pixem re yecwme’nstut: Hunting to take care of one’s self

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Abstract

Indigenous peoples of Canada are more affected by chronic health disparities relative to the rest of the Canadian population. The onset of illness and health conditions relate to the colonization of the population that separated Indigenous peoples from their land and culture, imposed through Western European values. Prior to colonization Indigenous peoples were free of chronic disease and illness that result from physical inactivity. Increased levels of physical activity (PA) positively impacts overall health. Hunting is a form of PA practiced in many Indigenous communities.

The purpose of the study is to monitor the PA of Indigenous participants while they are hunting to determine whether participants’ obtaining adequate levels of physical activity. The Canadian Physical Activity Guideline defines adequate levels of PA as 150-minutes of moderate-to-vigorous levels of physical activity a week or 30-minutes per day to maintain fitness.

The hypothesis is that participants engaged in hunting can exceed 30-minutes of PA at a moderate to vigorous level of intensity in one day.

With a community based participatory approach, the observational study is a within study design, where participants used accelerometers and heart rate monitors on four separate days (two hunting; two non-hunting). The participants resting heart rate (HR), and HR reserve were used to individualize thresholds of PA. Intensity was observed through movement (position, steps) and HR.

Although moderate (29.1 ± 36.8 minutes) (P= 0.68) and vigorous (20.7 ± 40.4 minutes) (P= 0.39) intensities did not statistically differ between hunting and on-reserve days, participants achieved the recommended 30 minutes of moderate-to-vigorous activity per day while hunting. Steps indicate significantly greater opportunity for movement while hunting, accumulating
13235 ± 3681 compared with 7470 ± 3773 on-reserve not hunting (P= 0.01). Consideration should be given to promoting hunting as a viable PA for Indigenous peoples.
Lay Summary

It is understood that Indigenous peoples of Canada face significant health disparities. This collaborative observational research conducted between the University of British Columbia and a First Nation community in the mid-interior of BC, aimed to understand whether hunting meets Canadian Physical Activity requirements for daily physical activity (PA). The community goal was to provide meaningful understanding of whether hunting activity on-reserve provides a source of PA to promote health. Hunting, when pursued mostly on foot can generate sufficient amount and intensity of PA to induce a physiological response to offer positive health adaptations. When the hunt is successful, and game is further away from vehicular access, the likelihood of gaining a health benefit from PA increases.
Preface

The Community of Esk’etemc was first approached through its chief by the lead student investigator of this thesis. The chief later granted permission for the investigation team to work transparently with the community. The University of British Columbia’s Behavior Research Ethics Board granted approval for research on November 21, 2019. The ethics approval certificate number for the current study is H18-02651. All work that comes from this cooperative project has been brought through and approved by community leaders before any action has taken place. The specific questions addressed and outcomes in this thesis have not yet been published in full.

I was the lead investigator for the project. I was responsible for all community engagement, major areas of conceptual formation, data collection and analysis, as well as the majority of manuscript composition. Jennifer Jakobi, PhD, was the supervisory author on this project and was involved throughout the project in the conceptual framework and manuscript development.
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I would like to thank chief Fred Robbins of Esk’etemc for allowing us as an investigative team into the community to pursue our goals of monitoring physical effects of hunting. Without his permission we would not have been able to pursue such a project. I acknowledge the work of my supervisor Dr. Jennifer Jakobi, who has mentored me through the processes of this thesis project providing me with support and guidance. I will also like to recognize and thank my committee members Dr. Braden Te Hiwi and Dr. Kathy Rush, who were always available when I needed additional insight or a helping hand with my thesis.
Dedication

I dedicate the work done in this thesis to my community Esket’emc first nations and my supportive family for understanding the long periods away from home. I would also like to dedicate my work here to Dr. Gareth Jones, who was there to help me begin my journey, allowing me to take my first steps as a master’s student.
Chapter 1: Introduction

1.1 Background

The Indigenous population is growing fast, as it accounted for 3.8% of the national population in 2006 but is now 4.9% of the population (Public Health Agency of Canada 2016; Statistics Canada 2017). It is important to acknowledge this increase in population growth as Indigenous peoples have faced overwhelming chronic disparities that have affected rural, remote, and urban communities (Richmond 2016). With a growth rate of 42.5% over the last ten years the Indigenous population is predicted to face increased and continued challenges, with pre-existing health inequalities that remain unattended (Kolahdooz 2015; Statistics Canada 2016; Richmond 2016).

The primary cause for health disparities is inequalities across a range of health determinants which create a complex system that affects the individual, community, and environment (Kirmayer 2003; Waldram 2008; Czyzewski 2011; Gibson 2015; Kolahdooz 2015; Browne 2016; Auger 2016; Murdoch-Flowers 2019). Primary health disparities for the Indigenous population are associated with the cardiovascular and digestive systems, impairing the overall physiological health of the population (Booth 2012; Wilk 2018). These are not the only disparities they are widely experienced among the Indigenous population. Disparities include but are not limited to obesity, diabetes, hypertension, osteoporosis, osteoarthritis, depression, and certain cancers (Warburton 2006). Certain risk factors that lead to health disparities can be identified as modifiable conditions (Warburton 2006), which means they can be prevented by healthy behaviors such as regular physical activity and exercise (Warburton 2006; Yu 2016).
Determinants to health such as food insecurities, suicide, and dispossession are also harmful to the mental and emotional health of the Indigenous population and individuals (Czyzewski 2011; Lopez-Carmen. 2019). Colonial policies and attitudes have shaped social, economic, cultural, and political factors that have negatively affected diverse determinants of health for the Indigenous population (Adelson 2005; Czyzewski 2011; Freemantle 2015). Barriers and policies have led to a reduced quality of life and a shorter life expectancy (Tjepkema 2011; Tobias 2013; Gibson 2015; Public Health Agency of Canada 2016; Spence 2016; George 2019), with the Indigenous population living 12 years less than the non-Indigenous population (Koladooz 2015). To address concerns that surround the health of the Indigenous peoples the approach needs to be relevant to the community, with trust and integrity built from a mutual relationship (Foulds 2011; Gibson 2015; Rice 2016; Pelletier 2017; Piotr 2017; Lopez-Carmen 2019). Indigenous communities take a holistic approach to life, inclusive of health encompassing mental, spiritual, and emotional aspects. Thus, interventions to improve health need to observe and align with life satisfaction (Kirmayer 2003; Chelsea 2017; Lopez-Carmen 2019).

This study examines the role of Indigenous methods of PA and their contribution to health benefits. The use of PA has been proven to benefit quality of life and longevity (Gill 2013) by reducing morbidities such as cardiovascular disease, diabetes, hypertension/dyslipidemia, osteoarthritis, stroke, respiratory problems, cancers, and liver and gallbladder disease (Booth 2012). It is well established that PA plays a role in improving one’s physical, physiological, mental, and emotional qualities of life (Gracey 2009); however, interventions that target exercise adherence for Indigenous populations in rural communities remain unclear (Pelletier 2020). When approaching techniques regarding physical activity interventions it is best to create a sustainable lifestyle that is accessible for an individual to gain physical satisfaction (Gill 2013).
Considering the lifestyle of the Indigenous peoples and barriers the population faces on a daily basis, the process would be best approached through collaboration with the local community and research formed based on their interests. The community has a firm understanding of barriers they face and resources that are available. Academic literature is underdeveloped in its knowledge on the role that traditional or cultural activities contribute to physical activity and, in turn, healthy lifestyles.

Indigenous groups refer to, and understand, the intra-groups of the Indigenous population, and the differences in culture, practices, and procedures between each community (Spence 2016). The community that the investigative team in this study is working together with is Secwepemc in the mid-interior region of British Columbia (BC). The community is rural and separate from towns or cities, much like other reserves in the mid-interior and in northern BC. A great deal of the communities are similar in that they are rural or isolated and each face independent difficulties, however, being from the same nation their cultures are similar. Yet, each community has its own practices performed that align with their nations culture with different protocols surrounding each communities’ traditions. It is important to work with the community, with the leaders and with the community members when research is performed, or when programs are implemented within an Indigenous community. Outcomes of the shared project can only be tailored to that community as the extent of the findings or teachings of that program/system are limited. A growing body of literature recognizes the use of community-based participation when interacting with Indigenous populations to acquire a better understanding of community interests (Foulds 2011; Richmond 2016; Jones 2018; Murdoch-Flowers 2019; Allen 2020). Evidence supports the importance of recognizing Indigenous culture and its uniqueness, and respecting knowledge systems and practices through culturally appropriate approaches and techniques.
(Adelson 2005; Browne 2016; Richmond 2016; Spence 2016; Pelletier 2017). Remaining true to the purpose of the study, understanding traditions and culture of the community will be of great benefit for the community. Cultural relevance will support the community, fostering their understanding to help maintain adherence to positive health changes. The use of traditional activities such as hunting will have a personal connection, as hunting has traditionally been a part of the community’s history. Therefore the project will provide further understanding of the PA an individual endures in their communities hunting experience and practice.

In this study the aim is to monitor physical activity of on-reserve Indigenous participants while they are engaged in a modern land-based activity (hunting) and determine if they are obtaining adequate levels of PA in a real-world setting. Throughout this paper “on-reserve” and “non-hunting days” will be used to identify the recording sessions that were not spent hunting rather in the community partaking in “normal” activities of living and working on the reserve. The hypothesis is that for adults from a rural/remote Indigenous community the modern method of hunting that includes this communities’ cultural practices will exceed the recommended guideline of PA (30 min/day or projected 150 min/week). To determine this the different contributions of duration, and intensity of PA will be quantified over hunting and compared to a typical day on reserve. The goal is to recognize the health and fitness value of PA benefits acquired during a modern, culturally appropriate, land-based activity (hunting) for the participating community and to compare the range of activities of hunting (e.g., hiking, stalking, butchering, sitting, driving) to those of daily activity (e.g., work and/or leisure activities). Hunting provides an opportunity for learning about physical literacy through the lens of traditional or cultural activities practiced in the natural environment, and whether current activities are relevant and capable of maintaining or increasing PA levels of Indigenous peoples.
1.1.1 Indigenous Health Gap

Indigenous reserves in rural or remote areas are severely affected by health disparities, which is highlighted in studies that compare health determinants for the Indigenous population to the rest of Canada or urban communities (Kirmayer 2003; Leeuw 2013; Adelson 2015; Kolahdooz 2015). Frequently mentioned disparities that relate to cardiovascular, digestive system, and cognitive function aspects of health are major causes for mortality or loss of ambulatory living at an older age. Although these diseases have been highly prevalent in Indigenous communities, the comparison between Indigenous communities and the general population of Canada is difficult (Public Health Agency of Canada (PHAC) 2016). A comparison is challenged by: 1. the data was collected in different ways, not only between Canada population and Indigenous communities’ but between Indigenous Communities’; 2. the years the data were collected was also different, and inconsistent with the population of Canada’s data collection years (Indigenous health statistics 2008/2010 v. the rest of Canada 2014). Further work needs to be directed towards Indigenous health in order to recognize sufficient health outcomes for the population and the individual Indigenous communities.

The PHAC (2016) report is similarly challenged. Although diseases, PA levels, and poor conditions based on multiple sources are included, the information regarding the Indigenous population was gathered in a different manner, and it did not compare data to the Canadian Physical Activity Guidelines (CPAG). Conversely, the non-Indigenous population was compared to the CPAG (PHAC 2016). The same report made similar observations regarding cardiovascular disease (CVD), food insecurity, and diabetes in Indigenous communities. These examples are used because the outcome of each disease or condition directly relates to benefits gained from
PA. Studies demonstrate that the aforementioned diseases are higher among Indigenous peoples because of physical inactivity or lack of access to resources (Tjepkema 2011; Gill 2013; George 2019). In 2008/2010, Indigenous peoples on-reserve reported high blood pressure (22%), heart disease (6%), and stroke symptoms (2%), but there were no comparisons to the larger Canadian population (PHAC 2016). Only 46% of the Indigenous population had the ability to provide adequate food for their household, meaning 54% are at risk of food insecurity (40% are moderately at risk and 14% are severely at risk) (PHAC 2016). Food security is relevant because, without proper nutrition, activity levels are lower (Skinner 2013), and the energy required to perform at an optimal level of exercise for extended periods cannot be maintained. The findings, although challenged by data collection procedures, do include some statistics regarding Indigenous peoples living on-reserve and give a potentially more accurate look at health outcome.

There is considerable variability in the reports on diabetes in the Indigenous population. PHAC (2016) statistics cannot be adequately compared because age is not reported, the manner of data collection is different, and there is no identification of methods that were used in collecting the data for the report. The data indicate that ~16% of on-reserve and 6% of off-reserve First Nations, 4% of Métis, and 2% of Inuit individuals are diabetic. Other reviews on the prevalence of diabetes indicate that the Canadian Indigenous population is 3-6 times more likely to report diabetes than the remainder of the Canadian population (Crowshoe 2017). The PHAC (2016) report states non-Indigenous female population in Canada have a diabetes incidence rate of 9% for those aged 25-64 years, and 18% for those aged 64+ years, whereas males are substantially lower. This is in stark contrast to non-indigenous peoples where approximately 1% of males aged 20-34 years and 3% of males aged 35-44 years (PHAC 2016; Crowshoe 2017). Thus, the
Indigenous populations incidence rate of ~6-16% indicates a high need to employ strategies to mitigate diabetes and health complications associated with this disease. Physical activity is a well-established strategy.

These examples highlight only a few of the disparities in determinants of health that Indigenous peoples face, and do not include the contextual policies and historical trauma of assimilative practices that also decrease longevity and quality of life.

1.1.2 Physical Activity and Indigenous Health

Historically, Indigenous methods of gathering food and medicines represented meaningful PA that was paramount for a sustainable lifestyle. Engagement in traditional activities such as hunting and gathering was a necessity of Indigenous life, increasing physical conditioning and helped to keep the population relatively free of chronic disease (Dapice 2018). Colonization and assimilation attempts contributed to dispossession (Wilson 2011), specifically the loss of cultural practices related to traditional land-based PA—an activity that required higher levels of individual physical fitness and skill (Rode 1994; O’Neill 2018). Activities such as hunting and gathering food required physical literacy (PL) skills and the knowledge necessary to perform such complex tasks. Physical literacy is defined as having the “motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life” (ParticipACTION 2015). Physical literacy can be beneficial for promoting PA participation in children through to older adults (Jones 2018), while at the same time supporting the knowledge that exists amongst the population or individuals. However, evidence indicates that an understanding of these components that influence PL, as applied to Indigenous culture, have almost been lost because of barriers reducing land-based experiences
that support a physical lifestyle (Richmond 2016; O’Neill 2018). Hunting promotes PA through positive health practices that use Indigenous knowledge and sharing of stories between Elders and youth, thus positively influencing community health by reinforcing culture at the same time as an active lifestyle (Wilson 2011; Verba 2014).

PA interventions can create positive health change, yet participant adherence is an ongoing challenge. PA can influence indicators of health determinants, such as waist circumference, blood pressure, and cholesterol; such measures have been explored in Indigenous peoples involved in community-based PA interventions (Foulds 2017). Indigenous peoples traditionally were active through cultural events and lifestyle. Yet, Indigenous communities have shifted from being physically active through traditional/cultural activities such as hunting, fishing, harvesting plants and plant-medicines, to a more sedentary lifestyle reliant upon colonial conveniences (Katzmarzyk 2008). The implementation of colonial and/or modern interventions comes with challenges for rural or remote communities (Spence 2016), associated with the individual communities’ and culture. Thus, no one idea or approach can be used as a blanket intervention to solve Indigenous health problems. However, what is similar across communities is most rural or remote communities have difficulties related to access to facilities and supports for adherence to PA interventions or practices (Katzmarzyk 2008).

Leaving the reserve for urban centers creates behaviors unique from on-reserve activities. It is important to recognize leaving the reserve to a larger urban location suggests participants can extend daily activities beyond the natural routine at home or work. Staying faithful to the study, activities were monitored on-reserve where participants spend most of their time through the week.
During Canada’s attempt at assimilating the Indigenous peoples into a colonial culture, limitations in accessing traditional land-based resources were imposed (Murdoch-Flowers 2019). The Indigenous peoples maintained their resilience and communities continue to engage in cultural activities in their traditional territories (King 2014), keeping in mind all cultures are not the same. In BC the traditional territories often extend well beyond the reserve lands of the Indigenous peoples allowing Band members to hunt and harvest over a much larger area than what is offered on-reserve. Indigenous peoples are able to hunt legally in their traditional territory year-round, and perform related tasks such as trapping, and harvesting wild plants and medicines. Accounts of these traditional activities are rarely seen in literature; however, there is qualitative evidence from Indigenous communities (on- and off-reserve) that suggests these activities can be strenuous enough to engender health and fitness benefit (Peiris 2008; Kind 2014). Indigenous practices are important to understand as study intervention techniques directly affect the community (Kolahdooz 2015; Freemantle 2015; Spence 2016; Allen 2020).

Implementing community-based participation also allows for greater adherence (Foulds 2017; Rolleston 2017; Jones 2018; Allen 2020), and relevance of intervention techniques to community interests (George 2013). The prospect of improving the overall health and well-being of an Indigenous population, through innovative and culturally specific education strategies, is likely the best practice for making a positive and effective change in the health behaviors of Indigenous populations in rural or remote settings (Rolleston 2017).

To attain physiological health benefits from PA, an individual must reach a certain level of intensity in their activity. Light to moderate exertion levels will provide minimal benefits, whereas moderate to vigorous PA increases fitness levels and overall function (George 2013). Improved health through regular exercise maintenance will assist in disease management;
indeed, fitness provides resilience to health status and the functional independence to support overall quality of life (Katzmarzyk 2008; Murdoch-Flowers 2019).

The Canadian Physical Activity Guidelines (CPAG) recommend that all Canadians accumulate a minimum of 150 minutes per week of moderate to vigorous intensity PA for minimal physical maintenance. For improvement or further benefits, it is recommended an individual achieve higher levels of intensity for longer periods. Previous work monitoring metabolic rate during hunting suggested that activities associated with walking/hiking and dragging deer generate cardiovascular responses similar to maximal treadmill running (Verba 2014; Petterson 1999). To understand whether hunting meets the CPAG measurements requires an examination of “real” activity. Indigenous communities have a strong cultural connection to activities like hunting; they play a role in their history. Activities such as hunting embody earlier methods of wholistic knowledge systems where the peoples lived alongside the land. Their traditional territory, and traditional activities engaged aspects of mental, emotional, physical, and spiritual health and thus were interactively intertwined and understandably mutually worked together. Although practices around traditional activities have adapted, protocols still exist for Indigenous communities for what existed traditionally (Murdoch-Flowers 2019; Allen 2020). Indigenous protocol is rarely seen in literature, as traditional knowledge is valuable and kept within the community where teachings are orally passed down through generations (Waldrum 2008). Traditional or ceremonial protocol are shared amongst the members of the community. Indigenous knowledge keepers understand the importance of an array of traditional practices that interconnect and involve holistic health of the individual and the community (Waldrum 2008; Murdoch-Flowers 2019) and passing that knowledge to the next generation is important. To-date no study has
combined elements of community understanding and quantitative measures to understanding the PA associated with hunting.

1.1.3 Approach to Working with a BC First Nation community

Historically, research has not fully supported the interests and beliefs of the Indigenous population in Canada and has been critiqued for being inappropriate because of the lack of practical relevance or engagement with Indigenous peoples and communities (Laveaux 2009; Morton Ninomiya 2017). Community-based research (CBPR) in public health is research that equitably involves community members, leaders, investigators, and researchers to collaboratively work together and utilize their unique strengths towards the same goal of enhancing the health and well-being of the community as well as social and cultural structures (Israel 1998). In 1998 Israel and colleagues identified eight key principles that speak to community involvement in research. These eight principles include: 1. Recognize community as a unity of identity; 2. Build on strengths and resources within the community; 3. Facilitate collaborative partnerships in all phases of the research; 4. Integrate knowledge and action for mutual benefit of all partners; 5. Promote a co-learning and empowering process that attends to social inequalities; 6. Involve a cyclical and iterative process; 7. Address health from both positive and ecological perspectives; and 8. Disseminates findings and knowledge gained to all partners. The principles were readdressed 11 years later and recreated into nine principles that contextualize the content and terminology to be more suited to Indigenous rural communities (Laveaux 2009). These include: 1. Acknowledge historical experience with research and with health issues and work to overcome the negative image of research; 2. Recognize tribal sovereignty; 3. Differentiate between tribal and community membership; 4. Understand tribal diversity and its implications; 5. Plan for
extended timelines; 6. Recognize key gatekeepers; 7. Prepare for leadership turnover; 8. Interpret data within the cultural context; and 9. Utilize Indigenous ways of knowing (Laveaux 2009). It is important to recognize that the principles that are generated are general guidelines, and that each community differs in terms of health, culture, structure, and social disparities (Laveaux 2009). While CBPR guidelines are best suited to approach Indigenous communities, it is expected in Canada that research with Indigenous communities respect Indigenous knowledge and associated knowledge systems that are inclusive of the four R’s approach: respect, relevance, reciprocity and responsibility (Kirkness 2016) and follow the Owner, Control, Access, and Possessions (OCAP®) principles (First Nations Centre 2019).

The CBPR approach was selected for this study because it is engaging and considers the interests of the Indigenous community. When working collaboratively with rural Indigenous communities, it is important to build a relationship based on trust and honesty with the local community. This includes gaining approval from community leaders, for example the elders, chief, council, management, or department heads. Approaching community leaders adds an extra step not typically required in the research process before participant recruitment. This step includes building a trustful yet understanding relationship with the community and Indigenous peoples, which may require an extended amount of time. Seeking approval from the community leaders was done prior to participant recruitment. If approval is granted by both community leaders and the academic process, then actively engaging with the community regarding research and seeking out recruits to participate in the research study can begin.

This research is being performed as an in-community observational study. The primary researcher will be physically engaging with the community chief, council, elders, and members.
The primary researcher is from the community, working collaboratively from both a researcher and community perspective and this will be important to effectively achieve a greater understanding of the importance of PA in general and traditional PA in particular. Community input and understanding of the complex dynamics that exist will be important with respect to understanding social health disparities at the individual level. Community curiosity will also be valuable in terms of adjusting the questions being asked throughout the study. Catering to the interests of the Indigenous peoples as the research progresses and refining the outcomes will be important to ensure that the questions and results are directly relevant to rural Indigenous communities.

1.1.4 Statement of the problem

Scientific literature has yet to focus on Indigenous cultural or traditional benefits to health and how such activities are used to promote adequate levels of daily physical activity. Recent studies suggest working directly with Indigenous communities is beneficial because it is informed by community interest and knowledge (Pelletier. 2020). The narrative around being traditionally active is understood best by the community, as the practices and protocol exist in their stories. Our aim is to investigate how hunting, an activity widely practiced in Indigenous communities, remains relevant but not widely used or understood as a tool to gain adequate levels of PA.

Indigenous peoples are facing greater health disparities and poorer access to options for maintaining an active lifestyle than other Canadians. Searching for on-reserve PA options that feature Indigenous methods is important for cultural meaning and safety. Hunting is important as many communities have a history of such activity prior to colonial contact, with evidence that Indigenous peoples historically led active lives free of chronic disease or conditions.
1.1.5 Significance of the Study

The study will maintain relevance to Indigenous culture through a culturally safe approach that respects the peoples involved. The study will also benefit the Indigenous population due to its relevance to their history and resilience in revitalizing culture related to Indigenous methods of learning/teaching. The purpose of the research is not to obtain or extract information without permission from the community but to develop meaningful options for activity through Indigenous methods to enhance the PA of Indigenous populations. Thus, the study may help to inform reliable methods of PA on-reserve or in remote areas. This type of research is important as physical activity monitoring is missing in other studies that have aimed to obtain Indigenous peoples’s input and thoughts on meaningful activity.
Chapter 2: Methods and Approach

2.1 Methods

2.1.1 Community Based Participatory Research

Prior to the start of this project the community was introduced to the research project at the leadership level. Meetings between the Chief and I were held to determine if the proposed research was a priority for the community. Band leadership was informed that they would be involved throughout the research project and would be able to immediately act upon the results if necessary. This form of CBPR encourages the use of existing knowledge systems within the community to adjust the scope of the research, reflecting the unique surroundings and culture of the community. CBPR provides a platform to amalgamate similar beliefs through the exchange of collaborative knowledge between all parties invested in the project. Following the study, to present information to the community, a document consisting of a summary will be provided to the community leaders and participants that remove scientific and experimental “jargon”.

Throughout the project, conversations have been shared with those involved with the study and information regarding the project and findings have been continuously shared with the participants.

I am a member of this First Nations community, located in the mid-interior of British Columbia and I have a pre-established relationship with community leaders. This relationship was founded on trust and understanding. This research will form my thesis requirement for my MSc. Because I am a member of this community, I am very familiar with it. To prevent coercion, the pre-existing relationship was not used, in any way, shape, or form as a means to entice participation in the project. Investigators have been transparent with community leaders regarding the research
process throughout the project, especially with the collection, distribution and sharing of information with the community.

2.1.2 Participants

This research investigation was open to all those living on the reserve who had a history of engaging in regular hunting practices, were over the age of 18 years, and were able to provide informed consent. Following the CBPR model, participant recruitment followed a two-step recruitment process: (1) Community leadership was first approached and provided with information regarding the study. Leadership recommended who should participate in the study; and (2) After community leaders approved of the collaborative research investigation with the community the recommended participants were approached by Sidney Paul co-investigator and a member of the community, for voluntary participation in the study, where information regarding the project was distributed and informed consent was explained. Participants were kindly reminded that the project did not require mandatory participation, and they could drop out at any time.

Participants that were invited to take-part in the research project had a history of being actively involved with the community, all had grown up on-reserve and had lived most of their lives in the rural community. As hunters, the participants were very familiar with safety and cultural protocols passed down through the generations. In addition, participants also experienced barriers to accessing health care, recreation facilities, and many of the modern conveniences that would be available if they were living in a modern urban environment.
2.1.3 Equipment

The ActiGraph™ wGT3X-BT accelerometers (Figure 1; Pensacola, FL) were used to record both movement intensity, duration of PA, and periods of sedentary behaviour. Polar™ H7 Heart Rate Sensors (Kempele, Finland) were used to observe HR during the hunting activity. Heart rate data were transmitted and stored to a 4 GB memory chip within the wGT3X-BT accelerometer. The devices were connected through Bluetooth® transmission. The accelerometers were set at a data sampling rate of 100Hz and later uploaded to ActiLife 6™ software (Pensacola, FL). The 100Hz represents the threshold of acceleration required to register actual physical movement each second. This high sampling frequency provides a rigorous representation of participant movement for each second of monitoring. However, because the data were being collected over a long duration (6-7 hours), per-second movement values were averaged and logged every 60 seconds. The logging of data across 60 second epochs allowed for a longer sampling period and easier amalgamation with the HR values, measured as beats per minute. The idle sleep mode was enabled to record any inactivity of ≥10 seconds. However, as soon as there was movement or an active HR recording the device would wake-up and immediately start recording. Start times were selected based on the participants suggestion. For example, if a participant said they were going hunting at 7:00 am the next day the accelerometer would be set to begin recording at 6:00 am to ensure devices were enabled when participants commenced their activity. The stop time was left open, meaning devices would record until stopped. Leaving the devices end time open was to maximize the length of recording. There was no concern for battery life as the battery life is tested by Polar™ to last
days even with the 100Hz recording rate. To be confident, the lead investigator pilot tested the equipment. Results of the pilot test showed that the equipment will actively record for up to 20 days.

Participants were instructed on how to properly manage the accelerometers and heart rate monitors on their own. They were instructed on how to properly position the accelerometer on the waist to monitor ambulatory movement (active bouts, steps count) with the accelerometer in the correct orientation to record proper triaxle planes. The placement of the heart rate monitor around the chest was practiced with the participant. The elastic strap was securely fastened around the chest with the HR transmitter located just above the sternum. Participants were instructed on how to properly use the device. Instructions provided by Polar™ suggest dampening the electrodes on the side of the chest strap before fitting the HR monitor to their chest for an improved-immediate recording of heart rate.

The accelerometers recorded HR and PA simultaneously and stored the data in real-time within the device. Following each hunting session, the data were downloaded to the ActiLife 6™ Analysis Software for off-line data analysis. The files were later analyzed on ActiLife 6™ to check for discrepancies such as faulty recording, missing data, and device wear time.

Participants also logged activity using personal paper journals. The journals provided additional qualitative information related to the hunting activity performed throughout the day and enabled verification of the accelerometer recordings. For example, participants recorded driving-time for a given duration and identified the approximate time when they got out to walk, hike, etc. The accelerometer recordings for movement were cross-referenced with journal log entries to ensure that data analysis of hunting and non-hunting activities was appropriately coded and onset time
initiated. If participants failed to log their PA behaviours then a follow-up interview was immediately requested, where the investigator and participant reviewed the accelerometer and HR data. Interviews were used to recall PA behaviours to corroborate the quantitative values. Questions were asked on how the participant’s day went wearing the device. If any high or low episodes in activity were evident participants were asked what may have triggered the response. Participants were also asked to confirm the time they started hunting and whether the hunt was successful.

2.1.4 Study Design

This CBPR study was designed to observe the PA characteristics of hunting wild game by Indigenous community members. Before data collection commenced, participant characteristics were assessed, including; resting HR (HRrest), weight, height and age. The study was designed as a CBPR project to receive input from community leaders and members who live on reserve and to help re-evaluate interest as the project proceeded. Re-evaluation consisted of going through the findings of the project as they progressed, and agreement of the direction of the project where the community leaders and investigation team were comfortable moving forward. It also took into account the best interest of those directly affected by the research findings. For Indigenous peoples living on-reserve life is affected by colonial restraints, isolating Indigenous populations into portions of the land they had “managed” pre-colonial contact. I am using the term manage in this context to describe the Indigenous peoples and their interconnectedness to the land prior to colonization. Colonization imposed barriers on this managed land, and limited activities of harvesting, hunting, or managing their traditional territories, and this also reduced their physical movement. However, hunting provides an opportunity for Indigenous peoples to
hunt in their traditional territory, which allows for more space to move freely. The study was
designed to observe activities of hunting and to compare hunting activity to on-reserve lifestyle
activities. To validate recordings participants were asked to record two days of hunting and two
days of daily activity on-reserve. The on-reserve days were intended to be normal behavior days,
and participants were asked to maintain behavioral habits that exist within their typical routine.

The HRrest and age predicted HR maximum (HRmax) were used to determine HR reserve and
target HR intensity, which were required to establish the individual’s thresholds for moderate
and vigorous PA intensity that needed to be achieved during the hunting excursion. Levels of
moderate and vigorous intensity PA would engender the greatest health benefits. The self-
reported information participants provided from their hunt was cross referenced with the HR and
accelerometer data to establish onset of activities and transition between activities, for example
driving or hunting.

The wGT3X-BT™ accelerometer records movement vibration across three planes x, y and z
(vertical, horizontal and diagonal). This triaxial accelerometer also collects HR data so that
changes in movement vibration can be combined with the participant’s physiological response.
The HR values provide an additive measure of movement intensity, providing improved
reporting accuracy relative to the movement being performed. For example, if a participant is
driving down a particularly bumpy road, the accelerometer will record significant movement
accelerations; however, HR will generally not change. Therefore, the movement intensity,
relative to physiological response is not justifiable. Whereas, increased movement accelerations
as a result of walking over uneven ground will be supported by an increase in HR relative to the
amount of physical work being performed by the participant. After the recording period was
completed the accelerometers were returned to the investigator for uploading to the ActiLife 6™ software. The memory was then cleared from the accelerometer before it was initialized for the next day of data recording.

ActiLife 6™ uses a series of algorithms to predict intensity of movement. Both movement and HR data were simultaneously analyzed using the ActiLife 6™ software. The investigator also determined each participant’s age-predicted maximal HR (220-age) and calculated their individual HR reserve to determine HR thresholds associated with light, moderate and vigorous PA intensity (See Figure 2). Participants were asked to record the two hunting days as close together as possible, the same was asked for on-reserve recordings. However, it was not necessary to record consecutively, the purpose was to observe any findings in the natural habit of participants. So, when consecutive days were not possible then they were asked to record days where activity followed their most natural routine. For example, if participants left the community on the day following a hunting day, then they were asked to record the next possible time to the last recording day. The same pattern was asked of the on-reserve days; to record as close as possible and not record on days that do not follow their standard routine.

Figure 2: Representative recording of participants HR levels. The orange bar indicates heart rate thresholds for light, blue moderate and green intense physical activity for this individual.
2.1.5 Data Analysis

Data were downloaded through ActiLife 6™ software as AGD files to establish data scoring and data validation. The downloaded data were later converted and exported into Excel CSV files, and subsequently converted into XLS files. Files were converted from CVS format to XLS, where it was observed in both XLS and IBM Statistical Package for the Social Sciences (SPSS)®.

Variables exported from the wGT3X-BT™ were Axis movements (x, y, and z), steps, HR, and body position (vertical, sitting, and lying). ActiLife 6™ software was used to validate and observe time. Validated data, using the ActiLife 6™ was then scored with Freedson algorithms within the same software program (Sasaki. 2011). The algorithms were chosen for males 19-60 years of age and the best fit of ground-based activity (Freedson. 1998; Saskai 2011).

The values for each hunting day as well as each non-hunting day were assessed for outliers and missing values. Aberrant recordings and missed data points were removed. Data were removed where there was <3 hours of recording throughout the day and unusable information, which consisted of inconsecutive heart rate recording for longer than 60 minutes. HR was chosen over movement in determining faulty data because participants may have less movement during activities of daily living. Sedentary movement may be mistaken for faulty data. The length of HR monitor time is longer and aberrant data points appear when the accelerometer becomes dislodged from the waste belt, or is abruptly contacted e.g., placing a seatbelt on for driving, or gun strap placement. The body position or movement was calculated within a pre-programmed
algorithm that determines exercise intensity based on movement displacement, speed, and time through the epochs gathered with the built-in triaxle accelerometer, over the three planes of movement. Data collected for each participant, were compared within each type of activity across the two-days. This within data comparison was undertaken to ensure that the recording days were typical representations of that type of activity. Subsequent averages across the two hunting days and the two normal activity days were made to gain best representation of the activity. Sessions were re-recorded by participants if there were substantial gaps in recordings (e.g. HR, equipment powers off, removal of uncomfortable equipment, etc.), or irregular data points in the output (substantial data gaps).

To establish HRrest participants sat quietly for five minutes. The pulse from the wrist was recorded following the fifth minute and was reported as that individual’s baseline HR at rest. The five minutes of sitting was used to ensure all participants baseline HR was recorded at rest. An age-predicted formula (220-age) was used to estimate each individual participant’s safe HRmax value. These values were used to ascertain the participant’s HRR, the difference between HRmax and HRrest. To clearly understand the intensity of PA accomplished each day, the HRR was separated into four different intensity zones; sedentary, low, moderate and vigorous. The physiological demand of PA, for each participant on hunting and non-hunting days, is characterized by the duration of time spent within each HRR intensity zone (Table 1).

The average resting HRrest was recorded after an individual sat calmly for 5 minutes of rest, and this was recorded a day prior to a recording session. HR max was calculated as:

\[
HRmax = 220 - age
\]
HR reserves (HRR) allows for a better targeted HR training zone because the modified HRR calculation considers HRrest. HRR was calculated as:

\[
HRR = (HR_{max} - HR_{rest})
\]

And target HR zones were determined

\[
target\ HR\ zones = (HRR \times \text{training intensity}%) + HR_{rest}
\]

The percentages used to represent low, moderate, and high levels were 40%, 55%, and 70%, respectively (Table 1). The intensity levels were related to known standards to determine health (>55%) and fitness (>70%) benefits (Heyward 2014). For example, an individual working at a level of 40% is exerting themselves above basal HR at a low intensity. This zone when engaged in for short periods of time is an inadequate level to experience physiological adaptations to induce fitness gains (Hofmann 2011). Participants exerting themselves above 55% exertion levels begin to experience cardiovascular health benefits, and those working at intensities ≥ 70% would achieve improvements to aerobic fitness levels (Hofmann 2011; Heyward 2014). Working below the suggested threshold values of 40% of HRR or ≤100 bpm was identified as sedentary behaviour (Heyward 2014), which is defined as low end energy expenditure, of less than 1.0 to 1.5 basal metabolic rate (METs) (Owen 2010). Creating heart rate zones based on the response to a participant’s activity was expected to demonstrate how land-based activities that are important to their culture and/or community, such as hunting, provide fitness and health benefit relative to activities of daily living.
Table 1 Physical Activity Intensity Related to Fitness, Percent Heart Rate Reserve, and Heart Rate

<table>
<thead>
<tr>
<th>PA intensity</th>
<th>Contribution to Health and Fitness</th>
<th>% Range of HRR</th>
<th>Sample Participant HR limits (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary (&lt;2.0 METS)</td>
<td>Poor</td>
<td>&lt;40</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Light (2.0-2.9 METS)</td>
<td>Fair</td>
<td>40-55</td>
<td>100-135</td>
</tr>
<tr>
<td>Moderate (3-5.9 METS)</td>
<td>Average</td>
<td>55-70</td>
<td>135-155</td>
</tr>
<tr>
<td>Vigorous (≥ 6.0 METS)</td>
<td>Excellent</td>
<td>70- &lt;90</td>
<td>&gt;155</td>
</tr>
</tbody>
</table>

Note: PA=physical activity; HRR = Heart Rate Reserve; HR= Heart Rate; bpm= beats per minute Qualitative values of light, moderate, moderate-vigorous, and vigorous activity (Column 1) and the intensity’s contribution to health and fitness (Column 2); corresponding HRR range (Column 3) and the participant’s heart rate reserve values (Column 4).

2.1.6. Statistical Approach

Statistical comparisons were undertaken using SPSS® (Version 26; Chicago, IL). Data were set up in Microsoft Excel and evaluated with paired t-tests to determine whether there were any significant differences within common activity days e.g., hunting day 1 and hunting day 2. Because there were no significant differences within data, sessions were averaged, and the hunting day was then compared to the non-hunting day.

To compare variables between the hunting and non-hunting days a paired sample t-test was used for HR, steps, and PA levels. HR was categorized into four different levels to evaluate time spent in sedentary, low, moderate, and vigorous activities. Movement was determined through accelerometer equipment, which recorded epochs on different axes (axis x, axis y, and axis z) and these are inherently used to determine step count. Significance was set to p<0.05 and data were reported as means ± SD.
Chapter 3: Results

3.1 Results

3.1.1 Participant Characteristics

Following the recommendation of Chief and Council to begin recruiting, six indigenous males, 36 ± 11 years of age volunteered to participate in the study. Participants lived on reserve and were all members of the community located in the mid-interior region of British Columbia along the Fraser River. Each participant was an experienced hunter (13+ years of experience) and hunted regularly throughout the year. Participants were required to record their PA behaviors over two successive winter hunting days between September and March, followed by two days on-reserve where they were instructed to go about their normal daily routines.

Participant’s average height, weight and body mass index (BMI) were: 174.8 ± 6.5 cm, 86.4 ± 8.9 kg, and 28.2 ± 2 kg/m² respectively. Average resting HR was 63 ± 6 bpm. From the resting HR, HRmax, and HRR, the heart rate zones for intensity of physical activity were determined for each participant (Table 2). All participants were physically independent and self-reported to be in good health. However, one participant reported that they had a respiratory health condition that required occasional use of an inhaler, but they had not required this medication in the past year. A second participant reported that they were taking medication for anxiety; however, they did not use this medication during this research investigation.
Table 2 Participant heart rate characteristics

<table>
<thead>
<tr>
<th>Participant</th>
<th>HRrest (bpm)</th>
<th>HRmax (bpm)</th>
<th>HRR (bpm)</th>
<th>Sed (bpm)</th>
<th>Light (bpm)</th>
<th>Mod (bpm)</th>
<th>Vig (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>63</td>
<td>192</td>
<td>129</td>
<td>&lt;114</td>
<td>114 - 134</td>
<td>134 - 153</td>
<td>&gt;153</td>
</tr>
<tr>
<td>2.00</td>
<td>65</td>
<td>193</td>
<td>128</td>
<td>&lt;116</td>
<td>116 - 135</td>
<td>135 - 154</td>
<td>&gt;154</td>
</tr>
<tr>
<td>3.00</td>
<td>70</td>
<td>186</td>
<td>116</td>
<td>&lt;116</td>
<td>116 - 134</td>
<td>134 - 151</td>
<td>&gt;151</td>
</tr>
<tr>
<td>4.00</td>
<td>65</td>
<td>164</td>
<td>99</td>
<td>&lt;105</td>
<td>105 - 119</td>
<td>119 - 134</td>
<td>&gt;134</td>
</tr>
<tr>
<td>5.00</td>
<td>53</td>
<td>177</td>
<td>124</td>
<td>&lt;103</td>
<td>103 - 121</td>
<td>121 - 140</td>
<td>&gt;140</td>
</tr>
<tr>
<td>6.00</td>
<td>61</td>
<td>184</td>
<td>123</td>
<td>&lt;110</td>
<td>110 - 129</td>
<td>129 - 147</td>
<td>&gt;147</td>
</tr>
</tbody>
</table>

HR = heart rate; bpm = beats per minute; HRrest = resting heart rate; HRmax = maximum age-predicted heart rate; HRR = heart rate reserve; Sed = sedentary; Mod = moderate; Vig = vigorous.

3.1.2 Within day comparisons for hunting and non-hunting days

Average recorded HR, for each participant, did not differ within the hunting days or within the non-hunting days (Table 3). There was no-difference in total PA duration (minutes per day) between the two recorded hunting days. Similarly, no-differences existed for the duration of PA accumulated between the two non-hunting days (Table 4). Participants 3.00, 5.00 and 6.00 had no recordings on day 2 of hunting because of injury, family matters, and faulty recording due to participant and/or equipment error.
Table 3 Average HR recorded for each participant during hunting and non-hunting days

<table>
<thead>
<tr>
<th>Participant</th>
<th>Hunting HR (bpm)</th>
<th>Non-hunting HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
</tr>
<tr>
<td>1.00</td>
<td>104</td>
<td>130</td>
</tr>
<tr>
<td>2.00</td>
<td>86</td>
<td>117</td>
</tr>
<tr>
<td>3.00</td>
<td>94</td>
<td>-</td>
</tr>
<tr>
<td>4.00</td>
<td>89</td>
<td>76</td>
</tr>
<tr>
<td>5.00</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>6.00</td>
<td>99</td>
<td>-</td>
</tr>
<tr>
<td>Average</td>
<td>92</td>
<td>108</td>
</tr>
<tr>
<td>± SD</td>
<td>9</td>
<td>62</td>
</tr>
<tr>
<td>P value</td>
<td>0.406</td>
<td>0.839</td>
</tr>
</tbody>
</table>

HR = heart rate; bpm = beats per minute; P ≤ 0.05

Table 4 Duration of PA recorded for hunting and non-hunting days for each participant.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Hunting (min)</th>
<th>Non-hunting (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
</tr>
<tr>
<td>1.00</td>
<td>551.0</td>
<td>766.0</td>
</tr>
<tr>
<td>2.00</td>
<td>594.1</td>
<td>564.0</td>
</tr>
<tr>
<td>3.00</td>
<td>526.0</td>
<td>-</td>
</tr>
<tr>
<td>4.00</td>
<td>299.6</td>
<td>609.0</td>
</tr>
<tr>
<td>5.00</td>
<td>1053.5</td>
<td>-</td>
</tr>
<tr>
<td>6.00</td>
<td>626.8</td>
<td>-</td>
</tr>
<tr>
<td>Average</td>
<td>608.5</td>
<td>646.3</td>
</tr>
<tr>
<td>± SD</td>
<td>246.6</td>
<td>106.0</td>
</tr>
<tr>
<td>P value</td>
<td>0.245</td>
<td>0.254</td>
</tr>
</tbody>
</table>

min = minutes; SD = standard deviation; P ≤ 0.05

Waist born accelerometers were used to record daily step counts. There was no difference in daily steps within hunting days, and within non-hunting days. During hunting days, the average step count was significantly higher, almost double the step count achieved on non-hunting days (Table 5).
Table 5 Five-hour step counts recorded for hunting and non-hunting day.

<table>
<thead>
<tr>
<th>Day</th>
<th>Step Counts ± SD</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting 1</td>
<td>12434 ± 4309</td>
<td>0.13</td>
</tr>
<tr>
<td>Hunting 2</td>
<td>14838 ± 1419</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>13235 ± 3681</td>
<td></td>
</tr>
<tr>
<td>Non-hunting 1</td>
<td>7430 ± 2067</td>
<td>0.28</td>
</tr>
<tr>
<td>Non-hunting 2</td>
<td>7502 ± 5201</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>7470 ± 3773</td>
<td>0.01</td>
</tr>
</tbody>
</table>

SD= Standard deviation; P ≤ 0.05

To examine the differences in PA intensity performed each day, the participant’s average duration within each of the HRR intensity zones was calculated. This provided an estimate of the amount of time participants, on average, spent within each of the four HRR intensity zones; sedentary, low, moderate and vigorous. Despite visible differences, the average time spent within each HRR intensity zone was similar across hunting days and non-hunting days (Table 6). There were no statistically significant differences between days one and two for hunting and non-hunting days for each of the four zones of PA intensity. Therefore, the data were pooled to allow for between-group comparisons of PA and intensity for hunting versus non-hunting days. The amount of time spent sedentary during a hunting day was approximately 14 minutes less than recorded on non-hunting days, and the amount of time spent in the vigorous HR zone was approximately 17 minutes greater during hunting versus non-hunting days. However, there were no statistically significant differences between the average duration of time spent in each of these zones between hunting and non-hunting days.
Table 6 Duration of time spent within each physical activity intensity zone during hunting and non-hunting days, derived from 5-hours in the middle of participants record time.

<table>
<thead>
<tr>
<th></th>
<th>Sed (min)</th>
<th>Low (min)</th>
<th>Mod (min)</th>
<th>Vig (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting day 1</td>
<td>244.83</td>
<td>39.50</td>
<td>13.17</td>
<td>3.00</td>
</tr>
<tr>
<td>Hunting day 2</td>
<td>186.67</td>
<td>29.33</td>
<td>41.67</td>
<td>42.33</td>
</tr>
<tr>
<td>Average ± SD P value</td>
<td>225.4 ± 85.6</td>
<td>40.6 ± 36.3</td>
<td>29.1 ± 36.8</td>
<td>20.7 ± 40.4</td>
</tr>
<tr>
<td>Non-Hunting day 1</td>
<td>231.83</td>
<td>59.33</td>
<td>7.50</td>
<td>1.33</td>
</tr>
<tr>
<td>Non-Hunting day 2</td>
<td>247.67</td>
<td>27.83</td>
<td>18.50</td>
<td>6.00</td>
</tr>
<tr>
<td>Average ± SD P value</td>
<td>239.8 ± 55.4</td>
<td>43.6 ± 43.6</td>
<td>13.0 ± 24.1</td>
<td>3.7 ± 3.7</td>
</tr>
</tbody>
</table>

3.1.3 Adjusted comparisons between hunting and non-hunting days

Although, significant differences for average step counts between hunting and non-hunting days existed (Table 5), there were no significant differences between recorded HR values between hunting and non-hunting days: sedentary (P= 0.85), low, (P= 0.62), moderate (P= 0.68), and vigorous (P= 0.39).

To further evaluate PA the duration of recording was reconsidered over the middle time period of each sampling day, as travel to and from the hunting site required long periods of sedentary PA behavior because participants were seated in a vehicle. Therefore, the middle five hours of each day were examined for both hunting and non-hunting days.

Of the five hours of activity evaluated for hunting and non-hunting days there was no difference in time spent standing, sitting or lying between hunting and non-hunting days (Table 7). Participants spent an average of 56% standing, 33% sitting, and 1% lying during hunting. Whereas on non-hunting days participants spent 57% standing, 37% sitting, and 6% lying.
Table 7 Time spent standing, sitting, and lying down for middle five hours of recording sessions.

<table>
<thead>
<tr>
<th></th>
<th>Standing</th>
<th>Sitting</th>
<th>Lying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting</td>
<td>57%</td>
<td>32%</td>
<td>1%</td>
</tr>
<tr>
<td>Non-Hunting</td>
<td>57%</td>
<td>37%</td>
<td>6%</td>
</tr>
<tr>
<td>P value</td>
<td>0.293</td>
<td>0.846</td>
<td>0.156</td>
</tr>
</tbody>
</table>

Note: The time does not equate to 100%, the percentage merely represents the time recorded in these positions, and during some period’s equipment could not adequately orient body position.

The average steps for hunting and for non-hunting differed significantly when the middle 5 hours were compared (p= 0.01). The average duration of the sedentary behavior (<40% of HRR) recorded on hunting days did not differ from the non-hunting days (p= 0.85). The time spent at a moderate intensity also did not differ between hunting and non-hunting (p= 0.62). Higher levels of PA intensity are typically shorter relative to moderate and low, and this is evident in the hunting and non-hunting days. Although the duration of time spent in high levels of PA were approximately 4-times greater on hunting than non-hunting days, these values were not statistically significant (p= 0.38) (Table 8).

Table 8 Comparison of time for middle 5-hours hunting and non-hunting days

<table>
<thead>
<tr>
<th>Adjusted variables</th>
<th>Hunting ± SD</th>
<th>Non-Hunting ± SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average HR (bpm)</td>
<td>101 ± 22</td>
<td>93 ± 17</td>
<td>0.53</td>
</tr>
<tr>
<td>Total Step counts</td>
<td>11912 ± 3681.4</td>
<td>7470.9 ± 3773.4</td>
<td>0.01</td>
</tr>
<tr>
<td>Sedentary Duration (min)</td>
<td>225.4 ± 85.6</td>
<td>239.8 ± 55.4</td>
<td>0.85</td>
</tr>
<tr>
<td>Low PA Duration (min)</td>
<td>36.1 ± 36.6</td>
<td>43.6 ± 47.3</td>
<td>0.62</td>
</tr>
<tr>
<td>Moderate PA Duration (min)</td>
<td>22.7 ± 34.4</td>
<td>13.0 ± 24.1</td>
<td>0.68</td>
</tr>
<tr>
<td>Vigorous PA Duration (min)</td>
<td>16.1 ± 36.1</td>
<td>3.7 ± 8.4</td>
<td>0.39</td>
</tr>
</tbody>
</table>

PA = physical activity; SD = standard deviation; p > .05
Chapter 4: Discussion

4.1 General findings

Hunting is a traditional practice used by Indigenous peoples to obtain essential foods to not only nourish families and communities but maintain food security. Hunting has been part of British Columbia’s first nation communities since precolonial contact, and the introduction of Western European lifestyle reduced the number of peoples who engaged in hunting. However, this lost cultural activity might have reduced health benefits for Indigenous peoples, beyond immediate food resource, since the activity itself is physically demanding. There is physical effort experienced by Indigenous peoples who undertake activities such as hunting, fishing, and traditional dancing (Murdoch-Flowers 2019). The purpose of this study was to monitor the PA levels of Indigenous males, living on-reserve, as they hunted to determine if the traditional activity was sufficient to induce a health benefit. Exercise exertion levels were measured through HR response, steps and duration of activity in three body positions (standing, sitting, lying).

Participants while hunting achieved an average of 29.1 ± 36.8 minutes of moderate and 20.7 ± 40.4 minutes of vigorous PA, which suggests that participants maintained a cumulative average ~49 minutes of moderate to vigorous levels of PA while hunting. Thus, participants achieve sufficient volume of moderate and intense activity to meet recommendations of the CPAG. In comparison, the duration of activity was ~16.7 minutes of moderate to vigorous PA for the non-hunting days on-reserve, which is insufficient to reach the threshold for adequate levels of PA.

Participants also achieved a higher number of step counts per day during hunting days compared to non-hunting days. Specific to each participant, Table 2 displays participant HR characteristics and activity intensity calculated using HRR and Karvonen formula for exercise intensity (She 2015). While hunting, participants spent approximately an hour at a moderate to vigorous level
of PA, according to each person’s independent predicted value of achieving greater than 55% of their HRR. Similar to duration of appropriate intensity, step counts and HR intensity, there was more time spent upright during hunting days than non-hunting days. These findings demonstrate that participants reached sufficient PA intensity and duration during hunting to satisfy the required 30-minutes of moderate-vigorous PA per day suggested by the CPAG. This study shows that Indigenous peoples who participate in hunting for 2-3 days per week acquire the CPAG recommendation of 150min per week of PA.

4.1.1 Within Day Comparisons

Participants engaged in hunting practises that they had learned from protocol and knowledge traditions passed down from community elders, or a combined hybrid form of hunting developed over time through knowledge passed down and personal experience. The general Indigenous practices and protocol applied by the hunters included aspects of time of morning departure, where to walk to find deer, when and where to track and hunt deer (topography and terrain), and how to track deer. For a small community such as the Secwepemc reserve the general Indigenous knowledge typically remains the same across the community and generations of hunters. Since this study was done on a small reserve, which required participants to be from the reserve and have lived there for longer than 12-months it is safe to assume all participants had a shared traditional knowledge of hunting in the territory, as ways of knowing are maintained in community (Barnhardt 2008). Inclusion criteria required participants to be a member of the reserve, and most of the volunteers had lived their whole lives on the reserve and had hunted from a young age in this territory; the least experienced being 13.5 years. This indicates that participants have a good understanding of practices associated with hunting, traditional
knowledge around hunting, and ritualistic behavior surrounding hunting. Although the traditions remain similar across community members most hunters follow their own methods and styles when they hunt: preparation time and approach, driving, walking, tracking. The hunter’s knowledge of animal behaviour throughout the day (dawn, morning, mid day, late afternoon), and weather/seasons (hot, cold, raining, snowing) are upheld and applied by all hunters in this community. After considering the traditional knowledge and personal rituals hunters have, the activities of the day and how these are executed, such as walking and reserving energy when necessary, are relatively consistent across hunters. Thus, the findings from this study can be applied broadly to Indigenous hunters in this community and potentially those living in similar rural and remote areas of British Columbia who follow similar hunting traditions and practises, and hunt in geographical regions that have similar topography and climate.

Prior studies reported cross disciplinary data that observes hunting with the purpose of linking Indigenous peoples to the land and understanding whether or not there is a healthy interaction between the land and its inhabitants (King 2014). Another study recognized hunting as an important outlet for Northern Indigenous communities to combat food insecurity, as many of the peoples regularly consume traditional foods (wild meat) (Skinner 2013). These studies did not quantify the PA involved in the traditional activities, nor the intensity of PA involved in those activities. Thus, this study aimed to quantify PA of the traditional activity of hunting. To ensure representative data of hunting and on-reserve activity, two days of each activity were collected and subsequently averaged, following determination of non-statistical difference within days. This within approach of averaging between days minimizes the likelihood of outliers and allows for natural behaviour observation. The activities that surround hunting induce relatively high intensity levels, suggesting a physically demanding workload. To ensure this assumption of
hunting being similar across days I first initiated a comparison of two independent hunting days. Further, to ensure that the on-reserve days were representative I also compared within two on-reserve days where participants engaged in typical activities. This approach enabled me to capture the diversity of activities that occur on-reserve because occupations across the hunters varied substantially. Some participants were engaged in occupations that required being outdoors with field work, while others spent much of their day in office. The observations on PA intensity were determined by HR and movement calculations. The within day comparisons for hunting as well as on-reserve non-hunting days did not differ (see Table 3, 4, 5, and 6). Average HR did not differ within the hunting days (p = 0.41) or for the on-reserve days (p = 0.84). The largest difference was for day 2 of hunting where average HR was 108 BPM, whereas on the other hunting day and on-reserve day HR was ~92 BPM (Table 3). This difference likely arises from missing data points on day 2 for hunting from participant 3, 5, and 6, as well as the successful hunts on day 2. Successful hunts include a variety of tasks that you would not see in an unsuccessful hunt such as dragging/lifting/carrying the animal, cleaning the animal, and skinning the animal. All activities are standard procedures when killing a deer. As seen in Paul’s study (2019), killing a deer can indicate an increase in PA levels while dragging and skinning the deer.

A within study design was used, and determined that intensities did not differ within days for hunting: sedentary (p = 0.29), low (p = 0.33), moderate (p = 0.50), vigorous (p = 0.50) or on-reserve activity: sedentary (p = 0.64), low (p = 0.10), moderate (p = 0.68), and vigorous (p = 0.39) (see Table 6). These within day comparisons were also non-significant for step count as well as for average duration of time spent in intensity categories for hunting as well as on-reserve. These within day comparisons, not differing across all measurements made for PA during hunting as
well as on-reserve indicate that averaging across the days is viable to gain a representative understanding of typical PA of hunters while hunting and on-reserve.

The within design applied in data collection is important to gain a representative sample of the behaviors associated with hunting relative to on-reserve activities. This approach of having hunters record both activities is important as it allows a direct comparison within an individual and minimizes the variability associated with the diverse employment and on-reserve activity of individuals. However, the dataset is incomplete for three participants (3.00, 5.00, and 6.00) for second hunting day. The missing data were not associated with drop-out of participants and are beyond the control of the investigation. Reasons include personal family matters, physical injury (unrelated to the study), and equipment/user error. With respect to personal reasons the participants were not asked to engage in further testing. As for the equipment/user error, the participant put on the device in front of a member of the investigation team and wore the devices throughout the day of hunting. Post recording, it was observed that the device failed after two hours of recording, the participant mentioned the device may have moved due to hunting attire but no overt touching or tampering with the device occurred. Another recording session was not possible due to weather, personal scheduling and change of season limiting hunting.

4.1.2 Differences between hunting and non-hunting days

In this study all participants hunted in the community’s traditional territory which consisted of a mixture of forest and fields. The typical day for hunting is from waking up until dark; most devices were worn for ~10 hours. Although participants drove to hunting cites, much of the
The countryside was not reachable by vehicles. The countryside is vast in terrain for these Indigenous hunters and has plenty of hills, ravines, steep embankments, and fields that require extensive walking/hiking throughout the day. It is important to recognize that hunters recorded in this study have reduced opportunity to experience the potential health and fitness benefits associated with traditional practice. Participants while hunting achieved sufficient levels of PA even with the introduction of technology, such as off-road vehicles and rifles. Traditional hunting methods required families to move for days and/or weeks on foot in order to obtain adequate levels of food to provide for their families. Contemporary Indigenous peoples hunt far less than their predecessors because modern ways have lessened the access to game through years of limiting the traditional hunting territories, as many areas are no longer under Indigenous control, and commercialization has created access to modern and packaged food sources near or on-reserve (Kirmayer 2003; Czyzewski 2011; Leeuw 2012). Frequently moving around in a semi-nomadic lifestyle might not be as common as before but hunting still holds positive features such as maintaining adequate levels of PA and creating an opportunity to revitalize traditions of a communities’ culture. Values that surround hunting outside of PA connect Indigenous peoples to their culture, history, and practices that generate the opportunity for spiritual, cultural, and emotional aspects of health. Living in rural communities and on-reserve has its own constraints that restrict physical movement such as lack of sidewalks, parks, recreations centers, and accessibility to other modern types of PA (Peiris 2008; Allen 2020). There is little research on accessibility and opportunities.
for PA in Indigenous communities, and whether communities provide sufficient opportunities, resources and expertise for PA participation (Allen 2020). The later is important, as trained professionals who understand the health benefit of PA, and diverse ways in which it can be acquired are not widely available on many reserves. Evidence from this study suggests that participants were more PA when involved in hunting. Some participants verbally self-reported feeling more energetic and physically fit following hunting season. Hunting practice remains traditional to the community and its members, because the knowledge is passed down from the elders of the family. Much of the methods remain the same with the exception of modern tools like off-road vehicles and scoped rifles. Elements of behaviour that surround the habits of the animal remain the same, and thus aspects such as geographical area, tracking deer, lifting and skinning deer remain unchanged to our ancestors. These aspects of traditional hunting foster PA and contribute to the health benefit associated with hunting. Although access and opportunities have changed, and the necessity of hunting to provide food is less, hunters can still gain PA from actively engaging.

An individual carrying a deer will undergo heightened levels of exertion than walking without carrying a load. The activity of hunting is substantive to create exertion through walking as well as carrying hunting gear and game. Mule deer (specific to the area) weigh approximately 160lbs during the time of hunting (October – February) and personal winter gear and equipment weigh an additional 5-10kg during this season. Thus, the load carried on a successful hunting day could exceed 170lbs. This is a substantive weight to induce increased exertion and levels of PA, and in turn, positive health benefits.
Individual HR is important. The harder an individual is working the greater the cardiovascular system is challenged, and this can be recorded as a higher HR response. The higher intensities are seen in two of the participants. To gain a health benefit the cardiovascular system needs to be challenged. The key intensities recommended by the CPAG to gain a health benefit are moderate (55% HRR) to vigorous (>70% HRR) (Heyward 2014). In the literature lower intensity levels for healthy adults (40-49% HRR) have been suggested to induce a training affect, however, these studies also mention the lower limits (~40% HRR) are not yet established (Hofmann 2011). Heyward’s (2014) light-moderate levels of intensity threshold recommendations are derived from the American College of Sports Medicines (ACSM) 9th edition, which corresponds to 3 METs or the equivalent of walking slowly around one’s home (Pascatello 2014). The ACSM also suggests lower levels of intensity for those starting out an exercise program (Pascatello 2014). In this study the intensity level of 55% HRR was determined as appropriate because hunters were familiar with physical exertion and the land hunted on.

The intensity (see Table 2) to create a moderate level of PA for each person based upon age and resting HR varies to achieve an intensity benefit. For example, participant 1.00 would need to achieve a HR of 134-153 BPM and >153 BPM to acquire moderate and vigorous activity levels, respectively. Participant 1.00 achieved ~218 cumulative minutes with a HR zone of moderate to vigorous levels of intensity, and thereby this individual gained a health benefit. Participant 2.00 also had a successful hunt that demonstrated high values for moderate (43 minutes) and vigorous (31 minutes) levels of PA, surpassing their daily recommended values. Participant 5.00 and 6.00 where also successful, however, these hunters were closer to the road and were able to utilize a vehicle to access the animal. Thus, the load was carried a shorter distance than other participants, but they did reach adequate levels of moderate (38 minutes; 42 minutes) and vigorous (15
minutes; 32 minutes), respectively. Thus, even with vehicular assists the minimum was achieved. However, recommendations for hunting as a form of PA must ensure that the success of the hunt as well as minimized vehicular use and maximized walking/hiking are conveyed.

Overall, participants spent a mean time of ~49 minutes of PA at a moderate to vigorous intensity level per day, above the recommended time of 30 minutes per day. Hunters typically go twice per week depending on the season, if this is the case, they are nearly reaching the required amount for a week (requirement, 150 minutes per week) in two days of hunting. Participants involved in the study that stand out are 2.00, 3.00, 5.00, and 6.00 all of which individually surpassed the daily required recommendation for a day because of walking/hiking and they had a successful hunt. A successful hunt is important because individuals exhibit increased PA because there is generally greater hiking (usually at a brisk pace), and additional levels of activity surrounding dragging, positioning and cleaning the deer. The activities vary in time based on the skill and practice of the hunter. These types of activities increase HR long enough to be meaningful for health benefit. To highlight, hunter 1.00 reached 122 minutes of moderate intensity and 149 minutes of vigorous intensity, on a successful day of hunting where they carried their kill over a long distance, with the help of an additional member of the party. Thus, the level of PA achieved to meet the CPAG is high when the hunt is successful and where the animal is killed at a distance from vehicular access to the game.

In this investigation participants exceeded the CPAG for daily PA, achieving ~66.8 minutes of PA at a moderate to vigorous intensity on days that they hunted compared to non-hunting days. The CPAG is in place to recommend adequate levels and duration of PA necessary to maintain fitness. The HR achieved during activity is a reliable measure of exercise, reflecting the body’s
demand for energy, such that, the more strenuous a task the more effort is required by the body and the response is an elevation in HR. Without going further into physiological detail, essentially the greater the body works the more energy is required to operate, and the heart responds to these demands by increasing rate of contraction and this represents PA intensity. To gain a fitness and health benefit an individual has to surpass the recommended threshold of intensity and/or duration, based upon their individual HR zones (Heyward 2014; Pascatello 2014). Overall, participants demonstrate higher levels of HR while hunting compared with on-reserve and this is more certain when the hunt is successful, game is carried and use of vehicles minimized. Being outside with the purpose of hunting creates more opportunity to engage in PA than on-reserve where activities are limited in nature. Beyond PA, which is important there is increasing literature to suggest that individuals who engage in outdoor activities report higher levels of happiness and overall well-being (Allen 2020). This is beyond the scope of this study and requires further consideration in other studies on hunting and Indigenous cultural activities.

This study offers examples that highlight the work that can be performed to gain a meaningful health benefit from PA while engaged in hunting, however, there are cases in the study where participants did not achieve adequate levels of PA. Although there was no statistical difference between day 1 and 2 of hunting, participant 2.00 on day 1 of hunting did not achieve PA levels to induce a health benefit. On this day, low intensity was extensive (300 minutes, after averaging for five hours) while hunting because the day was primarily comprised of driving. Similar observations were evident for participant 3.00 on day 2 of hunting (300 minutes low intensity), where they were either sitting or driving for the majority of their day. These individual assessments further substantiate the importance of walking in contributing to PA, and that driving minimizes health benefits, and it seems a less successful hunt also lessens health benefits.
associated with PA. Although, a direct comparison of the effect of a successful compared with unsuccessful hunt is beyond the specific objectives of this study it seems that in the four days that a successful hunt occurred participants demonstrated prolonged PA at higher intensity levels. This is particularly noticeable when participants were far from vehicles or roads to access their kill.

Adequate levels of exercise intensity identified by heart rate were achieved by participants when they hunted, and more PA was evident because step counts were also higher. The accelerometer could not estimate effort individuals were making with each step alone. Steps offer an indication of total PA, whereas HR response was used as a measure of physical exertion. There was a large variation in the recording duration, and thus data were compared over a similar 5-hour period. After time adjustment, the number of steps taken on hunting days (13235 ± 3681) were still higher than non-hunting days (7470 ± 3773; p= .01). Irrespective of intensity, the literature also suggests step counts ~7,000 steps/day are an indication of achieving slow energy burn throughout the day that yields individual health benefits (Tudore-Locke 2011). As steps increase to >10,000 steps/day regularly throughout the week the health benefit is similar to accumulating 150 mins moderate to vigorous physical activity (MVPA) per week (in bouts of 10- minutes) (Tudore-Locke 2011). Walking improves BMI, posture, balance, strength and decreases blood pressure, and depression, which creates competence in individuals (Tudore-Locke 2011). These hunters likely achieved a health benefit from walking and minimizing vehicular use.

On non-hunting days movement and steps varied substantially between participants, because jobs and activities vary between office work and field work. Some participants had higher physical movement levels because their jobs were more physical in nature (e.g. forestry/logging relative
to desk-based work). Although these are jobs requiring movement, little PA was achieved for these participants to maintain fitness, decrease body weight and/or reduce chronic disease risk.

Non-hunting days where the participant spent time on-reserve the step count was significantly lower ($7470 \pm 3773$; $p = .01$). Participants had rarely met the threshold to gain adequate levels of PA, as recommended by previous research of walking $\sim 7,000$ steps at a regular pace throughout the day, where cadence does not exceed intensity thresholds and individuals are breathing heavy or sweating (Tudor-Locke 2011). These findings suggest that daily PA achieved on-reserve is often not enough for Indigenous persons to achieve health and fitness benefits. There are findings in the literature that suggests cardiometabolic benefits from walking. Studies have assessed walk programs or interventions in children to older adults (Tudor-Locke 2011) and suggest individuals with a regular routine of walking $>7000$ steps a day in their rural community will experience cardiometabolic change. Furthermore, individuals reaching $>10,000$ steps a day can experience benefits that can be compared to MVPA session in bouts of 10 minutes (Tudor-Locke 2011; Bassett 2017). Although PA can be gained on-reserve the participants in this rural community study need to engage in higher levels to achieve satisfactory health benefits.

Accelerometer y-axis indicated longer durations of sitting ($41\% \pm 20\%$) and lying ($6\% \pm 8\%$) while not hunting and living on-reserve. Hunters spent $57\%$ of the time standing, and although this was similar between hunting and on-reserve days the amount of time spent sitting and lying on-reserve was greater than hunting. The “Standing”, “Sitting, and “Lying” variables are not specific, and are not descriptive of an activity being undertaken as the accelerometer only records along the X, Y, and Z planes. Standing can indicate a person standing in a static position, or doing more dynamic PA such as walking, running, jumping, etc. Essentially any activities in
the up-right positions are recorded irrespective of velocity of movement in that plane. The combination of upright positioning and step count, alongside intensity recordings indicate higher levels of PA for hunting than on-reserve activities.

### 4.1.3 Importance of Hunting – Beyond Physical Activity and Health

Segregation and colonization caused generations of damage to the Indigenous population (Currie 2012; Jones 2018). This study of hunting indirectly addresses the effects caused by segregation imposed through the model of living on reserve enforced through colonization. The limited opportunity for an active lifestyle for Indigenous peoples who reside in isolated and rural communities and have lost access to traditional territories to hunt highlight the negative impact of living on contained reserves (Leeuw 2012). This is seen in this thesis through PA and is well known through lost Indigenous culture and knowledge through other well documented means such as the 60s scoop, residential schools, day schools, and within itself the formation of reserves that restricted Indigenous peoples from traditional activities (Leeuw 2012; Barron 1988). The formation of reserves through the 19th and the 20th century not only restricted the territory of Indigenous peoples, but it was also mandatory to have Indian Agents on reserves where the Pass system was enforced requiring permission to leave the community (Barron 1988; Currie 2012; Rogers 2015). These agents required Indigenous peoples to abide by the Canadian federal law which furthered the assimilation into the European culture (Rogers 2015). Around the same time as land was being restricted and taken away by Government, cultural practices
were also disallowed in Canada (example, practice of hunting and gathering food) (Leeuw 2012). Without minimizing the many dire and more important negative effects of colonization, and staying faithful to the study, my individual perspective is that colonization also removed Indigenous peoples from an immediate opportunity for an active lifestyle and this limitation further harmed Indigenous peoples' health and lifestyle. Reduction in land restricted opportunity to be involved in land-based activities and ability to freely connect to the land because of land loss.

Location of hunting is specified because terrain and behaviour differ between areas and also contribute to PA. Participation in PA is differentiated based on location, whether individuals are home, travelling, playing sports, or participating in recreation activity (this includes hunting). For example, hunters prepared for activity based on weather and destination of the hunt with the hopes of successfully tracking a deer. This preparation would vary between regions, and just as travel is important for sport and recreation participation it is also an element of hunting. The First Nation peoples in BC have been separated into rural or isolated locations, generally away from larger metropolitan centres (Leeuw 2012). For Indigenous peoples of a small rural community, being separated creates difficulty, especially when a system was historically set up to segregate the population from the rest of the world. Segregation through colonization placed many of the communities in smaller established locations and less desirable terrain (Czyzewski 2011; Leeuw 2012). Isolation caused difficulty for peoples of these communities to access resources that are in place to help sustain a healthy lifestyle, this extends into modern time through limitations in access to traditional hunting areas as well as facilities for PA and treatment and rehabilitation (Katzmarzyk 2008; Czyzewski 2011; Leeuw 2012). Resources include but are not limited to facilities, but also extend to health and medical professionals. The resources do not reach the
population because of, separation from larger communities, experiences related to systematic racism that shift the imbalance of power and comfort in health facilities (clinics, hospitals, offices, etc.), and miscommunication (Peiris. 2008; Czyzewski 2011; Gibson 2015). Literature suggests that these barriers, intended to lessen the psychological stress, mistreatment, and misinformation of colonization, are challenged by communication issues, financial support (access or understanding to financial support), and travel (understanding access to support travel) (Auger 2016; Browne 2016; Peiris 2008). Current literature suggests that utilizing Indigenous methods of healing can be fulfilling to the community identity (Murdoch-Flowers 2019; Allen 2020), findings indicate that Indigenous practices are positive in nature causing Indigenous peoples to feel more comfortable with a culturally safe approach (Auger 2016; Murdoch-Flower 2019; Allen 2020).

Throughout history there was an attempt to minimize the importance of, and restrict hunting activities, but it remains relevant to today to Indigenous communities in rural areas. Even though modern tools are used participants in this study achieved levels of meaningful PA. The Canadian governments have attempted to assimilate the culture of Indigenous peoples (Czyzewski 2011; Leeuw 2012; Rogers 2015), but practices such as hunting remain. Still used to provide food for families, hunting activities are often overlooked for the physical efforts they involve in sustaining cultural food practices. The literature suggests more than 10,000 steps is adequate for fitness benefits. Hunters in this study walked ~12,000 across vast country in the mid-interior of BC. The weather, gear and equipment are important, because hunters carried enough food and water and wore appropriate clothing in preparation for weather changes for a day. The clothing weighs more than standard daily attire, for its durability and comfort for fall weather. This weight, coupled with a successful hunt that requires carrying or dragging the deer across terrain.
of ravines, ditches, dirt roads, and rocks results in PA that is sufficient to generate sustained levels of vigorous activity to gain a cardiovascular response and health benefit. Without a successful hunt, participants still achieved adequate steps to experience a health change.

Hunting is a cultural activity that can contribute to a health benefit of Indigenous peoples.
Chapter 5: Limitations and Recommendations

5.1 Limitations

Linking the university to the reserve proved difficult. The university has certain standards to maintain integrity, as does the Indigenous community. Both community and the University have an understanding, however, research methods and studies involving Indigenous rural communities are limited in numbers and approaches and best-practices are still being formed. For example, creating Ethics applications that involved Indigenous communities has several small steps, connecting both University and community logistics. Communication was difficult at times; the community is separate from any larger urban centres and outside of cell reception. These elements of communication were challenging, however, part way through the study, internet access improved on the reserve. Clarity of understanding and an appreciation of values of both parties involved will benefit future studies conducted in rural Indigenous communities.

This study was observational in nature, and thus ensuring that recordings were done on appropriate days took longer than expected, and often were met only when it was convenient for the participants. Thus, weather and personal commitments were factors influencing data collection and limited the sample size. This also created uncertainty with potential participants, as some were interested in recording a couple of times but weary of four separate recording days. Community engagement proved difficult; participants turned down invitations because of HR monitoring and not understanding fully what the devices were intended to record. The nature of informed consent also created doubt. This type of documentation and signing creates uncertainty due to historical misrepresentation of intent. Overall, recruitment and data collection were
longer than anticipated, and this resulted in a switch in seasons for the game being hunted if data collection continued.

The primary type of game that was being hunted was mule deer, which is quite common in interior regions of British Columbia. The deer typically weigh between 68Kg to 113Kg and are ~92cm from ground to shoulder height. During the time participants were hunting the deer would have been on the heavy end of the spectrum, because of the season. At the time hunters had started, the deer would have been mid- or late- rut. Deer gain weight for mating season, and for the winter, this includes muscle mass, adipose tissue, and external fur. Moose are common in the same regions, but in much higher elevations with fewer hills. Moose are much larger, however, the participants in the study only tracked down deer in the region they had hunted in.

Without previously knowing the community and the community leaders the research project would have taken longer and likely been impossible to undertake. It is important to build a relationship with the peoples and their leaders. The results of this investigation will primarily affect the community and their ecological knowledge systems. Understanding and knowing this is imperative to research, and to the Indigenous peoples. The nature of research in these rural and remote communities is challenging and regular exchange limits the potential for research buy-in; even observational.

Ideally more data would have been collected. The sample size is limited given the timing of the year for hunting and the duration in which the thesis data collection should occur. Data collection could only be done during the hunting season, which can be unpredictable and does not align with academic course work. At times, I was simultaneously involved in the thesis project that directly required me as lead investigator to be in the community and coursework. Participant
interest, seasons, weather, and equipment availability were all uncontrollable factors that influenced the participant recording and potentially participant interest. As a research investigator, I made myself readily available across all acceptable platforms, yet communication was difficult being away from the community. The design also required a lot of commitment from participants. The sample size is also small because little exists in the literature for PA related to hunting, and thus for this study in a rural community caution was applied to ensure the data recorded was representative of typical hunting and on-reserve activity days as reported by participants and informed by personal and cultural practises.

5.2 Recommendations

Future work with rural first nation communities will require building a relationship with the leaders and the community. Without a reciprocal relationship co-joined projects will not succeed and be meaningful. Being physically in the community and working directly in the community for longer periods would be positive for both University and community; more one on one time with the community members and leaders is needed. This approach to research is atypical and timely, albeit valuable and necessary. Next, a deeper evaluation of the existing methodological literature alongside with the Indigenous communities throughout Canada is needed. This collaborative evaluation as well as actively being in the community will also increase participant recruitment, creating a safe space where the investigative team can make participants feel more comfortable with asking questions and explaining technology and their interest in the research. Ultimately, having an open presentation for the community, on a day that best suits the community leaders of course, where planning can be coordinated at the onset with the leaders
will contribute to ensuring best results. The leaders understand community operations and ideal calendar timing; prior to any hunting season.

The presentation for Indigenous communities should highlight, with the entire investigative team present, the purpose of the project and the interest of the University team. This approach will ensure the leaders and community members are accepting of the peoples doing the study as well as comfortable with the methods and the equipment that will be used in the project. If possible, a member of the investigative team should attend hunting camps being hosted by community leaders and attend these camps. Participation in these events will ensure continuity and identifiable support of community leaders and elders. This would increase participation of community members.
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doi:10.1525/jer.2013.8.2.129


Appendices

Appendix A

Participant activity included are the non-hunting days and Hunting movements. Minutes spent being active; steps; positions and percentage of recorded time in each position.

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<th>Subjec t</th>
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<th>Mod</th>
<th>High</th>
<th>Steps</th>
<th>Standing Time</th>
<th>Sitting Time</th>
<th>Lying Time</th>
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<th>Standing g</th>
<th>Sittin g</th>
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Note: SD = standard deviation; % = percentage