EXAMINING THE EFFECTIVENESS OF A COMMUNITY-BASED PHYSICAL ACTIVITY INTERVENTION ON HEALTH-RELATED PHYSICAL FITNESS IN INDIGENOUS ADULTS

by

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The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, a thesis/dissertation entitled:

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Abstract

Background: Improving the health and well-being of Indigenous peoples is a priority in Canada. A high prevalence of chronic diseases (such as cardiovascular disease, type 2 diabetes and obesity) has been reported among Indigenous communities. Despite the growing awareness of the health disparities faced by Indigenous communities compared to the general population, limited research exists on how to improve the cardio-metabolic health of Indigenous communities in culturally appropriate ways. Physical activity and fitness is well known to be of benefit for health.

Objective: To evaluate the effectiveness of a community-based walking and running physical activity program on improving health-related physical fitness and other risk factors for cardiovascular disease and type 2 diabetes.

Methods: Six Indigenous communities participating in the program hosted a health screening. A total of 87 adults of varying ages (44.6 ± 14.9 yr), health status and previous physical activity levels were included in this study. A trained Indigenous community member delivered weekly running and walking sessions. Aerobic fitness, muscular strength, body composition, blood pressure, total cholesterol, high density lipoprotein cholesterol, glucose, glycosylated haemoglobin and physical activity behaviour were assessed pre-and post-training.

Results: Improvements in cardiorespiratory fitness and muscular strength were observed after the program. Health-related outcomes including waist circumference and blood pressure were reduced.

Conclusion: A community-based physical activity program, led by an Indigenous community member, was effective at improving the cardio-metabolic health of Indigenous adults. Future research should consider modelling the design and implementation of this physical activity program when working with Indigenous communities to reduce cardio-metabolic diseases.

Lay Summary

Indigenous peoples of Canada are more likely to develop chronic diseases such as heart disease, type 2 diabetes and obesity compared to the rest of Canadians. Most research has focused on quantifying the rates of these diseases with little information available on how to best address these health issues in a culturally appropriate way. Increasing levels of physical activity and improving physically fitness has shown to be beneficial for health. This study evaluated whether a community-based physical activity program improved health-related physical fitness among 52 Indigenous adults. After the program, participants were more aerobically fit and had increased muscle strength. In addition, participants experienced health benefits including inches lost from their waist and increased levels of physical activity. This physical activity program was beneficial for some aspects of physical health among Indigenous adults.

Preface

Amanda M. De Faye was the primary author of this manuscript and was responsible for the topic of interest, data collection, and the creation of related thesis chapters. All analysis was conducted by Amanda M. de Faye. All of the work in this thesis is original and unpublished.

The Health Beat initiative was conducted in partnership with Drs. Darren Warburton and Shannon Bredin and SportMedBC. Dr. Warburton helped develop the topic of interest and provided feedback and edits. Drs. Foulds and Bredin, members of the supervisory committee, helped guide the direction of the thesis and provided edits. Colleagues, volunteers and local health professionals assisted in the collection of data and data entry.

Ethical approval for this investigation was obtained from the UBC Clinic Research Ethics Board (Certificate H07-03187).

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACSM	The American College of Sports Medicine
A1C	Glycosylated Haemoglobin
ARW	Aboriginal Runwalk
BMI	Body Mass Index
CBPR	Community-based, Participatory Research
DBP	Diastolic Blood Pressure
GS	Combined Grip Strength
HDL	High Density Lipoprotein Cholesterol
ISPARC	Indigenous Sport, Physical Activity and Recreation Council
SBP	Systolic Blood Pressure
TC	Total Cholesterol
VO_2max	Maximal Aerobic Power
WC	Waist Circumference
6MWT	6-minute Walk Test

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To all Indigenous communities who are taking steps to healthy living.

Chapter 1: Introduction

This chapter provides background and rationale for this thesis investigation. Specific aims and expected hypothesis are also highlighted.

1.1 Introduction and Rationale

Indigenous peoples experience some of the worst health disparities in comparison to non-Indigenous populations living in Canada (1,2). Of particular concern, are the disproportionately high rates of cardio-metabolic diseases, including cardiovascular disease and type 2 diabetes, that affect many communities (3–5). The prevalence of type 2 diabetes varies across language group, cultural area and degree of isolation; however rates as high as 3-5 fold higher than the national Canadian average have been previously reported among Indigenous communities (6–9). These findings, amongst many others, resulted in researchers calling Indigenous populations' experience of diabetes an "epidemic in progress" (9). In British Columbia, current rates of type 2 diabetes amongst First Nation populations are estimated to be 40% higher than other ethnicities (1). Indigenous populations living in Canada also experience greater rates of cardiovascular disease (3,10). A recent report estimated First Nation populations living in British Columbia to have a 25% higher prevalence rate of ischemic heart diseases compared to non-Indigenous populations (1). Furthermore, cardiovascular disease is the most common cause of death amongst Métis men and First Nation men and women (11). Indigenous men and women are also more likely to die from type 2 diabetes, a preventable cause of death, than non-Indigenous men and women (12). Although the life expectancy of Indigenous men and women is projected to have increased by 1-2 years since 2001, there is still a discrepancy of 4 or more years between Indigenous and non-Indigenous populations that needs to be addressed (13). Overall, the reported health status of Indigenous

populations living in Canada has invoked a call for action amongst researchers, health policy makers and Indigenous communities themselves (9,10).

Despite researchers and health policy makers prioritizing Indigenous health in Canada, the majority of the available literature is limited to quantifying rather than addressing the disproportionate rates and root causes of chronic disease and mortality (14–16). Although slightly outdated, a review conducted by Young on Indigenous health research in Canada revealed that select communities are overrepresented in the literature and zero articles reported interventions to address the health issues some Indigenous communities face (17). This is problematic as it serves to reinforce the negative, unhealthy image of Indigenous people and gives strength to the colonial rule that has prevented Indigenous people from self-determination for the previous century (10). Since then, a few studies have used physical activity interventions to improve health outcomes and physical fitness of Indigenous communities in Canada with varying levels of success (18–23). Another review also highlighted a different issue that has been commonplace in Indigenous research, the lack of community-based, participatory research with Indigenous communities (16).

Many researchers agree that the health disparities experienced by Indigenous people living in Canada are a consequence of colonialism and the residential school system. Environmental dispossession, loss of cultural identity, the residential school system, and the social-economic determinants of health (e.g. unemployment, low income, low education levels, food insecurity, and lack of access to health care) are seen as the root cause of disproportionate rates of disease rather than genetics (2,10,14,24–27). Addressing these causes will require partnerships between Indigenous communities, government of all levels and researchers to come up with a complex, multi-factorial solution that provides economic and wellness opportunities and respects the cultures, traditions, and practices of Indigenous peoples (26). Ultimately, Indigenous communities

must be provided with the opportunity to determine their path to health and wellness through self-determination as this has been recognized as an essential and effective means of addressing health and wellness disparities within Indigenous communities (10,26). Therefore, Indigenous health research needs to provide opportunities for self-determination amongst Indigenous communities, involve Indigenous communities and leaders as equal partners, share the knowledge and seek to fulfill the priorities identified from within Indigenous communities (10,15). In addition, trust and longstanding friendship outside of research relationships may be the path forward for truly decolonizing research methods (28).

The primary and secondary prevention of cardiometabolic disease is a clear priority for many Indigenous communities in British Columbia; however, there is limited literature addressing cardiometabolic disease prevention and maintenance (26,29). Physical activity is a well-established primary and secondary preventative strategy against type 2 diabetes and cardiovascular disease, however there are limited published physical activity interventions specific to Indigenous populations (18,30–34). Although not necessarily the all-encompassing solution to the health disparities experienced by many Indigenous people, incorporating physical activity into daily routines is beneficial for cardiometabolic health. Regular physical activity has been shown to improve risk factors for cardiovascular disease, including lipid levels, glucose levels, waist circumference, body mass index, and blood pressure (30,35–37). Amongst Indigenous communities in Canada, estimates have suggested that 59% of Indigenous adults are physically inactive and only 21% of First Nation adults meet the recommended guidelines for physical activity (5,38).

In British Columbia, a 13-week community based physical activity intervention was effective in significantly improving waist circumference, total cholesterol, systolic blood pressure

and physical activity levels in First Nation and Métis adults (18). However, one limitation of this successful intervention is the lack of direct, objective measurement of physical activity or physical fitness. Self-report (subjective) levels of physical activity, while inexpensive and easy to administer, show limited reliability and validity as issues with recall and response bias often arise (39). Moreover, these surveys have seldom been validated for use within Indigenous communities. When compared to direct measures, self-report was found to have low to moderate correlations with no clear pattern of under or over-reporting (40). Monitoring levels of physical activity is of importance due to the strong association between physical activity, morbidity, and premature mortality (34). In order to obtain accurate reports of physical activity levels, direct measures are recommended (40).

Physical activity is often defined as "any bodily movement produced by skeletal muscles that result in energy expenditure" (41). In contrast, health-related physical fitness is "a physiologic state of well-being that allows one to meet the demands of daily living or that provides the basis for sport performance, or both" (34). Although closely related, as physical fitness is generally improved as physical activity levels increase, these two terms represent distinct constructs and should not be used interchangeably (42). The relationship between physical fitness and health status is consistently stronger than the relationship between physical activity behaviour and health (34,42–45).

Health-related physical fitness includes the components of physical fitness that are related to health status including cardiovascular fitness, musculoskeletal fitness, body composition, and metabolism (34). Low levels of cardiorespiratory fitness are associated with premature mortality from all causes and cardiovascular disease while improvements in cardiorespiratory fitness reduces risk of early death (44,46). The gold standard measure of aerobic (cardiorespiratory) fitness is

considered to be the direct assessment of maximal aerobic power (VO_2max), which is defined as "the highest rate at which oxygen can be taken up and consumed by the body during intense exercise" (47). Maximal aerobic power can be measured through maximal or submaximal graded exercise tests (47). Although direct measurement of VO_2 max is considered optimal for assessing aerobic fitness there are many instances where submaximal tests may be more appropriate and/or feasible (such as work with clinical populations or research conducted in field settings) (47–49). Common submaximal tests used in field testing include Cooper 12 minute run test, the 1.5 mile test for time, the Rockport One-Mile Fitness Walking Test and the 6-minute walk test (6MWT) (47). Musculoskeletal fitness is associated with positive health outcomes, including reduced risk for morbidity and premature mortality (50). Musculoskeletal strength, a component of musculoskeletal fitness, has positive associations with functional independence, overall quality of life and reduced risk for premature mortality and morbidity (50). Musculoskeletal strength can be assessed through a variety of tests including one repetition maximum tests for select muscle groups (e.g. bench press or leg extensions), number of push ups, number of curl ups or a grip strength test (47). In a recent review, grip strength was found to be the best predictor for premature mortality, disability, complications, and length of hospital stay (51). In addition, the affordability, portability and simplicity have resulted in grip strength being considered a "vital" screening tool for middle-aged and older adults (51).

Limited data is available on physical activity interventions with Indigenous populations in Canada (31,52). Of the available literature, only a few studies directly measure changes in physical activity or fitness. Moreover, limited studies have involved Indigenous community leaders as the key advocates for health change within their own community. To the best of our knowledge, there have been no studies with Indigenous adults evaluating changes in physical fitness after a

community-based, Indigenous led, physical activity intervention. Accordingly, the primary purpose of this research was to demonstrate the effectiveness of a community-based, Indigenous led physical activity intervention on improving the physical fitness and reducing the risk for cardiometabolic disease of Indigenous peoples.

1.2 Aims

We sought to determine whether a 13-week community-based, Indigenous led physical activity program could improve health-related physical fitness and reduce the risk for cardiometabolic disease in Indigenous peoples.

Specific Aim 1: The primary aim of our investigation was to assess whether a community based, culturally appropriate 13 week running and/or walking program improves the cardio-respiratory fitness of Indigenous adults living in British Columbia.

Specific Aim 2: The secondary objective of our investigation was to assess whether the program improves musculoskeletal fitness of Indigenous adults living in British Columbia.

Specific Aim 3: The third objective of our investigation is to determine whether the level of physical fitness at baseline affected the improvement of health-related outcomes after the intervention.

1.3 Hypothesis

We hypothesized that:

A) The Indigenous led, community-based, physical activity intervention would be effective in improving the cardiorespiratory fitness of Indigenous adults who adhered to the program.

B) The physical activity intervention would be effective in improving the musculoskeletal fitness of Indigenous adults who adhered to the program.

C) Adults with lower levels of health-related physical fitness (i.e., aerobic and musculoskeletal fitness) at baseline would experience greater improvements in health-related outcomes.

Chapter 2: Review of the Literature

The purpose of this chapter is to provide a detailed introduction regarding the importance of physical activity across the lifespan as well as give an overview of the current physical activity levels of Indigenous people and the health and wellness implications. Furthermore, this chapter will outline the unique risks and challenges many First Nation communities face before describing physical activity interventions tailored to First Nations adults.

2.1 Background

2.1.1 Terminology

Defining who and what it means to be Indigenous is a complex issue. Indigenous identity is thought to be composed of two main criteria: Indigenous to the land they live on and separate from the colonial societies and states (53). In Canada, the term "Aboriginal", rather than Indigenous, was chosen by the state to represent the descendants of the original inhabitants of North America who were here prior to the arrival of Europeans. Under section 35 of the Canadian Constitution Act, three culturally distinct groups of Aboriginal people are legally recognized- Indian, Métis and Inuit. The colonial term "Indian" has been largely replaced with the widely accepted term "First Nations". To comply with internationally recognized standards as well as to avoid perpetuating the complex array of problems with state-constructed terms, this paper will use the term "Indigenous" rather than "Aboriginal, and "First Nations" rather than "Indian".

2.1.2 Indigenous Populations

In Canada, approximately 1, 670,000 people have self-identified as Indigenous, representing 4.9% of the total Canadian population (54). First Nations people make up the majority of the Indigenous population at 58.4%, whereas Métis and Inuit represent 35.1% and 3.9% respectively. The Indigenous population has the fastest growth rate in Canada. Since 2006, the

Indigenous population has grown by 42.5%, more than four times the growth rate of the general population. This is largely due to the high birth rate, but also a result of more people identifying as Indigenous. Recent years have seen a dramatic growth in those who identify as Métis, with their population doubling from 1996 to 2006 (55). Since 2006, the Métis population has risen 51.2%, the highest of any Indigenous group (54). However, Indigenous populations have the lowest life expectancy of all Canadians, approximately 5 years less than the national average. As a result of the low life expectancy and high birth rate, the Indigenous population is relatively young, with approximately 28% of the Indigenous population under the age of 15, compared to 7% for the general population (55). This is important to keep in mind when aiming to find solutions to the specific chronic health issues that Indigenous people face.

2.2 The Cardio-metabolic Health History of Canadian Indigenous Populations

Historically, the Indigenous peoples of Canada had low rates of cardiovascular disease and type 2 diabetes (18,24). This is largely attributed to the nomadic, traditional lifestyle that Indigenous people led as they hunted and gathered food (56). Their traditional lifestyle was physically demanding, requiring prolonged bouts of moderate to vigorous activity, which has been well documented as a protectant against cardio-metabolic diseases (34,56). However, the historical and cultural consequences of colonialism have negatively impacted the health and well-being of generations of Indigenous Canadians; the effects of which are widespread today (57). Rates of cardio-metabolic diseases have dramatically increased in the past few decades. Even worse, these rates are disproportionately high compared to the general population (4,24,58,59). The high incidence of cardio-metabolic diseases has been directly attributed to the dispossession of and displacement from their traditional lands, the trauma of residential schools, lack of self-

determination, assimilation and the racism experienced while under colonial rule, which is still present today (2,24,25,57).

2.2.1 Rates of Cardiovascular disease in Indigenous Populations

Cardiovascular disease refers to a class of diseases that concern the heart or circulatory system. In Canada, cardiovascular disease is the leading cause of death of Métis men and First Nations men and women (11). The prevalence rate of cardiovascular disease is 2.5 times higher amongst Indigenous Canadians than European Canadians (3). Encouragingly, British Columbia has seen a decline in the rates of ischemic heart disease however these rates are still approximately 25% higher in Indigenous over non-Indigenous populations (1). The majority of the research quantifying rates of cardiovascular disease amongst Indigenous adults appear to be conducted more than 10 years ago and needs to be updated (60,61). More recent studies have evaluated the modifiable and non-modifiable risk factors for cardiovascular disease amongst Indigenous populations, including family and personal history, smoking, diet, obesity, abdominal obesity, cholesterol levels, glucose intolerance and blood pressure in adults and youth (3). Research has strongly suggested that the onset of atherosclerosis, which is the buildup of plaque in the arteries that can lead to a heart attack or stroke, likely develops during childhood and youth (62). This highlights the critical importance of educating and addressing cardiovascular risk starting at a young age, rather than waiting until adulthood or after clinical manifestations occur. Important modifiable risk factors for atherosclerotic CVD include diet, obesity, smoking, lipid profiles, blood pressure, physical activity and physical fitness (63).

2.2.1.1 Diet

Colonialism, land dispossession, the residential school system, the Sixties Scoop, and displacement from traditional territories has forced many Indigenous people to shift away from

traditional foods to a more “Western” diet, which has had considerable influences on health status (64). For many Indigenous people, eating traditional foods is essential for good health, wellness and cultural identity (65,66). Dietary analysis of First Nations communities from British Columbia, Alberta, Manitoba and Ontario reported a high prevalence (53.9%) of ultra-processed foods consumed in a day (67). Participants who reported eating more traditional food (plants and wild game) also reported eating less ultra-processed food, reiterating the importance of eating traditional food (67). However, lack of access to traditional food sources, as well as the loss of traditional hunting and gathering knowledge, has led to increased consumption of refined food including flour and sugar (64,68). Many Indigenous families experience food insecurity, defined as inconsistent access to food due to either limited availability or the inability to pay for food (69). Availability and cost of healthy food, especially in isolated areas, makes it difficult to obtain foods of nutritional value (57,70). Further, Indigenous populations living on or off the reserve are amongst the poorest in all of Canada (26). Healthy, nutritious food is often expensive and many low-income household have no choice to but to choose low-cost, high calorie food (71). Food insecurity is linked to poor health outcomes in Indigenous populations, including obesity, stress, and poor mental health (69,72,73). Indigenous populations are more vulnerable to food insecurity, with the Canadian Community Health survey reporting 33% of off-reserve Indigenous households experiencing food insecurity compared to only 9% of non-Indigenous households (73,74).

2.2.1.2 Obesity

Indigenous adults and youth have a high prevalence of obesity that has been well documented in the literature (5,69,75–78). National studies, including the Canadian Community Health Survey and First Nations Regional Longitudinal Healthy Survey, reported adult obesity rates of 26% in First Nations living off-reserve, 22% in Metis and 26% in Inuit (11,79). Similar

rates of obesity amongst children and youth have been reported with a further 29% of children being overweight (11,79). Obesity in childhood is a strong predictor for obesity in adulthood, which is linked to a variety of co-morbidities including cardiovascular disease, insulin resistance, type 2 diabetes, dyslipidemia, high blood pressure and stroke (80). These chronic diseases and conditions impair quality of life and cause premature death. Some of the predictors of obesity including low socioeconomic status, food insecurity and physical inactivity are highly prevalent in Indigenous communities and can be directly attributed to the impact of colonialism (64,77). The influence of the residential school system on the risk for obesity and diabetes can also not be overlooked (81).

2.2.1.3 Smoking

Indigenous populations engage in higher smoking rates compared to non-Indigenous populations (10). This is true of Indigenous youth as well, with Indigenous youth living off-reserve experiencing double the smoking rates of non-Indigenous youth (82). Other reports in some communities have found rates as high as 50% of youth surveyed are currently smoking with smoking initiation reported to begin at age 4 (83,84). Approximately 57% of First Nations on-reserve and 32% of First Nations off-reserve are current smokers, more than double the rate of 15% in non-Indigenous people (77,79). Métis and Inuit smoking rates are similarly disproportionately high at 30% and 39% respectively (77). Consequently, all three groups also experience higher rates of second hand smoke in the home, compared to only 7% in non-Indigenous populations. Smoking is well known to cause respiratory diseases, heart disease and lung cancer as well as increase risk of pregnant mothers having premature or low birth weight babies (85). In British Columbia, smoking-attributable mortality accounted for 28.6 deaths per 10,000 First Nations people in 2001 and an estimated 17.3% of all deaths could have been

prevented with the elimination of smoking (86). Although smoking-attributable mortality is comparable to the non-Indigenous population, culturally appropriate smoking prevention and cessation programs for First Nation communities have been advocated for due to the disproportionate number of Indigenous people who are current smokers.

2.2.1.4 Blood pressure

Hypertension, also known as high blood pressure, is defined as consistently elevated blood pressure above 140 mmHg systolic blood pressure or 90 mmHg diastolic blood pressure (87). Hypertension is of medical concern due to its associations with atherosclerosis, heart attack, stroke, kidney damage and cardiovascular disease mortality (88). Limited information is available about hypertension amongst Indigenous adults but a recent review conducted by Foulds and Warburton suggests a low prevalence of hypertension when compared to the general population or other ethnic groups (89). Although this is encouraging, ethnic specific guidelines may be needed as Indigenous populations experience higher rates of stroke compared to non-Indigenous populations (3,90). One explanation proposed to explain the discrepancy is that hypertension is generally associated with age and the Indigenous population is relatively young (89). More research is needed to understand the trend of normal blood pressure combined with high rates of other chronic diseases seen in Indigenous communities.

2.2.1.5 Cholesterol levels

Dyslipidemia, high levels of cholesterol in the blood, are associated with an increased risk of atherosclerosis and coronary heart disease (79). Despite disproportionately high rates of cardiovascular disease, minimal studies have reported on levels of dyslipidemia amongst adult Indigenous populations. In the Oji-Cree First Nation community of Sandy Lake, 48% of adults were found to have low levels of high-density lipoprotein (HDL), which is considered protective

against atherosclerosis (91). In a First Nation community in Alberta, 73% adults had abnormal HDL levels and 44% had abnormal triglycerides (92). Interestingly, in both studies low rates of HDL were the second most prevalent abnormality of the metabolic syndrome, following elevated waist circumference (91,92). As smoking is associated with decreased rates of HDL, it is possible that the dyslipidemia may partially result from the high rates of smoking seen in Indigenous communities (93,94). Much still needs to be done to quantify and address dyslipidemia amongst Indigenous populations to help prevent the development of cardiovascular disease.

2.2.1.6 Glucose Intolerance

In many Indigenous communities across Canada, rates of type 2 diabetes are disproportionately high compared to non-Indigenous populations (95). For example, type 2 diabetes prevalence is 40% higher among First Nations populations living in British Columbia (96). Adverse complications associated with diabetes, including cardiovascular disease, lower limb amputation, retinopathy, kidney disease, hypertension and nervous system disorders, and diabetes mortality occur at higher rates among Indigenous populations (97,98). This has largely been attributed to earlier onset of diabetes, reduced access to health care due to geographical barriers and social determinants of health (97,99)In addition, rates of gestational diabetes among First Nations women are 2-3 fold higher than other ethnicities, which increases the risk for both mother and child developing type 2 diabetes in the future (96).

2.2.1.7 Physical activity

The effects of physical activity have been widely researched for decades, with an overwhelming and irrefutable amount of evidence suggesting that physical activity is beneficial for physical and mental health (34,100). Regular physical activity reduces risk for multiple chronic diseases including cardiovascular disease, diabetes mellitus, cancer (particularly colon and breast),

obesity, hypertension, bone and joint diseases such as osteoporosis and osteoarthritis, and depression (30,100). Physical activity is not only important for the prevention of cardio-metabolic disease, but also for the management of diagnosed diseases. For example, engaging in regular aerobic and/or resistance exercise improves glycemic control in individuals with type 2 diabetes (101–103). Similarly, individuals diagnosed with coronary artery disease who participate in physical activity have shown to undergo weight loss, improve lipid profiles, decrease inflammation, and experience lower rates of cardiac events (104). Physical activity is also strongly associated with reduced risk for premature mortality from all-cause and cardiovascular-related death (34,105). However, despite the overwhelming evidence demonstrating the benefits of physical activity, only 21% of First Nation Canadian adults engage in regular moderate and vigorous physical activity (56). Amongst North American Indigenous adults, a review conducted by Foulds and colleagues found similar rates, reporting 27.2% of 151,213 adults included in the review were found to meet international guidelines of 150 minutes of moderate to vigorous physical activity (52,106). It is important to note that these guidelines are for optimal health benefits and marked health benefits can occur at much lower doses of physical activity (34,107,108).

Physical inactivity is a modifiable risk factor for the development of cardio-metabolic diseases including heart disease, type 2 diabetes and obesity (34). Physical inactivity, often operationally defined as not meeting physical activity guidelines, has been associated with cardio-metabolic risk biomarkers including poorer measurements of waist circumference, body mass index, systolic and diastolic blood pressure, lipid profiles and glucose (106,109). Physical inactivity is the fourth leading cause of death worldwide (110). Amongst First Nation populations, if 21% of adults are sufficiently active, approximately 79% are insufficiently inactive (52,56,111).

The rise of inactivity has been largely attributed to the technological innovations that have dramatically changed the way humans sit and move about their day (112). Amongst Indigenous populations, the rise of inactivity is also a result of colonialism, the residential school system, and the loss of their traditional, active lifestyle (10). Correspondingly, the rates of chronic diseases linked to physical inactivity, particularly obesity, cardiovascular disease, and type 2 diabetes have dramatically increased (10,30,113,114). Culturally appropriate and safe physical activity interventions in communities are needed for the prevention of cardio-metabolic diseases, starting in childhood and continuing across the lifespan (52).

2.2.1.8 Physical Fitness

As discussed previously, similar to physical activity, physical fitness is a modifiable risk factor for the development of obesity, metabolic syndrome and cardiovascular disease (34,45). Health-related physical fitness, including cardiorespiratory fitness and musculoskeletal fitness, has been shown to improve with multiple types of training (50,115–117). There is a plethora of research that has demonstrated that aerobic exercise improves cardiorespiratory fitness in many different populations, ranging from youth to older adults (107,117,118). Although difficult to ascertain the minimal dose needed to improve cardiorespiratory fitness, walking five days a week at a low intensity of 45% of maximal aerobic capacity and expending 1000 kcal per week was sufficient to improve VO_2max in healthy, older women (108,119). Similarly, a multitude of research demonstrates the effectiveness of resistance training for improving components of musculoskeletal fitness in a variety of populations (50,115,120) Grip strength is a simple and valid tool for measuring muscular strength that has shown to be strongly associated with the development of chronic disease, disability, and premature mortality (51,121,122). In older, sedentary and hypertensive women, resistance training targeted at major muscle groups twice a

week for 12 weeks was sufficient to improve grip strength (123). For sedentary individuals, engaging in routine physical activity can be sufficient to improve musculoskeletal fitness (50,115).

However, limited data is available on the heath-related physical fitness of Indigenous adults living in Canada (52). A recent review by Hedayat and colleagues examined cardiorespiratory fitness amongst North American Indigenous populations (124). Their findings indicated that cardiorespiratory fitness amongst Indigenous populations has declined most likely as a result of loss of a traditional, active lifestyle (124–126). This was most evident in two decades of research conducted by Rode and Shephard with Inuit adults that found that VO_2max and peak muscle force, as measured by handgrip strength and length extension force, significantly declined over time with the rapid rise of an urban, sedentary lifestyle (125). Use of snowmobiles, private vehicles, televisions, computer games and the lack of hunting expeditions were cited as probable explanations for marked declines in cardiorespiratory and musculoskeletal fitness (125).

Despite grip strength being a strong predictor for mortality, morbidity and disability, only a few studies have evaluated grip strength in Indigenous adults, mostly in Elders or individuals living with chronic disease such as diabetes or arthritis (51,127–130). More research is needed to further assess levels of cardiorespiratory fitness and muscular strength as well as develop strategies in consultation with community to improve physical fitness.

Chapter 3: Physical Activity Interventions Amongst Indigenous Populations in North America: A Systematic Review

This chapter provides an overview of the existing literature pertaining to physical activity interventions with Indigenous communities that used direct measures of physical activity and fitness.

3.1 Introduction

Cardiovascular disease, obesity and type 2 diabetes are highly prevalent among Indigenous peoples of North America (1,79,131). While select chronic diseases are on the rise across North America, Indigenous populations are disproportionately affected by cardiovascular disease, obesity and type 2 diabetes (3,5). This is problematic as these diseases not only cause pre-mature mortality but also impact quality of life (97,132,133).

Cardiovascular disease is the leading cause of death in Indigenous populations in the United States and is either the first or second leading causes of death in Canada depending on the group surveyed (11,60,134,135). Approximately 6% of First Nations on-reserve, 11% of First Nations off-reserve, 10% of Métis and 9% of Inuit populations were reported to have cardiovascular disease compared to 14% in the general population (77,79). However, risk factors for cardiovascular disease, including smoking and obesity, were considerably higher for Indigenous populations (77,79). In Canada, Indigenous people's smoking rates ranged from 30-39% compared to 15% among non-Indigenous populations (77). In the United States, American Indian and Alaskan Native youth and adults have the highest prevalence of cigarette smoking among all racial/ethnic groups with regional rates of 44% for males and 37% for females being reported (92, 93).

Obesity rates are significantly higher among Canadian Indigenous adults, 37.8% compared to 22.6% in non-Indigenous populations (5). A sample conducted in Saskatchewan reported obesity rates of 26% among First Nations, 22% for Métis and 26% for Inuit compared to 16% in non-Indigenous populations (77). Similar rates around 30% among American Indians and Alaska Natives have been reported (138). Obesity in youth is on the rise with estimates ranging from 15-38% of Indigenous children and youth being obese (5,75,139). Childhood obesity is a key predictor of adulthood obesity and even if the weight is lost in adulthood, there is an increased risk of morbidity and premature mortality (140). Similar evidence of co-morbidities, including hyperlipidemia, high blood pressure and elevated glucose levels, are seen between obese children and adults (140).

Type 2 diabetes is of particular concern in Indigenous communities. While variable by region and community, rates of type 2 diabetes among Indigenous populations are 3-5X higher than non-Indigenous populations (6–9). Community studies with older Canadian adults have found rates as high as 50% in First Nations women and 40% in First Nations men aged 60 or older (141). In the United States, diabetes prevalence among Indigenous populations is estimated to be 16%; however community rates have been found to vary from 5.5% in Alaska Natives to 33% in American Indians in Southern Arizona (142). Indigenous Canadian and American Indian youth to have the highest risk for developing type 2 diabetes when compared to other ethnicities (97).

Despite the multitude of studies that quantify the prevalence of chronic disease among Indigenous populations in North America, there is an overwhelming lack of intervention studies focused on promoting health and preventing chronic disease among Indigenous communities through the use of physical activity (52). Physical activity is a well-documented primary and secondary preventative measure against chronic diseases such as cardiovascular disease, diabetes,

obesity and hypertension (34,143,144). Levels of physical activity in Indigenous populations are difficult to determine due to a lack of research (52,56,124). Of the limited research available, the consensus suggests that most Indigenous adults in North America are not meeting recommended levels of regular physical activity (38,145). In Canada, an estimated 21% of Indigenous adults were found to be meeting national and international guidelines and engaging in moderate to vigorous levels of physical activity three to four times per week (38). Increasing physical activity levels in North American Indigenous populations should be made a priority; however, a review conducted by Foulds and colleagues found only 17 published articles with physical activity interventions across North America (52). In Canada, 5 physical activity interventions with Indigenous adults were identified and only 1 study was found to objectively measure physical activity (31). Although easier to measure, self-report levels of physical activity (e.g. questionnaire, diary) have been found to be unreliable measures of physical activity (40). When comparing self-report to direct measures of physical activity, such as accelerometers, low to moderate correlations have been found with no clear patterns emerging for over or under reporting (40,146). As such, it is imperative to include direct measures of physical activity for validity, accuracy and reliability.

It should be noted that levels of physical activity are not the only measurement of health. Research has shown that physical fitness, defined as "a physiologic state of well-being that allows one to meet the demands of daily living or that provides the basis for sport performance, or both" is similar predictive of morbidity and mortality (34,42). In relation to cardiovascular disease risk factors, physical fitness has been shown to be of better predictor value than physical activity (34,43). Therefore, this systematic review examines articles reporting on physical activity interventions with North American Indigenous communities that included an objective measure of physical activity or physical fitness.

3.2 Methods

3.2.1 Inclusion and Exclusion Criteria

Studies eligible for inclusion included those with a physical activity intervention conducted with North American Indigenous populations (First Nations, Métis, Inuit, American Indian, and/or Alaska Natives). To be included, studies had to have a clear, regular physical activity component within the intervention as well as an objective measure of physical activity or physical fitness pre and post intervention. Excluded studies included those who only used measures of self-report for physical activity levels or investigations with multiple ethnic groups where data for Indigenous populations could not easily be separated. All ages (children, youth, adults, Elders) were eligible for inclusion as were controlled and uncontrolled studies.

3.2.2 Study Selection and Data Extraction

Details of search strategy can be found in Appendix A. Search results were evaluated for inclusion through a multi-step process conducted by two reviewers independently. Duplications were first removed by citation title before screening began. Each article was screened for inclusion based on title, abstract and full text. At each level, the number of exclusions was recorded and reasons for exclusion were provided for full text screening (Figure 1). Reviewers had an 83.3% agreement and discrepancies were resolved through discussion and consensus. Reviews and key articles were cross-referenced to search for additional studies to include. Data was extracted using a standardized data extraction form and verified by two reviewers. Information of interest included study design, country, baseline characteristics of population, details and location of intervention, physical activity outcomes as measured by direct tests, health-related outcomes and compliance with OCAP ® principles relating to the ownership, control, access, and possession of the data.

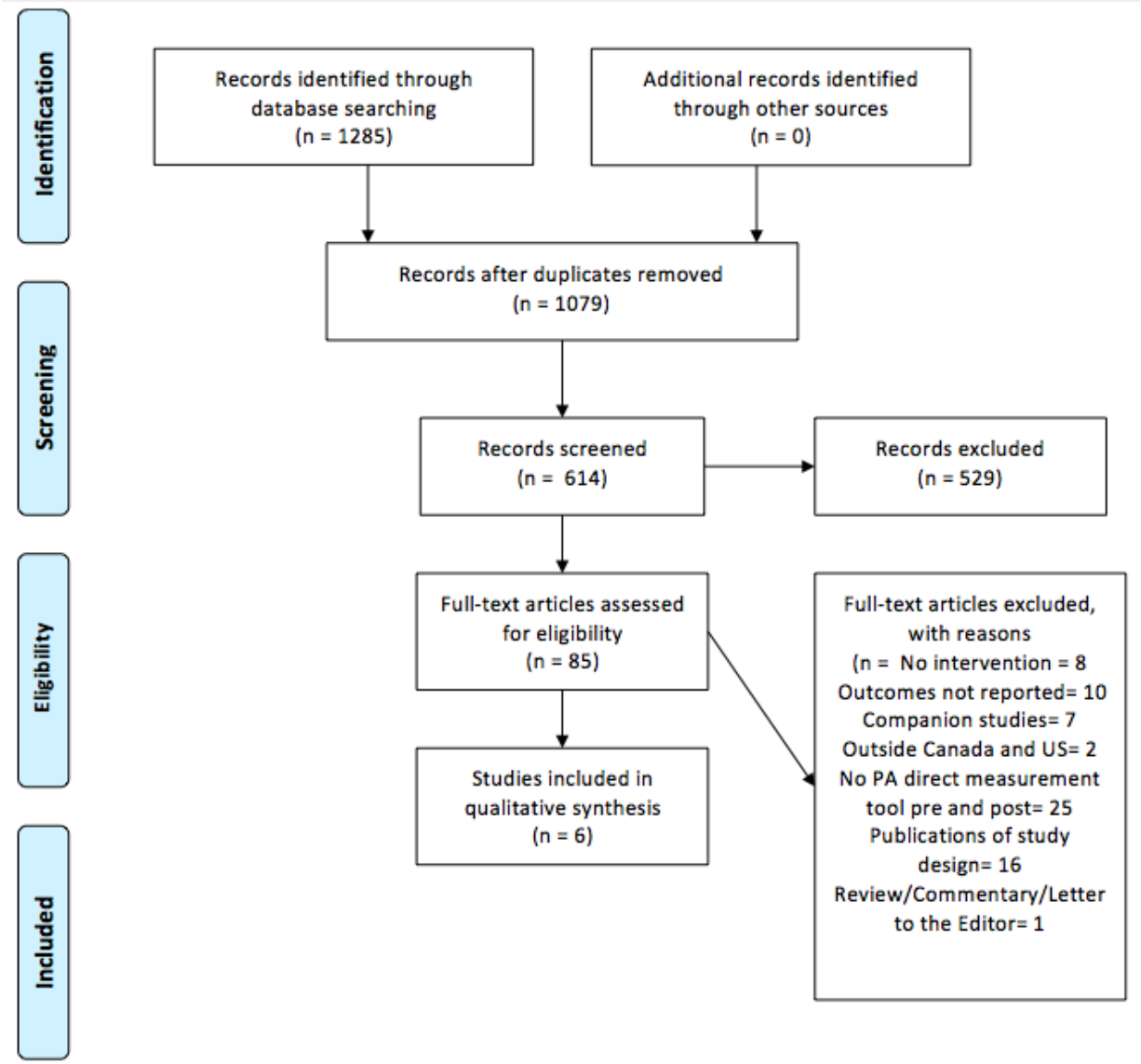

Figure 1 Citations examined for systematic review of physical activity interventions with direct measures among Indigenous populations of North America

3.2.3 Quality and Level of Evidence

The quality of the articles was assessed independently by two reviewers according to the Downs and Black Scoring System (147). Each included article was given a score out of 27 with consensus achieved through discussion.

3.3 Results

3.3.1 Literature Search Findings

Initial searches identified 1285 articles with 1071 articles being screened after duplicates were removed (Figure 1). A total of 989 articles were excluded after title or abstract review, leaving 81 articles remaining for full text review. Six articles were assessed as meeting eligibility criteria and were included in the narrative synthesis (Figure 1).

Of the six included studies, the quality of the study methodology averaged 15.2 ± 2.3 of 27 criteria, ranging from 11-18. Four of the six included studies were approved by the Indigenous community involved; however, zero studies publically recognized that the data belongs to the community. Only two of the six included studies employed community collaboration and reported ongoing research relationships (23,148).

3.3.2 Population and Community Characteristics

Two of the included studies were conducted with Indigenous groups in Canada, one in British Columbia and 1 in Quebec. The remaining four included articles were conducted across the United States, including the states of Washington, Arizona, New Mexico, and South Dakota. All studies were conducted with First Nations or American Indian participants. One of the six studies also included Alaskan Native participants (149). The studies ranged in age demographics; five studies were conducted with youth, and one study with Elders. The settings of the included articles ranged greatly with one study conducted in an urban center, three studies in community schools on reserve and two investigations unspecified. The studies with children and youth were exclusively conducted in schools.

3.3.3 Intervention Characteristics

Interventions ranged greatly among included articles in delivery, targeting either increasing physical activity (23,150), or obesity and types 2 diabetes prevention (148,151,152), or self-evaluation and substance use (153) (Appendix B). Three of the interventions were multi-faceted, comprising of an educated component focused on promoting physical activity and healthy diets (23,151,152). School based interventions focused on providing opportunities for physical activity through increasing frequency of physical education classes, increasing time of recess and incorporating physical activity breaks in the classroom throughout the day (23,148,151–153). Intervention lengths ranged from 6 weeks to 3 years.

3.3.4 Physical Activity and Fitness Outcomes

Levels of physical activity were assessed in five of the six included articles, with three studies using accelerometry while the remaining two studies used pedometry. Results from the studies that used accelerometry reported no significant changes in physical activity levels after the intervention compared to baseline (23,151,152). In contrast, the study conducted by Sawchuk and colleagues reported significant changes in step counts and levels of physical activity among Elders (150).

Physical fitness was assessed pre and post intervention in five studies; cardiorespiratory fitness was measured using the 6MWT (150), the Leger Shuttle Run (23,148) and Cooper's 12 Minute Run (153), while musculoskeletal fitness was assessed using curls ups and push ups (148). Two studies also assessed hamstring flexibility through the sit and reach test (148,153). Results of the studies that assessed physical fitness were mostly positive. All five articles reported significant improvements in cardiorespiratory fitness after the intervention, including increased distance in the 6MWT and Cooper 12 Minute Run as well as increased laps on the shuttle run (23,148,150,153).

Girls and boys significantly improved their push-ups with girls also improving their curl-ups as well at follow-up (148). Hamstring flexibility was found to improve in one study but not the other (153).

3.3.5 Health Outcomes

Body Mass Index (BMI) was the most commonly measured health outcome and was not found to improve after the interventions. Rather, three of the four included articles found that BMI had significantly increased at follow-up (148,151,152). Other measured outcomes included Quality of Life, Self-Esteem Inventory, Physical Self-Efficacy scale, waist circumference, percentage body fat, blood pressure, insulin sensitivity, fasting glucose, cholesterol levels and triglyceride levels. Improvements were seen in the vitality, social functioning and mental health subscales on the Quality of Life questionnaire in one investigation (150). Another included study also found improved fasting plasma glucose levels and decreased diabetes at follow-up compared to baseline (148). No other significant improvements were seen in follow-up after the interventions.

3.4 Discussion

The focus of this systematic review is to report on health-related interventions that objectively measured levels of physical activity or physical fitness in North American Indigenous populations. What has become evident from this review is the minimal use of direct measurement tools by researchers for capturing changes in physical activity or physical fitness among Indigenous communities.

This review reveals that studies that included regular physical activity sessions as a component of the intervention reported significant improvements in physical fitness, specifically cardiorespiratory fitness. Among Indigenous children and youth, incorporating regular aerobic exercises in physical education class at school was sufficient to improve cardiovascular fitness at

follow-up. In previously sedentary Elders walked significantly further in the 6MWT after a simple six week walking program. Improving cardiorespiratory fitness is associated with a reduction for premature mortality, with individuals who have the lowest fitness level experiencing the greatest risk reduction after improving cardiovascular fitness (154). An increase in exercise capacity by 1 peak metabolic equivalent (MET) has been shown to reduce risk of mortality by 10-15% in both sexes and up to 30% in adults with low fitness (154–156). Although this same relationship has not been established in children and youth, improvements in cardiorespiratory fitness may help offset the negative consequences of childhood overweight and obesity (23,157). Although the available research is limited and outdated, the cardiorespiratory fitness of Indigenous populations is believed to be declining (124). This can be largely attributed to the loss of a traditional, active lifestyle combined with low socioeconomic status, availability of resources and geographic isolation (158,159). While more research is needed, improving the cardiovascular fitness of Indigenous populations may be an appropriate chronic disease prevention strategy (124).

In contrast, the studies that included measurement of patterns of physical activity reported no significant changes (23,151,152). All three studies cited insufficient time monitoring participants as a possible reason for not finding significant changes in physical activity. In addition, the Pathways Obesity Prevention Program reported monitoring different participants at baseline and follow-up, further contributing to methodology issues with these two studies (151,152). The use of accelerometers, although more reliable and valid compared to self-report, has drawbacks including the high expense and in some cases, the technical expertise needed to download and analyze the results (40,160). The remoteness of some communities requires travel for researchers who do not live in the community, which can limit the amount of time available for

follow-up. The use of cardiorespiratory fitness tests rather than accelerometers may be of more value when working with Indigenous populations.

All of the interventions were focused on the promotion of physical activity except one study conducted by Scott and Myers which was aimed at increasing self-enhancement on substance use through fitness training (153). This may reflect a difference in health priorities at the time in the 1980s as substance abuse was considered to be "the most serious health problem facing Native Americans" (161). Only recently have chronic diseases such as cardiovascular disease, type 2 diabetes and obesity emerged as a health concern among Indigenous populations (97,162). Historically, chronic diseases were relatively rare while infectious diseases posed more of a problem (163). Although some infectious diseases still pose an issue, the rise of lifestyle chronic diseases, disproportional to the general population, has become a health priority among Indigenous communities (9,25,77,79).

Previous physical activity interventions among Indigenous adults have been shown to improve risk factors for chronic disease such as body mass index, waist circumference, total cholesterol, and blood pressure (18,20,21). However, this review revealed that interventions with a direct measure of physical activity or fitness reported minimal positive changes in health outcomes beyond physical fitness. All of the interventions aimed at children and youth were exclusively conducted in schools (23,148,151–153). Body mass index was the most commonly reported measurement, with 3 out of 4 studies reporting significant increases in Indigenous children and youth after the school-based intervention despite increases in physical activity and fitness (148,151,152). This finding is consistent with other school-based interventions in Indigenous and non-Indigenous children and youth (164–166). Although difficult to determine the exact cause, lack of improvements in BMI may be partially attributed to the role of diet (166). Many factors

that predict overweight and obesity, including low socioeconomic status, food insecurity, and availability of healthy foods, are common in Indigenous communities and beyond the control of a school-based intervention (77,79,164). In addition, the amount of physical activity provided through physical education classes ranged from 75- 90 min, which may have been an insufficient dose to improve BMI. Among adults, 200-300 min of moderate intensity activity is recommended for long-term weight loss (167). Schools are constrained by the curriculum, limiting the amount of time that can be dedicated to physical activity. Alternatively, the amount of physical activity time may have been sufficient for children with a higher BMI, but the effects were attenuated in the entire population (166). The effect of physical activity on reducing BMI has been greater in children with obesity, compared to children without obesity (168). Based off the available data, further research is needed to ascertain whether school-based interventions are the best method of delivery for Indigenous children and youth or whether an alternative method would produce significant changes in BMI.

Community based, participatory research (CBPR) is recently considered to be "best practice" when working with Indigenous populations in a research setting (169,170). To briefly summarize, CBPR is a collaborative research practice that involves community members, organizational representatives, and researchers in all phases of the research process to address a locally relevant issue (171,172). Through this collaborative approach, researchers seek to minimize the power inequalities that exists between researchers and underrepresented minorities by fully involving participants with every step of the project, including contributing knowledge, sharing decision making and ownership of the project (170). However, of the included studies in this review, only 2 of the articles reported using CBPR methodologies while the remaining articles reported limited or no engagement with the communities involved. This is problematic as it serves

to reinforce the colonial power imbalances that has plagued Indigenous research for decades, further contributing to the lack of distrust for research in Indigenous communities (173). While reconciling what CBPR entails and bridging together Western research practices with Indigenous knowledge can be difficult, the collaboration, relationships and process based inquiry is vital for the success of research with Indigenous people (28,174).

There are a number of limitations for this review. The first limitation is that despite authors' best intentions, some pertinent studies may have been missed. Selection bias may have occurred due to chosen databases and interventions published outside of academic databases were not included. The second limitation is that interventions were highly variable in age demographic, region and measurements tools, making it difficult to compare studies and impossible to conduct a meta-analysis. Further, research tends to group populations together, however it must be acknowledged that each community participating in the included studies has their own set of traditions, culture, values, barriers, and political environment. The third limitation is the lack of available research from Indigenous communities that evaluates changes in physical activity and fitness as measured by objective tools. Other reviews have noted the lack of available literature regarding physical activity interventions among Indigenous communities (31,52,175). Among the articles that did collaborate with Indigenous communities, many used measures of self-report rather than direct measurements of physical activity (18,20,22). This is problematic due to the inaccuracy of self-report when compared to direct measurement and questionnaires may not be sensitive to changes in physical activity levels (40). Further collaborative research is needed to address the prevalence of cardiovascular disease, diabetes, obesity and low levels of physical activity reported in Indigenous communities, starting with physical activity interventions.

3.5 Conclusions

The present systematic review included seven studies that directly measured levels of physical activity or physical fitness in North American Indigenous populations. Interventions that measured changes in cardiorespiratory fitness reported significant findings while those that measured levels of physical activity through accelerometers found no significant changes after the intervention. As physical fitness is similarly predictive of mortality and morbidity as physical activity levels, incorporating measures of cardiorespiratory fitness in future interventions may be of benefit to participants and researchers. In addition, this may overcome the difficulties with using accelerometers while proving to be more reliable than self-report. Further research is needed to develop interventions that address the health disparities in comparison to the general population that Indigenous communities face in North America.

Chapter 4: Thesis Investigation: Effectiveness of a community based physical activity intervention on the physical fitness of Indigenous adults

The purpose of this chapter is to provide a rationale for the thesis investigation, a detailed description of the method, presentation of the results and a discussion of the findings.

4.1 Introduction/ Purpose/ Rationale

Indigenous populations across Canada have disproportionately high rates of cardio-metabolic diseases (95,97,176). Obesity, a co-morbidity of cardiovascular disease and type 2 diabetes, is highly prevalent in many Indigenous communities (5). Physical activity is a well-known protectant against cardio-metabolic diseases and obesity, yet there are limited community interventions focused on promoting physical activity (31,34,52). Of the published interventions, the majority of these studies did not use direct measurements such as accelerometers or pedometers to measure change in physical activity, but rather relied on self-report. Direct measures are much more accurate and valid compared to self-report, however they can be expensive, time intensive, intrusive and require specialized training (40). Physical fitness is similarly predictive of morbidity and mortality and can be accurately assessed in community with simple tests such as the 6MWT and hand grip strength test (45,124). The Aboriginal Run Walk (ARW) and HealthBeat programs have already been shown to be effective in improving health profiles and behaviors of Indigenous adults (18). This intervention seeks to evaluate if this community-based intervention is also successful for increasing physical fitness in Indigenous adults. We hypothesized that our physical activity intervention would be effective in changing the cardiorespiratory and musculoskeletal fitness of participants who adhere to the program.

4.2 Procedures and Methods

Ethics approval for this research was obtained from the University of British Columbia's Research Ethics Board. The research was conducted under ethics approval certificate H07-03187.

4.2.1 Participants

In conjunction with SportMedBC and the Indigenous Sport, Physical Activity and Recreation Council (ISPARC), Indigenous communities were invited to participate in a 13 week training program known as the Aboriginal RunWalk. Of the participating communities, six expressed interest in hosting a HealthBeat Screening, a pre and post health screening program that provides opportunity for participants to learn about their health and experience how physical activity can improve health. All participants of the HealthBeat program were over the age of 18 and self-identified as First Nations, Métis or Inuit. Participants had to be members of the Aboriginal RunWalk program and over 18 yr, but no other exclusion criteria existed. As a result, participants varied greatly in age, chronic disease status, and previous levels of physical activity.

4.2.2 Recruitment

All participants were recruited through their Aboriginal Run Walk Leader, who was responsible for leading the Aboriginal RunWalk physical activity program in their respective community. These leaders ran their program out of their school, health services department, recreation department, school, or other work organization. Recruitment for this study occurred solely in the community, the academics responsible for this project had no involvement whatsoever with the recruitment process.

4.2.3 Sample Size

Based off *a priori* calculations using G Power version 3.1.9.2 software, a sample size of 14 was needed to detect a change in the primary outcome variable (physical fitness) with a power of

80% and an α=0.05. The reference population used to calculate effect size was from Foulds and colleagues as this is the same intervention with a different group of participants (18). In preparation for a 50% attrition rate, a sample size of 28 adults was needed.

4.2.4 Testing Days

Testing Day 1: Baseline

Adults participating in the Aboriginal Run Walk Program who consented to participate in this study underwent a HealthBeat screening prior to the start of their training program. All screenings occurred in community, either at a health center, band office or community hall. To begin, a series of questionnaires that assessed family and personal history of cardio-metabolic disease, as well as health behaviors were administered to participants. Next, anthropometrics were taken behind the privacy of a screen. Resting blood pressure and heart rate were taken afterwards, followed by a grip strength test. Tests for cholesterol and glucose levels were taken with a finger prick. A 6-minute walk test was also conducted. The HealthBeat screening concluded with a goal setting and counseling session where participants reviewed their results with a certified exercise professional and set health-related goals.

Testing Day 2: Follow-up

Thirteen weeks after baseline assessments were taken, a post health screening was offered in each community at the same venue. To assess participation in the Aboriginal RunWalk program, participants were asked what percentage of Aboriginal RunWalk program did they complete. Options included less than 50%, 50-74%, 75-99% or 100%. All other measurements were repeated, with the exception of questions pertaining to family and personal history of heart disease and diabetes as well as menopausal status for women.

4.2.5 Methods

Prior to the first health screening, Aboriginal RunWalk leaders and participants were instructed to register on SportMedBC's website for the Aboriginal RunWalk Program. During registration, participants completed the Physical Activity Readiness Questionnaire (PAR-Q+) and self-selected a training program: Walk10K, LearnToRun10K or Run10KStronger. On the day of the health screening, participants who agreed to be in the study signed an informed consent form (Appendix C). Participants who had not registered online prior to the first day of testing, underwent pre-screening for contraindications to exercise using the PAR-Q+ (177). Each participant was given a brief overview of the tests taken before commencing screening and given a results sheet (Appendix D) as well as a "health passport" to keep where results were recorded and compared to normative ranges (Appendix E). Participants were encouraged to bring their health passport to follow up appointments with local health professionals.

A detailed description of the methods used for data collection has been described elsewhere (18,178). Briefly, the health screen began with a series of questions to determine prevalence and risk factors for cardiovascular disease and type 2 diabetes. Questions included family history of cardiovascular disease, personal history of cardiovascular disease and type 2 diabetes, menopausal status (for women), and smoking behavior. Family history of heart disease was defined as having an immediate family member (parent, sibling, child) who had heart disease before the age of 55 years in men and 65 years in women. Smoking-related questions included the number of cigarettes per day (if any), exposure to second hand smoke, and use of other commercial tobacco-related products. Use of traditional tobacco for ritual, ceremonial or prayer purposes was not recorded. Physical activity was assessed using the Healthy Physical Activity Participation Questionnaire as well as the Godin- Shepard Leisure Time Physical Activity Questionnaire. The Healthy Physical

Activity Participation Questionnaire assesses the frequency and intensity of physical activity on a weekly basis as well as perceived physical fitness that can be used to determine a health benefit rating from an accumulated score (179). Similarly, participants were asked how many times per week they exercise at strenuous, moderate and mild intensities for at least 15 minutes (180). This information was used to determine whether participants were active, moderately active or insufficiently inactive, as determined by the Godin- Shepard Leisure Time Physical Activity Questionnaire (180).

Anthropometric measurements, including height, weight and waist circumference were taken according to Canadian Physical Activity, Fitness, and Lifestyle Approach (CPAFLA) standardized protocols (179). To protect the privacy of the participants, these tests were conducted behind a screen. Participants were asked to empty their pockets and to take off their shoes, hats and jackets before stepping on the scale. Weight was measured in kilograms. Next, participants were asked to stand straight with their backs and heels against the stadiometer, to place their feet together and look straight ahead. Height was measured to the nearest centimeter. Body mass index (BMI) was calculated using the participant's weight in kilograms divided by their height squared in meters (kg/m^2). BMI was classified according to standard World Health Organization's classifications (181). Waist circumference (WC) was measured using the top of the iliac crest over a thin shirt. Participants were asked to point to their hipbones and a measuring tape was evenly placed around their body in line with the top of the hipbones. Participants were asked to cross their arms, then inhale and exhale. Upon exhale, the tape was recorded to the nearest 0.5cm. Abdominal obesity was classified by World Health Organization standards (181).

Next, participants were asked to be seated and quietly rest for one minute before blood pressure and resting heart rate was taken. Blood pressure and resting heart rate was assessed using

an automated machine (BP-TRU, model BPM-100, VSM Medical, Vancouver, BC). Different size cuffs were available for the testers. The blood pressure cuff was placed around each participant's non-dominant arm and their elbow was positioned straight resting on the table with their palm up. Participants were asked to have their feet placed on the ground and to refrain from talking or thinking while undergoing the test. After one reading, the scores were recorded. If the first blood pressure reading was greater than 120 mmHg systolic blood pressure (SBP) or 80 mmHg diastolic blood pressure (DBP), then second and third measurements were taken. If three blood pressure readings were taken, the average was recorded. Blood pressure classifications were considered normal if under 120 mmHg SBP and 80 mmHg DBP, elevated if between 130-139 mmHg SBP and/or 80-89 mmHg DBP, and high if above 140 mmHg SBP and/or 90 mmHg DBP. Previous diagnosis of hypertension and blood pressure medication use were recorded. Participants with elevated or high blood pressure readings were asked to have another blood pressure reading at the end of the health screening. If blood pressure reading remained high, the participant was referred to follow-up with their community health nurse or doctor. Participants with readings above 140 mmHg SBP and/or 90 mmHg DBP were classified as hypertensive.

After blood pressure, participants underwent a grip strength test using a dynamometer (Baseline Smedley Spring Dynamometers, Fabrication Enterprise Inc., White Plains, New York). Participants were asked to stand and instructed to position their fingers so that their second joints line up around the grip bar, which was adjusted if needed. Participants were asked to position their arm 45 degrees away from the body, to take a deep breathe in and to squeeze as hard as possible while exhaling. Grip strength was recorded in kilograms and the test was repeated on the other hand. Grip strength was tested twice on each hand and a combined grip score (using the highest

score recorded for each hand) was calculated. Combined grip strength classifications were ranked according to the CPAFLA (179).

Next, participants underwent a non-fasting finger prick blood test to obtain 35 μL of blood for the measurement of total cholesterol (TC), high density lipoprotein (HDL) and non-fasting glucose levels (Cholestech LDX, Cholestech, Inverness Medical, Hayward, CA). Participants were asked how many hours since their last meal and cholesterol and diabetes medication use were recorded. With the same finger prick, a 1 μL of blood was obtained for the measurement of glycosylated haemoglobin A1C levels (DCA Vantage Analyzer, Siemens, Tarrytown, New York). Diabetes was classified by an A1C measurement equal or greater than 6.5 $mmol \cdot L^{-1}$ or a non-fasting glucose measurement equal or greater than 11.1 $mmol \cdot L^{-1}$ (182). Participants with elevated or high levels of total cholesterol, non-fasting glucose, A1C or low levels of HDL were referred to follow-up with their community health nurse or doctor.

Participants then underwent a 6-minute walk test (6MWT) (183). Cones were laid out every 5 meters for a distance of 30 meters. Participants were instructed to walk as fast as possible without running between the cones for a total time of 6 minutes. Laps were counted and total distance in meters was recorded.

At the end of the measurements, all participants met with a trained health professional to discuss their results. Couples or family members were given the choice to attend a goal-setting session together or independently. During the discussion, participants were asked to identify areas of improvement and to develop health and fitness related goals. Informational handouts were provided regarding preventing and maintaining type 2 diabetes, cardiovascular disease, high blood pressure, cholesterol, glucose, grip strength, obesity, stress, physical activity and smoking cessation.

4.2.6 Physical Activity Intervention

The Aboriginal RunWalk (ARW) Program originated in 2007 when a First Nations leader from the Penticton Indian Band recommended bringing the community based model used by Sun Run InTraining clinics to First Nation communities. Since then, the program has successfully expanded to over 10,000 participants of mostly First Nations and Métis ancestry living in over 200 communities across British Columbia. In collaboration with SportMedBC and the Indigenous Sport, Physical Activity and Recreation Council (ISPARC), Indigenous communities are invited to send a member to an annual regional training session to learn how to lead a 13-week running and walking training program called the Aboriginal RunWalk Program. Hosted in 5 regions (Terrace, Prince George, Kamloops, Nanaimo and Abbotsford), the regional training sessions are an opportunity for community members from all over British Columbia to network, access resources and develop skills that they can bring back to their community. After the sessions, newly trained community leaders travel back to their home and are responsible for organizing a running and/or walking group in their community.

The 13-week free program consists of three training intensities building towards 10km: the Walk10K, LearnToRun10k or Run10kStronger, and participants choose which training intensity is best suited to them. As the names suggest, the Walk10K program is for those who want to improve their walking capacity, the LearnToRun10K uses interval training to gradually progress from walking to running and the Run10KStronger is for participants who already have a strong running base. Participants will meet up at least one a week for a group training session and be assigned two more sessions to be conducted either alone or in a group for a total of three training sessions a week. The ARW program culminates with participation in either the Sun Run or a local community event.

4.2.7 Statistical Analysis

Data analysis was performed using SPSS Version 20.0 software (SPSS Inc, Chicago IL). Descriptive data, including means and standard deviations, were calculated for all variables of interest. T-tests were used to identify any significant differences between those that attended follow up testing and those that could not attend. Paired samples t-tests were used to assess the changes in measures from pre- screening to post- screening with a significance level of $p<0.05$. Primary variables analyzed included grip strength, 6MWT distance and predicted VO_2 max. Predicted VO_2 max was calculated using the equation created by Burr and colleagues which uses the 6MWT distance, body weight, age, and resting heart rate (48). Secondary variables analyzed included BMI, WC, SBP, DBP, non-fasting glucose, A1C levels, TC, HDL, and TC/ HDL ratio. An in-depth analysis and discussion of these measures was not included in this thesis as this part of the program has been investigated previously (18). In order to evaluate the effect of cardiorespiratory and musculoskeletal fitness on change of health-related outcomes before and after the intervention, participants were grouped into fitness categories. To assess cardiorespiratory fitness, participants were grouped into three ACSM fitness categories (very poor, poor/fair, and good/excellent) using the Balke Treadmill test as a reference and based off their predicted VO_2max score at baseline, age and gender (47). This process was repeated for musculoskeletal fitness; participants were grouped into four CPAFLA fitness categories (poor, below average, average, and above average) based off their grip strength score at baseline, age and gender (179). The overall change in measures was calculated. Using the ACSM and CPAFLA fitness groups, ANOVA analyses were performed to compare the change in measures. Self-reported levels of moderate and strenuous physical activity were used to rank participants into insufficient, moderately active and

active levels of physical activity as determined by the equation provided by Godin and Shepherd (180).

4.3 Results

4.3.1 Participant Characteristics

Of the 2,377 Indigenous participants of the Aboriginal RunWalk program in 2018, six communities elected to host a health screening from a wide geographical representation of communities across British Columbia. A total of 147 adults underwent the health screening, with 87 adult participants giving consent to be included in this study. Participant Characteristics are presented in table 1. Chronic disease prevalence amongst participants ranged from 13.4-38.9%, depending on the disease (Table 1). Risk factors for chronic disease varied, with waist obesity being the most prevalent amongst participants. Family history of cardiovascular disease, obesity and physical inactivity were the next common risk factors that emerged. The rate of commercial tobacco use, either in the form of smoking cigarettes or using chew tobacco, was 24.4% with the majority of participants smoking 10 or less cigarettes a day. Due to the small sample size of Métis participants, the data was combined with data from First Nations participants.

Table 1- Participant characteristics at baseline.

Characteristics	Female (N=69)	Male (N=18)	*P-Value*
Age, yr (SD)	45 ± 14.4	42 ± 17.1	0.54
Self-identified First Nations	63 ± 91.3	14 ± 77.8	0.13
Self-identified Métis	2 ± 2.9	2 ± 11.1	0.14
Family CVD history, n (%)	42 ± 60.9	13 ± 72.2	0.79
Personal CVD history, n (%)	13 ± 18.8	3 ±16.7	0.87
Diabetes, n (%)	9 ± 13.4	5 ± 27.8	0.16
Hypertension, n (%)	21 ± 30.4	7 ± 38.9	0.53
Obese, n (%)	55 ±75.3	9 ± 50.0	0.02
Abdominally Obese, n (%)	67 ± 91.7	11 ± 61.1	<0.001
Current Smoker or tobacco user, n (%)	16 ± 23.1	4 ± 22.2	0.74
Physically Inactive, n (%)	50 ± 72.5	10 ± 55.6	0.29

SD, standard deviation; CVD, cardiovascular disease.

Of the 87 participants who consented to participate in this study, the majority were female. The age range of participants was 19-78 yr, with an average age of 44.6 ± 14.9 yr (Figure 2).

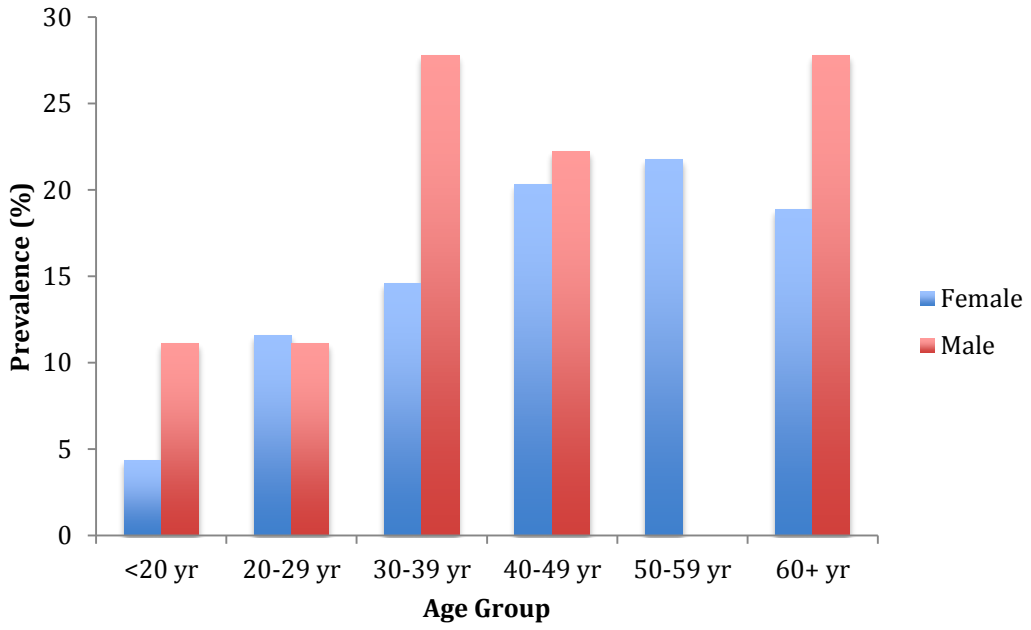

Figure 2 Age distribution of HealthBeat participants at baseline.

Participants who completed the post-screening did not significantly differ from those who only attended pre-screening, with the exception of three measures (Table 2). Average weight, BMI

and systolic blood pressure were found to significantly differ between the two groups, with participants who attended post screening having poorer results.

Table 2 HealthBeat program participant characteristics by attendance of post-screening sessions.

	Did not attend post screening (N=35)	**Attended post screening (N=52)**	***P-value***
Age (years) ± SD	42.7 ± 14.8	45.9 ± 15.0	0.32
Weight (kg) ± SD	84.1 ± 16.4	92.0 ± 17.6	0.04
BMI ($kg \cdot m^{-2}$) ± SD	30.9 ± 8.1	34.9 ± 6.8	0.02
WC (cm) ± SD	105.5 ± 13.8	112.2 ± 19.2	0.08
SBP (mmHg) ± SD	120.6 ± 18.0	131.8 ± 24.8	0.03
DBP (mmHg) ± SD	78.0 ± 13.6	82.8 ± 21.1	0.24
TC ($mmol \cdot L^{-1}$) ± SD	4.6 ± 1.0	4.9 ± 1.0	0.28
HDL ($mmol \cdot L^{-1}$) ± SD	1.3 ± 0.4	1.3 ± 0.4	0.72
TC/HDL ratio ± SD	3.9 ± 1.5	4.1 ± 1.6	0.58
Glucose ($mmol \cdot L^{-1}$) ± SD	6.8 ± 3.3	6.6 ± 3.5	0.83
A1C ($mmol \cdot L^{-1}$) ± SD	5.4 ± 1.1	5.7 ± 1.6	0.32
GS (kg) ± SD	59.6 ± 20.1	61.3 ± 22.1	0.71
6MWT (m) ± SD	493.6 ± 106.4	479.3 ± 107.4	0.54

BMI, body mass index; SD, standard deviation; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; HDL, high density lipoprotein cholesterol; A1C, glycosylated haemoglobin; GS, combined grip strength; 6MWT, 6-minute walk test.

4.3.2 Program Characteristics

For the self-selected program intensities, the majority of the participants chose to participate in the Walk10K program (65.9%), followed by the LearntoRun10K program (29.6%), with the Run10KStronger chosen the least (4.5%). Dropout rates for the Aboriginal RunWalk program were not available as participants may not have returned for the post-screening but continued on to complete the 13 week program. At post-screening, more than half (58.1%) of participants reported completing 50% or more of the Aboriginal RunWalk program sessions (Figure 3).

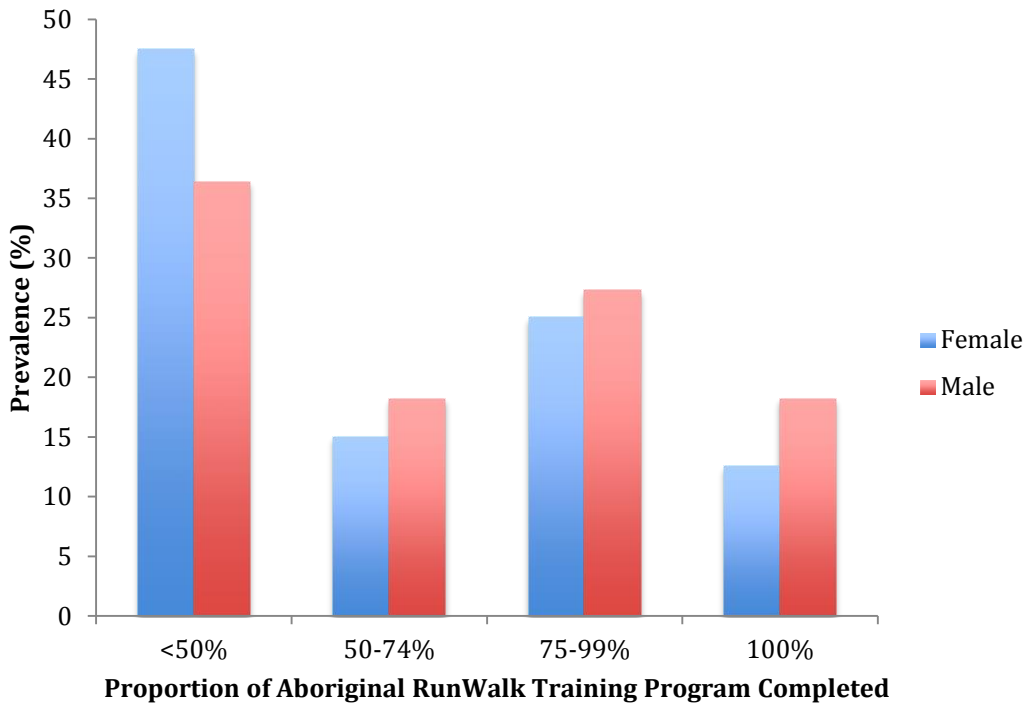

Figure 3 The proportion of Aboriginal RunWalk training program completed by HealthBeat participants.

4.3.3 Post-screening Results

Of the 87 participants who completed baseline measurements, 52 (59.8%) participants returned for the second screening after the completion of the Aboriginal RunWalk program. After 13 weeks of training, all three measures of physical fitness showed significant improvements. Aerobic fitness, as measured by the 6-minute walk test, was significantly increased following the physical activity program, $p<0.005$ (Figure 4). The mean distance walked in pre-screening improved by 58 meters at post-screening.

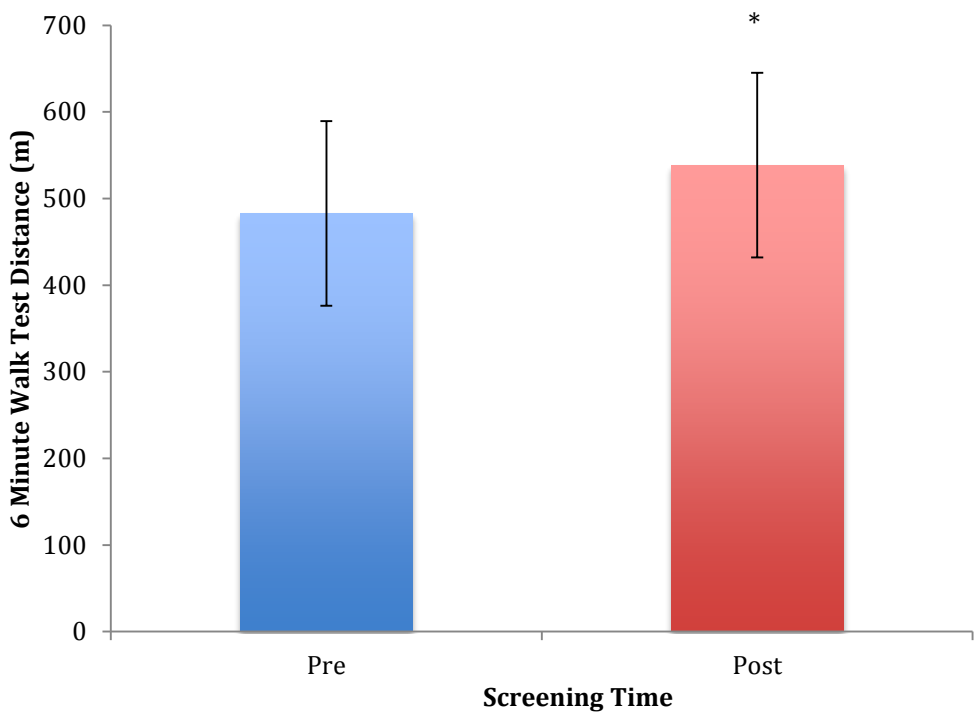

Figure 4 The change in distance walked during the 6-minute walk test with training. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Predicted VO_2 max significantly improved as well, with the mean improving by 2.2 $ml \cdot kg^{-1} \cdot min^{-1}$, $p<0.005$ (Figure 5).

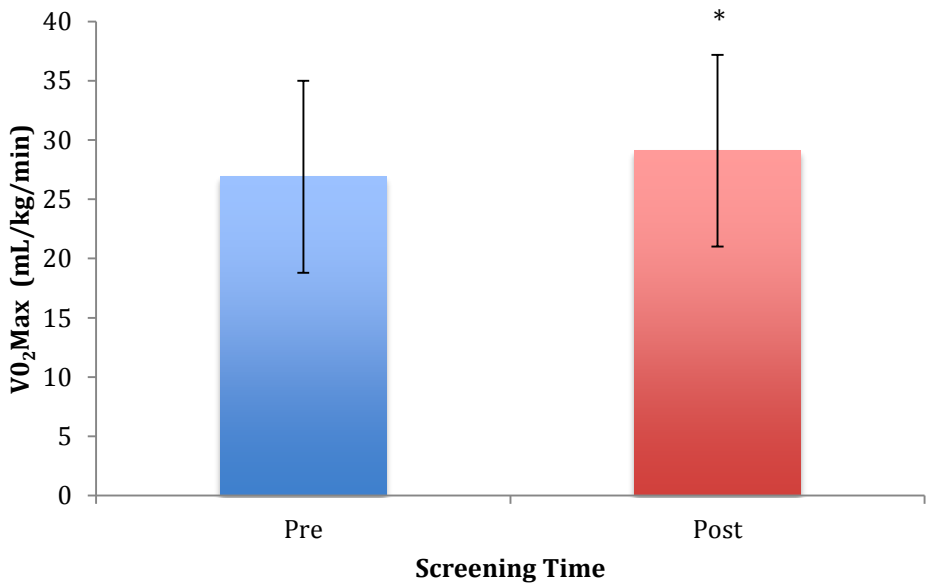

Figure 5 The change in predicted VO_2max after training. Asterisk (*) indicates significant changes with training, $p < 0.05$.

At baseline, well over the majority (74.4%) of the participants were rated as having very poor fitness as defined by ACSM's fitness categories for maximal aerobic power (47). Following the intervention, 46.2% of the participants had moved up one category or more compared to baseline, $p<0.001$ (Figure 6). Three participants had moved up two fitness categories. At follow-up, only 38.5% of participants were ranked as having very poor fitness, a decrease of 35.6% from baseline.

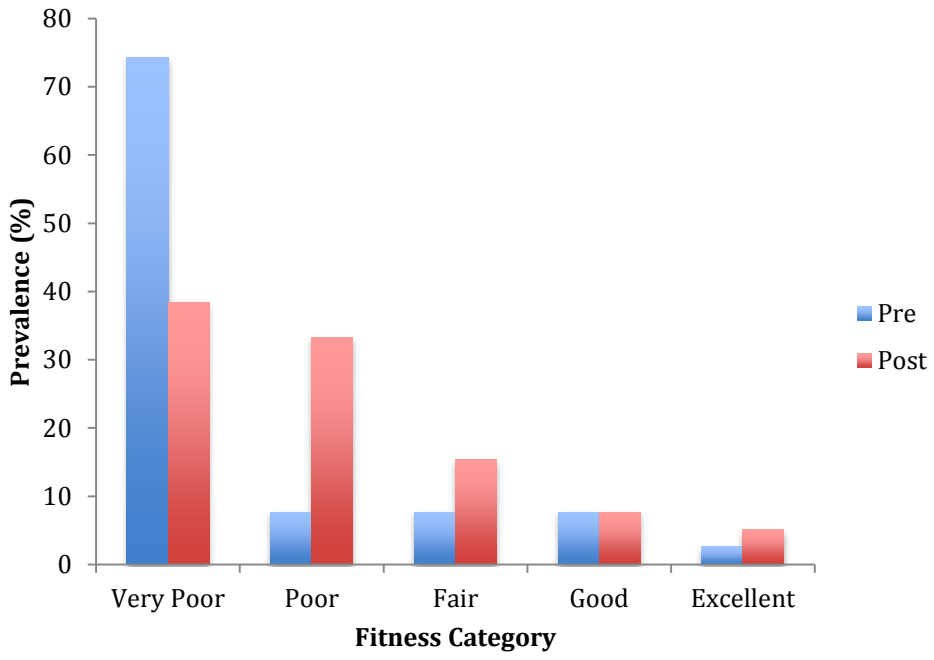

Figure 6 The change in aerobic fitness by ACSM category after training.

Musculoskeletal strength, as measured by combined grip strength, significantly improved, $p=0.01$ (Figure 7).

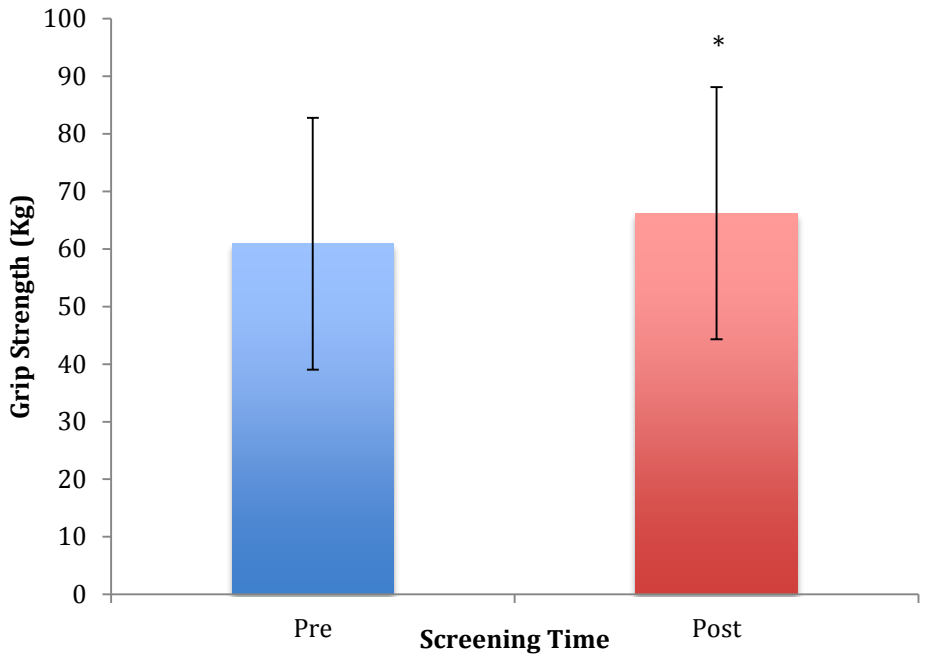

Figure 7 The change in grip strength scores with training. Asterisk (*) indicates significant changes with training, $p < 0.05$.

At baseline, 45.1% of participants had a grip strength that ranked as "poor" and 33.3% had a grip strength that ranked as "above average" according to CPAFLA's grip strength norms (179). After the intervention, 33.3% of participants had moved to a higher category, with only 25.6% ranked as poor and 43.1% ranked as "above average" (Figure 8).

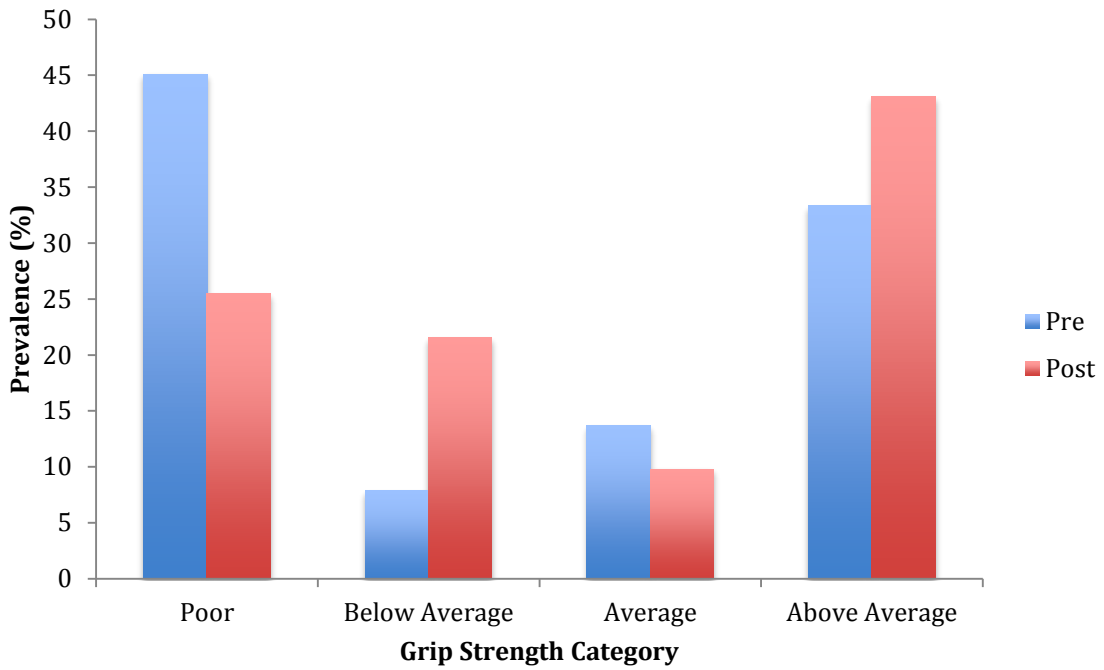

Figure 8 The change in grip strength by CPAFLA category after training.

Following the 13 week training, a significant decrease in waist circumference was seen, p=0.02 (Table 3). Both systolic and diastolic blood pressure decreased with changes approaching significance. No other significant improvements were seen. A1C was significantly worse after training, p=0.01.

Table 3 Overall changes in health measures with training (mean ±SD).

Health Measure	Pre-Screening	Post-Screening	*P-value*
Weight (kg) ± SD	92.0 ± 17.6	91.0 ± 17.1	0.15
BMI (kg-m^2) ± SD	34.9 ± 6.8	34.5 ± 6.5	0.14
WC (cm) ± SD	112.2 ± 19.2	109.5 ± 16.1	0.02
SBP (mmHg) ± SD	132.2 ± 25.5	126.7 ± 21.4	0.06
DBP (mmHg) ± SD	83.0 ± 21.6	77.2 ± 14.0	0.07
TC (mmol·L^{-1}) ± SD	4.9 ± 1.0	4.8 ± 0.9	0.55
HDL (mmol·L^{-1}) ± SD	1.3 ± 0.4	1.2 ± 0.4	0.25
TC/HDL ratio ± SD	4.1 ± 1.6	4.1 ± 1.3	0.81
Non Fasting Glucose (mmol·L^{-1}) ± SD	6.6 ± 3.5	6.4 ± 2.4	0.57
A1C (mmol·L^{-1}) ± SD	5.8 ± 1.6	6.0 ± 1.9	0.01

BMI, body mass index; SD, standard deviation; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; HDL, high density lipoprotein cholesterol; A1C, glycosylated haemoglobin.

Participants were grouped into three cardiorespiratory fitness categories (very poor, poor/fair, good/excellent) by their predicted VO_2max scores at baseline testing. An ANOVA analysis revealed no significant differences in the change in health-related outcomes between aerobic fitness groups (Table 4).

Table 4 Change in health-related outcomes by ACSM cardiorespiratory fitness categories (mean ±SD).

	Very Poor (N=29)	**Poor/Fair (N=6)**	**Good/ Excellent (N=4)**	***P-value***
WC ± SD	-3.4 ± 3.6	-2.6 ± 4.9	-4.1 ± 3.1	0.81
BMI ± SD	-0.4 ± 0.9	0.1 ± 0.5	-0.2 ± 1.0	0.41
SBP ± SD	-5.0 ± 16.3	-2.8± 11.1	-5.3 ± 7.1	0.95
DBP ± SD	-6.4 ± 23.4	-4.1 ± 7.7	-2.8 ± 10.3	0.93
TC/HDL ratio ± SD	-0.1 ± 0.5	-0.1 ± 0.8	0.1 ± 0.5	0.88
HDL ± SD	-0.0 ± 0.2	-0.7 ± 0.2	-0.2 ± 0.1	0.67
Glucose ± SD	-0.1 ± 2.2	-0.1 ± 1.4	-0.8 ± 1.2	0.85
A1C ± SD	0.3 ± 0.7	-0.2 ± 0.2	0.0 ± 0.0	0.89
GS ± SD	5.0 ± 8.2	6.0 ± 20.2	0.3 ± 6.8	0.60
6MWT ± SD	70.0 ± 113.3	24.2 ± 46.5	22.5 ± 95.3	0.49
VO_2max ± SD	2.85 ± 3.8	1.0 ± 2.4	-0.5 ± 1.9	0.15

WC, waist circumference; SD, standard deviation; BMI, body mass index; TC/HDL, total cholesterol/high density lipoprotein ratio; HDL, high density lipoprotein cholesterol; A1C, glycosylated haemoglobin; GS, combined grip strength; 6MWT; 6-minute walk test; VO_2max; Predicted VO_2 max.

There was a statistically significant difference between musculoskeletal fitness groups on the grip strength measure as determined by one-way ANOVA ($F(3,46)= 3.110$, $p=0.04$) (Table 5). A Tukey post-test analysis revealed that the change in combined grip strength was statistically different between the poor and above average grip strength groups, with greater change among the poor grip strength group, $p=0.02$ (Figure 9). There was no statistically significant difference change in grip strength between below average and average groups, $p=0.98$. In addition, the ANOVA analysis revealed a statistically significant difference between musculoskeletal fitness groups on the HDL measure a ($F(3,45)= 3.562$, $p=0.02$). However, no significant differences between groups were seen in a Tukey post hoc-test. Differences in the below average and above average groups were approaching significance ($p= 0.07$) as were between average and above average groups ($p=0.06$).

Table 5 Change in health-related outcomes by CPAFLA musculoskeletal fitness categories (mean ±SD).

	Poor (N=23)	**Below Average (N=4)**	**Average (N=7)**	**Above Average (N=17)**	***P-value***
BMI ± SD	-0.7 ± 2.1	0.8 ± 0.5	-0.5 ± 1.0	-0.1 ± 2.1	0.82
WC ± SD	-3.2 ± 4.9	-3.0 ± 5.8	-2.6 ± 3.2	-4.2 ± 5.9	0.88
SBP± SD	-3.4 ± 16.9	-6.7 ± 8.0	-9.4 ± 21.4	-6.6 ± 22.8	0.91
DBP ± SD	-4.9 ± 27.1	1.3 ± 14.1	-16.8 ± 16.5	-4.1 ± 14.0	0.57
TC ± SD	0.1 ± 0.8	-0.2 ± 0.4	-0.3 ± 0.5	-0.1 ± 1.2	0.84
HDL ± SD	-0.1 ± 0.1	-0.2 ± 0.4	-0.2 ± 0.1	0.1 ± 0.2	0.02
TC/HDL ratio ± SD	0.3 ± 0.8	0.2 ± 0.4	0.5 ± 0.7	-0.5 ± 1.7	0.19
Glucose ± SD	-0.4 ± 3.1	0.6 ± 0.8	-0.9 ± 1.7	0.2 ± 1.2	0.60
A1C ± SD	0.3 ± 0.7	0.2 ± 0.1	0.3 ± 0.3	0.2 ± 0.3	0.88
GS ± SD	11.0 ± 14.9	6.5 ± 6.4	3.5 ± 4.8	-1.8 ± 13.5	0.04
6MWT ± SD	91.4 ± 135.0	95.0 ± 31.3	21.4 ± 35.6	30.0 ± 79.1	0.26
VO_2max ± SD	2.9 ± 5.0	1.9 ± 0.1	1.9 ± 2.4	1.7 ± 2.0	0.83

BMI, body mass index; SD, standard deviation; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; HDL, high density lipoprotein; A1C, glycosylated haemoglobin; GS, combined grip strength; 6MWT, 6-minute walk test; VO_2 max, predicted VO_2max.

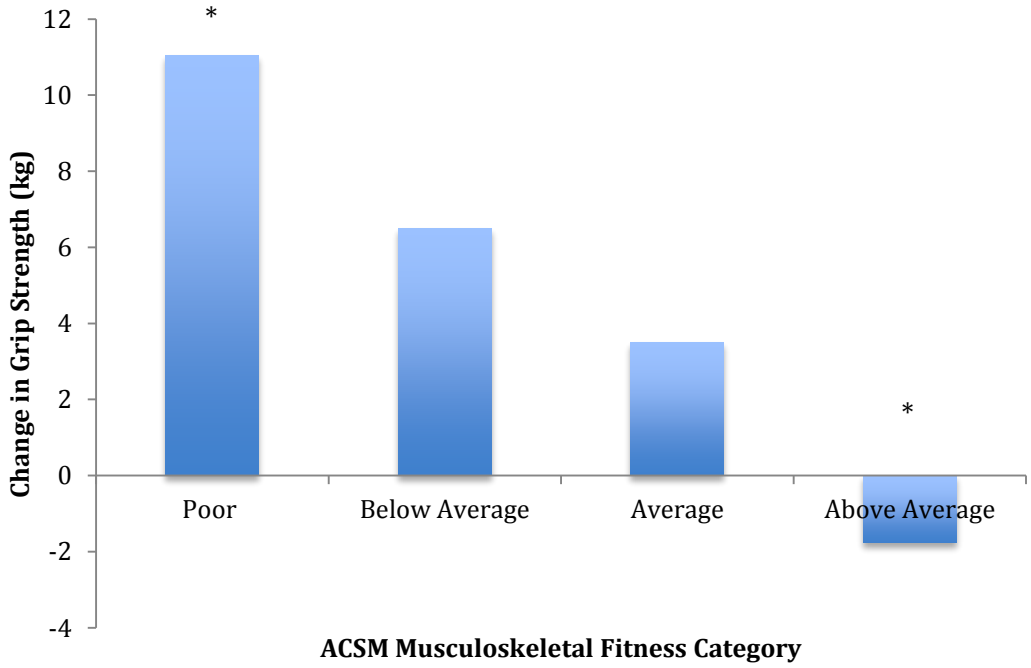

Figure 9 Change in grip strength with training by CPAFLA musculoskeletal fitness groups. Asterisk (*) indicates significant changes with training, $p < 0.05$.

Of the participants that returned for follow-up, the number of participants that were insufficiently active remained the same after the intervention as based on the self-reported results from the Godin -Shephard Leisure-Time Physical Activity Questionnaire. However, after the intervention, more participants were sufficiently active (39.2% versus 27.5%), moving out of the moderately active category (Figure 10).

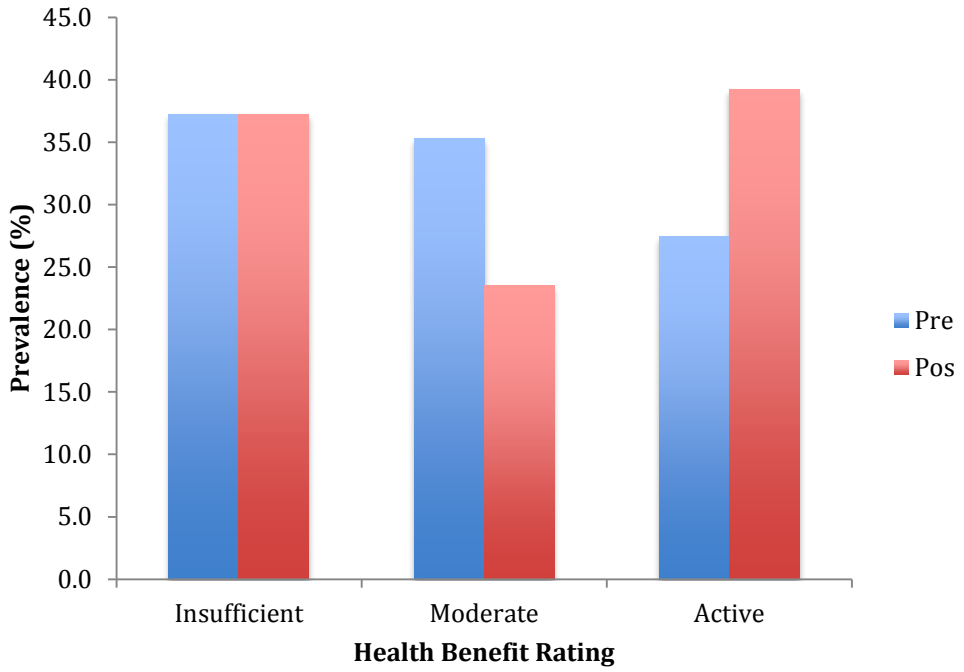

Figure 10 The change in health benefit rating based on physical activity participation after training.

4.4 Discussion

The primary purpose of this investigation was to determine whether a 13-week community-based physical activity program would improve physical fitness of Indigenous adults. This study demonstrated the program's effectiveness in significantly improving cardiorespiratory fitness and musculoskeletal strength of the adults who completed follow-up testing. In addition, waist circumference was significantly decreased and other health measures such as SBP and DBP may have improved. Physical activity, either aerobic or resistance training or both, has been shown to

reduce levels of A1C among individuals living with or without type 2 diabetes (102,184). Contrary to expectations, A1C significantly increased after the intervention. This finding occurred despite improvements in waist circumference and physical fitness, two variables that are predictive of type 2 diabetes risk (185–187). It is possible that the training may have slowed down the rate of A1C worsening. In addition, although the finding is statistically significant, an A1C average of 6 $mmol \cdot L^{-1}$ is well below the clinical criteria for diagnosing diabetes (97). Clinical relevance, the practical importance of treatment effect, is independent of statistical significance (188). Although not assessed directly, it is possible that the statistically significant increase in A1C is not clinically relevant. Participants who had poor grip strength at baseline experienced significantly greater improvements in strength after the intervention compared to those who had above average grip strength at baseline. There was no difference in the amount of change for cardiorespiratory fitness between participants with different aerobic fitness levels at baseline. After the physical activity intervention, more participants reported being sufficiently active to receive significant health benefits (180).

Participant baseline health characteristics were similar to those reported by Foulds and colleagues in 2011, with this study reporting higher prevalence of personal and family history of chronic disease (18). The cause of this is unknown but it may be a result of a smaller number of communities included in this sample and variations in the health profile of communities selected. Both interventions found significant improvements in waist circumference and although not found to be significant in this study, there was a trend towards systolic blood pressure being reduced after training. In this study, participants who returned for follow-up screening had significantly poorer measures of weight, body mass index and systolic at baseline compared to those who did not attend follow-up screening. Previous studies looking at attrition bias have found that participants

who are less healthy and less active are more likely to drop out of physical activity interventions (189). However, research has repeatedly shown that individuals who are least fit benefit the most from engaging in regular physical activity (18,34,154). Encouragingly, this program has demonstrated the ability to retain participants who benefit the most from physical activity. In the future, these results may be predictive of participants who continue with the program but are not necessarily reflective of the group that signs up. With a 60% retention rate, this program had a much lower attrition rate than what was reported by Foulds and colleagues (18). Although difficult to determine why, possible explanations include increased rapport with staff and researchers developed over the last decade as well as increased awareness of the program and priority of health within communities.

Cardiorespiratory fitness and musculoskeletal strength have emerged as a health-related components of physical fitness due to their associations with morbidity, premature mortality, functional independence and overall quality of life (34,44,50). The level of cardiorespiratory fitness, measured by peak metabolic equivalent (MET), has been quantified with risk of mortality. Although ranges vary, a 1-MET increase reduces the risk of mortality by 10-25% in men and women (154–156). In individuals living with cardiovascular disease with low cardiorespiratory fitness, an improvement in 1-MET after a 12-week cardiac rehabilitation program was associated with a 30% reduction in overall mortality (190). To the best of our knowledge, improvements in grip strength have not been quantified like VO_2max with a percentage reduction of mortality for every 1 unit of improvement. However there are strong associations between low levels of grip strength and all-cause mortality, cardiovascular mortality, non-cardiovascular mortality, myocardial infarction, stroke and disability (51,122). In addition, fitness training that improves musculoskeletal fitness is associated with improvements in health status (115). While, future

research is needed to quantify the extent to which improvements in grip strength reduce mortality and cardiovascular disease, it is evident that such a relationship exists. The high prevalence of adults in this study with very poor levels of cardiorespiratory fitness at baseline combined with the improvements seen after training, demonstrates the appropriateness of this type of intervention for improving physical fitness and health of Indigenous adults.

Despite the physical activity intervention being solely composed of aerobic exercise, it is interesting to note that musculoskeletal strength was significantly increased after training. Resistance training is well known to improve musculoskeletal strength, however there is less information regarding the effects of aerobic exercise on skeletal muscle function with much of the information available pertaining to clinical populations (191). Middle aged diabetic men who were randomized to either 6 months of aerobic or resistance training were shown to improve grip strength with the aerobic training group showing greater improvements in grip strength (192). The exact mechanism is unknown but may be related to increased upper limb muscle activation during a walking or running stride or the release of circulating factors after exercise that increase muscle mass such as the growth hormone (193,194).

To the best of our knowledge, this is one of the few investigations that have sought to improve physical fitness in Indigenous adults living in Canada. There is a clear research gap pertaining to physical activity interventions in North American Indigenous communities (52). A recent review found that much of the literature pertaining to Indigenous adults in Canada has focused on improving physical activity levels with mixed results (31). Two studies, including Foulds and colleagues, found increased self-reported levels of physical activity after the intervention (18,22) whereas two other articles reported no significant changes in physical activity and one did not assess physical activity levels (19,20). Only one of the reported articles used a

direct, objective measure of physical activity (19). This study is unique in having evaluated physical fitness through two direct measures, the 6MWT, and grip strength tests.

The remaining literature from Canadian communities has focused on Indigenous children and youth in almost exclusively school settings in response to the high prevalence of type 2 diabetes and obesity (23,52,164,165). However, it is of equal importance to target adults as parents and grandparents role model healthy behaviours to their children and control children's access to unhealthy foods. Children with physically active parents are more likely to be active themselves, starting from a young age into adolescence (195,196). In addition, Indigenous culture, history and teachings are passed down through generations via oral tradition (197). Preventing premature mortality amongst adults is not only important on an individual level but for the preservation of culture and health of the community as a whole.

Community based, participatory research has been identified as best practice for working with Indigenous communities (169,170). The successful findings in this study are reflective of the engagement and subsequent relationships and rapport developed over time between community leaders, participants, the Aboriginal RunWalk staff, and the Indigenous Sport, Physical Activity, Recreation Council staff as well as partner funding agencies including BC's Ministry of Health and the First Nations Health Authority. It is important to recognize that the driving force behind the healthy living programs, including the Aboriginal RunWalk and HealthBeat, is to empower communities and ensure that all programs are led by Indigenous community leaders. The use of a train the trainer model and two simple modes of physical activity, walking and running, allows the Aboriginal RunWalk to overcome many of the common barriers that Indigenous communities face including lack of fitness instructions, facilities and equipment (198,199). The health screenings offered in conjunction were designed to be informative for participants and the community as a

whole. By providing aggregate data to communities that participated, the data can be used for assessing the health of community, informing the direction of new programs and applying for funding (Appendix F). This sharing of data acknowledges and respects the rights of First Nations communities to access, own and control information pertaining to their culture and members. This is in compliance with OCAP®, which are a set of standards that guide how data from First Nations communities should be collected, protected, and are collectively owned by the community or group involved (200). These guiding principles have arisen as a result of decades of research being conducted on First Nations communities that was of no benefit to the community or individuals, led by non-Indigenous researchers and research results were not shared with the community involved (200). While the data obtained from the health screenings validates the effectiveness of the Aboriginal RunWalk program for improving health status in Indigenous communities, the primary purpose of the health screenings is to be of benefit to the communities, leaders and participants involved.

4.4.1 Limitations

Although this investigation provided valuable information that can be used in future research, there are limitations. Although randomized, controlled trials are considered to be the gold standard of evidence, these types of trials are not considered appropriate when working in the field of Indigenous research (31). There was no control group in this study as all communities wished to be involved with the health screenings. Due to the remote nature of many of the communities and travel constraints, the research team was only able to spend one day in each community for follow-up testing. This likely contributed to the loss of participants at follow-up. The small sample size (n=52) may have not had enough power to detect statistical changes at follow-up, particularly in the sub-analysis by fitness category. In addition, the Aboriginal RunWalk program dropout rate

could not be determined as participants may not have attended the follow-up screening but continued on to complete the 13 week training program.

As with most study designs, different types of bias may be present. The Hawthorne effect may have occurred, as participants were knowledgeable of the follow-up screening and may have modified their physical activity behavior in response to the upcoming follow-up screening or the presence of a trained community member. In order to reduce observer bias, this study could have conducted a follow-up screening months after the Aboriginal RunWalk program had ended to determine whether health improvements occurred as a result of the program or the Hawthorne effect. However, this was not financially feasible or within the confines of the program, which was designed to provide a health intervention to all participants. Sampling bias, specifically healthy user bias, was also likely present as individuals who volunteer to follow treatment regimens are often not representative of the entire population. As well, response bias may have occurred during the questionnaires, which examined physical activity behavior, health status, smoking status, and commercial tobacco use.

4.5 Knowledge Translation

A knowledge translation plan is integral for the dissemination of knowledge stemming from research into practice at both the clinical and policy level. The knowledge generated by this research is of interest to a number of different audiences including policy makers, health care providers, Indigenous communities and participants. A multi-strategy approach will be employed to ensure that knowledge acquired through this research is appropriately translated to the targeted knowledge-user audience.

In order to diffuse knowledge to researchers, the findings of this study will be submitted for publication in a peer-reviewed academic journal (Chapter 4). As previously mentioned, there is

minimal research examining physical activity programs and physical fitness in Indigenous adults in North America. The “train the train model” used in this research may be effective in overcoming barriers that many Indigenous communities face. In addition, the systematic review will also be submitted for publication (Chapter 3).

However, it is also important to employ non-academic modes of communications. A summary report was submitted to the Ministry of Health, detailing the positive effects of the program. A similar report was provided to ISPARC for them to disseminate through their channels. In addition, a promotional video was created following the stories of three participants and the health improvements they experienced after the Aboriginal RunWalk program. This video has been shared with leaders and funders, and is available online with multiple partners promoting the video on their website and social media.

Each participant received a health “passport” that contrasts results from baseline and follow-up screenings alongside normative ranges for each measurement (Appendix E). Each community will receive an Infographic that highlights the importance of routine for wholistic health (spiritual, physical, mental and emotional) as well as provide relevant information regarding the programs and current health status of participants (Appendix F). Using a strength-based approach, each Infographic will be individualized and emphasizing the strengths that emerged at the screenings within each community.

Chapter 5: Conclusion

This chapter describes the contribution of this research to the field of Indigenous health. In addition, strengths of the research are highlighted and possible future research directions are provided.

To the best of our knowledge, this is one of the few investigations to examine health-related physical fitness after a physical activity program with Indigenous adults living in Canada. The HealthBeat screenings demonstrated the capability of the Aboriginal RunWalk program in improving the cardiorespiratory fitness and muscular strength of Indigenous participants. In addition, other health-related outcomes including waist circumference and self-reported levels of physical activity were improved after the Aboriginal RunWalk program. Combining the limited research available pertaining to physical activity interventions in Indigenous communities with the high prevalence of cardio-metabolic diseases in Canada makes these findings important.

The success of this investigation can be attributed to a number of factors. The use of a community-based program was a culturally appropriate and effective method for improving health status of Indigenous adults. The delivery of the program through a trained community member eliminated the need for fitness instructors as well as empowered those trained to practice leadership and tailor the program to best suit their community's needs. By using two simple modes of exercise, walking and running, the barriers to physical activity that Indigenous communities often face were eliminated. Lastly, the collaboration between all participating bodies including communities, SportMedBC, ISPARC, the BC Ministry of Health, the First Nations Health Authority and researchers was integral to the success of the program. Longstanding relationships and friendships have built the trust that allowed for this research to occur.

Future physical activity program research with Indigenous communities should consider replicating or incorporating the model outlined in this investigation. The Aboriginal Runwalk has served Indigenous communities across British Columbia for over ten years and provided the platform for which other healthy living programs are delivered across the province. Despite the success of the program, further research is needed to determine whether these results could be duplicated in other areas of Canada. Creating this program in another province would likely require the support of provincial and national government bodies. While different Indigenous communities may have different needs from those living in British Columbia, the widespread prevalence of cardiovascular disease and type 2 diabetes across the country suggest that future action is needed.

Additional research is needed to also quantify the physical fitness of Indigenous communities, particularly with regards to musculoskeletal fitness. Limited research exists with regards to changes in muscular strength after physical activity programs with Indigenous populations. Physical fitness is similarly predictive of morbidity and mortality, more accurate than self-report levels of physical activity and easy to measure with simple tests such as grip strength and 6-minute walk test. Incorporating resistance training combined with aerobic training may allow for further health benefits beyond the results of this investigation.

Overall, the Aboriginal RunWalk program was successful in improving the health status of Indigenous adults living in British Columbia.

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Appendices

Appendix A: Systematic Review Search Strategy

The following electronic bibliographical databases were searched for this review:

- MEDLINE (1950- Week of July 9-15, 2018, OVID Interface)
- EMBASE (1980- Week of July 9-15, 2018, OVID Interface)
- Cochrane Library (Week of July 9-15, 2018, OVID Interface)

Using a combination of medical subject headings, keywords and phrases, relevant studies were found. All search results were downloaded onto desktop reference manager software, Mendelay (London, UK).

Appendix B: Systematic Review Article Information Table

Author	Location	N	Intervention	Physical Activity and Fitness Outcomes	Health-related Outcomes	Community Engagement
Sawchuk et al., 2011	United States	36	6 week walking program to increase physical activity in Elders.	Step count and 6 minute walk distance significantly increased with both control and goal setting groups at follow-up.	Quality of life (as measured by Short Form-36 of the Medical Outcomes Survey) including Social Functioning, Vitality and Mental health Composite subscales were significantly improved in both groups at follow-up.	None reported
Tomlin et al., 2012	Canada	148	7 month school based intervention with children and youth that incorporated 15 minutes of PA per day in the classroom as well as 75-80 minutes of gym class per week.	Significant improvement in aerobic fitness laps completed in shuttle run test at follow-up. No significant changes in accelerometer measured PA after intervention.	No significant improvements in BMI, waist circumference, systolic or diastolic blood pressure at follow-up. Waist circumference significantly increased.	Community Based Participatory Research employed, chief and council approached researchers. Given approval and support from elected Band Council, Elders, hereditary chiefs, health director, school administration and parents.

Author	Location	N	Intervention	Physical Activity and Fitness Outcomes	Health-related Outcomes	Community Engagement
Going et al., 2003	United States	574	3 year school-based intervention with children that increased physical education classes to a minimum of three 30-minute sessions per week. Daily recess and exercises breaks (1-2 per day, 2-10 mins) targeting fitness were encouraged.	No significant differences in activity levels as measured by accelerometers at intervention schools compared to control schools.	Average BMI and body fat percentage significantly increased at follow-up.	Approval was obtained from school, community and tribal authorities.
Caballero et al., 2003	United States	1704	3 year school based intervention with children targeting increased physical education classes, food service, classroom curriculum regarding healthy behaviour and family participations.	No significant differences in activity levels as measured by accelerometers at intervention schools compared to control schools.	Body fat percentage significantly increased and a higher percentage of children in both groups exceeded 85th percentile for BMI reference values at follow-up.	Approval by school, community and tribal authorities.

Author	Location	N	Intervention	Physical Activity and Fitness Outcomes	Health-related Outcomes	Community Engagement
Teufel-Shone et al., 2014	United States	109	2 year school-based intervention with children that consisted of two activity sessions of 45-60 minutes per week.	Girls showed significant improvements in curl-ups, push-ups, and the PACER run at follow-up. Boys showed significant improvements in push-ups at follow-up..	Significant difference in fasting plasma glucose, more children had normal levels at follow-up than baseline and significantly fewer children were classified as having diabetes at end of follow-up. More participants were overweight and obese at follow-up.	Community Based Participatory Research employed. Informed by assessment, community and university research team collectively developed an in-school physical activity intervention that was led by 3 community members. Supported and approved by Band Council, school administration and school board.
Scott & Myers, 1988	Canada	76	6 month school-based intervention with youth that incorporated physical fitness training into physical education class by a trained community member.	The treatment group had significantly improved their cardiovascular fitness and hamstring flexibility compared to the control group at folllow-up. Both groups significantly improved their agility scores and neither had improved their upper or lower body strength.	Self-esteem and self-efficacy was improved in treatment but not control group at follow-up.	None reported

Appendix C: Informed Consent

School of Kinesiology
Faculty of Education
Rm. 208, Lower Mall Research
Station 2259 Lower Mall, University of
British Columbia,
Vancouver, BC V6T 1Z4.

Tel: (604) 822-1337
http://kin.educ.ubc.ca

RESEARCH PROJECT CONSENT FORM INFORMATION SHEET

Title of Project: Transforming our understanding, enhancing our practices: engaging Indigenous ways of knowing in the promotion of healthy lifestyle behaviours

Principal Investigator: D. Warburton, Ph.D. – School of Kinesiology, UBC
Co-Investigators: S. Bredin, Ph.D. – School of Kinesiology, UBC

Institutions: University of British Columbia

Contact Person: Dr Darren Warburton's Laboratory: (604)-822-1337 (available 24 hours)

If you are a parent or legal guardian of a child who may take part in this study, permission from you and the assent (agreement) of your child may be required. When we say "you" or "your" in this consent form, we mean you and/or your child; "we" means the doctors and other staff.

Invitation

We would like to invite you to participate in an investigation that is focused on evaluating the effectiveness of a physical activity intervention (HealthBeat) for reducing cardiovascular risk and diabetes risk in persons of Indigenous ancestry. We are looking for males and females of Indigenous ethnicity, over the age of 10. We are interested in assessing the health status of Indigenous adults living in British Columbia and then testing whether a community-based intervention is capable of reducing the risk of diabetes and cardiovascular disease. The results of our investigation will provide information regarding the potential benefit of this intervention.

You should not participate in this investigation if you: 1) are younger than 10 or 2) are pregnant (for women only).

Who is conducting this study?

This study is being conducted by the UBC Cardiovascular Physiology and Rehabilitation Laboratory in collaboration with SportMedBC.

Procedures:
Please review the following consent form which will outline all aspects of the investigation. If you have any questions or are interested in participating in this investigation please contact the laboratory by phone (604-

822-1337). A researcher with the study will further discuss the investigation and schedule the measurement sessions at your local community hall or health center. The consent form will be reviewed at the first session and your written consent will be sought should you decide to participate. The measurement sessions will take place over 2 separate days, spaced 13 weeks apart and will require a time commitment of approximately 1 hour (hr) on each day. After the first measurement session you will continue training with your Indigenous RunWalk group.

HealthBeat Program

The HealthBeat program is a combination of a health screening and 13-week physical activity intervention, known as the Indigenous RunWalk (IRW) Program that has been widely adopted across BC. Prior to the start of the program a comprehensive health screening is conducted and an estimate of risk for cardiovascular disease and diabetes is determined. The 13-week ARW program is progressive and prepares participants to complete a 10km event (either by walking, running or by performing a combination of the two). Each week consists of 3 sessions per week where time and/or distance is specified according to the group (walk, walk/run combination, run). Sessions vary from 30-90 minutes depending on the week and the group (walk, walk/run combination, run). Participants meet once per week with a group and perform the other two sessions on their own or with friends. The full schedule will be provided to participants after the first health screening and a consultation with them about their goals.

ARW participants will continue training with their group and will be contacted near the end of the training program to schedule a return visit to the local community hall or health center for the final health assessment. Again, this will take place over 1 day with an approximate time involvement of 1 hr. Therefore, the total time commitment for subjects is 1 hr (initial assessment) + 1 hr (final assessment) + regular clinic training times over 13 weeks.

The measurement sessions

The health assessment is identical at all time points. It is conducted at two time points (before and after the exercise program).This assessment will take place over two days and consists of measures of body composition (height, weight, waist circumference, skin folds), insulin sensitivity, certain blood parameters (cholesterol, glucose), heart rate and blood pressure, musculoskeletal and cardiovascular fitness. There will also be several questionnaires regarding physical activity, sedentary behavior, sleep quality, self-efficacy, alcohol consumption, smoking behavior, depression, self-perception and eating behaviours.

Day 1 (Pre Screening):

On this day you will report to your local community hall or health center in clothing and shoes suitable for exercise or bring it with you to change into once you are here.

Questionnaires: You will be asked to complete a series of questionnaires upon arrival at the testing center. These questionnaires aims to assess general physical activity, smoking behavior, personal and family risk for cardiovascular disease and diabetes, sedentary behavior, sleep quality, and dietary habits.

Body Composition and Anthropometric Measurements: We will assess your body composition after the questionnaires behind the privacy of a screen or in a separate room. First we will ask you to remove your shoes to measure your height and weight. Then we will measure your waist circumference on top of your shirt. These measurements are all non-invasive and painless.

***Blood Pressure and Heart Rate*:** We will measure your blood pressure and heart rate by attaching a blood pressure cuff around your upper arm while you are sitting down. When fully inflated, the cuff can be uncomfortable but it will start to deflate almost immediately and the discomfort you feel will stop.

Muscular strength: To measure muscular strength, you will be asked to squeeze a grip in each of your hands as tight as possible. You will do this twice with each hand. You may feel some muscular fatigue after this portion of the test.

Blood Measurements: Blood samples will only be conducted in adults (19 yrs and above). We will measure a number of blood parameters that are thought to important for determining the risk of diabetes and cardiovascular disease. This will be done by pricking the end of your finger and obtaining a drop of blood. The drop of blood will be inserted into a tray that is placed inside a machine. The machine will provide us with values of total cholesterol, HDL ("good") cholesterol, non-HDL cholesterol, LDL ("bad") cholesterol, the ratio of total cholesterol to HDL cholesterol, and non- fasting glucose. You will feel a prick as we are obtaining the blood sample.
A1C levels: Immediately after obtaining blood for the blood tests, we will obtain one more drop of blood from the same pinprick. This will be inserted into a tray that is placed into a different machine. The machine will provide us with values of A1C, the average blood sugar levels over the past three months to help determine risk of diabetes.

Cardiovascular Fitness: You will be asked to walk quickly for a total of 6 minutes. You will also be asked to rate your level of effort during this test. We will measure the distance walked to indicate your level of cardiovascular fitness. Your heart rate and breathing rate will likely increase; you may sweat and feel some fatigue, which may cause some temporary discomfort.

Risks:
The tests of physical fitness and training may cause you to become tired and short of breath for a short period of time. There are no known permanent adverse side effects that have resulted from these exercise sessions. Data from individuals with or without heart disease indicates that the likelihood of having a heart attack or dying during an exercise stress test is 1 in 10,000 tests. All exercise testing and body composition measures will be performed under the supervision of a qualified exercise professional. These individuals have received the most advanced exercise training in Canada and are certified in first aid, CPR and the use of an automated external defibrillator (AED).

Since there is a variable response from individuals during exercise, unanticipated complications may occur that would require treatment. Few problems have been associated with exercise testing, and the shortness of breath and muscular soreness usually clear quickly with little or no treatment. Due to the volume of training associated with the HealthBeat program you may experience heightened levels of muscular soreness, as mentioned above this should clear quickly with little or no treatment. In the event that you are experiencing physical discomfort (muscles, bones, joints) beyond your normal control, you must be aware that participation in this study is entirely voluntary. Every effort will be made to conduct the test in such a way as to minimize discomfort and risk. There is the risk of discomfort, bruising and light-headedness due to blood draw. There is a minimal risk of infection with any blood sampling. This risk will be minimized with blood samples being drawn by trained technicians under sterile conditions. Signing this consent form in no way limits your legal rights against the sponsor, investigators, or anyone else.

Benefits:
You will receive complete individual and group summaries of body composition and cardiovascular and musculoskeletal fitness results from this investigation. You will also get an assessment of your risk for cardiovascular disease and type 2 diabetes. If an abnormality in any measurement is observed (at any time period) that indicates an elevated risk a member of our research team will contact you directly regarding the findings.

Reimbursement:
Draw prizes will be awarded at follow-up testing sessions (prizes valued at less then $150). You will be included in the draw, whether or not you withdraw from the study at any time point.

Rights and Welfare of the Individual:

You have the right to refuse to participate in this study.

Your confidentiality will be respected. However, research records and health or other source records identifying you may be inspected in the presence of the Investigator or his or her designate by representatives of SportMedBC and the UBC Clinical Research Ethics Board for the purpose of monitoring the research. No information or records that disclose your identity will be published without your consent, nor will any information or records that disclose your identity be removed or released without your consent unless required by law.

You will be assigned a unique study number as a participant in this study. This number will not include any personal information that could identify you (e.g., it will not include your Personal Health Number, SIN, or your initials, etc.). Only this number will be used on any research-related information collected about you during the course of this study, so that your identity will be kept confidential. Information that contains your identity will remain only with the Principal Investigator and/or designate. The list that matches your name to the unique study number that is used on your research-related information will not be removed or released without your consent unless required by law.

Your rights to privacy are legally protected by federal and provincial laws that require safeguards to insure that your privacy is respected. You also have the legal right of access to the information about you that has been provided to the sponsor and, if need be, an opportunity to correct any errors in this information. Further details about these laws are available on request to your study doctor.

By signing this form, you do not give up any of your legal rights and you do not release the study doctor, participating institutions, or anyone else from their legal and professional duties. If you become ill or physically injured as a result of participation in this study, medical treatment will be provided at no additional cost to you. The costs of your medical treatment will be paid by your provincial medical plan and/or by the study sponsor SportMedBC.

Please be assured that you may ask questions at any time. We will be glad to discuss your results with you when they have become available and we welcome your comments and suggestions. Should you have any concerns about this study or wish further information, please contact Dr. Darren Warburton (604-822-4603) at the University of British Columbia.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598. Please reference the study number (H07-03187) when calling so the Complaint Line staff can better assist you.

Transforming our understanding, enhancing our practices: engaging Indigenous ways of knowing in the promotion of healthy lifestyle behaviours.

Participant Consent

My signature on this consent form means:

- I have read and understood the information in this consent form.
- I have had enough time to think about the information provided.
- I have been able to ask for advice if needed.
- I have been able to ask questions and have had satisfactory responses to my questions.
- I understand that all of the information collected will be kept confidential and that the results will only be used for scientific purposes.
- I understand that my participation in this study is voluntary.
- I understand that I am completely free at any time to refuse to participate or to withdraw from this study at any time, and that this will not change the quality of care that I receive.
- I understand that I am not waiving any of my legal rights as a result of signing this consent form.
- I understand that there is no guarantee that this study will provide any benefits to me.

The parent(s)/guardian(s)/substitute decision-maker (legally authorized representative) and the investigator are satisfied that the information contained in this consent form was explained to the child/participant to the extent that he/she is able to understand it, that all questions have been answered, and that the child/participant assents to participating in the research.

I will receive a signed copy of this consent form for my own records.

I consent to participate in this study.

_____ _____

Printed name Date

_____

Participant's or Substitute decision maker's Signature

In cases where a legally authorized person signed this consent form, Name of child/ participant:_____

_____ _____

Printed Name of Investigator Date

_____

Signature of Investigator

Appendix D: HealthBeat Results Sheet

BEFORE Results Sheet

ID#		First Name		Age		Gender	❒ Male ❒ Female
Program	❒ Walk10K ❒ LearnToRun10K ❒ RunWalk10K ❒ Run10KStronger ❒ EitNation ❒HYHC					Postal Code	
Would you describe yourself as:	❒ First Nations ❒ Inuit ❒ Métis ❒ Other: _____						

1. FAMILY HISTORY OF HEART DISEASE

Has someone in your family had heart disease? ***Example: Angina (chest pain), a heart attack, coronary bypass surgery or a stroke***	❒ YES ❒ NO ❒ I don't know
If YES Was it your mother/father, brother/sister or one of your children?	❒ YES ❒ NO
If YES Was it BEFORE age 55 (males) or BEFORE age 65 (females)?	❒ YES ❒ NO

2. PERSONAL HISTORY

Have you had angina (chest pain), a heart attack, coronary bypass surgery or a stroke?	❒ YES ❒ NO
Do you have diabetes? (Does not include diabetes in pregnancy)	❒ YES ❒ NO

3. MENOPAUSAL STATUS ***Women Only (Menopause = no regular period for 2 years)***

- ❒ I have not started menopause **(I still get regular periods)**
- ❒ I am pregnant
- ❒ I started menopause less than 10 years ago **(I stopped having regular periods LESS than 10 year ago)**
- ❒ I started menopause 10+ years ago **(I stopped having regular periods 10 or MORE years ago)**

4. SMOKING & TOBACCO

❒ I have never smoked	❒ I smoke **10** cigarettes **or less** a day	❒ I only use chew tobacco
❒ I quit **MORE** than 2 years ago	❒ I smoke **11 to 20** cigarettes a day	❒ I only smoke a pipe or cigar
❒ I quit **LESS** than 2 years ago	❒ I smoke **20 or more** cigarettes a day	❒ I am exposed to 2nd hand smoke

5. PHYSICAL ACTIVITY ***(Before the start of the Aboriginal RunWalk Program)***

BEFORE the RunWalk program, in a typical **7-Day period** (a week), how many times on average do you do the following kinds of activity for **more than 15 minutes** during your free time?	**Strenuous** (e.g. running, jogging)	_____ times/wk
	Moderate (e.g. fast walking, baseball)	_____ times/wk
	Mild (e.g. yoga, fishing, bowling)	_____ times/wk
BEFORE the RunWalk program, I did **30 minutes** of moderate physical activity: *Example: Brisk walking, running, heavy housework*	❒ 5 or more days a week ❒ 3 to 4 days a week	❒ 1 to 2 days a week ❒ Less than 1 day a week
When I am active I feel that I make a(n):	❒ Intense effort ❒ Moderate effort ❒ Light effort	
I would rate my level of fitness as:	❒ Very good ❒ Good ❒ Average ❒ Poor ❒ Very Poor	

6. HEALTHY WEIGHT, SHAPE & STRENGTH

Height	cm	Weight	kg	Waist girth	cm	BMI (kg/m/m)	
		Grip Left	kg	Grip Right	kg	Combined Grip	kg

7. BLOOD PRESSURE

#2	/ mmHg	#3	/ mmHg	AVG	/ mmHg	Pulse	beats/min

Has your doctor told you your blood pressure is too high?	❒ YES ❒ NO ❒ I don't know

Do you take medicine for blood pressure?	❒ YES ❒ NO ❒ I don't know

8. CHOLESTEROL & BLOOD SUGAR (GLUCOSE)		Aerobic Fitness Test: _____m
How many hours since you last ate or drank?	_____ hours	Stick cholesterol/glucose results label here
A1C (sugar attached to red blood cells):	_____ %	
Has your doctor told you your cholesterol is too high?	❒ YES ❒ NO ❒ I don't know	
Do you take medicine for cholesterol?	❒ YES ❒ NO ❒ I don't know	
Do you take medicine for diabetes?	❒ YES ❒ NO ❒ I don't know	
9. MY HEALTHY CHANGE		

Appendix E: HealthBeat Passport

SportMed Health Beat Profile

SportMed HEALTHBEAT

ID	DATE BEFORE
Name	DATE AFTER

UNCHANGEABLE HEALTH MEASURES	√ CHECK BOX
AGE	years
Under 40	Low Risk
40 to 49	Reduced Risk
50 to 59	Elevated Risk
60 to 69	High Risk
70 and over	Very High Risk
GENDER	
Male	High Risk
Non-menopausal female (still have regular periods, have not yet started menopause)	Low Risk
Menopausal female (stopped having regular periods LESS than 10 years ago)	Elevated Risk
Menopausal female (stopped having regular periods 10 or MORE years ago)	High Risk
HEREDITY Family history of cardiovascular disease (e.g. angina, heart attack, stroke, coronary bypass surgery) in a 1st degree relative (mother/father, brother/sister or child) BEFORE age 55 years (male) or age 65 years (female)	
NO	Low Risk
YES	High Risk
Unknown, don't know my family history	Elevated Risk
PERSONAL HISTORY Have been diagnosed with diabetes and/or cardiovascular disease	
NO	Low Risk
YES (Not including diabetes during pregnancy)	Very High Risk

SportMed HEALTH BEAT Main Areas for Improvement	SportMed HEALTH BEAT Ideal Health Measures
1.	1.
2.	2.
3.	3.

PLEASE NOTE: The SportMed Health Beat screening tool was developed by the Cardiovascular Physiology and Rehabilitation Laboratory at the University of British Columbia in conjunction with SportMedBC and was designed as an educational resource to help you understand health measures contributing to cardiovascular disease. These classifications are based on research classifications and interpretations. These tests and classifications are not sufficient to medically diagnose cardiovascular disease, diabetes or other chronic conditions. This resource was developed to educate and increase awareness of your own personal health. If you have any specific concerns about your risk for cardiovascular disease, diabetes or any other health related concerns, please discuss with your physician.

Funded by the Ministry of Health in partnership with the Aboriginal Sport, Recreation and Physical Activity Partners Council and supported by the BC Physical Activity Strategy

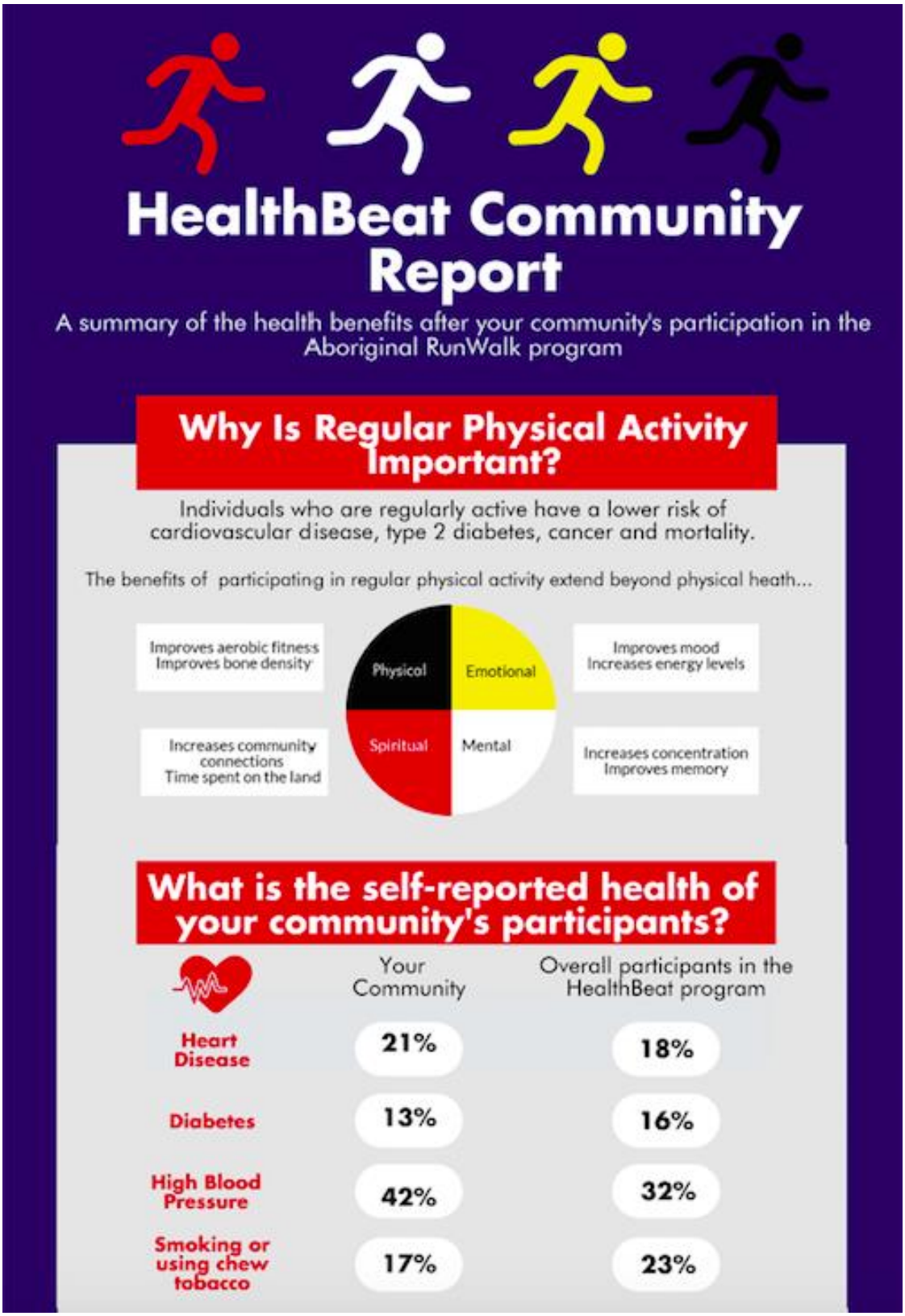
SportMedBC · UBC · British Columbia Ministry of Health · BC Healthy Living Alliance · Aboriginal Sport, Recreation & Physical Activity Partners Council

HEALTH MEASURES I CAN IMPROVE	BEFORE	AFTER
PHYSICAL ACTIVITY I do 30 minutes of moderate intensity physical activity:	√ CHECK BOX	√ CHECK BOX
5 or more days per week	Low Health Risk	Low Health Risk
3 to 4 days per week	Reduced Health Risk	Reduced Health Risk
1 to 2 days per week	Elevated Health Risk	Elevated Health Risk
Less than one day per week	High Health Risk	High Health Risk
PHYSICAL ACTIVITY I do vigorous intensity physical activity:		
2 or more times per week	Reduced Health Risk	Reduced Health Risk
once per week	Elevated Health Risk	Elevated Health Risk
Less than once per week	High Health Risk	High Health Risk
SMOKING		
I have never smoked	Reduced Health Risk	Reduced Health Risk
I quit smoking **MORE** than 2 years ago	Reduced Health Risk	Reduced Health Risk
I quit **LESS** than 2 years ago	Elevated Health Risk	Elevated Health Risk
I don't smoke, but I am exposed to 2nd-hand smoke	Elevated Health Risk	Elevated Health Risk
I smoke a pipe/cigar &/or chew tobacco	Elevated Health Risk	Elevated Health Risk
I smoke **10** cigarettes or less per day	Elevated Health Risk	Elevated Health Risk
I smoke **11 to 19** cigarettes per day	High Health Risk	High Health Risk
I smoke **20** or more cigarettes per day	Very High Health Risk	Very High Health Risk
WEIGHT Body Mass Index (BMI)	kg/m^2	kg/m^2
18.5 to 24.9	At target	At target
25.0 to 29.9	Elevated Health Risk	Elevated Health Risk
30.0 **or higher**	High Health Risk	High Health Risk
WEIGHT Waist Circumference	cm	cm
Less than 94 cm **(Male)** or 80 cm **(Female)**	At target	At target
94 to 102 cm **(Male)** or 80 to 88 cm **(Female)**	Elevated Health Risk	Elevated Health Risk
Greater than 102 cm **(Male)** or 88 cm **(Female)**	High Health Risk	High Health Risk
GRIP STRENGTH Combined Right and Left	kg	kg
*Note: interpretations based on 40-49 yrs, younger should have stronger grip, older may have lower grip		
Greater than 96 kg **(Male)** or 60 kg **(Female)**	Low Health Risk	Low Health Risk
88 to 96 kg **(Male)** or 54 to 60 kg **(Female)**	Reduced Health Risk	Reduced Health Risk
80 to 87 kg **(Male)** or 49 to 53 kg **(Female)**	Elevated Health Risk	Elevated Health Risk
Less than 80kg **(Male)** or 53 kg **(Female)**	High Health Risk	High Health Risk
BLOOD PRESSURE	/ mmHg	/ mmHg
Less than 130/85	At target	At target
130/85 to 139/89	Borderline	Borderline
140/90 to 159/99	Elevated	Elevated
160/100 **or higher**	Too high - See your doctor	Too high - See your doctor

HEALTH MEASURES I CAN IMPROVE	BEFORE	AFTER
A1C	%	%
Less than 6.0%	At target	At target
6.1 to 6.9%	At risk for diabetes	At risk for diabetes
Greater or equal to 7.0%	Too High	Too High
NON-FASTING GLUCOSE	mmol/L	mmol/L
Less than 7.0 (or) 7.8 and recent food intake	At target	At target
7.0 to 11.0 (depending on time of last food)	Borderline	Borderline
Greater or equal to 11.1	Too high - See your doctor	Too high - See your doctor
TOTAL CHOLESTEROL	mmol/L	mmol/L
Less than 5.2	At target	At target
Greater or equal to 6.2	Too High	Too High
TC/HDL RATIO		
Less than 4.0	At target	At target
4.0 to 4.9	Borderline	Borderline
5.0 to 5.9	Elevated	Elevated
6.0 **or higher**	Too High	Too High
HDL CHOLESTEROL	mmol/L	mmol/L
Greater or equal to 1.03 (Males) or 1.29 (Females)	At target	At target
Between 0.9 and 1.03 (Males) or 1.1 and 1.29 (Females)	Borderline	Borderline
Less than 0.9 (Males) or 1.1 (Females)	Too Low	Too Low
AEROBIC FITNESS MEASURE	M	M

SportMed HEALTHBEAT

Appendix F: Community Infographic



What did program participation look like?

24 participants came for the initial HealthBeat screening

17 participants returned for the follow-up HealthBeat screening

21% of participants identified as male

79% of participants identified as female

47% of participants completed 3/4 of the training sessions

18% of participants completed more than half of the training sessions

35% of participants completed less than half of the training sessions

What were the results?

After participating in the Aboriginal RunWalk program, participants had improved:

- **Waist Circumference**
- **Muscular Strength**
- **Aerobic Fitness**
- **Blood Pressure**

We would like to acknowledge and thank all of the Aboriginal RunWalk leaders and participants who welcomed us onto their traditional territory, participated in the HealthBeat program and entrusted us with their data.

SOURCE Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. Canadian Medical Association Journal, 174 (6), 801-809.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. Current opinion in psychiatry, 18(2), 189-193.

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