medicine (IOM). Based on the conclusions of almost 1000 published studies, the IOM has confirmed the synergistic effects of calcium along with vitamin D on maintaining bone health (avoiding poor bone

health) and promoting skeletal growth (Slomski, 2011). Because there was not enough scientific evidence supporting calcium's overall benefits on health when the previous recommendations were released in 1997, the IOM was only able to set an Adequate Intake (AI) range, which is an amount assumed to be adequate for a group of healthy people based on experimental approximations (Gibson, 2005). However, in this report, the IOM has for the first time, set the Recommended Dietary Allowances (RDAs), an intake level that meets the nutrient needs of 97-98% of the healthy individuals, for calcium (Slomski, 2011).

North Americans need from 700 to 1300 mg/d of calcium depending on age, according to the new recommendations (Table 2-3). The IOM (IOM, 2011) recommends the following RDAs per day for calcium:

- 700 milligrams (mg) for children (both genders) aged 1 to 3 years
- 1000 mg for children (both genders) aged 4 to 8 years
- 1300 mg for adolescents (both genders) aged between 9-18 years
- 1000 mg for adults (both genders) aged between 19-50 years
- 1000 mg for men aged 51-70 years; 1200 mg for women aged 51-70 years
- 1200 mg for seniors (both genders) over 70 years of age

Current Estimated Average Requirements (EARs) for calcium are:

- 500 mg for children (both genders) aged 1 to 3 years
- 800 mg for children (both genders) aged 4 to 8 years
- 1100 mg for adolescents (both genders) aged between 9-18 years
- 800 mg for adults (both genders) aged between 19-50 years
- 800 mg for men aged 51-70 years; 1000 mg for women aged 51-70 years
- 1000 mg for seniors (both genders) over 70 years of age

Current Tolerable Upper Intake Levels (ULs) for calcium are:

- 2500 mg for children (both genders) aged 1 to 8 years
- 3000 mg for adolescents (both genders) aged between 9-18 years
- 2500 mg for adults (both genders) aged between 19-50 years
- 2000 mg for adults over 50 years of age

ii. Canadians' Overall Calcium Intakes from Food Sources

Information on Canadians' calcium consumption was gathered as part of the 24-hour dietary recall component of the 2004 CCHS Nutrition. Survey respondents were asked to list all foods and beverages consumed during 24 hours before the day of their interview; specifically, from midnight to midnight. A sub-sample of the population responded to second 24-hour recall a few days later to help assess the day-to-day variation in an individual's food/beverage intake. Estimates of usual calcium intake from food were determined with the Software for Intake Distribution Estimation (SIDE) program (Barr, 2006) using data from at least two 24-hour recalls. The results from the CCHS indicate that the calcium intake of Canadian adults remains in need of improvement, despite fortification and supplement use (Vatanparast et al., 2009). According to the 2004 CCHS (Figure 2-4) (Health Canada, 2008; Vatanparast et al., 2009), Canadians' average daily intake of calcium from foods were below the RDA of 1000 mg per day for all age groups except for young men aged 19-30 years (1107 mg/d). Overall, males consumed more calcium than females, with intakes above 1000 mg/d for those aged 19-30 years and intakes between 750-940 mg/d for those aged 31-70 years. Females aged 19-50 years had higher calcium intakes (approximately 850 mg/d) than those aged 51-70 years (740 mg/d). The average calcium intakes from foods were slightly less for seniors over 70 years of age at approximately 762 mg/d for males and 690 mg/d for females.

iii. Calcium Food Sources in the Canadian Diet

Calcium from both food sources and dietary supplements reflects the total calcium intake of an individual. Dairy foods such as milk, cheese, and yogurt are naturally high in calcium and are therefore considered excellent sources of calcium. According to the United States Department of Agriculture (USDA), calcium in the typical diets in the U.S. and Canada is primarily from dairy products. In the U.S., the majority (72%) of calcium comes from milk, cheese, yogurt, and dairy-based dishes such as pizza, lasagna, and sandwiches served

with cheese. Other important calcium sources include vegetables, grains, legumes, fruits, meat, poultry & fish, eggs, and miscellaneous foods, which account for the remaining 25% of calcium (USDA, 2009; IOM, 2011).

The most recent similar data in Canada was from the 1997-1998 Food Habits of Canadian Survey, results showed that calcium in the Canadian diet was mainly from dairy products, which accounted for at least 46% of calcium from foods. This survey was a home-administered 24-hour dietary recall survey (n=1,543) (Table 2-4) (Johnson-Down et al., 2006). Without the consumption of dairy products, an adequate calcium intake seems very difficult to achieve. Fluid milk, cheese, refined breads were the top three calcium sources, accounting for almost 60% of daily calcium intake for men and women aged 18-65 years. Other important calcium food sources for men and women aged 18-34 years included: hamburgers/pizza (5.5% vs. 3.7%), other vegetables (2.6% vs. 2.2%), and soups/sauces (2.3% vs. 2.7%). Other important calcium food sources for men and women aged 35-65 years were other vegetables (3.3% vs.4.3%), whole-grain breads (3.8% vs. 3.1%), and ice cream/pudding (2.7% vs.2.5%).

Since calcium-fortified products were lawfully permitted for sale since late 1990s, fortification of calcium in foods that do not naturally contain this nutrient, such as orange juice and ready-to-eat cereals has become commonplace in North America (Calvo et al., 2004; Poliquin et al., 2009). These calcium-fortified products may have also positively influenced calcium intake of Canadians as these and other calcium-fortified products appeared to have had a positive association with calcium intake for Americans (Forshee et al., 2006).

f. Canadians' Vitamin D Consumption: Results from the 2004 Canadian Community Health Survey Cycle 2.2-Nutrition

i. *Dietary Recommended Intakes (DRIs) for Vitamin D*

According to a new report from the IOM, most Americans and Canadians up to age 70 require no more than 15 micrograms (μg) of vitamin D per day to maintain bone health, and those aged 71 years and older may need as much as

20 µg daily (Slomski, 2011). After reviewing nearly 1000 studies on 25 health outcomes, the IOM committee concluded on a higher vitamin D intake (Table 2-5), a threefold increase for some age groups, compared with the previous recommendations set in 1997 (Slomski, 2011). In 1997, the IOM recommended 5 µg daily for individuals up to 50 years of age, 10 µg for those aged 51 to 70 years, 15 µg for those aged 71 years or older (IOM, 2011). The committee that wrote the report also reviewed hundreds of studies and reports on other possible health effects of vitamin D, such as protection against cancer, heart disease, autoimmune diseases and diabetes. Further investigation are still required on these studies as they have come to conflicting and mixed results and do not offer the evidence needed to confirm that vitamin D has these effects.

For the first time the IOM has set Recommended Dietary Allowances (RDAs), a measure for nutrient intake that meets the needs of 97-98% of the healthy individuals, for vitamin D (Slomski, 2011). When the previous version of the DRIs was released in 1997, there were not nearly as many studies on vitamin D, the IOM was therefore only able to set an Adequate Intake (AI) range, which is an intake level that is assumed adequate for a group of healthy individuals based on experimental approximations (Slomski, 2011). To maintain bone health, the new RDAs for vitamin D are 15 µg daily for all age groups. Individuals aged 71 years or older may need up to 20 µg if they are not physically active or have significant declines in kidney function affecting their vitamin D metabolism (Ross et al., 2010). The committee also set ULs of 100 µg of vitamin D for adults and children aged 9 years or older, which is double the level from 1997. The UL for children age 1-3 years is 63 µg per day and 75 µg per day for children aged 4-8 years. The EARs are set to 10 µg per day for individuals in all age groups.

ii. Canadians' Overall Vitamin D Intakes from Food Sources

Information on Canadians' vitamin D consumption was gathered as part of the 24-hour dietary recall component of the 2004 Canadian Community Health Survey (CCHS)-2.2. Survey respondents were asked to list all foods and

beverages consumed during the 24 hours before the day of their interview; specifically, from midnight to midnight. A sub-sample of the population responded to a second 24-hour recall a few days later to help assess the day-to-day variation in an individual's food/beverage intake. Estimates of usual vitamin D intake from food were determined with the Software for Intake Distribution program. In a report (Vatanparast et al., 2010), the vitamin D intake from food was also examined according to income, education, food security status and chronic disease conditions and the vitamin D intake of Caucasian Canadians was compared to that of other Canadians.

The mean dietary vitamin D intake of all Canadians (Figure 2-5) was 6.2 μg/d, with males 9-18 years having the highest mean intakes (7.3 μg/d) and females aged 70 years and older having the highest mean intakes (6.1 μg/d). On other hand, females aged 51-70 years (5.1 μg/d) and males aged 19-50 years had the lowest intakes (5.8 μg/d). Males in all age groups under 70 years had higher intakes than females in the corresponding age group. The only significant ethnic difference was seen for Caucasian Canadian males 9-18 years having a higher vitamin D intake (7.5 μg/d) than 9-18 years male Canadians of other origins (6.4 μg/d). However, there were many sex differences in intake for females. Male Canadians of other origins aged 51-70 years (7.4 μg/d) and female Canadians of other origins aged over 70 years (10.7 μg/d) had the highest vitamin D intakes. Whereas male Canadians of other origins aged 9-18 years (5.1 μg/d) and female Canadians of other origins aged 51-70 years (3.7 μg/d) had the lowest vitamin D intakes. When evaluating vitamin D intake from food based on socio-economic factors, there was no significant difference in vitamin D in take between low and middle/high income groups. Vitamin D intake did not differ by education. Individuals reporting chronic conditions had similar vitamin D intake from food compared to apparently healthy people (5.9 μg/d vs. 5.8 μg/d).

iii. Vitamin D Food Sources in the Canadian Diet

Very little vitamin D is naturally present in foods. Vitamin D can be acquired from sources where it occurs naturally such as fatty ocean fish, organ meats, and egg yolks (vitamin D_3 from animal sources) and fungi (vitamin D_2 from plants) and fortified products (such as milk, margarine, and orange juice) (Mattila et al., 2002; Wu et al., 2009). Fluid cow milk (2 µg per 100 mL) and margarine have mandatory fortification with vitamin D in Canada (Calvo et al., 2004). According to the 2004 CCHS (Figure 2-6) (Vatanparast et al., 2010), milk products were the main source of vitamin D in the Canadian diet, contributing to 49.1% of dietary vitamin D intake, followed by meat and meat alternatives (31.1%), other foods (11.8%), grain products (5.5%) and vegetable and fruit (2.4%). Milk products contributed approximately 2.9 µg/d vitamin D for all age/gender groups, with males aged 9-18 years having the highest contribution (4.7 µg/d) and females 19-50 years the lowest contribution (2.0 µg/d). The contribution of milk products and meat and meat alternatives to vitamin D intake varies by age. While milk products contributed to 75% of dietary vitamin D intake in children aged 1-8 years, their contribution decreased by age in individuals over age 9 years and that from meat and meat alternatives increased.

g. Cultural Differences in Sources of Calcium and Vitamin D in the Northern American and Chinese Diets

In the typical traditional Chinese diet consumed in East Asia, calcium mainly comes from plant foods (e.g., vegetables and soy products) (Lee et al., 1994; Jackson et al., 2001; Lv et al, 2007) whereas dairy products are heavily relied on as the main source of dietary calcium in the Canadian diet (Johnson-Down et al., 2006). Traditionally, the Chinese diet is comprised of plant-based foods and relies on vegetables, not dairy products, for calcium (Lee et al., 1994; Jackson et al., 2001; Lv et al., 2007). In a study of Chinese in Hong Kong (Pun et al., 1991), Pun et al found that vegetables were contributing as much as 30% of total calcium intake to Chinese individuals' diet. Only about 20% of calcium

consumed came from milk and milk products and that milk consumption in the Chinese population decreased rapidly with increasing age. Rice (8.5%) and bean curd (8.4%), on the other hand, accounted for approximately 17.0% of their overall calcium intake. Similar estimates were also reported from the results of 2001-2002 Nutrition and Health Survey in Taiwan (NAHSIT) (Pan et al., 1999), about 31.5% of calcium was supplied by dairy products. Vegetables (19.0%) and soy bean & products (8.1%) were found among the top contributors to total dietary calcium intake.

Dairy products, despite being excellent sources of calcium and vitamin D, may not be often consumed within the traditional Chinese diets due to lack of familiarity (not included in the basic cultural food patterns) and potentially lactose intolerance (Jackson et al., 2001; Lv et al, 2007). The results of 2002 China Health and Nutrition Survey (Ma et al., 2007) also showed that plant foods provided most of the dietary calcium intakes (54.6% v.s. 71.7%) for urban and rural residents in China. In contrast, in the typical North American diet, at least 40-70% of total dietary calcium intake is supplied by milk and milk products, milk, cheese, and yogurt in particular (Fleming and Heibach., 1994; Lechman-Slawson et al., 2001; Berube et al., 2005; Johnson-Down et al., 2006; Poliquin et al., 2009). Vegetables, such as broccoli and Chinese cabbage (i.e., bok choy), that are often mentioned as good calcium sources provide only 2%-5% of total calcium intake (Fleming and Heibach, 1994; Leachman-Slawson et al., 2001; Jackson et al., 2001). Moreover, even less contribution from soy bean products to calcium intake is observed. Data from the 2005-2006 National Health and Nutrition Examination Surveys in the United States (USDA, 2005-2006) and 1997-1998 Food Habits of Canadians survey (Poliquin et al., 2009) also indicate that top contributors of calcium in the North American diet are dairy products.

According to the Canadian Community Health Survey (CCHS) 2004-Nutrition (Health Canada, 2008; Vatanparast et al., 2010), dairy products are the primary food source of vitamin D in Canada, contributing to at least 49.1% of

dietary vitamin D intake, followed by meat and alternatives (31.1%), other foods (11.8%), grain products (5.5%), and vegetable and fruit (2.4%). However, the results from 1993-1996 NAHSIT (Pan et al., 1999) showed that the top vitamin D food sources found in Taiwanese adults were fish (57.9 %), eggs (10.1%), and meats (9.6%) for males; fish (39.2%), dairy products (14.3%), and eggs (9.6%) for females.

Overall, studies of Chinese living in Asia show that the Chinese diet consumed in Asian countries differs from the Canadian diet for sources of calcium and vitamin D. Dairy products, despite being excellent food sources of calcium and vitamin D, very few Chinese individuals regularly consume them partly because of the social habit of low dairy consumption. In other words, dietary practices established early in life may play a large role in consumption patterns; potentially in part due to the high prevalence of lactose intolerance observed in Chinese population (Pun et al., 1991; Klesges et al., 1999; Jackson et al., 2001). These lactose-intolerant persons generally avoid calcium-rich and vitamin-D-fortified dairy products due to the presence of intolerance symptoms and therefore have lower intakes in these nutrients. Yet, little is known whether Chinese individuals' food sources of calcium and vitamin D change when they move to Canada and start incorporating Canadian foods in their diet while retaining some of their own. More research is required to identify common food sources of calcium and vitamin D in Chinese Canadians to ensure that nutrition messaging and education about these nutrients for Chinese Canadians reflect current patterns of intake.

Table 2-1. Summary of studies examining dietary acculturation in Chinese immigrants in the United States and Canada

Authors, Year	Population	Acculturation Indexes/ Scales	Dietary measures	Main Findings	Weaknesses/Strengths
Grivetti & Paquette, 1978	30 first generation Chinese adults originating from China, Hong Kong, Taiwan in north-central California	Length of residence in the U.S.	A Food Frequency Questionnaire (FFQ) that assessed frequency of consumption of five food categories: animal products, dairy items, fruits, vegetables, and bread/cereal products before and after arrival in the U.S.	After arrival in the U.S., the consumption of rice, bok choy, mushroom, lotus root decreased; whereas the consumption of dairy products, hot and cold cereals, lettuce, squash, and zucchini increased.	Strength: Use of FFQ: directly measured and compared changes in consumption frequency of certain food groups before and after immigration. Weakness: The sample size was small. Time in host country: the only acculturation characteristic used.
Yang et al., 1979	102 first generation Chinese adults living in Lincoln, Nebraska	Length of residence in the U.S.	A FFQ was used to assess food habits, prior practices, and changes in food consumption pattern.	Lunch was the most changed meal and dinner was the least changed in a day. Dinner was often the meal eaten with family in a traditional way. American foods were usually not accepted and eaten in their natural style and were modified to be more Chinese-like. (continued)	Strength: The FFQ assessed changes in food consumption pattern and behaviours before and after immigration. Weakness: However, only food habits were compared, changes in food intakes were not directly measured. Time in host country: the only acculturation index used.

Authors, Year	Population	Acculturation Indexes/ Scales	Dietary measures	Main Findings	Weaknesses/Strengths
Hrboticky & Krondl, 1985	36 first and 18 second generation Chinese adolescent (aged 14-16 yrs) males living in Toronto	Generation status (1st versus 2nd), language use, length of residence in Canada/age ratio	A FFQ consisted of 91 common North American food items and 27 traditional Chinese foods was used to assess the food use.	The 2nd generation Chinese used Canadian items (highly processed foods) such as cakes, processed meats, potato chips, and cold breakfast cereals more frequently than their 1st generation counterparts.	Strength: Compared two generations of Chinese for differences in their food consumptions. Consumption of various food groups: direct measure of diet changes. Weakness: small sample size
Lee et al., 1994	2488 middle-aged and elderly Chinese (aged 53-66 yrs) living in China, U.S., & Canada	Country of residence (North America versus China)	Two FFQs were individually developed to include common food items suitable for use in North America and China.	Higher consumption of meat (mainly beef), dairy products, and fruits was found in North American Chinese when compared to Chinese in China.	Strength: FFQs were specifically developed for use in 2 study sites. Differences in food consumption could be compared between 2 cultures. Weakness: FFQ, lengthy and time-consuming.
Pan et al., 1999	63 college and junior college students (aged 21-35 yrs) from Taiwan, China, Hong Kong and Korea living in Florida	Length of stay in the US	A FFQ that assessed 1) the consumption of grains/vegetables/fruit/meat dairy products/fats/sweets/ mixed dishes 2) numbers of meals eaten per day, snack consumption and dining out per week.	Immigration to the U.S. was significantly associated with increased frequency of consumption in fats/sweets, dairy products, and fruits and decreased frequency of consumption in meats and vegetables (continued)	Strength: Length of stay: commonly used for assessing general acculturation in many studies. Consumption of various food groups/related eating habits: direct measure of diet changes. Weakness: small sample size

Authors, Year	Population	Acculturation Indexes/ Scales	Dietary measures	Main Findings	Weaknesses/Strengths
Satia et al., 2000	30 Chinese-American women (mean age: 52 yrs) living in/around Seattle	English proficiency	24-hr dietary recall. A qualitative interview consisted of 1) factors influencing food choices 2) listing of food items at home and identifying them as either American or Chinese.	Breakfast appeared to be the first meal to be "Westernized", largely for reasons of convenience. Food quality, cost, availability were the most important predictors of dietary change after immigration to the U.S.	Strength: Qualitative interview: provide more information on the psychosocial factors in dietary changes (attitudes, beliefs, knowledge). Listing of food items at home: direct observation of the changes in food purchase Weakness: time-consuming.
Satia et al., 2001	244 Chinese-American and Chinese-Canadian women (aged 20 yrs & older) in Seattle and Vancouver	Dietary acculturation scale (foods/behaviors associated with Western and Chinese diets); age at immigration; media preferences.	1) A dietary acculturation scale that measured the degree of Chinese and Western dietary preference. 2) Fruit and vegetable intake were assessed by FFQ. 3) Fat-related dietary habits were measured with a dietary habits questionnaire.	Significant associations of Western acculturation with higher fat-related dietary habits and increased fruit and vegetable intake since immigration were found using the scale but not other indexes (age at immigration and media preferences) with diets. (continued)	Strength: Fruit, vegetables, and fat-related dietary habits: commonly used food groups to measure the westernization of diets. Weakness: Only the consumption of certain food groups (fat/fruit/vegetables) was assessed.

Authors, Year	Population	Acculturation Indexes/ Scales	Dietary measures	Main Findings	Weaknesses/Strengths
Satia et al., 2001	244 Chinese females (aged 20 yrs & older) residing in Seattle, U.S. and Vancouver, Canada.	Age, education level, marriage, employment outside the home, length of residence in the North America	1) The household food inventory: 114 major contributors of fat and/or were useful indicator foods of dietary change. 2) Western dietary acculturation scale: measured the degree of Western dietary preference 3) Fat-related dietary habits were measured.	Western dietary acculturation was higher in households with more high-fat and reduced-fat foods. Greater acculturation to North American food habits was associated a younger age, higher education, marriage, employment outside the home, and longer residence in the North America.	Strength: Use of dietary acculturation scale and household food inventory: directly measured the level of Western dietary preference and dietary change. Weakness: Participants were all females: couldn't assess gender differences in dietary behaviours and food preferences.
Nan et al., 2004	399 Chinese-Americans (aged 18 yrs & older) in Pennsylvania	Length of residency in the U.S., English proficiency, number of congenial American friends	A self-administered questionnaire that included 1) questions about general food habits 2) FFQ measured the consumption frequency of 97 food items 1 yr before immigration and within the past year in the U.S.	The consumption frequency of western foods ↑and that of traditional Chinese foods ↓ after immigration. Persons who resided in the U.S. for a longer period of time had a greater ↑ in their consumption of vegetables, drinks, and fats/sweets (continued)	Strength: Number of congenial American friends: assess respondents' degree of ethnic identification with host culture or original culture. Weakness: FFQ with 97 items too lengthy: gather details regarding changes in food consumption before and after immigration.

Authors, Year	Population	Acculturation Indexes/ Scales	Dietary measures	Main Findings	Weaknesses/Strengths
Bojanic et al., 2006	163 Chinese people (mean age: 29-36 yrs) living in a large university town in western Massachusetts	Acculturation scale: language preference, ethnic identity and classification, cultural heritage, ethnic behavior, interaction.	A self-administered questionnaire that assessed the dining-out behaviors (frequency, average check, average tip, preference for various types of restaurants and cuisines)	The high assimilation group dined out significantly more often for both lunch and dinner than low assimilation and ethnic affirmation groups.	Strength: Dining-out behaviors/ preference: general indicators for acculturation but provide only limited information. Weakness: Need further assessments for measuring changes in food consumption.
Kwok et al., 2009	106 elderly Chinese adults (aged 45-64 yrs) originating from China, Hong Kong, Taiwan living in Toronto	Age at immigration, years in Canada, education level, self-reported English proficiency	A questionnaire was developed to assess fat-related behaviors and fruit and vegetable consumption. The higher score the lower fat intake and fruit and vegetable consumption.	A high percent of participants reported eating a Western-style breakfast and traditional Chinese dinner. Green leafy vegetables (e.g., bok choy) and fruits were regularly consumed. Lettuce salads and potatoes were eaten less.	Strength: The dietary questionnaire was developed to measure fat-related behaviours and fruit and vegetable consumption. Weakness: The study findings were specific to the Chinese elderly. Didn't measure changes in consumption of other foods.

Table 2-2 Dietary Reference Intakes (DRIs) for sodium, Food and Nutrition Board, Institute of Medicine, National Academics

Sodium (mg/day)			
Sex/age groups		AI	UL
Children	1-3 yr	1000	1500
	4-8 yr	1200	1900
Males	9-13 yr	1500	2200
	14-18 yr	1500	2300
	19-30 yr	1500	2300
	31-50 yr	1500	2300
	51-70 yr	1300	2300
	over 70 yr	1200	2300
Females	9-13 yr	1500	2200
	14-18 yr	1500	2300
	19-30 yr	1500	2300
	31-50 yr	1500	2300
	51-70 yr	1300	2300
	over 70 yr	1200	2300
AI: Adequate intake; UL: Tolerable Upper Intake Level			

Table 2-3 Dietary Reference Intakes (DRIs) for calcium, Food and Nutrition Board, Institute of Medicine, National Academics

Calcium (mg/day)			
Sex/age groups		RDA	UL
Children	1-3 yr	700	2500
	4-8 yr	1000	2500
Males	9-13 yr	1300	3000
	14-18 yr	1300	3000
	19-30 yr	1000	2500
	31-50 yr	1000	2500
	51-70 yr	1000	2000
	over 70 yr	1200	2000
Females	9-13 yr	1300	3000
	14-18 yr	1300	3000
	19-30 yr	1000	2500
	31-50 yr	1000	2500
	51-70 yr	1200	2000
	over 70 yr	1200	2000
RDA: Recommended Dietary Allowance; UL: Tolerable Upper Intake Level			

Table 2-4 Percentage of daily mean calcium consumption contributed by food groupings in Canadians aged 18 to 65 years, 1997-1998 Food Habits of Canadians Survey

Food category	Men 18-34 years (n=125)	Men 35-65 years (n=447)	Women 18-34 years (n=206)	Women 35-65 years (n=765)
Mean (mg)	815	748	849	862
	%			
Fluid milk	35.0	35.6	37.0	33.3
Cheese	18.8	12.1	12.1	13.4
Refined breads	7.88	8.99	8.89	8.29
Hamburgers/pizza	5.47	2.21	3.66	1.96
Other vegetables	2.58	3.34	2.21	4.26
Whole-grain breads	2.33	3.81	1.63	3.09
Soups/sauces	2.32	2.31	2.71	2.23
Mixed pasta dishes	2.31	1.36	1.81	1.50
Ice cream /pudding	1.62	2.65	1.78	2.49

Table 2-5 Dietary Reference Intakes (DRIs) for vitamin D, Food and Nutrition Board, Institute of Medicine, National Academics

Vitamin D (μg/day)			
Sex/age groups		RDA	UL
Children	1-3 yr	15	63
	4-8 yr	15	75
Males	9-13 yr	15	100
	14-18 yr	15	100
	19-30 yr	15	100
	31-50 yr	15	100
	51-70 yr	15	100
	over 70 yr	20	100
Females	9-13 yr	15	100
	14-18 yr	15	100
	19-30 yr	15	100
	31-50 yr	15	100
	51-70 yr	15	100
	over 70 yr	20	100
RDA: Recommended Dietary Allowance; UL: Tolerable Upper Intake Level			

Figure 2-1 Proposed model of dietary acculturation: The process by which racial/ethnic immigrant groups adopt the eating patterns of their host country (Satia & Neuhouser, 2002) (Cited with permission).

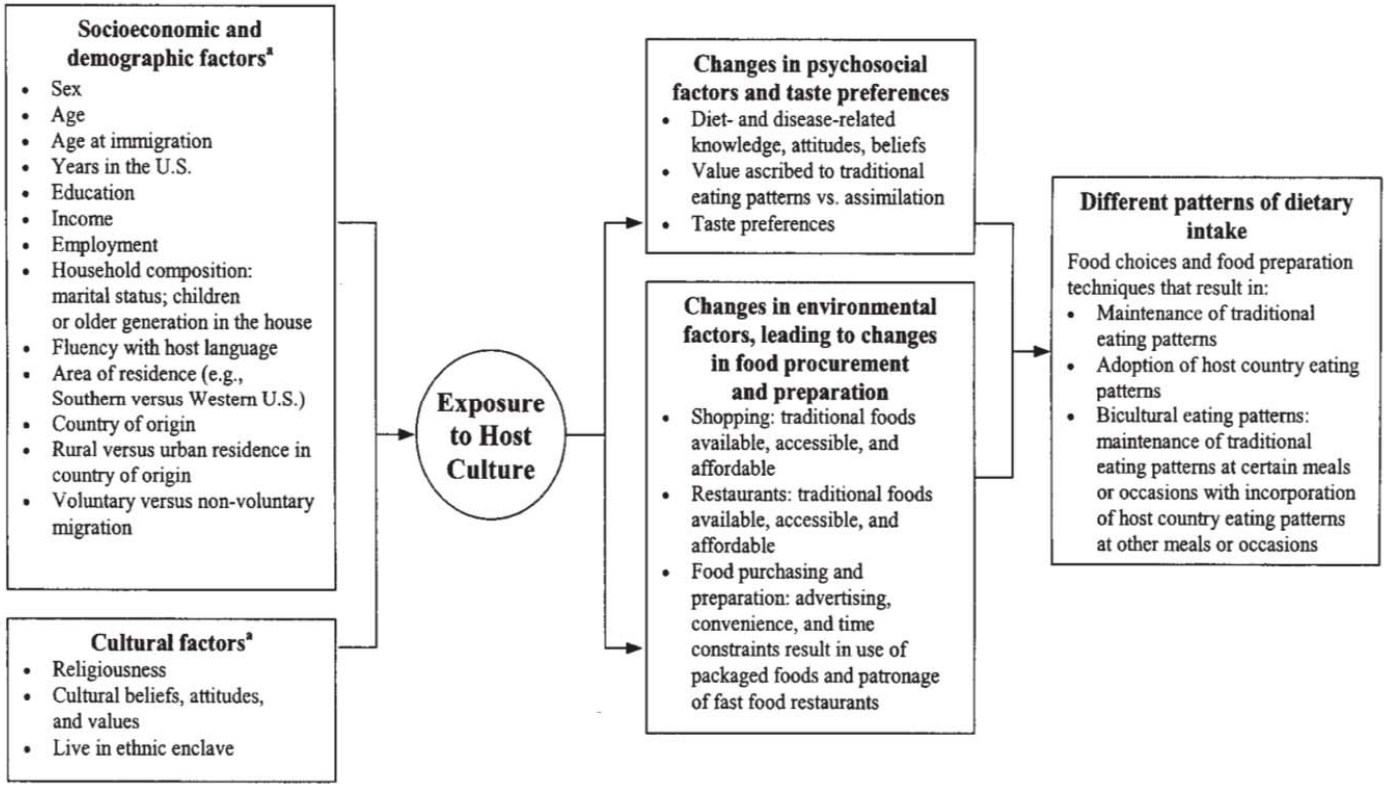
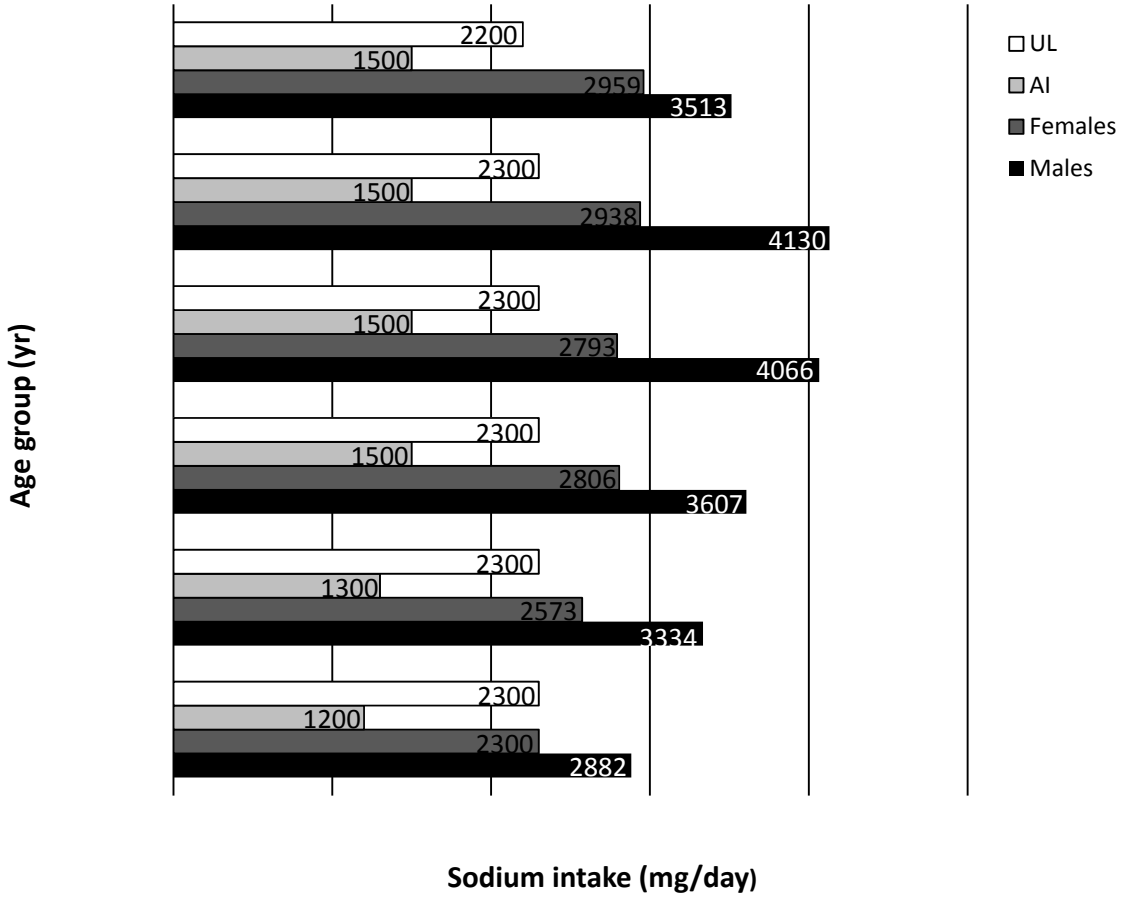


Figure 2-2. Average daily sodium intake, by age group and sex, for the 2004 Canadian Community Health Survey-2.2

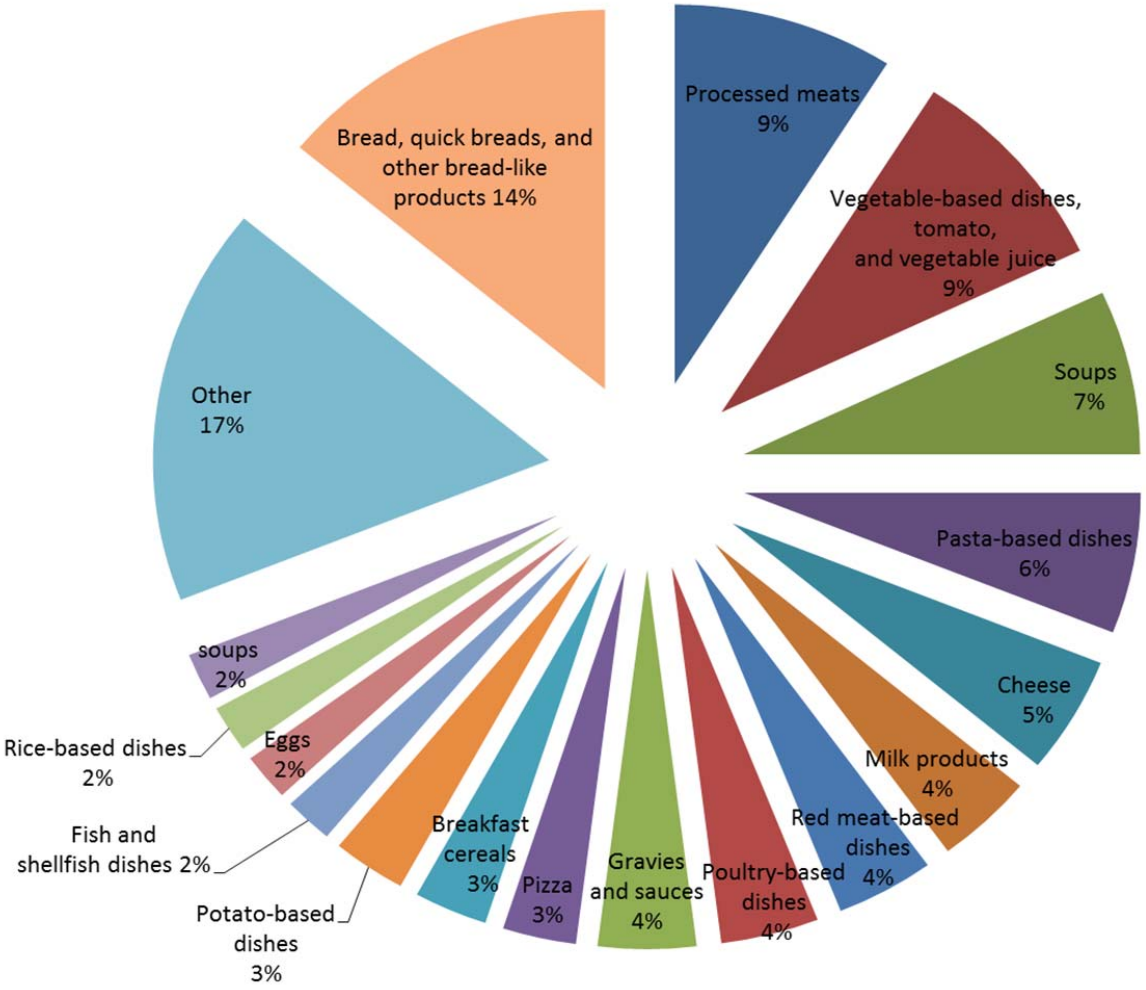


AI: Adequate Intake; UL: Tolerable Upper Intake Level

NOTE: Excludes salt added at table or while cooking.

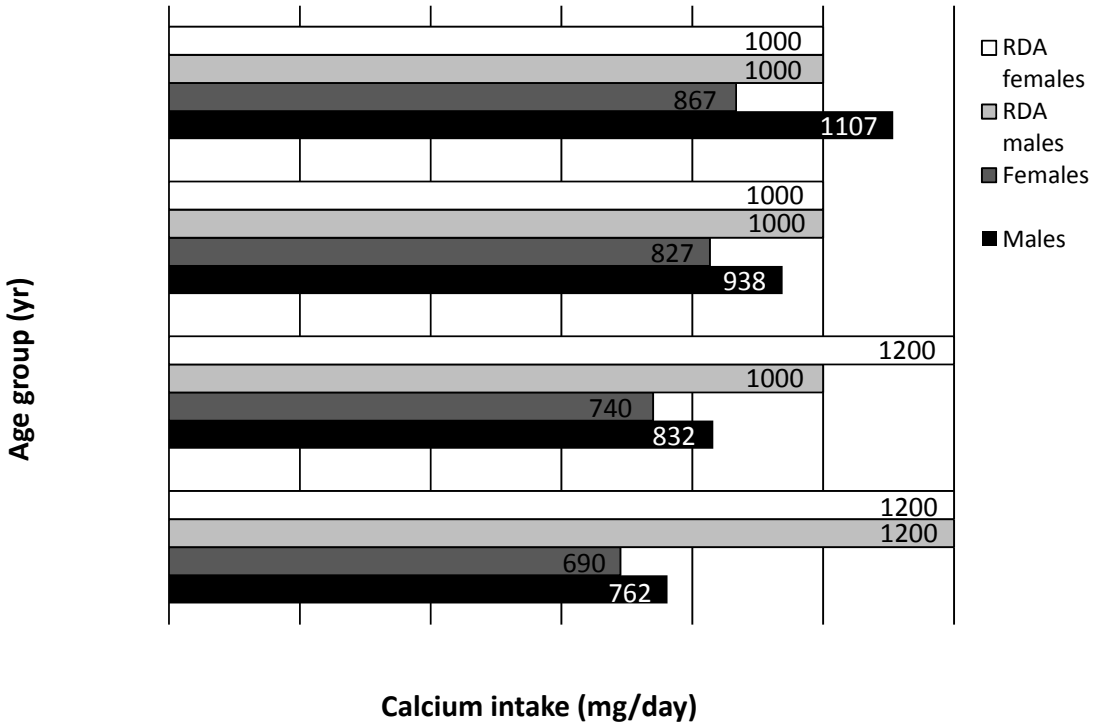
Data source: Canadian Community Health Survey-Nutrition conducted in 2004 (excluding territories) by Statistics Canada.

Figure 2-3. Major food sources of sodium in the Canadian diet from the 2004 Canadian Community Health Survey-2.2



Data source: Canadian Community Health Survey-Nutrition conducted in 2004 (excluding territories) by Statistics Canada.

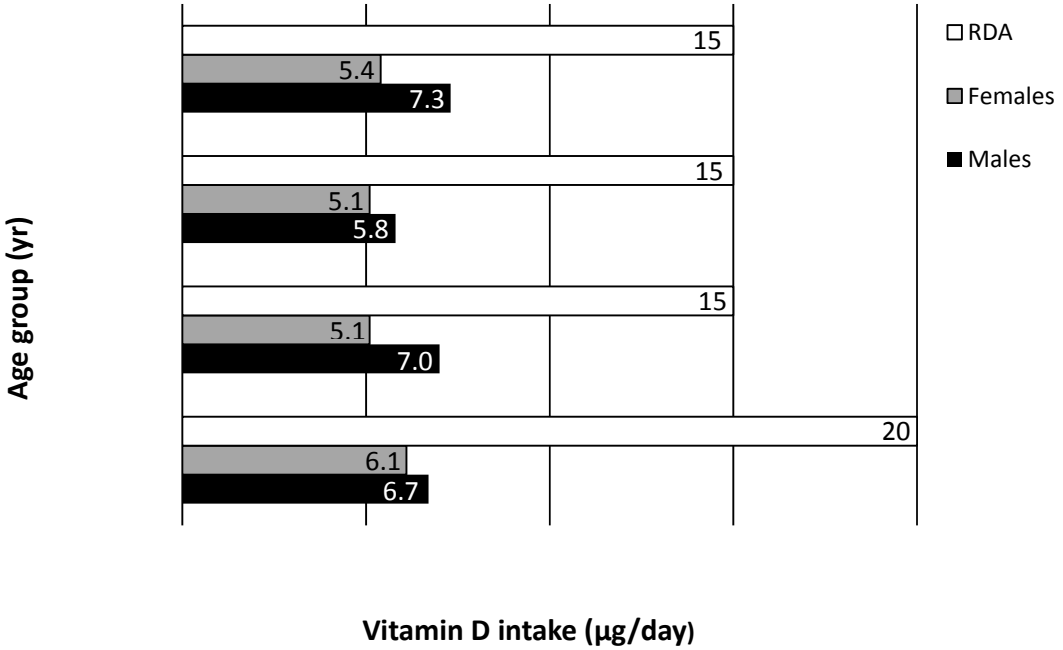
Figure 2-4 Average daily calcium intake from food sources, by age group and sex, for the 2004 Canadian Community Health Survey-2.2



RDA: Recommended Dietary Allowance

Data source: Canadian Community Health Survey-Nutrition conducted in 2004 (excluding territories) by Statistics Canada.

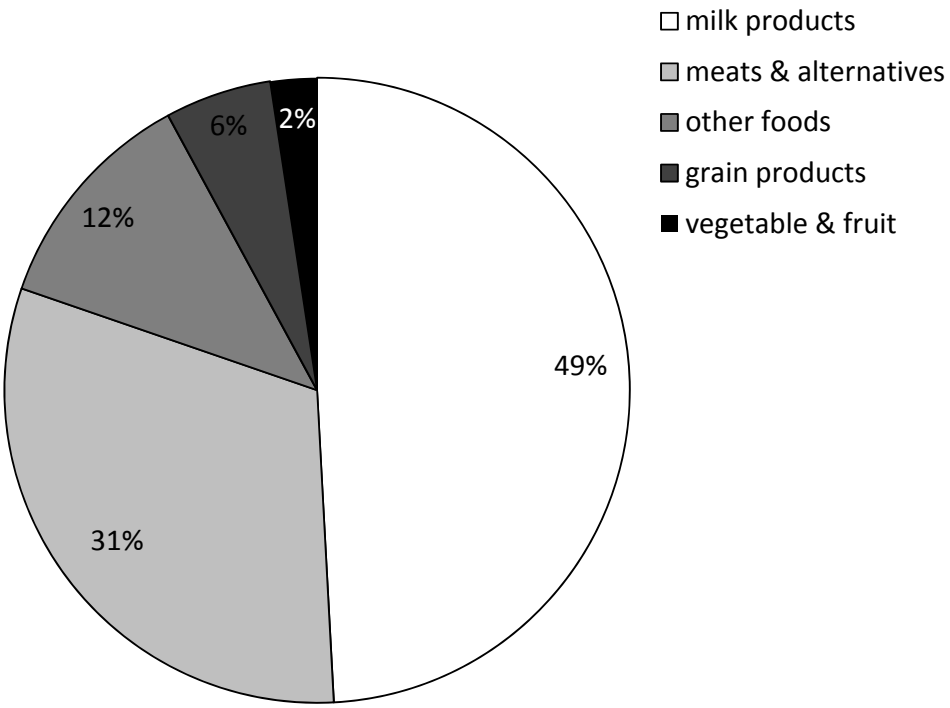
Figure 2-5 Average daily vitamin D intake from food sources, by age group and sex, for the 2004 Canadian Community Health Survey-2.2



RDA: Recommended Dietary Allowance

Data source: Canadian Community Health Survey-Nutrition conducted in 2004 (excluding territories) by Statistics Canada.

Figure 2-6 Major food sources of vitamin D in the Canadian diet



Data source: Canadian Community Health Survey-Nutrition conducted in 2004 (excluding territories) by Statistics Canada.

2.4 LITERATURE CITED

Anderson CA, Appel LJ, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *Journal of American Dietetic Association. 2010; 110(5): 736-45.*

Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. *New England Journal of Medicine. 1997; 336: 1117-24.*

Babbar RK, Handa AB, Lo CM, et al. Bone health of immigrant Chinese women living in New York City. *Journal of Community Health. 2006; 31(1): 7-23.*

Bakris G, Hill M, Mancia G, Steyn K, Black HR, Pickering T, et al. Achieving blood pressure goals globally: Five core actions for health-care professionals. A worldwide call to action. *Journal of Human Hypertension. 2008; 22(1): 63-70.*

Barr SI. Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology, Nutrition, & Metabolism. 2006; 31(1): 66-73.*

Barr SI, Petit MA, Vigna YM, Prior JC. Eating attitudes and habitual calcium intake in peripubertal girls are associated with initial bone mineral content and its change over 2 years. *Journal of Bone and Mineral Research. 2001; 16: 940-7.*

Bentley B. A review of methods to measure dietary sodium intake. *Journal of Cardiovascular Nursing. 2006; 21(1): 63-7.*

Berry JW. Social and cultural change. In: HC Trandis & R. Brislin, eds. Handbook of Cross-cultural Psychology. Boston, Mass; Allyn and Bacon; 1980.

Bojanic D, Xu Y. An investigation of acculturation and the dining-out behavior of Chinese living in the United States. *International Journal of Hospitality Management. 2006; 25(2): 211-26.*

Bow CH, Cheung E, Cheung CL, Xiao SM, Loong C, Soong C, Tan KC, Luckey MM, et al. Ethnic difference of clinical vertebral fracture risk. *Osteoporosis International. 2011, April 02* [Epub ahead of print].

Brookins GK. Culture, ethnicity, and bicultural competence: Implications for children with chronic illness and disability. *Pediatrics. 1993; 91: 1056-62.*

Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *International Journal of Epidemiology. 2009; 38(3): 791-813.*

Brulé D. 2004 Canadian Community Health Survey, personal communication. Toronto, ON: Health Canada; 2010.

Cade J, Thompson R, Burley V, Warm D. Development, validation and utilization of food frequency questionniares, a review. *Public Health Nutrition. 2002; 5: 567-87.*

Caggiula AW, Wing RR, Nowalk MP, et al. The measurement of sodium and potassium intake. *American Journal of Clinical Nutrition. 1985; 42: 391-8.*

Calvo MS, Whiting SJ, Barton CN. Vitamin D fortification in the United States and Canada: current status and data needs. *American Journal of Clinical Nutrition. 2004; 80(suppl): 1710s-6s.*

Calvo MS, Whiting SJ. Prevalence of vitamin D insufficiency in Canada and the United States: importance to health status and efficacy of current food fortification and dietary supplement use. *Nutrition Review. 2003; 61(3): 107-13.*

Cassels A. Move over war on trans-fats; make way for the war on salt. *Canadian Medical Association Journal. 2008; 178(2): 256.*

Champagne CM, Lastor KC. Sodium intake: Challenges for researchers attempting to assess consumption relative to health risks. *Journal of food composition and analysis. 2009; 22(suppl): 19-22.*

Chang HY, Hu YW, Yue CS, Wen YW, Yeh WT, Hsu LS, Tsai SY, Pan WH. Effect of potassium-enriched salt on cardiovascular mortality and medical

expenses of elderly men. *American Journal of Clinical Nutrition. 2006; 83: 1289-96.*

Chen TC, Chimeh F, Lu ZR, Mathieu J, Person KS, Zhang AQ, Kohn N, Martinello S, Berkowitz R, Holick MF: Factors that influence the cutaneous synthesis and dietary sources of vitamin D. *Archives of Biochemistry and Biophysics. 2007; 460(2): 213-217.*

Chung M, Balk EM, Brendel M, Ip S, Lau J, Lee JH, Lichtenstein A. Vitamin D and Calcium: A Systematic Review of Health Outcomes. Evidence Report/Technology Assessment Number 183. Boston, MA: Tufts Evidence-based Practice Center; 2009.

Chyou PH. Nomura AM. Hankin JH. Stemmermann GN. A case-cohort study of diet and stomach cancer. *Cancer Research. 1990;50(23): 7501-4.*

Citizenship and Immigration Canada. Immigration and Refugee Protection Act 2001 http://www.laws.justice.gc.ca/eng/acts/I-2.5/index.html. Accessed September 8th, 2011.

Cook NR, Cutler JA, Obarzanek E, Buring JE, Rexrode KM, Kumanyika, SK, Appel LJ, Whelton PK. Long term effects of dietary sodium reduction on cardiovascular disease outcomes: Observational follow-up of the Trials of Hypertension Prevention (TOHP). *British Medical Journal. 2007; 334: 885.*

Dawson-Hughes B, Heaney RP, Holick MF, et al. Estimates of optimal vitamin D status. *Osteoporosis International 2005; 16: 713-6.*

Dewey KG, Strode MA, Ruiz Fitch Y. Dietary change among migrant and non-migrant Mexican American families in northern California. *Ecology of Food and Nutrition. 1984; 14: 11-24.*

Dodd KW. Technical Guide to C-SIDE (Software for Intake Distribution Estimation), Version 1.0, Dietary Assessment Research Series Report 9, A, 1996.

http://www.card.iastate.edu/publications/DBS/PDFFiles/96tr32.pdf. Accessed September 16th, 2011.

Edward NG, Wilkins R, Gendron F, Berthelot JM. The changing health of immigrants. *Canadian Social Trends. 2005; 15-9.*

Espeland MA, Kumanyika S, Wilson AC, et al. Lifestyle interventions influence relative errors in self-reported diet intake of sodium and potassium. *Annals of Epidemiology. 2001; 11: 85-93.*

Ezzati M, Lopez AD, Rodgers A, Vander HS, Murray CJ. Selected major risk factors and global and regional burden of disease. *Lancet. 2002; 360(9343): 1347-60.*

FAO. Food and Agricultural Organization of the United Nations; Preparation and use of food based dietary guidelines, 1996. http://www.fao.org/DOCREP/x0243e/x0243e00.htm. Accessed September 9th, 2011.

Fischer PW, Vigneault M, Huang R, Arvaniti K, Roach P. Sodium food sources in the Canadian diet. *Applied Physiology, Nutrition, & Metabolism. 2009; 34(5): 884-892.*

Fitzgerald AL, Maclean DR, Veugelers PJ. Dietary reference intakes: a comparison with the Nova Scotia Nutrition Survey. *Canadian Journal of Dietetic Practice & Research. 2002; 63(4): 176-83.*

Fleming KH, Heimbach JT. Consumption of calcium in the U.S.: food sources and intake levels. *Journal of Nutrition. 1994; 124(8 Suppl): 1426S-30S.*

Fodor JG, Whitmore B, Leenen F, Larochelle P. Lifestyle modifications to prevent and control hypertension. 5. recommendations on dietary salt. Canadian hypertension society, Canadian coalition for high blood pressure prevention and control, laboratory center for disease control at health Canada, heart and stroke foundation of Canada. *Canadian Medical Association Journal. 1999; 160(Suppl): S29-34.*

Food Standards Agency. Agency publishes 2012 salt reduction targets. http://www.food.gov.uk/news/pressreleases/2009/may/salttargets. Accessed September 16th, 2011.

Food Standards Agency. UK Salt Reduction Initiatives. http://www.food.gov.uk/multimedia/pdfs/saltreductioninitiatives.pdf. Accessed September 16th, 2011.

Forshee RA, Anderson PA, Storey ML. Changes in calcium intake and association with beverage consumption and demographics: comparing data from CSFII 1994-1996, 1998 and NHANES 1999-2002. *Journal of American College of Nutrition. 2006; 25(2): 108-16*.

Garriguet D. Sodium consumption at all ages. *Health Reports. 2007; 18(2): 47-52.*

Gibson RS. Principles of nutritional assessment. 2nd ed. Oxford, NY: Oxford University Press, Inc; 2005.

Ginde AT, Liu MC, Camargo CA Jr. Demographic differences and trends of vitamin D insufficiency in the US population,1988-2004. *Archives of Internal Medicine. 2009; 169(6): 626-32.*

Giovannucci E, Liu Y, Hollis BW, Rimm EB. 25-hydroxyvitamin D and risk of myocardial infarction in men: a prospective study. *Archives of Internal Medicine 2008; 168: 1174-80.*

Gozdzik A, Barta JL, Wu H, et al. Low wintertime vitamin D levels in a sample of healthy young adults of diverse ancestry living in the Toronto area: associations with vitamin D intake and skin pigmentation. *Biomed Central Public Health. 2008; 8: 336.*

Grivetti LE, Paquette B. Nontraditional ethnic food choices among first-generation Chinese in California. *Journal of Nutrition Education. 1978; 10: 109-12.*

Gu D, Gupta A, Muntner P, Hu S, Duan X, Chen J, et al. Prevalence of cardiovascular disease risk factor clustering among the adult population of china: Results from the international collaborative study of

cardiovascular disease in Asia (InterAsia). *Circulation. 2005; 112(5): 658-65.*

Hajjar I, Kotchen JM, Kotchen TA. Hypertension: trends in prevalence, incidence, and control. *Annual Reviews of Public Health.* 2006; 27: 465-90.

Hanley DA, Cranney A, Jones G, Whiting SJ, Leslie WD, Cole DEC, Atkinson SA, et al. Vitamin D in adult health and disease: a review and guideline statement from Osteoporosis Canada. *Canadian Medical Association Journal. 2010; 182(12): E160-8.*

Havas S, Roccella EJ, Lenfant C. Reducing the public health burden from elevated blood pressure levels in the United States by lowering intake of dietary sodium. *American Journal of Public Health. 2004; 94(1): 19-22.*

Health Canada. Sodium reduction strategy for Canada: Recommendations of the Sodium Working Group, 2010. http://www.hc-sc.gc.ca/fn-an/nutrition/sodium/strateg/index-eng.php. Accessed September 14th, 2011.

Heaney RP. Calcium, dairy products and osteoporosis. *Journal of the American College of Nutrition. 2000; 19(2 Suppl): 83S-99S.*

Hebert JR, Yunsheng M, Clemow L, et al. Gender differences in social desirability and social approval bias in dietary self-report. *American Journal of Epidemiology. 1997; 146: 1046-55.*

Heise D. Hispanic American influence on the U.S. food industry. USDA Agricultural Research Service 2002 September. http://www.nal.usda.gov. Accessed September 9th, 2011.

Holick MF: The vitamin D epidemic and its health consequences. *Journal of Nutrition. 2005; 135(11): 2739S-48S.*

Holick MF: Vitamin D deficiency. *New England Journal of Medicine 2007, 357(3): 266-81.*

Hrboticky N, Krondl M. Dietary acculturation process of Chinese adolescent immigrants. *Nutrition Research. 1985; 5: 1185-97.*

Huget JL. The Lancet weighs in on JAMA's salt study. The Washington Post. *2011*

Institute of Medicine, Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: National Academy Press; 2011.

Institute of Medicine. Dietary Reference Intakes: applications in dietary assessment. Washington, DC: National Academy Press; 2004.

Jackson KA, Savaiano DA. Lactose mal-digestion, calcium intake and osteoporosis in African-, Asian-, and Hispanic-Americans. *Journal of the American College of Nutrition. 2001; 20(2 Suppl): 198S-207S.*

James WP, Ralph A, Sanchez-Castillo CP. The dominance of salt in manufactured food in the sodium intake of affluent societies. *Lancet. 1987; 1(8530): 426-29.*

Joffres MR, Campbell NR, Manns B, Tu K. Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada. *Canadian Journal of Cardiology. 2007; 1;23(6): 437-43.*

Johnson-Down L, Ritter H, Starkey LJ, Gray-Donald K. Primary food sources of nutrients in the diet of Canadian adults. *Canadian Journal of Dietetic Practice & Research. 2006; 67(1): 7-13.*

Jones G. Pharmacokinetics of vitamin D toxicity. *American Journal of Clinical Nutrition. 2008; 88: 582S-6S.*

Kalcik S. Ethnic food ways in America: symbol and the performance of identity. In ethnic and regional food ways in the United States. Knoxville: University of Tennessee Press.

Kaplan MS, Chang C, Newsom JT, McFarland BH. Acculturation status and hypertension among Asian immigrants in Canada*. Journal of Epidemiology & Community Health. 2002; 56(6): 455-6.*

Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review. *Journal of Hypertension*. 2004; 22(1): 11-19.

Kelemen LE, Anand SS, Vuksan V, et al. Development and evaluation of cultural food frequency questionnaires for South Asians, Chinese, and Europeans in North America. *Journal of American Dietetic Association. 2003; 103(9): 1178-84.*

Kittler PG & Sucher KP. Food and Culture. 4th ed. Toronto, ON: Wadsworth; 2004.

Klesges RC, Harmon-Clayton K, Ward KD, et al. Predictors of milk consumption in a population of 17- to 35-year-old military personnel. *Journal of American Dietetic Association. 1999; 99(7): 821-6.*

Kotchen TA, McCarron DA. Dietary electrolytes and blood pressure. A statement for health care professionals from the American Heart Association Nutrition Committee. *Circulation. 98: 613-7.*

Kristal AR, Andrilla HA, Koepsell TD, et al. Dietary assessment instruments are susceptible to intervention associated response set bias. *Journal of American Dietetic Association. 1998; 98: 40-3.*

Kwok S, Mann L, Wong K, Blum I. Dietary habits and health beliefs of Chinese Canadians. *Canadian Journal of Dietetic Practice & Research. 2009; 70(2): 73-80.*

Lancaster KJ, Watts SO, Dixon LB. Dietary intake and risk of coronary heart disease differ among ethnic subgroups of black Americans. *Journal of Nutrition. 2006; 136(2): 446-451.*

Langlois K. Greene-Finestone L. Little J. Hidiroglou N. Whiting S. Vitamin D status of Canadians as measured in the 2007 to 2009 Canadian Health Measures Survey. *Health Reports. 2010; 21(1): 47-55.*

Langsetmo L, Poliquin S, Hanley DA, Prior JC, Barr S, Anastassiades T, Towheed T, Goltzman D, Kreiger N. Dietary patterns in Canadian men and women ages 25 and older: relationship to demographics, body mass index, and bone mineral density. *Biomed Central Musculoskeletal Disorders. 2010; 11: 20.*

Lappe JM, Travers-Gustafson D, Davies KM, Recker RR, Heaney RP, Vitamin D and calcium supplementation reduces cancer risk: results of a randomized Trial. *American Journal of Clinical Nutrition. 2007; 85: 1586-91.*

Larkin FA, Metzer H, Guire K. Comparison of three consecutive day and three random day records of dietary intake. *Journal of American Dietetic Association. 1991; 91: 1538-42.*

Lau EM. Epidemiology of osteoporosis in urbanized Asian populations. *Osteoporosis International. 1997; 7(Suppl 3): S91-5.*

Lauderdale DS, Kuohung V, Chang SL, Chin MH. Identifying older Chinese immigrants at high risk for osteoporosis. *Journal of General Internal Medicine. 2003; 18(7): 508-15.*

Lawes CM, Vander HS, Law MR, Elliott P, MacMahon S, Rodgers A. Blood pressure and the global burden of disease 2000. part II: Estimates of attributable burden. *Journal of Hypertension. 2006; 24(3): 423-30.*

Leachman-Slawson D, McClanahan BS, Clemens LH, et al. Food sources of calcium in a sample of African-American and Euro-American collegiate athletes. *International Journal of Sport Nutrition & Exercise Metabolism. 2001; 11(2): 199-208.*

Lee MM, Wu-Williams A, Whittemore AS, et al. Comparison of dietary habits, physical activity and body size among Chinese in North America and China. *International Journal of Epidemiology. 1994; 23(5): 984-90.*

Lee RD, Nieman DC. Nutritional Assessment. 5th ed. New York, NY: McGraw-Hill; 2010.

Lee SK, Sobal J, Frongillo EA. Acculturation and dietary practices among Korean Americans. *Journal of American Dietetic Association.1999; 99(9): 1084-9.*

Livingstone M, Robson P, Wallace J. Issues in dietary intake assessment of children and adolescents. *British Journal of Nutrition. 2004; 92(suppl): 213-22.*

Lo CW, Paris PW, Clemens TL, Nolan J, Holick MF. Vitamin D absorption in healthy subjects and in patients with intestinal mal-absorption syndromes. *American Journal of Clinical Nutrition. 1985; 42: 644-9.*

Loria CM, Obarzanek E, Ernst ND. Choose and prepare foods with less salt: Dietary advice for all Americans. *Journal of Nutrition. 2001; 131(2S-1): 536S-51S.*

Lu YP. Investigation of acculturation changes in food intake of Taiwanese students attending the University of Wisconsin-Stout [dissertation]. Menomonie, Wisconsin: University of Wisconsin-Stout; 2000.

Lv N, Brown JL, Liu B. Enhancing nutrition consumption in the American diet: Factors influencing dairy product consumption of Chinese Americans in Pennsylvania. *Topics in Clinical Nutrition. 2007; 22(3): 258-71.*

Lv N, Cason KL. Current dietary pattern and acculturation of Chinese Americans in Pennsylvania. *Topics in Clinical Nutrition. 2003; 18(4): 291-300.*

Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *Journal of American Dietetic Association. 2004; 104(5): 771-8.*

Ma G, Li Y, Jin Y, Zhai F, Kok FJ, Yang X. Phytate intake and molar ratios of phytate to zinc, iron and calcium in the diets of people in China. *European Journal of Clinical Nutrition. 2007; 61(3): 368-74.*

MacLaughlin J, Holick MF. Aging decreases the capacity of human skin to produce vitamin D3. *Journal of Clinical Investigation. 1985; 76: 1536-1538.*

Man CMD. 2007. Technological functions of salt in food products. In Reducing salt in foods. Practical strategies. CRC Press, Boca Raton, 157-73.

Marger MN. Race and Ethnic Relations: American and Global Perspectives. 5th ed. Stanford, Conn: Wadsworth; 2000.

Marmot MG, Syme SL. Acculturation and coronary heart disease in Japanese-Americans. *American Journal of Epidemiology. 1976; 104(3): 225-47.*

Mattes RD, Donnelly D. Relative contributions of dietary sodium sources. *Journal of American College of Nutrition. 1991; 10(4): 383-93.*

Mattila P, Lampib A-M, Ronkainenb R, Toivob J, PiironenV. Sterol and vitamin D2 contents in some wild and cultivated mushrooms. *Food Chemistry. 2002; 76: 293-8.*

McCarron DA. Importance of nutrient Intake on blood pressure, salt sensitivity, and Health Outcomes. Brussels: European Salt Producer's Association; 2007.

McCarron DA. The dietary guideline for sodium: should we shake it up? Yes! *American Journal of Clinical Nutrition. 2000; 71: 1013-9.*

Meleis AI, Lipson JG, Paul SM. Ethnicity and health among five Middle Eastern immigrant groups. *Nursing Research. 1992; 42: 98-103.*

Mithal A, Wahl DA, Bonjour JP, et al. Global vitamin D status and determinants of hypovitaminosis D. *Osteoporosis International 2009. Aug 19* [Epub ahead of print].

Mohan S. Campbell NR. Willis K. Effective population-wide public health interventions to promote sodium reduction. *Canadian Medical Association Journal. 2009; 181(9): 605-9.*

Mussell K, eds. Ethnic and Regional Food Ways in the US. The Performance of Group Identity. Knoxville, Tenn: University of Tennessee Press; 1984.

Nan LV, Cason KL. Dietary pattern change and acculturation of Chinese-Americans in Pennsylvania. *Journal of the American Dietetic Association. 2004; 104(5): 771-8.*

National Institute of Health. 2011. Osteoporosis overview http://www.niams.nih.gov/Health_Info/Bone/Osteoporosis/overview.asp. Accessed Sept 15th, 2011.

National Institute of Health. 2011. Dietary supplement fact sheet: Vitamin D http://ods.od.nih.gov/factsheets/vitamind/. Accessed Oct 20th, 2011.

Negy C, Woods DJ. The importance of acculturation in understanding research with Hispanic Americans. *Hispanic Journal of Behavioral Science. 1992; 14(2): 224-47.*

Nelson M, Bingham SA. Assessment of food consumption and nutrient intake. In: Margetts BM, Nelson M, eds. Design Concepts in Nutritional Epidemiology. Oxford, NY: Oxford University Press, Inc; 1997.

Nicklas TA. Calcium intake trends and health consequences from childhood through adulthood. *Journal of the American College of Nutrition. 2003; 22(5): 340-56.*

Nusser SM, Carriquiry AL, Dodd KW, et al. A semi-parametric transformation approach to estimating trends in dietary sodium intake and comparison between intake and 24-h excretion of sodium. *Journal of the American Statistical Association 1996; 91(436): 1440-9*.

Padilla Am & Perez W. Acculturation, Social Identity, and Social Cognition: A New Perspective. *Hispanic Journal of Behavioral Sciences. 2003; 25(1): 35-55.*

Pan WH, Kao MD, Tzeng MS, et al. Nutrition and Health Survey in Taiwan (NAHSIT) 1993-1996: design, contents, and operations. *Nutritional Science Journal. 1999; 24: 1-10.* [In Chinese].

Pan Y, Dixon Z, Himburg S, Huffman F. Asian Students Change their Eating Patterns After Living in the United States. *Journal of the American Dietetic Association. 1999; 99(1): 54-7.*

Pelto GH, Pelto PJ, Lung'aho MS. "Modern" and "Traditional" food use in West Finland: An example of quantitative pattern analysis. *Nutrition Research. 1981; 1: 63-71.*

Peng LY. Dietary Acculturation of Chinese Students in the United States [thesis]. Akron, Ohio: University of Akron; 2005.

Perez CE. Health status and health behavior among immigrants. *Health Reports, 2002; 13(3): 1-12.*

Persons S. Ethnic studies at Chicago: 1905-45. Urbana: University of Illinois Press; 1987.

Poliquin S, Joseph L, Gray-Donald K. Calcium and vitamin D intakes in an adult Canadian population. *Canadian Journal of Dietetic Practice & Research. 2009; 70(1): 21-7.*

Potter J, ed. World Cancer Research Fund and the American Institute for Cancer Research, Food, Nutrition, and Prevention of Cancer: a Global Perspective. Washington, DC: American Institute for Cancer Research; 1997.

Pritchard JM, Seechurn T, Atkinson SA. A Food Frequency Questionnaire for the Assessment of Calcium, Vitamin D and Vitamin K: A Pilot Validation Study. *Nutrients. 2010; 2, 805-19.*

Pun KK, Chan LML, Chung V, Wong FHW. Calcium content of common food items in Chinese diet. *Calcified Tissue International. 1991; 48: 153-6.*

Reinivuo H, Valsta LM, Laatikainen T, Tuomilehto J, Pietinen P. Sodium in the Finnish diet: II *European Journal of Clinical Nutrition. 2006; 60: 1160–7.*

Ross AC, Taylor CL, Yaktine AL, Del Valle HB. DRI Dietary Reference Intakes; Calcium Vitamin D. Committee to Review Dietary Reference Intakes for Vitamin D and Calcium. Washington, DC: National Academy Press; 2011.

Ross AC. Manson JE. Abrams SA. Aloia JF. Brannon PM. Clinton SK. Durazo-Arvizu RA, et al. The 2011 Dietary Reference Intakes for Calcium and Vitamin D: what dietetics practitioners need to know. *Journal of the American Dietetic Association. 2011; 111(4): 524-7.*

Roth DE, Martz P, Yeo R, Prosser C, Bell M, Jones AB. Are national vitamin D guidelines sufficient to maintain adequate blood levels in children? *Canadian Journal of Public. 2005; 96(6): 443-9.*

Rucker D, Allan JA, Fick GH, Hanley DA. Vitamin D insufficiency in a population of healthy western Canadians. *Canadian Medical Association Journal. 2002; 166(12): 1517-24.*

Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *Journal of American Dietetic Association. 2001; 101(5): 548-53.*

Satia JA, Patterson RE, Neuhouser ML, Elder J. Dietary acculturation: Applications to nutrition research and dietetics. *Journal of American Dietetic Association. 2002; 102(8): 1105-18.*

Satia JA, Patterson RE, Taylor VM, Cheney CL, Shiu-Thorton S, Chitnarong K, Kristal AR. Use of qualitative methods to study diet, acculturation, and health in Chinese-American women. *Journal of American of Dietetic Association. 2000; 100(8): 934-40.*

Satia JA. Dietary acculturation: definition, process, assessment, and implications. *International Journal of Human Ecology. 2003; 4(1): 71-86.*

Sato Y, Tamaki J, Kitayama F, Kusaka Y, Kodera Y, Koutani A, Iki M. Development of a FFQ to measure the dietary calcium intake of adult Japanese women. *Tohoku University Medical Press. 2005; 207: 217-22.*

Shi Y, Groh MD, Morrison H, Robinson C, Vardy L. Dietary sodium intake among Canadian adults with and without hypertension. *Chronic Diseases in Canada. 2011; 31(2): 79-87.*

Siani A, Guglielmucci F, Farinaro E, Strazzullo P. Increasing evidence for the role of salt and salt-sensitivity in hypertension. *Nutrition Metabolism and Cardiovascular Diseases. 2000; 10: 93-100.*

Singh RJ. Are clinical laboratories prepared for accurate testing of 25-hydroxy vitamin D? *Clinical Chemistry. 2008; 54: 221-3.*

Slomski A. IOM endorses vitamin D, calcium only for bone health, dispels deficiency claims. *Journal of American Medical Association. 2011; 305(5): 453-5.*

Statistics Canada. 2006 Census: Ethnic origin, visible minorities, place of work and mode of transportation. http://www.statcan.gc.ca/daily-quotidien/080402/dq080402a-eng.htm Accessed September 8th, 2011.

Statistics Canada. Canada's Ethno-cultural Mosaic, 2006 Census. Ottawa, ON: Ministry of Industry; 2008.

Statistics Canada. Provinces and Territories, 2006 census of population. Visible minority groups, percentage distribution, for Canada. http://www40.statcan.gc.ca/l01/ind01/l2_30000-eng.htm Accessed September 8th, 2011.

Steffen PR, Smith TB, Larson M, Butler L. Acculturation to Western society as a risk factor for high blood pressure: a meta-analytic review. *Psychosomatic Medicine. 2006; 68(3):386-97.*

Stolarz-Skrzypek K. Kuznetsova T. Thijs L. Tikhonoff V. Seidlerova J. Richart T. Jin Y. Olszanecka A. Malyutina S. Casiglia E. Filipovsky J. Kawecka-Jaszcz K. Nikitin Y. Staessen JA. European Project on Genes in Hypertension (EPOGH) Investigators. Fatal and nonfatal outcomes, incidence of hypertension, and blood pressure changes in relation to urinary sodium excretion. *Journal of American Medical Association. 2011; 305(17): 1777-85.*

Strazzullo P. The salt controversy at the turn of the century: no to prejudiced thinking, yes to concerted action. *American Journal of Clinical Nutrition. 2001; 73(3): 662-3.*

Szapocznik J, Kurtines W. Acculturation, biculturalism, and adjustment among Cuban Americans. In: Padilla AM, ed. Acculturation: Theory, Models, and Some New Findings. Boulder, Colorado: Westview; 1980: 130-59.

Szathmary EJE, Ritenbaugh C, Goodby CSM. Dietary change and plasma glucose levels in an Amerindian population undergoing cultural transition. *Social Science and Medicine. 1987; 24: 791-804.*

Taylor C, Lamparello B, Kruczek K, Anderson EJ, Hubbard J, Misra M. Validation of a food frequency questionnaire for determining calcium and vitamin D intake by adolescent girls with anorexia nervosa. *Journal of American of Dietetic Association. 2009; 109: 479-85.*

Taylor CB, Sharpe T, Shisslak C, Bryson S, Estes LS, Gray N, McKnight KM, Crago M, Kraemer HC, Killen JD. Factors associated with weight concerns in adolescent girls. *International Journal of Eating Disorders. 1998; 24(1): 31-42.*

Taylor RS, Ashton KE, Moxham T, Hooper L, Ebrahim S. Reduced Dietary Salt for the Prevention of Cardiovascular Disease: A Meta-Analysis of Randomized Controlled Trials (Cochrane Review). American *Journal of Hypertension. 2011; 24: 843-53.*

Tian HG, Hu G, Dong QN, et al. Dietary sodium and potassium, socioeconomic status and blood pressure in a Chinese population. *Appetite. 1996; 26(3): 235-46.*

Trimble J. Introduction: Social Change and Acculturation. Acculturation: Advances in Theory, Measurement, and Applied Research. American Psychological Association; 2003.

U.S. Department of Agriculture/Economic Research Service Nutrient Availability Data (2009). http://www.ers.usda.gov/Data/FoodConsumption/NutrientAvailIndex.htm. Accessed September 16, 2011.

Vatanparast H, Calvo MS, Green TJ, Whiting SJ. Despite mandatory fortification of staple foods, vitamin D intakes of Canadian children and adults are inadequate. *Journal of Steroid Biochemistry & Molecular Biology. 2010; 121(1-2): 301-3.*

Vatanparast H, Dolega-Cieszkowski JH, Whiting SJ. Many adult Canadians are not meeting current calcium recommendations from food and supplement intake. *Applied Physiology, Nutrition, & Metabolism. 2009; 34(2): 191-6.*

Vieth R, Cole DE, Hawker GA, Trang HM, Rubin LA. Wintertime vitamin D insufficiency is common in young Canadian women, and their vitamin D intake does not prevent it. *European Journal of Clinical Nutrition. 2001; 55(12): 1091-7.*

Whitworth JA. World Health Organization, International Society of Hypertension Writing Group. 2003 world health organization (WHO)/International society of hypertension (ISH) statement on management of hypertension. *Journal of Hypertension. 2003; 21(11): 1983-92.*

Wilkins K, Campbell NR, Joffres MR, et al. Blood pressure in Canadian adults. *Health Reports. 2010; 21(1): 37-46.*

Wilson DK, Ampey-Thornhill G. The role of gender and family support on dietary compliance in an African American adolescent hypertension prevention study. *Annual Behavioral Medicine. 2001; 23: 59-67.*

World Action on Salt and Health. Finland Salt Action Summary, 2009. http://www.worldactiononsalt.com/action/finland.doc. Accessed September 14th, 2011.

World Health Organization Forum. Reducing salt intake in populations: Report of a WHO forum and technical meeting, 2006. World Health Organization Web site. www.who.int/dietphysicalactivity/SaltReport-VC-April07.pdf. Accessed September 14th, 2011.

World Health Organization. Global Strategy on Diet, Physical Activity and Health Chronic Disease - key risk factors include high cholesterol, high blood pressure, low fruit and vegetable intake. Geneva, Switzerland: WHO press; 2003.

Wu H, Gozdzik A, Barta JL, et al. The development and evaluation of a food frequency questionnaire used in assessing vitamin D intake in a sample of healthy young Canadian adults of diverse ancestry. *Nutrition Research. 2009; 29(4): 255-61.*

Wu SJ, Pan WH, Yeh NH, Chang HY. Dietary nutrient intake and major food sources: the Nutrition and Health Survey of Taiwan Elementary School Children 2001-2002. *Asia Pacific Journal of Clinical Nutrition. 2007; 16(Suppl 2): 518-33.*

Yang EJ, Chung HK, Kim WY, Bianchi L, Song WO. Chronic diseases and dietary changes in relation to Korean-Americans' length of residence in the United Sates. *Journal of the American Dietetic Association, 2007; 107(6): 942-50.*

Yang GP, Fox HM. Food habit changes of Chinese persons living in Lincoln, Nebraska. *Journal of American Dietetic Association. 1979; 75: 420-4.*

3. RESEARCH METHODS

3.1 PARTICIPANTS & SETTINGS

The study was conducted in 2010 with a convenience sample of 81 men and women of Chinese descent originating from China, Taiwan, Hong Kong (either born in or outside of Canada) and aged between 18-58 years. Participants were recruited from the University of Alberta in Edmonton, Alberta. Forty participants were Canadian-born Chinese (CBC) and 41 were foreign-born Chinese (FBC). The study was elicited by advertising through campus posters and circulating recruitment emails on the listservs of international or Chinese student groups (e.g., UAISN: University of Alberta International Students' Network; ASK: Asian Students on Kampus; CSC: Chinese Students' Club). Exclusion criteria included history of chronic heart failure or hypertension or any other chronic conditions that might require dietary sodium restriction. The study received ethics approval from the Physical Education and Recreation, Agricultural, Life & Environmental Sciences and Native Studies Research Ethics Board, University of Alberta. All participants gave written informed consent prior to study enrollment. Participants received a $ 25 gift certificate as an honorarium upon completion of two 24-hour dietary recalls for their participation.

3.2 DATA COLLECTION

a. Dietary data: 24-hour dietary recalls

i. Multi-pass technique

Two in-depth 24-hour dietary recalls were collected for each participant following a four stage, multi-pass interviewing technique (Gibson, 2005) for one weekday and weekend day. A day-of the-week effect on usual intakes of an individual was accounted for by representing all days of the week in the study design. The interviews were administered in person by one trained bilingual (Mandarin-English) interviewer in the language of participant's preference. In the first step, a complete list of all foods and beverages (but not dietary supplements

such as multi-vitamins or minerals) consumed during the previous 24 hours before the day of interview, from midnight to midnight, were recorded, followed, in the second step, by a detailed description of each food and beverage consumed, including cooking methods, additions in cooking and/or at the table, and brand names (if possible). Standardized probe questions were used to elicit specific details for each food item. For example, for commercially-packaged foods, probe questions included the kind of food and brand name. In the third step, photographs, a set of measuring cups, spoons, and ruler, local household utensils (calibrated for use), or food models of various type were used as memory aids or to assist the respondent in assessing portion sizes of food items consumed. Information on the ingredients of mixed dishes consumed by the respondents was collected at this time. Finally in the fourth step, the recall was reviewed with the participant to ensure that all items have been recorded correctly. Specific areas to recheck for included unclear and unspecified time gap between meals and any misinterpreted or forgotten information such as a snack.

ii. Food portion size estimation

Estimates of the amount of each food and beverage item consumed were obtained in household measures. To assist participants in specifying and quantifying foods, various aids were used including 3-dimensional life-size food replicas (Nasco Life/form® with calibrated weight and/or volume), pictures, and containers of various sizes and types (spoons, cups, bowls, plates, commercial cans, and packets). These tools were standardized and specific to the Chinese food environment. Individual ingredients in mixed dishes were estimated by the participant, and then the portion (weight and/or volume) of the mixture consumed by the participant was estimated with these tools. Salt and soy sauce added in food preparation and at the table were estimated by the participant with the calibrated measuring spoons; the amount (volume) was then recorded. If foods reported were not prepared by the participants, their ingredients were verified either by contacting the cook, if possible, or asking the participant to do

so. Otherwise, the amounts and types of ingredients and seasonings in those foods were estimated based on generic recipes of the same type. Several recipes in the Food Processor software system were utilized to estimate standard seasonings and fats used in preparation such as green onion cake, sour and spicy soup, and Mapo tofu, a Chinese dish from the Szechuan province.

iii. Dietary data entry

Four individuals who only completed one recall were dropped from the analysis leaving 77 participants (n=38 Canadian-born Chinese (CBC); n= 39 Foreign-born Chinese (FBC)) from which to derive dietary source and nutrient intake information. Dietary data was entered into the Food Processor SQL® for Windows package version 10.6.0 (ESHA Research, Salem, OR, USA). The data entry procedure was in accordance with The Food Processor Data Entry Manual (ESHA research, 2006). A default food list was created for common foods (e.g., skim milk or commercial whole wheat bread) or food with little description (e.g., store bought chocolate chip cookie). This default list was followed to ensure consistency and reliability in data entry process. The Canadian Nutrient File (2007b) was used to obtain the nutrient composition of most Canadian foods and beverages. However, if a food item couldn't be found in the Health Canada Database, the closest match was chosen from the United States Department of Agriculture database. The USDA data source was derived from the National Nutrient Database for Standard Reference, Release 23 (USDA, 2010). Seldom, very few foods were chosen from the Brand Name/Manufacturer foods (from the Food Processor SQL® built-in database) when the best match was not in the Health Canada or USDA databases. Because these brand name foods might not have as many nutrients listed and reflect North American food products, the number of nutrients listed for each item was compared and the food item with the greatest number of nutrients listed was chosen when choosing between multiple brand name foods. The nutrient composition of several Chinese specific foods/ingredients was derived from the table of Taiwan food composition (2003)

(Department of Health, Taiwan, 2003).

When entering food amounts, if the measurement listed in the recall was not listed as one of the measure choices in the Food Processor program, an online measurement conversion source, the calorie counter (www.thecaloriecounter.com) was referred to for the conversion. However, if the measure was taken in comparison to the food models (Nasco Life/form® with calibrated weight and/or volume), the equivalent measurement and units were used.

The dietary recalls were checked twice by the interviewer for accuracy of input. The total energy intake (kcal/day) was used as the indicator of quality of dietary data collection and entry (Dennis et al., 2003; Anderson et al., 2010). The dietary recalls for exceptionally high (more than 5,000 kcal/day for women or more than 8,000 kcal/day for men) or low (less than 500 kcal/day) energy intakes were checked and verified for accuracy (Anderson et al., 2010). No participants were excluded from analyses. Foods with multiple ingredients were disaggregated during electronic data entry and analysis only if the respondents were able to provide a breakdown of the ingredients, that is, if foods were home-made; for example, a home-made steamed pork bun was entered as flour, garlic, leeks, pork, salt, oyster sauce, sugar, sesame oil and scrambled eggs became whole egg, tomato, green onion, oil.

b. Non-dietary data: demographic information

Demographic information such as participants' age (self-reported), gender, birth place, years in Canada (self-reported and categorized as <5, 5-15, 16-25, and >25 years), and occupation was obtained at the beginning of each 24-hour dietary recall interview for each participant. Participants were put under one of the birth place categories (i.e., China, Taiwan, or Hong Kong) if foreign-born and under Canada if Canadian-born. Participants' age at immigration to Canada was calculated by subtracting the length of time in Canada from self-reported age. Participants were described as either "University students" or

"non-student" under occupation status.

3.3 DATA ANALYSIS/CONSIDERATIONS

a. Statistical analysis

Continuous variables (both dietary and non-dietary data) were reported as means and standard deviations. The chi-square statistic was applied to test for group differences involving categorical demographic data and the t-test for differences between continuous variables by birth status (i.e., CBC vs. FBC), occupation status (i.e. student vs. non-student) and between the sexes. Linear regression, Pearson's correlation, and Spearman rho were used to assess the relationship between FBC's age and length of time (years) in Canada and their overall absolute and energy-adjusted (per 1000 Kcal) sodium, calcium, and vitamin D intakes. A one-way ANOVA was used to test for FBC's intake differences in sodium, calcium, and vitamin D among three year groups by their length of time in Canada. Statistical significance was considered at $p < 0.05$; analyses were performed using the SPSS for Windows statistical software package (version 16.0, SPSS, Inc., Chicago, IL, 2006). Due to day-to-day variations in nutrient intakes, valid estimates of micronutrient adequacy cannot be obtained using a one-day recall period (Barr, 2006). For multiple recalls, the Software for Intake Distribution Estimation (version 1.0, PC-SIDE, Iowa State University, Ames, IA, 2003) was used to adjust for intra-individual variations in sodium, calcium, and vitamin D intakes for 74 participants who were 19-50 years old and produce estimates of usual intake of these nutrients. The prevalence of excessive intake of sodium was then estimated and expressed as the proportion of the population exceeding the Upper Tolerable Intake Level (UL) for adults (IOM, 2004). The risks for calcium and vitamin D inadequacy were also reported based on the Estimated Average Requirements (EARs) for adults (IOM, 2011).

b. Overall dietary nutrient intake

Dietary data from participants who completed both 24-hour recall interviews (n=77) were converted into daily energy, macronutrient (i.e., carbohydrate, protein, and fat), and micro-nutrient intakes (i.e., vitamins and minerals). The mean percentages of energy from carbohydrate, protein, and fat (% of total carbohydrate, protein, and fat) were calculated by summing estimates for carbohydrate, protein, and fat for each food from both recalls and dividing by the total carbohydrate, protein and, fat consumed by the participants. The daily mean intakes for carbohydrate, protein, and fat were calculated and expressed in grams.

c. Dietary sources of sodium, calcium, and vitamin D

All foods and beverages were classified and assigned to one of 15 sodium food groups, 18 calcium food groups, and 11 vitamin D food groups by the interviewer based on their contribution to sodium, calcium and, vitamin D intakes. There was no double counting; for example, if a food was coded as "mixed dishes", the recipe, not the ingredients, was used, and vice versa. This enabled identification of foods and food groups that accounted for individual dietary sodium, calcium and, vitamin D intakes. Total sodium, calcium and, vitamin D intakes were calculated by summing estimates from all contributory food sources, including beverages, consumed at home or away from home. The contribution that specific food groups made to sodium, calcium and, vitamin D (% of total sodium, calcium or vitamin D intake) was calculated by summing the sodium, calcium and, vitamin D intakes from both dietary recalls for each food category and dividing by the total sodium, calcium and, vitamin D consumed by the participants.

A sodium food group was decided when the foods categorized under this group contributed at least 0.25% to either or both FBC's and CBC's total sodium intake. The same approach was applied to decide the calcium and vitamin D food groups. The sodium, calcium, and vitamin D food groups were

then cross-compared between CBC and FBC to determine the respective major food sources of these nutrients for CBC and FBC. For each and every food group, the sodium, calcium, and vitamin D intake was expressed as mg/person/day and daily consumption of each food was quantified as gram/person/day. Quantities for the meat and alternatives and pastas/noodles were expressed in terms of cooked weight. Among the sodium food groups, the dietary source category "Salt" reflects salt added during home cooking and at the table as well as when prepared by restaurants (through estimates based on generic recipes) but excludes salt in fast and processed foods (i.e., they remained aggregated in their own categories).

3.4 LITERATURE CITED

Anderson CA, Appel LJ, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *Journal of American Dietetic Association. 2010; 110(5): 736-45.*

Barr SI. Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology, Nutrition, & Metabolism. 2006; 31(1): 66-73.*

Dennis B, Stamler J, Buzzard M, Conway R, Elliott P, Moag-Stahlberg A, Okayama A, Okuda N, Robertson C, Robinson F. INTERMAP: the dietary data-process and dietary control. *Journal of Human Hypertension. 2003; 17: 609-22.*

Gibson RS. Principles of nutritional assessment. 2nd ed. Oxford, NY: Oxford University Press, Inc; 2005.

Institute of Medicine, Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: National Academy Press; 2011.

Institute of Medicine. Dietary Reference Intakes: applications in dietary assessment. Washington, DC: National Academy Press; 2004.

Table of Taiwan food composition [in Chinese]. Food and Drug Administration, Department of Health, Executive Yuan, R.O.C (Taiwan) website. http://www.doh.gov.tw/CHT2006/DM/DM2.aspx?now_fod_list_no=572&class_no=3&level_no=2. Accessed September 16th, 2011.

U.S. Department of Agriculture, Agricultural Research Service. 2010. USDA National Nutrient Database for Standard Reference, Release 23. Nutrient Data Laboratory Home Page, http://www.ars.usda.gov/ba/bhnrc/ndl. Accessed September 16, 2011.

4. DIETRARY SODIUM INTAKES AND FOOD SOURCES OF SODIUM IN CHINESE ADULTS IN EDMONTON, CANADA

4.1 INTRODUCTION

Chinese Canadians are the second largest visible minority group in Canada, representing 3.9% of the total Canadian population and 24% of the total visible minority population (Statistics Canada, 2006). In 2006, there were about 1.2 million Chinese residents in Canada, with 74.5% being foreign-born (i.e., first-generation Canadian) (Statistics Canada, 2006). Sources of sodium in the Chinese diet consumed in Asian countries differ from the North American diet (James et al., 1987; Mattes et al., 1991; Brown et al., 2009). In the traditional Chinese diet, sodium mainly comes from discretionary use of salt, that is, salt or sauces containing salt added to foods when cooking (Anderson et al., 2010; Brown et al., 2009). However, a different picture with regards to dietary sources of sodium is apparent for the typical Northern American diet where an estimated 77% of sodium consumed comes from processed or restaurant-prepared foods with only 11% from discretionary use of salt (6% added at the table and 5% added during cooking) (Mattes et al., 1991; James et al., 1987). Despite the differences, little is known whether sodium sources change when Chinese individuals immigrate to Canada or the United States.

High levels of dietary sodium intakes are etiologically associated with elevated blood pressure (prehypertension/hypertension) and adverse cardiovascular health (Havas et al., 2004; Kearney et al., 2004; Hajjar et al., 2006). The Canadian Health Measures Survey (CHMS) estimated that hypertension affects nearly one-fifth (19%) of Canadian adults aged 20-79 years (Wilkins et al., 2010). Almost 30% of hypertension among Canadians may be attributed to excess dietary sodium (Joffres et al., 2007). Only a few studies (Mattes et al., 1991; Tian et al., 1996; Wu et al., 2007; Fischer et al., 2009; Anderson et al., 2010) have characterized and assessed the relative contribution of various food groups to overall sodium intake. Fewer studies exist for Chinese Canadians. Diverse

health outcomes among the Chinese population in Canada may have resulted, in part, from the effects of dietary acculturation whereby Chinese immigrants adopt the dietary practices of the mainstream culture (i.e., Westernized food habits) while still retaining their own. For this reason Chinese Canadians, both Canadian and foreign born, may require different nutrition messages than Caucasian Canadians in general (Satia et al., 2000; Satia et al., 2001; Satia et al., 2002).

Extensive research evidence indicates that lowering sodium intake reduces cardiovascular events (Chang et al., 2006; Cook et al., 2007). Research is therefore required to identify the common dietary sodium sources of Chinese Canadians to enable dietetic practitioners and nutrition educators to assist Chinese Canadians to make healthy food choices. The primary objectives of this study were to examine sodium intake and identify primary food sources of sodium consumed by Chinese adults in Edmonton Alberta, Canada. The study compared sodium intake and dietary sources of sodium between Canadian-born Chinese and foreign-born Chinese participants. We hypothesized that the common sodium food sources of the Chinese population differed by place of birth (i.e., Canada versus Asia). Study findings can be useful for sodium reduction nutrition messaging for each group.

4.2 Methods & SUBJECTS

a. Participants

The study was conducted in 2010 with a convenience sample of 81 men and women of Chinese descent originating from Canada, China, Taiwan, or Hong Kong and aged between 18-58 years. Participants were recruited from the University of Alberta. Subject recruitment was elicited by advertising through campus posters and circulating recruitment emails on the listserves of international/ Chinese student groups. Exclusion criteria included history of chronic heart failure or hypertension or any other chronic conditions that might

require dietary sodium restriction. The study received ethics approval from the Physical Education and Recreation, Agricultural, Life & Environmental Sciences and Native Studies Research Ethics Board, University of Alberta.

b. Data collection

Two in-depth 24-hour dietary recalls were collected following the multi-pass technique (Gibson, 2005) for one weekday and weekend day from 77 participants (n=38 Canadian-born Chinese (CBC); n= 39 Foreign-born Chinese (FBC)). Four individuals completed only one recall. The interviews were administered in person by one bilingual (Mandarin-English) trained interviewer following a protocol in the language of participant's preference. All foods and beverages consumed during the previous 24 hours before the day of interview, from midnight to midnight, were recorded. Dietary supplements such as multi-vitamins and minerals were not included. Demographic information (participants' age, gender, birth place, years in Canada, and occupation) was obtained at the beginning of each interview.

To assist participants in specifying and quantifying foods, various aids were used including 3-dimensional food models, pictures, containers of various sizes and types (spoons, cups, bowls, plates, commercial cans, and packets). These aids were standardized and specific to the Chinese eating food environment. The amount of salt and condiments used in food preparation were estimated by the participants using measuring spoons. If reported foods were not prepared by the participants, their ingredients were verified with the person who prepared the food when possible. Otherwise, the amounts and types of ingredients/seasonings in those foods were estimated based on generic recipes of the same type. Several recipes in the Food Processor software system were utilized to estimate standard seasonings and fats used in preparation (i.e., green onion cake, sour and spicy soup, and Mapo tofu, a Chinese dish from the Sichuan (Szechuan) province).

c. Data entry and dietary analysis

Dietary information was entered into the Food Processor SQL® for Windows package version 10.6.0 (ESHA Research, Salem, OR, USA). The Canadian Nutrient File (2007b) was used to obtain the sodium and nutrient composition of Canadian foods and beverages; whereas the sodium and nutrient composition of several Chinese specific foods/ingredients was derived from the Taiwan food composition table (2003) (Department of Health; Taiwan, 2003). A default food list was created and followed to ensure ingredient entry consistency. Foods with multiple ingredients were disaggregated during electronic data entry and analyzed only if the respondents were able to provide a breakdown of the ingredients. For example, a home-made steamed pork bun was entered as flour, garlic, leeks, pork, salt, oyster sauce, sugar, and sesame oil; and, scrambled eggs became whole egg, tomato, green onion, oil. All foods were classified and assigned to one of 15 food groups. This enabled identification of foods and food groups that accounted for the majority of dietary sources of sodium. There was no double counting; for example, if a food was coded as “mixed dishes”, the recipe, not the ingredients, was used, and vice versa.

Total sodium intake was calculated by summing estimates from all contributory food sources, including foods and beverages, consumed at home or away from home for both CBC and FBC participants. The dietary source category “Salt” reflects table salt added to food during home cooking and at the table as well as when prepared by restaurants but excludes salt in fast and processed foods (i.e., they remained aggregated in their own categories). The contribution that specific food groups made to percent of total sodium intake was calculated by summing the sodium intakes from both dietary recalls for each food category and dividing by the total sodium consumed by the participants. Fifteen food groups were ranked based on their contribution to sodium. Daily consumption of each food and food group was also quantified and expressed in grams.

Quantities for meat and alternatives and pastas/noodles were expressed in terms of cooked weight.

The dietary recalls were checked twice for accuracy of input by the interviewer. Exceptionally high or low nutrient intakes were confirmed and verified if any 24-hour dietary recall was less than 500 kcal/day or more than 5,000 kcal/day for women or more than 8,000 kcal/day for men (Anderson et al., 2010).

d. Statistical analysis:

For descriptive purposes, continuous variables were reported as means and standard deviations. The Chi-square statistic was used to test for group differences involving categorical demographic data; whereas the independent *t* test was used to test for group differences (gender and birth status) for continuous demographic and dietary data. The relationship between the sodium intake (absolute and energy-adjusted (per 1000 kcal)) and FBC's years in Canada was explored using both one-way ANOVA (Analysis of Variance) and Pearson's correlation. Statistical significance was considered at $p< 0.05$; analyses were performed using the SPSS for Windows statistical software package (version 16.0, SPSS, Inc., Chicago, IL, 2006). Due to day-to-day variations in nutrient intakes, valid estimates of micronutrient adequacy cannot be obtained using a single dietary recall (Barr et al., 2006). The Software for Intake Distribution Estimation (version 1.0, PC-SIDE, Iowa State University, Ames, IA, 2003) was used to adjust for intra-individual variations in sodium intakes for participants aged between 19-50 years old (n=74) and to produce estimates of usual intake. The prevalence of excessive intake of sodium was then estimated and expressed as the proportion of the sample exceeding the Upper Tolerable Intake Level (UL) for adults (IOM, 2000).

4.3 RESULTS

a. Demographics

Table 4-1 summarizes participants' characteristics. The respective mean ages for CBC and FBC were 25 ± 6.2 and 30 ± 10.2 years (*P*=0.02). The proportion of male and female participants was close to 50% for both CBC and FBC. The majority of FBC was from Mainland China (n=31, 76%) and had been in Canada for less than five years (n=24, 59%). On average, FBC participants had resided in Canada for 3.5 (10.0) years (median and interquartile range). Their mean age at immigration to Canada was 23.5 ± 8.2 years. The percentages of University students were similar for both CBC and FBC (70.0% vs. 75.6%, respectively, *P*=0.57).

b. Overall dietary nutrient intakes

Dietary data from participants who completed both 24-hour recall interviews (n=77) were used to describe macro- and micronutrient intakes. The mean daily energy intake was 2,401 ± 842 kcal. The respective daily mean intakes for carbohydrate, protein, and fat were 328 ± 130 g, 102 ± 44 g, and 77± 35 g. The mean percentages of energy from carbohydrate, protein, and fat were 55%, 17%, and 29%, respectively. The mean energy and macro- and micronutrient intakes between CBC and FBC (Table 4-2) were not significantly different. The mean energy and macro- and micronutrient intakes were not significantly different between FBC living in Canada for less than and more than five years (Table 4-3). Also, the overall nutrient intakes were not significantly different between students (75.3%) and non-student (24.7%) participants (results not shown).

c. Sodium intakes and food sources of sodium

The average sodium intake of the 77 participants was 3,623 ± 1,406 mg/day. Mean sodium intake was 3,614 ± 1,549 mg/day/person for CBC and 3,631 ± 1,263 mg/day/person for FBC (Table 4-2) and were not significantly

different between CBC and FBC (*P*=0.958). Daily sodium intake for males (4,175 ± 1,518 mg) was significantly higher than for females (3,162 ± 1,130 mg) (*P*=0.002); however, sodium intake per 1000 kcal/day was not significantly different between the sexes (1,431 ± 520 mg for females and 1,604 ± 573 mg for males)(*P*=0.179). Usual sodium intakes (Figure 4-1) of 99% of males and 84% of females aged between 19-50 years (n=74) exceeded the Tolerable Upper Intake Level (UL) of 2300 mg/day for adults (IOM, 2000). For FBC no statistically significant associations were found between years living in Canada and sodium intake (results not shown).

The major food sources of sodium for both CBC and FBC were commercially prepared/processed foods (59.8% versus 54.1% of sodium, respectively). Important sodium sources for CBC were store-bought grains (e.g., breads/cereals/pastas) (11.4%), fast foods (11.2%), restaurant-prepared mixed dishes (7.4%), soups/broths (6.9%), snacks/candy bars (5.5%), cured meats (5.3%), and dairy products (e.g., cheese/yogurt/ice cream) (5.2%). For FBC, important sources of sodium were commercially processed meats and poultry (9.1%), grains (8.9%), mixed dishes (8.7%), soups and broths (8.1%), fast foods (5.6%), dairy products (4.4%), and pickled vegetables (3.1%).

Condiments, which included table salt, contributed substantially to dietary sodium intake of CBC and FBC (27.8% and 35.1% of sodium, respectively); mostly from table salt added to foods during home cooking and when prepared by restaurants (13.3% of sodium) (1.25 g salt/person/day) for CBC vs. (20.7% of sodium) (1.96 g salt/person/day) for FBC. Soy sauce accounted for 4.9% and 7.6% of total sodium intake for CBC and FBC, respectively. Sodium from monosodium glutamate (MSG) was minimal at 1.1% of the total for FBC and none for CBC. Western condiments (e.g., ketchup, mustard, and pickle relish, etc.) contributed 5.7% and 0.5%, respectively, to the total sodium intake of CBC and FBC.

4.4 DISCUSSION

The present study was the first to use standardized methods to measure sodium intake in a Chinese Canadian population and to compare the food sources of sodium by birth status (i.e., Canadian-born Chinese vs. foreign-born Chinese). We showed that the majority of sodium consumed by CBC was found in commercially processed foods. Salt and other sauces/condiments added to foods during home cooking, at the table or when prepared by restaurants contributed to more than one-quarter of the sodium intake of CBC. Contrary to what was hypothesized, FBC also obtained the majority of their total sodium from commercially processed foods but about a third of their sodium came from discretionary use of salt or other sauces/condiments added to foods. Some other differences in sodium food sources were that CBC got a greater percent of sodium from fast foods and Western-style condiments than FBC; whereas table salt and Asian-style condiments contributed more sodium to the diet of FBC than CBC.

Similar to our study sample, the Canadian Community Health Survey (CCHS) 2004-Nutrition (Garriguet, 2007; Fischer et al., 2009) showed that more than half (55%) of dietary sodium in the general Canadian diet is from commercially prepared foods; pizza/sandwiches/submarines/hamburgers/hotdogs (19%), soups (7.4%), poultry/poultry dishes/beef (6.7%), cheese/cereals (6.2%), pasta (5.7%), liquid milk/milk-based beverages (4.0 %), potatoes (3.4%), and sauces (2.9%). Similarly, data from the United States National Health and Nutrition Examination Surveys (NHANES) in 2001-2002 (Moshfegh et al., 2005), 2003-2004 (USDA, 2003-2004), and 2005-2006 (USDA, 2005-2006) indicated that top contributors of sodium are breads, grains/cereals, meats, poultry, eggs, dairy products, sauces/seasoning, and soups. Grain products (breads, cereals, noodles/pastas) are an important contributor of sodium due to the large quantity and high frequency of consumption of these foods rather than their sodium content. Foods such as

cured meats and sauces, on the other hand, are often consumed in small quantities, but contribute substantially to the amount of sodium in the diet because of their high sodium content (Fischer et al., 2009; Anderson et al., 2010).

The People's Republic of China INTERMAP study found extensive use of table salt (75.8%) in home cooking and at the table (Anderson et al., 2010). The Taiwan Nutrition and Health Survey 2001-2002 reported that discretionary use of salt, soy sauce, other seasonings as well as pickles accounted for more than 60% of sodium from food sources (Wu et al., 2007). Other data from China (Tian et al., 1996; Zhai and Yang, 2002) also show that the discretionary use of cooking salt, soy sauce, and the flavor enhancer MSG are major sources of sodium. Taken together, these studies indicate higher sodium intakes from discretionary consumption and lower dietary sodium from processed or restaurant-prepared foods than among the Chinese-Canadians in our Edmonton sample. The latter had sodium intake mainly from the high frequency of consumption of commercially processed foods typical of Western diets (Sanchez-Castillo et al., 1987; Mattes et al., 1991; Tian et al., 1996) whereas discretionary sodium intake, that is, salt added to foods during home cooking and when prepared by restaurants, only contributed moderately to sodium intake.

Globally, hypertension is of great public health concern because hypertension is the single most important cause attributable to mortality (Khaw and Barret-Connor, 1988). High levels of dietary sodium are an established risk factor for prehypertension/ hypertension, stroke, coronary vascular disease, congestive heart failure, and renal failure. The WHO recommendation for sodium is <2,000 mg/day (WHO, 2007) and the Institute of Medicine's recommended Tolerable Upper Intake Level (UL) for sodium is 2,300 mg/day for adults (IOM, 2000). In Canada and other countries, sodium intake is higher than these recommendations (Brown et al., 2009; Anderson et al., 2010). The mean sodium intake in China derived from the INTERMAP study is 3,990 mg/day (Anderson et al., 2010), and the China Health and Nutrition Survey 2002 gave an

estimate of 6,268 mg/day (Zhai and Yang, 2002). In rural farming populations in China, salt is still used for the preservation and storage of foods (e.g., salting of vegetables, eggs, and meats) where home refrigerators are not widely available (Anderson et al., 2010). In comparison, the sodium intake of FBC in Edmonton, many of whom were born in China, was 3,631 ± 1,263 mg per day. Results from the 2004 CCHS-Nutrition indicate that Canadian adults consume 3,400 mg sodium per day, that the average daily intake of sodium exceeds the ULs (Figure 4-1), and that males consume more sodium than females (Figure 4-2) (Mattes and Donnelly, 1991; Garriguet, 2007). Similarly, the average sodium intake of our Edmonton sample (CBC and FBC altogether) in the current study was 3,622 ± 1,406 mg with usual sodium intakes of 99% of males and 84% of females exceeding the UL.

The results showed that CBC and FBC participants both ate foods more typical of a Northern American than traditional Chinese diets with regards to sources of sodium. This finding might be attributable to changes in the dietary environment or dietary acculturation. Dietary acculturation is a complex process which occurs when a minority group in a new country adopts the food habits of the mainstream culture (Satia et al., 2001; Satia et al., 2002). Dietary changes occur by substitution, addition, or modification. Among Chinese immigrants to Canada and the United States, rice continues to be an important staple, but other traditional foods are replaced by cereal, bread, sandwiches, and soft drinks (Chau et al., 1990; Pan et al., 1999; Lee etal., 1999; Lv and Cason, 2004). In a study by Tian and colleagues, inclusion of processed foods is reflective of adoption of western dietary practices in the Chinese population (Tian et al., 1996). Dietary changes are related to the length of stay in the new country and to social contact with people in the new culture (Lee et al., 1999; Lv and Cason, 2004; Bojanic and Xu, 2006).

Given that the majority (75.3%) of our sample was comprised of students attending the University of Alberta, the overall food environment at the

University may have also played an important role in determining these students' food choices. Having typical Canadian grocery store chains (such as SAFEWAY and Sobey's) located within walking distance to the University and fast food restaurants located on campus may provide easy access to Western-style foods and lead to convenient purchase of these foods as a result. In a study, Parvanta (1987) found that Chinese students with limited amounts of money to spend tended to buy relatively cheaper Western-style foods such as fast foods. Fast foods are generally more economical and can be purchased in most University cafeterias compared to ethnic foods (Parvanta, 1987; Pan et al., 1999). Other explanations for adoption of processed/restaurant-prepared foods among Asian students in North America include limited time to prepare traditional dishes because of hectic school schedules and increased availability of Western-style foods (Ho et al., 1966; Parvanta, 1987; Pan et al., 1999;).

Among our FBC sample, many had factors that have been used to predict degree of dietary acculturation to Western eating patterns, such as length of time in Canada (3.5 years, on average) and being well-educated and fluent in English (a mandatory requirement for admission to the University of Alberta) which may account for the similarity in sodium intake between CBC and FBC. In addition, although we did not capture the underlying reason why FBC rapidly acculturated, it likely due to having young children at home. We did not collect data on whether participants have young children in the household, the age of these children, the type of child care/school their children attend, and information on children's overall food environment. It might have well been that a high percentage of the FBC sample had children at home influencing their food choices (Satiaet al., 2002; Dearth-Wesley et al., 2011). Lv and Brown (2011) reported that many young children had learned to like certain Western foods (such as chicken nuggets, spaghetti, macaroni and cheese, cookies, sandwiches, and pizza) over traditional Chinese dishes. These Western foods were provided to children at day cares and schools. Over time, by the constant request of the

children, some families started to adopt and serve these popular semi-manufactured Western foods well-liked by the children at home in addition to the Chinese foods (Lv and Brown, 2011).

Kaplan and coworkers (2002) found a positive relationship between Asian immigrants' length of residence in Canada and blood pressure which may be the result of changes in dietary practices, including meals patterns and food choices. Nutritional messages to reduce sodium intake would be most effective if they were tailored to the level of acculturation of the target audience (Satia et al., 2001). Our findings indicate that after 3.5 years in Canada (on average), the sodium intake of FBC is comparable to CBC, that FBC have lower sodium intakes than adults in China, and that both FBC and CBC have excessive intakes of sodium. Individual efforts to reduce salt intake are often ineffective at lowering sodium consumption. The INTERMAP data (Anderson et al., 2010) show that for individuals who made a conscious effort to reduce salt intake only small reductions in sodium were observed; and salt intake still remained considerably above the recommended levels. For both CBC and FBC, efforts to reduce sodium intake should target reductions in the consumption of commercially processed or prepackaged foods and lowering the sodium content of commercially processed products as opposed to limiting discretionary use of salt for Chinese individuals who are practicing more traditional Chinese diets.

A healthy public policy approach involving restaurants and food industry sectors is important in determining levels of salt in foods. For this reason in 2007, Health Canada established the Sodium Working Group to develop a population health strategy for reducing sodium intake among Canadians with the goal of reducing the daily sodium intake of the population to 2,300 mg by 2016 (Health Canada, 2010). The strategy proposed is comprehensive and includes partnership with the food industry and restaurant and foodservice sector to set sodium reduction targets for processed foods in Canada. However, a high percentage of processed food products and condiments sold at Chinese grocery

chains and used by Chinese Canadians are often manufactured outside of Canada limiting the ability of Health Canada to target these products. To effectively reduce the sodium intake of Chinese Canadians, the importers of these products (managers and owners of grocery stores) need to be made aware of this issue, and the public needs heightened awareness of the potentially higher sodium content of food products prepared in Asian countries.

Another public health issue around sodium reduction that needs to be noted is that the table salt in the U.S. and Canada is mandatorily iodized with potassium iodide whereas the salt used in food processing and fast food industries is not (Venkatesh Mannar & Dunn, 1995; Dasgupta et al., 2007). Avoiding discretionary use of salt lowers not only the sodium but also iodine intake. This is especially concerning for populations facing thyroid problems (such as goiter) if their iodine intake from natural food sources (such as seafood) or supplementation is inadequate (NIH, 2011). As indicated by Satin (2006) the iodine intake would increase by five times without increasing salt intake if salt from all sources was iodized. In summary, restaurants and food industries should be urged not only to cut back on the levels of salt in their products but also to replace the remaining salt with iodized one so that the meals eaten away from home can provide as much as iodine as meals prepared at home (Dasgupta et al., 2007).

4.5 STRENGTHS & LIMITATIONS

The strengths of this study include standardized collection of nutrition data specific to the Chinese Canadian food environment based on two in-depth, multi-pass 24-hour dietary recalls per participant; updated and standardized tables on the nutrient content of reported foods; and multiple quality control procedures. The limitations are a relatively small sample size potentially limiting the generalizability of the study findings. The 24-hour dietary recall method used in the study also meant that data were subject to individual recall bias. Specific problems encountered for estimating dietary sodium intake included: accurately

quantifying the amount of table salt added during cooking (including at the restaurants) and at the table, and that not all salt added during cooking is retained by the food (i.e., salt remains on the plate or in the cooking water). In addition, no urinary sodium excretion was assessed to verify individuals' sodium intakes.

4.6 CONCLUSIONS

The aims of this study were achieved, namely, to document sodium intakes and identify the common sodium food sources among some Chinese individuals in Canada, Canadian-born and foreign-born alike. However, the efforts in this area still need to be enhanced so that nutrition messages can be developed and tailored to reflect intake patterns of Chinese Canadians. The study findings imply many similar sodium sources for both CBC and FBC and that reduction of salt consumption from processed foods is essential for both groups as is moderation in salt/soy sauce use in home cooking or when eating at restaurants. The study results can be useful for dietetic practitioners who work with Chinese clients to educate them on the major food sources of sodium to ensure that sodium reduction strategies in this population are effective. This study also lays the groundwork for further research on sodium-related dietary practices in Chinese Canadians and Americans, to see if similar findings can be found among Chinese individuals in different parts of Canada and the United States. For nutrition researchers in Canada and the United States, the top food sources of sodium reported in this study could form the foundation for the development of a food frequency questionnaire for assessing sodium intake in the Chinese ethnic population.

Table 4-1 Demographic characteristics of participants (n= 81)

	Canadian-born (n= 40)	Foreign-born (n= 41)	*P* value
	N (%)		
Age (y)			
< 35	35 (87.5)	27 (65.9)	0.02
≥ 35	5 (12.5)	14 (34.1)	
Mean age (y) ± SD	25.0 ± 6.2	30.8 ± 10.2	0.01
Gender			
Males	19 (47.5)	18 (43.9)	0.75
Females	21 (52.5)	23 (56.1)	
Birth place			
Canada	40 (100.0)	0 (0)	
Mainland China	0 (0)	31 (75.6)	NA
Hong Kong	0 (0)	5 (12.2)	
Taiwan	0 (0)	5 (12.2)	
Years in Canada (y)			
<5	0 (0)	24 (58.5)	
5 -15	0 (0)	9 (22.0)	NA
16 -25	26 (65.0)	6 (14.6)	
>25	14 (35.0)	2 (4.9)	
Years in Canada (y) (Median and interquartile range)	NA	3.5 (10.0)	NA
Mean age at arrival in Canada (y) ± SD	NA	23.5 ± 8.2	
Language preference			
English	40 (100.0)	6 (14.6)	NA
Chinese-Mandarin	0 (0)	35 (85.4)	
Occupation status			
University students	28 (70.0)	31 (75.6)	0.57
Non-student	12 (30.0)	10 (24.4)	
NA: Not applicable			

Table 4-2 Daily energy and nutrient intakes (mean ± SD) of Canadian-born and foreign-born Chinese

	Canadian-born (n= 39)	Foreign-born (n=38)	Total (n=77)	Dietary Reference Intakes	*P* value
Energy (kcal)	2506 ± 935	2293 ± 732	2401 ± 842	NA	0.270
Protein (g)	104 ± 46	100 ± 42	102 ± 44	RDA 19-50 yr: ♂ 56 ♀ 46	0.734
Total fat (g)	78 ± 37	76 ± 34	77 ± 35	NA	0.847
Sugar (g)	97 ± 41	88 ± 40	93 ± 41	NA	0.344
Carbohydrate (g)	349 ± 148	306 ± 105	328 ± 130	RDA 19-50 yr: ♂ 130 ♀ 130	0.143
Calcium (mg)	781 ± 337	809 ± 369	795 ± 351	RDA 19-50 yr: ♂ 1000 ♀ 1000	0.737
Phosphorus (mg)	1322 ± 520	1374 ± 560	1348 ± 537	RDA 19-50 yr: ♂ 700 ♀ 700	0.670
Iron (mg)	16.5 ± 7.0	14.5 ± 5.6	15.5 ± 6.4	RDA 19-50 yr: ♂ 8 ♀ 18	0.186
Zinc (mg)	11.9 ± 6.1	12.6 ± 8.2	12.3 ± 7.1	RDA 19-50 yr: ♂ 11 ♀ 8	0.659
Sodium (mg)	3614 ± 1549	3631 ± 1264	3623 ± 1406	AI 19-50 yr: ♂ 1500 ♀ 1500	0.958
Vitamin B1 (mg)	1.8 ± 1.0	1.6 ± 0.7	1.7 ± 0.9	RDA 19-50 yr: ♂ 1.2 ♀ 1.1	0.314
Vitamin B2 (mg)	1.9 ± 0.7	1.9 ± 0.7	1.9 ± 0.7	RDA 19-50 yr: ♂ 1.3 ♀ 1.1	0.931
Vitamin B 6 (mg)	2.1 ± 1.1	1.7 ± 0.7	1.9 ± 0.9	RDA 19-50 yr: ♂ 1.3 ♀ 1.3	0.062
Vitamin B12 (μg)	3.9 ± 2.1	5.3 ± 3.4	4.6 ± 2.9	RDA 19-50 yr: ♂ 2.4 ♀ 2.4	0.460
Vitamin A (μg RAE)	746 ± 543	612 ± 369	680 ± 467	RDA 19-50 yr: ♂ 900 ♀ 700	0.213
Vitamin C (mg)	145 ± 102	146 ± 89	145 ± 95	RDA 19-50 yr: ♂ 90 ♀ 75	0.966
Vitamin D (μg)	3.8 ± 3.4	5.0 ± 3.9	4.4 ± 3.7	RDA 19-50 yr: ♂ 15 ♀ 15	0.158
% Energy from fat	28 ± 8	30 ± 8	29 ± 8	AMDR 19-50 yr: ♂ 20-35 ♀ 20-35	0.390
% Energy from protein	17 ± 4	17 ± 4	17 ± 4	AMDR 19-50 yr: ♂ 10-35 ♀ 10-35	0.388
% Energy from carbohydrate	56 ± 10	54 ± 9	55 ± 9	AMDR 19-50 yr: ♂ 45-65 ♀ 45-65	0.381

RDA: recommended dietary allowances; AI: adequate intakes; AMDR: acceptable macronutrient distribution range

Table 4-3 Daily energy and nutrient intakes (mean ± SD) of Foreign-born Chinese in Edmonton, Canada

Length of time in Canada	Less than 5 years (n= 22)	More than 5 years (n=16)	Total (n=38)	Dietary Reference Intakes	*P* value
Energy (kcal)	2255 ± 727	2341 ± 761	2293 ± 732	NA	0.712
Protein (g)	101 ± 42	99 ± 42	100 ± 42	RDA 19-50 yr: ♂ 56 ♀ 46	0.843
Total fat (g)	76 ± 35	77 ± 34	76 ± 34	NA	0.946
Sugar (g)	87 ± 38	90 ± 44	88 ± 40	NA	0.830
Carbohydrate (g)	297 ± 99	318 ± 116	306 ± 105	RDA 19-50 yr: ♂ 130 ♀ 130	0.550
Calcium (mg)	809 ± 296	808 ± 461	809 ± 369	RDA 19-50 yr: ♂ 1000 ♀ 1000	0.998
Phosphorus (mg)	1385 ± 545	1360 ± 597	1374 ± 560	RDA 19-50 yr: ♂ 700 ♀ 700	0.897
Iron (mg)	14.1 ± 4.6	15.1 ± 6.9	14.5 ± 5.6	RDA 19-50 yr: ♂ 8 ♀ 18	0.621
Zinc (mg)	12.0 ± 6.2	13.6 ± 10.5	12.6 ± 8.2	RDA 19-50 yr: ♂ 11 ♀ 8	0.563
Sodium (mg)	3747 ± 1196	3472 ± 1375	3631 ± 1264	AI 19-50 yr: ♂ 1500 ♀ 1500	0.516
Vitamin B1 (mg)	1.6 ± 0.8	1.7 ± 0.6	1.6 ± 0.7	RDA 19-50 yr: ♂ 1.2 ♀ 1.1	0.820
Vitamin B2 (mg)	1.9 ± 0.5	2.0 ± 0.9	1.9 ± 0.7	RDA 19-50 yr: ♂ 1.3 ♀ 1.1	0.883
Vitamin B 6 (mg)	1.8 ± 0.7	1.6 ± 0.7	1.7 ± 0.7	RDA 19-50 yr: ♂ 1.3 ♀ 1.3	0.610
Vitamin B12 (μg)	6.0 ± 3.7	4.2 ± 2.8	5.3 ± 3.4	RDA 19-50 yr: ♂ 2.4 ♀ 2.4	0.120
Vitamin A (μg RAE)	538 ± 245	714 ± 482	612 ± 369	RDA 19-50 yr: ♂ 900 ♀ 700	0.194
Vitamin C (mg)	161 ± 98	125 ± 72	146 ± 89	RDA 19-50 yr: ♂ 90 ♀ 75	0.229
Vitamin D (μg)	4.8 ± 3.4	5.4 ± 4.6	5.0 ± 3.9	RDA 19-50 yr: ♂ 15 ♀ 15	0.647
% Energy from fat	30 ± 8	30 ± 8	30 ± 8	AMDR 19-50 yr: ♂ 20-35 ♀ 20-35	0.880
% Energy from protein	18 ± 4	17 ± 4	17 ± 4	AMDR 19-50 yr: ♂ 10-35 ♀ 10-35	0.329
% Energy from carbohydrate	53 ± 8	54 ± 10	54 ± 9	AMDR 19-50 yr: ♂ 45-65 ♀ 45-65	0.902

RDA: recommended dietary allowances; AI: adequate intakes; AMDR: acceptable macronutrient distribution range

Table 4-4 Dietary sources of sodium for Chinese adults in Edmonton, Canada

	Canadian-born (n=39*)			Foreign-born (n=38*)		
Daily consumption of foods and food groups	weight (g/d/ person)	mg/d/ person	% Na	weight (g/d/ person)	mg/d/ person	% Na
	mean=3614 ± 1549 mg			mean=3631 ± 1264 mg		
Condiments, total	47.4	1003.3	27.8	17.1	1275.4	35.1
Common	6.6	504.3	14.0	4.0	752.3	20.7
Table salt (from home cooking and restaurants)	1.3	480.6	13.3	2.0	749.9	20.7
BBQ sauce/hot sauce	5.3	23.7	0.7	2.1	2.5	0.1
Canadian, total	33.6	204.4	5.7	2.5	18.9	0.5
Ketchup/mustard/pickle relish/salsa	33.6	204.4	5.7	2.5	18.9	0.5
Asian, total	7.2	294.6	8.2	10.6	504.2	13.9
Soy sauce	3.5	178.4	4.9	5.0	276.8	7.6
Teriyaki sauce	2.1	78.2	2.2	3.5	134.7	3.7
Oyster sauce/bean paste/stir-fry sauce	1.6	38.0	1.1	1.8	54.8	1.5
MSG (added in home cooking)	0.0	0.0	0.0	0.3	38.0	1.0
Soups and broths	40.2	248.7	6.9	30.6	295.7	8.1
Fast foods, total	88.7	404.9	11.2	37.5	203.5	5.6
Burgers/hotdogs/fried chicken/fries	56.6	240.6	6.7	2.9	13.3	0.4
Pizzas/sandwiches	32.1	164.3	4.5	34.7	190.3	5.2
Grains, total	208.7	411.1	11.4	107.7	324.0	8.9
Breads	30.0	170.8	4.7	27.9	165.6	4.6
Cereals	19.8	86.0	2.4	8.2	37.6	1.0
Muffins/buns/bagels/waffles	15.1	78.2	2.2	11.1	52.7	1.4
Pastas/noodles	143.7	76.0	2.1	60.5	68.1	1.9
Dairy, total	236.7	193.9	5.4	328.0	159.4	4.4
Cheese	11.3	89.3	2.5	3.2	17.2	0.5
Yogurt/ice cream	28.0	17.3	0.5	36.2	20.8	0.6
Soy milk	13.3	6.2	0.2	45.1	19.4	0.5
Milk	184.2	81.2	2.2	243.5	101.9	2.8

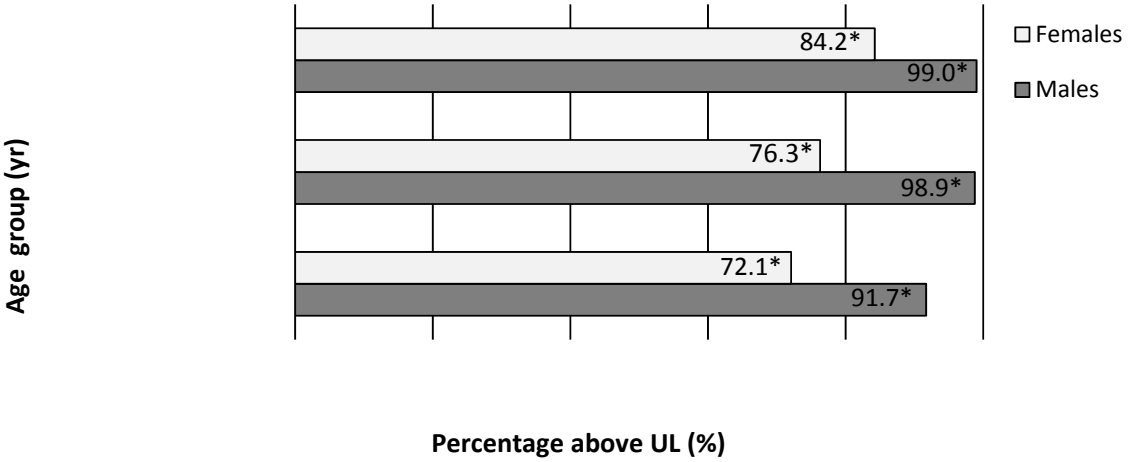
(continued)

Table 4-4 Dietary sources of sodium for Chinese adults in Edmonton, Canada

(continued)	Canadian-born (n=39*)			Foreign-born (n=38*)		
Daily consumption of foods and food groups	weight (g/d/ person)	mg/d/ person	% Na	weight (g/d/ person)	mg/d/ person	% Na
Meats and alternatives, total	182.7	386.7	10.7	195.0	509.2	14.0
Sausages/luncheon meat/ cured meat/meat loaf	19.0	182.3	5.0	18.2	232.6	6.4
Smoked/canned fish	2.2	10.4	0.3	4.6	36.4	1.0
Seafood(shrimps/mollusks /fish)	17.0	26.6	0.7	37.6	51.7	1.4
Poultry	63.5	70.7	2.0	44.0	98.2	2.7
Eggs	24.9	55.0	1.5	26.5	48.6	1.3
Red meats	56.0	41.6	1.2	64.1	41.6	1.1
Snack foods, total	188.2	198.4	5.5	32.2	174.5	4.8
Snack mixes/chips	78.7	128.0	3.5	7.9	39.2	1.1
Cookies/crackers	47.3	52.3	1.4	17.0	127.0	3.5
Candies/candy bars	62.3	18.1	0.5	7.3	8.4	0.2
Mixed dishes, total	93.1	335.8	9.3	72.5	317.3	8.7
Sushi/fish-based surimi/teriyaki dishes	38.8	145.7	4.0	45.0	162.9	4.5
Dim Sum dumplings/buns/ wontons/green onion cakes	34.4	121.4	3.4	27.5	154.4	4.3
Stew/curry/gravy/mashed potatoes	20.0	68.8	1.9	0.0	0.0	0.0
Spreads and dips, total	19.8	115.9	3.2	13.8	52.2	1.4
Hummus	5.0	19.0	0.5	0.0	0.0	0.0
Salad dressing	3.3	20.3	0.6	10.0	38.4	1.1
Alfredo sauce	5.9	48.2	1.3	0.0	0.0	0.0
Butter/margarine/peanut butter	5.6	28.3	0.8	3.8	13.8	0.4
Nuts and seeds	2.5	0.3	0.0	12.3	45.6	1.3
Pickled vegetables	6.5	87.1	2.4	10.1	114.2	3.1
Cake/pastries/pies	21.6	46.7	1.3	10.9	30.3	0.8
Other	NA	181.5	5.0	NA	129.9	3.6
Total		3614.2	100.0		3631.2	100.0

NA: not applicable
*Information were excluded from the analysis focused on food sources of sodium if participants only completed one dietary recall (n=4).

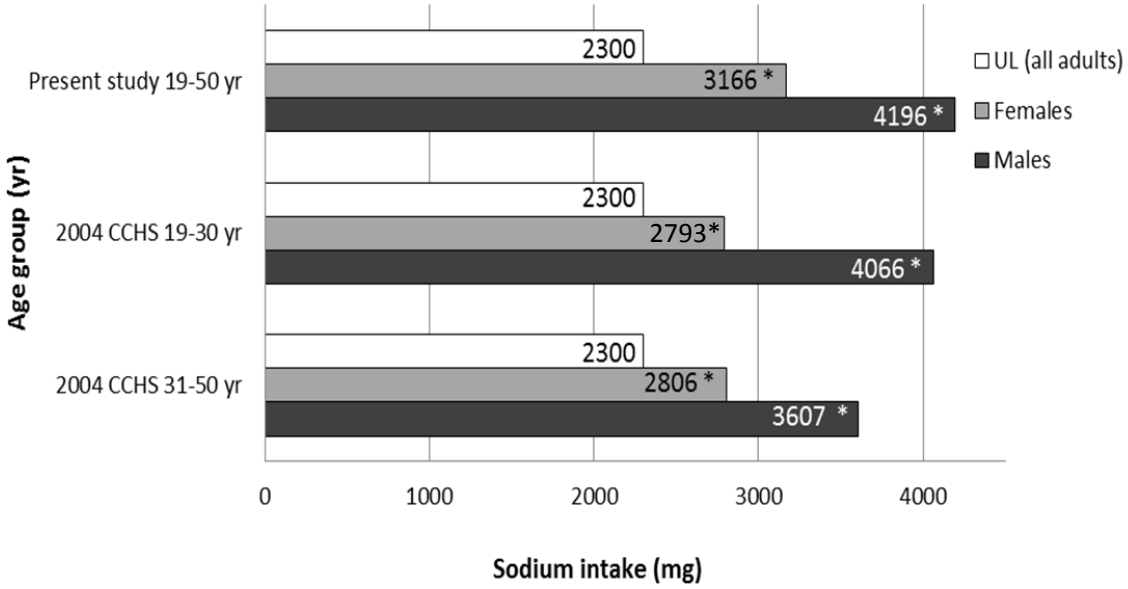
Figure 4-1 Percentage of people with usual sodium intake above the tolerable upper intake level (UL) (2300 mg), by age group and sex, for the present study and 2004 Canadian Community Health Survey-2.2



UL: upper tolerable intake level; 2004 CCHS: Canadian Community Health Survey-Nutrition conducted by Health Canada in 2004.

*Adjusted for intra-individual variation of intake using the Software for Intake Distribution Program® (SIDE). Information from one food recalls were excluded from the SIDE analysis if participants were not between the specified age range of 19-50 years (n=7).

Figure 4-2 Average daily sodium intake by age group and sex for present study and 2004 Canadian Community Health Survey-2.2



* Adjusted for intra-individual variation of intake using the Software for Intake Distribution Program® (SIDE). Information from one food recalls were excluded from the SIDE analysis if participants were not between the specified age range of 19-50 years (n=7).

UL: upper tolerable intake level; 2004 CCHS: Canadian Community Health Survey-Nutrition conducted by Health Canada in 2004.

4.7 LITERATURE CITED

Anderson CA, Appel LJ, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *Journal of American Dietetic Association. 2010; 110(5): 736-45.*

Barr SI. Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology, Nutrition, & Metabolism. 2006; 31(1): 66-73.*

Bojanic D, Xu Y. An investigation of acculturation and the dining-out behavior of Chinese living in the United States. *International Journal of Hospitality Management. 2006; 25(2): 211-26.*

Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *International Journal of Epidemiology. 2009; 38(3): 791-813.*

Chang HY, Hu YW, Yue CS, Wen YW, Yeh WT, Hsu LS, Tsai SY, Pan WH. Effect of potassium-enriched salt on cardiovascular mortality and medical expenses of elderly men. *American Journal of Clinical Nutrition. 2006; 83: 1289-96.*

Chau P, Lee H, Tseng R, Downs NJ. Dietary habits, health beliefs, and food practices of elderly Chinese women. *Journal of American Dietetic Association. 1990; 90: 579-80.*

Cook NR, Cutler JA, Obarzanek E, Buring JE, Rexrode KM, Kumanyika, SK, Appel LJ, Whelton PK. Long term effects of dietary sodium reduction on cardiovascular disease outcomes: Observational follow-up of the Trials of Hypertension Prevention (TOHP). *British Medical Journal. 2007; 334: 885.*

Dasgupta PK, Liu Y, Dyke JV. Iodine nutrition: iodine content of iodized salt in the United States. *Environmental Science & Technology. 2008; 42: 1315-23.*

Dearth-Wesley T, Gordon-Larsen P, Adair LS, Siega-Riz AM, Zhang B, Popkin BM. Less Traditional Diets in Chinese Mothers and Children Are Similarly

Linked to Socioeconomic and Cohort Factors but Vary with Increasing Child Age. *Journal of Nutrition. 2011; 141: 1705-11.*

Fischer PW, Vigneault M, Huang R, Arvaniti K, Roach P. Sodium food sources in the Canadian diet. *Applied Physiology, Nutrition, & Metabolism. 2009; 34(5): 884-92.*

Garriguet D. Sodium consumption at all ages. *Health Reports*. *2007; 18(2): 47-52.*

Gibson RS. Principles of Nutritional Assessment. 2nd ed. New York: Oxford University Press; 2005.

Hajjar I, Kotchen JM, Kotchen TA. Hypertension: trends in prevalence, incidence, and control. *Annual Review of Public Health. 2006; 27: 465-90.*

Havas S, Roccella EJ, Lenfant C. Reducing the public health burden from elevated blood pressure levels in the United States by lowering intake of dietary sodium. *American Journal of Public Health*. *2004; 94(1): 19-22.*

Health Canada. Multi-stakeholder working group on sodium reduction. http://www.hc-sc.gc.ca/fn-an/nutrition/sodium/sodium-working-travail-group-eng.php. Accessed September 16th, 2011.

Health Canada. Sodium reduction strategy for Canada: Recommendations of the Sodium Working Group, 2010. http://www.hc-sc.gc.ca/fn-an/nutrition/sodium/strateg/index-eng.php. Accessed Sept 14th, 2011.

Ho GP, Nolan FL, Dodds ML. Adaptation to American dietary patterns by students from oriental countries. *Journal of Home Economics*. *1966; 58: 277-80.*

Holt R. The Food and Agriculture Organization/World Health Organization expert report on diet, nutrition and prevention of chronic diseases. *Diabetes, Obesity, & Metabolism*. *2003; 5(5): 354.*

Institute of Medicine. Dietary Reference Intakes: applications in dietary assessment. Washington: National Academy Press; 2000.

James WP, Ralph A, Sanchez-Castillo CP. The dominance of salt in manufactured food in the sodium intake of affluent societies. *Lancet*. *1987; 1(8530): 426-9.*

Joffres MR, Campbell NR, Manns B, Tu K. Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada. *Canadian Journal of Cardiology. 2007; 1;23(6): 437-43.*

Kaplan MS, Chang C, Newsom JT, McFarland BH. Acculturation status and hypertension among Asian immigrants in Canada. *Journal of Epidemiology & Community Health. 2002; 56(6): 455-6.*

Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review.[see comment]. *Journal of Hypertension. 2004; 22(1): 11-9.*

Khaw KT, Barrett-Connor E. The association between blood pressure, age, and dietary sodium and potassium: A population study. *Circulation.1988; 77: 53-61.*

Lee SK, Sobal J, Frongillo EA,Jr. Acculturation and dietary practices among Korean Americans. *Journal of American Dietetic Association.1999; 99(9): 1084-9.*

Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *Journal of American Dietetic Association*. *2004; 104(5): 771-8.*

Lv N, Brown JL. Chinese American family food systems: impact of Western influences. *Journal of Nutrition Education & Behavior. 2010; 42(2): 106-14.*

Mannar Venkatesh MG, Dunn JT. Salt iodization for the elimination of iodine deficiency. *International Council for Control of Iodine Deficiency Disorders. 1995.*

Mattes RD, Donnelly D. Relative contributions of dietary sodium sources. *Journal of American College of Nutrition. 1991; 10(4): 383-93.*

Moshfegh A, Goldman J, Cleveland L. What We Eat in America, NHANES 2001-2002: Usual Nutrient Intakes from Food Compared to Dietary Reference Intakes. Washington, DC: US Department of Agriculture, Agricultural Research Service; 2005.

National Institute of Health. 2011. Dietary fact sheet: iodine http://ods.od.nih.gov/factsheets/Iodine-HealthProfessional. Accessed Oct 23rd, 2011.

Nutrient intakes from food: Mean amounts consumed per individual, one day, 2003-2004. US Dept of Agriculture, Agricultural Research Service Web site. www.ars.usda.gov/ba/bhnrc/fsrg. Accessed September 16th, 2011.

Nutrient intakes from food: Mean amounts consumed per individual, one day, 2005-2006. US Dept of Agriculture, Agricultural Research Service Web site. www.ars.usda.gov/ba/bhnrc/fsrg. Accessed September 16th, 2011.

Pan Y, Dixon Z, Himburg S, Huffman F. Asian Students Change their Eating Patterns After Living in the United States. *Journal of the American Dietetic Association*. *1999; 99(1): 54-7.*

Parvanta S. *Adoption of Dietary Innovations among Chinese Students in the United States: A Case Study of an Unplanned Diffusion Process* [dissertation]. Bloomington, Ind: Indiana University; 1987.

Sanchez-Castillo CP, Warrender S, Whitehead TP, James WP. An assessment of the sources of dietary salt in a British population. *Clinical Science*. *1987; 72: 95-102.*

Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *Journal of American Dietetic Association. 2001; 101(5): 548-53.*

Satia JA, Patterson RE, Neuhouser ML, Elder J. Dietary acculturation: Applications to nutrition research and dietetics. *Journal of American Dietetic Association.* 2002; 102(8): 1105-18.

Satia JA, Patterson RE, Taylor VM, et al. Use of qualitative methods to study diet, acculturation, and health in Chinese-American women. *Journal of American Dietetic Association. 2000; 100(8): 934-40.*

Satin M. A pinch of (iodized) salt. *Food Technology. 2006; 60(11): 92.*

Statistics Canada. Visible minority groups, percentage distribution, for Canada. Provinces and Territories, 2006 census of population. http://www40.statcan.gc.ca/l01/ind01/l2_30000-eng.htm. Accessed September 16th, 2011.

Steffen PR, Smith TB, Larson M, Butler L. Acculturation to Western society as a risk factor for high blood pressure: a meta-analytic review. *Psychosomatic Medicine. 2006; 68(3): 386-97.*

Table of Taiwan food composition [in Chinese]. Food and Drug Administration, Department of Health, Executive Yuan, R.O.C (Taiwan) website. http://www.doh.gov.tw/CHT2006/DM/DM2.aspx?now_fod_list_no=572&class_no=3&level_no=2. Accessed September 16th, 2011.

Tian HG, Hu G, Dong QN, et al. Dietary sodium and potassium, socioeconomic status and blood pressure in a Chinese population. *Appetite*. *1996; 26(3): 35-246.*

Wilkins K, Campbell NR, Joffres MR, et al. Blood pressure in Canadian adults. *Health Reports*. *2010; 21(1): 37-46.*

World Health Organization Forum, 2006. Reducing salt intake in populations: Report of a WHO forum and technical meeting. World Health Organization Web site. www.who.int/dietphysicalactivity/SaltReport-VC-April07.pdf. Accessed Sept 14th, 2011.

Wu SJ, Pan WH, Yeh NH, Chang HY. Dietary nutrient intake and major food sources: the Nutrition and Health Survey of Taiwan Elementary School Children 2001-2002. *Asia Pacific Journal of Clinical Nutrition. 2007; 16(Suppl 2): 518-33.*

Zhai FY, Yang XG. China National Health and Nutrition Survey—Report Two: Food and Nutrients Intake in 2002 [in Chinese]. Beijing, China: People's Medical Publishing House; 2006:254.

5. DIETARY CALCIUM AND VITAMIN D INTAKES AND THEIR FOOD SOURCES AMONG CHINESE ADULTS IN EDMONTON, CANADA

5.1 INTRODUCTION

Reducing diet-related diseases among Chinese Canadians is important. Chinese are the second largest visible minority group in Canada, representing 3.9% of the total population and 24% of the total visible minority population (Statistics Canada, 2006). In 2006, there were about 1.2 million persons of Chinese ethnicity in Canada, with 74.5% being foreign-born (Statistics Canada, 2006). Diverse health outcomes among the Chinese population in Canada may have resulted, in part, from the effects of dietary acculturation whereby Chinese immigrants adopt the dietary practices of the mainstream culture (that is, Westernized food habits) while still retaining their own culturally distinct dietary practices to a greater or lesser degree. Of particular interest are food sources of vitamin D and calcium given that Chinese immigrants in North America, especially women and older immigrants, have a high risk of low bone mineral density and osteoporosis (Lau, 1997; Siris et al., 2001; Lauderdale et al., 2003; Babbar et al., 2006).

A low intake of calcium and vitamin D increases risk for osteoporosis, bone fracture, and other health problems (Heaney 2000; Holick, 2007; Major, 2008). Recently, there has been an interest in the role that vitamin D may play in reducing the risk of some forms of cancer, autoimmune, infectious, and cardiovascular diseases (Holick, 2007; Haroon and Regan, 2010). Inadequate calcium intake has also been found positively associated with obesity, colon cancer, and hypertension (Nicklas, 2003; Major, 2008). Although health promotion strategies that are culturally appropriate and tailored to reflect food intake patterns of Chinese Canadians are required (Heaney, 2000; Satia et al., 2000; Satia et al., 2001; Satia et al., 2002) , not enough is known about how dietary acculturation influences the nutrient intakes of Chinese Canadians.

Many dietary focused osteoporosis-prevention efforts in Canada and the United States are aimed at the general population and do not consider cultural influences on dietary intake (Kittler and Sucher, 2004; Lv and Brown, 2011). Sources of calcium in the Chinese diet consumed in Asian countries differ from the Canadian (Westernized) diet (Pun et al., 1991; Johnson-Down et al., 2006; Ma et al., 2007; Poliquin et al., 2009). In the traditional Chinese diet, calcium mainly comes from plant foods (e.g., vegetables and soy products) whereas dairy products are the main source of calcium in the typical Canadian diet (Pun et al., 1991; Johnson-Down et al., 2006; Ma et al., 2007; Poliquin et al., 2009). Dairy products, despite being excellent sources of calcium and vitamin D, may not be often consumed within traditional Chinese diets due to lack of familiarity (that is, not included in traditional cultural food patterns) and potentially lactose intolerance (Lee et al.,1994; Jackson and Savaiano, 2001; Lv and Brown, 2007).

More research is required to identify common dietary sources of calcium and vitamin D in Chinese Canadians to ensure that nutrition messaging and education about these nutrients for Chinese Canadians reflect current patterns of intake. The objectives of this study among Chinese adults in Edmonton, Canada were to examine the intakes of calcium and vitamin D from foods, to identify the primary food sources of calcium and vitamin D, and to assess whether intakes differed between Canadian-born Chinese and Asian-born Chinese. We hypothesized that foreign-born Chinese would have lower intakes of calcium and vitamin D than Canadian-born Chinese and that the food sources of calcium and vitamin D would differ by region of origin. It was anticipated that study findings could be used to improve nutrition messaging about food sources of calcium and vitamin D for each group.

5.2. METHODS AND MATERIALS

a. Participants

A convenience sample of 81 men and women of Chinese descent originating from China, Taiwan or Hong Kong (either born in or outside of Canada)

and aged between 18-58 years were recruited from the University of Alberta in 2010. The study was advertised on campus through posters and circulating recruitment emails on the listservs of international/ Chinese student groups. The study received ethics approval from the Physical Education and Recreation, Agricultural, Life & Environmental Sciences and Native Studies Research Ethics Board, University of Alberta. All participants gave written informed consent.

b. Data collection

Two in-depth 24-hour dietary recalls were collected following the multi-pass technique (Gibson, 2005) for one weekday and weekend day. Four individuals who only completed one recall were dropped from the analysis leaving 77 participants (n=38 Canadian-born Chinese (CBC); n= 39 Foreign-born Chinese (FBC)) from which to derive dietary source and nutrient intake information. The interviews were administered in person by one trained bilingual (Mandarin-English) interviewer in the language of participant's preference. All foods and beverages (but not dietary supplements) consumed during the previous 24 hours before the day of the interview, from midnight to midnight, were recorded. Demographic information (participants' age, gender, birth place, years in Canada, and occupation) was obtained at the beginning of each interview. To assist participants in specifying and quantifying foods, various aids were used including 3-dimensional food models, pictures, and containers of various sizes and types (spoons, cups, bowls, plates, commercial cans, and packets). These tools were standardized and specific to the Chinese food environment. If foods reported were not prepared by the participants, their ingredients were verified with the cook, if possible. Otherwise, the amounts and types of ingredients and seasonings in those foods were estimated based on generic recipes of the same type.

c . Data entry and dietary analysis

Dietary information was entered into the Food Processor SQL® for Windows package version 10.6.0 (ESHA Research, Salem, OR, USA). The Canadian

Nutrient File (2007b) was used to obtain the nutrient composition of Canadian foods and beverages; whereas the nutrient composition of several Chinese specific foods/ingredients was derived from the table of Taiwan food composition (2003) (Department of Health, Taiwan, 2003). A default food list was created and followed to ensure ingredient entry consistency. The dietary recalls were checked twice for accuracy of input by the interviewer. The dietary recalls for exceptionally high (more than 5,000 kcal/day for women or more than 8,000 kcal/day for men) or low (less than 500 kcal/day) energy intakes were checked and verified for accuracy (Anderson et al., 2010). No participants were excluded from analyses.

All foods were classified and assigned to one of 18 calcium food groups and 11 vitamin D food groups based on their contribution to calcium and vitamin D intakes. This enabled identification of foods and food groups that accounted for individual dietary calcium and vitamin D intakes. There was no double counting; for example, if a food was coded as “mixed dishes”, the recipe, not the ingredients, was used, and vice versa. Dietary data from participants who completed both 24-hour recall interviews (n=77) were converted into macro- and micro-nutrient intakes. Total calcium and vitamin D intakes were calculated by summing estimates from all contributory food sources, including beverages, consumed at home or away from home. Foods with multiple ingredients were disaggregated during electronic data entry and analyses only if the respondents were able to provide a description of the ingredients, that is, if foods were home-made. The contribution that specific food groups made to calcium and vitamin D (% of total calcium or vitamin D intake) was calculated by summing the calcium and vitamin D intakes from both dietary recalls for each food category and dividing by the total calcium and vitamin D consumed by the participants. Daily consumption of each food and food group was quantified and expressed in grams. Quantities for the meat and alternatives and pastas/noodles were expressed in terms of cooked weight.

d. Statistical analysis

Continuous variables were reported as means and standard deviations. The chi-square statistic was applied to test for group differences involving categorical demographic data and the *t* test for differences between continuous variables by birth status (i.e., CBC vs. FBC) and between the sexes. The relationship between the calcium and vitamin D intakes (absolute and energy-adjusted (per 1000 Kcal)) and FBC's years in Canada was explored using both one-way ANOVA (Analysis of Variance) and Pearson's correlation. Statistical significance was considered at $p< 0.05$; analyses were performed using the SPSS for Windows statistical software package (version 16.0, SPSS, Inc., Chicago, IL, 2006). Due to day-to-day variations in nutrient intakes, valid estimates of micronutrient adequacy cannot be obtained using a one-day recall period (Barr, 2006). For multiple recalls, the Software for Intake Distribution Estimation (version 1.0, PC-SIDE, Iowa State University, Ames, IA, 2003) was used to estimate usual intakes of calcium and vitamin D for the 74 participants who were 19-50 years old and to report their risks for inadequacy based on the Estimated Average Requirements (EARs) (IOM, 2000).

5.3. RESULTS

a. The characteristics of the study sample

Table 4-1 summarizes participants' characteristics. The respective mean ages for CBC and FBC were 25.0 ± 6.2 and 30.8 ± 10.2 years (*P*=0.02). The proportion of male and female participants was close to 50% for both CBC and FBC. The majority of FBC was from Mainland China (n=31, 76%) and had been in Canada for less than five years (n=24, 59%). On average, FBC had resided in Canada for 3.5 (10.0) years (median and interquartile range). Their mean age at migration to Canada was 23.5 ± 8.2 years. The percentages of University students (70.0% versus 75.6%, respectively) were similar in both CBC and FBC (*P*=0.57).

b. Overall dietary nutrient intakes

The mean daily energy intake was 2,401 ± 842 kcal. The respective daily mean intakes for carbohydrate, protein, and fat were 328 ± 130 g, 102 ± 44 g, and 77 ± 35 g. The mean percentages of energy from carbohydrate, protein, and fat were 55%, 17%, and 29%, respectively. The mean energy and macro- and micronutrient intakes between CBC and FBC (Table 4-2) were not significantly different. The mean energy and macro- and micronutrient intakes were not significantly different between FBC living in Canada for less than and more than five years (Table 4-3). Also, the overall nutrient intakes were not significant between student (75.3%) and non-student (24.7%) participants (results not shown).

c. Calcium and vitamin D intakes and their food sources

Mean calcium intake was 781 ± 337 mg/day/person for CBC and 809 ± 369 mg/day/person for FBC (*P*=0.737) (Table 5-1). Overall 36% of males and 78% of females were at risk for calcium inadequacy and had usual calcium intakes from food that fell below the estimated average requirement (EAR) of 800 mg/day (IOM, 2011). Daily calcium intake for males (897 ± 400 mg) was significantly higher than for females (710 ± 282 mg) (*P*=0.02). Likewise, the mean daily intake of vitamin D was higher for males (5.4 ± 4.2 µg) than females (3.6 ± 3.0 µg) (*P*=0.03). However, both calcium (*P*=0.165) and vitamin D (*P*=0.762) intake per 1000 kcal/day were not significantly different between genders. For FBC no statistically significant associations were found between years living in Canada and calcium and vitamin D intake or dairy consumption (results not shown).

Dairy foods (e.g., milk, cheese, yogurt, and ice cream/cream) were the top sources of calcium for both CBC (42.4% of calcium) and FBC (44.0% of calcium) participants. Among dairy food sources, milk contributed the most to calcium for CBC (28.6% of calcium) and for FBC (35.6% of calcium). Other important calcium sources for CBC were store-bought grains (e.g.,

breads/cereals/pastas) (12.7%), vegetables (e.g., broccoli/bok choy/spinach/celery, lettuce/carrot, beans/peas, and seaweeds) (8.2%), burgers/hotdogs/pizzas/sandwiches (4.7%), and eggs/red meats/poultry (3.9 %). For FBC, important calcium food contributors included vegetables (10.4%), store-bought grains (9.3%), soybean products (tofu and soy beverages) (8.1%), meats and alternatives (e.g., sea food, eggs, red meats/poultry, and cured meats) (6.7%), fruits (oranges/grapefruit/kiwi/watermelon) (3.8%), and burgers/hotdogs/pizzas/sandwiches (3.7%).

Mean vitamin D intake was 3.8 ± 3.4 µg/day/person for CBC and 5.0 ± 3.9 µg/day/person for FBC (*P*=0.158) (Table 5-2). The usual intakes of vitamin D from food sources of 98% of males and 100% of females did not meet the EAR of 10 µg/day for adults. Milk contributed the single largest amount of vitamin D to the diets of CBC and FBC (49.3% and 50.6% of vitamin D, respectively). Fatty fish (e.g., salmon/tuna/catfish) accounted for 12.5% and 16.7% of total vitamin D intake for CBC and FBC, respectively. Other important vitamin D food sources for CBC were: red meats (11.1%), butter/margarine (5.3%), eggs (4.8%), and mushrooms (4.0%). While for FBC, important sources of vitamin D included mushrooms (9.2%), red meats (6.1%), eggs (4.7%), and butter/margarine (3.1%).

5.4. DISCUSSION

This study was the first to use standardized methods to measure calcium and vitamin D intakes in Chinese Canadians and to compare their food sources of these nutrients by place of birth. Calcium and vitamin D intakes of FBC and CBC were comparable and below the Institute of Medicine recommended dietary allowance of 1,000 mg/day for calcium and 15 µg/day for vitamin D for adults aged 19-50 years (IOM, 2011). A high prevalence of participants, particularly females, was at risk for calcium inadequacy and almost all participants were below the EAR for vitamin D. If these results are characteristic of other Canadians of Chinese ethnicity, then efforts must be made to encourage increased consumption of both nutrients in this minority group. Contrary to what

was hypothesized, the findings showed that for both FBC and CBC, calcium and vitamin D were obtained mainly from milk and milk products. Indeed, dairy foods contributed to about 43% of calcium and to slightly more than half of vitamin D of both FBC and CBC. The findings indicate that our Chinese participants; both Canadian- and foreign-born were eating foods more typical of a North American than traditional Chinese diet with regards to sources of calcium and vitamin D.

Similar to our sample, data from the 1997-1998 Food Habits of Canadians survey (Poliquin et al., 2009), 2005-2006 National Health and Nutrition Examination Surveys in the United States (USDA, 2005-2006) and other studies (Fleming and Heibach, 1994; Leachman-Slawson et al., 2001; Berube et al., 2005; Johnson-Down et al., 2006; Poliquin et al., 2009) indicated that at least 40-70% of dietary calcium is supplied by milk and milk products, milk, cheese, and yogurt in the typical Northern American diet. Vegetables, such as broccoli and Chinese cabbage (e.g., bok choy), although often mentioned as good calcium sources, provide only 2-5% of total calcium intake in the North American diet (Fleming and Heibach, 1994; Leachman-Slawson et al., 2001; Jackson and Savaiano, 2001). In contrast, most calcium in the traditional Chinese diet is from plant-based foods not dairy products (Lee et al., 1994; Jackson and Savaiano, 2001; Lv et al., 2007; Ma et al., 2007). A study of Chinese in Hong Kong (Pun et al., 1991) found that 20% of calcium consumed came from milk and milk products. Findings of the 2001-2002 Nutrition and Health Survey in Taiwan (NAHSIT) (Wu et al., 2007) were similar with about 31.5% of calcium supplied by dairy products. Of interest, the contribution of soy and soy products to calcium was the same for FBC in Edmonton as for persons included in the 2001- 2002 NAHSIT (Wu et al., 2007) and a dietary study in Hong Kong (Pun et al., 1991) indicating the importance of soy in their diet.

Vitamin D is limited to a few naturally occurring foods. Vitamin D occurs naturally as vitamin D_3 (cholecalciferol) in fatty ocean fish, organ meats, and egg yolks and vitamin D_2 (ergocalciferol) in mushrooms and fungi (Mattila et al., 2002;

Wu et al., 2009). Both vitamin D_2 and D_3 can be found in fortified products such as milk, milk products, margarine, and orange juice (Calvo et al., 2004). According to the Canadian Community Health Survey (CCHS) 2004-Nutrition (Vantanparast et al., 2010), in Canada dairy products are the primary food source of vitamin D, contributing to at least 49.1% of dietary vitamin D intake, followed by meat and alternatives (31.1%). Similarly for both CBC and FBC, red meat and fish also made an important contribution to vitamin D. One of the characteristics of North-East Asian diets is the relatively high and regular consumption of fungi (Lee et al., 2008). Fungal foods such as mushrooms and yeast are important natural food sources of ergosterol which may be converted to ergocalciferol (vitamin D_2) when these foods are exposed to ultraviolet light (Mattila et al., 2002). The results from the 1993-1996 NAHSIT study in Taiwan indicated that mushrooms accounted for 3% of total vitamin D intake (Lee et al., 2008) whereas mushrooms provided 9.2% of vitamin D for FBC and 4% for CBC.

Both males and females in our sample consumed less calcium and vitamin D than their counterparts in the general Canadian population included in the CCHS (Figures 5-1 and 5-2); however, the intake of calcium (794 mg/day) was higher than that reported for adults in Taiwan (462 mg/day) (Pan et al., 1999; Lu, 2000), China (338 mg/day) (Ma et al.,2007), and Hong Kong (<500 mg/day) (Pun et al., 1991). In contrast, the typical vitamin D intake of males (4.8 μg) and females (2.9 μg) in our study was similar to the intake of adults aged 19-44 years in Taiwan (4.7 μg/day for males and 3.9 μg/day for females) (Lee e al., 2008).

There are several determinants that may influence the dietary calcium and vitamin D intakes among Chinese Canadians. Dietary practices established early in life play a large role in dairy consumption patterns; potentially in part due to the high prevalence of lactose intolerance (real and perceived) observed in Chinese populations (Pun et al., 1991; Klesges et al., 1999; Jackson and Savaiano, 2001; Lv et al., 2007). Generally, the lactose-intolerant may avoid calcium-rich and vitamin-D-fortified dairy products due to the presence of

intolerance symptoms and therefore have lower intakes in these nutrients. However, dietary acculturation can lead to increased dairy consumption and positively influence calcium and vitamin D intakes in Chinese immigrants in North America (Lee et al., 1994; Lee et al., 1999; Satia et al., 2001; Lv et al., 2004; Lv et al., 2007). Pan and colleagues found a significant increase in dairy product intake among Asian students after living in the United States for more than three years (Pan et al., 1999). In a study of Chinese Americans in Pennsylvania (Lv and Cason, 2004), dairy products consumption was largely increased in both recent immigrants and those who had resided in the U.S. for more than 15 years. Perhaps Chinese Americans increase their frequency of consumption of dairy products quickly after immigration because dairy products are more readily available and accessible and are comparatively less expensive in North America than in Asia.

In addition, Lv and Brown (2010) also found that having young and second-generation children positively influenced dairy consumption in the Chinese American families (Lv and Brown, 2010) as family members' food preferences and personal flexibility often shape the family's dietary pattern (Lv and Brown, 2010). Many parents reported that their children had learned to eat and like Western foods from day cares and schools, where children became accustomed to eating dairy products and dairy-based dishes (e.g., sandwiches served with cheese, pizza, lasagna, and macaroni and cheese). These dairy foods and dishes were then gradually adopted and served by some families with young children demanding them (Lv and Brown, 2010).

However, it was still an unexpected finding to see higher overall dairy products (mainly milk) consumption and slightly higher calcium and vitamin D intakes in FBC than in their Canadian-born counterparts. Possible explanations may be that many FBC had factors predictive of dietary acculturation to Western eating patterns including fluency in the English language (a mandatory admission requirement to the University of Alberta) , a high level of education (hence,

higher level of knowledge in nutrition and health), and long term residency in Canada (3.5 years, on average). In addition, one reason we did not capture for why FBC rapidly acculturated was having young children at home (Satia et al., 2002; Dearth-Wesley et al., 2011).

Vitamin D nutritional status is unique among vitamins and minerals because it varies by environment, for eample, latitude, culture, and food fortification regulation. It is difficult to define vitamin D nutrition because vitamin D is synthesized in the skin through the action of UV light in addition to being obtained from dietary sources. Many studies have identified a high prevalence of vitamin D insufficiency in healthy adults living in Canada (Vieth et al., 2001; Rucker et al., 2002; Roth et al., 2005; Holick, 2007; Lappe et al.,2007), particularly during the winter when endogenous synthesis of vitamin D is non-existent. Hence, the Canadian population is reliant on dietary sources for vitamin D from foods or supplements for most of the year (Vatanparast et al., 2010). This is concerning because the higher skin melanin levels of Asians reduces endogenous cutaneous vitamin D synthesis (Holick, 2007), and indeed, Canadians of East Asian ancestry have lower vitamin D intakes and a poorer vitamin D status in the winter than Canadians of European descent (Gozdzik et al., 2008). Increased consumption of certain vitamin D-rich foods such as eggs, organ meats, and fortified margarines is not consistent with the current healthy guidelines due to their high cholesterol and/or fat content. However, because fluid cow's milk has mandatory fortification of vitamin D (2 µg per 100 mL for all types) in Canada, encouraging increased consumption of fortified milk or fortified soy beverages is recommended in Eating Well with Canada's Food Guide (Calvo et al., 2004; Health Canada, 2007). Fortified milk and soy beverages not only provide vitamin D but also calcium. Calcium-fortified plant-based beverages and fruit juice may also positively influence calcium intake as more foods and beverages have been fortified with calcium since the 1990s (Forshee et al., 2006). However, fruit juice only contributed minimally to overall calcium intake because

the volume of juice consumed was low for CBC (109 g/day) and FBC (67 g/day). Perhaps these beverages would have contributed more significantly to calcium intake, if our Edmonton sample had consumed more of these calcium-fortified fruit juices.

5.5 STRENGTHS AND LIMITATIONS

The strengths of this study are that it included standardized collection of nutrition data (specific to Chinese food environment) based on two in-depth, multi-pass 24-hour dietary recalls per participant; updated and standardized tables on the nutrient content of reported foods; and multiple quality control procedures. The limitations include a relatively small sample size potentially limiting the generalizability of study findings. The foods database limitations in nutrient content may create interpretation challenges. Because more calcium- and vitamin D- fortified items are commercially available, calcium and vitamin D contents of foods are highly variable (Calvo et al., 2004). Calcium and vitamin D intakes from supplements were not examined so intake may have been underreported. In addition, no blood tests were performed to assess circulating 25-hydroxyvitamin D concentrations to verify individuals' vitamin D status. Additionally, we did not gather any information regarding the participants' decisions for their food choices.

5.6. CONCLUSIONS

Both males and females participants in our study consumed less calcium and vitamin D than their counterparts in the general Canadian population; thus, Chinese of Canadian ancestry may be at particular risk for calcium and vitamin D deficiency. For both Canadian-born and foreign-born Chinese dairy foods made an important contribution to calcium and vitamin D intake and dairy foods could therefore be promoted in this subpopulation. Given the low intake of both calcium and vitamin D, supplements may also be required for individuals to meet the recommended intakes of these nutrients (Calvo et al., 2003; Poliquin, 2009).

This study lays the groundwork for further research on calcium/vitamin D-related dietary practices in Chinese Canadians. It would be important to duplicate the study among Chinese individuals in different parts of Canada. For nutrition researchers in Canada and the United States, the top food sources of calcium and vitamin D reported in this study could form the foundation for the development of food frequency questionnaires for the Chinese ethnic population.

Table 5-1 Dietary sources of calcium of Chinese adults in Edmonton, Canada

	Canadian-born (n= 39*)			Foreign-born (n= 38*)		
Daily consumption of foods and food groups	Weight (g/d/ person)	mg/d/ person	% Ca	Weight (g/d/ person)	mg/d/ person	% Ca
	mean= 781 ± 337 mg			mean= 809 ± 369 mg		
Dairy, total	226.85	331.25	42.39	286.83	355.19	43.93
Milk	184.16	223.49	28.60	243.49	287.83	35.60
Cheese	11.30	67.07	8.58	3.20	17.85	2.21
Yogurt	19.95	27.78	3.55	30.84	37.76	4.67
Ice cream/cream	11.45	12.92	1.65	9.30	11.75	1.45
Grains, total	424.11	98.89	12.66	399.59	75.45	9.33
Breads	29.97	25.42	3.25	27.88	29.48	3.65
Muffins/buns/waffles/ bagels	15.15	22.55	2.89	11.11	13.26	1.64
Cereals	19.82	22.03	2.82	8.24	14.63	1.81
Pastas/noodles	143.73	20.91	2.68	60.49	7.86	0.97
Rice/flour	215.45	7.99	1.02	291.87	10.22	1.26
Soy bean products, total	18.92	20.41	2.61	73.91	65.08	8.05
Tofu	5.66	7.93	1.02	28.77	31.86	3.94
Soy beverage	13.25	12.48	1.60	45.15	33.22	4.11
Vegetables, total	134.74	63.92	8.18	146.95	84.15	10.41
Broccoli/bok choy/ spinach/celery	62.51	42.24	5.41	107.26	67.22	8.31
Beans/peas	28.15	7.25	0.93	18.48	7.45	0.92
Lettuces/carrots	43.05	12.89	1.65	17.54	4.66	0.58
Seaweeds	1.03	1.54	0.20	3.68	4.83	0.60
Meats and alternatives, total	182.74	41.32	5.29	192.56	53.91	6.67
Eggs with yolks	25.42	16.04	2.05	27.19	13.59	1.68
Seafood (eg. fish/shrimp/mollusk)	19.24	6.14	0.79	42.05	16.44	2.03
Sausages/luncheon meats/cured meats/meat loaf	18.51	4.67	0.60	17.00	10.88	1.35
Red meats/poultry	119.56	14.47	1.85	106.32	13.00	1.61
Coffee/cocoa	92.26	22.98	2.94	86.66	16.65	2.06
						(continued)

Table 5-1 Dietary sources of calcium of Chinese adults in Edmonton, Canada

(continued)	Canadian-born (n= 39)			Foreign-born (n= 38)		
Daily consumption of foods and food groups	Weight (g/d/ Person)	mg/d/ person	% Ca	Weight (g/d/ person)	mg/d/ person	% Ca
Fast foods, total	88.71	40.34	5.16	40.56	33.05	4.09
Burgers/ hotdogs/pizzas/ sandwiches	50.20	36.84	4.71	32.79	29.73	3.68
Fried chicken/fries	38.51	3.50	0.45	7.77	3.32	0.41
Snacks, total	41.04	19.24	2.46	32.16	18.24	2.26
Candies/candy bars	13.67	8.17	1.05	7.31	6.39	0.79
Cookies/crackers/snack mixes/chips	27.36	11.07	1.42	24.86	11.86	1.47
Mixed dishes, total	82.16	25.08	3.21	55.60	12.54	1.55
Sushi/fish-based surimi	27.78	13.99	1.79	28.11	6.56	0.81
Dim Sum dumplings/buns/ wontons/green onion cakes	34.40	7.03	0.90	27.49	5.98	0.74
Stew/curry/gravy/ mashed potatoes	19.97	4.06	0.52	0.00	0.00	0.00
Fruits, total	128.07	21.28	2.72	156.57	30.33	3.75
Oranges	79.74	16.58	2.12	94.47	24.26	3.00
Grapefruits/kiwis/ watermelon	48.33	4.70	0.60	62.10	6.07	0.75
Nuts and seeds, total	3.65	9.75	1.25	14.01	13.90	1.72
Cakes/pastries/pies	25.33	8.81	1.13	10.90	4.48	0.55
Spreads and dips (eg. butter/margarine/ salad dressing)	17.39	5.87	0.75	8.29	1.99	0.25
Juices	108.60	14.89	1.90	67.11	5.43	0.67
Soups & broths	40.21	2.70	0.35	30.63	3.08	0.38
Spices	3.45	6.19	0.79	1.12	2.65	0.33
Other	NA	48.49	6.20	NA	32.43	4.01
Total		781.41	100.00		808.58	100.00

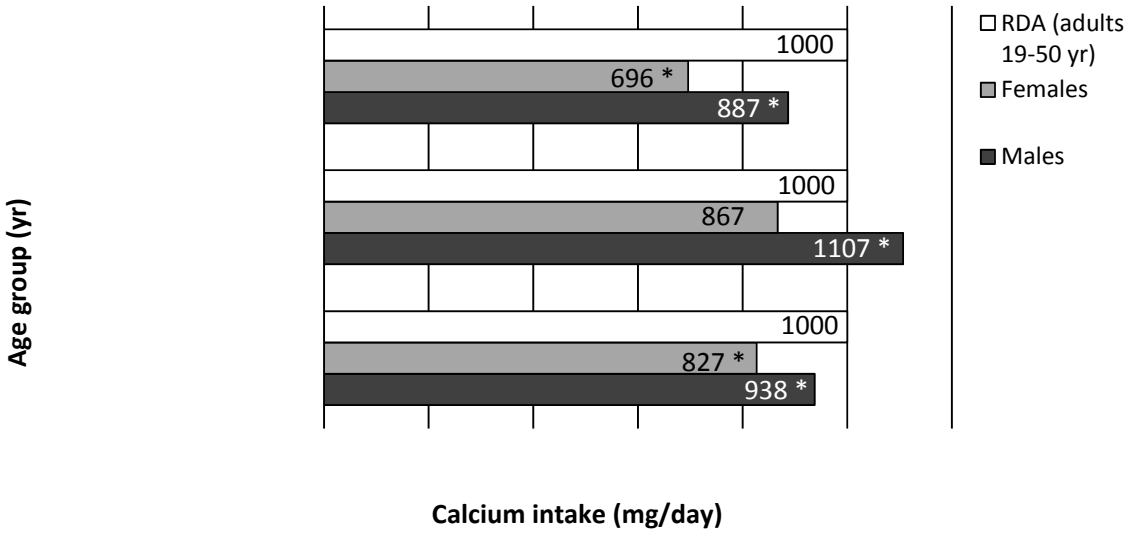
NA: not applicable
*Information were excluded from the analysis focused on food sources of calcium if participants only completed one dietary recall (n=4).

Table 5-2 Dietary sources of vitamin D of Chinese adults in Edmonton, Canada

	Canadian-born (n= 39*)			Foreign-born (n= 38*)		
Daily consumption of foods and food groups	Weight (g/d/ person)	µg/d/ person	% vitamin D	Weight (g/d/ person)	µg/d/ person	% vitamin D
	mean= 3.8 ± 3.4 µg			mean= 5.0 ± 3.9 µg		
Dairy	220.16	2.01	52.43	255.99	2.61	51.89
Milk	184.16	1.89	49.34	243.49	2.54	50.55
Cheese	11.30	0.01	0.37	3.20	0.01	0.16
Ice cream	8.06	0.06	1.66	5.32	0.04	0.83
Cream	3.39	0.01	0.39	3.98	0.02	0.35
Soy milk	13.25	0.03	0.67	0.00	0.00	0.00
Meats & alt	182.88	1.25	32.66	194.08	1.64	32.63
Fatty fish (eg.salmon/tuna/catfish)	12.29	0.48	12.54	23.61	0.84	16.72
Red meats	56.04	0.42	11.06	64.26	0.30	6.05
Eggs	25.42	0.18	4.75	26.47	0.24	4.69
Seafood (eg.shrimp/mollusk/crab)	7.00	0.00	0.03	21.12	0.06	1.25
Sausages/luncheon meats/cured meats	18.60	0.06	1.66	15.90	0.14	2.80
Poultry	63.52	0.10	2.62	42.72	0.06	1.12
Spreads & dips	5.49	0.21	5.39	4.31	0.16	3.20
Butter/margarine	2.24	0.20	5.30	2.00	0.16	3.14
Salad dressing	3.26	0.00	0.09	2.31	0.00	0.06
Mushrooms	19.03	0.15	3.98	23.48	0.46	9.17
Coffee/cocoa	6.66	0.05	1.38	9.07	0.08	1.64
Muffins/waffles/scones/ pancakes	10.46	0.02	0.48	7.61	0.03	0.59
Burgers/ hotdogs	19.10	0.05	1.24	0.00	0.00	0.00
Butter cookies	0.82	0.00	0.07	5.58	0.02	0.42
Mashed potatoes	9.03	0.04	1.14	0.00	0.00	0.00
Cakes/pastries	19.63	0.03	0.76	5.59	0.01	0.27
Other	NA	0.02	0.46	NA	0.01	0.18
Total		3.84	100.00		5.03	100.00

NA: not applicable
*Information were excluded from the analysis focused on food sources of vitamin D if participants only completed one dietary recall (n=4).

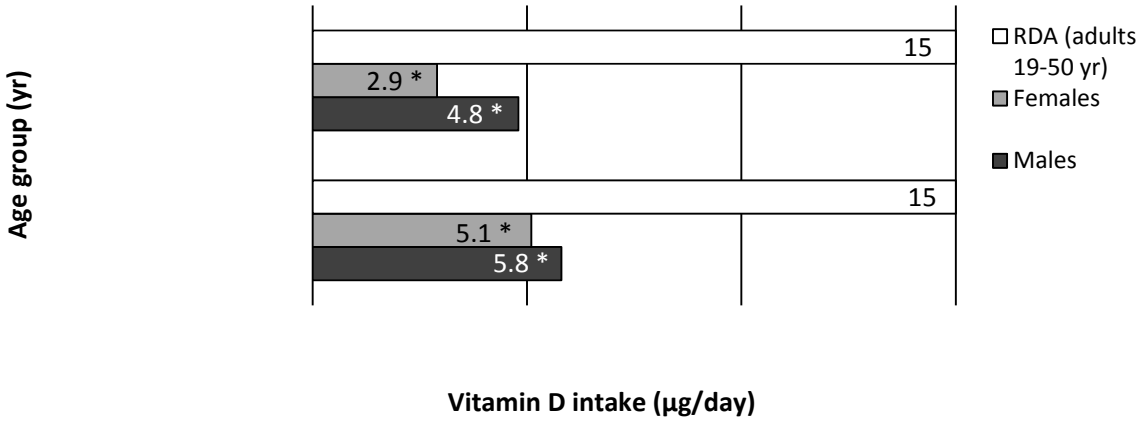
Figure 5-1 Average daily calcium intake from food sources, by age group and sex, for present study and Canadian Community Health Survey-2.2



* Adjusted for intra-individual variation of intake using the Software for Intake Program® (SIDE). Information from one food recalls were excluded from the SIDE analysis if participants were not between the specified age range of 19-50 years (n=7).

RDA: Recommended Dietary Allowance is the average daily dietary allowance; 2004 CCHS 2.2.: Canadian Community Health Survey-Nutrition conducted in 2004 by Health Canada.

Figure 5-2 Average daily vitamin D intake from food sources, by age group and sex, for present study and Canadian Community Health Survey-2.2



* Adjusted for intra-individual variation of intake using the Software for Intake Program® (SIDE). Information from one food recalls were excluded from the SIDE analysis if participants were not between the specified age range of 19-50 years (n=7).

RDA: Recommended Dietary Allowance is the average daily dietary allowance; 2004 CCHS 2.2.: Canadian Community Health Survey-Nutrition conducted in 2004 by Health Canada.

5.7 LITERATURE CITED

Anderson CA, Appel LJ, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *Journal of American Dietetic Association. 2010; 110(5): 736-45.*

Babbar RK, Handa AB, Lo CM, et al. Bone health of immigrant Chinese women living in New York City. *Journal of Community Health. 2006; 31(1): 7-23.*

Barr SI. Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology Nutrition and Metabolism. 2006; 31(1): 66-73.*

Berube S, Diorio C, Masse B, et al. Vitamin D and calcium intakes from food or supplements and mammographic breast density. *Cancer Epidemiology, Biomarkers & Prevention. 2005; 14(7): 1653-9.*

Calvo MS, Whiting SJ, Barton CN. Vitamin D fortification in the United States and Canada: current status and data needs. *American Journal of Clinical Nutrition. 2004; 80(6 Suppl): 1710S-6S.*

Calvo MS, Whiting SJ. Prevalence of vitamin D insufficiency in Canada and the United States: importance to health status and efficacy of current food fortification and dietary supplement use. *Nutrition Reviews. 2003; 61(3): 107-13.*

Dearth-Wesley T, Gordon-Larsen P, Adair LS, Siega-Riz AM, Zhang B, Popkin BM. Less Traditional Diets in Chinese Mothers and Children Are Similarly Linked to Socioeconomic and Cohort Factors but Vary with Increasing Child Age. *Journal of Nutrition. 2011; 141: 1705-11.*

Dodiuk-Gad RP, Rozen GS, Rennert G, Rennert HS, Ish-Shalom S. Sustained effect of short-term calcium supplementation on bone mass in adolescent girls with low calcium intake. *American Journal of Clinical Nutrition. 2005; 81(1): 168-74.*

Fleming KH, Heimbach JT. Consumption of calcium in the U.S.: food sources and intake levels. *Journal of Nutrition. 1994; 124(8 Suppl): 1426S-30S.*

Forshee RA, Anderson PA, Storey ML. Changes in calcium intake and association with beverage consumption and demographics: comparing data from CSFII 1994-1996, 1998 and NHANES 1999-2002. *Journal of American College of Nutrition. 2006; 25(2): 108-16.*

Gibson RS. Principles of Nutritional Assessment. 2nd ed. New York: Oxford University Press; 2005.

Gozdzik A, Barta JL, Wu H, et al. Low wintertime vitamin D levels in a sample of healthy young adults of diverse ancestry living in the Toronto area: associations with vitamin D intake and skin pigmentation. *BMC Public Health. 2008; 8: 336.*

Haroon M, Regan MJ. Vitamin D deficiency: the time to ignore it has passed. *International Journal of Rheumatic Diseases. 2010; 13(4): 318-23.*

Health Canada. Canada's Food Guide to Healthy Eating. Ottawa, ON: Health Promotion and Programs Branch, Minister of Public Works and Government Services Canada, 2007.

Heaney RP. Calcium, dairy products and osteoporosis. *Journal of American College of Nutrition. 2000; 19(2 Suppl): 83S-99S.*

Holick MF: Vitamin D deficiency. *New England Journal of Medicine. 2007; 357(3): 266-81.*

Institute of Medicine, Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: National Academy Press; 2011.

Institute of Medicine. Dietary Reference Intakes: applications in dietary assessment. Washington, DC: National Academy Press; 2000.

Jackson KA, Savaiano DA. Lactose mal-digestion, calcium intake and osteoporosis in African-, Asian-, and Hispanic-Americans. *Journal of American College of Nutrition. 2001; 20(2 Suppl): 198S-207S.*

Johnson-Down L, Ritter H, Starkey LJ, Gray-Donald K. Primary food sources of nutrients in the diet of Canadian adults. *Canadian Journal of Dietetic Practice & Research. 2006; 67(1): 7-13.*

Kittler PG & Sucher KP. Food and Culture. 4th ed. Toronto, ON: Wadsworth; 2004: 6-8.

Klesges RC, Harmon-Clayton K, Ward KD, et al. Predictors of milk consumption in a population of 17- to 35-year-old military personnel. *Journal of American Dietetic Association. 1999; 99(7): 821-6.*

Kwok S, Mann L, Wong K, Blum I. Dietary habits and health beliefs of Chinese Canadians. *Canadian Journal of Dietetic Practice & Research. 2009; 70(2): 73-80.*

Lappe JM, Travers-Gustafson D, Davies KM, Recker RR, Heaney RP: Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial. *American Journal of Clinical Nutrition. 2007; 85(6): 1586-91.*

Lau EM. Epidemiology of osteoporosis in urbanized Asian populations. *Osteoporosis International. 1997; 7(Suppl 3): S91-5.*

Lauderdale DS, Kuohung V, Chang SL, Chin MH. Identifying older Chinese immigrants at high risk for osteoporosis. *Journal of General Internal Medicine. 2003; 18(7): 508-15.*

Leachman-Slawson D, McClanahan BS, Clemens LH, et al. Food sources of calcium in a sample of African-American and Euro-American collegiate athletes. *International Journal of Sport Nutrition & Exercise Metabolism. 2001; 11(2): 199-208.*

Lee MM, Wu-Williams A, Whittemore AS, et al. Comparison of dietary habits, physical activity and body size among Chinese in North America and China. *International Journal of Epidemiology. 1994; 23(5): 984-90.*

Lee MS, Li HL, Hung TH, Chang HY, Yang FL, Wahlqvist ML. Vitamin D intake and its food sources in Taiwanese. *Asia Pacific Journal of Clinical Nutrition. 2008; 17(3): 397-407.*

Lee SK, Sobal J, Frongillo EA,Jr. Acculturation and dietary practices among Korean Americans. *Journal of American Dietetic Association.1999; 99(9): 1084-9.*

Lu YP. Investigation of acculturation changes in food intake of Taiwanese students attending the University of Wisconsin-Stout [dissertation]. Menomonie, Wisconsin: University of Wisconsin-Stout; 2000.

Lv N, Brown JL, Liu B. Enhancing nutrition consumption in the American diet: Factors influencing dairy product consumption of Chinese Americans in Pennsylvania. *Topics in Clinical Nutrition. 2007; 22(3): 258-71.*

Lv N, Brown JL. Chinese American family food systems: impact of Western influences. *Journal of Nutrition Education & Behavior. 2010; 42(2): 106-14.*

Lv N, Brown JL. Impact of a nutrition education program to increase intake of calcium-rich foods by Chinese-American women. *Journal of American Dietetic Association. 2011; 111(1): 143-9.*

Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *Journal of American Dietetic Association. 2004; 104(5): 771-8.*

Ma G, Li Y, Jin Y, Zhai F, Kok FJ, Yang X. Phytate intake and molar ratios of phytate to zinc, iron and calcium in the diets of people in China. *European Journal of Clinical Nutrition. 2007; 61(3): 368-74.*

Major GC, Chaput JP, Ledoux M, et al. Recent developments in calcium-related obesity research. *Obesity Reviews. 2008; 9(5): 428-45.*

Mattila P, Lampib A-M, Ronkainenb R, Toivob J, PiironenV. Sterol and vitamin D2 contents in some wild and cultivated mushrooms. *Food Chemistry. 2002; 76: 293-8.*

Nicklas TA. Calcium intake trends and health consequences from childhood through adulthood. *Journal of American College of Nutrition. 2003; 22(5): 340-56.*

Nutrient intakes from food: Mean amounts consumed per individual, one day, 2005-2006. US Dept of Agriculture, Agricultural Research Service Web site. www.ars.usda.gov/ba/bhnrc/fsrg. Accessed May 18th, 2011.

Pan WH, Kao MD, Tzeng MS, et al. Nutrition and Health Survey in Taiwan (NAHSIT) 1993-1996: design, contents, and operations. *Nutritional Science Journal. 1999; 24:1-10.* [In Chinese].

Pan Y, Dixon Z, Himburg S, Huffman F. Asian Students Change their Eating Patterns After Living in the United States. *Journal of the American Dietetic Association. 1999; 99(1): 54-7.*

Poliquin S, Joseph L, Gray-Donald K. Calcium and vitamin D intakes in an adult Canadian population. *Canadian Journal of Dietetic Practice & Research. 2009; 70(1): 21-7.*

Pun KK, Chan LML, Chung V, Wong FHW. Calcium content of common food items in Chinese diet. *Calcified Tissue International. 1991; 48: 153-6.*

Roth DE, Martz P, Yeo R, Prosser C, Bell M, Jones AB. Are national vitamin D guidelines sufficient to maintain adequate blood levels in children? *Canadian Journal of Public Health. 2005; 96(6): 443-9.*

Rucker D, Allan JA, Fick GH, Hanley DA. Vitamin D insufficiency in a population of healthy western Canadians. *Canadian Medical Association Journal. 2002; 166(12): 1517-24.*

Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *Journal of American Dietetic Association. 2001; 101(5): 548-53.*

Satia JA, Patterson RE, Neuhouser ML, Elder J. Dietary acculturation: Applications to nutrition research and dietetics. *Journal of American Dietetic Association. 2002; 102(8): 1105-18.*

Satia JA, Patterson RE, Taylor VM, Cheney CL, Shiu-Thorton S, Chitnarong K, Kristal AR. Use of qualitative methods to study diet, acculturation, and

health in Chinese-American women. *Journal of American Dietetic Association. 2000; 100(8): 934-40.*

Schwalfenberg GK, Genuis SJ, Hiltz MN. Addressing vitamin D deficiency in Canada: a public health innovation whose time has come. *Public Health. 2010; 124(6): 350-9.*

Segal E, Zinman C, Raz B, Ish-Shalom S. Low patient compliance--a major negative factor in achieving vitamin D adequacy in elderly hip fracture patients supplemented with 800IU of vitamin D3 daily. *Archives of Gerontology & Geriatrics. 2009; 49(3): 364-7.*

Siris ES, Miller PD, Barrett-Connor E, Faulkner KG, Wehren LE, Abbot TA, Berger ML, Santora AC, Sherwood LM. Identification and fracture outcomes of undiagnosed low bone mineral density in post-menopausal women: Results from the National Osteoporosis Risk Assessment. *Journal of American Medical Association. 2001; 286: 2815-22.*

Statistics Canada. Visible minority groups, percentage distribution, for Canada. Provinces and Territories, 2006 census of population. http://www40.statcan.gc.ca/l01/ind01/l2_30000-eng.htm. Accessed May 18th, 2011.

Table of Taiwan food composition [in Chinese]. Food and Drug Administration, Department of Health, Executive Yuan, R.O.C (Taiwan) website. http://www.doh.gov.tw/CHT2006/DM/DM2.aspx?now_fod_list_no=572&class_no=3&level_no=2 Accessed September 16th, 2011.

University of Alberta 2011- 2012 calendar, office of the registrar and student awards.http://www.registrar.ualberta.ca/calendar/Admission/UndergradPrograms/13.3.html. Accessed September 16th, 2011.

University of Alberta, faculty of graduate studies and research, graduate program manual. http://www.gradstudies.ualberta.ca/gradmanual/5.8.html. Accessed September 16th, 2011.

Vatanparast H, Calvo MS, Green TJ, Whiting SJ. Despite mandatory fortification of staple foods, vitamin D intakes of Canadian children and adults are inadequate. *Journal of Steroid Biochemistry & Molecular Biology. 2010; 121(1-2): 301-3.*

Vatanparast H, Dolega-Cieszkowski JH, Whiting SJ. Many adult Canadians are not meeting current calcium recommendations from food and supplement intake. *Applied Physiology, Nutrition, & Metabolism. 2009; 34(2): 191-6.*

Vieth R, Cole DE, Hawker GA, Trang HM, Rubin LA. Wintertime vitamin D insufficiency is common in young Canadian women, and their vitamin D intake does not prevent it. *European Journal of Clinical Nutrition. 2001; 55(12): 1091-7.*

Wu H, Gozdzik A, Barta JL, et al. The development and evaluation of a food frequency questionnaire used in assessing vitamin D intake in a sample of healthy young Canadian adults of diverse ancestry. *Nutrition Research. 2009; 29(4): 255-61.*

Wu SJ, Pan WH, Yeh NH, Chang HY. Dietary nutrient intake and major food sources: the Nutrition and Health Survey of Taiwan Elementary School Children 2001-2002. *Asia Pacific Journal of Clinical Nutrition. 2007; 16(Suppl 2): 518-33.*

Zheng Y, Zhou H, Modzelewski JR, et al. Accelerated bone resorption, due to dietary calcium deficiency, promotes breast cancer tumor growth in bone. *Cancer Research. 2007; 67(19): 9542-8.*

6. SUMMARY AND CONCLUSIONS

Our results show that the majority (59.8%) of sodium consumed by Canadian-born Chinese (CBC) was from commercially processed foods. Salt and other sauces/condiments added to foods during home cooking, at the table or when prepared by restaurants contributed to more than one-quarter of the sodium intake of CBC. Similarly, foreign-born Chinese (FBC) also obtained the majority (54.1%) of their total sodium from commercially processed foods but about a third of their sodium came from discretionary use of salt or other sauces/condiments added to foods.

Similar to our findings, the Canadian Community Health Survey (CCHS) 2004-Nutrition (Garriguet, 2007; Fischer et al., 2009) and data from the United States National Health and Nutrition Examination Surveys (NHANES) in 2001-2006 (Moshfegh et al., 2005; USDA, 2003-2004; USDA, 2005-2006) indicated that top contributors of sodium are primarily commercially-processed foods such as breads, grains/cereals, meats, poultry, eggs, dairy products, sauces/seasoning, and soups. It is important to note that although grain products (breads, cereals, noodles/pastas) are an important contributor of sodium, it is due to the large quantity and high frequency of consumption of these foods rather than their sodium content. Foods such as cured meats and sauces, on the other hand, are often consumed in small quantities, but contribute substantially to the amount of sodium in the diet because of their high levels of sodium (Fischer et al., 2009; Anderson et al., 2010).

Data on sodium sources from China and Taiwan show that the discretionary use of cooking salt, soy sauce, and the flavor enhancer MSG are major sources (60% -75.8%) of sodium in the Chinese diet consumed in Asian countries (Anderson et al., 2010; Brown et al., 2009). Taken together, these studies indicate higher sodium intakes from discretionary consumption and lower dietary sodium from processed or restaurant-prepared foods than among the Chinese-Canadians in our Edmonton sample. Both CBC and FBC had sodium

intake mainly from the high frequency of consumption of commercially processed foods typical of western diets (Sanchez-Castillo et al., 1987; Mattes et al., 1991; Tian et al., 1996) whereas discretionary sodium intake, that is, salt added to foods during home cooking and when prepared by restaurants only contributed moderately to sodium intake.

This finding might be attributable to changes in the dietary environment or dietary acculturation. In a study by Tian and colleagues, inclusion of processed foods is found to be reflective of adoption of western dietary practices in the Chinese population (Tian et al., 1996). A few possible explanations discussed about adoption of processed/restaurant-prepared foods among Asian students in North America included easy and convenient purchase of these foods, limited time to prepare traditional dishes because of hectic school schedules and availability of Canadian (Western)-style foods (Ho et al., 1966; Parvanta, 1987; Pan et al., 1999).

In addition to examining the food sources of sodium, we also reported the prevalence of excessive sodium intake. Our results show the average sodium intake of Chinese-Canadians in this study was 3,623 mg/day with usual sodium intakes of 99% of males and 84% of females exceeding the UL. A comparison of mean sodium intake estimates based on the INTERMAP China data (3,990 mg/day) (Anderson et al., 2010), 2002 China Health and Nutrition Survey (6,268 mg/day) (Zhai and Yang, 2002), and present study (3,623 mg/day) suggests that Chinese adults in China consume more sodium than do their counterparts in Canada. Our findings indicate that after seven years, on average, in Canada, the sodium intake of FBC is comparable to CBC, that FBC have lower sodium intakes than adults in China, and that both FBC and CBC have excessive intakes of sodium. Overall, the study findings imply many similar sodium sources for both CBC and FBC and that reduction of salt consumption from processed foods is essential for both groups as is moderation in salt/soy sauce use in home cooking or when eating at a restaurant. Since a high percentage of processed food

products and condiments sold at Chinese grocery chains and used by Chinese Canadians are often manufactured outside of Canada limiting the ability of Health Canada to regulate sodium content of these products, it is reasonable to anticipate that intake of processed foods will continue to influence sodium intakes among Chinese Canadians.

The top foods contributing to total calcium and vitamin D intakes of our Edmonton Chinese sample were also examined in this study. For both FBC and CBC, calcium (43%) and vitamin D (52%) were obtained mainly from milk and milk products. Data from the 1997-1998 Food Habits of Canadians survey (Poliquin et al., 2009), 2005-2006 National Health and Nutrition Examination Surveys in the United States (USDA, 2005-2006) and other studies (Fleming and Heibach, 1994; Leachman-Slawson et al., 2001; Berube et al., 2005; Johnson-Down et al., 2006; Poliquin et al., 2009) showed similarly that at least 40-70% of dietary calcium is supplied by milk and milk products, milk, cheese, and yogurt in the typical Northern American diet. In contrast, the traditional Chinese diet is comprised of plant-based foods and relies on vegetables, not dairy products, for calcium (Lee et al., 1994; Jackson and Savaiano, 2001; Lv et al., 2007). Studies from China, Taiwan, and Hong Kong showed that plant foods such as vegetables and soy bean products contributed as much as 70% of calcium to the total calcium intake in the Chinese population whereas only 20% of calcium consumed came from milk and milk products. In comparison with these findings, our results showed a much higher contribution of dairy foods to the overall calcium intakes of both FBC (43.9%) and CBC (42.4%) with a notably lower contribution of plant foods (e.g., vegetables) to calcium.

According to the Canadian Community Health Survey (CCHS) 2004-Nutrition (Vantanparast et al., 2010), in Canada dairy products are the primary food source of vitamin D, contributing to at least 49.1% of dietary vitamin D intake, followed by meat and alternatives (31.1%), other foods (11.8%), grain products (5.5%), and vegetable and fruit (2.4%). Similarly for both CBC and FBC,

dairy foods, mostly milk, were the predominant source of vitamin D with meat and alternatives also making an important contribution. Fungal foods are important in the Asian diet. For this reason, mushrooms provided 9.2% of vitamin D for FBC and 4% for CBC since fungal foods are important natural food sources of ergosterol which may be converted to ergocalciferol (vitamin D2) when exposed to ultraviolet light (Mattila et al., 2002).

Calcium and vitamin D intakes of FBC and CBC were comparable and below the Institute of Medicine (IOM)'s recommended dietary allowance (RDA) of 1,000 mg/day for calcium and 15 µg/day for vitamin D for adults aged 19-50 years regardless of gender (IOM, 2011). Our findings were comparable to those from the 2004 CCHS-nutrition (Vatanparast et al., 2010), in that males consumed more calcium and vitamin D from foods than did females; however, both males and females in our sample consumed less than their counterparts in the general population included in the CCHS.

Among Chinese in our sample 36% of males and 78% of females were at risk for calcium inadequacy and had usual calcium intakes from food that fell below the estimated average requirement (EAR) of 800 mg/day (IOM, 2011). A comparison of mean calcium intake estimates from food sources based on the 1993-1996 NAHSIT in Taiwan (462 mg/day) (Pan et al., 1999; Lu, 2000), 2002 China Health and Nutrition Survey (338 mg/day) (Ma et al.,2007), a dietary study in Hong Kong (<500 mg/day) (Pun et al., 1991), and present study (794 mg/day) suggests that Chinese adults in Canada (from our sample) consume far more calcium than do their counterparts in Asia. The usual intakes of vitamin D from food sources of 98% of males and 100% of females in our sample did not meet the EAR of 10 µg/day for adults.

There has been evidence to suggest that dietary acculturation can lead to increased dairy consumption and positively influence calcium and vitamin D intakes in Chinese immigrants living in North America (Lee et al., 1994; Lee et al., 1999; Satia et al., 2001; Lv and Cason, 2004; Lv et al., 2007). Studies show that

Chinese Americans begin to increase their frequency of consumption of dairy products quickly after immigration because dairy products are presumably more readily available and accessible and are comparatively less expensive in North America than in Asia (Pan et al., 1999; Lv and Cason, 2004). However, we did not observe significant increases in FBC's dairy consumption by length of residence in Canada. Instead, we found higher overall dairy products (mainly milk) consumption and slightly higher calcium and vitamin D intakes in FBC than in their Canadian-born counterparts. Reasons for this are unclear but might be attributable to a mere reflection of individual's food preference in our CBC and FBC samples.

In sum, for both Canadian-born and foreign-born Chinese dairy foods made an important contribution to calcium and vitamin D intake as compared to other food sources. In addition, for both groups, plant foods (grains, soy bean products, and vegetables) also contributed to overall calcium intake and as did meat and alternatives (fatty fish, red meats, and eggs) to vitamin D. Supplements may be required for individuals to meet the recommended intakes for these nutrients (Calvo et al., 2003; Poliquin, 2009);

6.1 FINAL COMMENTS

The results presented described the sodium, calcium, and vitamin D-related dietary behaviors associated with dietary acculturation in Chinese adults from a convenience sample in Edmonton, Alberta. We were able to report the overall macronutrient and micronutrient intakes of these Chinese individuals with a special focus on sodium, calcium, and vitamin D. The respective food sources of these nutrients were reported and ranked in addition to the prevalence of excessive sodium intake and the risk of calcium and vitamin D inadequacies. Our study demonstrated that Chinese adults in Edmonton had similar intakes of sodium, calcium, and vitamin D and food sources contributing to these nutrients regardless of their region of origin that is, Canada versus Asia. In addition, we reported no significant relationship between FBC's length of time

(years) in Canada and their sodium, calcium, and vitamin D intakes. This was the first study, to the author's knowledge, that assessed the sodium, calcium, and vitamin D intakes in Chinese Canadians and to identify the food sources of these nutrients by region of origin and length of time in Canada (for FBC). The findings that commercially-processed foods and dairy products are the primary respective food sources of sodium and calcium and vitamin D imply that this Edmonton sample was consuming foods more typical of Western diets and that these foods are important to target to optimize intakes of these nutrients in Chinese Canadians.

The information obtained and reported in this thesis has made an important contribution to the literature in understanding what traditional Chinese and Canadian foods contribute to sodium, calcium, and vitamin D intake. In addition, these reported findings provide us with a more thorough understanding of the diet consumed by Chinese Canadians. The findings from this study will be useful for dietetic practitioners who work with Chinese clients to target their specific nutritional needs and educate them on the major food sources of sodium, calcium, and vitamin D and to optimize their intakes to meet the current requirements.

For example, some applications of the study findings include developing Chinese-specific nutrition education programs and education materials in both English and Chinese to teach Chinese Canadians at large about the relationship between sodium/calcium/vitamin D and health, foods that are high in sodium or natural rich sources of calcium and vitamin D, supplementation of calcium and vitamin D, and ways to deal with lactose intolerance to increase their calcium and vitamin D intakes etc. These nutrition education programs can be designed to reach Chinese population through Chinese supermarkets, churches, Chinese schools, Chinese newspapers, and radio/television stations. Nutrition intervention strategies for Chinese Canadians will be more efficient if the healthful aspects of both traditional and Western diets are encouraged (Kwok et

al., 2009). For example, Chinese immigrants may be encouraged to maintain their traditional healthful dietary patterns and increase consumption of fruits and vegetables (rich sources of potassium, calcium, and magnesium) as they are beneficial for lowering blood pressure (Lee et al, 1994; Appel et al., 1997). Use of dairy products can be introduced to Chinese immigrants who seldom consume them as healthful food choices in the Western diet. Because convenience and availability are the two important reasons leading to dietary changes of immigrants (Lv & Cason, 2004), recipes of convenient and healthy Chinese-style Western foods could also be developed to introduce other nutritious Western foods into Chinese immigrant's diet and promote home-made cuisines over fast/ processed foods.

6.2 FUTURE DIRECTIONS

As Chinese Canadians, the fastest growing visible minority group, acculturate and adopt the dietary practices of Canada more information is needed about the foods they eat to optimize their dietary choices and health outcomes. This study helped lay the groundwork for further research on sodium, calcium, and vitamin D-related dietary practices in Chinese Canadians. Our study findings can be used to develop culturally appropriate food frequency questionnaires to evaluate intake of sodium, calcium, and vitamin D in Asian Canadians. However, the efforts in this area still need to be enhanced so that nutrition messages can be properly developed and tailored to Chinese Canadians as immigrants at different stages of acculturation require different dietary advice and needs.

Firstly, further research should involve qualitative approaches to explore the underlying psychosocial aspect of the critical "why" and "how" answers to explain Chinese immigrants' changes in their attitudes and beliefs about food, taste preference; food purchasing and preparation behaviors; and, dietary intakes and patterns. After obtaining knowledge in this area, the development of culturally sensitive health promotion programs and dietary interventions for

Chinese immigrant communities according to their level of acculturation can be developed to better address identified issues facing this population. Secondly, if our study findings are generalizable to other Chinese in Canada, this ethnic group is at greater risk than the general Canadian population for excessive sodium intake and deficiency in calcium and vitamin D regardless of nation of birth. It is important that subsequent efforts be made to see if similar findings can be found among Chinese individuals in different parts of Canada. Thirdly, because of the rather small sample size of this study, we were unable to report any significant relationships between the nutrient intakes and Chinese immigrants' length of time in Canada. Future research on immigrant health will benefit this population more by involving larger sample population. Fourthly, a major limitation of this study was that it was cross-sectional making it difficult to make any firm conclusions about causation. Future studies would benefit from using controlled and longitudinal designs that carefully assess both dietary and physiological changes, as well as psychological changes. Lastly, further studies will be able to better explore the effects of dietary acculturation on Chinese immigrants' dietary intakes and improve the quality of the findings obtained in acculturation studies by incorporating more validated acculturation scales to measure level of acculturation which this study lacked.

As globalization results in ever-larger trading and political relations, more and more populations experience rapid social change (Berry, 2005 & 2008). Dietary changes, within immigrant groups or groups undergoing acculturation, have become an issue of increasing interest in community nutrition and nutritional anthropology (Lands et al., 1990). Epidemiological studies of diet and its relationship to various social aspects of a particular population or culture can contribute to the development of nutrition programs and services in both clinical and community-based settings. Information from these studies is inevitably needed and useful in the implementation of such programs and services for

immigrant settlement at national, provincial, and local levels as Canada continues to be one of the most ethnically diverse countries in the world.

6.3 LIETRATURE CITED

Anderson CA, Appel LJ, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *Journal of American Dietetic Association. 2010; 110(5): 736-45.*

Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. *New England Journal of Medicine. 1997; 336: 1117-24.*

Berry JW. Acculturation: Living successfully in two cultures. *International Journal of Intercultural Relations. 2005; 29(6): 697-712.*

Berry JW. Globalization and acculturation*. International Journal of Intercultural Relations. 2008; 32(4): 328-36.*

Berube S, Diorio C, Masse B, et al. Vitamin D and calcium intakes from food or supplements and mammographic breast density. *Cancer Epidemiology, Biomarkers & Prevention. 2005; 14(7): 1653-9.*

Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *International Journal of Epidemiology. 2009; 38(3): 791-813.*

Calvo MS, Whiting SJ. Prevalence of vitamin D insufficiency in Canada and the United States: importance to health status and efficacy of current food fortification and dietary supplement use. *Nutrition Reviews. 2003 ;61(3):107-13.*

Fischer PW, Vigneault M, Huang R, Arvaniti K, Roach P. Sodium food sources in the Canadian diet. *Applied Physiology, Nutrition, & Metabolism. 2009; 34(5): 884-92.*

Fleming KH, Heimbach JT. Consumption of calcium in the U.S.: food sources and intake levels. *Journal of Nutrition. 1994; 124(8 Suppl): 1426S-30S.*

Garriguet D. Sodium consumption at all ages. *Health Reports. 2007; 18(2): 47-52.*

Ho GP, Nolan FL, Dodds ML. Adaptation to American dietary patterns by students from oriental countries. *Journal of Home Economics. 1966; 58: 277-80.*

Institute of Medicine, Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: National Academy Press; 2011.

Jackson KA, Savaiano DA. Lactose maldigestion, calcium intake and osteoporosis in African-, Asian-, and Hispanic-Americans*. Journal of American College of Nutrition. 2001; 20(2 Suppl): 198S-207S.*

Johnson-Down L, Ritter H, Starkey LJ, Gray-Donald K. Primary food sources of nutrients in the diet of Canadian adults*. Canadian Journal of Dietetic Practice & Research. 2006; 67(1): 7-13.*

Kwok S, Mann L, Wong K, Blum I. Dietary habits and health beliefs of Chinese Canadians. *Canadian Journal of Dietetic Practice & Research. 2009; 70(2): 73-80.*

Lands WE, Hamazaki T, Yamazaki K, Okuyama H, Sakai K, Goto Y, et al. Changing dietary patterns. *American Journal of Clinical Nutrition. 1990; 51(6): 991-3.*

Leachman-Slawson D, McClanahan BS, Clemens LH, et al. Food sources of calcium in a sample of African-American an Euro-American collegiate athletes. *International Journal of Sport Nutrition & Exercise Metabolism. 2001; 11(2): 199-208.*

Lee MM, Wu-Williams A, Whittemore AS, et al. Comparison of dietary habits, physical activity and body size among Chinese in North America and China. *International Journal of Epidemiology. 1994; 23(5): 984-90.*

Lee SK, Sobal J, Frongillo EA,Jr. Acculturation and dietary practices among Korean Americans. *Journal of American Dietetic Association. 1999; 99(9): 1084-9.*

Lu YP. Investigation of acculturation changes in food intake of Taiwanese students attending the University of Wisconsin-Stout [dissertation]. Menomonie, Wisconsin: University of Wisconsin-Stout; 2000.

Lv N, Brown JL, Liu B. Enhancing nutrition consumption in the American diet: Factors influencing dairy product consumption of Chinese Americans in Pennsylvania. *Topics in Clinical Nutrition. 2007; 22(3): 258-71.*

Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *Journal of American Dietetic Association. 2004; 104(5): 771-8.*

Ma G, Li Y, Jin Y, Zhai F, Kok FJ, Yang X. Phytate intake and molar ratios of phytate to zinc, iron and calcium in the diets of people in China. *European Journal of Clinical Nutrition. 2007; 61(3): 368-74.*

Mattes RD, Donnelly D. Relative contributions of dietary sodium sources. *Journal of American College of Nutrition. 1991; 10(4): 383-93.*

Mattila P, Lampib A-M, Ronkainenb R, Toivob J, PiironenV. Sterol and vitamin D2 contents in some wild and cultivated mushrooms. *Food Chemistry. 2002; 76: 293-8.*

Moshfegh A, Goldman J, Cleveland L. What We Eat in America, NHANES 2001-2002: Usual Nutrient Intakes from Food Compared to Dietary Reference Intakes. Washington, DC: US Department of Agriculture, Agricultural Research Service; 2005.

Nutrient intakes from food: Mean amounts consumed per individual, one day, 2003-2004. US Department of Agriculture, Agricultural Research Service Web site. www.ars.usda.gov/ba/bhnrc/fsrg. Accessed September 16th, 2011.

Nutrient intakes from food: Mean amounts consumed per individual, one day, 2005-2006. US Department of Agriculture, Agricultural Research Service Web site. www.ars.usda.gov/ba/bhnrc/fsrg. Accessed September 16th, 2011.

Pan Y, Dixon Z, Himburg S, Huffman F. Asian Students Change their Eating Patterns After Living in the United States. *Journal of the American Dietetic Association. 1999; 99(1): 54-7.*

Parvanta S. Adoption of Dietary Innovations among Chinese Students in the United States: A Case Study of an Unplanned Diffusion Process [dissertation]. Bloomington, Ind: Indiana University; 1987.

Poliquin S, Joseph L, Gray-Donald K. Calcium and vitamin D intakes in an adult Canadian population. *Canadian Journal of Dietetic Practice & Research. 2009; 70(1): 21-7.*

Pun KK, Chan LML, Chung V, Wong FHW. Calcium content of common food items in Chinese diet. *Calcified Tissue International. 1991; 48: 153-6.*

Sanchez-Castillo CP, Warrender S, Whitehead TP, James WP. An assessment of the sources of dietary salt in a British population. *Clinical Science (London). 1987; 72: 95-102.*

Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *Journal of American Dietetic Association. 2001; 101(5): 548-53.*

Tian HG, Hu G, Dong QN, et al. Dietary sodium and potassium, socioeconomic status and blood pressure in a Chinese population. *Appetite. 1996; 26(3): 235-46.*

Vatanparast H, Calvo MS, Green TJ, Whiting SJ. Despite mandatory fortification of staple foods, vitamin D intakes of Canadian children and adults are inadequate. *Journal of Steroid Biochemistry & Molecular Biology. 2010; 121(1-2): 301-3.*

Zhai FY, Yang XG. China National Health and Nutrition Survey-Report Two: Food and Nutrients Intake in 2002 [in Chinese]. Beijing, China: People's Medical Publishing House; 2006: 254.

APPENDICES

APPENDIX A

ETHNICS APPROVAL

UNIVERSITY OF ALBERTA

Faculty of Physical Education and Recreation
Faculty of Agricultural, Life & Environmental Sciences
Faculty of Native Studies
Research Ethics Board

2-14 Agriculture-Forestry Centre
Edmonton, Alberta, Canada T6G 2P5

Tel: 78
Fax: 78

Notification of Ethics Approval

Study ID:	Pro00010341
Study Title:	Sodium-related dietary behaviors of Chinese Canadians and dietary acculturation
Study Investigator:	Yan-Han Yu
Approval Expiry Date:	February 11, 2011

I have received your application for research ethics review and conclude that your proposed research meet the University of Alberta standards for research involving human participants (GFC Policy Section 66). On behalf of the Physical Education and Recreation, Agricultural, Life & Environmental Sciences and Native Studies Research Ethics Board (PER-ALES-NS REB), I am providing **research ethics approval** for your proposed research.

The research ethics approval is valid for one year and will expire on February 11, 2011.

A renewal report must be submitted prior to the expiry of this approval if your study still requires ethics approval at that time. If you do not renew before the renewal expiry date, you will have to re-submit an ethics application. If there are changes to the project that need to be reviewed, please file an amendment. If any adverse effects to human participants are encountered in your research, please contact the undersigned immediately.

Sincerely,

Kelvin Jones, Ph.D.
Chair, Physical Education and Recreation (PER), Agricultural Life & Environmental Sciences (ALES) and Native Studies (NS)

Note: This correspondence includes an electronic signature (validation and approval via an online system).

APPENDIX B

INFORMATION LETTER

UNIVERSITY OF ALBERTA

Study Title: Sodium-Related Dietary Behaviors of Chinese Canadians and Dietary Acculturation

Participant Information Letter (24-hour Dietary Recall)

Background/ Purpose: High blood pressure is of great concern because it causes chronic diseases. Eating too many salt or salty foods may raise blood pressure and harm heart health. We are doing a study to understand the way Chinese people in Canada eat. This information will help us to improve the diet and nutrition of Chinese living in Canada.

Procedures: You will be asked to take part in 45-minute interviews and answer questions about the types and amounts of food and drinks you had the day before. Notes will be taken of what you say during the interview.

Possible benefits/risks:

You will be able to reflect on your diet and food choices and learn more about nutrition knowledge through the study. You will also receive a $25 gift card to a local grocery store for participating. The risks to you are very small.

Confidentiality: All the information that you give will be kept private. You will not be personally identified in any reports from this study. Only research staff will have access to your information. Data in paper form will be stored in a locked filing cabinet. The electronic data will be stored on a computer that is password-protected in the Agriculture & Forestry Centre at the University of Alberta.

Voluntary participation: Taking part in this study is voluntary. You can say "no" to participating. As well, if you agree to participate, you are still free to withdraw from the study at any time. Also, your data will be destroyed if you choose it to be.

Please contact any of the following people if you have any questions or concerns about this study at any time:

Research Assistant		
Julie Yu	yu@ualberta.ca	(780) 492-8837
Principal Investigators		
Dr. Noreen Willows	noreen.willows@ualberta.ca	(780) 492-3989
Dr. Anna Farmer	anna.farmer@ualberta.ca	(780) 492-2693

THE INFORMATION LETTER MUST BE ATTACHED TO THE CONSENT FORM AND A COPY GIVEN TO THE RESEARCH SUBJECT

APPENDIX C

INFORMED CONSENT FORM

UNIVERSITY OF ALBERTA

Study Title: Sodium-Related Dietary Behaviors of Chinese Canadians and Dietary Acculturation

Informed Consent Form (24-hour Recall)

To be completed by the research participant

I know that participation in this study is voluntary and involves the following steps	YES	NO
➢ Having a chance to ask questions and discuss the study	☐	☐
➢ Understanding the benefits and risks of participating in this study	☐	☐
➢ Signing a consent form	☐	☐
➢ Taking part in an individual interview and answering questions about my food intakes and consumption	☐	☐
➢ The study has been clearly explained to me	☐	☐
➢ I understand my role and that I am free to withdraw from the study at any time	☐	☐

Third party contact information: If you have any concerns about your rights as a study participant, you may contact Kelvin Jones, Chair of the Agricultural, Life and Environmental studies and Native Studies research ethics board at 780-492-0302 or kejones@ualberta.ca. He has no direct involvement with the study.

Please contact any of the following people if you have any questions or concerns about this study at any time:

Research Assistant		
Julie Yu	yu@ualberta.ca	(780) 492-7950
Principal Investigators		
Dr. Noreen Willows	noreen.willows@ualberta.ca	(780) 492-3989
Dr. Anna Farmer	anna.farmer@ualberta.ca	(780) 492-2693

I agree to take part in this study as described here and on the Information Letter

Participant Printed Name Signature Date (dd/mm/yy)

Witness Printed Name Signature Date (dd/mm/yy)

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

APPENDIX D

24-HOUR DIETARY RECALL SHEET

Interviewer Name: _____
Date/ time of Recall: dd/mm/yyyy

Place eaten	Time	Food items / beverages consumed (Method of preparation) Brand names if applicable	Condiments, Sauces, Spreads	Portion/ serving sizes	NOTES

*Is the recall representative of your usual dietary intake?
Yes
No, in what way: page

APPENDIX E

SODIUM FOOD GROUPS

Food Group	**Food Item In Group**
Common condiments	Salt (from home cooking and restaurants), BBQ sauce, hot sauce
Canadian condiments	Ketchup, mustard, pickle relish, salsa
Asian condiments	Soy sauce, teriyaki sauce, oyster sauce, bean paste, stir-fry sauce, MSG (added in home cooking)
Soups & broths	Canned cream soup, miso soup, broth (beef, chicken, vegetable), sweet and sour soup
Fast foods	Burgers, hotdogs, fried chicken, fries, pizzas, sandwiches
Grains	Breads, cereals, muffins, buns, bagels, waffles, pastas, noodles
Dairy	Cheese, yogurt, ice cream, soy milk, milk
Meats and alternatives	Sausages, luncheon meat, cured meat, meat loaf , smoked and canned fish, seafood (shrimps, mollusks, fish), poultry, eggs, red meats
Snack foods	Snack mixes, chips, cookies, crackers, candies, candy bars
Mixed dishes	Sushi, fish-based surimi, teriyaki dishes, dim Sum dumplings, buns, wontons, green onion cakes, stew, curry, gravy, mashed potatoes
Spreads & dips	Hummus, salad dressing, Alfredo sauce, butter, margarine, peanut butter
Nuts & seeds	Almonds, cashew, peanuts, flaxseeds, sunflower seeds, sesame, walnuts
Pickled vegetables	Cabbage, Chinese gai choy, olive, cucumber, relish, kim chi, radish, ginger
Cake/pastries/pies	Croissant, Danish, doughnut, custard, moon cake, pie, cheese cake, chocolate cake

APPENDIX F

CALCIUM FOOD GROUPS

Food Group	**Food Item In Group**
Dairy products	Milk, cheese, yogurt, ice cream, cream
Grains	Breads, muffins, buns, waffles, bagels, cereals, pastas, noodles, rice, flour
Soy bean products	Tofu, soy beverage
Vegetables	Broccoli, bok choy, spinach, celery, beans, peas, lettuces, carrots, seaweeds
Meats and alternatives	Eggs with yolks, seafood (eg. fish, shrimp, mollusk), sausages, luncheon meats, cured meats, meat loaf, red meats, poultry
Coffee & cocoa	Brewed and instant coffee, milk tea, hot chocolate
Fast foods	Burgers, hotdogs, pizzas, sandwiches, fried chicken, fries
Snacks	Candies, candy bars, cookies, crackers, snack mixes, chips
Mixed dishes	Sushi, fish-based surimi, dim Sum dumplings, buns, Wontons, green onion cakes, stew, curry, gravy, mashed potatoes
Fruits	Oranges, grapefruits, kiwis, watermelon
Nuts & seeds	Almonds, cashews, peanuts, flax seeds, sesame, lotus seeds, sunflower seeds, walnuts
Cakes/pastries/pies	Cheese cake, croissant, doughnut, pie, moon cake
Spreads and dips	Margarine, butter, peanut butter, mayonnaise, salad dressing, hummus, jam
Juices	Juice (canned or bottled)
Soups & broths	Broth (beef, chicken, vegetable), canned cream soup, miso soup, sweet and sour soup
Spices	Curry powder, black and white pepper, chili pepper, Chinese five spice, garlic powder, basal, anise seeds

APPENDIX G

VITAMIN D FOOD GROUPS

Food Group	**Food Item In Group**
Dairy products	Milk, cheese, yogurt, ice cream, cream
Grains	Breads, muffins, buns, waffles, bagels, cereals, pastas, noodles, rice, flour
Soy bean products	Tofu, soy beverage
Vegetables	Broccoli, bok choy, spinach, celery, beans, peas, lettuces, carrots, seaweeds
Meats and alternatives	Eggs with yolks, seafood (eg. fish, shrimp, mollusk), sausages, luncheon meats, cured meats, meat loaf, red meats, poultry
Coffee & cocoa	Brewed and instant coffee, milk tea, hot chocolate
Fast foods	Burgers, hotdogs, pizzas, sandwiches, fried chicken, fries
Snacks	Candies, candy bars, cookies, crackers, snack mixes, chips
Mixed dishes	Sushi, fish-based surimi, dim Sum dumplings, buns, Wontons, green onion cakes, stew, curry, gravy, mashed potatoes
Fruits	Oranges, grapefruits, kiwis, watermelon
Nuts & seeds	Almonds, cashews, peanuts, flax seeds, sesame, lotus seeds, sunflower seeds, walnuts
Cakes/pastries/pies	Cheese cake, croissant, doughnut, pie, moon cake
Spreads and dips	Margarine, butter, peanut butter, mayonnaise, salad dressing, hummus, jam
Juices	Juice (canned or bottled)
Soups & broths	Broth (beef, chicken, vegetable), canned cream soup, miso soup, sweet and sour soup
Spices	Curry powder, black and white pepper, chili pepper, Chinese five spice, garlic powder, basal, anise seeds