# COMMUNITY-BASED PHYSICAL ACTIVITY AND THE RISK FOR CARDIOVASCULAR DISEASE IN ABORIGINAL CANADIANS

by

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## Abstract

**Introduction:** Aboriginal individuals continue to experience greater levels of cardiovascular disease (CVD) and diabetes than the Canadian general population, though these diseases were historically rare. Increasing evidence indicates rising sedentary behaviours from the traditional healthy and active lifestyles of this population. Various interventions have been implemented to address the health inequities in Aboriginal peoples with mixed results. Unfortunately, limited research has taken a culturally appropriate community approach to improve the health and well-being of Aboriginal peoples. By implementing a community-based and participatory physical activity (PA) and healthy living program, health and wellness can be improved in a culturally relevant context.

**Purposes:** The primary purpose of this investigation was to examine the health benefits of a community-based PA and healthy living intervention program for Aboriginal Canadians.

**Methods:** Participants were recruited through local Aboriginal offices representing male and female participants of wide ranging ages and CVD risk profiles. Each participant completed identical testing days pre- and post-training including a variety of CVD risk factors and four CVD risk scoring systems. Participants were self-assigned to three different community-based PA interventions including walking, walk/running, or running.

**Results:** Significant improvements in health measures and CVD risk scores were observed for both male and female participants of all age groups. The three PA programs produce similar improvements in health measures and risk scores. Individuals of high, moderate and low CVD risk also experienced similar improvements.

**Discussion:** High program compliance indicated success for improving PA of this population. Improvements among both genders and a variety of age groups support this program as a successful intervention for males and females of all ages. The similar changes in health status with each of the programs suggest that Aboriginal adults successfully self-select an appropriate PA intervention for health benefits. Moreover, the similarity in improvements among participants of a variety of CVD risk classifications indicates this individualized program was appropriate for improving the health status of individuals of a range of CVD risk profiles.

**Conclusion:** The self-selected intensities Hearts inTraining program was successful in improving health status and increasing PA for Aboriginal adults of all ages, genders and risk categories.

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# List of Symbols

| | |
|---|---|
| ≥ | Greater than or equal to |
| ≤ | Less than or equal to |
| > | Greater than |
| < | Less than |
| µ | Micro |
| ± | Plus or minus |
| % | Percent |
| † | Footnote below |
| ‡ | Footnote below |
| * | On table footnote below, on figure significant difference |

# List of Abbreviations

| | |
|---|---|
| cm | centimetres – units of length measurement |
| kcal | kilocalorie |
| $kg \cdot m^{-2}$ | kilograms per metre squared – unit of measurement for body mass index |
| min | minutes |
| mJ | Megajoule |
| mmHg | millimetres of mercury – units of blood pressure measurement |
| mmol/L | millimoles per litre – units of blood content measurements |
| yr | years |
| | |
| ACSM | American College of Sports Medicine |
| ATP | Adult Treatment Panel |
| BMI | Body Mass Index |
| CDC | Centre for Disease Control |
| CHD | Coronary Heart Disease |
| CI | Confidence Interval |
| CSEP | Canadian Society for Exercise Physiology |
| CVD | Cardiovascular Disease |
| DBP | Diastolic Blood Pressure |
| HDL | High Density Lipoprotein Cholesterol |
| LDL | Low Density Lipoprotein Cholesterol |
| LTR10K | Hearts inTraining Physical Activity Learn to Run Program |
| MetS | Metabolic Syndrome |
| NCEP | National Cholesterol Education Program |
| Nil | No significant differences observed |
| PAL | Physical Activity Level |
| PAR-Q | Physical Activity Readiness Questionnaire |
| Run10KFaster | Hearts inTraining Physical Activity Running Program |
| SBP | Systolic Blood Pressure |
| SD | Standard Deviation |
| TC | Total Cholesterol |
| TC:HDL | Total Cholesterol to High Density Lipoprotein Cholesterol ratio |
| TEE | Total Energy Expenditure |
| Walk10K | Hearts inTraining Physical Activity Walking program |
| WC | Waist Circumference |

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# Preface

Heather-Jean Foulds was a member of the Hearts inTraining screening team for the 2009-2010 program years, conducting data collection and coordinating with other employees and volunteers collecting data. A large majority of data entry, data editing and preparation was performed by Ms. Foulds. All writing and statistical analysis of this thesis was conducted by Heather-Jean Foulds. Heather-Jean Foulds also conducted data analysis and contributed to the writing of annual program reports for the 2009 and 2010 program years.

Dr. Darren Warburton provided funding for the research assistants, data collection, and analysis and co-supervised the research portion of this program. He wrote the grant and ethics proposals for this project. Dr. Warburton contributed substantially to the writing of annual program reports, providing expertise and interpretations. Supervision, advice and guidance for this thesis were provided by Dr. Warburton.

Dr. Shannon Bredin assisted with grant and ethics applications and the writing of annual program reports. She also supervised the systematic review of Aboriginal physical activity levels. Dr. Bredin also co-supervised the research portion of the Hearts inTraining program.

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# 1. Introduction to Thesis

Canadian Aboriginal people descend from the peoples inhabiting Canada prior to the arrival of Europeans (Willows, 2005). Aboriginal is a general term referring to Canadian Native peoples, including First Nations, Métis, and Inuit (Dean, 1998). First Nations peoples are registered under the federal Indian Act of 1876, Inuit peoples live in the Arctic and are a distinct group from other Aboriginal peoples (Dean, 1998). Métis is a broad term used to describe individuals of mixed First Nations and European ancestry (Willows, 2005). In 2006, there were approximately 1,172,790 Aboriginal people in Canada, characterized by 698,025 First Nations people, 50,485 Inuit people and 389,785 Métis people. Within British Columbia, 5% of the population identify as Aboriginal, representing 17% of all Canadian Aboriginals, or 196 075 individuals (Statistics Canada, 2008).

Aboriginal peoples have inhabited land throughout North America for more than 13,000 years (Dickason, 1992). Historically, North America Aboriginal populations reached upwards of 18 million people, including a diverse range of cultures and lifestyles (Dickason, 1992). Traditional subsistence methods included hunting, gathering, fishing and farming (Fredericks, 1999). Prior to the arrival of Europeans, Aboriginal peoples are thought to have led healthy, active lives (Dapice, 2006).

Cardiovascular disease is an increasing problem in today's society (Health Canada, 1999). This disease greatly impacts the health and well-being of individuals as well as society as a whole (Health Canada, 1999). In 1998, CVD health care costs in Canada reached an estimated $18 billion (Tu, et al., 2009). As the leading cause of death, disability and hospitalization in Canada, this disease has a tremendous impact on Canadian society (Health Canada, 1999). As compared to Caucasian individuals, increasing research suggests individuals of Asian, South Asian and Aboriginal descent appear to have significantly higher risks of CVD and related co-morbidities (Canadian Diabetes Association, 2007). The increased risk of CVD for individuals of specific ethnicities results from a combination of genetic predisposition and detrimental environmental factors, including lifestyle choices and socioeconomic factors (Abate & Chandalia, 2007). Current trends worldwide demonstrate an epidemic of sedentary lifestyle and overweight status, trends which may be two to threefold higher in Aboriginal populations (Lakka, et al., 2002). Aboriginal populations' experience of CVD mortality rates greater than that of the general population has only occurred since the 1980s (Liu, Hanley, Young, Harris, & Zinman, 2006). Rates of degenerative diseases including CVD and diabetes among Aboriginal peoples in Canada currently mirrors trends of developing populations throughout the world, where similar changes in lifestyle are currently occurring (Popkin, 1999; Reddy & Yusuf, 1998; Yusuf, Reddy, Ounpuu, & Anand, 2001).

Over the past four to five generations, Canadian Aboriginal populations have undergone a huge cultural shift including a decrease in physical activity levels and alterations in diet (Harris, et al., 2002). Aboriginal peoples are often referred to as a "population in transition" where the introduction of Western diet and sedentary activities alter the traditional lifestyle of Canadian First Nations (Hegele & Pollex, 2005). During this health transition, significant social, economic and cultural changes have also occurred (Liu, et al., 2006). Recent estimates suggest only 21% of Canadian Aboriginal adults are physically active (Young & Katzmarzyk, 2007). Canadian Aboriginal peoples experience an urgent need for physical activity promotion as a component of strategy to reduce the growing epidemic of chronic diseases these people face (Young & Katzmarzyk, 2007). Direct measurements have recorded significant increases in weight and skin-folds with significant decreases in aerobic fitness of Canadian Aboriginal populations over the past 40 years, with increases in western lifestyles (Rode & Shephard, 1984; Shephard, 1988). Comparisons of Aboriginal populations during these lifestyle transitions report higher weight and skin fold measures and decreased physical fitness from traditional to urbanized lifestyle (Rode & Shephard, 1971).

From 1950-1972, Aboriginal peoples experienced lower death rates from cardiovascular disease (CVD) as compared to Canadians of British and French descent (Trovato, 1988). Canadian Aboriginal populations experienced logit regression death rates due to CVD of 0.892 in comparison to the higher rates of 1.476 and 1.631 experienced by French and British Canadians, respectively, during this time (Trovato, 1988). However, since the 1950s, these mortality rates have increased steadily (Trovato, 1988). Canadian Aboriginal peoples currently experience poorer quality of life in terms of morbidity and mortality than the general Canadian population (Wilson & Rosenberg, 2002). Compared to any other group of Canadians, Aboriginal peoples experience the lowest life expectancy of all Canadians (Anand, et al., 2001).

Aboriginal ethnicity is now ranked as a greater risk factor for CVD than either weight or age (Thommasen, Patenaude, Anderson, Mc Arthur, & Tildesley, 2004). Aboriginal descent as a risk factor for CVD and other related chronic diseases results from a combination of genetic factors, individual susceptibility, and environmental conditions (Forouhi & Sattar, 2006). In addition to Aboriginal ethnicity, major risk factors for CVD include age, sex, blood pressure, cholesterol, smoking and diabetes (Castelli, 2001; D'Agostino, Sr., Grundy, Sullivan, & Wilson, 2001; Djousse, et al., 2001; Franklin, et al., 2001; Kannel & McGee, 1979c). Further risk factors, such as obesity, weight gain in adulthood and abdominal obesity, which are common in Aboriginal populations, further compound the CVD risk experienced by Aboriginal populations

(Belanger-Ducharme & Tremblay, 2005; Despres & Lemieux, 2006; Hubert, Feinleib, McNamara, & Castelli, 1983). While Aboriginal populations demonstrate greater smoking rates than other populations, this increasingly recognized independent risk factor of CVD further enhances the CVD risk experienced by Aboriginal populations (D'Agostino, et al., 2000; Millar, 1992). Within the next few decades, rates of CVD among Aboriginal Canadian populations are likely to continue increasing as more Aboriginal people move to a more 'urban' lifestyle (Yusuf, et al., 2001). In order to further characterize this increased risk, further research is required.

## 1.1 Aboriginal Culture

Traditional Aboriginal lifestyles consisted of nomadic patterns with feast/famine cycles (Statistics Canada, 2000). Varying from nation to nation, Aboriginal lifestyles included hunting, gathering, farming and fishing (Fredericks, 1999). These people existed traditionally in a hunter/gatherer society and were much more physically active than current lifestyles, though among Aboriginal populations these changes have occurred more recently than the general Canadian population (Dapice, 2006; Liu, et al., 2006; Shephard, 1988). Traditional Aboriginal individuals were recognized as being tall and strong in comparison to Caucasians, with historical populations healthier than current populations (Dapice, 2006). Records as recent as the last 40 years report significantly higher physical fitness among Canadian Aboriginal populations in comparison to the general population (Shephard, 1988). Skeletal remains of populations in the Western Hemisphere indicate North American Aboriginal peoples experienced some of the highest health indexes overall (Steckel, Rose, Larsen, & Walker, 2002).

First Nations peoples hold a holistic approach to health and well-being, which include culture and tradition as basic entities (Health Canada, 2003b). This wheel represents a holistic approach to health and well-being, including the family, community and the nation (Dapice, 2006). Aboriginal people retain an extremely strong concept of community and connectedness (Colomeda & Wenzel, 2000). North American Aboriginal populations education and knowledge acquisition are best achieved in a group setting, especially when the education can be linked to activities of daily living and previous knowledge (Colomeda & Wenzel, 2000). The western method for promoting heath education and health promotion often segregates individuals at greatest risk (Colomeda & Wenzel, 2000). This view is often perceived as 'blaming the victim' by Aboriginal populations (Colomeda & Wenzel, 2000). Aboriginal populations prefer more community based approaches where the entire community is involved in health education and health promotion rather than targeting at risk groups (Colomeda & Wenzel, 2000). To achieve effective health and development programs within these communities, cultural context and values must be considered utilizing a community based approach (Colomeda & Wenzel, 2000). Community-based health promotion projects may better encourage the health and healing of Aboriginal individuals by working within these traditional beliefs and worldviews.

## 1.2 Aboriginal Cardiovascular Disease Risk

### 1.2.1 Background

Within Canada, CVD is currently the leading cause of death, illness and disability, claiming 72, 556 lives in 2004 (Tu, et al., 2009). Cardiovascular disease has been the most common cause of death in Western cultures for at least 30 years including all diseases of the circulatory system (Barrett-Connor & Wingard, 1983; Health Canada, 1999). Common forms of CVD include ischemic heart disease, acute myocardial infarction, cerebrovascular disease (stroke), angina pectoris, peripheral vascular disease, pulmonary embolism, hypertension and congestive heart failure (Boaz, et al., 2000; Carson, et al., 1996; Health Canada, 1999; Laurent, et al., 2001). Clinical conditions of CVD and diabetes hold high mortality rates, requiring aggressive interventions (Lakka, et al., 2002). Many independent risk factors are known to contribute to risk and incidence of CVD, including family history of CVD and Metabolic Syndrome (Barrett-Connor & Khaw, 1984; Pollex, Hanley, et al., 2006). Independent risk factors are identified as risk factors where the risk factors are uncorrelated, codominant and there is no temporal precedence of either risk factor (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). In summary, independent risk factors are risk factors where the risk factors are not dependent upon each other and can exist independent of one another (Kraemer, et al., 2001). Family history may be defined as a parent or sibling experiencing coronary artery disease prior to age 60 years, including incidence of myocardial infarction, coronary artery bypass surgery, angina pectoris, exercise tolerance test diagnosis of ischemia, sudden cardiac death or angiography diagnosing coronary artery disease (Vita, et al., 1990). Metabolic Syndrome, as defined by the National Cholesterol Education Program Adult Treatment Panel III, is a collection of risk factors including at least 3 of 5 criteria (Pollex, Hanley, et al., 2006). Based on this definition, the Metabolic Syndrome criteria include abdominal obesity, with a waist circumference of greater than 102 cm for males or greater than 88cm for females, elevated plasma triglyceride levels of ≥1.68 mmol/L, low plasma HDL cholesterol levels of <1.04 mmol/L in males or <1.29 mmol/L in females, hypertension with a blood pressure of ≥130 mmHg systolic or ≥85 mmHg diastolic or the use of blood pressure medication, and impaired fasting glucose levels of ≥6.1 mmol/L.

The health of Aboriginal people has declined in relation to the Canadian population to the point where Aboriginal ethnicity is now recognized as an independent risk factor of diabetes and other related chronic diseases (Forouhi & Sattar, 2006; Thommasen, et al., 2004). Canadian Aboriginal populations currently share a disproportionate amount of physical disease and mental illness, compared to the general population (MacMillan, MacMillan, Offord, & Dingle, 1996). Epidemic rates of diabetes, obesity, childhood obesity and CVD have developed in many Aboriginal communities (Hegele & Pollex, 2005). Over the past 30 years, CVD mortality rates among Canadian Aboriginal people have risen dramatically (Liu, et al., 2006). While the overall Canadian population experiences a steady decline in occurrence and mortality caused by CVD, Canadian Aboriginal people experience a steady increase in rates of both the prevalence and mortality from CVD (Retnakaran, Hanley, Connelly, Harris, & Zinman, 2005). At every income level, rates of CVD are significantly higher for Aboriginal Canadians as compared to Canadians of European descent (Anand, et al., 2001). Canadian Aboriginal women experience 61% greater rates of Coronary Heart Disease (CHD) than that of other Canadian women (Yusuf, et al., 2001). The rates of heart disease, diabetes and hypertension in First Nations people living on reserve are as much as 3-fold higher than that observed in the Canadian general population (Thommasen, et al., 2004). Traditionally, diabetes and hypertension were rare in Aboriginal populations (Hoy, Light, & Megill, 1995). Moreover, in comparison to non-Aboriginal populations, Canadian Aboriginal people currently experience significantly higher rates of abdominal obesity, hypertriglyceridemia and hyperglycemia, while also experiencing low levels of High Density Lipoprotein (HDL) cholesterol (Liu, et al., 2006). Aboriginal populations have also experienced increasing rates of diabetes since the 1950s and increasing rates of heart disease since the 1970s (Davidson, Bulkow, & Gellin, 1993; Shah, Hux, & Zinman, 2000). Within British Columbia, local First Nations groups suffer greatly from CVD (Monsalve, Thommasen, Pachev, & Frohlich, 2005). In the Bella Coola region of Interior British Columbia, CVD was the leading cause of death from 1986-2001 (Monsalve, et al., 2005).

### 1.2.2 Non-Modifiable Cardiovascular Disease Risk Factors

#### *1.2.2.1 Aboriginal Ethnicity*

Aboriginal ethnicity is now associated with an increased risk of developing diabetes (Welty, et al., 1995). Ethnic differences in CVD cannot be accounted for through smoking, blood pressure and total cholesterol (TC) alone (Forouhi & Sattar, 2006). Moreover, though Aboriginal populations experience the lowest socioeconomic status among Canadians, these differences in socio-economic status do not explain fully the increased risk for CVD (Anand, et al., 2001; MacMillan, et al., 1996). Cardiovascular disease differences between ethnicities in part are accounted for by ethnic variations in insulin resistance, relative fat mass and fat location (Forouhi & Sattar, 2006). Increasing CVD in specific populations may be impacted by urban migration (Forouhi & Sattar, 2006). Predisposition to CVD development occurs at different rates in ethnic groups, leading to higher prevalence rates in some populations (Forouhi & Sattar, 2006). Documentation of higher CVD risk in Aboriginal populations is common (Forouhi & Sattar, 2006). Genetic variability associated with diabetes, plasma insulin concentrations and body mass index have been found (Hegele, et al., 1996). Further genetic variations between Aboriginal populations and general populations include 4 or 5 CVD genetic markers (Hegele, Young, & Connelly, 1997). These genetic variations among ethnicities have shown increased binding affinity and intracellular transportation of long chain fatty acids (Hegele, et al., 1996). This affinity and transportation is related to higher plasma triglyceride levels, which in turn leads to increased BMI and body fat (Hegele, et al., 1996). Ethnic variations among these chronic diseases further include variations in the dominant risk factor for CVD (Hegele & Pollex, 2005). In order to optimally identify individuals at risk of CVD, ethnic-specific criteria is required (Hegele & Pollex, 2005; Razak, et al., 2007). Ethnic variability in rates of circulatory diseases reports Aboriginal ethnicity above Inuit and Non-native ethnicities (Young, Moffatt, & O'Neil, 1993).

#### *1.2.2.2 Family History of Cardiovascular Disease*

A family history of CVD such as ischemic heart disease has long been established as a well-accepted risk factor for CVD (Barrett-Connor & Khaw, 1984). Heart disease risk factors and incidence of CHD have clustered in families for decades (Barrett-Connor & Khaw, 1984; Myers, Kiely, Cupples, & Kannel, 1990). A family history of CVD is known to be an independent risk factor for CVD and CVD mortality (Barrett-Connor & Khaw, 1984; Myers, et al., 1990). Future incidence of disease for individuals of all ages increases with a family history of CHD considering family members age and gender (Hunt, Williams, & Barlow, 1986). A family history of stroke in a first-degree relative is recognized as an independent risk factor for ischemic heart disease in men and stroke in women (Khaw & Barrett-Connor, 1986). An increase in risk for healthy family members, as high as 12 times greater, exists when two or more first degree relatives experience a history of CDV (Hunt, et al., 1986).

Reported rates of family history of CVD among Canadian Aboriginal populations are much greater than that of the general population. Canadian general population rates of reported family history of CVD are estimated at 17% (Bruce, Urowitz, Gladman, Ibanez, & Steiner, 2003). Reported rates among Canadian Aboriginal populations are much higher, with reports as high as 49% (Anand, et al., 2001). These greatly increased rates of family history of CVD highlight the increased risk for CVD among this population.

#### *1.2.2.3 Personal History of Cardiovascular Disease*

Personal history of hypertension, diabetes or other forms of CVD increases risk of CHD and stroke (Lee, Lowe, Woodward, & Tunstall-Pedoe, 1993). Associations have been observed between increased CVD mortality and a history of CVD (Laurent, et al., 2001). Laurent et al. (2001) found a previous history of CVD to produce the greatest odds ratio for all-cause mortality, more than three times higher than any other evaluated risk factor, including age, hypertension and diabetes. Individuals with a history of CHD experience a three to seven fold increase in risk of mortality from CHD (Haffner, Lehto, Ronnemaa, Pyorala, & Laakso, 1998). A prior myocardial infarction is also known to increase future risk of an CVD (Haffner, et al., 1998). Both diabetic and non-diabetic individuals with a previous history of CVD experience a significant increase in incidence of CVD death, fatal and nonfatal stroke and fatal and nonfatal myocardial infarction (Haffner, et al., 1998). Non-diabetic individuals with a previous history of CVD such as myocardial infarction experience increased CVD risk similar to diabetic individuals without a previous history of CVD (Haffner, et al., 1998). While mortality from myocardial infarction has declined in recent years, a corresponding increase in mortality from heart failure has occurred in individuals following initial myocardial infarction (Velagaleti, et al., 2008).

In comparison to the general Canadian population, rates of CVD history are greater among Aboriginal populations . Among Aboriginal populations, 17.2% report a personal history of CVD (Anand, et al., 2003). Reported rates of personal history of CVD among Canadian Aboriginal populations are around 7% (Anand, et al., 2001). These increased rates of CVD among Aboriginal populations highlight the further need for interventions to address this high risk population.

#### *1.2.2.4 Diabetes*

Diabetes is a well recognized risk factor for CVD (Grundy, 2004). For diabetics, the most prevalent cause of mortality is heart disease (Barrett-Connor & Wingard, 1983). All-cause mortality is found to be significantly associated with diabetes, producing an odds ratio second only to a previous history of CVD (Laurent, et al., 2001). Impaired glucose tolerance, or diabetes alone is known to increase CVD risk two- to three-fold (Kannel & McGee, 1979a). An individual's risk of CHD is increased up to four-fold with diabetes (Haffner, et al., 1998). For both men and women, ischemic heart disease mortality is independently and significantly predicted by diabetes (Barrett-Connor & Wingard, 1983). Diabetes even predicts risk for ischemic heart disease in the absence of other CVD risk factors (Barrett-Connor & Wingard, 1983). Mortality from CHD is known to be lower among diabetic individuals compared to non-diabetic individuals (Haffner, et al., 1998).

The experience of diabetes is significantly higher in Aboriginal populations than European populations within Canada (Anand, et al., 2001). These high rates of diabetes extend to all Aboriginal communities (Forouhi & Sattar, 2006). More troubling, these rates are increasing (Forouhi & Sattar, 2006). Of all CVD risk factors increasing in Aboriginal populations, diabetes is increasing the most (Retnakaran, et al., 2005). Within British Columbia, the rates of diabetes and diabetes complications occur more than expected in Aboriginal populations (Thommasen, et al., 2004). Throughout the world, the highest rates of non-insulin dependent diabetes occurring in youth are reported among the Canadian Aboriginal populations (Dean, 1998). Rates of impaired glucose tolerance and type 2 diabetes mellitus experienced by Ojibway-Cree populations in Ontario are among the top 5 in the world, including an estimated 40% of the population (Pollex, Hanley, et al., 2006). By contrast, type two diabetes mellitus was rare in ancestral First Nations populations and up until the last 50 years (Hoy, et al., 1995; Statistics Canada, 2000). Further, Aboriginal populations experience diabetes earlier in life, with greater severity at diagnosis and with a greater rate of complications (Statistics Canada, 2000). While this population experiences alarmingly elevated rates of diabetes, further research is required to identify culturally appropriate methods to reduce and prevent the onset of diabetes. Provincial estimates of the cost of physical inactivity among the general population reach $211 million; increasing the physical activity of this population would greatly improve the health and wellbeing among these people and diminish these health care costs (Colman & Walker, 2004).

#### ***1.2.2.5 Age***

Prevalence of all manifestations of atherosclerosis increases with age (Kannel & Vasan, 2009). Age is also known to increase risk for ischemic heart disease and coronary artery disease (Barrett-Connor & Wingard, 1983; Myers, et al., 1990). Both sexes experience a marked increase in risk for CHD as well as CHD mortality with increasing age (Jousilahti, Vartiainen, Tuomilehto, & Puska, 1999). With increasing age, most populations experience increasing total cholesterol levels (Jousilahti, et al., 1999). Similarly, blood pressure, and thus hypertension, generally increase with age (Jousilahti, et al., 1999).

The age of Aboriginal populations is younger than that of the Canadian general population (Statistics Canada, 2008). At every age group, Aboriginal Canadians experience increased rates of diabetes and poor health status (Statistics Canada, 2000; Young, Reading, Elias, & O'Neil, 2000). Among both Aboriginal and non-Aboriginal populations, increased rates of diabetes, mortality and disability are observed with increased age (Statistics Canada, 2000; Young, et al., 2000).

***1.2.2.6 Sex***

The female sex is known to be associated, in Western societies, with a reduced risk for all-cause mortality (Barrett-Connor & Wingard, 1983). The male sex is a well known risk factor for coronary artery disease and ischemic heart disease (Barrett-Connor & Wingard, 1983; Myers, et al., 1990). For instance, the prevalence of CHD in middle-aged men is two to five times greater compared to middle-aged women, where men experience roughly three times greater incidence rates and five times greater mortality rates (Jousilahti, et al., 1999). The prediction of CVD events, such as ischemic heart disease, is independently and significantly increased in males (Barrett-Connor & Wingard, 1983). Nearly half of CHD differences between men and women can be largely explained by differences in the prevalence of CVD risk factors between the sexes, with the TC to HDL (TC:HDL) ratio, and smoking behaviour as the major determinants (Jousilahti, et al., 1999). Differences in hormones are cited as a possible cause for these observed sex differences in CVD risk and mortality (Jousilahti, et al., 1999). With increasing age, this difference declines considerably (Jousilahti, et al., 1999).

Aboriginal populations experience similar influences of gender on rates of CVD (Davidson, et al., 1993; Hoy, et al., 1995). Among Aboriginal populations, males experience greater rates of Ischaemic heart disease, Cardiomyopathy and overall heart diseases in comparison to females (Davidson, et al., 1993). Aboriginal males also experience increased rates of cardiac disease, fatal CHD and fatal stroke in comparison to Aboriginal females (Howard, et al., 1999; Hoy, et al., 1995).

#### *1.2.2.7 Menopausal Status*

Women experiencing menopause, either naturally or surgically, also experience a greater increase in CVD risk compared to their premenopausal counterparts (Gordon, Kannel, Hjortland, & McNamara, 1978). The sharp increase in CVD incidence in women after middle age is thought to largely be the result of menopause (Peters, et al., 1999). Menopause negatively influences several CVD risk factors, including body fat distribution, plasma lipid profiles, blood pressure and glucose tolerance (Rosano, Vitale, Marazzi, & Volterrani, 2007). Perimenopausal women often experience increases in body weight, insulin sensitivity and blood pressures, which increase their risk for CVD (Collins, et al., 2007). A woman's age when she naturally experiences menopause is associated with risk of CHD (Hu, et al., 1999). Women who experience menopause early in life experience an increased risk for CVD mortality (van der Schouw, van der Graaf, Steyerberg, Eijkemans, & Banga, 1996).

Within Canada, hysterectomy rates are greatest among rural populations (Hall & Cohen, 1994). These regions are also characterized by large Aboriginal populations (Statistics Canada, 2008). Premenopausal hysterectomy surgery among women is known to increase a female's risk of CVD by threefold (Centerwall, 1981).

### 1.2.3 Modifiable Cardiovascular Disease Risk Factors

#### *1.2.3.1 Obesity*

Obesity has been linked repeatedly to increased risk of CVD, type 2 diabetes, cancer and premature death (Stein & Colditz, 2004). The most prevalent physical consequence of obesity is atherosclerotic CVD (Grundy, 2004). Further, obesity is associated with hypertension, elevated blood glucose and poor blood lipid profiles (Hubert, et al., 1983). An estimated 20-30% of CVD deaths have been attributed to excess body weight (Stein & Colditz, 2004). Normal body mass index values range from 18.5-24.9 $kg{\cdot}m^{-2}$ with overweight and obese ranging from 25.0-29.9 $kg{\cdot}m^{-2}$ and $\geq$30.0 $kg{\cdot}m^{-2}$, respectively (Health Canada, 2003a). Obese classifications are further divided into Class I, 30.0-34.9 $kg{\cdot}m^{-2}$, Class II, 35.0-39.9 $kg{\cdot}m^{-2}$ and Class III, $kg{\cdot}m^{-2}$ and over (Health Canada, 2003a). Overweight and obese individuals may experience 2-3 times greater risk of CVD (Stein & Colditz, 2004). Increased health risk associated with obesity occurs in individuals at the high end of normal body mass index (22.0-24.9 $kg{\cdot}m^{-2}$) as well as overweight and obese individuals (Stein & Colditz, 2004). Through randomized control trials, weight loss has demonstrated reduced blood pressure, improved glucose tolerance and improved lipid profile (Stein & Colditz, 2004). Even modest weight loss has lead to improved health outcomes (Stein & Colditz, 2004).

Worldwide, obesity has become increasingly common, reflecting sedentary occupations and plentiful accessibility to inexpensive foods (Grundy, 2004). Obesity rates among Canadian Aboriginal people are estimated at 47%, more than twice the general population estimate of 15.2% (Vanasse, Demers, Hemiari, & Courteau, 2006). Incidentally, obesity was rare in ancestral First Nations communities (Hoy, et al., 1995). In 1991, a sample of Ontario Aboriginal residents demonstrated 90% overweight or obese BMI (MacMillan, et al., 1996). Northern, remote communities, where inhabitants are largely of Aboriginal ancestry, demonstrate the greatest rates of obesity in Canada (Belanger-Ducharme & Tremblay, 2005). Obesity and fat distribution measures reflect dietary factors and physical inactivity levels (Daniel, Marion, Sheps, Hertzman, & Gamble, 1999). Within Aboriginal Canadians, BMI is a standard predictor of diabetic status, plasma glucose concentrations and glycated haemoglobin concentrations (Daniel, Marion, et al., 1999).

Continuing increases in rates of obesity among this population suggest a lack of success among past programs combating this epidemic. As rates of obesity among Aboriginal populations continue to increase, further initiatives to combat obesity are required. The need for community inclusive, long-term methods of reducing obesity rates among these populations is great.

#### *1.2.3.2 Abdominal Obesity*

Abdominal obesity has a well established association with increased CVD risk (Balkau, Picard, Vol, Fezeu, & Eschwege, 2007). Further, diabetes mellitus risk also shows strong relationships with increased abdominal obesity, even for individuals demonstrating a healthy BMI ($<25\ kg \cdot m^{-2}$) (Balkau, et al., 2007). Standardized measures for abdominal obesity utilize a waist circumference (WC) measure (Folsom, et al., 2000). Abdominal obesity is associated with CVD conditions including ischemic heart disease, stroke, hypertension, diabetes and dyslipidemia (Reeder, et al., 1997). Further, abdominal obesity is recognized as an independent risk factor for CHD (Rexrode, et al., 1998). Additionally, abdominal obesity has been more recently associated with insulin resistance, hyperinsulinemia and glucose intolerance (Reeder, et al., 1997). Associations have also been observed between abdominal obesity with diabetic status, plasma glucose concentration and glycosylated haemoglobin concentrations (Daniel, Marion, et al., 1999). Within Canada and the United States, standardized WC cut-off values for increased CVD and diabetes risk exist (Grundy, 2004). These values define abdominal obesity for men and women at ≥102cm and ≥88cm, respectively (Health Canada, 2003a). Additional low cut-off ranges for abdominal obesity are also specified at ≥94cm and ≥80cm, in males and females respectively (James, Leach, Kalamara, & Shayeghi, 2001).

Current trends demonstrate increasing abdominal obesity worldwide (Lakka, et al., 2002). The clustering of abdominal obesity with CVD risk factors of hypertension, diabetes and dyslipidemia has been demonstrated in a variety of ethnic populations (Reeder, et al., 1997). Further, overweight Aboriginal individuals demonstrate higher rates of abdominal obesity as compared to overweight individuals of European descent (Anand, et al., 2001). Reported abdominal obesity rates are greater in Aboriginal Canadian women than men (Pollex, Hanley, et al., 2006). Abdominal obesity within Canadian Aboriginal populations is the most prevent risk factor for Metabolic Syndrome (Pollex, Hanley, et al., 2006).

High levels of abdominal obesity among this population highlight the increasing need for programs to combat this condition. The increased rates of abdominal obesity among this ethnic population further identify the specific need of interventions to address abdominal obesity among Aboriginal populations.

#### *1.2.3.3 Hypertension*

It has long since been established that hypertensive individuals demonstrate increased experiences of atherosclerosis and CHD (Kannel, Schwartz, & McNamara, 1969). Further, hypertension is associated with substantial increase in morbidity and mortality from CVD (Kannel, et al., 1969). Elevated blood pressure is recognized as a strong predictor of CVD (Grundy, 2004). Elevated systolic and/or diastolic blood pressures (SBP and DBP respectively) are well established as risk factors for ischemic heart disease, stroke, atherosclerosis and overall mortality (Joffres, et al., 1992). Blood pressure is linearly related to CVD risk, where the relative risk increases from normotensive to borderline hypertensive to hypertensive individuals (Levy, Wilson, Anderson, & Castelli, 1990; Yano, McGee, & Reed, 1983). Age adjusted rates of CVD and all cause mortality increase with increasing SBP and DBP (Yano, et al., 1983).

In the Canadian Community Health Survey, Statistics Canada reported Aboriginal hypertension rates of 15.4% statistically different from the general population rate of 13.2% (Tjepkema, 2002). Elevated blood pressure in Aboriginal Canadians is significantly higher than that of European Canadians, though traditionally hypertension was rare in these populations (Anand, et al., 2001; Hoy, et al., 1995). Younger Aboriginal populations currently experience increasing rates of hypertension and mean blood pressure (Welty, et al., 1995). Further, it was suggested that ethnically specific adjusted cut off values for high blood pressure in Aboriginal populations may need to be established to better identify the associated risk of CVD in these populations (Pollex, Hanley, et al., 2006).

#### *1.2.3.4 High Total Cholesterol*

One of the most important observations in reducing risk for CVD is the effects of high TC levels (Castelli, 2001). Total cholesterol levels greater than 16.5 mmol/L experience the highest absolute risk for coronary artery disease (Castelli, 2001). However, individuals with TC between 8.25 and 11 mmol/L experience 35% of coronary artery disease incidence (Castelli, 2001). For individuals with CHD, plasma cholesterol levels are a strong predictor of future CVD (Haffner, et al., 1998). Lower cholesterol levels are found to reduce an individual’s risk of coronary artery disease and risk-reduction measures can rapidly improve cholesterol levels which significantly reduces morbidity and mortality from CVD (Castelli, 2001).

High cholesterol rates experienced by the Canadian Aboriginal population are significantly greater than that experienced by European Canadians (Anand, et al., 2001). Aboriginal Canadians also share a much higher burden of atherosclerosis compared to other groups of Canadians (Anand, et al., 2001). Further, CVD risk factors including abnormalities in glucose or lipids and novel risk factors associated with developing thrombosis are significantly higher in the Canadian Aboriginal populations (Anand, et al., 2001).

The increased rates of high cholesterol among Aboriginal populations in comparison to European populations highlights the need for interventions addressing this risk factor. Increased prevalence of risk factors among Aboriginal populations present an increased risk for CVD. While previous interventions have attempted to decrease CVD risk factors among Aboriginal populations, these peoples still experience increased rates of high cholesterol and other risk factors.

#### *1.2.3.5 High Ratios of High Density Lipoprotein to Total Cholesterol*

Common risk factors for CVD include low levels of HDL (Yusuf, et al., 2001). The TC:HDL is promoted as a more important indicator for CVD such as coronary artery disease than TC levels alone (Castelli, 2001). Levels of TC:HDL are recognized as the best predictor for ischemic heart disease (Lemieux, et al., 2001). This ratio is ideal for cholesterol risk assessment as it is convenient, simple and is unbounded, allowing for a true emphasis of extreme combinations to be identified as very high risk (Castelli, Abbott, & McNamara, 1983). Ideal values for this ratio are less than four, while ratios of 6.0 or greater are characteristic of individuals with excessive rates of CHD (Castelli, 2001; Castelli, et al., 1983).

Within Canada, Aboriginal populations are found to experience significantly higher ratios of TC:HDL than Caucasian and Chinese populations (Razak, et al., 2005). Aboriginal women incur low HDL cholesterol levels more frequently than Aboriginal men (Pollex, Hanley, et al., 2006). In British Columbian Aboriginal populations, both males and females experience greater prevalence of elevated TC:HDL as compared to Caucasian populations (Lear, Humphries, Frohlich, & Birmingham, 2007). Northern Ontario First Nations individuals were found to have a higher prevalence overall of low HDL cholesterol (Liu, et al., 2006). Within this Northern Ontario population, the disparity between sexes was nearly three times as large in First Nations compared to Non-Aboriginal populations (Liu, et al., 2006). Prevalence of elevated TC:HDL in Aboriginal populations is observed in 45.6% of populations (Hanley, et al., 2005).

While past interventions have attempted to reduce the risk of CVD and experience of CVD risk factors among Aboriginal peoples, these populations continue to present with increased risk factors. By addressing CVD risk factors such as TC:HDL levels, reductions in CVD rates among Aboriginal populations may be possible.

#### *1.2.3.6 Tobacco Use*

Smoking is recognized as a major risk factor for CVD, cited as the most preventable risk factor (Villablanca, McDonald, & Rutledge, 2000). An increased risk for myocardial infarction and sudden death is associated with smoking behaviour (Hjermann, Velve Byre, Holme, & Leren, 1981). There is a dose response relationship between smoking exposure and both traditional and non-traditional CVD risk factors (Retnakaran, et al., 2005). Exposure to second hand smoke is also known to contribute to heart disease (Steenland, 1992). Use of smokeless tobacco is also known to increase risk of CVD, though the risk is lower than cigarette smokers (Bolinder, Alfredsson, Englund, & de Faire, 1994). Within Canada, reductions in CVD prevalence in recent years are partially due to reductions in smoking (Health Canada, 1999).

In 2000-2001, Aboriginal populations demonstrated 51.4% smoking rates, nearly twice the level of non-Aboriginal populations, with rates as high as 58.8% in on-reserve populations (Health Canada, 2003b; Tjepkema, 2002). These Aboriginal smoking rates are among the highest rates in Canada, with smoking rates as high as 69.8% in on-reserve populations 18 to 29 years old (Health Canada, 2003b; Millar, 1992). Smoking rates among Aboriginal communities in the past decade have been recorded as high as 70-80% (Harris, et al., 2002). Within the Aboriginal populations, cigarette smoking has been shown to increase blood pressure (Retnakaran, et al., 2005). Cigarette smoking is also prevalent among Aboriginal youth (Retnakaran, et al., 2005). The enhanced use of cigarettes in Aboriginal youth may contribute to the increased rates of CVD observed in Aboriginal populations (Retnakaran, et al., 2005).

### 1.2.4 Composite Risk Assessment Systems

#### *1.2.4.1 Framingham Risk Score*

The Framingham CHD risk scoring system is a mathematical function developed to estimate future risk of CHD, or more recently, general CVD (D'Agostino, et al., 2000; D'Agostino, Sr., et al., 2008). Coronary Heart Disease risk assessments evaluate the 10 year risk of experiencing CHD events based on measures and factors including age, sex, SBP, DBP, smoking status, diabetes status and cholesterol, where cholesterol measures include HDL and either LDL or TC (Wilson, et al., 1998). This scoring system provides estimates of 10 year risk for all CHD events, hard CHD events excluding angina pectoris as well as a low risk 10 year score for individuals presenting low risk scores (Wilson, et al., 1998). More recently, an overall CVD risk assessment version of the Framingham future risk assessment system has been developed (D'Agostino, Sr., et al., 2008). Similar to the CHD scoring system, variables of sex, age, smoking and diabetic status, HDL cholesterol and SBP are included in the assessment

(D'Agostino, Sr., et al., 2008). The CVD scoring system utilizes TC measures as well as SBP treatment status in assessing overall risk for future CVD events (D'Agostino, Sr., et al., 2008).

Within Caucasian populations in the United States, Australia and New Zealand, the Framingham prediction scores are found to be reasonably accurate (D'Agostino, Sr., et al., 2001). Aboriginal populations, the Framingham prediction score appears to underestimate the risk of CHD events, possibly due to increased rates of poor cholesterol and diabetes in this population (D'Agostino, Sr., et al., 2001).

#### *1.2.4.2 ACTI-MENU Scoring System*

The ACTI-MENU scoring system assesses an individual's risk of CVD (Gagnon, et al., 2007). This scoring system incorporates risk factors including HDL, Low Density Lipoprotein (LDL) and TC as well as the triglycerides (Gagnon, et al., 2007). Additionally, this system incorporates risks for SBP, DBP, BMI, WC, tobacco use and history, physical activity behaviour, and birth control pill use (Gagnon, et al., 2007). This scoring system also assesses risk associated with age, gender, menopausal status, primary family history of CVD or diabetes, personal history of CVD, diabetes status and history of blood sugar tests (Gagnon, et al., 2007). Once the overall risk score is determined, the overall risk is determined, ranging from very low risk to very high risk (Gagnon, et al., 2007).

#### *1.2.4.3 National Cholesterol Education Program/Adult Treatment Panel III Scoring System*

The National Cholesterol Education Program (NCEP)/Adult Treatment Panel (ATP) III scoring system assesses an individual's risk of CHD (Blumenthal, 2002; Clearfield, 2002). This scoring system is based on the Framingham 10 year CHD risk scoring system with some differences, largely in age stratification of risk factors (Blumenthal, 2002; Clearfield, 2002). This scoring system incorporates gender, age, TC, HDL, SBP and smoking behaviour

(Blumenthal, 2002; Clearfield, 2002). An overall score is obtained from which a 10 year percent risk for CHD can be determined (Blumenthal, 2002; Clearfield, 2002). This updated scoring system includes revised HDL risk scores to help identified individuals at risk of CHD (Blumenthal, 2002; Clearfield, 2002).

## 1.3 Aboriginal Physical Activity

### 1.3.1 Background

Physical inactivity is recognized as an independent risk factor for CVD (Warburton, Charlesworth, Ivey, Nettlefold, & Bredin; Warburton, Katzmarzyk, Rhodes, & Shephard, 2007). Reduced physical activity has been associated with CVD associated chronic diseases including CHD, stroke, hypertension, type 2 diabetes mellitus and chronic low-grade inflammation (Petersen & Pedersen, 2005; Warburton, et al., 2007). Premature mortality and the development of many chronic diseases, including CVD, continue to be linked to physical inactivity (Blair & Brodney, 1999; Booth, Gordon, Carlson, & Hamilton, 2000; Katzmarzyk, Gledhill, & Shephard, 2000; Warburton, Nicol, & Bredin, 2006; Warburton, Nicol, & Bredin, 2006). Within British Columbia, physical inactivity has been directly linked to 16% of type 2 diabetes, 15% of heart disease, 10% of hypertension, and 19% of incidence of stroke (Colman & Walker, 2004). Likewise, similar findings have been outlined for Canadians (Katzmarzyk & Janssen, 2004; Warburton, et al., 2007). Aerobic activity has been shown to improve HDL cholesterol and triglyceride levels (Whitney, et al., 2004). Physically active women experience lower rates of gestational diabetes mellitus (Dyck, Klomp, Tan, Turnell, & Boctor, 2002). Further, increasing physical activity during pregnancy may help reduce the risk of gestational diabetes mellitus (Dyck, et al., 2002). While physical activity provides health benefits, the majority of Canadians of all ages do not meet the minimum level of physical activity required to achieve these benefits (Canadian Fitness and Lifestyle Research Institute, 1998, 2001; Craig, Russell, Cameron, & Beaulieu, 1999; Katzmarzyk, et al., 2000). The prevalence of physical inactivity in Canada is now equal to or greater than all other CVD modifiable risk factors, allowing physical inactivity to be classified as a high risk behaviour (Warburton, et al., 2007).

The increasing prevalence of this high risk behaviour creates an enormous burden on health care costs and human affliction (Booth, Chakravarthy, Gordon, & Spangenburg, 2002; Katzmarzyk, et al., 2000). An estimated $211 million per year is spent on health care directly resulting from physical inactivity according to the BC Ministry of Health Services (Colman & Walker, 2004). Additionally, an estimated $362 million per year of lost economic opportunity occurs due to premature death and disability resulting from physical inactivity (Colman & Walker, 2004). By reducing physical inactivity by 10%, an estimated $49 million has been saved in British Columbia and approximately $150 million in Canada (Katzmarzyk, et al., 2000). Both treatment and prevention of CVD within the Caucasian population can be significantly altered by regular physical activity (Health Canada, 1999). The use of community physical activity such as walking groups has been suggested to combat obesity, and consequently physical inactivity and CVD (Anand, et al., 2001). Further research is required to understand the impact of regular physical activity on the CVD risk of Aboriginal populations.

### 1.3.2 Systematic Review of Aboriginal Physical Activity Levels

A systematic review of literature reporting Canadian and United States Aboriginal daily physical activity levels up to January 2010 identified 1241 citations through MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrane Library, SPORTDiscus, ACP and DARE databases. This review, combined with additional referencing, compiled 76 articles for inclusion in this systematic review. Methods of measuring physical activity levels in this population included self reports or questionnaires, pedometry, accelerometry, and metabolic measuring.

Self reported measures of physical activity included 49 articles within this review. Based on the Canadian, American College of Sports Medicine (ACSM) and Center for Disease Control (CDC) physical activity recommendations, 31.2% of Aboriginal children and youth are classified as sedentary (n = 556, 2 articles). Female children are found to demonstrate increased levels of sedentary behaviour with 51.9% of female Aboriginal children and youth classified as sedentary (n = 192, 1 article) compared to 29.9% of male Aboriginal children and youth (n = 228, 1 article). Another article assessing the physical activity levels of Aboriginal youth and children reported 53% sedentary behaviour (n = 155) though this assessment was not based on Canadian, ACSM or CDC recommendations. Aboriginal children were found to engage in physical activity an average of 3.59 times per week (n = 435, 3 articles) and perform an average of 4.94 hours per week of physical activity (n = 443, 1 article).

Of Aboriginal adults surveyed (n = 34 474, 18 articles), an average 43.0% reported behaviour classified as sedentary according to Canadian, ACSM or CDC recommendations. Insufficient physical activity was reported by 26.4% of this population (n = 13 910, 6 articles), while 26.4% of the surveyed population (n = 95 409, 12 articles) were found to meet the Canadian, ACSM or CDC physical activity recommendations. Based on Canadian (i.e., CSEP), ACSM and CDC physical activity recommendations, 43.9% of Aboriginal adult males (n = 6412, 9 articles) and 42.4% of Aboriginal adult females (n = 14 452, 14 articles) reported sedentary behaviour. A further 39.6% of adult Aboriginal males (n = 656, 2 articles) and 32.6% of adult Aboriginal females (n = 1578, 4 articles) reported insufficient levels of physical activity. Similar proportions of adult Aboriginal males (n = 656, 2 articles) and females (n = 2227, 7 articles) reported physical activity levels meeting Canadian, ACSM or CDC recommendations with 37.7% and 36.8% respectively. Sedentary behaviour was observed in 15.7% of Aboriginal adults (n = 283, 1 article) and insufficient physical activity in 39.2% of individuals (n = 900, 2 articles) based on classifications other than recognized physical activity recommendations. Similarly, 20% of males and 30% of females were observed to demonstrate sedentary behaviour (n = 788, 1 article) while 39.2% of males (n = 278, 1 article) and 41.9% of females (n = 339, 1 article) reported insufficient physical activity not defined by Canadian, ACSM or CDC recommendations. Another investigation reported 70% of females were found to meet arbitrary physical activity recommendations (n = 23, 1 article). Of 2 articles (n = 317) including self reports of activity classification, 32.4% of Aboriginal adults classified themselves as being moderately active. An average of 58.6% self classified as being highly active, in the 2 articles reporting this classification (n = 1021). Aboriginal adults classified themselves as being regular exercisers in 81.4% of cases within the 3 articles (n = 2040) reporting this value. One article (n = 738) reported 76% of adult Female Aboriginals self classifying as highly active, with 94% classifying as regular exercisers. Aboriginal adults reported performing physical activity an average of 1.59 times per week (n = 7436, 5 articles) while achieving 6.06 hours per week of physical activity (n = 9.8, 5 articles). Adult Aboriginal females (n = 226, 1 article) also reported engaging in physical activity 3.9 times per week. However, differences in reported physical activity volumes existed with males (n = 243, 2 articles) reporting 9.87 hours of physical activity per week while females (n = 665, 5 articles) reported 4.67 hours of physical activity per week.

Physical activity levels of Aboriginal populations as reported using accelerometry and pedometry included 7 articles, 3 involving accelerometers and 4 using pedometers. Aboriginal children 9 to 12 years of age (n = 178) were measured to take an average 14 207 steps per day. During the most active eight hours of the day, male (n = 91) and female (n = 85) aboriginal children 8 to 12 years of age were recorded to perform an average of 4237 and 4042 steps respectively. Through measurement with pedometers, Aboriginal male adults (n = 1022) moved an average of 5013 steps per day, while Aboriginal female adults (n = 1582) took an average of 4822 steps per day. Both these averages are below the recommended 10 000 steps per day.

Similarly, adult Aboriginal females recorded to be meeting the 10 000 step per day recommendations included only 9% of the 127 women sampled. Average daily physical activity of Aboriginal adults (n = 176) as measured by accelerometers included 892 minutes of sedentary activity, 310 minutes of light activity, 237 minutes of moderate activity and 1 minute of vigorous activity. Additionally, over 8 hours of the day, males (n = 19) used an average of 868.5 kcal while females (n = 58) used 860.9 kcal.

Through metabolic monitoring, mostly utilizing the doubly-labelled water method, physical activity levels of Aboriginal peoples was also recorded. Aboriginal children 5 years of age (n = 214, 2 articles) were observed to extend an average total energy expenditure (TEE) of 5.96 MJ with an average physical activity level (PAL), the ratio of TEE to resting metabolic rate, of 1.38. This PAL is lower than the recommended 1.49-1.53 minimum for 5 year olds (Food and Agriculture Organization of the United Nations, 2004). Aboriginal adult total energy expenditure, as reported by 7 investigations (n = 865) found an average TEE of 10.41 MJ. Adult Aboriginal males (n = 555, 4 articles) and females (n = 350, 3 articles) expended average TEEs of 11.43 MJ and 9.65 MJ, respectively. Overall adult Aboriginal (n = 865, 7 articles) PAL values of 1.46 fall within the sedentary classification (Food and Agriculture Organization of the United Nations, 2004). This sedentary classification was observed for both adult Aboriginal male (n = 543, 3 articles) with a PAL of 1.38 and adult Aboriginal females (n = 341, 2 articles) with a PAL of 1.34 (Food and Agriculture Organization of the United Nations, 2004).

Overall, all methods of physical activity measurement indicate Aboriginal populations demonstrate low levels of physical activity. A third to half of Aboriginal populations were found to present sedentary physical activity levels. These low levels of physical activity are observed among Aboriginal populations of all ages. Adults, youth and children all presented with alarmingly low levels of physical activity. These low levels of physical activity among these populations highlight the continuing need for appropriate interventions to increase physical activity levels among Aboriginal populations. Future interventions addressing sedentary behaviour among this population should address physical activity levels of all age groups. Lifelong changes in physical activity levels are required among Aboriginal peoples. Future research is required to identify culturally appropriate lifestyle interventions to improve the physical activity levels and wellbeing of these populations throughout the lifespan.

### 1.3.3 Systematic Review of Aboriginal Physical Activity Interventions

Physical activity interventions involving Aboriginal populations have met with varying success. Of the 13 investigations identified in this systematic review, 8 investigations reported health measures or physical activity behaviour that could be used to evaluate the effectiveness of physical activity interventions in Aboriginal populations.

Interventions involving school children have been met with moderate success. A United States school based intervention promoting physical activity during school breaks and recess over 3 years found less decrease in physical activity as measured through accelerometry (n = 278) and significantly less decrease physical activity as measured by a questionnaire (n = 1503) in children participating in the intervention as compared to students from a control school. A Canadian high school intervention including a physical activity program for Aboriginal high school students (n = 74) on alternating days over 24 weeks led to significant changes in select indices of health-related physical fitness. Over the course of the intervention, significant improvements in cardiovascular fitness and hamstring flexibility were experienced by the physical activity participants, while both groups demonstrated significant improvements in agility and no significant changes in upper or lower body strength.

Structured physical activity programs offered for Aboriginal adults have also met with moderate success. A drop in aerobics class physical activity program offered to Zuni Aboriginal adults (n = 400) observed significantly greater improvements in weight, BMI and fasting blood glucose levels of participants who attended the classes as compared to community members not attending the physical activity classes. Similarly, a 6 week biweekly physical activity program with Aboriginal adults (n = 14) produced significant improvements in SBP of participants as compared to non-participants. A third intervention including intervals of high intensity aerobic exercise for Aboriginal adults (n = 6) 5-6 days per week over an average 7.7 weeks demonstrated significant increases in aerobic capacity, with non-significant improvements in weight, body fat and fasting plasma glucose.

Self-directed physical activity programs aimed at Aboriginal adults have met with variable success. One investigation involving Pima Aboriginal adults (n = 95) included two self-directed interventions, one a self-directed increase in physical activity (n = 48) and one educational intervention (n = 47). This intervention reported improvements in activity energy expenditure for both groups, with a greater non-significant increase in the educational intervention. Similarly, the educational intervention demonstrated smaller increases in weight, BMI and SBP while also demonstrating decreases in DBP and WC not observed in the physical activity intervention. However, none of these differences were significant. Another self-directed physical activity program required Aboriginal adult participants (n = 48) to logon to a website and report their weekly physical activities for 6 months. This investigation demonstrated significant differences in A1C changes between the intervention and control groups with the intervention group experiencing a decrease in A1C while the control group experienced an increase. One additional self-directed physical activity and weight loss program achieved modest success in increasing the physical activity of Aboriginal adults (n = 61). Aboriginal participants experienced the highest odds ratio for achieving the prescribed 150 min of physical activity per week, this value was near statistically significant.

A ninth investigation reported variable incidence of gestational diabetes in Aboriginal women (n = 7) with a history of gestational diabetes with the use of a physical activity program during pregnancy. Additionally, one other investigation measured changes in psychological factors involving elementary school students (n = 600) as a result of a physical activity and education intervention. Individuals participating in this physical activity intervention reported 71.8% interest in school as compared to 56.3% of their control group counterparts. One school based intervention assessed the usage of a drop in fitness centre at a high school over a 3 year period, but did not follow the use of individual students, or report health measures or physical activity levels of the Zuni Aboriginals utilizing the fitness centre. A Haida intervention offering drop in physical activity classes at a community centre reported individual comments reflecting improved feelings of wellness and physical ability but did not report health or physical activity changes in participants over the 15 month program. The thirteenth investigation included a one mile walk each school day for Pima 5-8 year old participants. However, this investigation did not report health or physical activity measures to evaluate the effectiveness of this physical activity portion or the intervention.

While numerous investigations have examined physical activity interventions among Aboriginal populations, few have met with significant improvements in health measures. Many investigations have not included sufficient sample sizes or included physical activity as the primary intervention. Among the few investigations addressing physical activity interventions for improving health measures, group- or community-based interventions have met with greater success than individual interventions. Physical activity programs among Aboriginal youth have all included physical activity programs within the school day. Future investigations should investigate the use of physical activity programs among Aboriginal youth separate from the school setting. To date, no investigations have examined the use of a physical activity program appropriate for community members of all ages. Among this community-oriented population, a program including family and community members of all ages may be more effective than age group specific programs. Overall, few health measures have been investigated. Future research should continue to explore the effectiveness of physical activity interventions for improving health measures. Previous physical activity interventions have included physical activity programs for either youth or adult populations. Further research is required to investigate the most successful method of increasing physical activity and improving health measures among Aboriginal populations in a culturally appropriate context.

### 1.4 Purpose

The primary purpose of this investigation was to evaluate the effectiveness of a community-based physical activity training intervention in Canadian Aboriginal populations. Within current published literature only 13 investigations have reported on physical activity interventions in North American Aboriginal populations. Of these 13 interventions, 6 include an educational or nutritional component as the main intervention with physical activity as a minor secondary component. Five of these investigations include a physical activity intervention as part of their objectives. Only four of the 13 investigations include physical activity as the main component of the intervention and include sufficient sample size to evaluate outcomes of the intervention. The lone Canadian investigation of these four evaluated a high school physical education class in the 1980s with the objective of evaluating physical activity as a substance abuse intervention (Scott & Myers, 1988). Currently, the effectiveness of physical activity interventions within Canadian Aboriginal populations is unknown. By evaluating the effectiveness of a community-based intervention, future initiative programs will be better able to make informed decisions regarding methods of reducing CVD on a large-scale level in this at risk population.

The secondary objective of this investigation was to evaluate the health status of British Columbian Aboriginal peoples and evaluate the effectiveness of a physical activity intervention in relation to the health status of the participants. Interventions including regular physical exercise are known to be effective in reducing the risk for chronic disease for individuals at high risk (D. E. Warburton, et al., 2006). Current research suggests individuals of Aboriginal ancestry experience a greater risk for developing CVD (Thommasen, et al., 2004). As these individuals experience an increased risk, they may have experience greater benefits from physical exercise interventions. This intervention aimed to determine if Aboriginal people at increased risk experience a greater benefit from physical activity in comparison to Aboriginal individuals at a lower risk.

The final objective of this intervention was to evaluate the effectiveness of three intensities of physical activity. Generally, it has been found that increasing volumes of exercise provide additional health benefits, including decreased risk of cancer, lower blood pressure, improved lipid profiles and decreased risk for premature death (D. E. Warburton, et al., 2006). By comparing three volumes of exercise, this investigation was able to evaluate any trend in increased health benefit experienced with increased volume of training in this population.

## 1.5 Hypotheses

### 1.5.1 Physical Activity Intervention

It was anticipated that a community-based physical activity intervention would be effective in reducing the CVD risk for Aboriginal Canadians. Over the duration of the physical activity intervention, participants were expected to demonstrate decreased risk for CVD through improved BMI, WC, blood pressure, blood glucose level, HDL cholesterol, TC, TC:HDL, physical activity frequency, smoking behaviour, Framingham risk scores, NCEP/ATP III risk score and/or ACTI-MENU risk score.

### 1.5.2 Cardiovascular Disease Risk

Individuals who had an increased CVD risk prior to the start of this community-based physical activity intervention were hypothesized to experience a greater reduction in CVD risk compared to individuals who had a lower pre-intervention CVD risk.

### 1.5.3 Physical Activity Intensity

It was anticipated that individuals within each of the three intensity programs would experience reductions in CVD risk. In comparing these three intensities, it was anticipated that the increased exercise volume of running and walk/run intensities will provide a greater reduction in CVD risk as compared to the lower intensity walking.

# 2. Research Methods

This research was conducted under the ethics approval Human Ethics – H06-70107. Detailed research methods for this investigation are presented below. Subsequent presentation of results from this investigation are presented in several subsequent chapters. Each results and discussion chapter includes a brief overview of the methods and statistical analyses pertaining to each particular results section.

## 2.1 Participants

In conjunction with SportMedBC, the Healthy Hearts Society and the Honour Your Health Challenge, Aboriginal communities throughout the province were invited to participate in a 13-week training program in preparation for the Vancouver Sun Run. Cohorts examined included the 2007, 2008, 2009 and 2010 recruits. Participants for this community-based intervention included First Nations, Inuit and Métis participants at least nineteen years of age, including males and females of a range of ages, physical activity exposure, medical status and CVD risk. Participating communities represented a variety of locations around the province of British Columbia including Bella Coola, Burns Lake, Campbell River, Chilliwack, Comox, Courtney, Kamloops, Kelowna, Lillooet, Morricetown, Nanaimo, New Aiyansh, New Hazelton, Penticton, Prince George, Smithers, Vancouver, Vernon, Victoria and Williams Lake.

### 2.1.1 Recruitment

Participants in the Hearts inTraining program were recruited through their local band office, First Nations Centre or Friendship Centre. The local Aboriginal community recruited participants for the training program through their membership lists, regular meetings and notices. Participants registered for the physical activity training program through group leaders. Individuals registered through the SportMedBC online registration.

### 2.1.2 Sample Size

Based on *a priori* calculations, a sample size of about 250 post-intervention was required to achieve a power of 80% for ACTI-MENU overall risk score. Allowing for a 50% attrition rate, a pre-intervention sample size of 500 was required. Specifically, sample size calculations were performed using GPower version 3.0.10 software, indicating a sample size of 242 post-intervention was required for t-tests for dependent, or paired, samples with a power of 0.80 and $\alpha$=0.05 in evaluating the ACTI-MENU scores. This calculation assumed the variance of pre- and post-intervention groups is equal and that the equality of variance assumption is met. This sample size was estimated to have sufficient power for evaluating changes in TC, SBP and DBP as well as WC.

## 2.2 Testing Days

Each participant attended two testing days, one prior to the start of the physical activity intervention and one following 13 weeks of training. The testing day occurring prior to the training program was conducted in the Aboriginal host community at a local Aboriginal band office or Friendship Centre. Testing after the 13 week training program was either conducted in Vancouver in conjunction with the Vancouver Sun Run, or in the Aboriginal host community around the time of the Sun Run. The 2007 and 2008 post-training testing were all conducted in Vancouver with the Sun Run. In 2009, the testing day after the training program were conducted in Vancouver with the Sun Run for communities in Southern British Columbia and the Vancouver area. For communities in Northern British Columbia, 2009 post-testing days were conducted within the Aboriginal host communities after the Vancouver Sun Run. In 2010, post-training testing days were conducted within the Aboriginal host communities in the weeks immediately prior to or following the Vancouver Sun Run.

All testing days included a full assessment of all measures included. Participants began with questionnaires regarding personal and family history of CVD and diabetes, demographic information, and behavioural risk factors. Testing then included anthropometric and blood pressure measurements. Within each testing day, a finger blood sample was utilized to measure blood sugar and cholesterol levels. Each testing day concluded with a counselling session where participants had the opportunity to review their results with a CSEP-trained volunteer or Hearts inTraining staff member.

### 2.3 Measurements

Prior to participating in the Hearts inTraining program, participants registered through the SportMedBC website. Registration included completing a Physical Activity Readiness Questionnaire (PAR-Q) form and self-selecting the Walk10K, LearnToRun10K or Run10KFaster program. When participants arrived at the first testing day, each participant was required to complete an informed consent form.

A modified ACTI-MENU scoring system was used to evaluate the CVD risk for individual participants. A folder was created for each participant recording their individual risk factors. These folders included scoring using this modified ACTI-MENU scoring system. Each participant was able to keep their own folder.

Survey questions were used to determine demographic, behavioural and history risk factors for CVD. These survey questions were collected by a researcher or volunteer supervised by a researcher. Demographic information collected included age, age group, gender and menopausal status. Actual age was recorded and then classified by age range according to the appropriate corresponding CVD risk starting at age 40. Gender was recorded along with appropriate additional CVD risk for male participants as well as a sliding scale of risk for female participants based on menopausal status. Female participants were asked questions about their menopausal status with additional CVD risk assigned for post-menopausal status and increased risk assigned for post-menopausal status for greater than 10 years.

History examined included personal history of diabetes and CVD, as well as primary family member history of CVD before age 55 yr for male and age 65 yr for female family members. A personal history of diabetes or CVD, including heart attack, angina, stroke or bypass surgery was collected for each participant. The family history of CVD was teased out through a series of questions to ensure maximum accuracy of responses. Family history of CVD occurring in primary male relatives prior to age 55 or primary female relatives prior to age 65 was also collected with additional risk assigned for the prevalence of personal or family history. A researcher or volunteer, supervised by a researcher, asked each personal and family history question to ensure comprehension and accuracy of responses.

Behavioural factors surveyed included frequency of 30 min of moderate physical activity and smoking behaviour. Physical activity was evaluated using the CSEP Healthy Physical Activity Participation Questionnaire (Canadian Society for Exercise Physiology, 2003). This questionnaire evaluated physical activity frequency, intensity and perceived physical fitness. ACTI-MENU scoring risk points were assigned on a sliding scale with no points assigned for individuals completing 30 min of moderate physical activity on at least 5 days per week (meeting Canadian and ACSM guidelines). Risk points were increasingly assigned for all individuals completing 30 min of moderate physical activity less than 5 days per week. Physical activity was classified as either active or inactive based on meeting Canadian physical activity recommendations ("Canada's physical activity guide to healthy active living," 1998; Warburton, et al.; Warburton, et al., 2007). Frequency of daily smoking was also determined including the volume of cigarettes inhaled per day. Smoking behaviour also evaluated the use of other forms of tobacco, including cigars, chewing tobacco or other tobacco products. Additionally, exposure to second hand smoke was recorded. For individuals who have quit smoking, the duration since they last smoked was also assessed. Individuals who have quit smoking more than two years ago, or individuals who have never smoked were not assigned risk points. However, individuals who reported exposure to second hand smoke, use other tobacco products or have quit less than two years ago were assigned ACTI-MENU risk points. Smokers were assigned more risk points with increasing risk points with increased daily cigarette use.

Anthropometric measurements were used to determine body composition. Body mass was measured once the participant has removed his or her shoes, jacket and any excess clothing and has emptied his or her pockets. During this time, the participant remained clothed. Mass of participants was measured to the nearest 100g (Health o meter Professional model 320KL, Health o meter, Sunbeam Products Inc., Alsip, IL, USA). Height was determined to the nearest 0.5 cm (seca 214 Portable height rod stadiometer, seca, Ontario, CA, USA), while the participant had removed his or her shoes and any hats or hair ornamentation that obstructs the stadiometer. Participants were instructed to stand tall with their heels against the back of the stadiometer, without leaning back or causing the stadiometer to lean backwards. Before the head slide was fit snugly to the participant's head, the participants were instructed to take a deep breath in. Height of each participant was recorded in centimetres to the nearest 0.5cm. Body mass index was determined from dividing the mass in kilograms by the height in metres squared. Obesity was classified according to standard World Health Organization classifications ("Obesity: preventing and managing the global epidemic. Report of a WHO consultation," 2000). Waist circumference was measured at the median of the iliac crest and bottom of the 12$^{th}$ rib as identified on the right side of the participant's body. Participants were asked to identify these two points on the right side of his or her body. A measuring tape was secured around the participant's waist evenly across sagittal and frontal planes. Participants were instructed to cross his or her arms across his or her chest. Once the tape was secure and evenly distributed, the researcher crossed the tape ends and instructed the participant to take a deep breath in and out. Once the participant exhaled, the point where the tape ends are crossed was recorded as the participant's WC. Waist circumference was recorded in centimetres, to the nearest 0.5cm. Abdominal obesity was classified using both low and normal cut-off points as defined by the World Health Organization (James, et al., 2001).

Participants were asked to remain seated for three minutes prior to the blood pressure measurement. Screening blood pressure was measured in this intervention using an automated non-invasive blood pressure system (BP-TRU, model BPM-100, VSM Medical, Vancouver, BC). Measurements were taken on the participant's left upper arm while the participant remained seated. Appropriate sized blood pressure cuffs were utilized for each participant. Participants were instructed to remain as still as possible and refrain from talking. During the measurements, the participant's left forearm was rested on an adjacent table. Participants were instructed to keep his or her feet flat on the ground and left palm facing upwards. Second and third measurements were only conducted if the participant's initial SBP was greater than 120 mmHg or the participant's initial DBP was greater than 80 mmHg. When three measures of blood pressure were obtained, the second and third measurements were utilized to determine the average blood pressure. Blood pressure data collection also included a history of any high blood pressure diagnoses and any prescribed blood pressure medication. Individuals were classified as having high blood pressure if they reported using hypertensive medication, or were recorded as having SBP >140 mmHg or DBP > 90 mmHg. Elevated blood pressure was defined as reported use of hypertensive medication or recorded SBP ≥130 mmHg or DBP ≥ 85 mmHg.

A non-fasting finger-prick blood test, utilizing 35 μL of blood, was performed to measure glucose, TC and HDL cholesterol levels (Cholestech LDX, Cholestech, Inverness Medical, Hayward, CA). Participants were asked to report the time since their last meal. Any previous diagnosis of high cholesterol was also identified as well as medication prescribed for high cholesterol. Individuals were also asked if they utilize any diabetes medication. Measures of elevated blood glucose levels or elevated TC levels were noted. Similarly, low HDL levels or high TC:HDL were noted as CVD risk factors. High TC was defined as reported use of cholesterol medication or TC of ≥ 6.2 mmol/L (Gagnon, et al., 2007; Oei, Vliegenthart, Hofman, Oudkerk, & Witteman, 2004). Elevated TC was defined as reported use of cholesterol medication or TC of >5.2 mmol/L, as defined by the ACTI-MENU scoring system (Gagnon, et al., 2007). HDL levels were classified according to the ATP III classification where low HDL was <1.03 mmol/L in males or <1.29 mmol/L in females (Grundy, Cleeman, Daniels, Donato, Eckel, Franklin, Gordon, Krauss, Savage, Smith Jr, et al., 2005). Hearts inTraining measured non-fasting HDL levels were not adjusted for these fasting classifications as fasting and non-fasting HDL levels are found to be not significantly different (Enger, Herbjornsen, Erikssen, & Fretland, 1977). High blood glucose levels were defined as reported use of diabetic medication or blood glucose level of >11.1 mmol/L, while elevated blood glucose levels were defined as the use of diabetic medication or blood glucose level >7.8 mmol/L. Both these glucose cut-off points are commonly used for non-fasting blood glucose measurements, and indicated by the ACTI-MENU scoring system (Gagnon, et al., 2007; Oei, et al., 2004; Rimm, Chan, Stampfer, Colditz, & Willett, 1995).

Following these measurements, each individual received an estimated overall risk score for CHD utilizing the Framingham risk score and a modified ACTI-MENU risk score (Gagnon, et al., 2007; Wilson, et al., 1998). Modifications to the ACTI-MENU scoring system included the exclusion of LDL and triglyceride measures as the participants were not fasting at the time of measurement. Within the ACTI-MENU scoring system, the omission of LDL and triglyceride measurements were scored as 1 point each, as dictated within the ACTI-MENU scoring system. Individuals measured to have random blood glucose levels > 11.1 mmol/L were scored as having a previous elevated blood sugar test, as this is the standard blood sugar level utilized for non-fasting blood glucose levels (Oei, et al., 2004; Rimm, et al., 1995). Individuals with a random blood glucose level <11.1 mmol/L did not receive points for previous elevated blood glucose measurements or family history of diabetes. Additionally, the birth control pill usage scores were not included in the Hearts inTraining history and behaviour section and thus were not included in the ACTI-MENU score. Cardiovascular disease risk scores were compiled for each individual using the ACTI-MENU scoring system, the Framingham CHD and CVD, as well as the NCEP/ATP III CHD scoring system.

Each individual in the Hearts inTraining program also had the opportunity to meet with a health care professional or councillor to explain and interpret the results. Health care professionals and councillors also assisted individual participants to develop goals and plans to improve their health-related physical fitness and CVD risk. Information handouts regarding stress management, reducing blood pressure, reducing TC and increasing HDL, diabetes management and smoking cessation were available to participants at this time. The Canada Food Guide for First Nations, Métis and Inuit people was also available in handout form for participants.

## 2.4 Hearts inTraining Physical Activity Program

The Hearts inTraining program involved a community intervention to incorporate the entire community. By increasing physical activity, this program strove to decrease the risk for CVD of all participants. The Hearts inTraining physical activity program consisted of three training intensity programs. These three programs, the Walk10K, LearnToRun10K or Run10KFaster programs were self selected by each participant. The Walk10K program consisted of group walking at a pace individual enough to keep each participant at an intense work out level. Participants in the LTR10K program completed intervals of walking and running with increasing proportions of running during the training, with the goal of being able to run for the entire workout by the end of the training program. The Run10KFaster program consisted of running training for individuals who were already able to run for a substantial portion of the training. These programs involved a 13 week community-based physical activity intervention followed by the Vancouver Sun Run 10 km race. Over 13 weeks, a community-based group exercise intervention included group training sessions at least once a week and prescribed individual exercise training to attain a minimum three times per week for each participant. Weekly exercise training sessions for the Hearts inTraining program were conducted by Aboriginal community members who participated in group fitness leader training sessions prior to the start of this program. At the completion of this 13 week training, participants had the opportunity to participate in either the Vancouver Sun Run or a local community 10km event.

## 3. Data Analysis

Data analyses were performed using Statistica 9.0 (Stats Soft, Tulsa, OK). Statistical analysis included t-tests and analysis of covariance (ANCOVA). Data analyzed included changes in SBP and DBP, blood glucose level, TC, HDL, TC:HDL, BMI, WC, ACTI-MENU Heart Health, Framingham CHD and CVD risk scores and NCEP/ATP III risk scores. All statistical analyses of Framingham and NCEP/ATP III risk scores were performed on the calculated raw score, rather than the percent risk. Additionally, chronic condition rates were also compared including prevalence of obesity, overweight or obesity, abdominal obesity at low and normal cut-off values, high and elevated SBP, high and elevated TC, high and elevated random blood glucose and low HDL. The four risk scoring systems were compared by calculating correlations of the pre-intervention risk scores of each program. Further analysis to identify significant or main interaction effects between different groups were further analyzed using Tukey's post-hoc tests with $\alpha$ set at 0.05. All statistical analyses were determined to be significant at an $\alpha$ set at 0.05.

Postal code data was used to determine urban and rural residence status as well as on and off reserve residence status. Urban and rural status was identified through classification of postal codes, where postal codes beginning with V0 were identified as rural and all others identified as urban (Canada Post, 2010). On and off reserve residences were determined through GIS mapping of British Columbia postal codes in conjunction with Aboriginal reserves of British Columbia. Mapping of these two regions allowed for identification of postal codes exclusively on reserve, exclusively off reserve and serving both on and off reserve residences. Participants reporting a postal code either exclusively on or off reserve were classified to the appropriate residence type. Additionally, rural postal codes centred within 200m of an Aboriginal reservation were classified as on reserve. The classification of these postal code locations as on reserve was also confirmed through knowledge of the testing location and participant residences. Due to the inability to differentiate between on and off reserve residence of postal codes serving both on and off reserve locations, rural postal codes with centres bordering with Aboriginal reservations were not included in classifications of on and off reserve residences.

Pre-intervention comparisons were performed by age group, gender, Hearts inTraining physical activity program, geographic location and status, diabetes status and hypertension status. Comparisons of genders were performed using t-tests. To compare pre-intervention measures of age groups, ANCOVA analyses were performed, adjusting for gender differences between age groups. Similarly, ANCOVA analyses were performed to compare physical activity program participants, after adjusting for age and gender. In order to evaluate rates of obesity, overweight and obesity, abdominal obesity at both cut-off values, hypertension, diabetes, low HDL and physical activity, multiple linear regressions were performed to determine odds ratios adjusted for age and gender. These odds ratios were adjusted to calculate relative risk ratios (Zhang & Yu, 1998). Relative risk ratios were determined for correlates including, gender, age groups, rural/urban setting, hypertensive status, diabetic status, physical activity status, smoking status and geographic region and on/off reserve residence.

In evaluating the primary hypothesis, t-tests were utilized to assess the changes in measures, chronic condition rates and CVD risk scores from pre- to post-intervention. These evaluations were performed overall, by gender, age group, by program and pre-intervention CVD risk category for the subsequent hypotheses. To evaluate differences in the effectiveness of the intervention based on gender or age group, ANCOVA analyses of post measure or CVD risk (dependent variable) by gender or age group (independent variable) adjusted for time between pre- and post-screening, pre-screening measure and either age or gender (covariates) were performed.

Evaluating the Hearts inTraining program effectiveness by the individual's risk of CVD was performed using t-tests of pre-screening and post-screening measures and CVD risks by CVD risk category. In order to compare the effectiveness of the Hearts inTraining program for individuals of different pre-intervention CVD risk category, ANCOVA analyses of post measure or CVD risk (dependent variable) by pre-intervention CVD risk category (independent variable) adjusted for age, gender, time from pre- to post-screening and pre-screening value (covariates) were performed. These analyses were repeated using each of the four risk scoring systems classifying participants according to low, moderate and high risk scores for Framingham and NCEP/ATP III scoring systems or as very low risk, low risk, average risk, high risk and very high risk for ACTI-MENU scoring system. The Framingham CHD and CVD scoring systems as well as the NCEP/ATP III scoring system provide a 10 year percent risk according to the overall risk score obtained (Blumenthal, 2002; D'Agostino, Sr., et al., 2008; Wilson, et al., 1998). For these three scoring systems, high risk was defined as individuals with 10 year risk greater than 20% and moderate risk was defined as individuals with 10 year risk 10-20%. ACTI-MENU scoring system risk classifications were determined as specified in the ACTI-MENU scoring system as very low risk, low risk, average risk, high risk or very high risk.

In evaluating the effectiveness of program intensities, t-tests of pre and post measures, chronic condition rates and CVD risks by program were performed. To compare the effectiveness of the three programs, ANCOVA analyses were performed. Due to self-selection of program intensity, inherent differences between groups may exist. ANCOVA analysis were used to overcome any inherent differences where program intensities (independent variable) were compared against the post-intervention measure (dependent variable), adjusted by the pre-intervention measure, age, gender and time between pre- and post-screening (covariates).

# 4. Hearts inTraining Participants

## 4.1 Introduction

Canadian Aboriginal people represent a distinct ethnic population who descend from the ancestral Canadians inhabiting this country prior to the arrival of Europeans (Willows, 2005). Within British Columbia, approximately 196 075 individuals identify as Aboriginal, comprising 5% of the provincial population (Statistics Canada, 2008). Eight of 10 Aboriginal individuals reside in Ontario and the Western provinces of Canada, while 17% of the Canadian Aboriginal population resides in British Columbia (Statistics Canada, 2008). While 81% Canadians live in urban settings, only 54% of Aboriginal individuals reside in urban centres (Statistics Canada, 2008). Additionally, more Aboriginal people reside off reserve than on reserve (Statistics Canada, 2008). Aboriginal populations are younger than non-aboriginal Canadians, with median age of Aboriginal populations falling within the 15 to 24 year age range (Statistics Canada, 2008).

The objective of this chapter was to describe and outline the participants of this investigation. This chapter outlines the gender, age, behavioural characteristics and health measures of participants evaluated in this investigation. Also examined in this chapter was the difference between participants who attended the post-screening session in comparison to participants who did not attend this screening. It was hypothesized this participant population would accurately represent the Aboriginal population of British Columbia.

## 4.2 Methods

Participants for the Hearts inTraining program were recruited through local First Nations band offices and Native Friendship Centres as outlined in Chapter 2. Pre- and post-screening sessions as well as the physical activity programs were conducted as outlined in Chapter 2 Research Methods. In order to compare differences between participants who did and did not attend the post-screening sessions, t-test comparing pre-intervention screening measures were conducted between the two groups. Differences in program compliance rates were evaluated using ANOVA analyses of the program compliance levels by gender, age group and physical activity program.

## 4.3 Results

Over the past four years, the Hearts inTraining program has been offered to more than 5925 Aboriginal individuals from over 242 communities around the province of British Columbia. During this time, health screening has been conducted in 20 locations, including 754 adults (≥18 years of age) and 18 youth in the pre-screening (Table 4-1). Of participants screened prior to the intervention, 24.1% resided on First Nations reserves. Participants attending the post-screening sessions included 14.4% residing on reserve. An estimated 73.9% of all participants registered for the Hearts inTraining program also registered for the Vancouver Sun Run. Drop-out rates for this program are not available as many participants who did not attend post-screening did complete the program and attend the Vancouver Sun Run.

**Table 4-1** Hearts inTraining program participant numbers (n).

| | | Pre-Screened Participants | Post-Screened Participants |
|---|---|---|---|
| Male | Youth | 7 | 3 |
| | Adult | 179 | 58 |
| | Total | 186 | 61 |
| Female | Youth | 11 | 4 |
| | Adult | 575 | 215 |
| | Total | 586 | 219 |

Of the 280 participants attending the post-screening sessions, the majority were female. A normal distribution of age groups was obtained with the median in the 40-49 year age group for both male and female participants (Table 4-2). The majority of participants were screened during the 2009 year.

**Table 4-2** Hearts inTraining participant numbers of participants attending the post-screening sessions (n) by year and age group

| | 2007 | | 2008 | | 2009 | | 2010 | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| <20 yr | 0 | 0 | 0 | 5 | 4 | 2 | 2 | 0 | 6 | 7 |
| 20-29 yr | 2 | 4 | 3 | 15 | 3 | 16 | 0 | 4 | 8 | 39 |
| 30-39 yr | 0 | 1 | 0 | 14 | 8 | 23 | 3 | 10 | 11 | 48 |
| 40-49 yr | 1 | 2 | 3 | 16 | 6 | 30 | 3 | 11 | 13 | 59 |
| 50-59 yr | 0 | 2 | 5 | 10 | 4 | 27 | 2 | 8 | 11 | 47 |
| ≥60 yr | 0 | 0 | 3 | 3 | 8 | 7 | 0 | 3 | 11 | 13 |
| Unknown | 1 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 6 |
| TOTAL | 4 | 14 | 14 | 63 | 33 | 106 | 10 | 36 | 61 | 219 |

yr, years.

Most of the Hearts inTraining participants did not use tobacco, with more than 50% being non-smokers for more than 2 years (Table 4-3). Of those participants who smoke, the vast majority smoke less than 10 cigarettes per day.

**Table 4-3** The prevalence (95% CI) of tobacco use and exposure among Hearts inTraining participants attending pre-screening sessions

| | | n | Prevalence (%) |
|---|---|---|---|
| Non Tobacco Users | Never Smoked | 277 | 36.1 (32.7-39.5) |
| | Quit ≥2 years ago | 217 | 28.3 (25.1-31.4) |
| | Quit <2 years ago | 78 | 10.2 (8.0-12.3) |
| | Exposed to Second Hand Smoke | 27 | 3.5 (2.2-4.8) |
| | Total Non Smokers | 599 | 78.0 (75.1-80.9) |
| Tobacco Users | Smoke ≤10 cigarettes per day | 145 | 18.9 (16.1-21.6) |
| | Smoke 11-20 cigarettes per day | 16 | 2.1 (1.1-3.1) |
| | Smoke >20 cigarettes per day | 4 | 0.5 (0.0-1.0) |
| | Use Chew Tobacco | 4 | 0.5 (0.0-1.0) |
| | Total Tobacco Users | 169 | 22.0 (19.1-24.9) |

CI, Confidence Interval

Participants completing the post-screening were not significantly different, pre-intervention, from participants who did not complete the post-screening for nearly every measure (Table 4-4). Average age, weight, BMI, WC, SBP, DBP and TC were not significantly different pre-intervention between participants who did and did not attend the post-screening session. Participants attending the post-screening session had higher HDL and glucose than participants not attending the post-screening, with near significance. Significantly lower pre-intervention TC:HDL ratios were observed for participants who completed the post-screening session.

**Table 4-4** Hearts inTraining program participant characteristics by attendance of post-screening session (mean ± SD).

| | Not Attend Post-Screening | Attended Post-Screening | *P*-value |
|---|---|---|---|
| Age (years) | 40.7±13.4 | 41.6±13.3 | 0.397126 |
| Weight (kg) | 83.6±19.2 | 83.9±19.8 | 0.792377 |
| BMI ($kg \cdot m^{-2}$) | 30.6±7.0 | 30.8±6.7 | 0.667579 |
| Waist Circumference (cm) | 100.5±17.2 | 100.0±16.1 | 0.734623 |
| Systolic Blood Pressure (mmHg) | 117.6±16.0 | 119.2±17.3 | 0.195963 |
| Diastolic Blood Pressure (mmHg) | 74.6±10.9 | 73.8±11.3 | 0.328286 |
| Total Cholesterol (mmol/L) | 4.86±1.09 | 4.80±1.03 | 0.427273 |
| HDL (mmol/L) | 1.30±0.42 | 1.36±0.42 | 0.079328 |
| TC:HDL Ratio | 4.18±1.95 | 3.90±1.61 | 0.045816 |
| Glucose (mmol/L) | 6.06±1.83 | 6.36±2.79 | 0.082782 |

BMI, Body Mass Index; HDL, High Density Lipoprotein Cholesterol; SD, Standard Deviation; TC, Total Cholesterol.

Male and female participants were of a similar age, covering a large age span from 12 to 77 years. Average time from pre- to post-screening was 86 days, ranging from 58 to 107 days. Time between pre- and post-testing was similar for male and female participants, with males passed an average of 89.0±14.4 days between testing sessions and females passed an average of 85.0±16.3 days.

The majority of Hearts inTraining participants who attended the post-screening sessions completed at least 75% of the training (Figure 4-1). Significantly more female participants completed 100% of the program, while significantly more male participants completed 50-74% of the program. No significant differences in the proportion of male and female participants completing 75-99% or <50% of the program were observed.

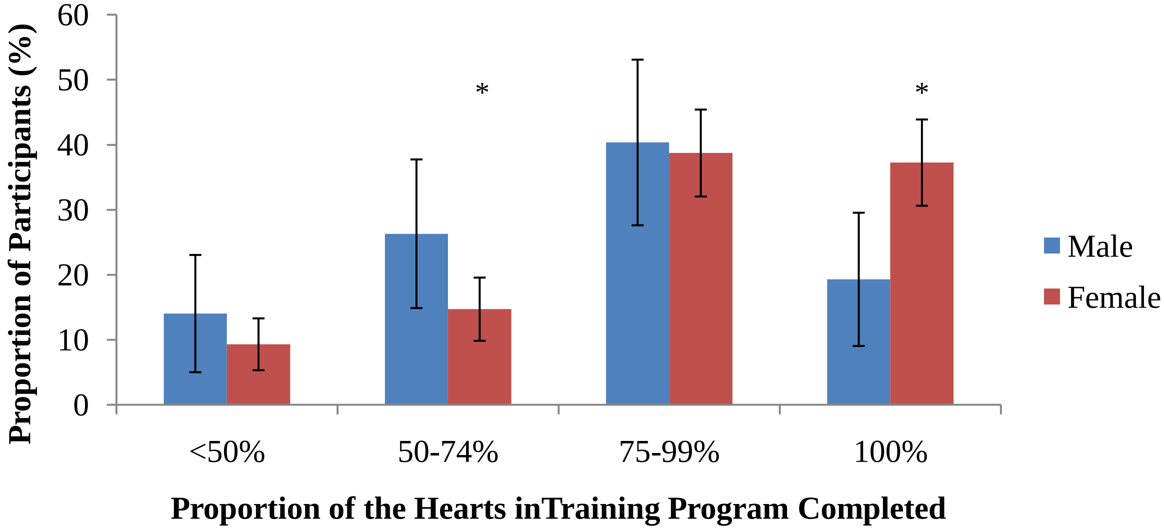


**Figure 4-1** The proportion of Hearts inTraining program completion by gender. Asterisk (*) indicates significant difference in proportion of female participants from proportion of male participants, $p < 0.05$.

The majority of participants <40 years of age completed 75-99% of the Hearts inTraining program (Figure 4-2). Of participants ≥20 years, roughly a third completed 100% of the program. Program compliance was highest among the 40-59 year age groups where the majority of participants completed 100% of the program. The largest proportion of participants completing <50% of the program was observed among the <20 year age group. Few significant differences were observed in program compliance between age groups. The ≥60 age group had significantly greater prevalence of participants completing 50-74% of the program than the 20-29 year age group.

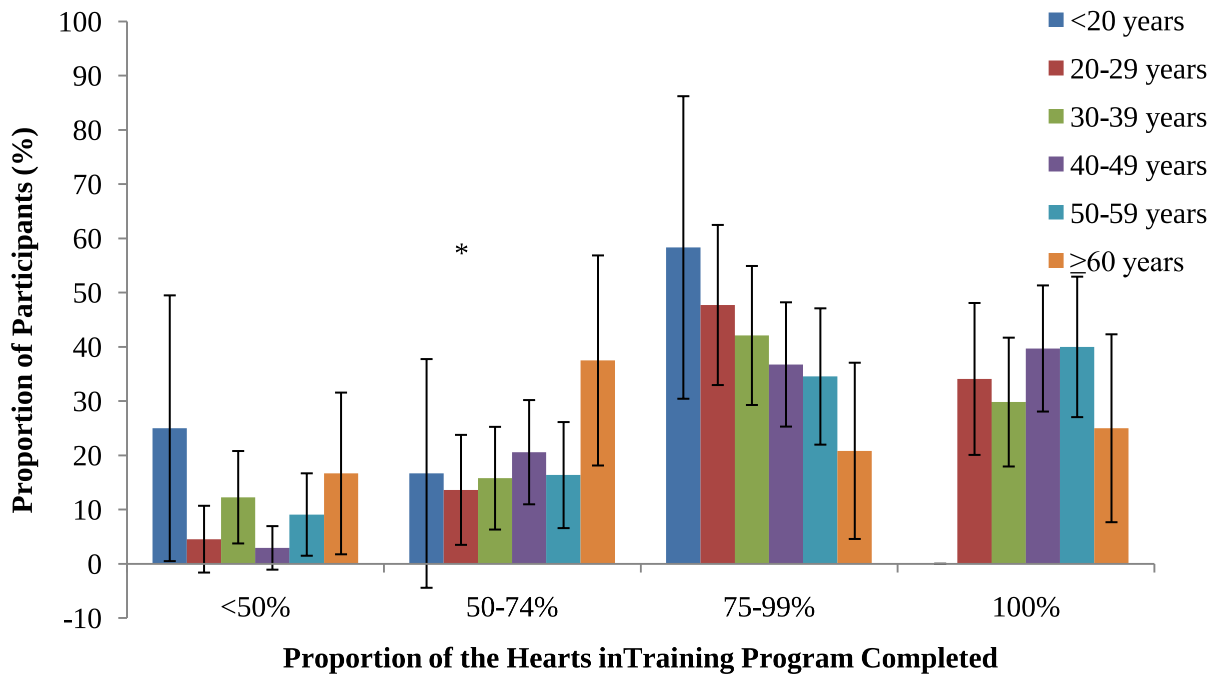


**Figure 4-2** The proportion of Hearts inTraining program completed by age group. Asterisk (*) indicates significant difference in proportion of participants from ≥60 age group, $p < 0.05$.

The majority of participants in all three programs completed at least 75% of the training. About a third of participants in all three physical activity programs reported completing 100% of the training program. No significant differences in program compliance were observed between the three programs.

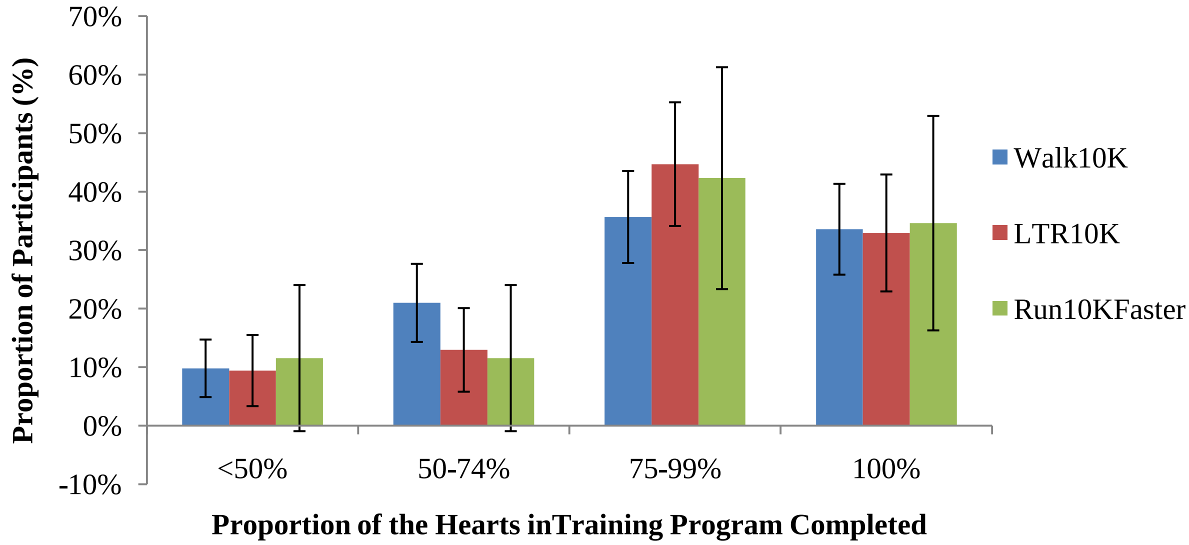


**Figure 4-3** The proportion of Hearts inTraining program completed by physical activity training program.

### 4.4 Discussion

The overall attrition rate was high, with only 36.3% of participants returning for the post-screening session. It is important to note that participants who did not attend a post-screening session are not classified as dropping out of the program. A large majority of participants who did not attend the post-screening session still completed the training program and attended the Vancouver Sun Run. However, due to scheduling conflicts and other challenges, these participants may not have been able to attend the post-screening. Because of the community-based nature of this program, it is not possible to determine what proportion of attrition is attributed to participants dropping out of the program and what proportion is due to participant's inability to attend the post-screening session.

In 2000-2001, Aboriginal populations demonstrated 51.4% smoking rates, nearly twice the level of non-Aboriginal populations, with rates as high as 58.8% in on-reserve populations (Health Canada, 2003b; Tjepkema, 2002). A more recent investigation from an Ontario

Aboriginal community reported smoking rates of 13.9-16.3% (Pollex, Al-Shali, et al., 2006). Current estimates of smoking within Canada report 18% of the Canadian population as smokers (Canadian Tobacco Use Monitoring Survey, 2010). The Hearts inTraining population reported smoking rates lower than national reports from 5-10 years ago but still slightly higher than recent national reports. It would appear the smoking rates among British Columbian Aboriginal populations have declined in recent years, but are still greater than rates among the general population.

Participants who attended the post-training session were representative of the sample as a whole. Weight, BMI, WC, SBP and DBP and TC were not significantly different between those attending the post-screening session and those who did not attend. As these measures were not significantly different, any improvements experienced by those returning for post-screening should be representative of changes experienced by the population as a whole. Changes experienced in glucose may be over represented by participants who returned for post-screening as their pre-screening blood glucose value was near significantly higher than that of participants not attending post-screening. Conversely, participants attending post-screening had significantly better TC:HDL ratios and near significantly better HDL levels than individuals not attending post-screening. As a result, the changes recorded for these values may have under estimated the changes experienced by the entire sample of participants.

Over the 13 week training program, most participants attended pre- and post-screening sessions about 86 days, or 13 weeks, apart. However, there was a large range of time spans between testing sessions, from 8 to 15 weeks. Due to this variability in testing times, it was necessary to adjust for time between pre- and post-testing when comparing changes experienced over the duration of the program. Because of the community nature of this program, and the logistics of testing numerous locations around the province, it was not possible to test all communities 13 weeks apart.

A large proportion of participants completed at least 75% of the training program. These completion rates are consistent along all age groups and all three training programs. Program completion was high among both male and female participants, with significantly more female participants completing 100% of the program. Among participants who attended the post-screening sessions, the majority completed ≥75% of the program. These reported completion rates indicate the Hearts inTraining program is appropriate for both genders and all age groups. The high levels of program completion indicate a high level of success for training participants. High levels of program compliance over the training period support the training program as the cause of changes in health measures recorded. Similar levels of program compliance reported between the three programs indicate all three of these programs are successful for training Aboriginal adults. High levels of compliance for this program indicate the community based intervention was favourable accepted by the participants as a whole. Future interventions should consider this type of program for increasing physical activity levels of Canadian Aboriginal populations.

## 4.5 Conclusion

Participants include a large number of female individuals and a smaller proportion of male participants. The majority of participants attending the post-screening sessions completed most or all of the physical activity training. Individuals attending the post-screening sessions are representative of the pre-screened population.

# 5. The Prevalence of Overweight and Obesity in British Columbian Aboriginal Adults

## 5.1 Introduction

The health of Canadian Aboriginal populations has declined dramatically over the past 60 years (Harris, et al., 2002; Liu, et al., 2006). Traditionally, Canadian Aboriginal populations experienced active lifestyles centered on hunting, gathering, fishing and/or farming societies (Dapice, 2006; Fredericks, 1999). Over the past four to five generations, cultural shifts experienced by this population include decreases in physical activity levels and alterations in diet (Harris, et al., 2002; Hegele & Pollex, 2005). The current epidemic trend of sedentary behaviour occurring within Canada may be two to threefold higher within the Aboriginal population (Lakka, et al., 2002).

Due to these recent changes in diet and lifestyle, Aboriginal populations throughout Canada currently experience epidemic rates of diabetes, obesity and CVD, as high as 3 fold greater than the Canadian general population (Hegele & Pollex, 2005; Retnakaran, et al., 2005). These rates of health conditions experienced within this population, mirror trends observed in developing countries, where similar lifestyle changes are occurring (Popkin, 1999; Reddy & Yusuf, 1998; Yusuf, et al., 2001). Past investigations of Canadian Aboriginal populations have reported rates of obesity as high as 47% and overweight or obesity prevalence as high as 90% (MacMillan, et al., 1996; Vanasse, et al., 2006). Similarly, Aboriginal Canadians have been reported to experience higher rates of Abdominal Obesity (AO) in comparison to Canadians of European descent (Anand, et al., 2001). It remains to be determined why persons of Aboriginal descent have a greater susceptibility to a variety of chronic conditions.

Previous investigations have reported high rates of obesity and overweight status in Aboriginal populations (MacMillan, et al., 1996; Monsalve, et al., 2005; Thommasen, et al., 2004; Vanasse, et al., 2006; Yusuf, et al., 2001). However, previous investigations using direct measurement of obesity have investigated a specific Aboriginal population in a specific geographic location (Daniel, Green, et al., 1999; Daniel, Marion, et al., 1999; Monsalve, et al., 2005; Thommasen, et al., 2004). Conversely, investigations reporting the obesity of Aboriginal populations on a more global scale have largely utilized self reported data, and generally exclude on reserve populations (Anand, et al., 2001; Langlois, Garriguet, & Findlay, 2009; Lix, Bruce, Sarkar, & Young, 2009; Vanasse, et al., 2006; Yusuf, et al., 2001). To date, no investigations have conducted direct measurements of obesity including both on and off reserve populations on a more global scale. The primary purpose of this investigation was to accurately examine the current overweight and obesity prevalence of British Columbian Aboriginal populations. In particular, we sought to determine the differential prevalence rates of overweight and obesity in Aboriginal adults (of varying ages) living on or off reserve from both urban and rural locations. We hypothesized that the obesity rates observed through direct measurement including on reserve populations would be higher than national reports which exclude on reserve populations, indicating an underestimation of obesity rates by national reports.

## 5.2 Methods

From January 2007 to February 2010, 759 Aboriginal adults, ≥18 years, from 21 locations around the Canadian province of British Columbia were measured for obesity and abdominal obesity (AO). Participants represented a range of ages, from 18 to 77 years. Each location individuals residing both on and off local reserves in nearby towns and cities were tested. Ethical approval was obtained through the Clinical Research Ethics Board at the

University of British Columbia and written informed consent was obtained from each participant prior to data collection. All participants were recruited through local First Nations band offices or Native Friendship Centres. Testing was conducted within the local Aboriginal communities with the assistance of local Aboriginal health care professionals and leaders. As in the past, our research was participatory in nature with Aboriginal community leaders playing important central roles in the design and implementation of the intervention.

Individual characteristics collected included age, sex and self-report of smoking status and medical personal and/or familiar history of diabetes, cardiovascular disease and hypertension. Anthropometric measures including height, weight and WC were assessed (and BMI calculated) according to standardized protocols established by the Canadian Society of Exercise Physiology (CSEP) (Canadian Society for Exercise Physiology, 2003). To ensure the accuracy and reliability of measurements CSEP-Certified Exercise Physiologists® were involved in the data collection. Measurements of height were determined using a seca 214 portable height rod stadiometer (seca corp., Ontario, CA, USA) to the nearest 0.1 cm. Height was measured from heels to the top of the head, with shoes removed while participants were at peak inhalation. Weight was recorded in kilograms to the nearest 0.2 kg using a Health o meter Professional model 320KL scale (Sunbeam Products Inc, Ontario, Canada) while participants wore light clothes having removed any heavy objects, shoes and jackets. Waist circumference was measured at the midpoint between the 12$^{th}$ rib and the iliac crest on the right side of the body using a flexible plastic tape to the nearest 0.1 cm. Participants were instructed to cross their arms over their chest and WC was measured at the end of exhalation. Body mass index (BMI) was calculated as weight in kilograms over height in metres squared. Obesity classifications were determined using the World Health Organization principle cut-off points ("Obesity: preventing and managing the global epidemic. Report of a WHO consultation," 2000). Abdominal obesity classifications utilized include both World Health Organization (WHO) level 1 and 2 classifications, labelled normal and low cut-off, respectively (James, et al., 2001). The prevalence of hypertension status was also verified through the direct assessment of resting blood pressure (BP-TRU, VSM Medical, Vancouver, BC). Geographic locations were classified into four regions. These regions reflect the health authority regions determined by the Province of British Columbia, with Vancouver Coastal and Fraser Health authorities combined to form the Vancouver/Lower Mainland region (Ministry of Health Services, 2010).

Statistical analyses were performed using Statistica 9.0 (Stats Soft, Tulsa, OK). For both genders, each age group and all geographic regions, mean, standard deviation and proportion of obesity and abdominal obesity were determined. Multiple linear regression analysis was conducted to identify correlates of obesity and relative risk ratios were calculated from these regression results (Zhang & Yu, 1998). For all statistical analyses, $P$ values <0.05 were considered significant.

## 5.3 Results

The average age of male and female participants was similar, with a large age span (18 to 77 yr) (Table 5-1). Both genders presented average BMI values in the obese range, with no significant difference between genders. Male participants presented with significantly higher mean WC measures, although both male and female average WC measures fell within the respective abdominal obese, normal cut-off/level 2 category. Male participants also presented with significantly higher rates of diabetes and directly measured hypertension. It should be highlighted that a significant proportion of the population with high blood pressure (assessed directly), 50.0% of males and 35.2% of females, were unaware of having hypertension.

**Table 5-1** Obesity characteristics and health status of British Columbian Aboriginal participants (mean ± SD).

| Characteristic | Male (n = 182) | Female (n = 577) | *P*-value |
|---|---|---|---|
| Age (yr) ± SD | 42.9±14.7 | 41.2±12.2 | 0.129774 |
| BMI ($kg \cdot m^{-2}$) ± SD | 30.3±5.6 | 30.9±7.2 | 0.382013 |
| WC (cm) ± SD | 104.2±14.7 | 99.3±17.9 | 0.000632 |
| Hypertension n (%) | 82 (45.0%) | 176 (30.5%) | 0.000281 |
| Hypertension *n (%) | 41 (22.5%) | 114 (19.8%) | 0.449539 |
| Diabetes n (%) | 22 (12.1%) | 39 (6.8%) | 0.015674 |

BMI, body mass index; SD, standard deviation; WC, waist circumference. * self-reported.

Nearly half of this population was observed to be obese with a further third presenting overweight BMI values according to WHO classifications, as outlined on Table 5-2 ("Obesity: preventing and managing the global epidemic. Report of a WHO consultation," 2000). Therefore, approximately 78% of the population were either overweight or obese. The prevalence of AO was also high, with two thirds determined to be centrally obese at the normal cut-off (James, et al., 2001). Overall, more than 84% of participants sampled were determined to be abdominally obese at the lower AO cut-off range (James, et al., 2001). Table 5-2 outlines the prevalence of obese, overweight and abdominally obese status by gender.

**Table 5-2** The prevalence (95% CI) of overweight and obesity among British Columbian Aboriginal populations by gender

| | Overweight (%) | Obese (%) | Centrally Obese, Low Cut-off (%) | Centrally Obese, Normal Cut-off (%) |
|---|---|---|---|---|
| Overall | 29.4 (26.3-32.7) | 48.6 (45.0-52.2) | 19.0 (16.2-21.8) | 65.1 (61.7-68.5) |
| Male | 33.0 (26.2-39.8) | 48.4 (41.1-55.7) | 22.5 (16.4-28.6) | 52.7 (45.4-60.0) |
| Female | 28.4 (24.7-32.1) | 48.7 (44.6-52.8) | 17.8 (14.7-20.9) | 69.0 (65.2-72.8) |
| *p*-value† | 0.17390 | 0.67825 | 0.00005 | 0.00000 |

†adjusted for age; CI, confidence interval.

Younger individuals presented with lower prevalence of obesity and AO, with a general increase in both obesity and AO with age (Figures 5-1 and 5-2). These trends were observed for both male and female participants. Peak obesity and AO prevalence rates were observed among both male and female participants at ≥60 yr. Mean BMI and WC values were also observed to increase with age, demonstrating similar peak values in the oldest age group.

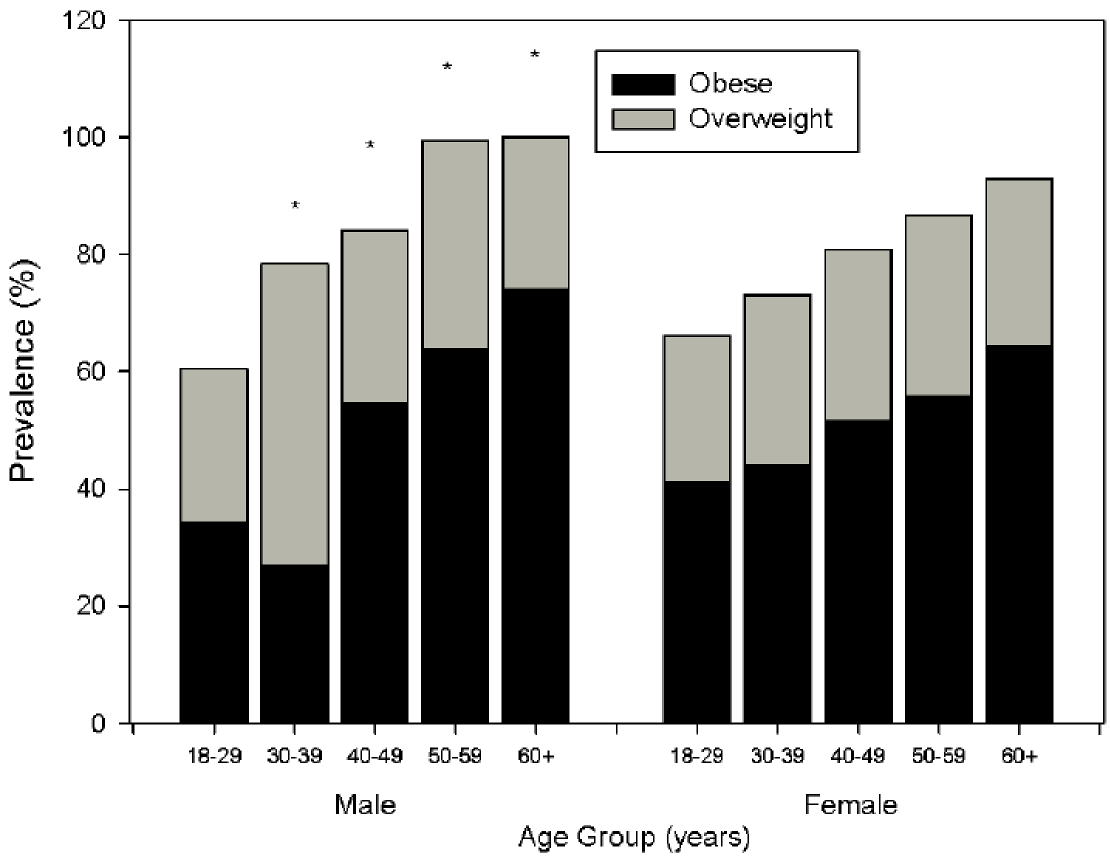


**Figure 5-1** The prevalence of overweight and obesity of British Columbian Aboriginal populations by gender and age. Asterisk (*) indicates significant difference in obesity prevalence from 18-29 years ($p$ <0.05).

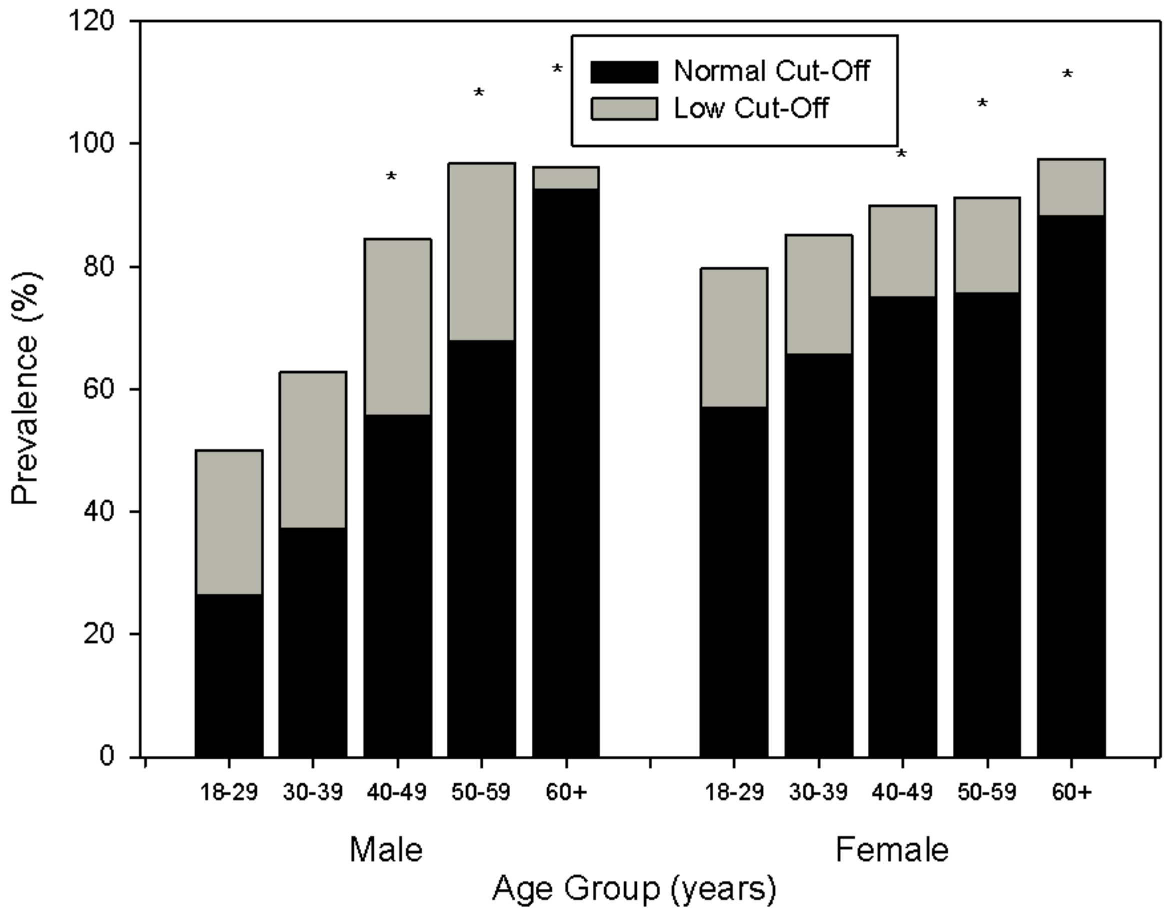


**Figure 5-2** The prevalence of abdominal obesity of British Columbian Aboriginal populations by gender and age. Asterisk (*) indicates significant difference in normal cut-off abdominal obesity prevalence from 18-29 years ($p$ < 0.05).

In general, relative risks of obesity, overweight or obesity and abdominal obesity at both cut-off ranges significantly increase with age. Relative risk ratios for obesity and overweight or obesity status significantly increased from age ≥40 years in comparison to 18-29 years age groups (Figure 5-3). Similarly, relative risk ratios for abdominal obesity, at both the normal and low cut-off values were found to significantly increase from age ≥30 years relative to the risk experienced by 18-29 year individuals (Figure 5-4).

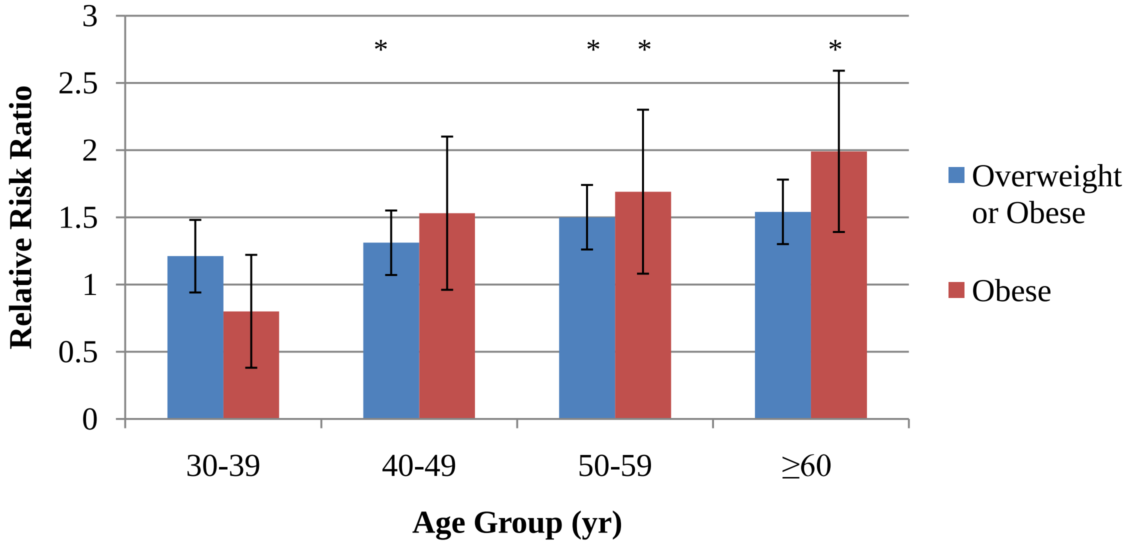


**Figure 5-3** The changes in relative risk of overweight or obesity among British Columbian Aboriginal adults with increasing age, in comparison to the relative risk of the 18-29 year age group adjusted for gender. Asterisk (*) indicates significant difference from 18-29 year age group ($p$ < 0.05).

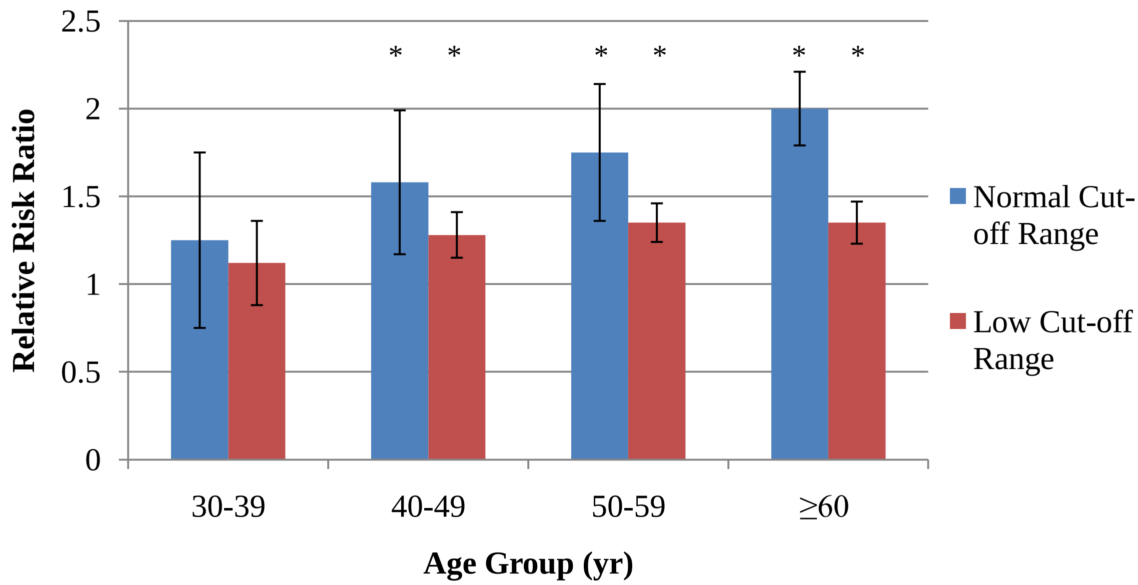


**Figure 5-4** The increase in relative risk of abdominal obesity of British Columbian Aboriginal adults with increasing age, in comparison to the relative risk of 18-29 year olds, adjusted for gender. Asterisk (*) indicates significant difference from 18-29 year age group ($p$ < 0.05).

Hypertensive individuals demonstrated significantly increased rates of obesity and central obesity after adjusting for age (Tables 5-3 and 5-4). Similarly, age-adjusted rates of hypertension significantly increased with increase in obesity status from normal weight for height to overweight to obese. Hypertension rates were also observed to increase significantly in individuals with AO. Obesity rates and AO rates adjusted for age were significantly greater among diabetic individuals compared to non-diabetic individuals. Rates of diabetes prevalence were significantly greater among obese individuals and individuals with AO, after adjusting for age. According to the geographic region, the prevalence of obesity and AO was lowest in the Vancouver/Lower Mainland metropolis region and greatest in the Northern region of the province (Table 5-3 and 5-4). An increase in the prevalence of obesity and AO was observed as geographical regions moved further from the Vancouver/Lower Mainland area, even after adjusting for age and gender differences between regions. Overall, significant increases in age and gender adjusted AO rates were observed from the Vancouver/Lower Mainland to both the Interior region and the Northern region. Similar rates of obesity, overweight or obesity and abdominal obesity at the low cut-off values were observed between rural and urban residents. Rural residents demonstrated near significantly greater rates of abdominal obesity at the normal cut-off in relation to urban residents. No significant differences in age and gender adjusted rates of obesity, overweight or obesity, or abdominal obesity were observed between on and off reserve residences.

**Table 5-3** Correlates of obesity among Canadian Aboriginal adults - multiple logistic regression analysis

| Covariate | Overweight or Obese RR (95% CI) | *P* value | Obesity RR (95% CI) | *P* value |
|---|---|---|---|---|
| Male* | 1.00 (referent) | | 1.00 (referent) | |
| Female* | 0.94 (0.83-1.03) | 0.221670 | 1.04 (0.86-1.21) | 0.678876 |
| Off Reserve‡ | 1.00 (referent) | | 1.00 (referent) | |
| On Reserve‡ | 1.02 (0.58-1.26) | 0.906845 | 0.89 (0.45-1.33) | 0.639037 |
| Urban‡ | 1.00 (referent) | | 1.00 (referent) | |
| Rural‡ | 0.95 (0.68-1.15) | 0.668470 | 1.09 (0.74-1.47) | 0.617658 |
| Non-Diabetic‡ | 1.00 (referent) | | 1.00 (referent) | |
| Diabetic‡ | 4.44 (N/A) | 0.997134 | 1.83 (1.27-2.08) | 0.006803 |
| Normotensive‡ | 1.00 (referent) | | 1.00 (referent) | |
| Hypertensive‡ | 1.25 (1.07-1.34) | 0.012617 | 1.56 (1.19-1.87) | 0.003224 |
| Lower mainland Region‡ | 1.00 (referent) | | 1.00 (referent) | |
| Vancouver Island‡ | 1.31 (0.87-1.48) | 0.137090 | 1.23 (0.57-2.00) | 0.550617 |
| Interior Region‡ | 1.12 (0.72-1.38) | 0.510179 | 1.38 (0.75-2.05) | 0.260693 |
| Northern Region‡ | 1.06 (0.66-1.34) | 0.754701 | 1.62 (0.94-2.24) | 0.076493 |

*adjusted for age, ‡adjusted for age and gender; CI, confidence interval, RR, relative risk ratio.

**Table 5-4** Correlates of abdominal obesity among Canadian Aboriginal adults - multiple logistic regression analysis

| Covariate | Abdominal Obesity RR (95% CI) | *P* value | Low Abdominal Obesity RR (95% CI) | *P* value |
|---|---|---|---|---|
| Male* | 1.00 (referent) | | 1.00 (referent) | |
| Female* | 1.34 (0.20-1.45) | 0.000005 | 1.17 (1.09-1.22) | 0.000145 |
| Off Reserve‡ | 1.00 (referent) | | 1.00 (referent) | |
| On Reserve‡ | 1.07 (0.62-1.43) | 0.749034 | 1.07 (0.79-1.18) | 0.548746 |
| Urban‡ | 1.00 (referent) | | 1.00 (referent) | |
| Rural‡ | 1.26 (1.00-1.46) | 0.051419 | 1.07 (0.91-1.16) | 0.322324 |
| Non-Diabetic‡ | 1.00 (referent) | | 1.00 (referent) | |
| Diabetic‡ | 1.50 (1.13-1.57) | 0.021036 | 6.31 (N/A) | 0.997091 |
| Normotensive‡ | 1.00 (referent) | | 1.00 (referent) | |
| Hypertensive‡ | 1.36 (1.13-1.52) | 0.003292 | 1.13 (1.02-1.19) | 0.030601 |
| Lower mainland Region‡ | 1.00 (referent) | | 1.00 (referent) | |
| Vancouver Island‡ | 1.41 (0.83-1.79) | 0.161825 | 1.05 (0.71-1.23) | 0.739571 |
| Interior Region‡ | 1.50 (1.01-1.81) | 0.046855 | 1.04 (0.74-1.21) | 0.761859 |
| Northern Region‡ | 1.68 (1.26-1.90) | 0.003632 | 1.12 (0.85-1.25) | 0.322213 |

*adjusted for age, ‡adjusted for age and gender; CI, confidence interval, RR, relative risk ratio.

## 5.4 Discussion

To date, no investigations have reported obesity prevalence in Canadian Aboriginal populations based on direct measurement, including both on and off reserve populations and covering a large geographic area including multiple distinct Aboriginal Nations. This investigation is unique in presenting directly measured obesity rates in a representative sample including both on and off reserve individuals and a large sample of distinct Aboriginal communities. Most investigations reporting obesity rates among the Canadian Aboriginal population are based on Canadian Community Health Survey's or other government initiatives which exclude on reserve populations and often utilize self-reported data (Langlois, et al., 2009;

Lix, et al., 2009; Vanasse, et al., 2006). Conversely, local investigations generally focus on one or a few specific Aboriginal populations (Daniel, Green, et al., 1999; Daniel, Marion, et al., 1999; Hegele & Pollex, 2005; Liu, et al., 2006). Recent investigations reporting obesity rates among Canadian Aboriginal populations have reported varying rates ranging from 15% to 47.5% depending on the inclusion of on reserve populations and the use of direct measurement (Lix, et al., 2009; Vanasse, et al., 2006). Without utilizing direct measurement including all sectors of the Aboriginal population, a true report of the obesity prevalence in this population cannot be determined.

This investigation observed equal or greater obesity rates than those previously published, including 48.4% in males and 48.7% in females. While 48.6% of participants were recorded to be obese in this investigation, a further 33.0% of males and 28.4% of females were overweight, leaving only 18.6% males and 22.9% of females demonstrating a healthy body mass for their height ("Obesity: preventing and managing the global epidemic. Report of a WHO consultation," 2000). The prevalence of AO in this population is even further alarming with 52.7% of males and 69.0% of females presenting as centrally obese at the normal cut-off values. When including the 22.5% of males and 17.8% of females who presented with WC values within the low-cut off range for AO, only 24.8% of males and 13.2% of females experience a healthy WC. The elevated obesity rates observed in this investigation indicate the underestimation provided by national surveys using self-reported data and excluding on reserve populations.

Obesity rates among Aboriginal populations from this investigation are much greater than rates among the general population. Canadian estimates report the obesity rates in Canada at 14.9%, including 13.9% of females and 15.9% of males (Belanger-Ducharme & Tremblay, 2005). Further, 33.3% of Canadians were reported to be overweight, including 41.0% of males and 25.7% of females (Belanger-Ducharme & Tremblay, 2005). Similar trends are observed for abdominal obesity, where reported non-Aboriginal rates are significantly lower than measured rates among Aboriginal populations (Liu, et al., 2006). Reported rates of abdominal obesity among non-Aboriginal populations are estimated at 26.0%, a much lower rate than the 65% recorded among the Aboriginal Hearts inTraining participants (Liu, et al., 2006).

Most national investigations of Aboriginal populations exclude on reserve populations (Langlois, et al., 2009; Lix, et al., 2009). Throughout published literature reporting national Aboriginal obesity rates, most investigations have reported lower obesity rates and mean BMI and WC values than those observed in this investigation. From the 2000/1 and 2005/6 Canadian Community Health Surveys, an increase in obesity rates of Canadian Aboriginal adults from 22.7% to 25.3% was reported along with overweight increases from 30.1% to 30.9% (Langlois, et al., 2009; Lix, et al., 2009). A Canadian Community Health Report published in 2000 reported obesity rates among this population at 29.5% in men and 37.3% in women (Langlois, et al., 2009). These investigations reporting lower obesity rates, exclude on reserve populations from their sample. Conversely, the 2003 Canadian Community Health Survey, which utilized random telephone dialling, and did not exclude on reserve populations, reported Aboriginal obesity rates most similar to this investigation at 47.5% (Vanasse, et al., 2006). As reports excluding on reserve populations have reported substantially lower obesity rates than investigations including these populations, future investigations reporting on this population need to include both on and off reserve populations to determine a truly representative measure.

While no significant differences in age and gender adjusted rates of obesity and overweight or obese status were observed between on and off reserve residences, on reserve residences presented with greater rates. Obesity rates among off reserve participants included

43.3% with obese BMI measurements and 73.5% with overweight or obese BMI measurements. In comparison, on reserve participants were observed to experience obesity rates including 54.7% obese and 80.0% overweight or obese. A recent Health Canada report identified the obesity rate among First Nations on-reserve populations at 36.0%, with a further 37.0% being overweight (Health Canada, 2003b). Rates of abdominal obesity are similar to obesity rates. On reserve participants presented with greater rates of abdominal obesity at both the normal and low cut off values, though no significant differences in age and gender adjusted relative risks for abdominal obesity were observed between on and off reserve participants. On reserve participants presented with abdominal obesity rates of 66.3% and 85.3% at the normal and low cut off ranges respectively. Similarly, off reserve participants presented with 57.2% and 80.8% abdominal obesity at the normal and low cut off ranges respectively. These alarmingly high rates of obesity and abdominal obesity highlight the urgent need for intervention to address the obesity epidemic among both on and off reserve Aboriginal peoples.

Other investigations conducted previously within the province of British Columbia have generally reported lower obesity rates to those observed in this investigation. The average BMI observations of Interior Aboriginal residents in this investigation included 30.3±7.1 $kg/m^2$ among women and 30.8±5.4 $kg/m^2$ among men. These values are higher than those observed by Daniel and colleges roughly 10 years ago in an investigation of similarly aged Interior British Columbian Aboriginal adults (Daniel, Green, et al., 1999; Daniel, Marion, et al., 1999). Daniel and colleges reported average BMI values of 28.1±5.7 $kg/m^2$ among men and 28.9±5.7 $kg/m^2$ among women (Daniel, Green, et al., 1999; Daniel, Marion, et al., 1999). Another investigation of a younger sample in the British Columbian Interior reported average BMI measurements of 26.99 $kg/m^2$ among Aboriginal participants (Monsalve, et al., 2005). The lower reports of obesity in previous investigations of similar populations indicate the obesity rates are continuing to increase within this population.

Within the Vancouver/Lower Mainland region, average BMI measurements in this investigation of 27.2±4.4 kg/$m^2$ in men and 28.5±6.6 kg/$m^2$ in women were similar to those observed in the recent M-CHAT investigation of individuals from the same region, 28.7±4.3 kg/$m^2$ and 27.7±5.5 kg/$m^2$ for men and women respectively. The M-CHAT project also observed comparable average WC measurements of 97.2±9.9 cm and 92.1±12.8 cm, for Aboriginal men and women respectively, similar to 96.2±12.5 cm and 93.5±16.3 cm observed in this project (Lear, et al., 2007; Lear, Kohli, Bondy, Tchernof, & Sniderman, 2009). Similar findings of two independent investigations indicate these obesity values are likely accurate.

Similar rates of obesity and overweight status were observed between rural and urban locations. However, near significant differences in abdominal obesity were observed where rural residents demonstrated higher rates of abdominal obesity in comparison to their urban counterparts. We observed 56.0% obesity among rural residents, with a further 28.4% overweight. These results match with rural and remote Aboriginal communities from the neighbouring province of Alberta, where obesity rates of 55.0% and a further 29.4% overweight were found (Oster & Toth, 2009). Alberta rural and remote locations also demonstrated 76.8% AO, in line with the 76.0% AO in rural British Columbian communities (Oster & Toth, 2009). Similar findings in two separate provinces indicate the obesity epidemic experienced within British Columbia may be similarly experienced by neighbouring provinces. These alarmingly high rates of obesity and AO observed in rural and remote locations support the urgent need for intervention and further health initiatives within these communities, throughout the country.

This investigation observed no significant difference in obesity or overweight prevalence between men and women, highlighting the need for interventions in both genders. These similar rates among males and females are similar to previous national reports (Katzmarzyk, 2008). However, as previously reported, women were observed to experience significantly greater prevalence of AO in comparison to men, even after adjusting for age (Hegele & Pollex, 2005; Pollex, Hanley, et al., 2006). In contrast to the 2000/1 and 2005/6 Canadian Community Health Surveys, this British Columbian investigation observed a significant increase in the prevalence of obesity with age (Lix, et al., 2009). These increases in obesity with age have previously been reported among Canadian Aboriginal populations in the 2004 Canadian Community Health Survey (Katzmarzyk, 2008).

Obesity is known to be associated with hypertension, throughout the lifespan (Kotsis, et al., 2005; Kotsis, Stabouli, Papakatsika, Rizos, & Parati). Results of this investigation support this observance, where individuals with hypertension were observed to have significantly increased rates of obesity as well as abdominal obesity, after adjusting for age and gender. Consistent with Kotsis *et al.*, obese individuals experienced significantly increased rates of hypertension in comparison to individuals of normal weight-for height (Kotsis, et al., 2005).

Within this investigation, diabetics were observed to have significantly higher obesity rates, after adjusting for age and gender. Since the 1970s, links between obesity and diabetes have been reported (Haslam). Obesity and weight gain have been associated with increased prevalence of type 2 diabetes (Wannamethee & Shaper, 1999). The high prevalence of obesity within this population indicates a substantial portion of this population is at risk for future development of diabetes.

Many trends in obesity distribution previously published were similarly observed in this investigation. Trends for geographic region in this investigation are similar to those observed for the general population, with the lowest obesity rates in Vancouver, though the 34.5% obesity rates for Aboriginal populations in the Vancouver region are substantially greater than the 6.2% reported for the general population (Vanasse, et al., 2006). This investigation observed significantly increased rates of obesity and abdominal obesity in both genders with geographic distance from the Vancouver/Lower Mainland region, even after adjusting for age. Other investigations have also observed greater obesity rates for Northern regions of the country, usually defined as the Territories (Belanger-Ducharme & Tremblay, 2005). This trend of increasing obesity with more Northern locations appears to exist within the province as well, with the Northern region demonstrating significantly increased obesity and AO rates from all other regions in the province.

The present data indicates alarmingly high rates of obesity and AO across genders, all ages and all geographic regions. Due to direct measurement with the use of CSEP-Certified Exercise Physiologists® and standardized protocols, these results are more accurate than many other investigations based on self-reported data. Previously published investigations have generally reported lower obesity and AO rates among this high risk population. The discrepancy between these results and previous investigations indicates the need for direct measurement, including on reserve populations in future estimates of obesity rates among Aboriginal populations. The high rates of obesity presented here indicate the obesity epidemic among Canadian Aboriginal populations continues. These results highlight the need for further interventions to address obesity and other chronic conditions experienced by this population. Increasing rates of obesity and AO with age, particularly in women, highlight the need for interventions across the lifespan. Interventions to address this obesity epidemic should address the changes in diet and lifestyle recently experienced within this population.

## 5.5 Conclusion

Studies including only Aboriginal populations from metropolitan or off reserve locations underestimate obesity rates among this population. Reports of obesity within this population need to utilize direct measurement and include all geographic, on and off reserve locations to accurately determine the extent of the obesity epidemic. Obesity remains a concern among this high risk population and further initiatives are required to combat this epidemic.

# 6. The Health Status of Adult British Columbian Aboriginal Populations

## 6.1 Introduction

In recent years, the health status of Canadian Aboriginal populations has been rapidly deteriorating (Harris, et al., 2002; Liu, et al., 2006; Trovato, 1988). Historically, Canadian Aboriginal populations led active, healthy lifestyles, relatively free of diabetes and chronic diseases (Dapice, 2006; Hoy, et al., 1995; Statistics Canada, 2000). Over the past thirty years, Aboriginal populations have experienced greater than average rates of cardiovascular disease (CVD) (Liu, et al., 2006). Canadian Aboriginal populations have been found to experience epidemic rates of chronic diseases mirroring those of developing countries (Reddy & Yusuf, 1998; Yusuf, et al., 2001). Within Canada, Aboriginal populations currently experience poorer quality of life than the general population and the lowest life expectancy of all Canadians (Anand, et al., 2001; Wilson & Rosenberg, 2002). Lifestyle changes incurred within this population over the past four to five generations include drastic reductions in physical activity levels and alterations in diet (Harris, et al., 2002; Hegele & Pollex, 2005). While Canada currently experiences an epidemic trend in sedentary behaviour, this trend may be two to threefold greater in the Canadian Aboriginal population (Lakka, et al., 2002). These recent changes in diet and lifestyle within the Aboriginal population likely contributed to the epidemic rates of obesity, diabetes and CVD this population experiences (Hegele & Pollex, 2005; Lakka, et al., 2002; Liu, et al., 2006; Retnakaran, et al., 2005).

The purpose of this investigation was to evaluate the health status of British Columbian Aboriginal populations from around the province, representing a variety of ages, both urban and rural, on and off reserve. We hypothesized that older individuals and those living in more northern locations would demonstrate decreased health status.

## 6.2 Methods

A total of 759 Aboriginal adults, ≥18 years ranging from 18 to 77 years, were screened for a variety of health measures from January 2007 to February 2010. Individuals sampled represent a variety of locations around the province of British Columbia, including 21 distinct locations. Each location included residents from both on and off reserve inhabitants. Written informed consent was obtained from each participant prior to screening and ethical approval was obtained through the Clinical Research Ethics Board at the University of British Columbia. Participants were recruited through local First Nations band offices or Native Friendship Centres and all screening was conducted within local Aboriginal communities. Local Aboriginal health care professionals and leaders assisted with testing within each location. Our research, as in past was participatory in nature with local Aboriginal community leaders playing important central roles in the design and implementation of the investigation.

Health screening in each community included individual characteristics of age, sex, self-reported smoking status and physical activity levels and personal and/or family medical history of diabetes, CVD and hypertension. Physical activity was measured using the Healthy Physical Activity Participation Questionnaire and classified using the Canadian recommendations ("Canada's physical activity guide to healthy active living," 1998; Canadian Society for Exercise Physiology, 2003; D. E. Warburton, et al., 2006). We assessed anthropometric measures of height, weight and waist circumference (WC) and calculated BMI, according to standardized protocols established by the Canadian Society of Exercise Physiology (CSEP)(Canadian Society for Exercise Physiology, 2003). Accuracy and reliability of anthropometric measurements were ensured through the use of CSEP-Certified Exercise Physiologists®. Obesity classifications were determined using the World Health Organization principle cut-off points ("Obesity:

preventing and managing the global epidemic. Report of a WHO consultation," 2000). Abdominal obesity classifications utilized the World Health Organization (WHO) classifications (James, et al., 2001). The prevalence of hypertension status was also verified through the direct assessment of resting blood pressure (BP-TRU, model BPM-100, VSM Medical, Vancouver, BC).

A non-fasting sample of blood was used to measure random blood sugar levels, total cholesterol (TC) and high-density lipoprotein cholesterol (HDL). The Cholestech LDX system (Cholestech, Inverness Medical, Hayward, CA) was used to measure all blood measures from one 35μL blood sample.

Metabolic syndrome (MetS) was determined using the ATP III definition where an individual was classified as having MetS if they presented with at least 3 of the 5 risk factors (Grundy, Cleeman, Daniels, Donato, Eckel, Franklin, Gordon, Krauss, Savage, Smith, et al., 2005). Four of these 5 risk factors were measured in this investigation, including WC >102 cm in men and >88 cm in women, HDL cholesterol <1.04 mmol/L in men and <1.29 mmol/L in women, blood pressure ≥130/85 mmHg or elevated blood sugar levels. Because blood samples were obtained non-fasting, elevated blood sugar levels were determined if blood glucose was >11.1 mmol/L, instead of fasting glucose >6.1 mmol/L, as this is the standard non-fasting glucose level utilized for diabetes diagnosis (Oei, et al., 2004; Rimm, et al., 1995). Cut-off values for HDL were not adjusted for non-fasting status as no significant changes in HDL have been found with fasting status (Enger, et al., 1977). High cholesterol was defined as total cholesterol values ≥6.2 mmol/L (Oei, et al., 2004). Non-fasting measures of total cholesterol values were not adjusted as negligible differences in total cholesterol have been found between fasting and non-fasting measurements (Tan, et al., 2003).

Geographic locations were classified into four regions. These regions reflect the health authority regions determined by the Province of British Columbia, with Vancouver Coastal and Fraser Health authorities combined to form the Vancouver/Lower Mainland region (Ministry of Health Services, 2010). On and off reserve residences were determined though GIS mapping of postal codes and Aboriginal reserves. Postal codes found to be distinctly on or off reserve were classified to the appropriate residence.

Statistical analyses were performed using Statistica 9.0 (Stats Soft, Tulsa, OK). Mean, standard deviation and proportion of risk factors and chronic conditions were determined for gender, age group, geographic regions, as well as on and off reserve, urban and rural residents. Relative risk ratios were calculated from multiple linear regression analyses to determine correlates of chronic conditions (Zhang & Yu, 1998). Statistical significance was considered for all statistical analyses where $P$ values <0.05.

## 6.3 Results

Male and female participants were of a similar age, covering a large age span from 18 to 77 years (Table 6-1). Average BMI values for both genders fell within the obese range, with no significant difference between males and females. Mean WC values were significantly greater in male participants, though both genders presented WC values within the abdominal obese category. Average screening blood pressure values were significantly different between genders. Males presented with significantly higher systolic and diastolic blood pressures. Total cholesterol values were nearly identical between males and females, though males presented with significantly lower HDL cholesterol. Male participants were also found to have significantly greater random blood sugar levels.

**Table 6-1** Health characteristics and health status of British Columbian Aboriginal participants (mean ± SD).

| Characteristic | Male (n = 182) | Female (n = 577) | *P*-value |
|---|---|---|---|
| Age (yr) ± SD | 42.9±14.7 | 41.2±12.2 | 0.129774 |
| BMI ($kg \cdot m^{-2}$) ± SD | 30.3±5.6 | 30.9±7.2 | 0.382013 |
| WC (cm) ± SD | 104.2±14.7 | 99.3±17.9 | 0.000632 |
| Systolic Blood Pressure (mmHg) ± SD | 124.1±15.8 | 116.6±16.4 | 0.000000 |
| Diastolic Blood Pressure (mmHg) ± SD | 79.2±12.1 | 73.0±10.3 | 0.000000 |
| Total Cholesterol (mmol/L) ± SD | 4.84±1.20 | 4.86±1.02 | 0.866605 |
| HDL (mmol/L) ± SD | 1.11±0.36 | 1.39±0.42 | 0.000000 |
| TC:HDL Ratio | 4.93±2.35 | 3.84±1.57 | 0.000000 |
| Random Blood Sugar Level (mmol/L) ± SD | 6.62±2.92 | 6.05±1.98 | 0.003503 |
| Healthy Physical Activity Participation Questionnaire | 8.18±2.52 | 6.82±2.78 | 0.000000 |

BMI, body mass index; SD, standard deviation; WC, waist circumference; HDL, high-density lipoprotein cholesterol; TC, Total Cholesterol.

Nearly a quarter of Aboriginal participants, both male and female reported a family history of CVD (Table 6-2). The self-reported personal history of CVD among male participants was more than double that of female participants. Diagnosis of diabetes among male participants was also nearly double that of female participants. Of female participants, more than 70% had not yet reached menopause.

**Table 6-2** The prevalence of inherent cardiovascular disease risk factors among Aboriginal British Columbians, n (%)

| Risk Factor | Male | Female |
|---|---|---|
| Family History of CVD† | 41 (23.2%) | 136 (24.1%) |
| Personal History of CVD | 16 (9.0%) | 24 (4.2%) |
| Diabetes Diagnosis | 21 (11.9%) | 35 (6.2%) |
| Menopause 10+ years ago | N/A | 62 (11.0%) |
| Menopause <10 years ago | N/A | 98 (17.3%) |

†CVD event in primary relatives before male age 55 years, female age 65 years

Rates of directly measured hypertension were significantly greater in male participants, while diabetes rates demonstrated near-significant differences between genders (Table 6-3). A significant proportion of individuals with directly assessed high blood pressure were unaware of having hypertension (50.0% of males and 35.2% of females). Rates of low HDL, according to ATP III HDL definitions were significantly greater among male participants (Grundy, Cleeman, Daniels, Donato, Eckel, Franklin, Gordon, Krauss, Savage, Smith, et al., 2005). Similarly, rates of high cholesterol were significantly greater among male participants. According to ATP III MetS definitions, significantly greater rates of MetS were observed for male participants (Grundy, Cleeman, Daniels, Donato, Eckel, Franklin, Gordon, Krauss, Savage, Smith, et al., 2005).

**Table 6-3** Prevalence (95% CI) of chronic conditions by gender

| | Male (%) | Female (%) | *p*-value[a] |
|---|---|---|---|
| Hypertension | 45.0 (37.8-52.2) | 30.5 (26.7-34.3) | 0.00200 |
| Hypertension* | 22.5 (16.4-28.6) | 19.8 (16.5-23.1) | 0.71016 |
| Diabetes | 12.1 (7.4-16.8) | 6.8 (4.7-8.9) | 0.05463 |
| Elevated Blood Glucose | 14.0 (8.8-19.2) | 8.0 (5.7-10.3) | 0.09107 |
| Obesity | 48.4 (41.1-55.7) | 48.7 (44.6-52.8) | 0.67825 |
| Abdominal Obesity | 52.7 (45.4-60.0) | 69.0 (65.2-72.8) | 0.00000 |
| Low HDL† | 46.8 (39.5-54.0 ) | 23.3 (19.8-26.7) | 0.00000 |
| High Cholesterol† | 21.0 (15.0-27.0) | 12.6 (9.8-12.3) | 0.02995 |
| Metabolic Syndrome† | 23.4 (17.2-29.5) | 11.3 (8.7-13.9) | 0.00014 |
| Smoker‡ | 20.2 (14.3-26.1) | 21.9 (18.5-25.3) | 0.59365 |
| Use/Exposed to Tobacco‡ | 26.4 (19.9-32.9) | 25.2 (21.6-28.8) | 0.86455 |
| Physically Inactive‡ | 63.7 (56.5-70.9) | 48.6 (44.4-52.8) | 0.00060 |

CI, confidence interval. [a]adjusted for age; †according to ATP III; ‡according to Canadian Physical Activity recommendations("Canada's physical activity guide to healthy active living," 1998); * self-reported.

Older individuals presented with significantly greater relative risks of hypertension, diabetes, low HDL and high cholesterol, with increases in relative risk as much as 16 times greater risk (Figures 6-1 and 6-2). From age 40, significantly greater rates were observed for diabetes, hypertension and high cholesterol, with near significantly higher relative risks of low HDL.

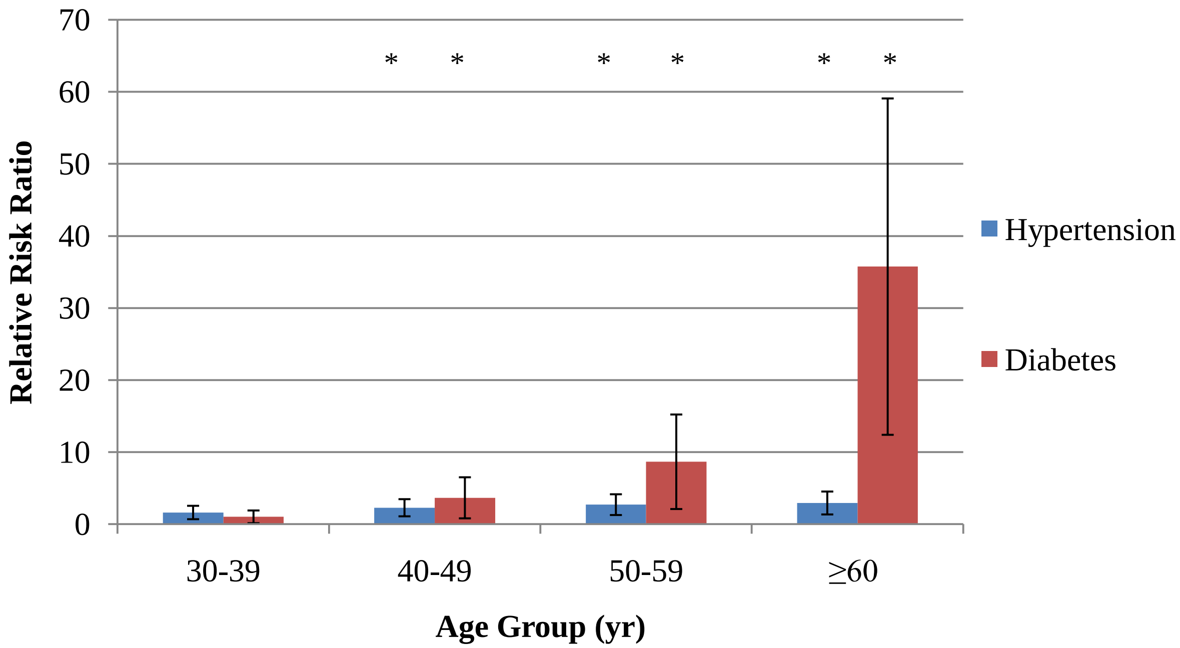


**Figure 6-1** The differences in relative risk ratios for hypertension and diabetes among British Columbian Aboriginal adults with increasing age in comparison to the relative risk of the 18-29 year age group, after adjusting for gender. Asterisk (*) indicates significant difference from 18-29 year age group ($p < 0.05$).

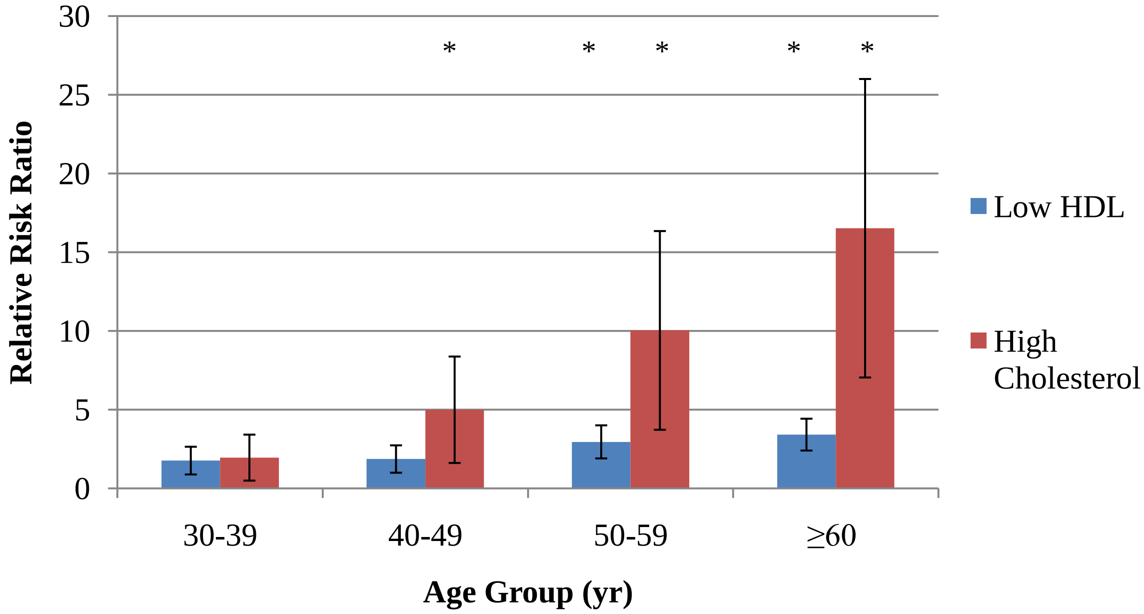


**Figure 6-2** The differences in relative risk ratios for high cholesterol and low HDL among British Columbian Aboriginal adults with increasing age in comparison to the relative risk of 18-29 year olds, after adjusting for gender. Asterisk (*) indicates significant difference from 18-29 year age group ($p < 0.05$).

Geographic region did not result in any significant changes in relative risks of hypertension, diabetes, low HDL or high cholesterol (Tables 6-4 and 6-5). Relative risks of hypertension, diabetes and low HDL were similar between urban and rural locations, with rural residents presenting with greater, non-significant relative risks. Rural residents presented with significantly higher risks of high cholesterol in comparison to urban residents. Similarly, participants residing on and off reserve experience similar age and gender adjusted relative risks for hypertension, diabetes, low HDL and high cholesterol. Participants who smoke or use/exposed to tobacco products demonstrated similar risks of diabetes, hypertension and low HDL compared to non-smokers or individuals not exposed to tobacco products. However, smokers presented with significantly lower relative risks for high cholesterol. Physically activity participants demonstrated near significantly lower relative risks of hypertension and diabetes compared to inactive participants.

**Table 6-4** Age, region and behavioural correlates of relative risk for hypertension and diabetes among Canadian Aboriginal adults - multiple logistic regression analysis

| Covariate | Hypertension RR (95% CI) | *P* value | Diabetes RR (95% CI) | *P* value |
|---|---|---|---|---|
| Male* | 1.00 (referent) | | 1.00 (referent) | |
| Female* | 1.42 (1.14-1.73) | 0.002917 | 1.51 (0.84-2.61) | 0.167952 |
| Off Reserve‡ | 1.00 (referent) | | 1.00 (referent) | |
| On Reserve‡ | 0.73 (0.28-1.52) | 0.448926 | 0.84 (0.08-6.43) | 0.883009 |
| Urban‡ | 1.00 (referent) | | 1.00 (referent) | |
| Rural‡ | 1.12 (0.70-1.64) | 0.613749 | 1.67 (0.58-4.19) | 0.330809 |
| Lower mainland Region‡ | 1.00 (referent) | | 1.00 (referent) | |
| Vancouver Island‡ | 0.88 (0.32-1.98) | 0.790827 | 0.86 (0.04-8.52) | 0.920455 |
| Interior Region‡ | 0.77 (0.32-1.63) | 0.530588 | 3.49 (0.43-10.96) | 0.223983 |
| Northern Region‡ | 0.98 (0.42-1.95) | 0.961418 | 3.13 (0.36-10.67) | 0.279343 |
| Non-Smoker‡ | 1.00 (referent) | | 1.00 (referent) | |
| Smoker‡ | 1.64 (0.74-3.09) | 0.264997 | 1.09 (0.95-1.15) | 0.143579 |
| No Tobacco Use/Exposure‡ | 1.00 (referent) | | 1.00 (referent) | |
| Use/Exposed to Tobacco‡ | 0.94 (0.51-1.50) | 0.817989 | 1.62 (0.49-4.29) | 0.41253 |
| Physically Active‡ | 1.00 (referent) | | 1.00 (referent) | |
| Physically Inactive‡ | 1.43 (0.94-1.93) | 0.086754 | 2.43 (0.91-5.51) | 0.073654 |

*adjusted for age, ‡adjusted for age and gender; CI, confidence interval, RR, relative risk ratio.

**Table 6-5** Age, region and behavioural correlates of relative risk for high cholesterol and low HDL among Canadian Aboriginal adults - multiple logistic regression analysis

| Covariate | Low HDL RR (95% CI) | *P* value | High Cholesterol RR (95% CI) | *P* value |
|---|---|---|---|---|
| Male* | 1.00 (referent) | | 1.00 (referent) | |
| Female* | 0.41 (0.30-0.58) | 0.000000 | 1.44 (0.96-2.19) | 0.078580 |
| Off Reserve‡ | 1.00 (referent) | | 1.00 (referent) | |
| On Reserve‡ | 1.08 (0.71-1.26) | 0.624481 | 1.40 (0.48-3.00) | 0.511400 |
| Urban‡ | 1.00 (referent) | | 1.00 (referent) | |
| Rural‡ | 1.13 (0.67-1.73) | 0.637575 | 2.98 (1.56-4.86) | 0.001647 |
| Lower mainland Region‡ | 1.00 (referent) | | 1.00 (referent) | |
| Vancouver Island‡ | 0.73 (0.26-1.87) | 0.539356 | 2.11 (0.48-6.40) | 0.309480 |
| Interior Region‡ | 1.78 (0.80-3.40) | 0.152655 | 1.81 (0.48-5.21) | 0.361734 |
| Northern Region‡ | 1.03 (0.43-2.20) | 0.941628 | 1.04 (0.25-3.60) | 0.953598 |
| Non-Smoker‡ | 1.00 (referent) | | 1.00 (referent) | |
| Smoker‡ | 0.91 (0.49-1.51) | 0.750140 | 0.34 (0.11-0.97) | 0.044170 |
| No Tobacco Use/Exposure‡ | 1.00 (referent) | | 1.00 (referent) | |
| Use/Exposed to Tobacco‡ | 0.76 (0.35-1.40) | 0.420893 | 0.45 (0.13-1.38) | 0.172365 |
| Physically Active‡ | 1.00 (referent) | | 1.00 (referent) | |
| Physically Inactive‡ | 1.16 (0.68-1.80) | 0.562165 | 0.98 (0.46-1.89) | 0.963874 |

*adjusted for age, ‡adjusted for age and gender; CI, confidence interval, RR, relative risk ratio.

## 6.4 Discussion

Males presented with significantly increased rates of hypertension, low HDL, high cholesterol and MetS. Participants 40 years and older presented with significantly increased relative risks of hypertension and high cholesterol, and near significantly increased relative risks of diabetes and low HDL. Geographic region, either health region or urban/rural classification, appears to have no significant impact on the prevalence of hypertension, diabetes, low HDL in this population, though urban settings produced lower relative risks for high cholesterol.

While many investigations report mortality rates from CVD among Aboriginal populations, few investigations have reported the personal or family history of CVD among this population. Self-reported family histories of CVD were substantially lower than rates reported among the Ontario Six Nations reserve population. The Six Nations population reported family history of CVD at 49%, double the frequency reported in our population (Anand, et al., 2001). Similarly, personal history of CVD was less frequent among our population than the Six Nations Ontario population, though the Ontario population was more than 10 years older than our British Columbian population (Anand, et al., 2001).

Hypertension rates observed in this investigation vary in comparison to published literature in this population. Consistent with published literature, higher rates of hypertension and higher average systolic blood pressure among male participants have been observed. A 2006 Ontario investigation reported higher rates of hypertension than those observed in our investigation: males 55.7% vs. 45.0% and females 43.7% vs. 30.5% (Liu, et al., 2006). An Alberta investigation reported lower hypertension rates than those observed in this investigation, 34.6% compared to 28.4% (Kaler, et al., 2006). The Strong Heart Study in the United States reported lower hypertension rates of 25.8% in males and 27.5% in females, but higher mean systolic blood pressure values of 128.4 mmHg in men and 127.4 mmHg in women (Welty, et al., 1995). The SHARE-AP project in Ontario reported similar systolic blood pressure values at 119.8 mmHg compared to 118.4 mmHg (Anand, et al., 2001). An important difference within our population is the awareness of hypertension; the Strong Heart Study reported 73% of men and 78% of women with hypertension were aware of their condition (Welty, et al., 1995). In contrast, hypertension awareness in our investigation was alarmingly low.

Rates of elevated blood glucose were higher among male participants, but lower than those observed in previous investigations. A investigation of the Ojibway-Cree population reported similar rates among male and female participants, with 22.0% and 21.8%, respectively

(Liu, et al., 2006). These values are higher than the 14.0% and 8.0% observed for male and female participants, respectively, in this investigation. Values found for an Alberta Cree population were similar to our findings, at 15.3% (Kaler, et al., 2006). The prevalence of diabetes in a British Columbian investigation of the Bella Coola region was 9.7%, similar to that observed in this investigation of the province as a whole (Thommasen, et al., 2004). These results indicate encouraging improvements in diabetes prevalence among Aboriginal populations in Western Canada.

Abnormally low HDL levels observed in this experiment are less frequent than observations in other Canadian Aboriginal investigations. The BRAID investigation reported abnormal HDL rates at 73.3%, significantly higher than the 28.8% observed in this investigation (Kaler, et al., 2006). A Sandy Lake Ojibway-Cree investigation reported 32.2% abnormal HDL among male participants and 53.8% among female participants (Liu, et al., 2006). In contrast, we observed higher rates of abnormal HDL among male participants at 46.8% than female participants, 23.3%. An investigation of the Bella Coola region of British Columbia reported higher TC values of 5.25 mmol/L compared to 4.86 mmol/L and lower values of HDL of 1.27 mmol/L compared to 1.32 mmol/L observed in our population (Monsalve, et al., 2005). Similarly, the SHARE-AP investigation from the Six Nations Reserve region in Ontario reported TC values of 5.11 mmol/L and HDL levels of 1.09 mmol/L among Aboriginal participants (Anand, et al., 2001). The reduced prevalence of abnormal HDL in our investigation population may indicate improving health status among British Columbian Aboriginal populations, most particularly in females.

Canadian hypertension rates are reported at 27.4%, higher than rates observed among the Aboriginal population in this investigation (Wolf-Maier, et al., 2003). This trend is applicable for both male and female participants, where national averages report 31.0% and 23.8% hypertension rates among males and females respectively, compared to 22.5% and 19.8% among the Hearts inTraining male and female participants, respectively (Wolf-Maier, et al., 2003). Rates of diabetes are also found to be higher among Hearts inTraining male participants than the general Canadian population (Lipscombe & Hux, 2007). Hearts inTraining participants reported 12.0% and 6.8% diabetes rates among males and females respectively, compared to 9.4% and 8.4% among the Canadian population (Lipscombe & Hux, 2007). Aboriginal participants were found to have lower total cholesterol levels than the general Canadian population. Male Aboriginal participants were found to have high cholesterol levels of 4.84 mmol/L, compared to 5.0 mmol/L among the Canadian population (Statistics Canada, 2010). Similarly, female Aboriginal participants total cholesterol levels of 4.86 mmol/L is lower than the 5.1 mmol/L reported among the Canadian population (Statistics Canada, 2010). Aboriginal male and female participants were recorded to have HDL levels of 1.11 mmol/L and 1.39 mmol/L, respectively. These levels are all much lower than the Canadian averages of 1.19 mmol/L and 1.46 mmol/L reported among Canadian males and females respectively (Statistics Canada, 2010).

Published rates of MetS in Canadian Aboriginal populations are high, and generally report higher rates among female participants. One Ontario investigation reported 29.9% in the Sandy Lake Ojibway-Cree population (Pollex, Hanley, et al., 2006). Another investigation from this same population reported 27.5% age-adjusted MetS rates using the same NCEP/ATP III definition, with higher crude rates among female participants (Liu, et al., 2006). These Sandy Lake investigations have reported greater prevalence among females for every number of MetS components (Liu, et al., 2006; Pollex, Hanley, et al., 2006). Conversely, we observed greater prevalence in males at every level of MetS risk factors. Similarly, another Ontario investigation from the Six Nations area also observed higher rates in female participants, reporting rates of 41.3% and 45.4% in Aboriginal participants using the NCEP/ATP III definition (Anand, et al., 2003).

Despite measuring only four of the five components of MetS, rates of MetS measured among this Aboriginal population are still in line with most national averages. A recent United States experiment reported 25.4% prevalence of MetS among the general population (Choi, Ford, Li, & Curhan, 2007). An older Canadian investigation reported MetS rates among Canadian males at 17.5% and Canadian females at 14.4% (Brien & Katzmarzyk, 2006). Due to the absence of triglyceride measures in this investigation, MetS rates determined are likely underestimated. The similarity in reported MetS rates despite missing 20% of the criteria indicates the increased risk experienced by this population. Increased risks for CVD, diabetes and MetS among Canadian Aboriginal populations highlight the need for further interventions to improve the health and quality of life for this population.

### 6.5 Conclusion

British Columbian Aboriginal populations present with healthier rates of chronic conditions in comparison to Ontario Aboriginal populations. Rates of chronic conditions are similar for Aboriginal populations throughout the province, including geographic region, urban and rural locations. Of particular interest, female participants in this study presented improved health status compared to male counterparts, contrary to other published studies.

# 7. The Physical Activity Levels among British Columbian Aboriginal Populations

## 7.1 Introduction

Low levels of physical activity are known to be associated with poorer health status (Warburton, et al.; Warburton, et al., 2007; D. E. Warburton, et al., 2006). Among Aboriginal adults, 43.0% are classified as sedentary (n = 34 474, 18 articles), with a further 26.4% of this population insufficiently active (n = 13 910, 6 articles).

The objective of this chapter was to examine the physical activity levels and physical activity status of British Columbian Aboriginal populations. This chapter compared the physical activity status of Aboriginal populations by gender, age group and geographical region. It was hypothesized this population would be mainly inactive.

## 7.2 Methods

Physical activity levels of British Columbian Aboriginal adults were collected using the Healthy Physical Activity Participation Questionnaire (Canadian Society for Exercise Physiology, 2003). From this questionnaire, results were classified as either active or inactive based on Canadian physical activity recommendations ("Canada's physical activity guide to healthy active living," 1998).

Statistical analyses performed included t-tests to compare differences in physical activity scores and rates by gender. In order to compare physical activity rates by age group, ANOVA analyses were performed. Multiple linear regression analyses were performed to determine relative risk ratios for physical activity by various correlates from adjusted odds ratios (Zhang & Yu, 1998). These regression analyses were adjusted for age and gender in comparing correlates.

## 7.3 Results

Male participants were found to report significantly greater physical activity scores than female participants (Table 7-1). Reported physical activity scores for overall physical activity, physical activity intensity and perceived physical activity fitness were higher among male participants (Table 7-1). However, female participants reported significantly higher physical activity frequency scores. It is important to note the scoring system for the Healthy Physical Activity Participation Questionnaire assigns males a higher score for similar perceived fitness while assigning females a higher score for physical activity frequency for the same weekly frequency (Canadian Society for Exercise Physiology, 2003).

**Table 7-1** The physical activity level of British Columbian Aboriginal adults

| | Male | Female | *P*-value |
|---|---|---|---|
| Frequency Score | 2.50±0.92 | 3.64±1.76 | 0.000000 |
| Intensity Score | 2.17±0.82 | 1.90±0.90 | 0.000322 |
| Perception Score | 3.50±1.71 | 1.28±1.16 | 0.000000 |
| Overall Score | 8.18±2.52 | 6.82±2.78 | 0.000000 |

based on the Healthy Physical Activity Participation Questionnaire

Male participants were also found to demonstrate significantly greater proportion of active individuals in comparison to Aboriginal female adults (Figure 7-1). While less than half of Aboriginal female adults were found to meet the Canadian physical activity recommendations, nearly two thirds of male participants reported physical activity levels that meet these recommendations.

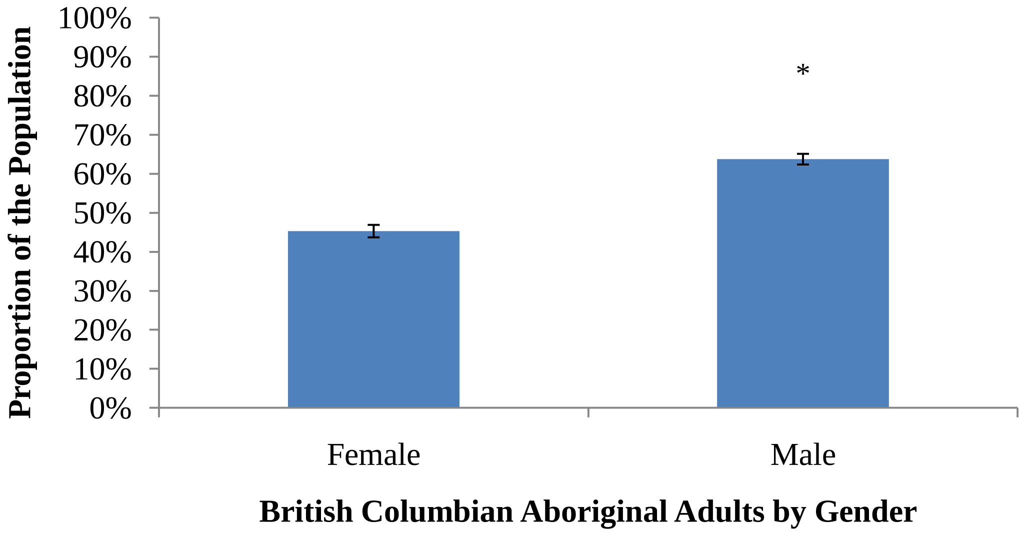


**Figure 7-1** The proportion of British Columbian Aboriginal adults meeting Canadian physical activity guidelines by gender. Asterisk (*) indicates significant difference between genders, $p < 0.05$.

Physical activity levels were similar across all age groups, as described on Figure 7-2. Among all age groups, about half the population reported meeting Canadian physical activity guidelines ("Canada's physical activity guide to healthy active living," 1998).


**Figure 7-2** The proportion of British Columbian Aboriginal adults meeting Canadian physical activity guidelines by age group. No significant differences were observed between age groups.

Across both genders, few significant differences in relative ratios of active status were observed between age groups (Figure 7-3). Among male participants, those ≥ 50 years of age were near significantly more likely to be active than those 18-29 years of age. No significant differences in relative ratio of active physical activity status were observed for female participants.

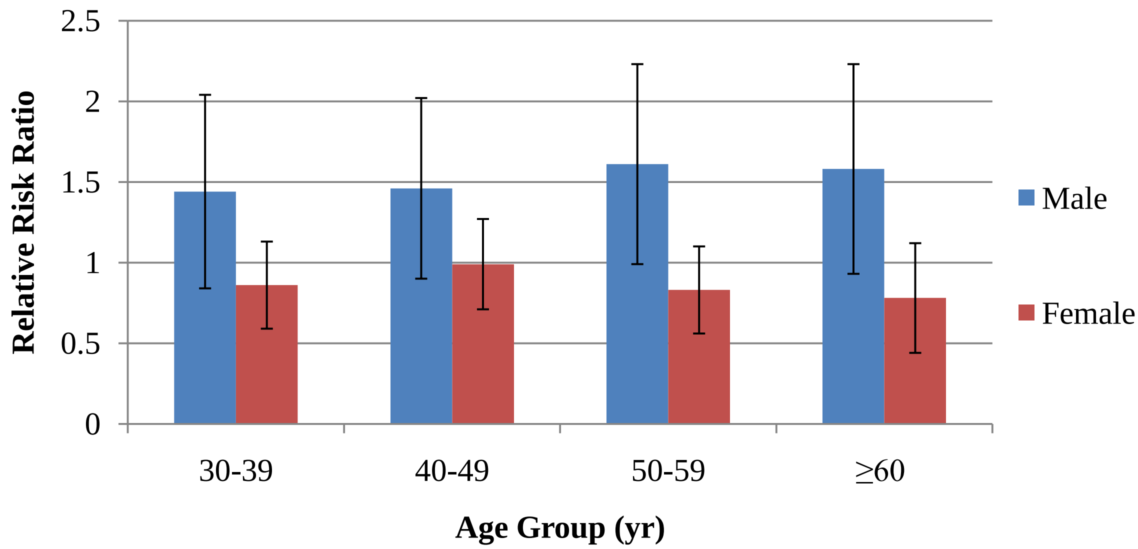


**Figure 7-3** The relative risk ratio of active physical activity status of age groups in relation to the 18-29 year age group, by gender. Asterisk (*) indicates significant differences from the 18-29 year age group ($p$ < 0.05).

The relative ratio of active physical activity status was significantly different between genders (Table 7-2). Male participants were significantly more likely to be active than females, by roughly 30%. Among those participants living in urban settings, female participants were significantly more likely to be active in relation to their rural counterparts. No significant differences in likelihood of active status between urban and rural settings were observed for male participants. Among diabetic individuals, Aboriginal adults demonstrated no significant differences in likelihood of active physical activity status. Similarly, no significant differences in the likelihood of active physical activity status were observed among male or female hypertensive individuals, though normotensive individuals were found to have non-significantly higher relative ratio of active status. In comparing the four health regions of British Columbia, significant differences in relative ratio of active physical activity status were observed. Both genders demonstrated significantly higher relative ratios of active status among the Vancouver

Island and Northern regions in comparison to the Interior region. The Vancouver/Lower mainland region demonstrated no significant differences from the Interior region among male participants with non-significantly higher relative ratios among female participants.

**Table 7-2** Correlates of physical activity status among Canadian Aboriginal adults by gender – multiple logistic regression analysis

| | Male | | Female | |
|---|---|---|---|---|
| Covariate | RR (95% CI) | *P* value | RR (95% CI) | *P* value |
| Off Reserve† | 1.00 (referent) | | 1.00 (referent) | |
| On Reserve† | 1.26 (0.87-1.50)‡ | 0.171297 | 1.22 (0.97-1.43) | 0.089043 |
| Rural† | 1.00 (referent) | | 1.00 (referent) | |
| Urban† | 1.11 (0.82-1.36) | 0.432955 | 1.30 (1.08-1.52) | 0.007942 |
| Diabetic† | 1.00 (referent) | | 1.00 (referent) | |
| Non-Diabetic† | 1.54 (0.77-2.03) | 0.170513 | 0.82 (0.33-1.42) | 0.573569 |
| Hypertensive† | 1.00 (referent) | | 1.00 (referent) | |
| Normotensive† | 1.13 (0.73-1.49) | 0.531804 | 1.15 (0.78-1.56) | 0.450175 |
| Interior Region† | 1.00 (referent) | | 1.00 (referent) | |
| Vancouver Island† | 1.31 (1.03-1.46) | 0.032187 | 1.70 (1.23-2.15) | 0.002276 |
| Vancouver/ Lower mainland Region† | 1.11 (0.73-1.36) | 0.551008 | 1.40 (0.96-1.88) | 0.081417 |
| Northern Region† | 1.25 (1.02-1.39) | 0.038416 | 1.59 (1.24-1.94) | 0.000619 |
| Obese† | 1.00 (referent) | | 1.00 (referent) | |
| Overweight† | 1.05 (0.73-1.33) | 0.775068 | 1.32 (1.05-1.61) | 0.019993 |
| Normal Weight† | 1.15 (0.73-1.48) | 0.484282 | 1.57 (1.26-1.86) | 0.000237 |

†adjusted for age; ‡not adjusted for age due to small sample size; CI, confidence interval, RR, relative risk ratio.

## 7.4 Discussion

Overall, 52.2% of the population reported physical activity levels meeting Canadian guidelines, including 45% of female adults and 64% of male adults. These reported physical activity levels are higher than any previous reports of Canadian Aboriginal adults. Canadian investigations have reported Canadian active physical activity prevalence rates ranging from

19.2% to 36.9% among Aboriginal adults (Katzmarzyk, 2008; Kirby, Levesque, Wabano, & Robertson-Wilson, 2007). A previous Canadian investigation of Aboriginal adults 40 and older reported 35.5% meeting Canadian physical activity guidelines (Brunet, Plotnikoff, Raine, & Courneya, 2005). These levels are still substantially lower than the reported rates observed in the Hearts inTraining investigation, with 48% to 55% of Aboriginal adults 40 and older meeting physical activity guidelines. National surveys have generally reported lower physical activity levels among Canadian Aboriginal adult, with only 19.2%, 21% and 26% reported in three national investigations (Bryan, Tremblay, Perez, Ardern, & Katzmarzyk, 2006; Katzmarzyk, 2008; Young & Katzmarzyk, 2007).

Comparing age differences in physical activity prevalence produced no significant differences. Older Aboriginal adults surveyed in this investigation reported physical activities similar to younger adults. The relative ratios of achieving Canadian physical activity recommendations were not significantly different between age groups. These results are in contrast with previous Canadian investigations of Aboriginal adults' physical activity levels. An investigation in Moose Factory Ontario reported decreases in prevalence of individuals achieving physical activity recommendations with increasing age (Kirby, et al., 2007). Similarly, the 2004 Canadian Community Health Survey reported significant decreases in active status based on physical activity guidelines with increasing age (Katzmarzyk, 2008).

The Hearts inTraining investigation found significant differences in physical activity status within geographic regions, after adjusting for age. Based on age adjusted prevalence of physical activity status meeting physical activity recommendations, both male and female Aboriginal adults reported significantly higher relative ratios of meeting recommendations in the Northern and Island regions of the province in comparison to the Interior region. Female participants also demonstrated significantly greater age adjusted relative ratios for active status in urban residences in comparison to rural residences. No significant differences between urban and rural residence were observed for male participants.

Of participants residing on reserve, recent national reports found only 21.3% reported physical activity levels meeting the Canadian physical activity recommendations (Health Canada, 2003b). Consistent with findings of the Hearts inTraining investigation, greater proportions of male participants on reserve reported meeting physical activity recommendations in this national report with 26.1% of males and 15.2% of females meeting Canadian guidelines (Health Canada, 2003b). Physical activity levels of British Columbian Aboriginal adults were reported to be greater than these recent national averages. Among on reserve Aboriginal adults, 42.1% of males and 40.5% of females report physical activity levels meeting Canadian guidelines. Aboriginal adults residing off reserve presented with near significantly greater rates of physical activity, with 60.0% of males and 51.9% of females meeting Canadian guidelines. Increases in these physical activity levels in comparison to previous national reports suggest Aboriginal adults are increasing their physical activity levels. However, further increases in physical activity should be promoted, particularly among on reserve populations.

Within Hearts inTraining participants, significant differences were observed in relative ratios of physical activity among female participants of varying BMI levels. Female participants of normal and overweight status reported significantly greater relative ratios of active physical activity status than obese female participants. Both national and local Canadian investigations have previously reported significant declines in active physical activity prevalence with increases in obesity status (Katzmarzyk, 2008; Kirby, et al., 2007). These changes in age adjusted physical activity relative ratios were not significant among male participants.

In comparison to other Canadian Aboriginal physical activity levels, this investigation produced similar or higher physical activity levels. As measured using the International Physical Activity questionnaire, Canadian Aboriginal physical activity levels included roughly 50% of the population being moderately active and 25% highly active (Anand, et al., 2007). From responses to the Godin Leisure-Time Exercise questionnaire, about 30% of Canadian Aboriginal adults report physical activity levels meeting Canadian physical activity guidelines (Kirby, et al., 2007). Another Canadian Aboriginal survey of physical activity status used the Lipid Research Clinics questionnaire reported about 25% of participants to be at least moderately active (Young, Sevenhuysen, Ling, & Moffatt, 1990). The physical activity levels reported in this investigation are similar to those observed using the International Physical Activity questionnaire. Based on these differences in physical activity levels with changes in questionnaire utilized, the questionnaire used to collect self-reported physical activity levels may influence the levels of physical activity determined.

Physical activity levels reported among this Aboriginal population are similar to those reported in the 2000-2001 Canadian Community Health Survey, where 42% of Aboriginal males and 52% of Aboriginal females were found to be physically inactive (Bryan & Walsh, 2004). From this Canadian survey, Aboriginal populations were found to be the least inactive, with White, Black, South Asian and Latin American populations reporting greater rates of physical inactivity in comparison to Aboriginal populations (Bryan & Walsh, 2004). Similarly, the Aboriginal population was found to be slightly more active than the non-Aboriginal Canadian population in comparing active physical activity status (Young & Katzmarzyk, 2007). A 2004 Canadian survey reported Aboriginal men to be more active than non-Aboriginal populations while Aboriginal women reported similar physical activity levels to non-Aboriginal women

(Katzmarzyk, 2008). Physical activity levels reported among the Hearts inTraining population are greater than those reported by other ethnicities among the 2000-2001 Canadian Community Health Survey (Bryan & Walsh, 2004).

The increased physical activity levels reported among the Hearts inTraining participants from previous national investigations suggests an increase in recent physical activity levels among this high risk population. In comparison to previous Canadian investigations, this sampling suggests physical activity status among this population is improving. Geographic differences in age adjusted relative risks of activity status suggest this increase in physical activity may not be uniform throughout the province. These differences between regions are not reflected in urban or rural residence, suggesting a more large scale regional improvement in physical activity. Overall, the prevalence of active physical activity status among this population is still an estimated 50%. This low level of physical activity highlights the further need for intervention to improve these physical activity levels among Canadian Aboriginal populations.

## 7.5 Conclusion

A large majority of British Columbian Aboriginal people are physically inactive. Physical activity levels of Aboriginal populations are similar among all age groups, with male individuals more active than female individuals.

# 8. The Effectiveness of Community-Based Physical Activity for Improving Health Status of Aboriginal Canadians

## 8.1 Introduction

Over the past 50 years, Canadian Aboriginal populations have experienced declines in health status and increasing rates of CVD (Harris, et al., 2002; Rode & Shephard, 1984; Shephard, 1988; Wilson & Rosenberg, 2002). Increases in physical activity are known to be associated with improved health status and life expectancy (Warburton, et al.; Warburton, et al., 2007; Warburton, et al., 2006).

The objective of this chapter was to evaluate the changes in health status and physical activity experienced by Aboriginal males and females over the Hearts inTraining intervention. This chapter also evaluated any differences in these health status and physical activity changes between genders. It was hypothesized that both male and female participants would experience improvements in health status and physical activity with the training program.

## 8.2 Methods

Pre- and post-screening sessions were conducted as outlined in Chapter 2 Research Methods. The three physical activity programs were conducted as previously described (Chapter 2). Overall changes experienced by male and female participants were evaluated through the use of t-tests. In order to evaluate the differential improvement in health measures and chronic condition rates experienced by male and female participants with training, ANCOVA analyses were used. These ANCOVA analyses of post-screening measure by gender were adjusted for differences in age, time from pre- to post-screening and pre-intervention measure. To evaluate changes in rates of chronic condition status with the training program, t-tests were used to compare pre and post rates. In order to compare changes in these rates of chronic conditions between genders, ANCOVA analyses were utilized, adjusting for differences in age, time from pre- to post-screening and pre-intervention chronic condition rates.

### 8.3 Results

Over 13 weeks of training, significant improvements in health measures were observed for both males and females (Table 8-1). Males experienced significant improvements in WC with near significant improvements in weight and BMI. Female participants experienced significant improvements in WC and TC, with near significant improvements in screening SBP and TC:HDL ratios. Prior to the training intervention, male and female participants demonstrated significant differences. Female participants were found to have significantly lower weight, WC, SBP and DBP, TC:HDL ratios and glucose. Male participants were also observed to have significantly lower HDL levels in comparison to female participants at pre-intervention.

**Table 8-1** Overall changes in health measures with training by gender (mean ± SD)

| | Health Measure | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Male | Weight (kg) | 91.6±17.5 | 89.6±18.3 | 0.068443 |
| | BMI (kg·m$^{-2}$) | 30.6±5.2 | 29.9±5.4 | 0.068908 |
| | Waist Circumference (cm) | 104.7±12.2 | 102.0±14.2 | 0.033712 |
| | Systolic Blood Pressure (mmHg) | 125.1±18.2 | 122.5±13.9 | 0.223215 |
| | Diastolic Blood Pressure (mmHg) | 77.8±14.8 | 75.9±11.9 | 0.205045 |
| | Total Cholesterol (mmol/L) | 4.78±1.03 | 4.60±0.95 | 0.117665 |
| | HDL (mmol/L) | 1.11±0.37 | 1.15±0.44 | 0.414401 |
| | TC:HDL Ratio | 4.88±2.20 | 4.69±2.42 | 0.645559 |
| | Glucose (mmol/L) | 7.05±3.79 | 6.72±2.17 | 0.496508 |
| Female | Weight (kg)† | 81.8±19.9 | 81.8±19.8 | 0.956012 |
| | BMI (kg·m$^{-2}$) | 30.9±7.1 | 30.9±7.3 | 0.890584 |
| | Waist Circumference (cm) † | 98.7±16.8 | 96.5±16.4 | 0.000035 |
| | Systolic Blood Pressure (mmHg) † | 117.5±16.7 | 116.0±13.0 | 0.086146 |
| | Diastolic Blood Pressure (mmHg) † | 72.7±9.9 | 72.1±9.9 | 0.370734 |
| | Total Cholesterol (mmol/L) | 4.80±1.03 | 4.68±0.97 | 0.049749 |
| | HDL (mmol/L) † | 1.42±0.41 | 1.45±0.41 | 0.177210 |
| | TC:HDL Ratio† | 3.64±1.30 | 3.50±1.43 | 0.092205 |
| | Glucose (mmol/L) † | 6.18±2.45 | 6.35±2.67 | 0.344675 |

SD, Standard Deviation; BMI, Body Mass Index; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; †significantly different from males pre-intervention.

Improvements in rates of most chronic conditions were observed for both males and females (Table 8-2). While obesity and overweight/obese status rates improved for both males and females, no significant changes were observed. Both males and females demonstrated significant improvements in rates of abdominal obesity at the normal cut-off. Female participants also experienced significant improvements in abdominal obesity rates at the low cut-off. Rates of both high and elevated blood pressure significantly improved for both male and female participants over the course of the training program. Female participants did not experience significant changes in rates of elevated blood sugar, though male participants did experience significant improvements in rates of high blood sugar with training. Rates of high and elevated TC as well as low HDL did not significantly change for either male or female participants.

**Table 8-2** The changes in prevalence (95% CI) of chronic conditions among British Columbian Aboriginal populations with training by gender

| Chronic Condition | | Pre-Intervention (%) | Post-Intervention (%) | *P*-value |
|---|---|---|---|---|
| Obesity | Male | 52.5 (39.9-65.0) | 48.3 (35.7-61.0) | 0.484122 |
| | Female | 48.4 (41.8-55.0) | 48.9 (42.2-55.5) | 0.835378 |
| | TOTAL | 49.3 (43.4-55.1) | 48.7 (42.9-54.6) | 0.857838 |
| Overweight or Obesity | Male | 83.6 (74.3-92.9) | 81.7 (71.9-91.5) | 0.708821 |
| | Female | 77.2 (71.6-82.7) | 74.9 (69.1-80.6) | 0.108981 |
| | TOTAL | 78.6 (73.8-83.4) | 76.3 (71.3-81.3) | 0.126857 |
| Abdominal Obesity Normal Cut-Off | Male | 61.0 (48.6-73.5) | 50.0 (37.4-62.6) | 0.024008 |
| | Female | 67.7 (61.5-73.9) | 64.4 (58.0-70.7) | 0.012094 |
| | TOTAL | 66.3 (60.7-71.9) | 61.3 (55.6-67.0) | 0.088112 |
| Abdominal Obesity Low Cut-Off | Male | 78.0 (67.4-88.5) | 70.0 (58.4-81.6) | 0.260401 |
| | Female | 88.5 (84.2-92.7) | 84.5 (79.7-89.3) | 0.038657 |
| | TOTAL | 86.2 (82.2-90.3) | 81.4 (76.8-85.9) | 0.018328 |
| High Blood Pressure | Male | 37.7 (25.5-49.9) | 19.7 (9.7-29.6) | 0.001090 |
| | Female | 18.3 (13.2-23.5) | 11.5 (7.2-15.7) | 0.010266 |
| | TOTAL | 22.6 (17.7-27.5) | 13.3 (9.3-17.2) | 0.000125 |
| Elevated Blood Pressure | Male | 47.5 (35.0-60.1) | 32.8 (21.0-44.6) | 0.018847 |
| | Female | 27.8 (21.8-33.7) | 21.1 (15.7-26.5) | 0.030427 |
| | TOTAL | 31.9 (26.4-37.4) | 23.7 (18.7-28.6) | 0.002184 |
| High Blood Sugar | Male | 17.9 (7.8-27.9) | 11.7 (3.5-19.8) | 0.083213 |
| | Female | 5.1 (2.2-8.0) | 5.0 (2.1-8.0) | 1.000000 |
| | TOTAL | 7.7 (4.5-10.9) | 6.5 (3.6-9.4) | 0.257594 |
| Elevated Blood Sugar | Male | 19.6 (9.2-30.0) | 16.7 (7.2-26.1) | 0.709063 |
| | Female | 8.8 (5.0-12.6) | 11.0 (6.9-15.2) | 0.201538 |
| | TOTAL | 11.0 (7.3-14.8) | 12.2 (8.4-16.1) | 0.354109 |
| High Total Cholesterol | Male | 12.3 (3.8-20.8) | 13.3 (4.7-21.9) | 0.658715 |
| | Female | 18.3 (13.2-23.5) | 11.0 (6.9-15.2) | 0.395023 |
| | TOTAL | 12.8 (8.9-16.8) | 11.5 (7.8-15.3) | 0.564660 |
| Elevated Total Cholesterol | Male | 35.1 (22.7-47.5) | 33.3 (21.4-45.3) | 1.000000 |
| | Female | 34.3 (27.9-40.6) | 30.3 (24.2-36.4) | 0.160352 |
| | TOTAL | 34.4 (28.8-40.0) | 30.9 (25.5-36.4) | 0.21699 |
| Low HDL | Male | 29.8 (17.9-41.7) | 33.3 (21.4-45.7) | 1.000000 |
| | Female | 24.2 (18.5-29.9) | 19.7 (14.4-25.0) | 0.366938 |
| | TOTAL | 25.4 (20.2-30.5) | 22.7 (17.7-27.6) | 0.415223 |

CI, Confidence Interval; HDL, High Density Lipoprotein Cholesterol.

Changes experienced by male and female participants over the course of the training program were different for some variables (Table 8-3). Changes in weight, BMI, WC, DBP, TC, HDL and glucose were similar, as indicated by similar post-intervention levels after adjusting for differences in age, time from pre to post and pre-intervention measure. Significant differences in post-intervention measure by genders were observed for changes in screening SBP and TC:HDL ratio after ANCOVA adjustment for age, pre- to post-time and pre-intervention measure. Female participants demonstrated significantly greater reductions in screening SBP, while male participants demonstrated significantly lower TC:HDL ratio with training.

**Table 8-3** Gender differences in health measure improvements with training†

| Health Measure | F Statistic | *P*-value | Gender Experiencing Greater Improvement |
|---|---|---|---|
| Weight | 0.2674 | 0.605499 | Nil |
| BMI | 2.1205 | 0.146516 | Nil |
| Waist Circumference | 0.3622 | 0.547810 | Nil |
| Systolic Blood Pressure | 4.8281 | 0.028858 | Female |
| Diastolic Blood Pressure | 1.1253 | 0.289735 | Nil |
| Total Cholesterol | 0.3779 | 0.539252 | Nil |
| HDL | 2.0108 | 0.157381 | Nil |
| TC:HDL Ratio | 4.63079 | 0.032328 | Male |
| Glucose | 0.01969 | 0.888520 | Nil |

BMI, Body Mass Index; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; †adjusted for age, time from pre- to post-screening and pre-intervention measure

Male and female participants experienced similar improvements in rates of chronic conditions as measured through comparisons of post-intervention rates after adjusting for age, time between pre- and post-screening and pre-intervention rates (Table 8-4). Post-intervention rates of abdominal obesity at the normal cut-off were near significantly lower more among male participants in comparison to female participants after adjustment. All other chronic condition rates were not significantly different post-intervention between genders, after adjusting for age, time from pre- to post-screening and pre-intervention rates.

**Table 8-4** Gender differences in prevalence of chronic condition improvements with training†

| Chronic Condition | F Statistic | *P*-value | Gender Experiencing Greater Improvement |
|---|---|---|---|
| Obesity | 0.6113 | 0.434980 | Nil |
| Overweight or Obesity | 0.0002 | 0.989774 | Nil |
| Abdominal Obesity - Normal Cut-Off | 2.9765 | 0.085658 | Nil |
| Abdominal Obesity - Low Cut-Off | 0.2394 | 0.625074 | Nil |
| High Blood Pressure | 0.08716 | 0.768051 | Nil |
| Elevated Blood Pressure | 0.39078 | 0.532425 | Nil |
| High Blood Sugar | 0.3025 | 0.582808 | Nil |
| Elevated Blood Sugar | 0.17771 | 0.673693 | Nil |
| High Total Cholesterol | 0.6217 | 0.431150 | Nil |
| Elevated Total Cholesterol | 0.19234 | 0.661344 | Nil |
| Low HDL | 0.4312 | 0.511998 | Nil |

BMI, Body Mass Index; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; Nil, no significant differences observed; †adjusted for age, time from pre- to post-and pre-intervention measure

Both male and female participants experienced significant improvements in physical activity scores as measured using the Healthy Physical Activity Participation Questionnaire (Table 8-5). Female participants reported significant improvements in frequency, intensity and perception of physical activity. Male participants reported significant improvements in frequency of physical activity, with non-significant improvements in intensity and perception of physical activity.

**Table 8-5** The changes in physical activity scores with training by gender (mean ± SD)

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| Score | Pre-Intervention | Post-Intervention | *P*-value | Pre-Intervention | Post-Intervention | *P*-value |
| Frequency† | 2.48±0.98 | 2.90±0.45 | 0.001583 | 3.66±1.73 | 4.76±0.79 | 0.000000 |
| Intensity | 2.05±0.97 | 2.09±0.78 | 0.901031 | 1.89±0.91 | 2.17±0.73 | 0.000084 |
| Perception† | 3.59±1.53 | 3.91±1.53 | 0.148488 | 1.37±1.19 | 2.03±1.11 | 0.000000 |
| Overall† | 8.11±2.49 | 8.90±2.07 | 0.017791 | 6.92±2.92 | 8.96±1.95 | 0.000000 |

SD, Standard Deviation; based on the Healthy Physical Activity Participation Questionnaire; †indicates significant difference between males and females pre-intervention.

Over the Hearts inTraining program, both male and female participants significantly increased the prevalence of participants meeting Canadian physical activity recommendations (Figure 8-1). The post-intervention prevalence of activity status experienced by male and female participants were not significantly different after adjusting for age, time from pre- to post-screening and pre-intervention prevalence. Overall, the percent of participants meeting the physical activity guidelines increased from 51% to 86%.

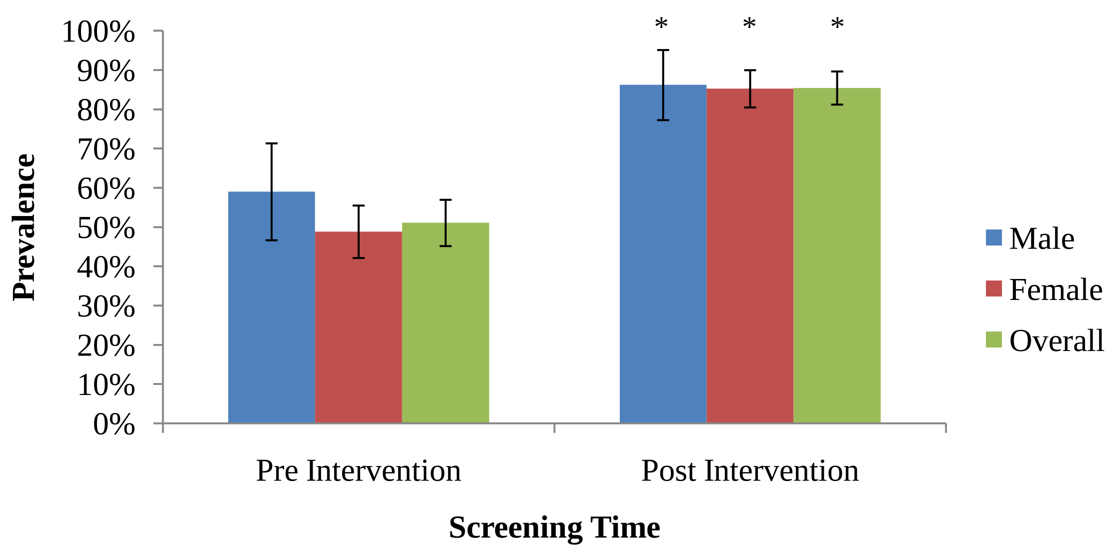


**Figure 8-1** The change in prevalence of participants meeting Canadian physical activity recommendations. Asterisk (*) indicates significant change from pre- to post-screening, $p < 0.05$.

### 8.4 Discussion

Differences between male and female participants before the program include differential rates of directly measured hypertension and reported diabetes as discussed in Chapter 11. As previously discussed, males were observed to have significantly higher weight, WC, SBP and DBP, TC:HDL ratios and glucose levels in comparison to female participants. Female participants were found to have significantly higher HDL levels in comparison to their male counterparts.

Over the 13 weeks of training, both male and female participants experienced significant improvements in health measures. As reported in previous investigations, the changes in free fat mass are often observed among male participants, but not female participants (Perusse, et al., 1997). These results are supported by our current findings where male participants demonstrated near significant decreases in weight and BMI, while female participants experienced no changes. Male participants were found to experience significant improvements in WC, with near significant improvements in weight and BMI. Though many of these changes were not statistically significant, overall males experienced improvements in every health measure recorded. Female participants experienced significant improvements in WC, SBP and TC. Near significant improvements were also observed in the TC:HDL ratio of female participants. Weight and BMI of female participants was not observed to change over this 13 week training program. With the exception of glucose levels, females were observed to experience non-significant improvements for every other measure recorded. Overall, most improvements in health measures were similar between male and females. Females experienced greater improvements in SBP after adjusting for age, pre- to post-screening time and pre-intervention

SBP. Male participants experienced greater improvements in TC:HDL ratios, after adjusting for age, pre- to post-screening time and pre-intervention TC:HDL ratio.

A previous investigation of a 12 week brisk walking program reported similar results to this investigation, with significant improvements in SBP and TC with no significant improvements in weight and BMI (Tully, Cupples, Chan, McGlade, & Young, 2005). However, the Hearts inTraining program also observed significant improvements in WC and non-significant improvements in HDL not found in the primary care investigation (Tully, et al., 2005). Another brisk walking intervention reported significant improvements in HDL, TC and WC over 6 weeks if high intensity walking (Murphy, Nevill, Neville, Biddle, & Hardman, 2002).

Physical activity interventions among Aboriginal populations have reported variable changes in health measures. The Pima Action program, which prescribed Pima Aboriginal adults increased individual physical activity, reported increases in weight, BMI, WC, blood pressure and fasting plasma glucose over 6 and 12 months post-intervention (Narayan, et al., 1998). A community-based physical activity program for American Indian elders reported significant improvements in SBP over the 6 week intervention (Kochevar, Smith, & Bernard, 2001). In contrast to our intervention, drop in community-based physical activity classes were associated with significant losses in weight in the Zuni Diabetes Project (Heath, Wilson, Smith, & Leonard, 1991). Conversely, the Diabetes Prevention Program Lifestyle Intervention arm reported Native American participants among the lowest success in achieving 7% weight loss prescriptions in comparison to other ethnic groups (Wing, et al., 2004). Similar to results observed with the Hearts inTraining program, non significant improvements in weight were observed with a high intensity cycling exercise intervention among Aboriginal participants (Reitman, Vasquez, Klimes, & Nagulesparan, 1984). These changes in weight were observed uniformly among male participants, but inconsistently among female participants (Reitman, et al., 1984). The Zuni Diabetes Project also observed significant improvements in fasting plasma glucose levels, while random blood glucose levels were not observed to significantly decline in the Hearts inTraining program (Heath, et al., 1991). Significant improvements in fasting plasma glucose were also observed among all male and female participants in a high intensity training program (Reitman, et al., 1984).

The Hearts inTraining program was also associated with improvements in rates of chronic conditions. While limited weight loss is generally observed among exercise interventions, improvements in body fat or WC are common (Shephard & Balady, 1999). Significant improvements in rates of abdominal obesity at the normal cut-off were observed for both male and female participants of the Hearts inTraining program. Additionally, male participants experienced significant improvements in rates of abdominal obesity at the low cut-off value. The abdominal obesity, normal cut-off rate among male participants was near significantly more improved than the rate among female participants, after adjusting for age, pre- to post-screening time and pre-intervention rates. This indicates males my experience greater improvements in WC with training. Exercise such as walking programs are known to decrease hypertension (Rippe, Ward, Porcari, & Freedson, 1988). These results were observed in the Hearts inTraining program where both male and female participants experienced significant reductions in rates of high and elevated blood pressure over the course of the intervention. Male participants also experienced significant improvements in rates of high blood glucose.

Physical activity levels, as evaluated by the Healthy Physical Activity Participation Questionnaire, improved for both male and female participants over the course of the intervention. Female participants reported significant improvements in physical activity frequency, intensity and perception. Males reported significant improvements in physical activity frequency. Increases in physical activity are commonly reported in physical activity interventions among Aboriginal populations. The Pima Action intervention reported 15.2 and 24.0 MET·h/month increases in physical activity after 6 and 12 months respectively (Narayan, et al., 1998). A six week community-based aerobics class intervention for American Indian elders also reported significant increases in physical activity over the course of the intervention (Kochevar, et al., 2001). The Diabetes Prevention Program Lifestyle arm reported the highest odds ratios for achieving individual prescribed exercise increase among Native American participants (Wing, et al., 2004).

Among this intervention and published literature, Aboriginal participants report increases in physical activity levels following physical activity interventions. Improvements in SBP are consistently observed among Aboriginal activity intervention participants when reported. Changes in weight and BMI are inconsistent among Aboriginal physical activity interventions. These weight and BMI changes may also be different among male and female participants. Within the few investigations of physical activity interventions among Aboriginal populations, none report changes in chronic condition rates, thus preventing comparison of these results with other literature. Similarly, only one intervention reported differential results by gender. Due to this lack of available literature, comparisons of Hearts inTraining health measure improvements by gender to other published Aboriginal investigations are not available. Further research and publication addressing physical activity interventions among Aboriginal populations are required to better understand the health improvements experienced by Aboriginal populations with increased physical activity.

## 8.5 Conclusion

Over the Hearts inTraining physical activity program, participants demonstrated improved health status. Improvements in health were similar between male and female participants, with no significant differences between genders. This physical activity program was appropriate for both male and female participants.

# 9. The Effectiveness of Community-Based Physical Activity Programs for Reducing the Risk of Cardiovascular Disease of Aboriginal Canadians

## 9.1 Introduction

Aboriginal adults currently experience increased risks for CVD (Forouhi & Sattar, 2006; Thommasen, et al., 2004). These increased rates of CVD are further compounded by increased CVD risk factors experienced by the Aboriginal population (Belanger-Ducharme & Tremblay, 2005; Despres & Lemieux, 2006; Hubert, et al., 1983). Risk scoring systems are available to predict and evaluate individual risk for CVD and CHD (Clearfield, 2002; D'Agostino, Sr., et al., 2008; Gagnon, et al., 2007; Wilson, et al., 1998).

The objective of this chapter was to evaluate the changes in risk for CVD experienced by Aboriginal adults with the Hearts inTraining physical activity program. This chapter evaluated the changes by both male and female participants as well as any differences in these changes between genders. It was hypothesized that both male and female participants would experience improved risk scores for CVD over the training program.

## 9.2 Methods

The Hearts inTraining physical activity program and screening sessions were conducted as described in Chapter 2 Research Methods. The risk of CVD was evaluated using multiple scoring systems, including the Framingham CHD and CVD scoring systems, the NCEP/ATP guidelines scoring system and the ACTI-MENU scoring system (Blumenthal, 2002; D'Agostino, Sr., et al., 2008; Gagnon, et al., 2007; Wilson, et al., 1998). Changes in Framingham scoring systems were evaluated using the score, rather than the percent risk as this score produces normal distribution of scores not provided by 10 year risk percent values. High risk of CVD and CHD using the Framingham CHD, Framingham CVD and ATP III scoring systems were defined as a 10 year risk of 20% or greater and moderate risk was defined as a 10 year risk of 10% or greater. The ACTI-MENU scoring system provided risk categories for very low, low, average, high and very high risks.

Correlations were calculated comparing the pre-intervention scores of each of the four risk scoring systems. Changes in individual's risk for CVD were evaluated using t-tests to compare pre and post risk scores, overall and by gender. In order to compare the changes in CVD risk with training by gender, ANCOVA analysis adjusted for age, time between pre- and post-testing and pre-testing risk score was conducted.

## 9.3 Results

Prior to the Hearts inTraining intervention, male and female participants presented with variable risk scores. Based on the ACTI-MENU scoring system, females average risk score fell in the average risk category with males on average presenting with a high risk. Conversely, using the Framingham CVD and CHD and NCEP/ATP III scoring systems much lower risk scores were predicted. Framingham CHD scores produced an average score corresponding to a 5-7% risks among male participants and a <1% risk among female participants. Using the other two scoring systems, males average risk score correlated with a 6.7% risk of CVD and a 1% risk of CHD while females average score corresponded with a risk of 2.4% risk of CVD and a <1% risk of CHD. Prior to the intervention, male participants presented with significantly higher scores for ACTI-MENU, Framingham CHD and Framingham CVD risk systems. Risk scores calculated through the NCEP/ATP III risk system were higher among male participants with near significance. All four scoring systems presented better risk stratification among female participants in comparison to male participants prior to the Hearts inTraining program.

The four risk scoring systems included in this analysis were all significantly correlated. Framingham CHD and CVD risk scores produced the highest correlation between pre-intervention scores, with the ACTI-MENU and NCEP/ATP III producing the lowest correlation. Both male and female participants and all three training programs demonstrated significant correlations between all risk scoring systems. The Framingham scoring systems were significantly correlated with both ACTI-MENU and NCEP/ATP III scores for all age groups, though the ACTI-MENU and NCEP/ATP III were not significantly correlated in most age groups.

Both male and female participants experienced significant reductions in CHD risk as assessed with the Framingham CHD scoring system and significant improvements in heart health as assessed with the ACTI-MENU Heart Health scoring system (Table 9-1). Female participants also experienced significant reductions in CVD risk assessed by the Framingham CVD scoring system and CHD risk assessed by the NCEP/ATP III scoring system. Male participants experienced near significant improvements in CHD risk as assessed by the NCEP/ATP III scoring system, but no significant changes in CVD risk assessed by the Framingham CVD scoring system.

**Table 9-1** Changes in cardiovascular disease and coronary heart disease risk scores with training by gender (mean ± SD)

| | | Pre-Intervention Score | Post-Intervention Score | *P*-value |
|---|---|---|---|---|
| ACTI-MENU Scoring System | Male | 37.2±18.1 | 34.3±17.3 | 0.000815 |
| | Female | 23.2±14.0 | 20.6±12.9 | 0.000000 |
| Framingham CHD Scoring System | Male | 3.5±4.0 | 2.7±3.9 | 0.009552 |
| | Female | -3.4±7.9 | -3.9±7.5 | 0.020715 |
| Framingham CVD Scoring System | Male | 7.8±6.9 | 7.7±6.6 | 0.710973 |
| | Female | 4.0±6.0 | 3.2±5.3 | 0.000801 |
| NCEP/ATP III Scoring System | Male | 8.2±8.2 | 7.4±8.4 | 0.080171 |
| | Female | 5.9±8.9 | 5.3±8.4 | 0.002802 |

SD, Standard Deviation; CVD, Cardiovascular Disease; CHD, Coronary Heart Disease; NCEP/ATP III, National Cholesterol Education Program/Adult Treatment Panel III.

Improvements in risk scores for CVD and CHD were not uniform between males and females. After adjusting for differences in age, time from pre- to post-screening and pre risk scores, females experienced significantly greater post-intervention risk scores for heart health through the ACTI-MENU scoring system and both Framingham CHD and CVD and NCEP/ATP III scoring systems. No significant differences in Framingham CVD risk score improvements were observed between genders.

Changes in ACTI-MENU heart health status were observed between pre- and post-screening. Overall, significant changes in heart health status were observed (Figure 9-1). Female participants also experienced significant changes in the prevalence of heart health status. Increases in the prevalence of very low and low risk status were observed for female participants while prevalence of high and very high risk status were observed to decrease with training. Significant changes in heart health status were not observed for male participants, who demonstrated shifts towards the average risk category with training.

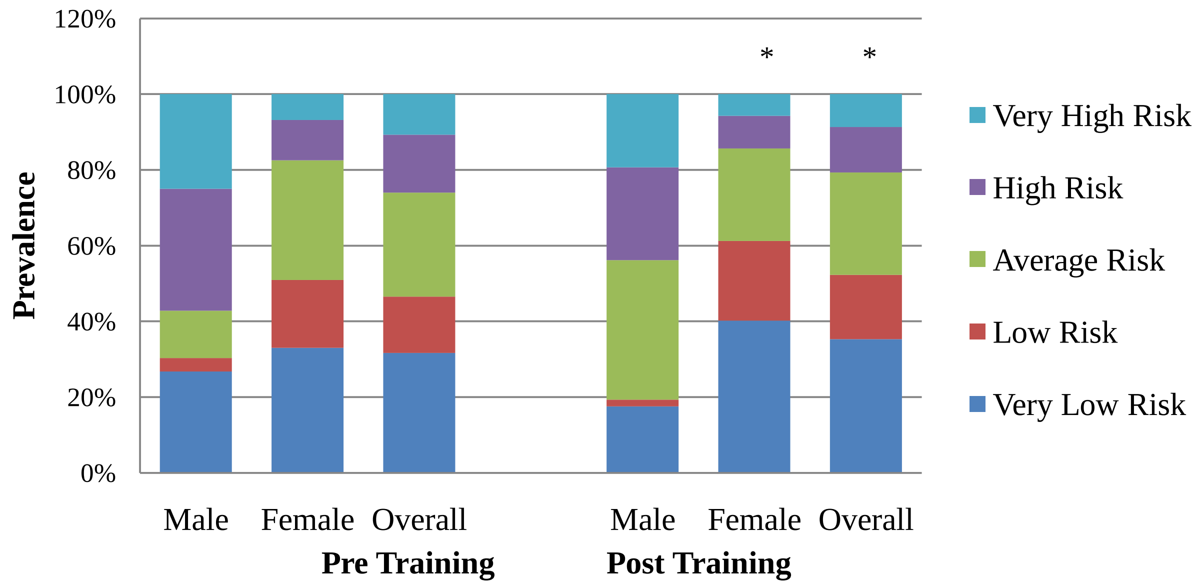


**Figure 9-1** The change in risk stratification of ACTI-MENU scoring system with training by gender. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Male and female participants experienced no significant changes in Framingham CHD risk categories over the training period, as described on Figure 9-2. Female participants demonstrated non-significant declines in the prevalence of the moderate risk category while male participants demonstrated non-significant declines in the prevalence of the high risk category.

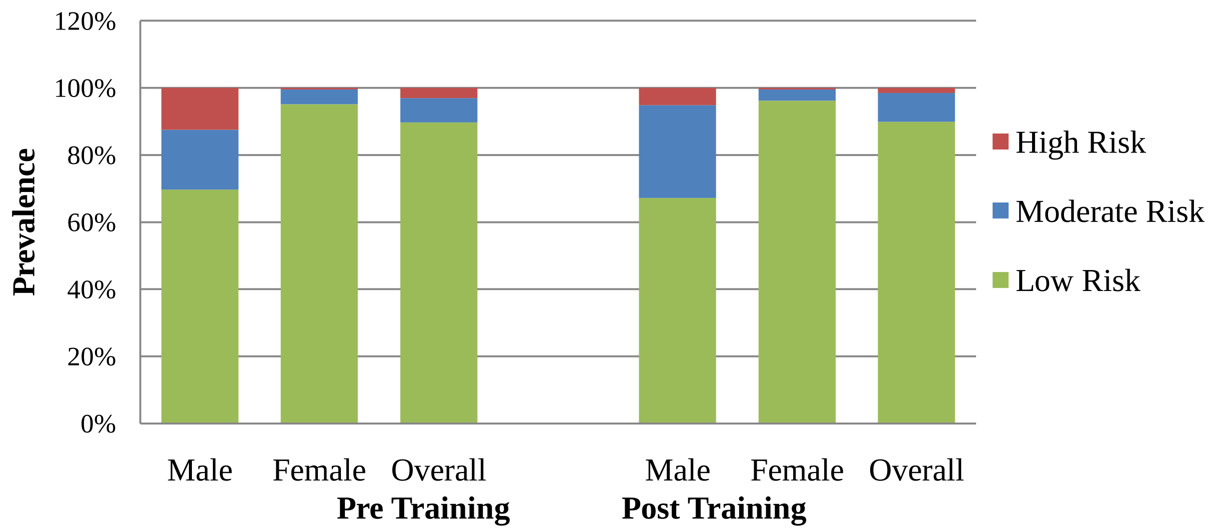


**Figure 9-2** The changes in risk stratification of Framingham CHD risk categories with training by gender. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Changes in Framingham CVD risk categories were not significant for either male or female participants. Figure 9-3 outlines these changes with training. Male participants demonstrated non-significant increases in the prevalence high risk status while female participants demonstrated non-significant increases in the prevalence of low risk status.

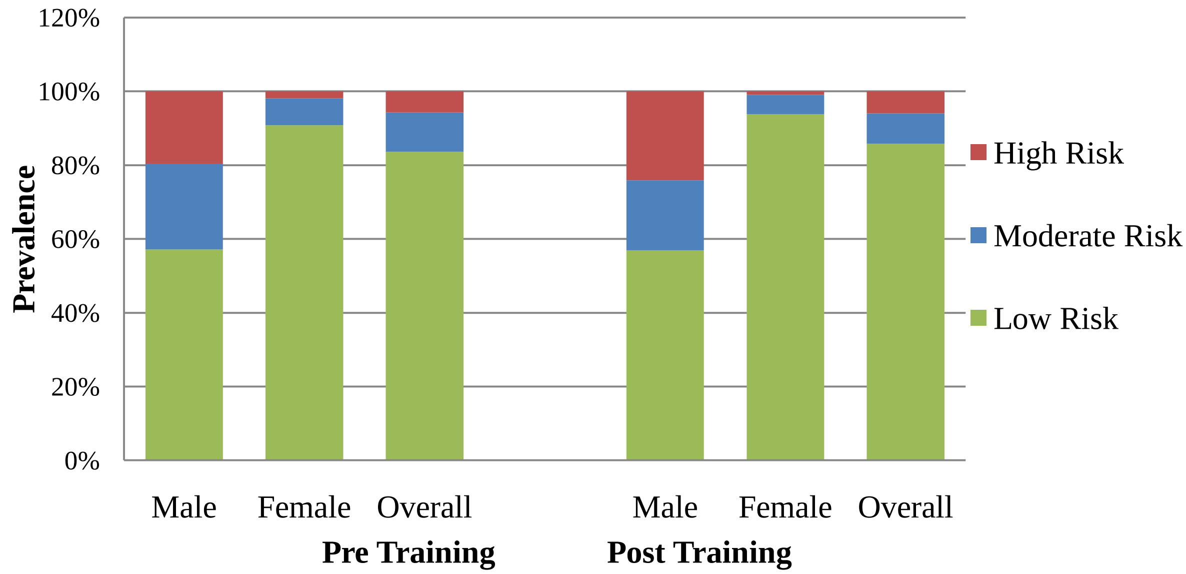


**Figure 9-3** The change in risk stratification of Framingham CVD risk categories with training by gender. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Overall changes in NCEP/ATP III risk classifications were significant over the training period (Figure 9-4). Male participants experienced significant declines in the prevalence of high risk status with increases in the prevalence of low and moderate risk status. Female participants experienced near significant changes in NCEP/ATP III risk status with increases in the prevalence of low risk status and decreases in the prevalence of high and moderate risk status.

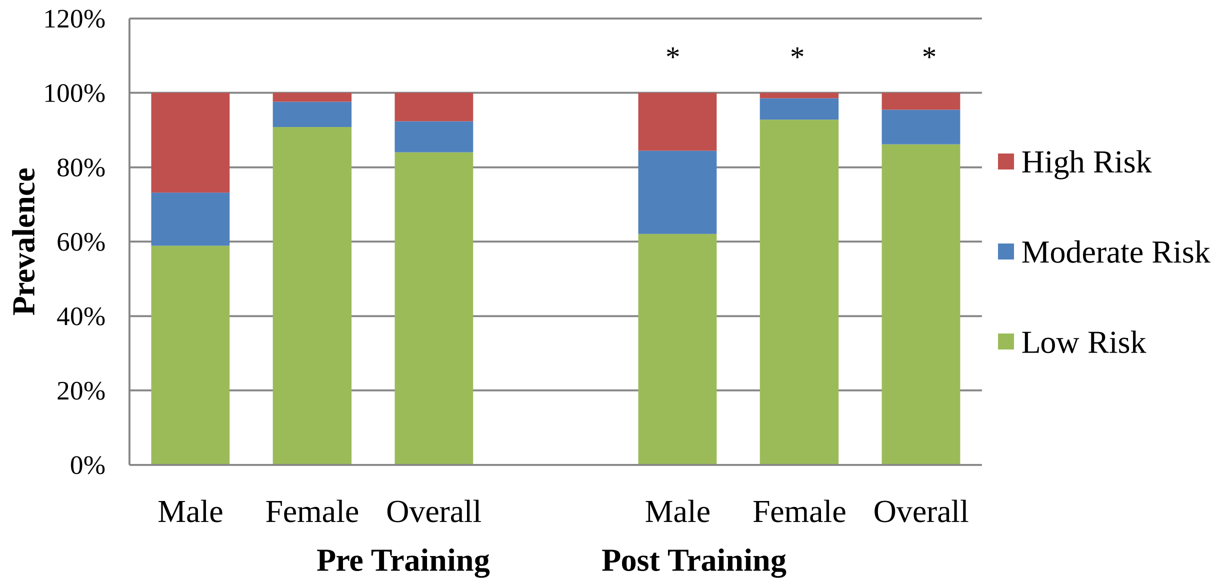


**Figure 9-4** The change in risk stratification of NCEP/ATP III risk categories with training by gender. Asterisk (*) indicates significant changes with training, $p < 0.05$.

### 9.4 Discussion

The use of four scoring systems in these analyses allowed for comparison of these systems. Among published literature, the Framingham CHD, Framingham CVD and NCEP/ATP III have been used (Blumenthal, 2002; Clearfield, 2002; D'Agostino, et al., 2000; D'Agostino, Sr., et al., 2001; D'Agostino, Sr., et al., 2008; Wilson, et al., 1998). However, these scoring systems do not include CVD risk factors of obesity, WC, physical activity or family and personal history of diabetes and CVD. Diabetes and CVD history are established risk factors known to increase an individual’s risk of CVD (Barrett-Connor & Khaw, 1984; Grundy, 2004; Kannel & McGee, 1979b; Laurent, et al., 2001; Lee, et al., 1993; Myers, et al., 1990). Similarly, obesity and abdominal obesity are known to substantially increase CVD risk (Balkau, et al., 2007; Grundy, 2004; Rexrode, et al., 1998; Stein & Colditz, 2004). The omission of these established risk factors from these three systems may reduce the accuracy of either risk scores or risk improvement experienced by this population over the course of training. The inclusion of these risk factors as well as menopausal status, physical activity, glucose levels and smoking within the ACTI-MENU scoring system provides additional measures of improvement (Gagnon, et al., 2007). However, the lack of validity within this scoring system questions the validity of risk assessments and future predictions based on this scoring system.

The high correlations produced between these four scoring systems highlight the similarity of these systems. Significant correlations between the Framingham and NCEP/ATP III scoring systems were expected as these three systems are all based on research from the Framingham study and utilize prediction equations based on the same measures (Blumenthal, 2002; D'Agostino, Sr., et al., 2008; Wilson, et al., 1998). Differences in ACTI-MENU and NCEP/ATP III risk scoring systems likely stem from different inclusion of risk factors and variations in scoring systems developed from different populations. While significant correlations are observed between these systems, the identification of high risk individuals was not uniform through these systems. Different sample numbers of high and moderate risk individuals were observed between all four systems, though the majority of participants were identified as low risk through each system. These differences in identification of moderate and high risk individuals between scoring systems highlights the differences in inclusion of established risk factors and the different strengths of these scoring systems. The use of multiple scoring systems in individual risk assessment allows for more thorough identification of at risk individuals.

The Hearts inTraining participants demonstrated average Framingham CHD risk scores below 10%, with males about 6% and females <1%. These risk scores are lower than those observed in an investigation of similarly aged Framingham participants (Balady, et al., 2004).

Based on NCEP/ATP III risk scoring classifications, female participants in the Hearts inTraining sample demonstrated similar risk stratification to a United States NHANES sample, with 95% of the population demonstrating low risk, 4% demonstrating moderate risk and <1% demonstrating high risk (Ford, Giles, & Mokdad, 2004). However, the male Hearts inTraining participants demonstrated poorer risk stratification in comparison to a United States average, with 70% low risk, 18% moderate risk and 13% high risk, compared to 66%, 29% and 5%, respectively, among the United States (Ford, et al., 2004). Based on Framingham CHD estimates, the Canadian Aboriginal population sampled demonstrate lower than average risk. However, based on NCEP/ATP III risk estimates, male participants demonstrate greater than average CHD risk. It is important to note the Framingham risk scores have only been validated among Caucasian and Black/African populations (Cappuccio, Oakeshott, Strazzullo, & Kerry, 2002; D'Agostino, Sr., et al., 2001). Framingham scoring systems have been found to underestimate the risk among Aboriginal females (D'Agostino, Sr., et al., 2001). Considering this likely underestimation, the Hearts inTraining participants likely demonstrate greater than average risk for CVD and CHD compared to the general population.

Changes among risk scores with training may be observed. The Hearts inTraining program was successful in reducing participants risk for CHD as indicated by the significant reductions in risk through three of the four scoring systems. Both male and female participants demonstrated significant reductions in at least two scoring systems with female participants demonstrating significant reductions in all scoring systems. The lack of significance in changes of male participants NCEP/ATP III risk should not be overemphasized as a small sample size may have prevented the statistical significance of these otherwise meaningful improvements.

Individual walking programs have been shown to reduce the Framingham CHD risk of participants (Tully, et al., 2005). The primary care intervention including individual brisk walking demonstrated average improvements in Framingham CHD scores of 0.44 points to 1.35 depending on SBP or DBP measure used (Tully, et al., 2005). These changes are similar to those observed among Hearts inTraining participants, where females demonstrated 0.5 point improvements and male participants demonstrated 0.8 point improvements.

The differential risk stratification provided through the ACTI-MENU scoring system may be useful in identifying individuals with potential for high risk later in life. This scoring system incorporates risk factors not included in other standardized risk scoring systems. By identifying individuals who may be at increased risk for future CHD or CVD due to elevated weight, BMI, WC and low physical activity this scoring system may be able to identify individuals at risk for future health issues who may not be identified through the other scoring systems.

All four scoring systems demonstrated significant improvements in risk scores with training. Walking programs are known to reduce risk factors and overall risk for CHD and CVD (Murphy, et al., 2002; Rippe, et al., 1988; Shephard & Balady, 1999). The Hearts inTraining program was similarly observed to reduce participants overall risk for CHD and CVD, though changes in risk classification may not have been observed through all scoring systems. Use of multiple scoring systems, including different risk factors, further solidifies these risk improvements as improved overall risk scores were observed across all scoring systems.

## 9.5 Conclusion

Improvements in risk for CVD were observed across all scoring systems. With the physical activity training programs, participants demonstrated reduced risk scores through all four scoring systems.

# 10. The Effectiveness of Community-Based Physical Activity for Improving Health Status of Aboriginal Canadians of Varying Ages

## 10.1 Introduction

Exercise training is known to improve health status and risk for chronic diseases (Warburton, et al.; Warburton, et al., 2007; Warburton, et al., 2006). Younger and older individuals are both known to experience improvements in health status with physical activity (Kohrt, et al., 1991; Meredith, et al., 1989).

The objective of this chapter was to evaluate changes in health status, CVD risk scores and physical activity experienced with physical activity training by age group. This chapter also evaluated any differences in health status, CVD risk scores and physical activity between age groups. It was hypothesized that all age groups would experience improvements in health status, CVD risk scores and physical activity with the Hearts inTraining program.

## 10.2 Methods

Pre- and post-screening sessions were conducted as outlined in Chapter 2 Research Methods. Overall changes in health measures, chronic condition rates and CVD risk scores experienced by different age groups were evaluated through the use of t-tests. In order to evaluate the differential improvement in health measures, CVD risk scores and chronic condition rates experienced by different age groups with training, ANCOVA analyses were used. These ANCOVA analyses of post-screening measure by age group were adjusted for differences in gender, time from pre- to post-screening and pre-intervention measure. Changes in rates of chronic condition status with training were evaluated through t-tests. In comparing these changes between age groups, ANCOVA analyses were used, adjusting for gender, pre- to post-screening time and pre-screening rates.

## 10.3 Results

Weight was observed to increase with increasing age, though no significant changes in weight were observed over the course of the training program (Table 10-1). Similar increases in BMI were observed with age, while no age group experienced significant changes in BMI with training. With the exception of the under 20 year age group, WC was observed to increase with age. Significant improvements in WC were observed over the training program for individuals 20-39 years of age, with less than 20 years and 50-59 years experienced near significant improvements and other age groups experienced non-significant improvements.

**Table 10-1** The changes in anthropometry experienced by age group with the Hearts inTraining program (mean ± SD)

| | Age Group | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Weight (kg) | <20 years | 80.7±23.7 | 80.7±23.2 | 0.979115 |
| | 20-29 years | 83.7±18.6 | 82.8±18.8 | 0.522477 |
| | 30-39 years | 83.0±21.1 | 81.4±16.4 | 0.137958 |
| | 40-49 years | 83.2±18.5 | 83.7±18.1 | 0.609262 |
| | 50-59 years | 84.9±21.0 | 85.4±21.2 | 0.764441 |
| | ≥60 years | 88.8±16.6 | 86.3±17.2 | 0.181560 |
| BMI ($kg \cdot m^{-2}$) | <20 years | 28.8±6.7 | 28.8±6.6 | 0.959557 |
| | 20-29 years | 29.6±6.0 | 29.3±6.1 | 0.546912 |
| | 30-39 years | 30.4±7.0 | 29.8±7.2 | 0.152834 |
| | 40-49 years | 31.2±6.6 | 31.5±6.7 | 0.516272 |
| | 50-59 years | 31.6±7.4 | 31.9±8.0 | 0.679246 |
| | ≥60 years | 32.6±5.3 | 31.7±5.9 | 0.179684 |
| Waist Circumference (cm) | <20 years | 97.6±14.8 | 94.8±15.4 | 0.083190 |
| | 20-29 years | 95.6±15.2 | 93.1±15.1 | 0.004360 |
| | 30-39 years | 98.3±16.4 | 94.0±16.4 | 0.000193 |
| | 40-49 years | 100.6±15.4 | 99.6±15.3 | 0.442126 |
| | 50-59 years | 101.0±16.5 | 99.2±15.8 | 0.090248 |
| | ≥60 years | 110.3±14.9 | 107.7±16.1 | 0.153586 |

SD, Standard Deviation; BMI, Body Mass Index

Over the training time, screening SBP was observed to decrease among age groups 40 years and older. Significant improvements in screened SBP were observed for the ≥60 year age group with near significant improvements in the 50-59 year age group, as described on Figure 10-1. Systolic blood pressure increased with increasing age, both pre- and post-intervention. After adjusting for differences in gender, time from pre- to post-intervention and pre-screening SBP, the post SBP values were not significantly different between age groups, indicating the changes in SBP with training were not significantly different between age groups.

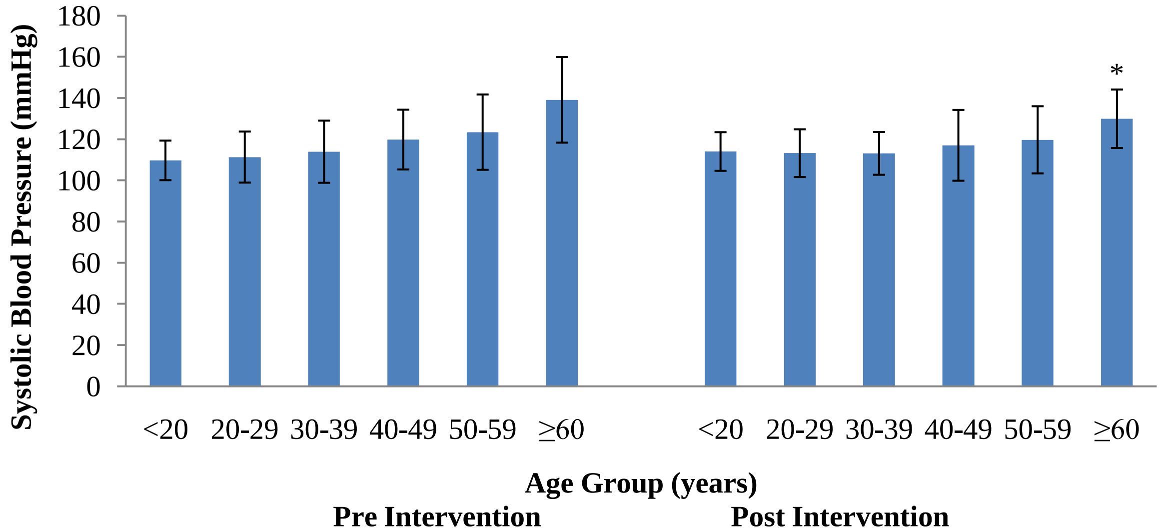


**Figure 10-1** The changes in screened systolic blood pressure with training by age group. Asterisk (*) indicates significant change from pre-intervention to post-intervention, $p < 0.05$.

Most age groups demonstrated similar screened DBP pre- and post-intervention, as outlined on Figure 10-2. Improvements in screening DBP were observed for age groups ≥50 years, with near significant improvements among the ≥60 year age group. Among the <20 year age group, screening DBP significantly increased over the course of the training program, though still well below the 80 mmHg risk category. Significant differences in the change in screened DBP with training between age groups were not observed after adjusting for age, time from pre- to post-intervention and pre-intervention screened DBP values.

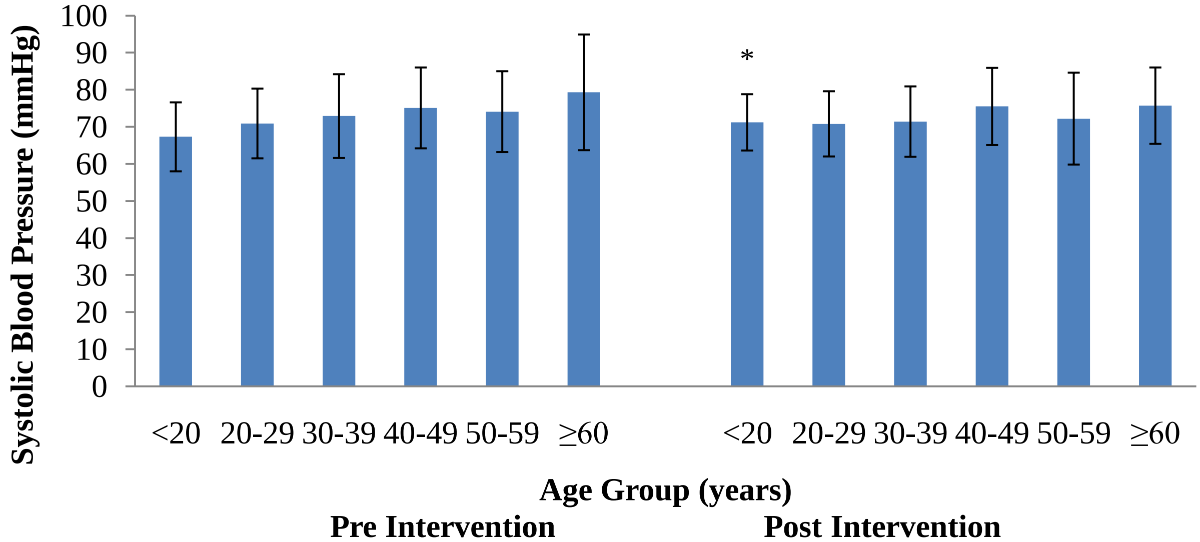


**Figure 10-2** The changes in screened diastolic blood pressure with training by age group. Asterisk (*) indicates significant change from pre-intervention to post-intervention, $p < 0.05$.

Total cholesterol, as outlined on Table 10-2, was observe to increase with age, until 59 years of age. Improvements in TC were observed for all age groups of 20 years and older. Significant changes in TC were only observed for 30-39 years of age, with non-significant changes in other age groups. From 20 to 59 years, pre-intervention HDL was observed to increase. While no significant changes in HDL were observed with training, improvements in HDL were observed for 20-29 years and ≥40 year age groups. An increase in TC:HDL ratios was observed with increasing age. Improvements in TC:HDL ratios were observed with training for 20-49 years and ≥60 years age groups. While no statistically significant changes were observed, near significant improvements were observed for 20-29 years and ≥60 years age groups. Random blood glucose values were observed to increase over the course of training in <50 years age groups and decrease in ≥50 years groups. Changes in blood glucose levels were near significant among the 20-29 year age group with no statistically significant changes in any group.

**Table 10-2** The changes in blood content by age group with training (mean ± SD)

| | Age Group | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Total Cholesterol (mmol/L) | <20 years | 4.15±0.73 | 4.36±0.82 | 0.451798 |
| | 20-29 years | 4.20±0.80 | 4.12±0.75 | 0.684271 |
| | 30-39 years | 4.78±0.92 | 4.55±0.77 | 0.022226 |
| | 40-49 years | 4.93±0.98 | 4.82±1.07 | 0.254390 |
| | 50-59 years | 5.21±1.08 | 5.06±0.97 | 0.219464 |
| | ≥60 years | 4.72±1.26 | 4.56±0.94 | 0.512156 |
| HDL (mmol/L) | <20 years | 1.55±0.40 | 1.53±0.40 | 0.754939 |
| | 20-29 years | 1.35±0.43 | 1.40±0.37 | 0.179538 |
| | 30-39 years | 1.38±0.42 | 1.36±0.42 | 0.634140 |
| | 40-49 years | 1.38±0.37 | 1.40±0.40 | 0.529684 |
| | 50-59 years | 1.41±0.40 | 1.44±0.54 | 0.505657 |
| | ≥60 years | 1.16±0.53 | 1.23±0.40 | 0.351594 |
| TC: HDL Ratio | <20 years | 2.85±0.91 | 3.15±1.41 | 0.611613 |
| | 20-29 years | 3.49±1.76 | 3.10±0.89 | 0.058717 |
| | 30-39 years | 3.78±0.42 | 3.66±1.44 | 0.640256 |
| | 40-49 years | 3.85±1.37 | 3.73±1.40 | 0.251365 |
| | 50-59 years | 4.02±1.45 | 4.34±2.79 | 0.265306 |
| | ≥60 years | 4.83±2.27 | 4.01±1.26 | 0.066465 |
| Random Blood Glucose (mmol/L) | <20 years | 5.76±0.67 | 5.80±0.84 | 0.649295 |
| | 20-29 years | 5.51±0.77 | 6.35±2.72 | 0.056957 |
| | 30-39 years | 5.77±1.11 | 5.78±0.81 | 0.830606 |
| | 40-49 years | 5.82±0.83 | 6.09±1.33 | 0.165398 |
| | 50-59 years | 7.14±4.23 | 7.06±3.48 | 0.912546 |
| | ≥60 years | 8.90±5.32 | 7.74±4.60 | 0.347251 |

SD, Standard Deviation; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol.

Changes in health measures experienced by age groups were not significantly different for most variables (Table 10-3). After adjusting for differences in gender, time between pre- and post-screening and the pre-intervention measure, post-intervention measures of weight, BMI and

WC were not significantly different between age groups. Similarly, changes in blood pressure were not statistically significantly different between any age groups. Post-intervention measures of TC, HLD and random blood glucose were not significantly different between groups after adjusting for gender, time from pre- to post-screening and pre-intervention levels. Significant differences in improvements of TC:HDL ratios were observed after adjusting for time between screenings and pre-intervention ratios. Males in the 50-59 year age group were found to experience a significantly greater increase in TC:HDL ratios in comparison with all other groups.

**Table 10-3** Age group differences in post health measure with training†

| Health Measure | F Statistic | *P*-value | Age Group Experiencing Greater Improvement |
|---|---|---|---|
| Weight | 0.6400 | 0.669375 | Nil |
| BMI | 0.6112 | 0.691438 | Nil |
| Waist Circumference | 1.4381 | 0.210989 | Nil |
| Systolic Blood Pressure | 0.88581 | 0.491080 | Nil |
| Diastolic Blood Pressure | 0.3426 | 0.886691 | Nil |
| Total Cholesterol | 1.3539 | 0.242341 | Nil |
| HDL | 1.0644 | 0.380647 | Nil |
| TC:HDL Ratio | 8.91634 | 0.000000 | Male 50-59 years |
| Glucose | 0.96024 | 0.442801 | Nil |

BMI, Body Mass Index; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; Nil, no significant differences observed; †adjusted for gender, time from pre to post and pre-intervention measure

Over the training period, obesity prevalence was observed to decrease among <30 and ≥60 year age groups, with significant decreases in obesity prevalence among the ≥60 year age group, as outlined on Table 10-4. The prevalence of overweight or obese status declined in age groups <20 and ≥40 year age groups, though no significant changes were observed. Declines in rates of abdominal obesity at the normal cut-off values were observed for all age groups except the 40-49 year age group. Among these improvements, significant declines in abdominal obesity prevalence were observed for the 30-39 year age group. The prevalence of abdominal obesity at the low cut-off value declined in all age groups over the training time, though no significant changes were observed and near-significant changes were only observed among the 20-29 year age group.

Differential changes in obesity status were not observed between age groups as post-intervention obesity and overweight/obesity rates were not significantly different between groups after adjusting for gender, time between pre- and post-testing and the pre-intervention rate. Similarly, no significant differences in post-intervention abdominal obesity rates at the low cut-off levels were observed between age groups. However, abdominal obesity rates post-intervention were observed to be significantly lower among 40-59 year age groups in comparison to younger age groups after adjusting for gender, time between pre- and post-testing and pre-intervention abdominal obesity rates. These differences suggest individuals 40-59 years experienced significantly greater reductions in abdominal obesity with training in comparison to younger age groups.

**Table 10-4** The changes in obesity prevalence (95% CI) among British Columbian Aboriginal populations with training by age group

| Chronic Condition | Age Group | Pre-Intervention (%) | Post-Intervention (%) | *P*-value |
|---|---|---|---|---|
| Obesity | <20 | 46.2 (19.1-73.2) | 38.5 (12.0-64.9) | 0.337049 |
| | 20-29 | 72.3 (59.6-85.1) | 44.7 (30.5-58.9) | 0.322542 |
| | 30-39 | 35.6 (23.4-47.8) | 37.3 (25.0-49.6) | 0.658579 |
| | 40-49 | 54.2 (42.7-65.7) | 59.2 (47.7-70.6) | 0.208160 |
| | 50-59 | 50.0 (37.1-62.9) | 51.7 (38.9-64.6) | 0.708938 |
| | ≥60 | 75.0 (57.7-92.3) | 58.3 (38.6-78.1) | 0.042766 |
| Overweight or Obesity | <20 | 69.2 (44.1-94.3) | 61.5 (35.1-88.0) | 0.584493 |
| | 20-29 | 68.1 (54.8-81.4) | 70.2 (57.1-83.3) | 0.322542 |
| | 30-39 | 71.2 (59.6-82.7) | 71.2 (59.6-82.7) | 0.418883 |
| | 40-49 | 81.9 (73.1-90.8) | 78.9 (69.4-88.4) | 0.483400 |
| | 50-59 | 84.5 (75.2-93.8) | 81.0 (70.9-91.1) | 0.159097 |
| | ≥60 | 95.8 (87.8-100.0) | 91.7 (80.6-100.0) | 0.327716 |
| Abdominal Obesity Normal Cut-Off | <20 | 46.2 (19.1-73.2) | 38.5 (12.0-64.9) | 0.337049 |
| | 20-29 | 54.4 (40.0-68.7) | 48.9 (34.6-63.2) | 0.182584 |
| | 30-39 | 60.7 (47.9-73.5) | 45.8 (33.0-58.5) | 0.010112 |
| | 40-49 | 69.4 (58.8-80.1) | 70.4 (59.8-81.0) | 0.708297 |
| | 50-59 | 72.4 (60.9-83.9) | 70.7 (59.0-82.4) | 0.568224 |
| | ≥60 | 87.5 (74.3-100.0) | 83.3 (68.4-98.2) | 0.327716 |
| Abdominal Obesity Low Cut-Off | <20 | 76.9 (54.0-99.8) | 69.2 (44.1-94.3) | 0.584493 |
| | 20-29 | 82.6 (71.7-93.6) | 76.6 (64.5-88.7) | 0.083187 |
| | 30-39 | 78.6 (67.8-89.3) | 72.9 (61.5-84.2) | 0.419136 |
| | 40-49 | 87.5 (79.9-95.1) | 85.9 (77.8-94.0) | 0.708297 |
| | 50-59 | 93.1 (86.6-99.6) | 86.2 (77.3-95.1) | 0.102932 |
| | ≥60 | 95.8 (87.8-100.0) | 91.7 (80.6-100.0) | 0.327716 |

CI, Confidence Interval; HDL, High Density Lipoprotein Cholesterol.

Reductions in the prevalence of high blood pressure were observed for all age groups ≥20 years, as outlined on Table 10-5. Among these changes, the prevalence of high blood pressure post-intervention among the ≥60 year age group was less than half of the pre-intervention rate.

Significant reductions in prevalence of high blood pressure were observed for ≥50 year age groups, with near significant reductions in the 20-29 year age group. Reductions in the prevalence of elevated blood pressure were observed for all ≥20 year age groups though significant changes were not observed and near significant reductions were only observed among the 50-59 year age group. Changes in the prevalence of high random blood glucose with training included non-significant reductions among the ≥50 year age groups. Elevated random blood glucose prevalence was observed to increase among most age groups, with significant increases among the 40-49 year age group. Conversely, the prevalence of elevated blood glucose significantly decreased among the ≥60 year age group.

Post-intervention rates of high and elevated blood pressure were not significantly different between age groups after adjusting for differences in gender, time from pre- to post-testing and pre-intervention rates. Similarly, no significant differences in post-intervention rates of high and elevated blood glucose levels were observed between age groups after adjusting for differences in gender, pre- to post-intervention time and pre-intervention rates.

**Table 10-5** The changes in prevalence (95% CI) of high and elevated blood pressure and blood glucose among British Columbian Aboriginal populations with training by age group

| Chronic Condition | Age Group | Pre-Intervention (%) | Post-Intervention (%) | *P*-value |
|---|---|---|---|---|
| High Blood Pressure | <20 | 0.0 | 0.0 | 1.000000 |
| | 20-29 | 10.6 (1.8-19.5) | 4.4 (0.0-10.2) | 0.083187 |
| | 30-39 | 8.6 (1.4-15.8) | 8.5 (1.4-15.6) | 1.000000 |
| | 40-49 | 19.4 (10.3-28.6) | 13.9 (5.9-21.9) | 0.208128 |
| | 50-59 | 34.5 (22.2-46.7) | 20.7 (10.3-31.1) | 0.044492 |
| | ≥60 | 62.5 (43.1-81.9) | 29.2 (11.0-47.4) | 0.002512 |
| Elevated Blood Pressure | <20 | 7.7 (0.0-22.8) | 7.7 (0.0-22.2) | 1.000000 |
| | 20-29 | 12.8 (3.2-22.3) | 8.7 (0.6-16.8) | 0.420221 |
| | 30-39 | 18.6 (8.6-28.7) | 11.9 (3.6-20.1) | 0.208624 |
| | 40-49 | 34.7 (23.7-45.7) | 26.4 (16.2-36.6) | 0.134622 |
| | 50-59 | 44.8 (32.0-57.6) | 32.8 (20.7-44.8) | 0.089675 |
| | ≥60 | 70.8 (52.6-89.0) | 58.3 (38.6-78.1) | 0.185272 |
| High Blood Glucose | <20 | 0.0 | 0.0 | 1.000000 |
| | 20-29 | 0.0 | 2.1 (0.0-6.3) | 0.322658 |
| | 30-39 | 1.8 (0.0-5.2) | 1.7 (0.0-5.1) | 1.000000 |
| | 40-49 | 1.4 (0.0-4.2) | 2.8 (0.0-6.6) | 0.320755 |
| | 50-59 | 12.3 (3.8-20.8) | 8.6 (1.3-15.9) | 0.159129 |
| | ≥60 | 43.5 (23.2-63.7) | 33.3 (14.1-52.6) | 0.161860 |
| Elevated Blood Glucose | <20 | 7.7 (0.0-23.4) | 7.7 (0.0-22.8) | 1.000000 |
| | 20-29 | 0.0 | 2.1 (0.0-6.3) | 0.322658 |
| | 30-39 | 1.8 (0.0-5.2) | 5.4 (0.0-11.2) | 0.658715 |
| | 40-49 | 2.8 (0.0-6.7) | 9.7 (2.9-16.6) | 0.058227 |
| | 50-59 | 15.8 (6.3-25.3) | 22.4 (11.7-33.1) | 0.159129 |
| | ≥60 | 52.2 (31.8-72.6) | 33.3 (14.5-52.2) | 0.042622 |

CI, Confidence Interval.

Reductions in the prevalence of high TC were observed for <40 and 50-59 year age groups (Table 10-6). Significant reductions in the prevalence of high TC were observed for the 30-39 year age group. Elevated TC rates were observed to decline among all ≥20 year age groups, though no reductions were statistically significant. Similarly, rates of low HDL were observed to decline among all age groups except the 30-39 year age group, though no changes were statistically significant. Significant differences in the post-intervention rates of high and elevated TC were observed between age groups after adjusting for gender, time between pre- and post-testing and pre-intervention rates. These differences exist between the increases in rates of elevated and high TC among youth age groups. The $<20$ year age group was found to have significantly higher rates of elevated and high TC from 20-29 and $\geq 40$ year age groups after adjusting for gender, time from pre to post and pre-intervention rates. No significant differences in post-intervention rates of low HDL were observed between groups after adjusting for differences in gender, pre- to post-intervention time and pre-intervention low HDL rates.

**Table 10-6** The changes in prevalence (95% CI) of abnormal cholesterol status among British Columbian Aboriginal populations with training by age group

| Chronic Condition | Age Group | Pre-Intervention (%) | Post-Intervention (%) | *P*-value |
|---|---|---|---|---|
| High Total Cholesterol | <20 | 0.0 | 0.0 | 1.000000 |
| | 20-29 | 2.2 (0.0-6.4) | 0.0 | 0.322658 |
| | 30-39 | 10.5 (2.6-18.5) | 1.7 (0.0-5.1) | 0.023957 |
| | 40-49 | 11.3 (3.9-18.6) | 15.3 (7.0-23.6) | 0.259742 |
| | 50-59 | 21.1 (10.5-31.6) | 13.8 (4.9-22.7) | 0.159129 |
| | ≥60 | 33.3 (14.5-52.2) | 41.7 (21.9-61.4) | 0.327716 |
| Elevated Total Cholesterol | <20 | 0.0 | 16.7 (0.0-37.8) | 0.166890 |
| | 20-29 | 8.7 (0.6-16.8) | 6.4 (0.0-13.4) | 0.659680 |
| | 30-39 | 28.1 (16.4-39.7) | 22.4 (11.7-33.1) | 0.321690 |
| | 40-49 | 38.0 (26.7-49.3) | 30.6 (19.9-41.0) | 0.227776 |
| | 50-59 | 52.6 (39.7-65.6) | 50.0 (37.1-62.9) | 0.597418 |
| | ≥60 | 54.2 (34.2-74.1) | 58.3 (38.6-78.1) | 0.664306 |
| Low HDL Cholesterol | <20 | 18.2 (0.0-41.0) | 25.0 (0.5-49.5) | 1.000000 |
| | 20-29 | 37.0 (23.0-50.9) | 34.0 (20.5-47.6) | 0.485547 |
| | 30-39 | 39.3 (26.5-52.1) | 43.1 (30.4-55.8) | 0.370529 |
| | 40-49 | 40.9 (29.4-52.3) | 36.1 (25.0-47.2) | 0.349401 |
| | 50-59 | 40.4 (27.6-53.1) | 37.9 (25.4-50.4) | 0.742091 |
| | ≥60 | 50.0 (30.0-70.0) | 45.8 (25.9-65.8) | 0.664306 |

CI, Confidence Interval; HDL, High Density Lipoprotein.

ACTI-MENU heart health scores were observed to improve with training for all age groups. Significant improvements in heart health ACTI-MENU scores were observed for age groups 20 and over (Table 10-7). After adjusting for gender, time between pre- and post-screening and the pre-scores, significant differences in heart health score improvements were observed where the 40-49 year age group experienced significantly greater improvements than the 20-29 year age group. Risk for CHD measured using the Framingham system did not significantly change over the training time for most age groups. Minimal changes in

Framingham CHD scores were observed for age groups younger than 50 years, with significant changes only observed for the improvements experienced by the 50-59 year age group. Similarly, Framingham CVD risk scores significantly improved only in the 50-59 year age group, though improvements were observed for age groups 20 years and older. NCEP/ATP III CHD risk scores demonstrated improvements with training for all age groups 20 years and older, with significant improvements experienced by age groups 30 years and older.

Differences in the post-intervention ACTI-MENU scores were observed between age groups after adjusting for differences in gender, pre- to post-intervention time and pre-intervention scores. These differences included the 40-49 year age group demonstrating significantly lower adjusted post-intervention scores in comparison to <30 year age groups. Similarly, significant differences in post-intervention Framingham CHD risk scores were observed between age groups. After adjusting for gender, pre-intervention risk scores and time between pre- and post-scoring, the ≥40 year age groups were found to have significantly lower CHD risk than <40 year age groups. Age group differences in adjusted post-intervention scores were also observed for the Framingham CVD risk scores. After adjusting for gender, pre-intervention scores and pre- to post-intervention time, the lowest adjusted post-intervention scores were observed among the 40-49 year age group. Youth were found to have significantly higher scores than ≥30 year age groups, the 20-29 year age group was found to have significantly higher scores than the ≥40 year age groups and the 30-39 year age group was found to have significantly higher adjusted post CVD risk scores than the 40-59 year age groups. Significant differences in adjusted post-intervention NCEP/ATP III risk scores were also observed between age groups. The lowest adjusted post-intervention risk scores were observed among the 40-59 year age groups where these age groups demonstrated significantly lower post-intervention scores from all other age groups after adjusting for differences in gender, pre-intervention scores and time between pre- and post-testing.

**Table 10-7** Changes in cardiovascular disease and coronary heart disease risk scores with training by age group (mean ± SD)

| | Age Group | Pre-Intervention Score | Post-Intervention Score | *P*-value |
|---|---|---|---|---|
| ACTI-MENU Scoring System | <20 | 19.8±8.1 | 18.2±9.1 | 0.193709 |
| | 20-29 | 16.1±9.2 | 13.9±9.0 | 0.003518 |
| | 30-39 | 19.8±8.9 | 16.7±8.6 | 0.000002 |
| | 40-49 | 23.8±10.6 | 21.5±9.8 | 0.000002 |
| | 50-59 | 32.3±13.8 | 29.7±12.9 | 0.007934 |
| | ≥60 | 56.0±18.1 | 51.5±17.1 | 0.000836 |
| Framingham CHD Scoring System | <20 | -9.3±6.4 | -8.7±7.3 | 0.682724 |
| | 20-29 | -10.6±5.4 | -10.8±5.0 | 0.269693 |
| | 30-39 | -7.1±5.6 | -7.2±5.2 | 0.386208 |
| | 40-49 | 0.1±3.2 | -0.3±3.3 | 0.386208 |
| | 50-59 | 4.8±3.0 | 3.8±3.7 | 0.059564 |
| | ≥60 | 8.2±4.2 | 6.8±3.6 | 0.152977 |
| Framingham CVD Scoring System | <20 | -2.1±2.5 | -1.0±2.8 | 0.191321 |
| | 20-29 | -1.7±2.6 | -2.0±2,5 | 0.191321 |
| | 30-39 | 1.1±3.9 | 0.8±3.5 | 0.509983 |
| | 40-49 | 5.5±3.6 | 5.0±3.3 | 0.509983 |
| | 50-59 | 9.7±3.9 | 8.5±4.5 | 0.056866 |
| | ≥60 | 15.5±4.3 | 14.0±4.2 | 0.102244 |
| NCEP/ATP III Scoring System | <20 | -1.1±8.2 | 0.1±7.3 | 0.379036 |
| | 20-29 | -3.1±6.3 | -3.7±6.0 | 0.125666 |
| | 30-39 | 3.4±9.3 | 2.5±8.3 | 0.051222 |
| | 40-49 | 8.7±6.4 | 8.2±6.4 | 0.051222 |
| | 50-59 | 12.4±3.8 | 11.7±3.7 | 0.049668 |
| | ≥60 | 14.8±2.7 | 13.7±2.7 | 0.010449 |

SD, Standard Deviation; CVD, Cardiovascular Disease; CHD, Coronary Heart Disease; NCEP/ATP III, National Cholesterol Education Program/Adult Treatment Panel III.

Improvements in heart health risk prevalence were observed among all age groups over the course of training (Figure 10-3). Changes in ACTI-MENU risk categories by age group were significant among the 30-39 and 50-59 year age groups. All age groups <50 years of age demonstrated increases in the prevalence of very low heart health risk after training, while groups ≥40 years demonstrated decreases in the prevalence of very high heart health risk.

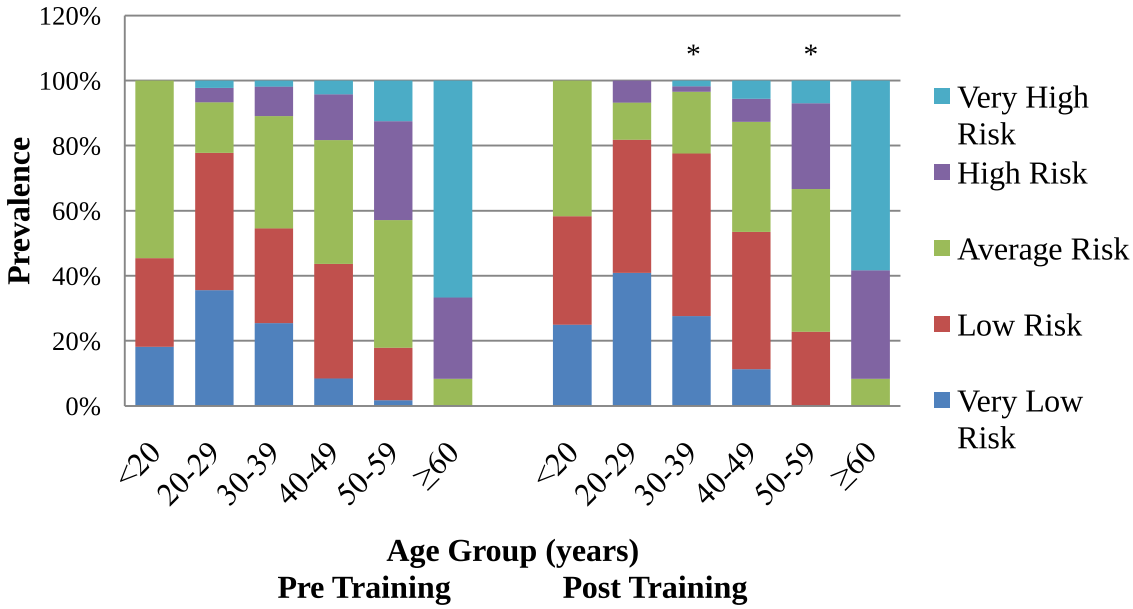


**Figure 10-3** The change in risk stratification of ACTI-MENU risk categories with training by age group. Asterisk (*) indicates significant changes with training, $p < 0.05$.

No significant changes in Framingham CHD risk score were observed over the training period for any age group. Rates of low, moderate and high risk status were nearly identical pre- and post-training for all age groups <60 years (Figure 10-4). The ≥60 year age group demonstrated increases in the prevalence of low and moderate risk status with decreases in high risk status, though these changes were not statistically significant.

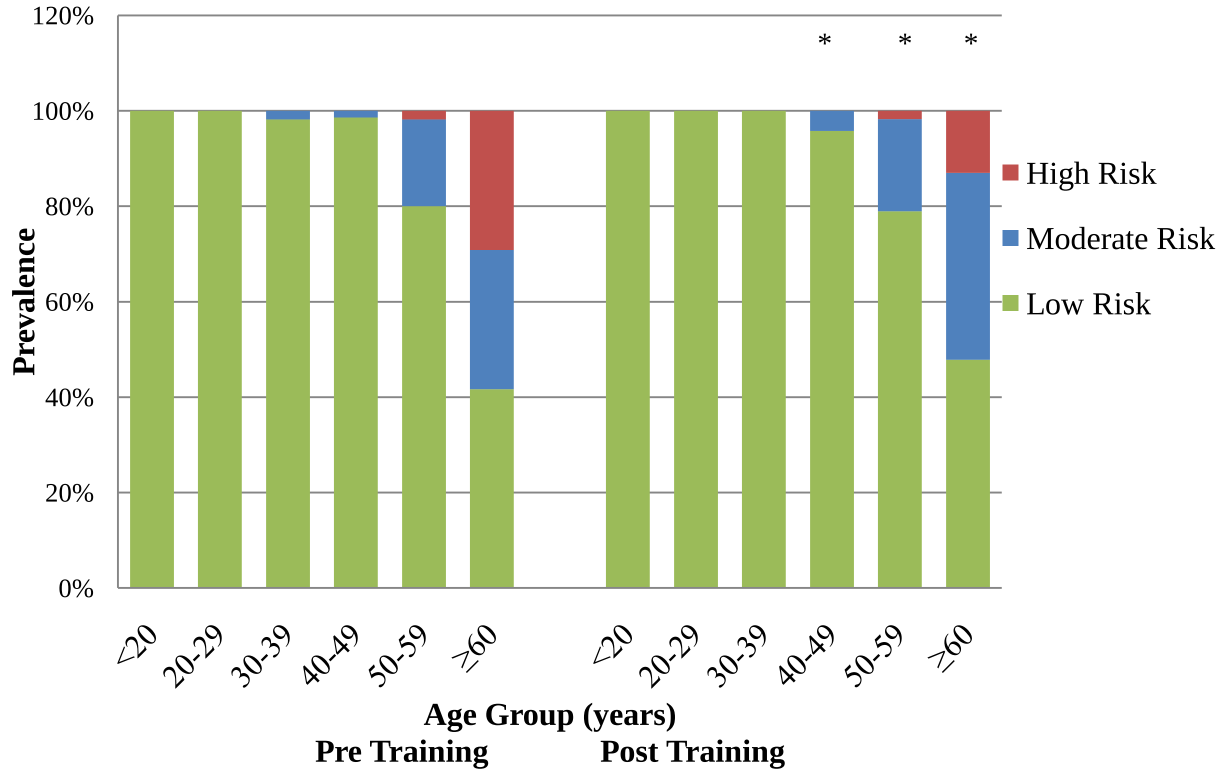


**Figure 10-4** The change in risk stratification of Framingham CHD risk categories with training by age group. Asterisk (*) indicates significant changes with training, $p < 0.05$.

No significant changes in Framingham CVD risk category were observed by age group. Age groups <40 years demonstrated 100% low risk status both pre- and post-training, as shown in Figure 10-5. All age groups ≥40 years demonstrated decreases in the prevalence of high risk status, though these changes were not statistically significant.

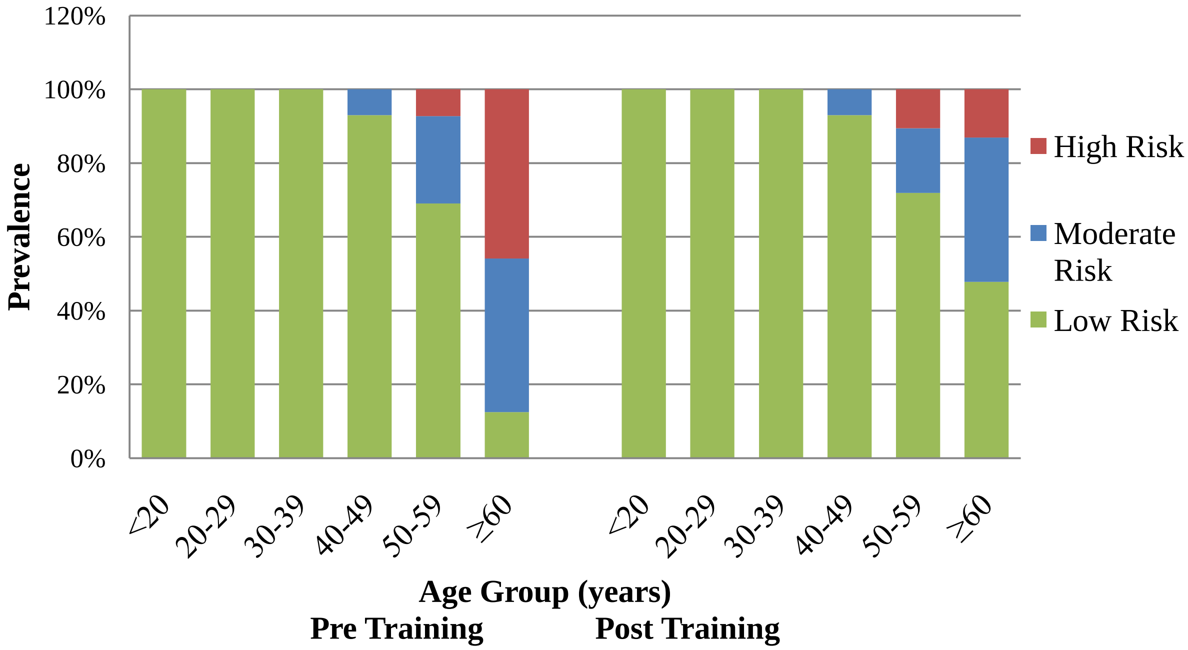


**Figure 10-5** The change in risk stratification of Framingham CVD risk categories with training by age group. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Over the training period, changes in NCEP/ATP III status were significant. As outlined on Figure 10-6, increases in the prevalence of low risk status and decreases in the prevalence of high risk status were observed for 20-49 and ≥60 year age groups, with significant increases among the ≥60 year age group. These changes observed among the 30-39 year age group were also nearly significant.

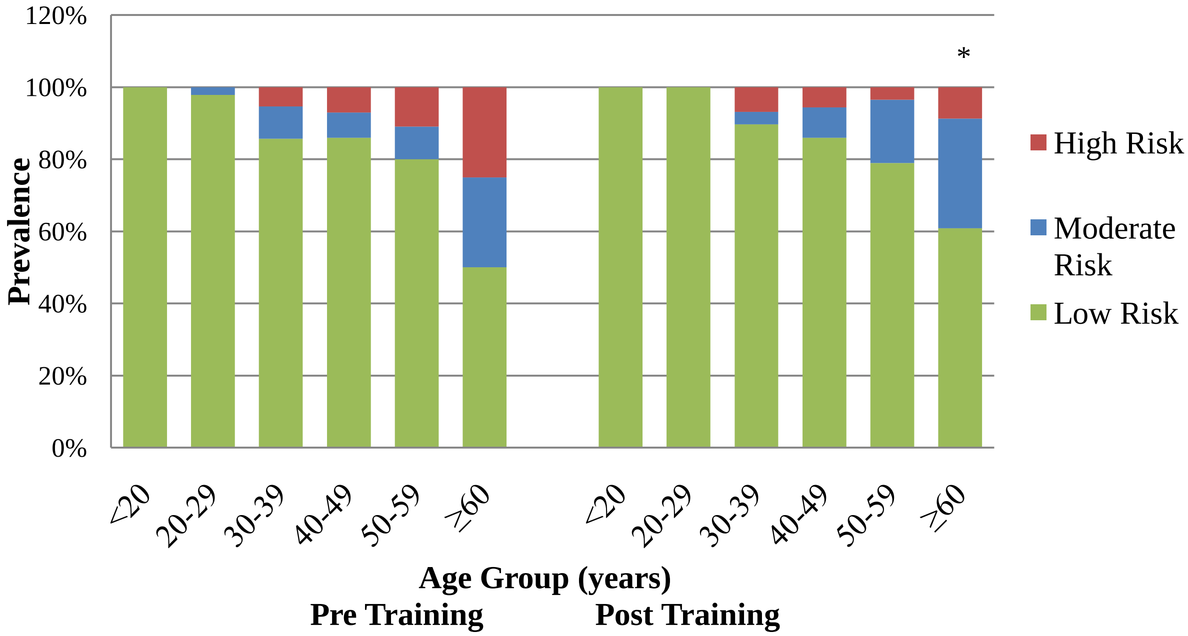


**Figure 10-6** The change in risk stratification of NCEP/ATP III risk categories with training by age group. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Individuals 20-59 years of age reported significant improvements in all physical activity measures, frequency, intensity and perception as determined using the healthy physical activity questionnaire (Table 10-8). No significant changes in reported physical activity were observed for participants <20 years of age or ≥60 years. However, the ≥60 year age group demonstrated near significant increases in their overall physical activity score.

**Table 10-8** The changes in physical activity scores by age group with training by age group (mean ± SD)

| | Age Group | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Frequency Score | <20 years | 3.15±1.34 | 3.85±1.14 | 0.069151 |
| | 20-29 years | 3.66±1.59 | 4.46±1.07 | 0.004011 |
| | 30-39 years | 3.47±1.41 | 4.49±0.88 | 0.000001 |
| | 40-49 years | 3.33±1.90 | 4.58±0.82 | 0.000001 |
| | 50-59 years | 3.39±1.77 | 4.33±1.20 | 0.000256 |
| | ≥60 years | 3.17±1.64 | 3.62±1.35 | 0.184515 |
| Intensity Score | <20 years | 2.31±0.48 | 1.77±0.83 | 0.027861 |
| | 20-29 years | 2.15±0.81 | 2.28±0.58 | 0.322658 |
| | 30-39 years | 1.90±0.84 | 2.15±0.81 | 0.083218 |
| | 40-49 years | 1.89±0.99 | 2.23±0.66 | 0.006470 |
| | 50-59 years | 1.75±1.05 | 2.11±0.79 | 0.013913 |
| | ≥60 years | 1.88±0.95 | 1.88±0.80 | 1.000000 |
| Perception Score | <20 years | 2.85±1.28 | 2.54±1.61 | 0.218758 |
| | 20-29 years | 1.89±1.55 | 2.56±1.33 | 0.000086 |
| | 30-39 years | 1.95±1.44 | 2.46±1.41 | 0.004407 |
| | 40-49 years | 1.68±1.63 | 2.34±1.34 | 0.000042 |
| | 50-59 years | 1.64±1.58 | 2.26±1.60 | 0.000057 |
| | ≥60 years | 2.21±1.74 | 2.71±1.55 | 0.155535 |
| Overall Score | <20 years | 8.31±2.18 | 8.15±1.99 | 0.721355 |
| | 20-29 years | 7.70±2.75 | 9.33±1.99 | 0.000248 |
| | 30-39 years | 7.32±2.56 | 9.10±1.91 | 0.000005 |
| | 40-49 years | 6.90±3.24 | 9.14±1.70 | 0.000000 |
| | 50-59 years | 6.79±3.00 | 8.70±2.19 | 0.000000 |
| | ≥60 years | 7.25±2.45 | 8.21±2.13 | 0.092911 |

SD, Standard Deviation; based on the Healthy Physical Activity Participation Questionnaire.

The proportion of participants meeting Canadian physical activity guidelines increased significantly over the training program among participants 20-59 years of age (Figure 10-7).

Post prevalence of active participants were not significantly different between age groups after adjusting for gender, time from pre- to post-screening and pre-intervention rates.

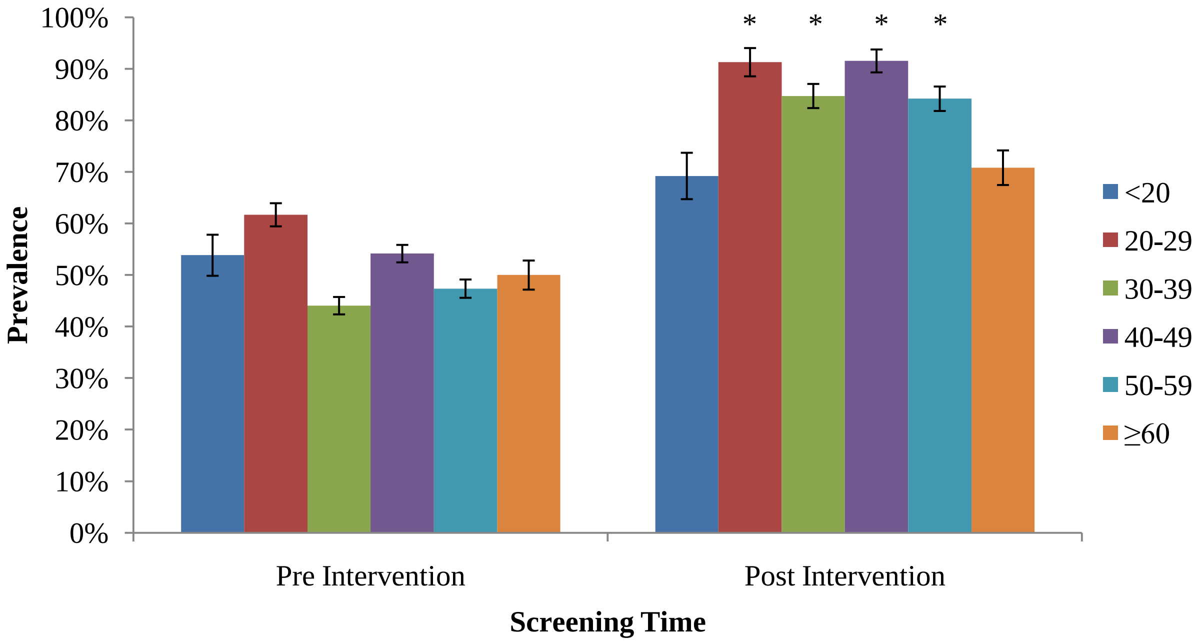


**Figure 10-7** The change in prevalence of participants meeting Canadian physical activity recommendations with training by age group. Asterisk (*) indicates significant changes with training, $p < 0.05$.

## 10.4 Discussion

In general, improvements in health measures, chronic condition rates, risk scores and physical activity were observed for all age groups. Improvements were observed among most health measures and chronic conditions rates. All age groups demonstrated improved risk scores over the course of the intervention.

Comparing the changes in health measures, chronic condition rates and risk scores observed between age groups, generally the older age groups experienced significantly greater improvements. Improvements in blood pressure, rates of high and elevated TC and rates of high and elevated blood sugar were observed to improve among older participants, but not in younger participants. After adjusting for pre-intervention scores, gender and time between pre- and post-screening, post-intervention risk scores were generally lower among the older age groups in comparison to younger age groups.

Published investigations to date report health and fitness improvements among older participants at similar levels to that of younger individuals (Kohrt, et al., 1991). Similar improvements in fitness have been observed for older (60s) compared to younger (20s) participants in response to training (Meredith, et al., 1989). Other investigations however, have reported greater improvements in maximal oxygen consumption with training among older participants (Stratton, et al., 1991). However, older adults have been found to require longer training times to improve HDL measures in comparison to younger individuals (King, Haskell, Young, Oka, & Stefanick, 1995). A training study in older and younger participants also found significant improvements in SBP, DBP, muscle glycogen and muscle oxidative capacity among older participants but not younger participants (Meredith, et al., 1989). Older participants of training programs have also been reported to experience improvements not experienced by younger participants, including improvements in plasminogen activators and plasminogen inhibitors (Stratton, et al., 1991).

Physical activity levels were observed to improve among all age groups. Prior to the intervention, low rates of active physical activity status were observed for all age groups. Significant improvements in active physical activity prevalence were observed for all 20-59 year age groups. The lack of statistical significance for improvements among the $<20$ and $\geq 60$ age groups may result from smaller sample sizes among these two groups.

A lack of statistical significance observed for many health measures and chronic condition rates likely results from small sample sizes among some age groups. While chronic condition rates were observed to decline by a large percentage, significance was not always indicated. These small sample sizes among some age groups may mask important improvements resulting from this intervention.

The Hearts inTraining program was successful for improving the health and physical activity of individuals of all ages. Improvements in health measures, chronic condition rates, physical activity levels and overall risk scores were observed among all age groups. While older individuals experienced greater improvements with training than younger individuals, all participants benefited from this program. The Hearts inTraining program was a successful intervention for Aboriginal adults of all ages.

## 10.5 Conclusion

Improvements in health status and risk for cardiovascular disease were observed among all age groups. Physical activity programs utilized in the Hearts inTraining program were appropriate for participants of all ages. Improvements with the physical activity program were not significantly different between age groups, indicating all age groups improved with training.

# 11. The Effectiveness of Community-Based Physical Activity for Improving Health Status of Aboriginal Canadians of Varying Cardiovascular Disease Risk

## 11.1 Introduction

Aboriginal individuals currently experience greater rates of mortality and morbidity in comparison to the Canadian general population (Anand, et al., 2001; Wilson & Rosenberg, 2002). Physical activity is known to improve health status and CVD risk (Warburton, et al.; Warburton, et al., 2007; Warburton, et al., 2006). Additionally, physical activity is recognized as a means of improving health and CVD risk among both healthy individuals and individuals with increased risk for morbidity and mortality (Shephard & Balady, 1999; Warburton, et al., 2006).

The objective of this chapter is to evaluate the changes in health status and physical activity with physical activity training by CVD risk classification. This chapter also evaluated any differences in the changes in health status and physical activity between CVD risk classifications over the Hearts inTraining program. It was hypothesized that participants with higher CVD risk would experience greater improvements in health status with training as compared to low risk individuals.

## 11.2 Methods

The Hearts inTraining physical activity program, and screening sessions were conducted as outlined in Chapter 2 Research Methods. With each CVD risk scoring system, participants were classified as high, moderate or low risk. Using the Framingham CHD and CVD risk system and the NCEP/ATP III risk system, high risk participants demonstrated pre-intervention CVD risk systems with a corresponding risk of >20%. Participants with a percent risk of 10-

20% were classified as having a moderate risk. The ACTI-MENU scoring classifications were defined according to the classifications specified with the scoring system (Gagnon, et al., 2007).

To evaluate the effectiveness of the physical activity program for individuals of varying CVD risk score, changes in health measure, CVD risk score and rates of chronic conditions were evaluated using t-tests of pre vs. post. Comparisons of the pre-intervention status of each program type were performed using one-way ANOVA analyses. In order to compare differences in success of the program for individuals with varying CVD risk, ANCOVA of health measures, CVD risk and chronic condition rates were performed for classified CVD risk, with adjustments for age, gender, time from pre- to post-screening and pre-screening measure.

### 11.3 Results

Participants determined to have high and moderate risk scores, through each of the four risk categories, were significantly older than low risk participants (Table 11-1) according to all risk scoring systems. The ACTI-MENU risk stratification also indicated significantly younger participants among the moderate risk group in comparison to the high risk group. The majority of participants using all four scoring systems were assessed low risk and fewest were assessed high risk. The proportion of male participants was observed to significantly increase with increasing risk category through the ACTI-MENU and NCEP/ATP III risk assessment systems. The low risk category of Framingham CHD and CVD risk scoring systems also reported significantly fewer male participants in comparison to the moderate and high risk categories.

**Table 11-1** The differences in health measures (mean ± SD) among risk scoring system by classification

| | Risk | N | Age (mean ± SD) | % male |
|---|---|---|---|---|
| ACTI-MENU | Very Low/Low† | 139 | 35.8±10.1 | 7.9% |
| | Moderate†‡ | 83 | 41.2±11.7 | 28.2% |
| | High/Very High‡ | 57 | 53.5±12.7 | 47.4% |
| Framingham CHD | Low | 236 | 39.7±12.1 | 16.5% |
| | Moderate‡ | 19 | 57.4±8.3 | 52.6% |
| | High‡ | 8 | 65.4±6.7 | 87.5% |
| Framingham CVD | Low | 220 | 38.4±11.4 | 14.5% |
| | Moderate‡ | 28 | 56.7±7.7 | 46.4% |
| | High‡ | 15 | 63.0±6.9 | 73.3% |
| NCEP/ATP III | Low | 221 | 39.8±12.5 | 14.9% |
| | Moderate‡ | 22 | 50.0±13.4 | 36.4% |
| | High‡ | 20 | 54.2±11.6 | 75.0% |

SD, Standard Deviation; NCEP/ATP III; National Cholesterol Education Program/Adult Treatment Panel III; ‡indicates significantly different age from low risk group pre-intervention after adjusting for gender and significantly different proportion of male participants after adjusting for age; †indicates significant difference in age from high risk group pre-intervention after adjusting for gender and significantly different proportion of male participants after adjusting for age.

Through stratification of participants with the ACTI-MENU scoring system, participants reporting high and moderate risk were observed to have significantly higher weight, BMI, WC and SBP in comparison to the low risk group pre-intervention (Table 11-2). The high risk group was also observed to have significantly poorer DBP, TC:HDL and glucose in comparison to the low risk group. Changes in health measures by risk classification were observed among all risk categories for WC, with no significant changes in weight, BMI, HDL or glucose for any classification. The low risk group demonstrated significant improvements in TC and TC:HDL, while no changes were observed among the other risk classifications. The moderate risk category participants were observed to have significant improvements in screened SBP and DBP, while the high risk group demonstrated significant improvements in screened SBP. Changes in health measures were not generally observed between risk categories as indicated by comparing post-intervention measures adjusted for age, gender, time from pre- to post-screening and pre-intervention measures. Significant differences in post-intervention measures after adjusting for pre-intervention measure, age, gender and time from pre- to post-screening were only observed for TC, where moderate risk participants had significantly higher values than low risk participants, TC:HDL, where high risk participants had significantly higher levels than the low risk and glucose, where high risk participants had significantly higher levels than both moderate and low risk individuals.

**Table 11-2** The changes in health measures (mean ± SD) with ACTI-MENU Risk

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Weight (kg) | Very Low/Low Risk | 77.7±18.3 | 76.8±17.8 | 0.256089 |
| | Moderate Risk‡ | 90.3±18.8 | 88.6±19.3 | 0.396810 |
| | High/Very High Risk‡ | 92.4±17.7 | 90.7±18.5 | 0.119625 |
| BMI ($kg \cdot m^{-2}$) | Very Low/Low Risk | 28.6±6.4 | 28.3±6.4 | 0.315377 |
| | Moderate Risk‡ | 33.2±6.4 | 32.6±6.9 | 0.331342 |
| | High/Very High Risk‡ | 33.6±6.0 | 33.0±6.5 | 0.146864 |
| Waist Circumference (cm) | Very Low/Low Risk | 93.6±15.3 | 91.1±15.4 | 0.000328 |
| | Moderate Risk‡ | 105.6±14.1 | 101.9±14.3 | 0.056498 |
| | High/Very High Risk‡ | 109.4±13.2 | 107.5±13.5 | 0.033376 |
| Systolic Blood Pressure (mmHg) | Very Low/Low Risk | 111.8±13.2 | 112.7±10.3 | 0.388137 |
| | Moderate Risk‡ | 120.0±13.1 | 118.0±11.2 | 0.025598 |
| | High/Very High Risk‡ | 130.7±18.6 | 126.1±15.3 | 0.058101 |

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Diastolic Blood Pressure (mmHg) | Very Low/Low Risk | 70.3±9.8 | 70.6±9.1 | 0.724031 |
| | Moderate Risk | 75.9±9.7 | 74.8±9.1 | 0.053647 |
| | High/Very High Risk‡ | 79.0±14.1 | 76.6±13.5 | 0.149284 |
| Total Cholesterol (mmol/L) | Very Low/Low Risk | 4.50±0.88 | 4.38±0.85 | 0.032584 |
| | Moderate Risk | 4.86±1.05 | 4.73±0.83 | 0.878369 |
| | High/Very High Risk | 5.13±1.20 | 4.90±1.04 | 0.153895 |
| HDL (mmol/L) | Very Low/Low Risk | 1.45±0.40 | 1.48±0.40 | 0.169372 |
| | Moderate Risk | 1.33±0.37 | 1.39±0.40 | 0.927159 |
| | High/Very High Risk | 1.17±0.38 | 1.20±0.49 | 0.571101 |
| TC:HDL Ratio | Very Low/Low Risk | 3.33±1.07 | 3.18±1.14 | 0.029672 |
| | Moderate Risk | 3.87±1.21 | 3.72±1.47 | 0.576079 |
| | High/Very High Risk‡ | 4.83±1.82 | 4.92±2.74 | 0.802234 |
| Glucose (mmol/L) | Very Low/Low Risk | 5.71±0.90 | 5.79±0.82 | 0.469955 |
| | Moderate Risk† | 5.76±0.93 | 6.24±2.39 | 0.237590 |
| | High/Very High Risk‡ | 8.44±5.39 | 8.48±4.96 | 0.960445 |

SD, Standard Deviation; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; ‡indicates significantly different from low risk group pre-intervention, after adjusting for age and gender; †indicates significant difference from high risk group pre-intervention, after adjusting for age and gender.

Risk stratification using the Framingham CHD scoring system produced significant differences pre-intervention among participants. In comparison to the low risk individuals, moderate risk individuals had significantly higher weight, BMI, WC, HDL and TC:HDL, after adjusting for age and gender. High risk individuals also demonstrated significantly higher values than low risk individuals for screened SBP, screened DBP, TC, HDL, TC:HDL and glucose pre-intervention after age and gender adjustment. As outlined on Table 11-3, over the intervention, few significant changes in health measures were observed, though improvements were observed for all risk categories at nearly every measure. The low risk individuals demonstrated significant improvements in WC and TC, and high risk individuals demonstrated significant improvements in HDL and TC:HDL. Differences in changes in health measures by risk classification were generally not observed. After adjusting for age, gender, pre-intervention measures and time from pre- to post-intervention screening, the post-intervention measures were only significantly different among the TC:HDL ratios, where moderate risk individuals demonstrated significantly higher post-intervention ratios than the low and high risk individuals.

**Table 11-3** The changes in health measures (mean ± SD) by Framingham CHD risk classification

| | Risk Level | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Weight (kg) | Low Risk | 82.4±19.2 | 82.2±19.1 | 0.893213 |
| | Moderate Risk† | 99.5±19.2 | 96.3±20.7 | 0.194726 |
| | High Risk | 90.2±14.1 | 88.8±15.0 | 0.148918 |
| BMI ($kg \cdot m^{-2}$) | Low Risk | 30.3±6.5 | 30.3±6.7 | 0.919335 |
| | Moderate Risk† | 35.7±7.4 | 34.6±8.1 | 0.181577 |
| | High Risk | 31.6±3.8 | 31.1±4.2 | 0.142465 |
| Waist Circumference (cm) | Low Risk | 98.4±15.7 | 96.2±15.6 | 0.000060 |
| | Moderate Risk† | 114.0±14.8 | 110.5±17.3 | 0.139979 |
| | High Risk | 110.7±10.0 | 109.2±12.8 | 0.369002 |
| Systolic Blood Pressure (mmHg) | Low Risk | 116.7±15.3 | 115.8±12.0 | 0.245933 |
| | Moderate Risk | 133.2±17.9 | 130.1±16.1 | 0.427952 |
| | High Risk† | 144.0±28.0 | 130.5±13.1 | 0.134902 |
| Diastolic Blood Pressure (mmHg) | Low Risk | 72.8±10.4 | 72.1±9.5 | 0.196341 |
| | Moderate Risk | 77.1±9.9 | 79.1±11.7 | 0.454865 |
| | High Risk† | 90.8±22.2 | 78.2±15.5 | 0.018642 |
| Total Cholesterol (mmol/L) | Low Risk | 4.73±0.98 | 4.63±0.95 | 0.079645 |
| | Moderate Risk | 5.13±1.39 | 5.06±1.17 | 0.624591 |
| | High Risk | 5.12±1.00 | 4.53±0.73 | 0.127063 |

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| HDL (mmol/L) | Low Risk | 1.42±0.40 | 1.44±0.41 | 0.461668 |
| | Moderate Risk† | 0.93±0.29 | 0.97±0.44 | 0.690431 |
| | High Risk† | 0.84±0.31 | 1.00±0.27 | 0.018642 |
| TC:HDL Ratio | Low Risk | 3.60±1.35 | 3.52±1.48 | 0.272228 |
| | Moderate Risk†‡ | 5.75±1.46 | 6.27±3.05 | 0.542172 |
| | High Risk† | 6.73±2.51 | 4.73±1.21 | 0.087719 |
| Glucose (mmol/L) | Low Risk | 6.06±2.32 | 6.26±2.51 | 0.237557 |
| | Moderate Risk | 6.85±3.10 | 7.84±3.07 | 0.077677 |
| | High Risk† | 12.7±6.94 | 7.26±3.48 | 0.125420 |

SD, Standard Deviation; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; †indicates significantly different from low risk group pre-intervention, after adjusting for age and gender; ‡indicates significant difference from high risk group pre-intervention, after adjusting for age and gender.

The Framingham CVD risk stratification produced three classifications of health risk, which demonstrated significant differences in several measures after adjusting for age and gender. In comparison to the high risk group, the low risk group demonstrated significantly lower screened SBP, screened DBP, HDL, TC:HDL and glucose. Moderate risk individuals also demonstrated significantly higher TC:HDL than the low risk group and significantly higher HDL from the high risk group. Over the course of the intervention, significant changes were observed with different change by different risk categories, as outlined on Table 11-4. The high risk participants demonstrated significant improvements in weight, BMI, screened SBP and screened DBP. Moderate risk participants demonstrated significant improvements in SBP with significantly worse glucose levels. The low risk participants demonstrated significant improvements in WC and TC:HDL with training. Post-intervention measures generally did not vary between risk categories after adjusting for age, gender, pre-intervention measure and time from pre- to post-intervention screening. After adjustments, the post-intervention TC levels were significantly lower among the high risk group in comparison to the low and moderate risk groups. Post-intervention TC:HDL ratios were significantly lower among low risk individuals in comparison to moderate risk individuals after adjustments.

**Table 11-4** The changes in health measures (mean ± SD) by Framingham CVD risk classification

| | Risk Level | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Weight (kg) | Low Risk | 82.2±19.6 | 82.1±19.4 | 0.884626 |
| | Moderate Risk | 90.4±18.2 | 88.8±19.4 | 0.336109 |
| | High Risk | 94.7±16.0 | 93.0±16.1 | 0.011074 |
| BMI (kg·m$^{-2}$) | Low Risk | 30.3±6.6 | 30.3±6.8 | 0.919691 |
| | Moderate Risk | 33.1±6.9 | 32.6±7.4 | 0.323951 |
| | High Risk | 32.7±5.4 | 32.1±5.2 | 0.013234 |
| Waist Circumference (cm) | Low Risk | 98.0±15.8 | 95.5±15.7 | 0.000026 |
| | Moderate Risk | 108.4±14.3 | 107.1±14.4 | 0.377294 |
| | High Risk | 111.8±13.2 | 110.8±14.3 | 0.319835 |
| Systolic Blood Pressure (mmHg) | Low Risk† | 114.8±13.1 | 115.1±11.6 | 0.815067 |
| | Moderate Risk | 135.7±19.0 | 127.5±14.9 | 0.026976 |
| | High Risk | 145.2±22.9 | 130.5±14.1 | 0.021543 |
| Diastolic Blood Pressure (mmHg) | Low Risk† | 72.3±9.9 | 71.8±9.3 | 0.445316 |
| | Moderate Risk | 79.1±12.1 | 77.3±13.0 | 0.462910 |
| | High Risk | 84.7±18.6 | 78.2±12.2 | 0.037315 |
| Total Cholesterol (mmol/L) | Low Risk | 4.69±0.94 | 4.60±0.92 | 0.102635 |
| | Moderate Risk | 5.21±1.27 | 5.19±1.20 | 0.884417 |
| | High Risk | 5.10±1.37 | 4.52±0.85 | 0.099167 |
| HDL (mmol/L) | Low Risk† | 1.40±0.40 | 1.43±0.40 | 0.244184 |
| | Moderate Risk† | 1.34±0.41 | 1.32±0.55 | 0.680452 |
| | High Risk | 0.86±0.36 | 0.91±0.26 | 0.616001 |

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| TC:HDL Ratio | Low Risk† | 3.64±1.42 | 3.48±1.28 | 0.037145 |
| | Moderate Risk† | 4.16±1.33 | 5.03±3.26 | 0.082343 |
| | High Risk | 6.45±2.04 | 5.44±2.41 | 0.265520 |
| Glucose (mmol/L) | Low Risk† | 6.04±2.39 | 6.21±2.57 | 0.340790 |
| | Moderate Risk†‡ | 6.26±1.92 | 7.21±2.34 | 0.029744 |
| | High Risk | 10.3±5.9 | 7.71±3.11 | 0.166278 |

SD, Standard Deviation; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; †indicates significantly different from high risk group pre-intervention, after adjusting for age and gender; ‡indicates significant difference from high risk group pre-intervention, after adjusting for age and gender.

Through stratification of participants using the NCEP/ATP III risk scoring system produced three categories of participants who demonstrated few significant pre-intervention differences (Table 11-5). Measures presenting significant pre-intervention differences include TC and TC:HDL where low risk individuals were significantly lower than high risk individuals. Through training, the changes in health measures were greatest among the high risk group, who demonstrated significant improvements in SBP, DBP and TC. The low and moderate risk groups demonstrated significant improvements in WC, while no other significant changes were observed. No groups were observed to have significantly higher post-intervention measures after adjusting for pre-intervention measure, age, gender and time from pre- to post-screening.

**Table 11-5** The changes in health measures (mean ± SD) by NCEP/ATP III risk classification

| | Risk Level | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Weight (kg) | Low Risk | 83.2±20.1 | 83.1±20.0 | 0.874412 |
| | Moderate Risk | 88.3±18.4 | 87.6±18.1 | 0.226868 |
| | High Risk | 85.9±12.9 | 83.3±12.8 | 0.252840 |
| BMI (kg·m$^{-2}$) | Low Risk | 30.6±6.7 | 30.6±7.0 | 0.939270 |
| | Moderate Risk | 33.2±6.7 | 33.0±6.7 | 0.250927 |
| | High Risk | 29.6±3.7 | 28.8±4.0 | 0.250872 |
| Waist Circumference (cm) | Low Risk | 98.7±16.3 | 96.2±15.6 | 0.000083 |
| | Moderate Risk | 108.4±16.2 | 106.9±15.0 | 0.078212 |
| | High Risk | 103.6±10.6 | 100.7±12.8 | 0.192458 |
| Systolic Blood Pressure (mmHg) | Low Risk | 116.8±16.0 | 116.0±12.5 | 0.394163 |
| | Moderate Risk | 128.4±15.7 | 124.9±14.2 | 0.167712 |
| | High Risk | 130.2±22.7 | 122.7±14.0 | 0.043806 |
| Diastolic Blood Pressure (mmHg) | Low Risk | 72.6±10.3 | 72.3±10.1 | 0.551727 |
| | Moderate Risk | 77.8±12.3 | 76.2±8.7 | 0.407706 |
| | High Risk | 81.5±16.8 | 75.0±10.9 | 0.012232 |
| Total Cholesterol (mmol/L) | Low Risk† | 4.72±1.00 | 4.66±0.98 | 0.271047 |
| | Moderate Risk | 4.77±0.86 | 4.56±0.80 | 0.140029 |
| | High Risk | 5.32±1.21 | 4.79±0.91 | 0.009092 |
| HDL (mmol/L) | Low Risk | 1.41±0.41 | 1.44±0.42 | 0.187336 |
| | Moderate Risk | 1.20±0.35 | 1.14±0.33 | 0.370124 |
| | High Risk | 1.06±0.40 | 1.11±0.45 | 0.636473 |
| TC:HDL Ratio | Low Risk† | 3.65±1.45 | 3.58±1.67 | 0.422629 |
| | Moderate Risk | 4.23±1.18 | 4.35±1.62 | 0.716703 |
| | High Risk | 5.64±2.26 | 5.06±2.43 | 0.410871 |

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Glucose (mmol/L) | Low Risk | 6.09±2.50 | 6.36±2.69 | 0.146786 |
| | Moderate Risk | 6.95±2.22 | 6.90±2.76 | 0.896269 |
| | High Risk | 7.88±5.20 | 6.41±1.19 | 0.263504 |

SD, Standard Deviation; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; †indicates significantly different from high risk group pre-intervention, after adjusting for age and gender.

Prior to the intervention, significant differences in chronic condition rates existed between ACTI-MENU risk categories, even after adjusting for age and gender, as indicated on Table 11-6. Low risk individuals presented with significantly lower rates of obesity, overweight or obesity and abdominal obesity at both cut-off levels in comparison to both moderate and high risk groups. Moderate risk individuals also presented with lower rates of obesity and normal cut-off abdominal obesity in comparison to high risk individuals. High risk individuals presented with significantly higher rates of elevated blood pressure from both low and moderate risk individuals and higher rates of high blood pressure in comparison to low risk individuals. Over the Hearts inTraining intervention, near significant improvements in obesity were observed for moderate and high risk individuals, with the low risk group experiencing near significant improvements in overweight or obesity rates. Abdominal obesity was observed to significantly improve at the normal cut-off level among low risk individuals and near significantly at the low cut-off level among moderate risk individuals. High risk individuals experienced significant improvements in rates of both high and elevated blood pressure, while moderate and low risk individuals experienced near significant improvements in rates of high blood pressure.

**Table 11-6** The changes in obesity and hypertension status (95% CI) by ACTI-MENU risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| Obesity | Very Low/Low Risk | 30.9 (23.3-38.6) | 30.9 (23.3-38.6) | 1.000000 |
| | Moderate Risk†‡ | 59.2 (47.7-70.6) | 66.2 (55.2-77.2) | 0.095815 |
| | High/Very High Risk† | 80.7 (70.5-90.9) | 69.6 (57.6-81.7) | 0.057034 |
| Overweight or Obese | Very Low/Low Risk | 64.7 (56.8-72.7) | 59.7 (51.6-67.9) | 0.051866 |
| | Moderate Risk† | 91.5 (85.1-98.0) | 94.4 (89.0-99.7) | 0.418087 |
| | High/Very High Risk† | 96.5 (91.7-100.0) | 92.9 (86.1-99.6) | 0.159161 |
| Abdominal Obese - Normal Cut-Off | Very Low/Low Risk | 51.5 (43.1-59.9) | 42.4 (34.2-50.7) | 0.004296 |
| | Moderate Risk†‡ | 72.9 (62.4-83.3) | 74.6 (64.5-84.8) | 0.657969 |
| | High/Very High Risk† | 91.2 (83.9-98.6) | 87.5 (78.8-96.2) | 0.321690 |
| Abdominal Obese - Low Cut-Off | Very Low/Low Risk | 79.4 (72.6-86.2) | 74.8 (67.6-82.0) | 0.226564 |
| | Moderate Risk† | 90.0 (83.0-97.0) | 80.3 (71.0-89.5) | 0.058219 |
| | High/Very High Risk† | 96.5 (91.7-100.0) | 94.6 (88.7-100.0) | 0.321690 |
| High Blood Pressure | Very Low/Low Risk | 7.9 (3.4-12.4) | 3.6 (0.5-6.7) | 0.057498 |
| | Moderate Risk | 23.9 (14.0-33.9) | 15.5 (7.1-23.9) | 0.083233 |
| | High/Very High Risk† | 50.9 (37.9-63.9) | 33.3 (21.1-45.6) | 0.011117 |
| Elevated Blood Pressure | Very Low/Low Risk | 15.8 (9.8-21.9) | 10.8 (5.6-15.9) | 0.127084 |
| | Moderate Risk‡ | 32.4 (21.5-43.3) | 26.8 (16.5-37.1) | 0.349401 |
| | High/Very High Risk† | 64.9 (52.5-77.3) | 49.1 (36.1-62.1) | 0.018752 |

CI, Confidence Interval; †indicates significantly different from low risk group pre-intervention, after adjusting for age and gender; ‡indicates significant difference from high risk group pre-intervention, after adjusting for age and gender.

Based on post-intervention rates adjusted for age, gender, time from pre- to post-intervention screening and pre-intervention rates, changes in chronic condition status were not uniform between ACTI-MENU risk groups. The low risk group experienced significantly lower post rates of overweight or obesity status in comparison to the high risk group. Low risk individuals also demonstrated significantly lower rates of abdominal obesity at the normal cut-off level in comparison to the high risk group.

Based on Framingham CHD risk categories, pre-intervention differences between the risk categories were not observed for obesity or abdominal obesity rates, after adjusting for age and gender. Rates of high blood pressure adjusted for age and gender were significantly higher among the high risk group in comparison to the low risk group. Changes in rates of obesity, outlined on Table 11-7, were not observed for any risk category. However, significant improvements in abdominal obesity rates were observed at both cut-off levels for the low risk group. Similarly, rates of high and elevated blood pressure were observed over the intervention among the low and moderate risk groups, with non-significant improvements among the high risk group. Over the course of the intervention, changes in obesity and blood pressure chronic condition rates were not significantly different between Framingham CHD risk categories, as indicated by post-intervention rates adjusted for pre-intervention rates, age, gender and time from pre- to post-screening.

**Table 11-7** The changes in obesity and hypertension status (95% CI) by Framingham CHD risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| Obesity | Low Risk | 4.2 (1.7-6.8) | 5.1 (2.3-7.9) | 0.532756 |
| | Moderate Risk | 73.7 (53.9-93.5) | 68.4 (47.5-89.3) | 0.666885 |
| | High Risk | 75.0 (45.0-100.0) | 62.5 (29.0-96.0) | 0.350617 |
| Overweight or Obese | Low Risk | 76.3 (70.8-81.7) | 74.5 (68.9-80.0) | 0.346865 |
| | Moderate Risk | 100.0 | 94.7 (84.7-100.0) | 0.330565 |
| | High Risk | 100.0 | 100.0 | 1.000000 |
| Abdominal Obese - Normal Cut-Off | Low Risk | 62.6 (56.4-68.7) | 58.3 (52.0-64.6) | 0.040969 |
| | Moderate Risk | 84.2 (67.8-100.0) | 84.2 (67.8-100.0) | 0.162829 |
| | High Risk | 87.5 (64.6-100.0) | 100.0 | 1.000000 |
| Abdominal Obese - Low Cut-Off | Low Risk | 84.3 (79.6-88.9) | 80.0 (74.9-85.1) | 0.040969 |
| | Moderate Risk | 100.0 | 94.7 (84.7-100.0) | 0.330565 |
| | High Risk | 100.0 | 100.0 | 1.000000 |
| High Blood Pressure | Low Risk | 17.0 (12.2-21.8) | 10.6 (6.7-14.6) | 0.005111 |
| | Moderate Risk | 52.6 (30.2-75.1) | 26.3 (6.5-46.1) | 0.020720 |
| | High Risk† | 75.0 (45.0-100.0) | 37.5 (4.0-71.0) | 0.079602 |
| Elevated Blood Pressure | Low Risk | 26.0 (20.4-31.6) | 20.0 (14.9-25.1) | 0.038733 |
| | Moderate Risk | 73.7 (53.9-93.5) | 47.4 (24.9-69.8) | 0.020720 |
| | High Risk | 75.0 (45.0-100.0) | 62.5 (29.0-96.0) | 0.598331 |

CI, Confidence Interval; †indicates significantly different from low risk group pre-intervention, after adjusting for age and gender.

Prior to the intervention, differences in rates of age and gender adjusted high and elevated blood pressures were observed between Framingham CVD risk classifications. The low risk group demonstrated significantly lower rates of both high and elevated blood pressure in comparison to the moderate and high risk groups. While no significant differences between risk classifications were observed in age and gender adjusted obesity and overweight or obesity rates, the moderate risk group was found to have significantly higher rates of abdominal obesity at the low cut-off level in comparison to the low risk group. Table 11-8 outlines the changes in obesity and blood pressure rates over the intervention. Obesity and overweight or obesity rates were not observed to change significantly among any of the three risk categories. Rates of abdominal obesity were observed to significantly improve only among the low risk group, with significant improvements at the normal cut-off and near significant improvements at the low cut-off. Significant improvements in rates of high blood pressure were observed among the moderate and high risk categories with significant improvements in elevated blood pressure among the moderate risk group. Changes in obesity and blood pressure chronic condition rates were not significantly different between Framingham CVD risk categories, as indicated by post-intervention rates adjusted for age, gender, time from pre- to post-screening and pre-intervention rates.

**Table 11-8** The changes in obesity and hypertension status (95% CI) by Framingham CVD risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| Obesity | Low Risk | 45.9 (39.3-52.5) | 47.5 (40.9-54.1) | 0.395000 |
| | Moderate Risk | 67.9 (50.6-85.2) | 64.3 (46.5-82.0) | 0.662916 |
| | High Risk | 66.7 (42.8-90.5) | 53.3 (28.1-78.6) | 0.164318 |
| Overweight or Obese | Low Risk | 75.5 (69.8-81.1) | 73.5 (67.7-79.4) | 0.346945 |
| | Moderate Risk | 92.9 (83.3-100.0) | 89.3 (77.8-100.0) | 0.326189 |
| | High Risk | 100.0 | 100.0 | 1.000000 |
| Abdominal Obese - Normal Cut-Off | Low Risk | 61.6 (55.2-68.1) | 56.6 (50.1-63.2) | 0.021463 |
| | Moderate Risk | 85.7 (72.8-98.7) | 85.7 (72.8-98.7) | 1.000000 |
| | High Risk | 86.7 (69.5-100.0) | 80.0 (59.8-100.0) | 0.334282 |
| Abdominal Obese - Low Cut-Off | Low Risk | 83.6 (78.7-88.5) | 67.1 (60.9-73.3) | 0.060410 |
| | Moderate Risk† | 96.4 (89.6-100.0) | 89.3 (77.8-100.0) | 0.161039 |
| | High Risk | 100.0 | 100.0 | 1.000000 |
| High Blood Pressure | Low Risk | 12.3 (7.9-16.6) | 8.7 (4.9-12.4) | 0.073568 |
| | Moderate Risk† | 60.7 (42.6-78.8) | 32.1 (14.8-49.4) | 0.008711 |
| | High Risk† | 80.0 (59.8-100.0) | 33.3 (9.5-57.2) | 0.003535 |
| Elevated Blood Pressure | Low Risk | 20.5 (15.1-25.8) | 16.9 (11.9-21.9) | 0.206630 |
| | Moderate Risk† | 78.6 (63.4-93.8) | 53.6 (35.1-72.0) | 0.016650 |
| | High Risk† | 93.3 (80.7-100.0) | 60.0 (35.2-84.8) | 0.164318 |

CI, Confidence Interval; †indicates significantly different from low risk group pre-intervention, after adjusting for age and gender.

Prior to the intervention, no significant differences in obesity or blood pressure chronic condition rates were observed between NCEP/ATP III risk categories after adjusting for age and gender. Significant changes in obesity and overweight or obesity status were not observed for any risk category over the course of the intervention (Table 11-9). Significant changes in abdominal obesity, at both cut-off levels, were only observed among the low risk group. All three risk classifications demonstrated significant improvements in rates of high blood pressure over the intervention, while the high risk group also demonstrated significant improvements in rates of elevated blood pressure.

**Table 11-9** The changes in obesity and hypertension status (95% CI) by NCEP/ATP III risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| Obesity | Low Risk | 48.0 (41.4-54.6) | 48.6 (42.0-55.2) | 0.684058 |
| | Moderate Risk | 68.2 (48.7-87.6) | 72.7 (54.1-91.3) | 0.328695 |
| | High Risk | 45.0 (23.2-66.8) | 35.0 (14.1-55.9) | 0.329877 |
| Overweight or Obese | Low Risk | 76.9 (71.4-82.5) | 75.0 (69.3-80.7) | 0.346940 |
| | Moderate Risk | 90.9 (78.9-100.0) | 90.9 (78.9-100.0) | 1.000000 |
| | High Risk | 85.0 (69.4-100.0) | 80.0 (62.5-97.5) | 0.329877 |
| Abdominal Obese - Normal Cut-Off | Low Risk | 63.2 (56.8-69.6) | 59.1 (52.6-65.6) | 0.060411 |
| | Moderate Risk | 86.4 (72.0-100.0) | 81.8 (65.7-97.9) | 0.328695 |
| | High Risk | 70.0 (49.9-90.1) | 60.0 (38.5-81.5) | 0.162550 |
| Abdominal Obese - Low Cut-Off | Low Risk | 85.0 (80.3-89.7) | 80.5 (75.2-85.7) | 0.032692 |
| | Moderate Risk | 86.4 (72.0-100.0) | 86.4 (72.0-100.0) | 1.000000 |
| | High Risk | 95.0 (85.4-100.0) | 90.0 (76.9-100.0) | 0.577032 |
| High Blood Pressure | Low Risk | 17.3 (12.3-22.3) | 10.9 (6.8-15.0) | 0.007858 |
| | Moderate Risk | 40.9 (20.4-61.5) | 22.7 (5.2-40.2) | 0.042463 |
| | High Risk | 45.0 (23.2-66.8) | 20.0 (2.5-37.5) | 0.020992 |
| Elevated Blood Pressure | Low Risk | 25.0 (19.3-30.7) | 20.0 (14.7-25.3) | 0.085827 |
| | Moderate Risk | 68.2 (48.7-87.6) | 54.5 (33.7-75.4) | 0.266436 |
| | High Risk | 55.0 (33.2-76.8) | 25.0 (6.0-44.0) | 0.010163 |

CI, Confidence Interval; NCEP/ATP III, National Cholesterol Education Program/Adult Treatment Panel III.

Over the Hearts inTraining intervention, changes in obesity and blood pressure chronic condition rates were not uniform between NCEP/ATP III risk categories. The high risk group demonstrated significantly lower post-intervention rates of elevated blood pressure after adjusting for pre-intervention rates, age, gender and time from pre- to post-testing. All other rates were not significantly different between groups.

Using the ACTI-MENU scoring classifications, no significant differences between risk categories were observed prior to the intervention among rates of high and elevated TC or low HDL, after adjusting for age and gender, as outlined on Table 11-10. The high risk group was observed to demonstrate significantly higher rates of age and gender adjusted high and elevated blood sugar in comparison to the other two groups. Over the course of the intervention, no significant changes in rates of these chronic conditions were observed for any risk category. Comparing the changes experienced by each risk category, by comparing post-intervention rates adjusted for pre-intervention rates, age, gender and time between testing, no significant differences in changes of low HDL, high blood sugar or high TC rates were observed between risk categories. Changes in rates of elevated blood sugar were significantly lower among high risk participants in comparison to low and moderate risk groups, while changes in rates of elevated TC were significantly greater among low risk groups in comparison to high and moderate risk groups.

**Table 11-10** The changes in cholesterol and blood sugar status (95% CI) by ACTI-MENU risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| High Total Cholesterol | Very Low/Low Risk | 5.1 (1.4-8.9) | 2.9 (0.1-5.7) | 0.180676 |
| | Moderate Risk | 43.5 (31.8-55.2) | 42.3 (30.8-53.7) | 1.000000 |
| | High/Very High Risk | 28.6 (16.7-40.4) | 24.6 (13.4-35.7) | 0.531931 |
| Elevated Total Cholesterol | Very Low/Low Risk | 19.9 (13.1-26.6) | 15.8 (9.8-21.9) | 0.158064 |
| | Moderate Risk | 17.4 (8.5-26.3) | 16.9 (8.2-25.6) | 1.000000 |
| | High/Very High Risk | 57.1 (44.2-70.1) | 54.4 (41.5-67.3) | 0.784307 |
| Low HDL | Very Low/Low Risk | 32.6 (24.7-40.5) | 33.1 (25.3-40.9) | 0.842340 |
| | Moderate Risk | 90.0 (83.0-97.0) | 83.1 (74.4-91.8) | 0.254274 |
| | High/Very High Risk | 46.4 (33.4-59.5) | 47.4 (34.4-60.3) | 1.000000 |
| High Blood Sugar | Very Low/Low Risk† | 0.0 | 0.0 | 1.000000 |
| | Moderate Risk† | 0.0 | 0.0 | 1.000000 |
| | High/Very High Risk | 32.7 (20.3-45.1) | 28.1 (16.4-39.7) | 0.419227 |
| Elevated Blood Sugar | Very Low/Low Risk† | 2.9 (0.1-5.8) | 2.2 (0.0-4.6) | 0.706936 |
| | Moderate Risk† | 2.9 (0.0-6.9) | 5.6 (0.3-11.0) | 0.418200 |
| | High/Very High Risk | 36.4 (23.7-49.1) | 38.6 (26.0-51.2) | 0.532020 |

CI, Confidence Interval; HDL, High Density Lipoprotein Cholesterol; †indicates significantly different from high risk group pre-intervention, after adjusting for age and gender.

Based on the Framingham CHD risk stratification, significant differences in rates of high and elevated TC, low HDL and elevated blood sugar were observed between the moderate and low risk groups, after adjusting for age and gender. Elevated blood sugar levels were also observed to be higher among the high risk group in comparison to the low risk group. Changes in high and elevated TC and blood sugar, as well as low HDL were not observed among any of the risk classifications over the course of the intervention, as outlined on Table 11-11.

Differences between Framingham CHD risk categories in post-intervention rates after adjustment for pre-intervention rates, age, gender and time between pre- and post-testing were only observed for changes in blood sugar levels. Changes in rates of high blood sugar were significantly greater among the low risk group in comparison to the moderate risk group, while changes in rates of elevated blood sugar were significantly greater among the high risk group in comparison to the low and moderate risk groups.

**Table 11-11** The changes in cholesterol and blood sugar status (95% CI) by Framingham CHD risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| High Total Cholesterol | Low Risk | 9.7 (6.0-13.5) | 8.5 (4.9-12.1) | 0.492465 |
| | Moderate Risk† | 52.6 (30.2-75.1) | 47.4 (24.9-69.8) | 0.577753 |
| | High Risk | 12.5 (0.0-35.4) | 12.5 (0.0-35.4) | 1.000000 |
| Elevated Total Cholesterol | Low Risk | 30.1 (24.2-35.9) | 28.5 (22.7-34.3) | 0.556464 |
| | Moderate Risk† | 73.7 (53.9-93.5) | 63.2 (41.5-84.8) | 0.330565 |
| | High Risk | 50.0 (15.4-84.6) | 37.5 (4.0-71.0) | 0.350617 |
| Low HDL | Low Risk | 35.6 (29.5-41.7) | 34.0 (28.0-40.1) | 0.669171 |
| | Moderate Risk† | 78.9 (60.6-97.3) | 68.4 (47.5-89.3) | 0.330565 |
| | High Risk | 75.0 (45.0-105.0) | 75.0 (45.0-105.0) | 1.000000 |
| High Blood Sugar | Low Risk | 3.0 (0.8-5.1) | 3.0 (0.8-5.2) | 1.000000 |
| | Moderate Risk | 36.8 (15.2-58.5) | 36.8 (15.2-58.5) | 1.000000 |
| | High Risk | 57.1 (20.5-93.8) | 25.0 (0.0-55.0) | 0.172308 |
| Elevated Blood Sugar | Low Risk | 5.1 (2.3-7.9) | 8.1 (4.6-11.5) | 0.089593 |
| | Moderate Risk† | 42.1 (19.9-64.3) | 52.6 (30.2-75.1) | 0.330565 |
| | High Risk† | 71.4 (38.0-104.9) | 25.0 (0.0-55.0) | 0.078141 |

CI, Confidence Interval; HDL, High Density Lipoprotein Cholesterol; †indicates significantly different from low risk group pre-intervention, after adjusting for age and gender.

Using risk stratification of the Framingham CVD scoring system, significant differences in age and gender adjusted rates of high TC, low HDL, high blood sugar and elevated blood sugar were observed between the low and high risk groups prior to the intervention (Table 11-12). Rates of elevated blood sugar were also significantly lower among the moderate risk group in comparison to the high risk group. Over the course of the intervention, no significant changes in any of the cholesterol or blood sugar chronic conditions were observed for any of the risk categories. Through comparisons of post-intervention rates adjusted for pre-intervention rates, age, gender and time between pre- and post-testing, changes in these rates between Framingham CVD risk categories were evaluated. The only difference in improvements of these chronic condition rates between risk categories was observed among the changes in low HDL levels, where the low risk group experienced significantly greater improvements as compared to the high risk group.

**Table 11-12** The changes in cholesterol and blood sugar status (95% CI) by Framingham CVD risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| High Total Cholesterol | Low Risk | 9.1 (5.3-12.9) | 7.3 (3.9-10.8) | 0.346945 |
| | Moderate Risk | 25.0 (9.0-41.0) | 28.6 (11.8-45.3) | 0.573155 |
| | High Risk† | 46.7 (21.4-71.9) | 40.0 (15.2-64.8) | 0.581627 |
| Elevated Total Cholesterol | Low Risk | 29.1 (23.1-35.1) | 26.9 (21.1-32.8) | 0.447025 |
| | Moderate Risk | 53.6 (35.1-72.0) | 53.6 (35.1-72.0) | 1.000000 |
| | High Risk | 66.7 (42.8-90.5) | 53.3 (28.1-78.6) | 0.164318 |
| Low HDL | Low Risk | 38.2 (31.8-44.6) | 35.2 (28.8-41.5) | 0.387700 |
| | Moderate Risk | 32.1 (14.8-49.4) | 35.7 (18.0-53.5) | 0.573155 |
| | High Risk† | 80.0 (59.8-100.2) | 80.0 (59.8-100.2) | 1.000000 |
| High Blood Sugar | Low Risk | 2.7 (0.6-4.9) | 2.7 (0.6-4.9) | 1.000000 |
| | Moderate Risk | 17.9 (3.7-32.0) | 17.9 (3.7-32.0) | 1.000000 |
| | High Risk† | 50.0 (23.8-76.2) | 33.3 (9.5-57.2) | 0.164823 |
| Elevated Blood Sugar | Low Risk | 4.5 (1.8-7.3) | 7.3 (3.8-10.7) | 0.108980 |
| | Moderate Risk‡ | 21.4 (6.2-36.6) | 28.6 (11.8-45.3) | 0.326189 |
| | High Risk† | 64.3 (39.2-89.4) | 46.7 (21.4-71.9) | 0.434614 |

CI, Confidence Interval; HDL, High Density Lipoprotein Cholesterol; †indicates significantly different from low risk group pre-intervention, after adjusting for age and gender; ‡indicates significant difference from high risk group pre-intervention, after adjusting for age and gender.

Among the NCEP/ATP III risk categories, no significant differences in blood sugar or cholesterol chronic condition rates were observed prior to the intervention, after adjusting for age and gender. Changes in high and elevated TC, low HDL and high blood sugar did not change significantly for any risk category over the training period (Table 11-13). Elevated blood sugar rates were observed to increase near significantly among the low risk group. Changes in these chronic condition rates between NCEP/ATP III risk categories were evaluated by comparing post-intervention rates adjusted for pre-intervention rates, age, gender and time from pre- to post-testing. Among all these chronic conditions, no significant differences between risk categories were observed over the Hearts inTraining program.

**Table 11-13** The changes in cholesterol and blood sugar status (95% CI) by NCEP/ATP III risk classification

| | Risk Category | Pre-Intervention Prevalence (%) | Post-Intervention Prevalence (%) | *P*-value |
|---|---|---|---|---|
| High Total Cholesterol | Low Risk | 11.3 (7.1-15.5) | 10.5 (6.4-14.5) | 0.638416 |
| | Moderate Risk | 18.2 (2.1-34.3) | 18.2 (2.1-34.3) | 1.000000 |
| | High Risk | 25.0 (6.0-44.0) | 15.0 (0.0-30.6) | 0.329877 |
| Elevated Total Cholesterol | Low Risk | 31.7 (25.5-37.8) | 29.5 (23.5-35.6) | 0.457311 |
| | Moderate Risk | 40.9 (20.4-61.5) | 36.4 (16.3-56.5) | 0.575793 |
| | High Risk | 50.0 (28.1-71.9) | 45.0 (23.2-66.8) | 0.577032 |
| Low HDL | Low Risk | 36.2 (29.9-42.5) | 33.2 (27.0-39.4) | 0.377551 |
| | Moderate Risk | 54.5 (33.7-75.4) | 59.1 (38.5-79.6) | 0.665194 |
| | High Risk | 68.4 (47.5-89.3) | 65.0 (44.1-85.9) | 1.000000 |
| High Blood Sugar | Low Risk | 5.0 (2.1-7.8) | 5.0 (2.1-7.9) | 1.000000 |
| | Moderate Risk | 13.6 (0.0-28.0) | 13.6 (0.0-28.0) | 1.000000 |
| | High Risk | 21.1 (2.7-39.4) | 10.0 (0.0-23.1) | 0.162829 |
| Elevated Blood Sugar | Low Risk | 6.8 (3.5-10.1) | 10.0 (6.0-14.0) | 0.070612 |
| | Moderate Risk | 27.3 (8.7-45.9) | 22.7 (5.2-40.2) | 0.665194 |
| | High Risk | 21.1 (2.7-39.4) | 20.0 (2.5-37.5) | 1.000000 |

CI, Confidence Interval; NCEP/ATP III, National Cholesterol Education/Adult Treatment Panel III; HDL, High Density Lipoprotein Cholesterol.

Changes in physical activity status by ACTI-MENU risk classification are outlined on Figure 11-1. Prior to the intervention, no significant differences in the proportion of participants who meet Canadian physical activity guidelines were observed between risk classifications, after adjusting for age and gender.  Significant increases in proportions of participants meeting physical activity guidelines were observed for all three risk classifications.

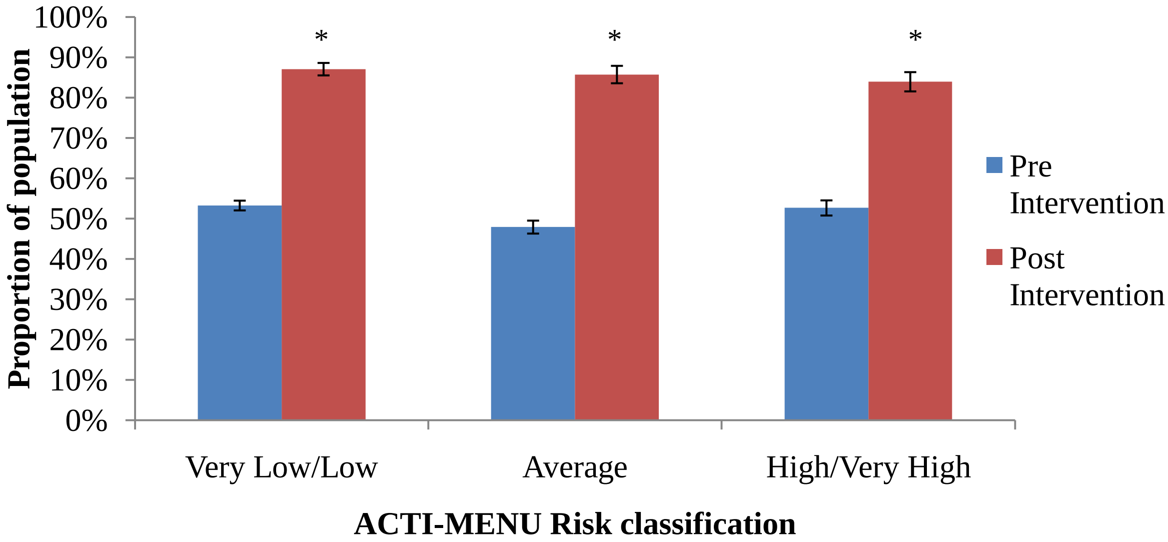


**Figure 11-1** The change in proportion of participants meeting Canadian physical activity guidelines over the intervention, by ACTI-MENU risk classification. Asterisk (*) indicates significant change from pre- to post-intervention.

Participants of the three Framingham CHD risk classifications reported no significant differences in proportions of participants meeting physical activity guidelines prior to the intervention after adjusting for age and gender.  Changes in physical activity status over the intervention are outlined on Figure 11-2.  Both the low and moderate risk groups reported significant increases in proportion of participants achieving Canadian physical activity guidelines.

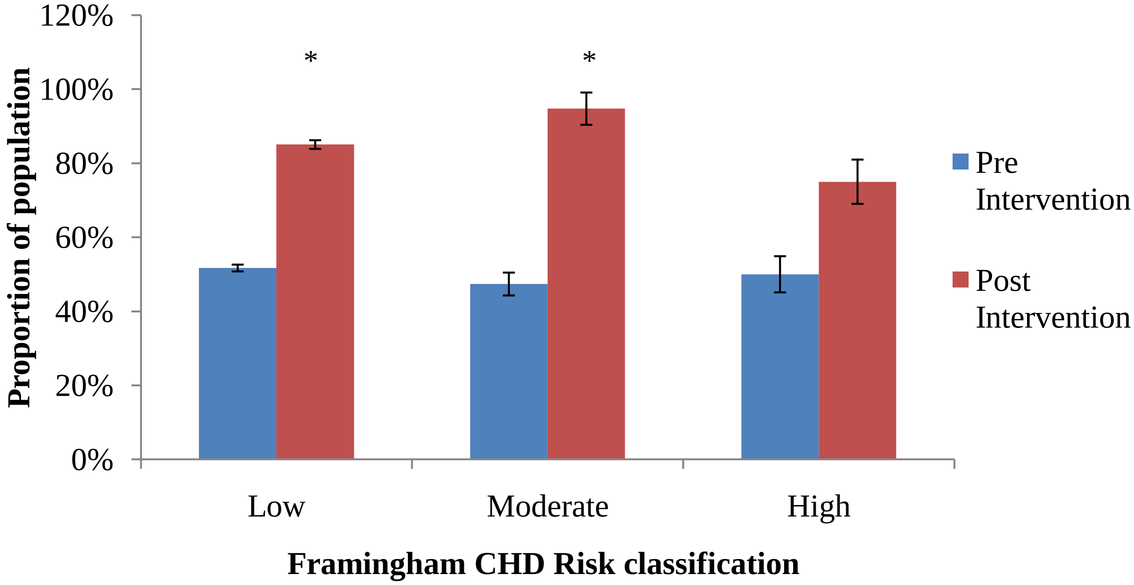


**Figure 11-2** The change in proportion of participants meeting Canadian physical activity guidelines over the intervention, by Framingham CHD risk classification. Asterisk (*) indicates significant change from pre- to post-intervention.

Changes in physical activity status over the course of the intervention among the three Framingham CVD risk classifications are described on Figure 11-3. Prior to the intervention, after adjusting for age and gender, no significant differences in physical activity status were observed between the three classifications. Over the course of the intervention, significant increases in proportion of participants achieving Canadian physical activity guidelines were observed for all three risk classifications.

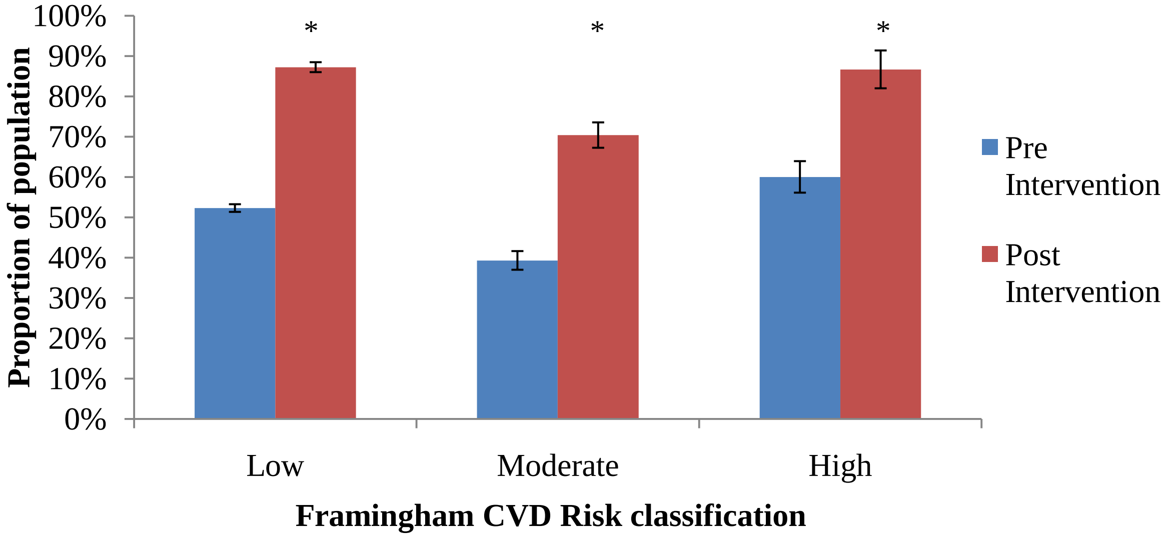


**Figure 11-3** The change in proportion of participants meeting Canadian physical activity guidelines over the intervention, by Framingham CVD risk classification. Asterisk (*) indicates significant change from pre- to post-intervention.

Prior to the intervention, significant differences in physical activity status were observed among the three risk classifications of the NCEP/ATP III risk scoring system, after adjusting for age and gender. A significantly greater proportion of participants classified as having a high risk for CHD reported meeting physical activity guidelines in comparison to the moderate risk participants. Changes in physical activity status by risk classification are outlined on Figure 11-4. Both the low and moderate risk groups reported significant increases in the proportion of participants achieving physical activity recommendations over the intervention.

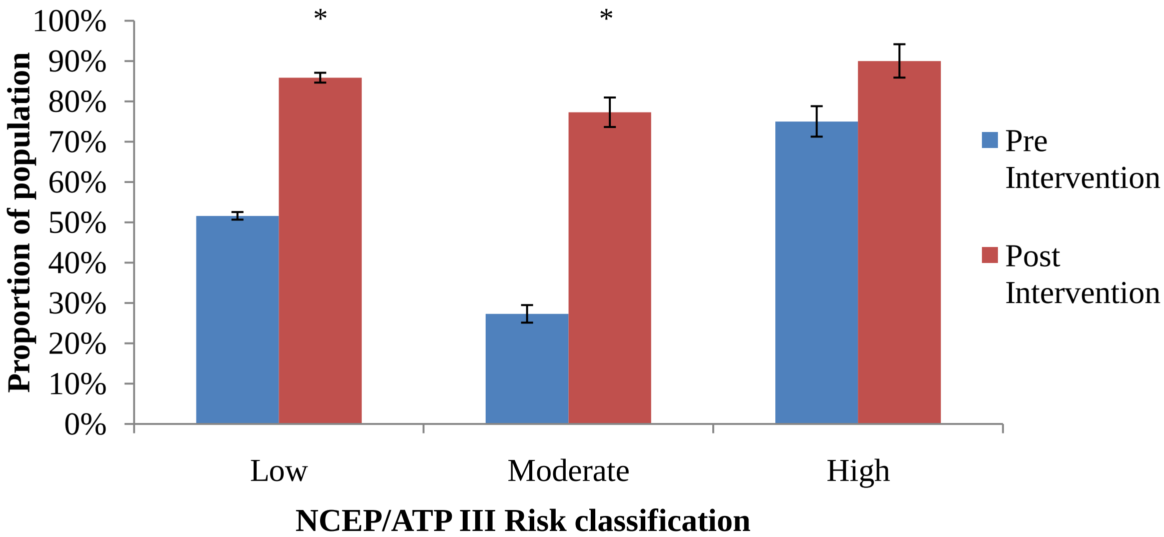


**Figure 11-4** The change in proportion of participants meeting Canadian physical activity guidelines over the intervention, by NCEP/ATP III risk classification. Asterisk (*) indicates significant change from pre- to post-intervention.

## 11.4 Discussion

Over the duration of the Hearts inTraining program, improvements in health status were observed. Using either of the four risk scoring systems, improvements were observed for high risk individuals over most health measures. The low risk individuals demonstration of improvement in health measures was more variable, with any of the risk scoring systems. Rates of most health status classifications were observed to improve with training among all three risk categories of each of the four scoring systems. Physical activity was reported to improve among all three risk categories of all four scoring systems.

Prior to the intervention, individuals defined as being high risk, through any of the four scoring systems, were recorded as having significantly poorer health profiles and significantly greater rates of poorer health status. This decreased health profile was expected as these health measures were included in the determination of high, moderate and low risk categories. The greater degree of improvements in health risk factors and chronic condition status were observed among the high risk individuals, as identified through any of the four risk scoring systems. These increased improvements among high risk individuals were expected as individuals with high risk have further improvements required to reach a healthy level. While individuals with low risk may demonstrate lower health measures closer to healthy levels, they require less improvement to reach a healthy level. While greater absolute measured improvements were observed among those at high risk, as determined through any of the scoring systems, statistical significance was often not observed. In general, high risk individuals experienced non-significant improvements in all risk factors and chronic condition rates. This lack of statistical significance is likely caused by low sample sizes of high risk participants and the inter-individual variability in the measures.

When comparing the effectiveness of the Hearts inTraining program across risk categories, no significant differences were generally observed. Physical activity is known to improve health and risk factors for both healthy individuals and individuals at increased risk for chronic conditions and mortality (Shephard & Balady, 1999; Warburton, et al., 2006). However, the differential effects of exercise training between healthy and increased risk individuals are unknown. Using any of the four risk classifications, significant differences in post-training measures adjusted for age, gender, time between pre- and post-screening and pre-intervention measures were not generally determined.

Physical activity levels of high, low and moderate risk individuals were generally similar prior to the intervention. With the exception of the NCEP/ATP III scoring system, no significant differences in proportion of the population meeting Canadian physical activity guidelines were observed pre-intervention. Differences in NCEP/ATP III pre-intervention physical activity levels reported high risk individuals as being more physically active than low and moderate risk individuals. This experience highlights the lack of physical activity behaviour incorporated into the NCEP/ATP III scoring system, where higher physical activity would be associated with lower risks. Over the intervention period, significant improvements in physical activity behaviour were reported for low and moderate risk individuals of all four scoring systems. Significant improvements were observed for high risk individuals through the Framingham CVD and ACTI-MENU systems, though improvements were observed with the other two systems as well.

### 11.5 Conclusion

The similarity in improvements for all three risk categories experienced through all four scoring systems indicates the Hearts inTraining program was effective for individuals of all risk categories. High risk individuals experienced greater absolute improvement in risk measures though these individuals experienced greater risk levels for these health measures prior to the intervention. Physical activity is known to improve health measures and reduce risk of chronic condition and death for both high and low risk individuals (Shephard & Balady, 1999; D. E. Warburton, et al., 2006). The Hearts inTraining program appears to be equally effective for individuals of high and low risk for CVD. As such, this program should be implemented in all communities as an effective approach to improving health of the community as a whole.

# 12. The Effectiveness of Self-Selected Physical Activity Programs in Aboriginal Canadians

## 12.1 Introduction

Exercise is associated with improved health status and reduced risk of chronic conditions (Warburton, et al.; Warburton, et al., 2007; Warburton, et al., 2006). Physical activity programs such as walking and running programs have previously been associated with improvements in health status and physical fitness (Murphy, et al., 2002; Rippe, et al., 1988). Walking programs are also recognized as a safe from of exercise for people with chronic conditions and other high risk individuals (Rippe, et al., 1988). Sedentary individuals are known to appropriately self-select physical activity programs of appropriate intensity to their physiological level (Lind, Joens-Matre, & Ekkekakis, 2005). Exercise of increased intensity is required for increased health benefits, though individuals who are extremely deconditioned experience health benefits at low levels of physical activity (Warburton, et al., 2006).

The objective of this chapter was to evaluate the changes in health status, CVD risk and physical activity with the Hearts inTraining program by physical activity program. This chapter also evaluated any differences in the improvements experienced between the three physical activity programs. It was hypothesized that individuals completing the Run10KFaster and LTR10K programs would experience greater improvements over the training program as compared to individuals in the Walk10K program.

## 12.2 Methods

Screening sessions and training programs were conducted as outlined in Research Methods Chapter 2. ANCOVA analysis was used to compare differences in health measures between groups where health measures were adjusted for differences in age and gender. To compare changes in health measures from pre- to post-intervention by training program, t-tests of pre vs. post measures were conducted. Changes in CVD risk scores by program were assessed using t-tests comparing pre and post risk scores. Similarly, t-tests were used to compare changes in chronic condition status over the course of the training program for each of the three programs. In order to compare the effectiveness of each program for improving health measures, ANCOVA analyses were conducted to adjust for differences in age, gender, time from pre- to post-screening and pre-screening measure. Each program was also compared for reductions in chronic condition status using ANCOVA adjusted for age, gender, time from pre- to post-screening and pre-screening chronic condition rates.

## 12.3 Results

Participants self-selecting the Walk10K group (n = 153, age = 45.7 ± 13.4) were significantly older than participants selecting the LTR10K (n = 88, age = 36.1 ± 11.3) and Run10KFaster (n = 27, age = 35.8 ± 10.5) groups. Even after adjusting for differences in age and gender, the Walk10K participants had significantly greater weight, BMI and WC from the other two groups. After adjusting for age and gender, the Run10KFaster group had significantly higher HDL prior to the intervention than the walk group. Prior to the Hearts inTraining intervention, the Walk10K group experienced significantly higher rates of obesity and abdominal obesity at the low cut-off in comparison to the Run10KFaster group. The Run10KFaster group experienced significantly lower rates of obesity or overweight status from the other two groups prior to the intervention. Rates of high and elevated blood pressure were not significantly different between groups prior to the intervention. Prior to the intervention, the rates of high and elevated blood sugar and TC were not significantly different between groups. After adjusting for age and gender, the Run10KFaster group had significantly lower rates of low HDL in comparison to the Walk10K group. Prior to the intervention, the Run10KFaster group demonstrated significantly lower ACTI-MENU and Framingham CVD risk scores than the other two groups, after adjusting for age and gender. The Run10KFaster group also demonstrated lower Framingham CHD and NCEP/ATP III risk scores, though program differences in these risk scores were not statistically significant. Prior to the intervention, no significant differences in physical activity frequency were observed between groups after adjusting for age and gender. The Walk10K participants demonstrated significantly lower physical activity intensity and overall physical activity scores prior to the Hearts inTraining program after adjusting for age and gender. Participants of the Run10KFaster group reported significantly higher perceived physical activity scores than the other two groups prior to the intervention, even after adjusting for age and gender. Significant differences were also observed between the Walk10K and Run10KFaster prevalence of participants meeting Canadian physical activity recommendations prior to the intervention.

Significant improvements in health measures were observed over the intervention for the Walk10K and LTR10K groups (Table 12-2). Neither weight nor BMI were observed to change over the training time. Both the Walk10K and LTR10K programs demonstrated significant reductions in WC with training, while the Run10KFaster program experienced non-significant improvements. The Walk10K program demonstrated significant improvements in screened SBP, while no changes were observed among the Run10KFaster group and non-significant increases were observed for the LTR10K group. Screened diastolic blood pressures were observed to decline non-significantly among the Walk10K and LTR10K groups while DBP of the Run10KFaster group did not change. Total cholesterol declined in all three groups with training, though the changes were only statistically significant among the Walk10K group. Similarly, HDL and TC:HDL improved for all three groups though these changes were not significant. Changes in random blood glucose levels for Walk10K and LTR10K groups were not significant. The Run10KFaster group demonstrated significant increases in random blood glucose from pre- to post-screening, though these changes are still below elevated levels.

**Table 12-1** The changes in health measures (mean ± SD) with self selected training program intensity and volume

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Weight (kg) | Walk10K | 88.5±21.2 | 87.3±21.1 | 0.202417 |
| | LTR10K† | 77.7±4.1 | 78.1±14.8 | 0.684233 |
| | Run10KFaster† | 75.8±16.8 | 76.0±16.7 | 0.919193 |
| BMI ($kg \cdot m^{-2}$) | Walk10K | 32.7±7.1 | 32.4±7.4 | 0.280653 |
| | LTR10K† | 28.7±4.8 | 28.9±5.4 | 0.627371 |
| | Run10KFaster† | 26.2±4.4 | 26.3±4.7 | 0.855190 |
| Waist Circumference (cm) | Walk10K | 104.8±15.8 | 102.4±16.1 | 0.002641 |
| | LTR10K† | 94.8±13.2 | 92.1±12.1 | 0.000041 |
| | Run10KFaster† | 89.0±13.1 | 87.2±14.4 | 0.327694 |
| Systolic Blood Pressure (mmHg) | Walk10K | 123.8±18.1 | 119.7±13.5 | 0.000584 |
| | LTR10K | 113.9±14.6 | 115.3±12.2 | 0.269722 |
| | Run10KFaster | 111.1±11.8 | 110.9±12.1 | 0.941985 |
| Diastolic Blood Pressure (mmHg) | Walk10K | 75.1±11.5 | 74.0±10.8 | 0.170110 |
| | LTR10K | 73.5±11.2 | 72.1±9.9 | 0.145037 |
| | Run10KFaster | 69.4±9.9 | 70.1±9.6 | 0.711527 |
| Total Cholesterol (mmol/L) | Walk10K | 4.81±1.08 | 4.65±1.02 | 0.064773 |
| | LTR10K | 4.80±0.97 | 4.71±0.91 | 0.267565 |
| | Run10KFaster | 4.67±0.97 | 4.59±0.87 | 0.567794 |

| | Program | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| HDL (mmol/L) | Walk10K | 1.30±0.40 | 1.32±0.42 | 0.519524 |
| | LTR10K | 1.39±0.38 | 1.44±0.40 | 0.212100 |
| | Run10KFaster† | 1.62±0.52 | 1.63±0.51 | 0.795871 |
| TC:HDL Ratio | Walk10K | 4.10±1.71 | 4.01±2.08 | 0.763412 |
| | LTR10K | 3.71±1.36 | 3.49±1.10 | 0.078266 |
| | Run10KFaster | 3.24±1.62 | 3.11±1.40 | 0.203537 |
| Glucose (mmol/L) | Walk10K | 6.68±3.16 | 6.78±3.21 | 0.671707 |
| | LTR10K | 6.03±2.52 | 5.87±1.32 | 0.565646 |
| | Run10KFaster | 5.33±0.79 | 5.98±0.98 | 0.014419 |

SD, Standard Deviation; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; †indicates significant differences from the Walk10K group before intervention, after adjusting for age and gender.

Over the course of the intervention, the prevalence of obesity did not significantly change in any of the three intervention programs (Table 12-2). The prevalence of overweight or obese status decreased among the Walk10K and LTR10K programs, with near significant decreases for Walk10K participants. The prevalence of abdominal obesity at both the normal and low cut-off was observed to decline with all three intervention programs, though LTR10K and Run10KFaster program changes were not significant and Walk10K program changes were near statistically significant. Declines in the rates of high and elevated blood pressure were observed for all three intervention programs, with declines as much as 10%. The improvements in rates of high and elevated blood pressure were significant among the Walk10K and LTR10K programs.

**Table 12-2** The changes in prevalence (95% CI) of obesity and hypertension among British Columbian Aboriginal populations with training by intervention program

| Chronic Condition | | Pre-Intervention (%) | Post-Intervention (%) | *P*-value |
|---|---|---|---|---|
| Obesity | Walk10K | 62.1 (54.4-69.8) | 59.5 (51.7-67.3) | 0.514480 |
| | LTR10K | 38.6 (28.5-48.8) | 39.8 (29.5-50.0) | 0.707746 |
| | Run10KFaster† | 14.8 (1.4-28.2) | 18.5 (3.9-33.2) | 0.573512 |
| Overweight or Obesity | Walk10K‡ | 85.6 (80.0-91.2) | 81.0 (74.8-87.3) | 0.057523 |
| | LTR10K‡ | 78.4 (69.8-87.0) | 75.0 (66.0-84.0) | 0.259176 |
| | Run10KFaster | 40.7 (22.2-59.3) | 48.1 (29.3-67.0) | 0.326527 |
| Abdominal Obesity Normal Cut-Off | Walk10K | 77.1 (70.4-83.8) | 72.6 (65.5-79.6) | 0.051889 |
| | LTR10K | 52.3 (41.8-62.7) | 50.0 (39.6-60.4) | 0.320116 |
| | Run10KFaster | 40.7 (22.2-59.3) | 29.6 (12.4-46.9) | 0.184643 |
| Abdominal Obesity Low Cut-Off | Walk10K | 90.2 (85.5-94.9) | 85.6 (80.0-91.2) | 0.083257 |
| | LTR10K | 81.8 (73.8-89.9) | 79.5 (71.1-88.0) | 0.320116 |
| | Run10KFaster† | 66.7 (48.9-84.4) | 59.3 (40.7-77.8) | 0.326527 |
| High Blood Pressure | Walk10K | 28.5 (21.3-35.7) | 17.8 (11.7-23.8) | 0.003186 |
| | LTR10K† | 14.8 (7.4-22.2) | 8.0 (2.3-13.6) | 0.013452 |
| | Run10KFaster | 11.1 (0.0-23.0) | 7.4 (0.0-17.3) | 0.573512 |
| Elevated Blood Pressure | Walk10K | 40.4 (32.6-48.2) | 30.9 (23.6-38.3) | 0.022642 |
| | LTR10K† | 22.7 (14.0-31.5) | 14.8 (7.4-22.2) | 0.051658 |
| | Run10KFaster† | 14.8 (1.4-28.2) | 7.4 (0.0-17.3) | 0.326527 |

CI, Confidence Interval; †indicates significantly different from Walk10K group pre-intervention after adjusting for age and gender; ‡indicates significant difference between LTR10K and Run10KFaster groups pre-intervention.

The prevalence of high and elevated random blood glucose levels did not change over the course of the intervention for any of the intervention programs (Table 12-3). While no significant changes in the prevalence of high or elevated TC were observed for any program, the Walk10K program demonstrated declines in rates of high and elevated TC. Similarly, rates of low HDL did not change over the course of the intervention for any of the programs, though the Walk10K program did experience non-significant declines.

**Table 12-3** The changes in prevalence (95% CI) of abnormal blood sugar and cholesterol rates among British Columbian Aboriginal populations with training by intervention program

| Chronic Condition | | Pre-Intervention (%) | Post-Intervention (%) | *P*-value |
|---|---|---|---|---|
| High Blood Sugar | Walk10K | 11.0 (5.9-16.0) | 9.3 (4.6-13.9) | 0.416103 |
| | LTR10K | 2.3 (0.0-5.4) | 1.1 (0.0-3.4) | 0.320084 |
| | Run10KFaster | 0.0 | 0.0 | 1.000000 |
| Elevated Blood Sugar | Walk10K | 16.4 (10.4-22.5) | 17.9 (11.8-24.0) | 0.671319 |
| | LTR10K | 2.3 (0.0-5.4) | 3.4 (0.0-7.2) | 0.566674 |
| | Run10KFaster | 0.0 | 7.4 (0.0-17.3) | 0.161179 |
| High Total Cholesterol | Walk10K | 17.0 (10.9-23.1) | 13.2 (7.8-18.7) | 0.226474 |
| | LTR10K | 8.0 (2.3-13.6) | 9.1 (3.1-15.1) | 0.740956 |
| | Run10KFaster | 7.4 (0.0-17.3) | 7.4 (0.0-17.3) | 1.000000 |
| Elevated Total Cholesterol | Walk10K | 37.4 (29.6-45.2) | 31.8 (24.4-39.2) | 0.144722 |
| | LTR10K | 33.0 (23.1-42.8) | 31.8 (22.1-41.5) | 0.783287 |
| | Run10KFaster | 14.8 (1.4-28.2) | 22.2 (6.5-37.9) | 0.424552 |
| Low HDL | Walk10K | 47.9 (39.8-56.0) | 43.7 (35.8-51.6) | 0.290411 |
| | LTR10K | 36.4 (26.3-46.4) | 36.4 (26.3-46.4) | 1.000000 |
| | Run10KFaster† | 11.1 (0.0-23.0) | 11.1 (0.0-23.0) | 1.000000 |

CI, Confidence Interval; HDL, High Density Lipoprotein Cholesterol; †indicates significantly different from Walk10K group pre-intervention.

Individuals in all programs reported increased physical activity behaviour over the training program. While significant improvements in health status may not have been observed, significant improvements in physical activity status and improvements in many health status classifications were observed. After adjusting for program differences in age, gender, time from pre- to post-testing and pre-intervention measure, no significant differences in post-intervention measure were found for any health measure (Table 12-4). Near significant differences were observed for HDL levels, where the Walk10K program demonstrated lower post HDL levels, even after adjusting for program differences. Differences in post chronic condition rates between intervention programs were not observed for any chronic condition after adjusting for age, gender, pre- to post-screening time and pre-intervention rates.

**Table 12-4** Differences in post health measures and chronic condition rates with training† by training program

| Health Measure | F Statistic | *P*-value | Training Program with lower post measure |
|---|---|---|---|
| Weight | 0.1793 | 0.835921 | Nil |
| BMI | 0.1637 | 0.849072 | Nil |
| Waist Circumference | 0.2004 | 0.818534 | Nil |
| Systolic Blood Pressure | 0.9610 | 0.383880 | Nil |
| Diastolic Blood Pressure | 0.2422 | 0.785082 | Nil |
| Total Cholesterol | 1.0391 | 0.355288 | Nil |
| HDL | 3.0010 | 0.051547 | Nil |
| TC:HDL Ratio | 2.31910 | 0.100491 | Nil |
| Glucose | 1.49557 | 0.226144 | Nil |
| Obesity | 0.0081 | 0.991969 | Nil |
| Overweight or Obesity | 1.3108 | 0.271404 | Nil |
| Abdominal Obesity Normal Cut-Off | 0.5808 | 0.560217 | Nil |
| Abdominal Obesity Low Cut-Off | 0.3825 | 0.682546 | Nil |
| High Blood Pressure | 0.38370 | 0.681731 | Nil |
| Elevated Blood Pressure | 1.45773 | 0.234697 | Nil |
| High Blood Glucose | 1.5056 | 0.223898 | Nil |
| Elevated Blood Glucose | 0.85454 | 0.426722 | Nil |
| High Total Cholesterol | 2.23123 | 0.109539 | Nil |
| Elevated Total Cholesterol | 1.36503 | 0.257277 | Nil |
| Low HDL | 1.3545 | 0.259982 | Nil |

BMI, Body Mass Index; HDL, High Density Lipoprotein Cholesterol; TC, Total Cholesterol; Nil, no significant differences observed; †adjusted for gender, age, time from pre to post and pre-intervention measure

Correlations of the four risk scoring systems ranking of participants as high, moderate or low risk were inconsistent. Male participants, and participants of the Walk10K and Run10KFaster programs produced significant correlations in risk stratification among all four scoring systems. Female participants and Run10KFaster participants risk stratification was significantly correlated between most scoring systems, except the NCEP/ATP III with both the ACTI-MENU and Framingham CHD risk assessments. Run10KFaster risk stratification was also not significant between the ACTI-MENU and Framingham CHD risk scoring systems.

Changes in risk scores over the training intervention were observed for all four risk scoring systems (Table 12-5). The Walk10K group demonstrated significant improvements in risk scores for all four systems. Similarly, the LTR10K group demonstrated significant improvements in CHD risk as assessed by the ACTI-MENU, Framingham CHD and NCEP/ATP III scoring systems. Participants in the LTR10K group also demonstrated near significant improvements in CVD risk as assessed using the Framingham CVD risk scoring system. Conversely, the Run10KFaster group did not demonstrate significant changes in CHD or CVD risk as assessed using any of the scoring systems; however their scores did improve for all four scoring systems. After adjusting for differences in age, gender, pre-intervention risk scores and time from pre- to post-screening, no significant differences in post ACTI-MENU or Framingham CHD risk scores were observed between program types. However, after the same adjustment using the Framingham CVD risk scores, the Walk10K group was found to have significantly higher post CVD risk scores than the other two groups, and the Run10KFaster group was found to have significantly lower post CVD risk scores from the other two groups. After performing the same adjustment on the NCEP/ATP III post risk scores, once again, the Run10KFaster group was found to have lower scores and the Walk10K group higher scores, though these differences were not statistically significant.

**Table 12-5** Changes in cardiovascular disease and coronary heart disease risk scores with training by intervention program (mean ± SD)

| | | Pre-Intervention Score | Post-Intervention Score | *P*-value |
|---|---|---|---|---|
| ACTI-MENU Scoring System | Walk10K | 31.6±16.4 | 28.4±15.3 | 0.000000 |
| | LTR10K | 20.5±12.0 | 17.9±11.9 | 0.000003 |
| | Run10KFaster | 15.6±11.1 | 14.7±10.3 | 0.414082 |
| Framingham CHD Scoring System | Walk10K | 0.6±7.2 | -0.0±6.8 | 0.021522 |
| | LTR10K | -5.0±7.3 | -5.5±7.0 | 0.021221 |
| | Run10KFaster | -6.2±7.2 | -6.3±7.0 | 0.694089 |
| Framingham CVD Scoring System | Walk10K | 7.1±6.4 | 6.2±6.0 | 0.022602 |
| | LTR10K | 2.2±5.3 | 1.8±4.8 | 0.097881 |
| | Run10KFaster | 0.6±4.3 | 0.4±4.7 | 0.627914 |
| NCEP/ATP III Scoring System | Walk10K | 8.8±8.3 | 8.3±8.0 | 0.009181 |
| | LTR10K | 3.9±8.6 | 3.1±7.8 | 0.035622 |
| | Run10KFaster | 1.8±8.4 | 0.6±8.0 | 0.271753 |

SD, Standard Deviation; CVD, Cardiovascular Disease; CHD, Coronary Heart Disease; NCEP/ATP III, National Cholesterol Education Program/Adult Treatment Panel III.

Using the ACTI-MENU risk scoring system, the risk category stratification was significantly worst among the Walk10K participants prior to the intervention. The prevalence of risk categories as determined using the ACTI-MENU scoring system were observed to significantly change among the Walk10K and LTR10K programs, as outlined on Figure 12-1. These two programs demonstrated increases in the prevalence of very low and low risk status with decreases in the prevalence of average, high and very high risk categories. The

Run10KFaster program did not demonstrate any changes in ACTI-MENU risk categories with training.

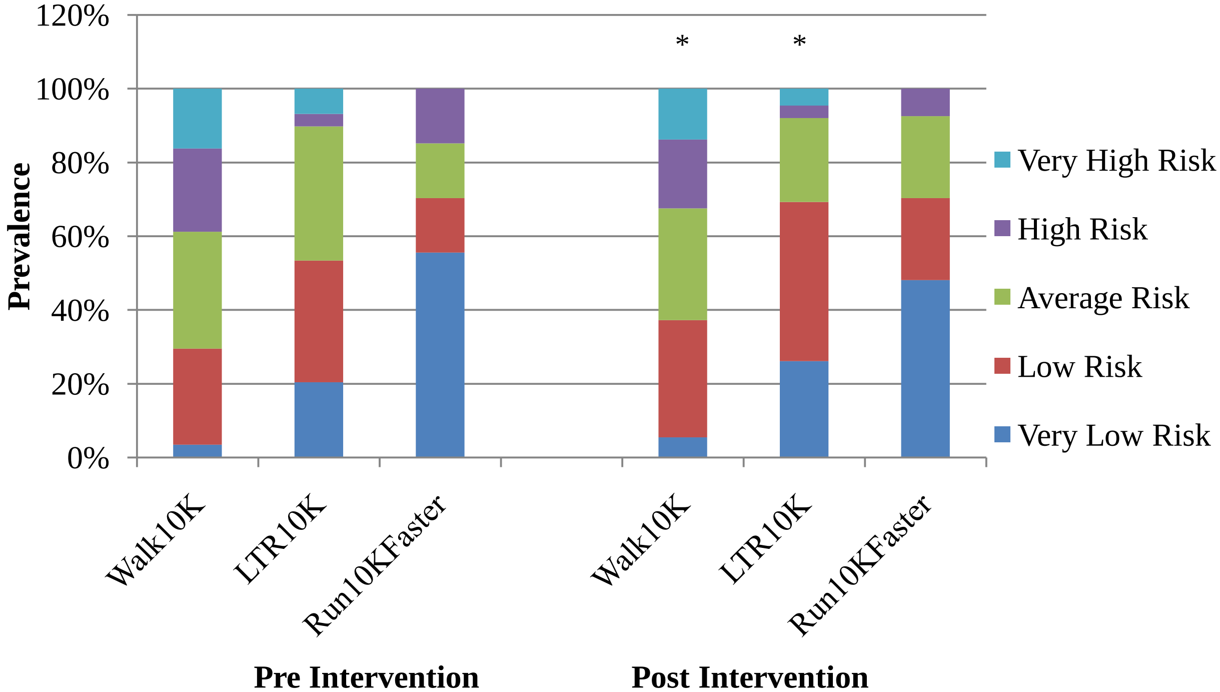


**Figure 12-1** The change in risk stratification of ACTI-MENU risk categories with training by Hearts inTraining intervention program. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Prior to the intervention, risk stratification as determined by the Framingham CHD scoring system was significantly better among the LTR10K participants in comparison to the Walk10K participants. Over the course of the training program, no significant changes in Framingham CHD risk status were observed for any of the intervention programs (Figure 12-2). The Walk10K program was observed to have the highest prevalence of high risk pre-intervention, with the Run10KFaster group and LTR10K groups presenting with majority low risk participants.

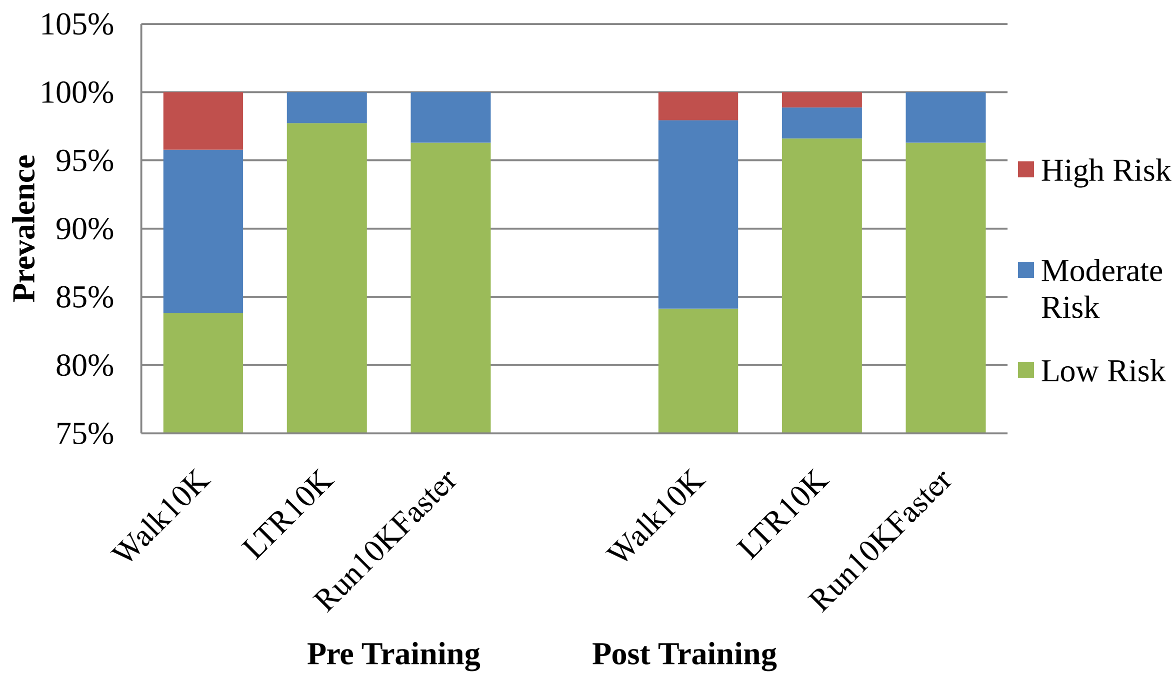


**Figure 12-2** The change in risk stratification of Framingham CHD risk categories with training by intervention program. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Using the Framingham CVD risk scoring system, the Walk10K program participants experienced significantly poorer risk stratification in comparison to the LTR10K and Run10KFaster participants pre-intervention. Over the course of the intervention, no significant changes in risk stratification were observed (Figure 12-3). The majority of participants in all three groups demonstrated low risk both pre- and post-intervention.

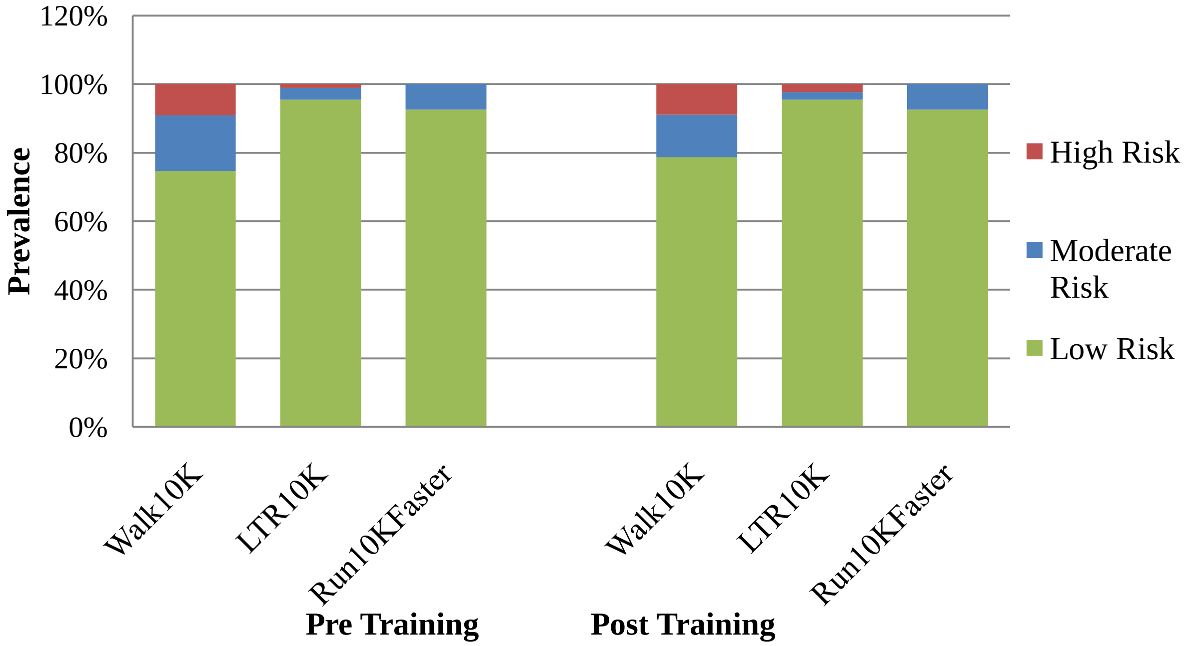


**Figure 12-3** The change in risk stratification of Framingham CVD risk categories with training by Hearts inTraining program. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Prior to the intervention, no significant differences in risks stratification were observed between the three intervention programs using the NCEP/ATP III risk scoring system. A large majority of participants in all three programs demonstrated low risk both prior to and following the intervention. Over the Hearts inTraining program, significant improvements in NCEP/ATP III risk status were observed for the Walk10K and LTR10K participants (Figure 12-4). Both these programs demonstrated significant increases in the prevalence of low risk status and significant decreases in the prevalence of high risk status. The Run10KFaster program participants did not demonstrate changes in risk stratification, with most participants in the low risk category and few in the moderate risk category.

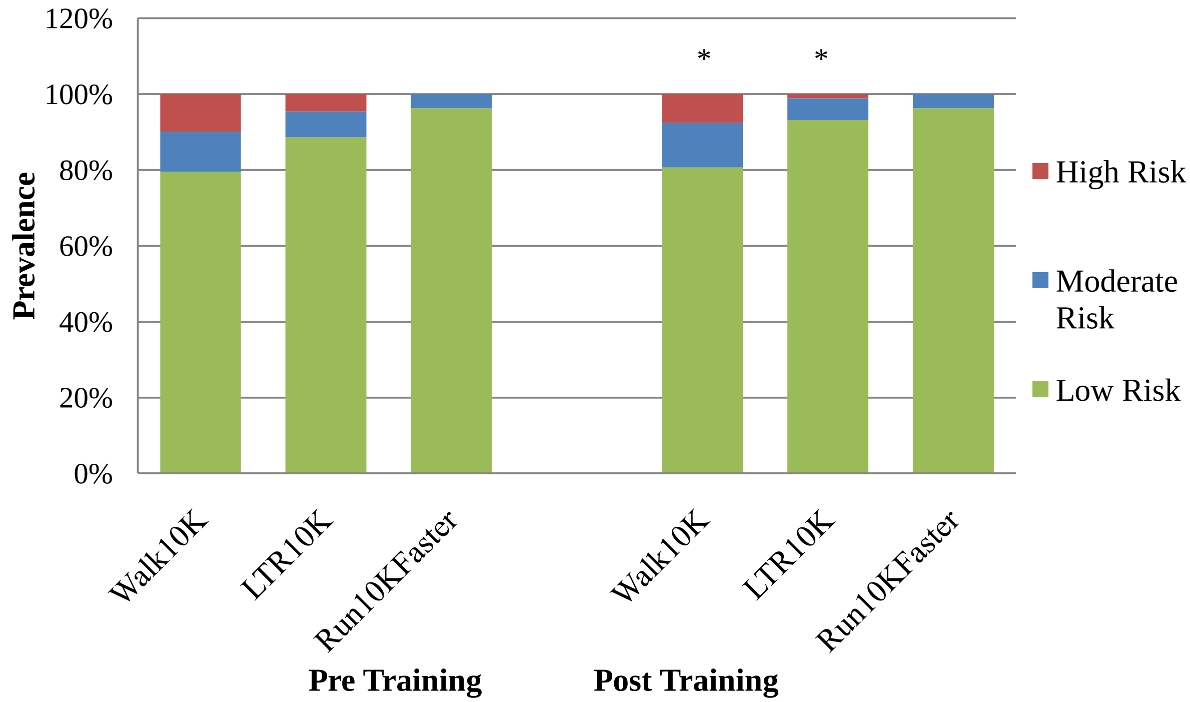


**Figure 12-4** The change in risk stratification of NCEP/ATP III risk categories with training by Hearts inTraining intervention program. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Over the course of the training program, significant increases in reported physical activity scores were observed (Table 12-6). The Walk10K program reported significant increases in frequency, intensity, perception and overall physical activity scores. Similarly, the LTR10K group reported significant increases in physical activity frequency, perception and overall score with non-significant increases in intensity score. Participants in the Run10K group reported significant increases in physical activity frequency, with minimal changes in the other scores. After adjusting for age, gender, time from pre- to post-testing and pre-intervention scores, the post-intervention physical activity scores were not significantly different between groups.

**Table 12-6** The changes in physical activity scores by age group with training by age group (mean ± SD)

| | Age Group | Pre-Intervention | Post-Intervention | *P*-value |
|---|---|---|---|---|
| Frequency Score | Walk10K | 3.18±1.72 | 4.32±1.07 | 0.000000 |
| | LTR10K | 3.64±1.59 | 4.52±0.97 | 0.000002 |
| | Run10KFaster | 3.93±1.52 | 4.15±1.26 | 0.000000 |
| Intensity Score | Walk10K | 1.72±1.00 | 2.03±0.79 | 0.000000 |
| | LTR10K | 2.11±0.76 | 2.25±0.63 | 0.128872 |
| | Run10KFaster | 2.48±0.51 | 2.41±0.69 | 0.646150 |
| Perception Score | Walk10K | 1.59±1.59 | 2.17±1.52 | 0.000000 |
| | LTR10K | 1.89±1.47 | 2.56±1.15 | 0.000001 |
| | Run10KFaster | 3.15±1.10 | 3.41±1.25 | 0.305512 |
| Overall Score | Walk10K | 6.50±2.89 | 8.52±2.04 | 0.000000 |
| | LTR10K | 7.64±2.70 | 9.33±1.83 | 0.000000 |
| | Run10KFaster | 9.56±1.58 | 9.96±1.63 | 0.380697 |

SD, Standard Deviation; based on the Healthy Physical Activity Participation Questionnaire.

Increases in the proportion of active participants were observed, with greater increases among the Walk10K participants (Figure 12-5). Significant increases in the proportion of participants meeting Canadian physical activity guidelines were observed for the Walk10K and LTR10K programs. After adjusting for age, gender, time from pre- to post-screening and pre-intervention prevalence of active status, post-intervention prevalence of participants meeting Canadian physical activity guidelines were not significantly different between the three intervention groups.

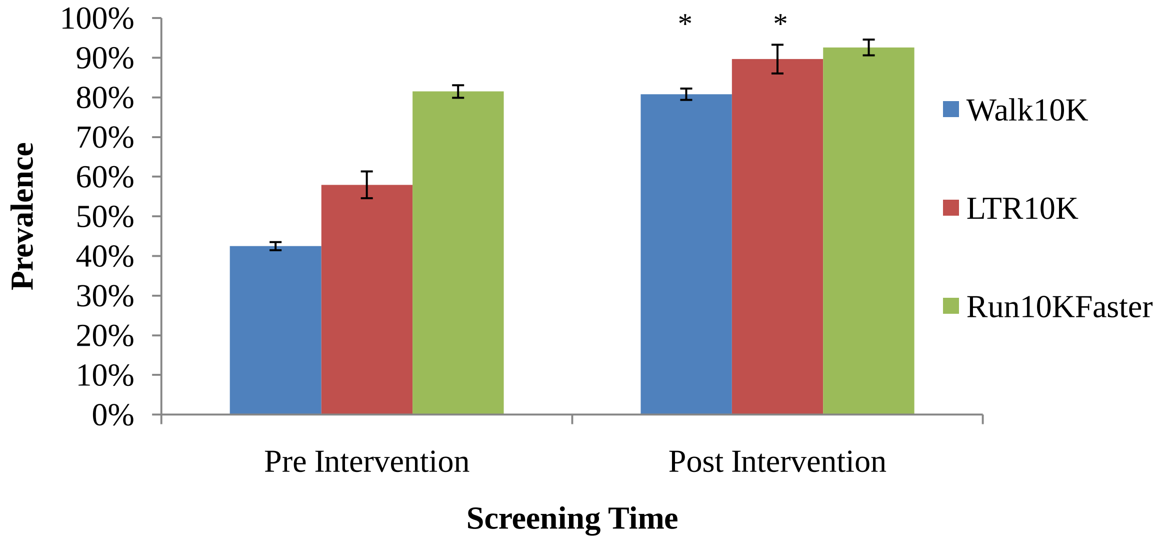


**Figure 12-5** The change in prevalence of participants meeting Canadian physical activity recommendations with training by age group. Asterisk (*) indicates significant changes with training, $p < 0.05$.

## 12.4 Discussion

Prior to the intervention, participants of the Walk10K program demonstrated poorer health measures, rates of chronic conditions and risk scores in comparison to the other groups. As Hearts inTraining participants self-selected their program, this increased risk profile among Walk10K program participants is expected as individuals who are unfit or have chronic conditions are likely to select a walking program. Most individuals who have previously been sedentary, self-select a physical activity intensity appropriate to their physiological level (Lind, et al., 2005). Walking and running programs have previously been shown to improve health and fitness, including improvements in TC, WC and SBP observed in the Hearts inTraining program (Murphy, et al., 2002; Rippe, et al., 1988).

All 4 risk scoring systems appear to be effective in identifying individuals at higher risk, as indicated by the high degree of correlation among male participants and participants of the

Walk10K and LTR10K programs. However, these systems appear to have different ability to identify participants among the lower risk categories, as identified through the risk score correlations among female and Run10KFaster participants. Framingham CHD and CVD risk scores were significantly correlated. These correlations were expected as these scoring systems are developed from the same investigation and same researchers (D'Agostino, Sr., et al., 2008; Wilson, et al., 1998).

The use of self-selected programs was likely more successful for program compliance and sustained health improvements. Individuals self-select programs they feel comfortable completing, thus allowing for greater compliance and program completion (Ekkekakis & Lind, 2006). The use of imposed program intensities may increase participants feeling of discomfort, pain or lack of confidence during or following the program, potentially compromising program compliance (Ekkekakis & Lind, 2006; Lind, et al., 2005). Exercise programs based on prescriptions of perceived intensity as well as programs prescribed based on 85% of $VO_{2max}$ have shown similar improvements in health of participants (Dunn, et al., 1999). The use of group physical activity, with group leaders trained to provide group physical activity programs with individualized intensity assisted in maintaining a high level of program intensity during training.

All three of the Hearts inTraining programs demonstrated improvements in health measures and rates of chronic conditions with training. Improvements in risk scores and prevalence of participants meeting Canadian physical activity recommendations were also observed for all three programs. However, more significant improvements were observed among the Walk10K participants in comparison to the other two programs. Pre-intervention health measures among the Run10KFaster participants were on average in healthy or near healthy ranges, including near normal BMI values, healthy WC, SBP, DBP, TC, HDL and TC:HDL, low risk scores and a high proportion of participants meeting physical activity guidelines. By contrast, Walk10K participants average health measures were often in the elevated range, with higher risk scores and low proportion of participants meeting physical activity guidelines. As Run10KFaster participants demonstrated healthy measures pre-intervention, less improvement was possible before participants measured within healthy ranges. Walk10K participants by contrast often required a large improvement to move these individuals to the healthy ranges of health measures. This difference in possible range for improvement likely contributed to the significant changes observed among Walk10K participants but not Run10KFaster participants.

A lack of statistical significance among most Run10KFaster program measures was also likely due to smaller sample size. The Walk10K group had a large number of participants, with fewer participants in the LTR10K program and very few participants completing post-screening among the Run10KFaster program. These differences in sample sizes likely mask some of the significant improvements experienced by the LTR10K and particularly the Run10KFaster program.

Differences in program success are likely due to pre-intervention risk differences between the three program groups. The Walk10K participants demonstrated significantly worse risk profiles prior to the intervention, while also demonstrating the greatest risk improvements. After adjusting for pre-intervention measures, post-intervention measures were not significantly different. These adjusted post-intervention measures indicate all three programs experienced similar success in improving health risk factors and chronic condition rates, after adjusting for pre-intervention differences. The similarities in post-intervention success indicate these three program intensities were effective in improving health of participants, and that participants self-selected program intensities effective for improving their own individual health.

The Hearts inTraining intensity programs should be advocated and implemented in all Canadian Aboriginal communities. Aboriginal Canadians effectively self-select the program intensity appropriate to their own physiological abilities and fitness levels. The use of self-selected programs is known to increase program compliance (Ekkekakis & Lind, 2006). Particular emphasis should be placed on walking programs, as individuals at high risk levels are able to participate in walking programs. Walking programs are a safe from of exercise for people with chronic conditions such as diabetes, as well as pregnant women and other high risk individuals (Rippe, et al., 1988). By encouraging and developing community walking programs within local communities, individuals with high risks for CVD can improve their health and future risk through an acceptable community program. The Hearts inTraining program is effective for improving the health and fitness of Canadian Aboriginal adults of all ability and risk levels. This community-based self-selected physical activity program is successful for improving the CVD risk for all community members.

## 12.5 Conclusion

Aboriginal populations effectively self-select a physical activity program appropriate to their personal fitness and physical ability. All three physical activity programs were equally effective in reducing the cardiovascular disease risk and improving health status of Aboriginal participants.

# 13. Conclusions

## 13.1 Discussions and Conclusions

Physical activity interventions among Aboriginal populations include a variety of methods. Interventions among Aboriginal youth have often implemented activities or access to fitness facilities within a school setting (Bachar, et al., 2006; Caballero, et al., 2003; Cook & Hurley, 1998; Ritenbaugh, et al., 2003; Scott & Myers, 1988). These youth interventions, as well as many interventions among Aboriginal adults, operate at a community level. Success in physical activity interventions has often observed among community based investigations of Aboriginal populations. Community based aerobics classes have been met with success among Aboriginal adults, for both general Aboriginal population in the Zuni Diabetes project, and among American Indian Elders but with more limited success among the British Columbian Haida population (Heath, et al., 1991; Heffernan, et al., 1999; Kochevar, et al., 2001). However, less successful results have been observed among individual prescribed exercise interventions among this population (Narayan, et al., 1998; Robertson, Kattelmann, & Ren, 2007; Wing, et al., 2004). Additionally, many investigations among Aboriginal adults have experienced small sample sizes, making results difficult to determine (Dyck, Sheppard, Klomp, Tan, & Chad, 1999; Heffernan, et al., 1999; Reitman, et al., 1984).

Of all interventions among Aboriginal populations, none have investigated walking or running programs. The ability to walk is recognized as the most distinctive feature of human evolution (Harcourt-Smith & Aiello, 2004; Tan, 2006). Walking is reported as a convenient method of increasing physical activity, and is the most commonly reported mode of physical activity (Owen, Humpel, Leslie, Bauman, & Sallis, 2004; Swartz, et al., 2003). Walking programs are known to be a cost-effective way to improve physical activity and quality of life among community groups (Fisher & Li, 2004). Walking is also found as the physical activity behaviour most likely to increase (Owen, et al., 2004).

The Hearts inTraining physical activity programs, including walking, running and walk/running demonstrates significant improvements in health measures and some health status classifications over 13 weeks of training. Improvements in health measures and chronic conditions were observed among both male and female participants. Similarly, health measure and chronic condition rate improvements were also experienced by all age groups. Individuals ranging in CVD risk status prior to the intervention experienced improved health measures and risk scores over the intervention. All three physical activity programs, the Walk10K, LTR10K and Run10KFaster programs demonstrated significantly improved health measures and improved chronic condition rates over the training period. Additionally, significant improvements in physical activity levels were observed over the course of the intervention. Improved rates of active physical activity status were observed for male and female participants of all age groups, all CVD risk classifications and participants of all three physical activity programs.

This program was expected to lead to decreased CVD risk among Aboriginal adults. Over the course of the intervention, significant improvements in CVD risk scores were observed among Aboriginal females using all four scoring systems. Among Aboriginal males, significant improvements were observed using two of the four risk scores. While near statistical significance for males risk changes using the NCEP/ATP III scoring system and no statistical significance was observed in the improvement of Aboriginal males risk scores using the Framingham CVD risk system, improvements in risk scores were observed with both scoring systems. Improved risk scores using all four scoring systems were also observed for all Aboriginal adult age groups ≥20 years. While improvements in risk scores among the <20 year age group were not observed, a lack of improvement in risk can not be concluded as these four risk scores are not validated for individuals under 20 years of age. Overall, this program was successful for reducing the CVD risk of Aboriginal adults.

It was hypothesized that the Hearts inTraining program would lead to greater improvements in health among those participants with increased risk of CVD prior to the intervention. After adjusting for differences in pre-intervention CVD risk levels, the improvements in CVD risk with the training program were not significantly different between CVD risk classifications. Individuals demonstrating both high and low CVD risk prior to the intervention experienced improvements in health measures, chronic condition rates and CVD risks over the course of the intervention. While individuals of higher CVD risk experienced greater absolute level of improvement, after adjusting for pre-intervention levels, the differences between risk categories were not significant. In contrast to the expected differences in improvements between CVD risk classes, improvements observed among participants of varying risk class were not different.

Individuals participating in the higher intensity Run10KFaster and LTR10K programs were hypothesized to experienced greater improvements in CVD risk in comparison to individuals participating in the Walk10K program. However, significant differences in the improvements observed among these three programs were not observed, even after adjusting for differences in CVD risk factors prior to the intervention. While pre-intervention differences in CVD risk factors were adjusted for in these comparisons, differences in individual fitness levels were not adjusted for. Due to the self-selection of these three training programs, individuals of higher fitness levels were more likely to self-select the Run10KFaster program, while individuals of lower fitness levels were more likely to select the Walk10K program (Lind, et al., 2005). The expected increased benefits of the Run10KFaster program may have been observed if the intervention changes were adjusted for aerobic fitness as well as age, gender, time between screening sessions and pre-intervention levels.

## 13.2 Strengths and Limitations

The Hearts inTraining program operated at a community level where the physical activity programs were conducted by community members and the physical activity programs were organized by local Aboriginal governments. Because this program was conducted on such a level, this research represents a natural experiment, occurring in existing natural communities. Conducting this experiment in a community-based setting at a community level allowed for evaluation of a real time, grass roots intervention presenting accurate and meaningful results that are relevant to this intervention outside the laboratory setting. In contrast to many investigations conducted within a laboratory setting, the outcomes and results of this investigation are translated directly to the community setting, presenting high external validity of results.

By conducting this physical activity program within the local Aboriginal communities with the assistance of local Aboriginal government, these programs could easily be continued and expanded from the local community. Conducting registration and implementation of this investigation through the local Aboriginal offices allowed for increased program recruitment and more effective testing of participants. By implementing these programs through the local Aboriginal government, these offices have the authority and resources to expand and continue these programs in future. Aboriginal government offices have contact with all local members and have regular programs running throughout the year. By coordinating with these offices, increased potential for future and further implementation of these physical activity programs was possible.

Because this physical activity intervention included health screening involving health care professionals, participants had the opportunity to learn about their health during this time. While being assessed for blood sugar, TC, HDL and blood pressure, opportunities for education were utilized. Many participants benefited from increased knowledge about the benefits of physical activity and how physical activity could improve their health outcomes. Information regarding cholesterol, elevated blood pressure, elevated blood sugar and other chronic conditions were available during this screening. Following the screening sessions, participants also had the opportunity to meet with health care professionals and councillors to review their screening results and set goals for the coming months. Through this education session, Aboriginal adults learned about their own health and steps they can take to improve their health outcomes. As education is known to lead to increased health and reduced CVD risk, this additional education setting may have further enhanced the health of these individuals (Farquhar, et al., 1977).

Using self-selected physical activity programs provided three different intensities of programs for participants to choose. By allowing for self-selected intensity, the program compliance may have been increased (Ekkekakis & Lind, 2006). Similarly, the use of a community-based intervention in this community designed population likely increased the compliance for this physical activity program (Colomeda & Wenzel, 2000).

One major strength of this program was the community-based self-government design. By conducting these physical activity programs at a community level through the local Aboriginal government offices, this program presented an opportunity for Aboriginal adults to take action to improve their own health. Operation of these programs through local Aboriginal government allowed for a self-government and empowerment opportunity. Through the education and physical activity programs Aboriginal adults were enabled to take a pro-active role in their own personal health.

The use of the ACTI-MENU scoring system within the Hearts inTraining program handouts allowed participants to gain knowledge and self empowerment regarding their own health and risk. By using a scoring system that incorporates a more inclusive system of risk factors, individuals learn about their own health and areas they can take action to improve their own health. A strength of the Hearts inTraining program was the self empowerment through knowledge regarding individual health factors. Within each screening system, participants were provided with a folder outlining their individual health measures along with the ACTI-MENU scoring system identifying risk points and ideal health measure ranges. Using the ACTI-MENU scoring system in this education provided participants with greater knowledge of CVD risk factors and thus greater ability for participants to undertake improvements on their own. By providing participants with this information, participants were enabled to better understand their own health and risk factors. Education regarding CVD risk factors is known to lead to reduced CVD risk, where face to face education is even more effective (Farquhar, et al., 1977).

Due to the community-based nature of this program, accurate attrition and dropout rates were not available. Because participants tracked were only those who attended both pre- and post-screening sessions, the drop out rates for the population could not be determined, as many participants who did not attend post-screening sessions did complete the program. Without accurate representation of overall physical activity attrition rates, determination of community completion and efficiency could not be determined fully.

Small sample size in some of the subgroups used for analysis of this program may have prevented statistical significance from being achieved. While improvements in many health measures and chronic condition status were observed for individuals of higher CVD risk and individuals in age groups <20 and ≥60 years, few statistically significant changes were recorded. The lack of statistical significance among these groups may be due to smaller sample sizes in these populations, rather than a lack of meaningful results. Clearly, further research in this area is required.

While participants reported differences in program completion, a multiple choice question using four categories of completion % were used to evaluate participants' completion of the Hearts inTraining physical activity intervention. Because a categorical report was used for this evaluation, adjustment for program completion in statistical analyses was not accurately possible. If individuals were able to report an exact percentage of training sessions completed, these statistical adjustments may have been possible. Additionally, because individuals were self-reporting program completion, inherent bias in this reporting likely occurred. As a result, reported program completion may over-estimate the actual program completion of Aboriginal adult participants.

Many investigations of health status report odds ratios of smoking status using classifications of regular smokers, occasional smokers and non-smokers. Smoking behaviour information collected among Hearts inTraining participants did not assess the regularity of smoking behaviour. As a result, comparison of health status variables and conditions to investigations reporting regular smoking were not possible.

Without conducting longitudinal analyses to evaluate mortality and specifically CVD mortality, it was not possible to determine the exact alterations in CVD risk provided by this program. Similarly, without the use of a control group not completing the physical activity program, the proportion of changes caused exclusively by the physical activity program could not be determined. Further, as education of health measures and methods for improving these health measures through physical activity, diet, decreased stress and other behavioural changes were included within the screening sessions, the effects of these screening sessions were not determined. The improvements observed through the Hearts inTraining program may have resulted from the physical activity program alone or a combination of the education and physical activity program.

## 13.3 Implications and Applications

The Hearts inTraining investigation provided important information to the field of Aboriginal health. This investigation demonstrated the benefits of a community-based walking and running program for improving the health and CVD risk of participants. Among this high risk group, improvements in rates of CVD and diabetes are important. The Hearts inTraining program provided evidence supporting the use of simple physical activity programs to alleviate this epidemic of chronic health status. By utilizing a culturally appropriate program, this physical activity intervention may be carried on and conducted within the local community, separate from the Hearts inTraining program. Self conduction of physical activity programs within local Aboriginal communities would improve the health and well-being of these populations, potentially reducing the disease burden experienced by these high risk populations.

This program highlighted the importance and success of local community-based physical activity programs run through the local Aboriginal government. The Hearts inTraining program demonstrated the potential benefits and health improvements for cost-effective local physical activity interventions that can be conducted from within local Aboriginal government, without large involvement of outside experts and expensive exercise equipment. Through the use of basic programs at a fundamental level, significant improvements in health status can be achieved. While many communities do not have resources to build training centres or purchase exercise equipment, simple programs such as walking and running can be effective in improving the health of the community.

From this program, future research should continue to investigate the effects of community-based programs accessible and available to all communities and all community members. Further research should investigate year long and long term programs to continue health improvement of Aboriginal Canadians. While participants experienced significant improvements in health over the 13 week training program, the long term effects of this program are not known. Further research within this Hearts inTraining program should investigate the changes in health measures and health status over many years.

Additional research should focus on the requirements of communities to conduct these types of physical activity programs on their own. Globally, large scale benefits would be achieved if Aboriginal communities could prepare and implement physical activity interventions among their members year round and on an ongoing basis. By researching what resources these communities need in order to successfully plan and conduct their own programs, national and provincial government bodies will have a better understanding of what resources are requried.

Future research should also investigate the implementation of community-based physical activity interventions including all members of the family, young and old. By increasing the physical activity of Aboriginal children and youth, the health of future Aboriginal adults may be improved. While school-based physical activity interventions of Aboriginal children and youth and physical activity interventions among Aboriginal adults have been conducted, no investigations have investigated a physical activity program including both age groups to date. Including children and youth into a physical activity program would increase the community inclusion for this population, improving the health of Aboriginal populations as a whole.

Overall, the Hearts inTraining program was a successful physical activity intervention for all Aboriginal adults. Young, old, male, female, fit and unfit, Aboriginal adults all experienced improved health status and CVD risk over the Hearts inTraining program. Aboriginal adults successfully self-selected physical activity program intensities appropriate to their personal fitness and ability levels. The Hearts inTraining program was successful in meeting the needs of Aboriginal adults of all abilities.

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# Appendices

## Appendix A Ethics Certificate of Expedited Approval

*The University of British Columbia*
*Office of Research Services*
*Clinical Research Ethics Board – Room 210, 828 West 10th Avenue, Vancouver, BC V5Z 1L8*

# ETHICS CERTIFICATE OF EXPEDITED APPROVAL: AMENDMENT

| PRINCIPAL INVESTIGATOR: | DEPARTMENT: | UBC CREB NUMBER: |
|---|---|---|
| Darren Warburton | UBC/Education/Human Kinetics | H07-03187 |

**INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:**

| Institution | Site |
|---|---|
| UBC | Vancouver (excludes UBC Hospital) |

**Other locations where the research will be conducted:**
N/A

**CO-INVESTIGATOR(S):**
Shannon S.D. Bredin

**SPONSORING AGENCIES:**
N/A

**PROJECT TITLE:**
The effectiveness of a novel community-based physical activity program on the risk for cardiovascular disease and diabetes in persons of different ethnicities

**REMINDER: The current UBC CREB approval for this study expires: March 15, 2011**

| AMENDMENT(S): | AMENDMENT APPROVAL DATE: |
|---|---|
| Change in a study team. | **June 30, 2010** |

CERTIFICATION:
**In respect of clinical trials:**
*1. The membership of this Research Ethics Board complies with the membership requirements for Research Ethics Boards defined in Division 5 of the Food and Drug Regulations.*
*2. The Research Ethics Board carries out its functions in a manner consistent with Good Clinical Practices.*
*3. This Research Ethics Board has reviewed and approved the clinical trial protocol and informed consent form for the trial which is to be conducted by the qualified investigator named above at the specified clinical trial site. This approval and the views of this Research Ethics Board have been documented in writing.*

The amendment(s) for the above-named project has been reviewed by the Chair of the University of British Columbia Clinical Research Ethics Board and the accompanying documentation was found to be acceptable on ethical grounds for research involving human subjects.

*Approval of the Clinical Research Ethics Board by one of:*

Dr. Peter Loewen, Chair
Dr. James McCormack, Associate Chair

## Appendix B Healthy Physical Activity Participation Questionnaire

**TOOL #21 HEALTHY PHYSICAL ACTIVITY PARTICIPATION QUESTIONNAIRE**

### DETERMINING THE HEALTH BENEFITS OF YOUR PHYSICAL ACTIVITY PARTICIPATION IS AS EASY AS A, B, C ...

A. Answer the following questions:

**#1 Frequency**

Over a typical seven-day period (one week), how many times do you engage in physical activity that is sufficiently prolonged and intense to cause sweating and a rapid heart beat?

- ☐ At least three times
- ☐ Normally once or twice
- ☐ Rarely or never

**#2 Intensity**

When you engage in physical activity, do you have the impression that you:

- ☐ Make an intense effort
- ☐ Make a moderate effort
- ☐ Make a light effort

**#3 Perceived Fitness**

In a general fashion, would you say that your current physical fitness is:

- ☐ Very Good
- ☐ Good
- ☐ Average
- ☐ Poor
- ☐ Very Poor

B. Circle your score for each answer and total your score.

*Scoring of Questionnaire Responses*

| Item | Male | Female | Male | Female | Male | Female |
|---|---|---|---|---|---|---|
| #1 Frequency | Rarely or never | | Normally once or twice | | At least three times | |
| | 0 | 0 | 2 | 3 | 3 | 5 |
| #2 Intensity | Light effort | | Moderate effort | | Intense effort | |
| | 0 | 0 | 1 | 2 | 3 | 3 |
| #3 Perceived Fitness | Very Poor or Poor | | Average | | Good or Very Good | |
| | 0 | 0 | 3 | 1 | 5 | 3 |

Total Score = ____________

C. Determine your health benefit rating based on your score from B.

| Health Benefit Zone | Total Score |
|---|---|
| Excellent | 9–11 |
| Very Good | 6–8 |
| Good | 4–5 |
| Fair | 1–3 |
| Needs Improvement | 0 |