

**Obesity, Physical Activity and Sedentary Behaviour Among Canadian First Nations Youth:
An Exploration of Associated Factors and Evaluation of a School Sports Program**

by

Michelle Gates

A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Doctor of Philosophy

in

Health Studies and Gerontology

Waterloo, Ontario, Canada, 2015

© Michelle Gates 2015

Author's Declaration

This thesis consists of material all of which I authored or co-authored, please see the **Statement of Contributions** for full details. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

The studies within this thesis have been prepared for publication, submitted or published in peer-reviewed academic journals. Those who have been closely involved are included as co-authors on the resulting manuscripts. Each author's contributions and the status of these manuscripts are shown below.

Study 1: Physical activity and fitness of Canadian Aboriginal youth: A systematic review. Michelle Gates designed the study, developed the search strategy, performed the search, screened the articles, extracted the findings, interpreted the results and wrote the dissertation chapter and resulting manuscript. Allison Gates helped to develop the search strategy, repeated the screening of articles and extraction of findings for accuracy, verified the interpretation of results and reviewed the manuscript. This manuscript is in preparation.

Study 2: Overweight and obesity among First Nations youth living on reserve in Canada: An exploration of relationships with socioeconomic, cultural and behavioural factors & Study 3: Relationships of socioeconomic, cultural and health-related factors with television viewing among First Nations youth living on reserve in Canada. Michelle Gates designed the studies, wrote and submitted the data application, conducted the statistical analyses, interpreted the findings and wrote the dissertation chapters and associated manuscripts. Allison Gates was involved in the study design and helped with the statistical analyses and interpretation of results. Drs. Rhona Hanning and Len Tsuji supervised the work and reviewed the data application. The First Nations Information Governance Centre designed the questions, collected and provided

access to the data. All authors reviewed the manuscripts. Versions of **Studies 2** and **3** have been submitted as:

Gates, M., Gates, A., Tsuji, L.J.S., & Hanning, R.M. (submitted). Overweight and obesity among First Nations youth living on reserve in Canada: An exploration of the influence of socioeconomic, cultural and behavioural factors.

Gates, M., Gates, A., Hanning, R.M., & Tsuji, L.J.S. (submitted). Television viewing among First Nations youth living on reserve in Canada: An exploration of the influence of socioeconomic, cultural and health-related factors.

Study 4: Physical activity and fitness of First Nations youth in a remote, isolated community: A needs assessment &

Study 5: A pilot school sports program in a remote First Nations community: An evaluation of process and outcomes. Michelle Gates designed the studies, collected the data, conducted the statistical analyses, interpreted the findings, disseminated the results and wrote the dissertation chapters and associated manuscripts. Allison Gates aided in the study design, data collection and the dissemination of findings, verified the interpretation of the results and repeated the qualitative analyses. Judy Stephen and Andrew Fehst were involved in the study design, ran the sports program, facilitated data collection, and helped in the interpretation and dissemination of the findings. Drs. Rhona Hanning and Len Tsuji were the co-principal investigators, supervised the project and were involved in designing the studies. All authors reviewed the manuscript. A version of **Study 4** has been published and is available at Springer via

<http://dx.doi.org/10.1007/s10900-015-0063-8>. Thus, permission to include a version herein has

been granted by Springer Science and Business Media (see **Letters of Copyright Permission**).

The citation is as follows:

Gates, M., Hanning, R.M., Gates, A., Stephen, J., Fehst, A., & Tsuji, L.J.S. (2015). Physical activity and fitness of First Nations youth in a remote and isolated northern Ontario community: A needs assessment. *Journal of Community Health*. doi: 10.1007/s10900-015-0063-8

A version of **Study 5** has been accepted and is in press. Copyright has not been transferred to the publisher at the time of submission of this thesis (to be published in 2016). However, permission to include a version herein has been granted by the editor of Health Behavior and Policy Review (see **Letters of Copyright Permission**). The citation is as follows:

Gates, M., Hanning, R.M., Gates, A., Stephen, J., Fehst, A., & Tsuji, L.J.S. (in press). A pilot school sports program in a remote Canadian First Nation: Evaluation of process and outcomes. *Health Behavior and Policy Review*.

The other chapters within this thesis are not intended for publication, and were authored solely by Michelle Gates under the supervision of Drs. Rhona Hanning and Len Tsuji.

Abstract

Background: Secondary to inequities in several determinants of health, Canadian Aboriginal youth are affected by a higher prevalence rate of obesity and chronic disease than the general population. While the factors contributing to obesity have been extensively studied among the general population, relatively little data are available for First Nations [FN] youth living on reserve. This dissertation will focus on two risk factors, physical inactivity and sedentary behaviour, amenable to change via community-level health promotion initiatives.

Purpose: To (a) review quantitative evidence on physical activity [PA], fitness and sedentary behaviour among Canadian Aboriginal youth, (b) explore the potential relationships of socioeconomic, cultural and health behavioural factors with overweight/obesity among FN youth living on reserve, (c) explore the potential relationships of socioeconomic, cultural and health-related factors with high (>1.5 hours/day) levels of television viewing among FN youth living on reserve, (d) conduct a needs assessment for PA programming in one subarctic Ontario FN, and (e) evaluate the implementation and outcomes of a school sport program in this community.

Methods: In **Study 1**, a systematic review of peer-reviewed quantitative research on the PA and fitness of Canadian Aboriginal youth was conducted. The studies, which also described sedentary behaviours, were summarized and the results were presented according to adherence to Canadian guidelines, age and sex differences, and associations with health outcomes. **Studies 2** and **3** used data collected for the 12-17 year old subset of the 2008-2010 First Nations Regional Health Survey [RHS]. The relationships between a number of independent variables and (a) overweight/obesity or (b) high television viewing were assessed using logistic regression, stratified by age and sex. Analyses were weighted to account for the sampling strategy. **Studies 4** and **5** responded to a subarctic Ontario FN community's desire for school-based sport

programming. A participatory, utilization-focused approach to program evaluation was employed in first conducting a needs assessment for PA and sport in the community (**Study 4**). Anthropometrics (body mass index [BMI], waist circumference, body fat percentage), PA (3 days of accelerometry) and physical fitness (informed by the Canadian Physical Activity, Fitness and Lifestyles Approach) were measured. Descriptive statistics were compared to reference data and group-level differences (by BMI, waist circumference and body fat status) were tested using Mann-Whitney U and Chi-square tests. Barriers and supports were assessed qualitatively. In **Study 5**, implementation and outcome evaluations for a school sports program were conducted by repeating the quantitative measures used in **Study 4**. Changes in these variables were tested using bootstrapped paired samples t-tests. Information on participation, satisfaction and program implementation was collected qualitatively. The qualitative data from **Studies 4** and **5** were analyzed inductively for themes by hand, and verified by a second researcher.

Results: The systematic review in **Study 1** revealed 23 records, 35% (n=8) of which reported on national survey data and 65% (n=15) that reported regional data from several FN sub-populations. National reports showed that about half of youth are ‘active’ and up to two-thirds spend more than 15 hours per week in screen-based sedentary time. Results from regional reports were highly variable. Cardiorespiratory endurance was the only measure of fitness reported in regional studies, and generally appeared low. Girls were almost universally less active than boys. Physical activity was associated with a number of health outcomes; most commonly, an inverse association with BMI or reduced odds of obesity at higher PA levels were reported. **Study 2** showed that among 12-17 year old FN youth living on reserve (n=2 888, representing 29 988 individuals in the weighted sample, 56.4% male), overweight/obesity (45.2% prevalence) was associated with younger age (p=0.024), knowledge of a FN language (p=0.015), lower PA level

($p=0.001$) and lower levels of video game use ($p=0.042$). Numerous age- and sex-based interactions prompted stratifying the sample for further analysis. No significant relationships were detected for boys aged 12-14 years. Among girls aged 12-14 years, reduced odds of overweight/obesity were observed among those who were moderately active (OR=0.48, 95% CI=0.26, 0.88) or active (OR=0.56, 95% CI=0.32, 0.96) as compared to inactive ($p=0.048$), and among those who spent more than 1.5 hours using a computer per day (OR=0.66, 95% CI=0.45, 0.96) as compared to those with lesser use ($p=0.028$). Among boys aged 15-17 years the odds of overweight/obesity were increased among those with parents in the middle education level (high school diploma; OR=1.78, 95% CI=1.15, 2.76) as compared to the lowest level ($p=0.032$), and those who always or almost always participated in their community's cultural events (OR=2.06, 95% CI=1.23, 3.44) as compared to less frequent participation ($p=0.005$). The odds of overweight/obesity were reduced among those playing more than 1.5 hours of video games per day (OR=0.69, 95% CI=0.47, 0.99) as compared to those with lesser use ($p=0.044$). Among girls aged 15-17 years, the odds of overweight/obesity were increased among those with knowledge of a FN language (OR=1.67, 95% CI=1.15, 2.42) as compared to those without ($p=0.007$). The odds of overweight/obesity were reduced for those playing more than 1.5 hours of video games per day (OR=0.43, 95% CI=0.27, 0.67) as compared to those with lesser use ($p=0.009$), and those who reported sometimes (OR=0.43, 95% CI=0.27, 0.67) or always (OR=0.51, 95% CI=0.30, 0.87) eating a nutritious diet as compared to those reporting rarely or never ($p=0.001$). In all cases, the bivariate relationships remained significant in the multivariate adjusted analyses.

Study 3 showed that among on-reserve FN youth ($n=3\ 658$, representing 40 462 individuals in the weighted sample, 53.1% male), 39.9% watched more than 1.5 hours of television daily. For the group, only attendance at community cultural events was associated with high television

viewing ($p=0.005$). No significant effects of the tested independent variables were detected for younger (12-14 year old) youth. Among boys aged 15-17 years the odds of high television watching were increased among those with parents having a higher education level (OR=1.73, 95% CI=1.11, 2.69 for high school diploma; OR=1.74, 95% CI=1.16, 2.60 for post-secondary education) as compared to the lowest level ($p=0.010$), those who always or almost always participated in their community's cultural events (OR=1.84, 95% CI=1.23, 2.75) as compared to less frequent participation ($p=0.003$), and those who were overweight or obese (OR=1.44, 95% CI=1.04, 2.00) as compared to normal weight ($p=0.028$). Among 15-17 year old girls the odds of high television viewing were reduced among those in the largest household size (OR=0.64, 95% CI=0.46, 0.89) as compared to the smallest size ($p=0.030$), and those reporting very good or excellent mental health (OR=0.63, 95% CI=0.45, 0.86) as compared to poorer mental health ($p=0.004$). The community needs assessment in **Study 4** revealed that in a subarctic Ontario FN, 63% of participating youth in grades 6-7 ($n=72$, 61.1% male) were overweight or obese, 51% were abdominally obese and 21% had excess body fat. Meanwhile, 86% met Canadian PA guidelines. Cardiorespiratory endurance appeared low in comparison to Canadian Health Measures Survey findings for the general population. Those who were overweight, obese, and/or abdominally obese had lower cardiorespiratory endurance than other youth ($p<0.001$). Barriers and supports to youth PA fell under the themes of motivation, role modelling, personnel and facilities, and environment and programs. The findings informed a locally implemented school sports program. In **Study 5**, after a 9-months (one school year) of the program, 57 youth (12.8 ± 1.0 years, 59.6% male) provided at least one of the process and outcome evaluation measures. Over the course of the program, youth increased their mean participation in moderate-to-vigorous PA by 47.9 minutes/day ($p=0.016$). Boys completed an average additional 10.5

shuttle run stages ($p=0.006$), and showed a non-significant trend toward improved cardiorespiratory endurance ($p=0.057$). Girls did not experience significant improvement in cardiorespiratory endurance. Both boys (+8.2 kg, $p=0.002$) and girls (+5.6 kg, $p=0.012$) improved their muscular strength. Flexibility improved for the group (+2.2 cm, $p=0.015$). Boys appeared to participate in the program more often than girls (not statistically significant); 28% of boys reported daily participation as compared to 15% of girls. Qualitative findings revealed barriers to implementation that were related to resource and infrastructure limitations. These were somewhat overcome by mobilizing of the few available resources and volunteer personnel.

Conclusions: Many Canadian Aboriginal youth fail to meet established PA and sedentary behaviour guidelines, and physical fitness appears low among a few FN populations. Available data support an inverse association for both higher amounts of PA and lesser time in sedentary behaviour relative to overweight and obesity, providing impetus for PA programming in vulnerable communities. Data from the RHS showed that among FN youth living on reserve, overweight/obesity and high levels of television viewing are prevalent across all age and sex groups. The identification of several factors affecting the odds of overweight/obesity and television viewing has provided some evidence that may inform health promotion initiatives, however more research is needed to fully understand the observed relationships. The findings suggest that programming will need to be tailored to various and sex categories. In a remote, northern Ontario FN community, although the majority of youth met Canadian PA guidelines, low physical fitness (particularly cardiorespiratory endurance) and a high prevalence of obesity and abdominal obesity supported the community's desire for school-based PA programming. In the same community, many pre-existing barriers were overcome to implement a school sports program, which was well received. The program was associated with positive outcomes, more so

among boys. Thus, future programming should target the participation of girls specifically.

Nonetheless, this work demonstrates the many beneficial outcomes that can be achieved when a community with relatively few pre-existing resources is empowered to implement local, sustainable programming supporting the health of their youth.

Acknowledgments

Thank you to the University of Waterloo for providing a welcoming environment to complete my studies and to my advisors, Drs. Rhona Hanning and Len Tsuji for the mentorship, encouragement and academic opportunities that have enriched my experience in Waterloo over the past several years. Your patience and advice along the way will never be forgotten. My committee members, Drs. Marty Cooke and Dan McCarthy also contributed valuable insights that pushed me to think about things in a different way than I would have alone. Thanks to my external examiner, Dr. Lucie Lévesque for reviewing my thesis and providing helpful feedback at the final stage. Thank you all for the friendly conversation at my thesis defence, a day that I had feared for quite a long time. I am also grateful to Dr. Ian Martin for his expertise and patience in helping to improve my understanding of statistics.

I would have not made it to this stage without many non-academic supporters, especially my parents. Thank you for always believing that I could finish, even though it seemed to take quite a long time. Thanks for having much more confidence in me than I will ever have in myself, and for demonstrating the importance of a balanced lifestyle that includes running and triathlon. These hobbies allowed me to finish this thesis in reasonable health, by providing something exciting to focus on and a few hours per day away from my computer. It should go without saying that I would not have made it far in life without my other half who has always been the one in charge, and the voice of reason on the days when the road ahead seemed too challenging to face alone. Thank you for being my most reliable research assistant, editor, motivator and training partner. Christopher and Shaio, thank you for offering a more relaxed perspective on life and for enticing me to not work on weekends. To my little dog, Frankincense (and his sister

Rosie), thanks for making these last few years more meaningful and the days spent with my computer less lonely. Finally, I am grateful to the students with whom I have shared the past several years.

Thanks to the First Nations Information Governance Centre for allowing access to data from the First Nations Regional Health Survey, and to Maria Santos, First Nations Data Centre coordinator, for her assistance and valued insight into the resulting manuscripts. I am thankful to the First Nations community that we partnered with for welcoming and working with us, including the youth who participated, and Judy Stephen and Andrew Fehst who initiated and managed the school sports program. Their commitment to the health of youth in the community is commendable. The community-based research was made possible by grant funds from the Canadian Institutes of Health Research [CIHR].

I am grateful for the funding that I received, which allowed me to focus exclusively on my studies. This included the Heart and Stroke Foundation of Ontario Master's Studentship Award (2009-2011), University of Waterloo Provost Doctoral Entrance Award for Women (2010), CIHR Training Grant in Population Intervention for Chronic Disease Prevention (2011-2013; partly funded by the Heart and Stroke Foundation in 2012-2013), CIHR Frederick Banting and Charles Best Canada Graduate Scholarship Doctoral Research Award (2012-2015) and the University of Waterloo President's Graduate Scholarship (2012-2015). Additional support from a number of teaching and research assistantships has been greatly appreciated.

Table of Contents	Page #
Author’s Declaration	ii
Statement of Contributions	iii
Abstract	vi
Acknowledgments	xii
Table of Contents	xiv
List of Figures	xx
List of Tables	xxi
List of Abbreviations	xxiii
1.0 Background	1
1.1 Aboriginal People in Canada	1
1.1.1 Canadian First Nations People	2
1.2 History of Canada’s Aboriginal People.....	3
1.3 Health Disparities Faced by Aboriginal People	5
1.4 Focus on Overweight and Obesity among Youth	6
1.4.1 Measurement	6
1.4.2 Prevalence	8
1.4.3 Consequences	8
1.5 Contributors to Obesity and Health Inequality	10
1.5.1 Inequities in the Broader Social Determinants of Health	11
1.6 Potentially Modifiable Health Behaviours	12
1.6.1 Impact of Physical Activity and Sedentary Behaviour on Health	13
1.6.2 Importance of Physical Activity for Aboriginal People	14
1.7 Initiatives to Promote Physical Activity	16
1.7.1 School-based Programs in Canadian Aboriginal Communities	17
2.0 Opening Remarks	20
2.1 Rationale	20
2.2 Thesis Organization and Broad Aims	22
2.3 Theoretical Framework	24
2.4 Research Ethics and Approach	26
2.5 Author’s Biases and Positionality	29

3.0 Study 1: Physical Activity and Fitness of Canadian Aboriginal Youth: A Systematic Review	33
3.1 Overview	33
3.2 Introduction	34
3.3 Objective	35
3.4 Methods	36
3.5 Results	37
3.5.1 Study Characteristics	37
3.5.2 Comparison to Available Standards	39
3.5.3 Sex and Age Differences.....	41
3.5.4 Health Outcomes	42
3.6 Discussion	57
3.6.1 Physical Activity	58
3.6.2 Sedentary Behaviour	61
3.6.3 Cardiorespiratory Endurance	63
3.6.4 Health Outcomes	65
3.6.5 Methodology and Generalizability	67
3.7 Limitations.....	69
3.8 Conclusion	69
3.9 Additional Publications Since 2014	70
4.0 Study 2: Overweight and Obesity among First Nations Youth Living On Reserve in Canada: Relationships with Socioeconomic, Cultural and Behavioural Factors	73
4.1 Overview	73
4.2 Introduction	75
4.3 Theoretical Framework	78
4.4 Objective and Hypotheses	79
4.4.1 Objective	79
4.4.2 Hypotheses	79
4.5 Methods	85
4.5.1 Participants and Survey Methodology.....	85
4.5.2 Classification of Overweight and Obesity	86
4.5.3 Independent Variables	86
4.5.4 Data Use and Ethics Approval	89

4.6 Data Analysis and Interpretation	89
4.7 Results	90
4.7.1 Participant Characteristics	90
4.7.2 Bivariate and Multivariate Adjusted Relationships for Youth Aged 12 to 14 Years.....	93
4.7.3 Bivariate and Multivariate Adjusted Relationships for Youth Aged 15 to 17 Years	96
4.8 Discussion	99
4.8.1 Socioeconomic Factors	99
4.8.2 Cultural Factors	102
4.8.3 Health Behaviours	104
4.8.4 Implications for First Nations Communities	107
4.9 Study Strengths and Limitations	108
4.10 Conclusion	109
4.11 Acknowledgments	110
5.0 Study 3: Relationships of Socioeconomic, Cultural and Health-related Factors with Television Viewing among First Nations Youth Living On Reserve in Canada	111
5.1 Overview	111
5.2 Introduction	113
5.3 Theoretical Framework	116
5.4 Objective and Hypotheses	116
5.4.1 Objective	116
5.4.2 Hypotheses	117
5.5 Methods	121
5.5.1 Participants and Survey Methodology	121
5.5.2 Television Viewing	121
5.5.3 Independent Variables	122
5.5.4 Data Use and Ethics Approval	125
5.6 Data Analysis and Interpretation	125
5.7 Results	126
5.7.1 Participant Characteristics	126
5.7.2 Bivariate and Multivariate Relationships	128
5.8 Discussion	131

5.8.1 High Levels of Television Viewing	131
5.8.2 Socioeconomic Factors	133
5.8.3 Cultural Factors	134
5.8.4 Health-related Factors	136
5.8.5 Implications for First Nations Communities and Continued Knowledge Gaps	137
5.9 Study Strengths and Limitations	138
5.10 Conclusion	140
5.11 Acknowledgments	140
6.0 Study 4: Physical Activity and Fitness of First Nations Youth in a Remote and Isolated Northern Ontario Community: A Needs Assessment	141
6.1 Overview	141
6.2 Introduction	143
6.3 Study Context	145
6.4 Evaluation Framework	148
6.4.1 Evaluation Type and Approach	148
6.4.2 Identification of Stakeholders	149
6.5 Evaluation Questions, Objectives and Hypotheses	150
6.5.1 Evaluation Questions and Objectives	150
6.5.2 Hypotheses	152
6.6 Methods	157
6.6.1 Setting and Recruitment of Participants	157
6.6.2 Anthropometry	159
6.6.3 Physical Activity	161
6.6.4 Physical Fitness	163
6.6.5 Supports and Barriers	167
6.7 Data Analysis and Interpretation	168
6.7.1 Quantitative Data	168
6.7.2 Qualitative Data	169
6.8 Results	170
6.8.1 Characteristics of the Target Population	170
6.8.2 Group-level Differences by Weight Status, Abdominal Obesity and Body Fat Percentage	175
6.8.3 Supports and Barriers for Youth to Participate in Physical Activity	179
6.9 Discussion	183

6.9.1 Anthropometric Measures	183
6.9.2 Physical Activity and Sedentary Behaviour	185
6.9.3 Physical Fitness	188
6.9.4 Supports, Barriers and Programming Needs	191
6.10 Study Strengths and Limitations	194
6.11 Conclusion	196
6.12 Acknowledgments	197
7.0 A Pilot School Sports Program in a Remote Canadian First Nation: Evaluation of Process and Outcomes	198
7.1 Overview	198
7.2 Introduction	200
7.3 Study Context	202
7.3.1 Program Description	204
7.4 Evaluation Framework	206
7.4.1 Evaluation Type and Approach	206
7.4.2 Program Logic Model	207
7.5 Evaluation Questions, Objectives and Hypotheses	209
7.5.1 Evaluation Questions and Objectives	209
7.5.2 Hypotheses	212
7.6 Methods	215
7.6.1 Study Design and Recruitment of Participants	215
7.6.2 Youth Participation, Satisfaction and Self-efficacy	216
7.6.3 Success Strategies, Challenges and Perceived Outcomes	218
7.6.4 Anthropometry, Physical Activity and Fitness	219
7.7 Data Analysis and Interpretation	220
7.7.1 Quantitative Data.....	220
7.7.2 Qualitative Data	221
7.8 Results	221
7.8.1 Characteristics of the Target Population	221
7.8.2 Youth Participation, Satisfaction and Self-efficacy	222
7.8.3 Success Strategies and Barriers Encountered During Implementation	225
7.8.4 Comparisons from Baseline to Post-program	228
7.9 Discussion	231

7.9.1 Success Strategies and Challenges During Implementation	231
7.9.2 Achievement of Short-term Outcomes	233
7.9.3 Sustainability and Next Steps	237
7.10 Study Strengths and Limitations	239
7.11 Conclusion	240
7.12 Acknowledgments	241
8.0 General Discussion	242
8.1 Key Contributions	247
8.2 Future Directions	250
9.0 Concluding Remarks	253
Letters of Copyright Permission	255
References	259
Appendices	290
Appendix A: Information and consent form for the physical activity program	290
Appendix B: Information letter and consent form for student focus groups	293
Appendix C: Child consent script for the physical activity program	296
Appendix D: Information letter and consent form for teacher focus groups	298
Appendix E: Protocol for anthropometric measures	301
Appendix F: Physical activity recall questionnaire for students	302
Appendix G: Protocol for fitness testing	305
Appendix H: Questions included in the focus group with grades 6 and 7 students about the supports and barriers to physical activity and sports participation	308
Appendix I: Questions included in the focus group with grades 6 and 7 teachers about the supports and barriers to physical activity for community youth	310
Appendix J: Interview questions for the sports program coordinator on the challenges and successes of a school sports program	312
Appendix K: Questionnaire for grades 6 and 7 teachers on the challenges and successes of a school sports program	313
Appendix L: Focus group questions for grades 6 and 7 students on their impressions of a school sports program	314

List of Figures	Page #
2.1 Organization of studies within the dissertation	23
3.2 Flow diagram of study selection	39
6.1 Stakeholder map for a potential school sports program in a subarctic Ontario First Nations community	150
6.2 Themes and associated barriers and supports to physical activity for youth in a subarctic Ontario First Nation and identified programming needs	182
7.1 Timeline for the project involving the process and outcomes evaluation of a pilot school sports program in a subarctic Ontario First Nations community	203
7.2 Logic model for a pilot school sports program in a subarctic Ontario First Nations community	208
7.3 Youth participation frequency in a pilot school sports program, by sex	222
7.4 Youth frequency of responses to the question ‘How sure are you that you can do physical activity for 60 minutes each day?’ after a pilot school sports program, by sex	224
7.5 Youth frequency of responses to the question ‘How sure are you that you can be physically active, no matter how tired you feel?’ after a pilot school sports program, by sex	225

List of Tables	Page #
3.1 Sources, search terms, eligibility criteria and sample search for the literature review	37
3.2 Characteristics of quantitative studies describing the physical activity, sedentary behaviour and cardiorespiratory endurance of Canadian Aboriginal youth of school age, by population	43
3.3 Physical activity of Canadian Aboriginal youth and relationships to health and other variables, by population	46
3.4 Sedentary behaviour of Canadian Aboriginal youth and relationships to health and other variables, by population	53
3.5 Cardiorespiratory endurance of Canadian Aboriginal youth and relationships to health and other variables, by population	56
4.1 Questions and associated response options related to demographic, socioeconomic, cultural and health behaviour factors on the 2008-2010 First Nations Regional Health Survey for 12 to 17 year old youth	87
4.2 Characteristics of the subset of youth from the 2008-2010 First Nations Regional Health Survey and bivariate associations with overweight/obesity	91
4.3 Bivariate and multivariate relationships between socioeconomic, cultural, and health behaviour factors and the presence of overweight/obesity among youth aged 12 to 14 years from the 2008-2010 First Nations Regional Health Survey	94
4.4 Bivariate and multivariate relationships between socioeconomic, cultural, and health behaviour factors and the presence of overweight/obesity among youth aged 15 to 17 years from the 2008-2010 First Nations Regional Health Survey	97
5.1 Questions and associated response options related to demographic, socioeconomic, cultural and health-related characteristics on the 2008-2010 First Nations Regional Health Survey for 12 to 17 year old youth	123
5.2 Characteristics of the subset of youth from the 2008-2010 First Nations Regional Health Survey and associations with high television viewing	127

5.3	Bivariate and multivariate relationships between socioeconomic, cultural and health-related factors and high television viewing among youth aged 15 to 17 years from the 2008-2010 First Nations Regional Health Survey	129
6.1	Questions, indicators, information sources and methods for a needs assessment for school sports program in a subarctic Ontario First Nation community	152
6.2	Standards used to classify anthropometric, physical activity and health data	169
6.3	Group anthropometric, physical activity and fitness characteristics, by sex	174
6.4	Group-level differences in anthropometry, physical activity and fitness characteristics by weight category	176
6.5	Group-level differences for anthropometry, physical activity and fitness by weight status and presence of abdominal obesity	178
7.1	Questions, indicators, information sources and methods for a process evaluation of a pilot sports program in a subarctic Ontario First Nation	210
7.2	Questions, indicators, information sources and methods for an outcome evaluation of a pilot school sports program in a subarctic Ontario First Nation	211
7.3	Questions and response options used to assess participation, satisfaction and self-efficacy after a pilot school sports program	217
7.4	Characteristics of the total sample of the target population before and after a pilot school sports program	221
7.5	Youth responses to survey questions on participation, satisfaction and self-efficacy after a pilot school sports program, by sex	223
7.6	Supports and barriers to the daily operations, resources, satisfaction, reach and sustainability of a pilot school sports program in a subarctic Ontario First Nations community	228
7.7	Paired comparison of anthropometric, physical activity and fitness variables before and after a pilot school sports program (October 2012 to June 2013)	230

List of Abbreviations

AANDC	Aboriginal Affairs and Northern Development Canada
APS	Aboriginal Peoples Survey
BC	British Columbia
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
CAPI	Computer Assisted Personal Interviewing Software
CBPR	Community Based Participatory Research
CCHS	Canadian Community Health Survey
CDC	Centers for Disease Control and Prevention
CHMS	Canadian Health Measures Survey
CI	Confidence Interval
CIHI	Canadian Institute for Health Information
CIHR	Canadian Institutes of Health Research
CV	Coefficient of Variation
CPAFLA	Canadian Physical Activity, Fitness and Lifestyle Approach
CPS	Canadian Pediatric Society
d	Day
DC	Dietitians of Canada
DEXA	Dual-energy X-ray Absorptiometry
ERIC	Education Resources Information Center
FN	First Nations
FNIGC	First Nations Information Governance Centre
h	Hour(s)
HOMA-IR	Homeostatic Model Assessment of Insulin Resistance
IOTF	International Obesity Task Force
KSDPP	Kahnawake Schools Diabetes Prevention Program
min	Minute(s)
MET	Metabolic Activity Equivalent
MVPA	Moderate-to-Vigorous Physical Activity
NHANES	National Health and Nutrition Examination Survey
NHBPEP	National High Blood Pressure Education Program Working Group on Blood Pressure in Children and Adolescents
NHS	National Household Survey
NSERC	Natural Sciences and Engineering Research Council of Canada
OB	Obese
OCAP®	Ownership, Control, Access, and Possession
OR	Odds Ratio

ORE	Office of Research Ethics
OW	Overweight
PA	Physical Activity
PHAC	Public Health Agency of Canada
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RHS	First Nations Regional Health Survey
SD	Standard Deviation
SE	Standard Error
SLHDP	Sandy Lake Health and Diabetes Project
SPSS	Statistical Package for the Social Sciences
SSHRC	Social Sciences and Humanities Research Council
TRC	Truth and Reconciliation Commission of Canada
TV	Television
VG	Video Game
VO₂max	Maximal Aerobic Power
WC	Waist Circumference
WHO	World Health Organization
y	Years

1.0 Background

1.1 Aboriginal People in Canada

Aboriginal people are descendants of the original inhabitants of Canada as defined by the 1982 Constitution Act (Aboriginal Affairs and Northern Development Canada [AANDC], 2012).

Under the Canadian Constitution, the term 'Aboriginal' refers to First Nations [FN], Métis and Inuit people (AANDC, 2012); these three subgroups each have distinct histories, cultures and languages (AANDC, 2012).

Demographic and health information about Canadians can be found within the Census of the Population (Statistics Canada, 2015a), the National Household Survey [NHS] (Statistics Canada, 2014a), the Canadian Community Health Survey [CCHS] (Statistics Canada, 2015b) and the Canadian Health Measures Survey [CHMS] (Statistics Canada, 2014b). These do not provide complete data due to Aboriginal people being either excluded or underrepresented (Statistics Canada, 2008, 2013a, 2014c, 2015c). Information specific to the social and economic conditions affecting Canadian Aboriginal people can be found in the Aboriginal Peoples Survey [APS], though these data do exclude individuals living on FN reserves and in certain communities in the Yukon and the Northwest Territories (Statistics Canada, 2012). In an attempt to fill the knowledge gap about on-reserve FN populations, the First Nations Regional Health Survey [RHS] publishes information on the health and wellness of FN people living in reserve communities from 10 regions across Canada, excluding Nunavut (FNIGC, 2012). Unfortunately, this important data source has been relatively underused in health promotion research.

First Nations people represent the greatest proportion of the Aboriginal population (61%), followed by Métis and Inuit peoples (Statistics Canada, 2013a). The 2011 NHS showed that the Aboriginal population had grown 20% since 2006; 1.4 million people now identify as Aboriginal, accounting for 4.3% of the Canadian population (Statistics Canada, 2013a). Some of this growth can be attributed to a greater number of individuals self-identifying as Aboriginal in recent years (Wilson & Macdonald, 2010). At the time of the 2011 NHS, the largest numbers of Aboriginal people (21.5% of the population) resided in Ontario, with many also living in the central and western provinces (i.e., British Columbia, Alberta, Saskatchewan and Manitoba) (Statistics Canada, 2013a). That said, Aboriginal people made up the greatest share of the total populations of Nunavut (86.3%) and the Northwest Territories (51.9%) (Statistics Canada, 2013a). Notably, 2.4% of people residing in Ontario were Aboriginal (Statistics Canada, 2013a).

1.1.1 Canadian First Nations People

In 2011, FN people accounted for 61% of the Aboriginal population and 2.6% of Canada's total population (Statistics Canada, 2013a). The FN population increased by 22.9% between 2006 and 2011 (Statistics Canada, 2013a). Seventy-five percent of FN people in Canada are registered as 'Status Indians' under the Indian Act (1876) and Bill C-31 (Act to amend the Indian Act, 1985) (Statistics Canada, 2013a). The Indian Act specifies a set of federal government obligations and "*regulates the management of Indian FN reserve lands, Indian moneys and other resources*" (AANDC, 2012). Those who are recognized as 'Status Indians' are entitled to specific rights, programs, services and benefits (AANDC, 2012). The most recent data show that, of Status FN people, 49.3% lived in one of the 615 recognized FN reserve communities across Canada (Statistics Canada, 2008, 2013a). A reserve is defined under the Indian Act as an area of land

“[...] held by Her Majesty for the use and benefit of the respective bands for which they were set apart, and subject to this Act and to the terms of any treaty or surrender, the Governor in Council may determine whether any purpose for which lands in a reserve are used or are to be used is for the use and benefit of the band” (Department of Justice Canada, 2013).

1.2 History of Canada’s Aboriginal People

Some historical context is important in order to understand the health challenges faced by Aboriginal people. This section will provide only a very brief synopsis. As the original inhabitants of Canada, their way of life depended on the Aboriginal nation or group (Lackenbauer, Moses, Sheffield, & Gohier, 2009). In particular, the Cree of northern Quebec and Ontario may have been more sedentary in the summer months when fishing was possible, and more nomadic in the winter months (Lackenbauer et al., 2009). By the 1500s, the British and French began to explore and settle in North America, establishing informal fur trades with FN people (AANDC, 2013; Lackenbauer et al., 2009). By 1821, the Hudson’s Bay Company had established a monopoly on the fur trade throughout most of Canada (AANDC, 2013).

Numerous conflicts spurred by the fur trade drove FN people from their traditional lands (AANDC, 2013; Lackenbauer et al., 2009). The 1763 Royal Proclamation was the first time that FN rights to land were recognized, though a number of land surrender treaties occurred over the next century (AANDC, 2013; Lackenbauer et al., 2009). With this, large portions of FN land were handed over to European settlers (AANDC, 2013). This was the beginning of the British Empire’s attempt to bring their view of ‘civilization’ to FN people, under the unfounded belief that the British way of life was superior (AANDC, 2013). Over the next century, even more FN

land was lost as FN people were pushed to settle on reserves (AANDC, 2013; Lackenbauer, 2009). Up to 98% of FN peoples' land was eventually lost to colonialism (LaRocque, 2007).

The Indian Act (1876) gave greater authority to the federal government over FN land and resources, which brought increased focus to the assimilation of FN people (AANDC, 2013; Lackenbauer, 2009). Residential schools became the primary vehicle for this, by forcing children to leave their homes and to attend schools away from their communities (The Truth and Reconciliation Commission of Canada [TRC], 2012). Here, they were stripped of their traditional heritage and language, and often subjected to various forms of abuse (TRC, 2012). The last residential school was closed in 1996, but assimilation policies and the residential school system have had long-lasting consequences (AANDC, 2013; TRC, 2012). They prevented Aboriginal peoples from passing on their teachings, cultural values and language to the next generation (TRC, 2012).

More recently, further review of Canada's policies included Bill C-31 (1985), which returned 'Indian Status' to about 60 000 people, as well as the establishment of the Royal Commission on Aboriginal Peoples in 1991 and the Inherent Right Policy in 1995, which acknowledged FN rights to self-government (AANDC, 2013). The government of Canada issued a formal apology in 2008, acknowledging the mistreatment of Aboriginal people under colonial policies (AANDC, 2013). Today, Aboriginal populations continue to show resilience in reclaiming their culture and language, despite their histories and the constraints that continue to be placed upon them.

1.3 Health Disparities Faced by Aboriginal People

Aboriginal people in Canada experience far worse health than the rest of the population, including poorer health outcomes, increased disease risk and higher prevalence rate of several chronic diseases (Gionet & Roshanafshar, 2013) including obesity (Public Health Agency of Canada [PHAC] & the Canadian Institute for Health Information [CIHI], 2011) and type 2 diabetes (PHAC, 2011). Perceived overall health is also lesser among Aboriginal people; 50% of FN and 54% of Aboriginal people report very good or excellent health, compared to 63% of the non-Aboriginal population (Gionet & Roshanafshar, 2013). Perception of mental health is also lower, with 66% of FN people reporting very good or excellent mental health compared to 75% of the general population (Gionet & Roshanafshar, 2013).

Discrepancies in overall health mean that FN people have shorter life expectancies and a greater risk of premature mortality (i.e., before age 75) than the non-Aboriginal population (Tjepkema, Wilkins, Sénécal, Guimond, Penney, 2009). According to Tjepkema et al. (2009), socioeconomic factors (e.g., income, educational attainment) may account for approximately two-thirds of excess mortality in Aboriginal men and almost one-third of excess mortality in Aboriginal women. Compounding the issue, access to health services, especially in rural and remote areas (including many FN reserves) is often limited (National Collaborating Centre for Aboriginal Health, 2011; Halseth & Ryser, 2006). Almost 40% of FN people living on reserve feel that they have lesser access to health services than individuals off-reserve, and 23.5% of those who would like to access traditional medicine report having difficulties doing so (FNIGC, 2012).

1.4 Focus on Overweight and Obesity among Youth

Of the health concerns faced by Canadians, overweight and obesity are among the most pressing, and Aboriginal people are disproportionately affected (Gionet & Roshanafshar, 2013). Given that the Aboriginal population is relatively young (more than one-third being <18 years) (Statistics Canada, 2013a), the increasing prevalence rates of overweight, obesity, and related comorbidities raise significant concerns for the future burden of chronic disease. To mitigate this, youth should be a priority target population for a variety of health promotion initiatives aimed at preventing obesity and its comorbidities (Willows, Hanley, & Delormier, 2012).

1.4.1 Measurement

Before discussing the population health burden of obesity, it is important to understand its measurement. This will provide context for interpreting the prevalence rates generated using various data sources, among which methodologies may differ. The body mass index [BMI] is a tool often used at the population level to classify adults into weight categories (World Health Organization [WHO], 2000, 2015a). The BMI has not been validated for the Aboriginal population and there is some controversy as to whether it is an appropriate measure (Lear, Humphries, Frolich, & Birmingham, 2007; Charbonneau-Roberts, Saudny-Unterberger, Kuhnlein, & Egeland, 2005; Razak, Anand, Vuksan, Davis, Jacobs, Teo, et al., 2005). It remains commonly used in the absence of better tools. The BMI provides common ground for simple comparisons between populations and over time (Gotay, Katzmarzyk, Janssen, Dawson, Aminoltejari, & Bartley, 2013).

Growth patterns mean that usual adult BMI cut-offs would not be applicable to children and youth at various stages of physical development. Thus, various age- and sex-specific cut-offs have been developed. The International Obesity Task Force [IOTF] cut-offs were derived using the average of centile cut-offs from a variety of national surveys (Cole & Lobstein, 2012; Cole, Flegal, Nicholls, & Jackson, 2007; Cole, Bellizzi, Flegal, & Dietz, 2000), making them likely to be suitable for a variety of populations and ethnicities, though they have not been specifically tested for Aboriginal youth. These cut-offs were used in the classification of 2008-2010 RHS data, which were utilized in **Studies 2** and **3**, within this dissertation. It is recognized, however, that the IOTF cut-offs tend to underestimate overweight and obesity prevalence (Reilly, Kelly, & Wilson, 2010).

More recently, the WHO proposed international growth charts for children and adolescents aged 5 to 19 years, utilizing data from the 1977 National Center for Health/WHO growth reference (de Onis, Onyango, Borghi, Siyam, Nishida, & Siekmann, 2007). These growth charts take into account the rising rates of pediatric obesity; prevalence estimates using these curves are therefore likely to be higher than those using IOTF cut-offs (Roberts, Shields, de Groh, Aziz, & Gilbert, 2012; Dietitians of Canada [DC] & Canadian Pediatric Society [CPS], 2010). The WHO growth curves currently represent the gold standard for classifying the growth of children and youth (de Onis & Lobstein, 2010; DC & CPS 2010). For this reason, the WHO cut-offs were chosen for the community-based research in **Studies 4** and **5**, within this dissertation.

1.4.2 Prevalence

Unfortunately there exist no recent, comprehensive data sources on overweight and obesity among Aboriginal youth as compared to the non-Aboriginal population. By examining various data sources, it is possible to begin to understand that Aboriginal youth are disproportionately affected. Though now more than 10 years old, the 2004 CCHS offers the most recent Canada-wide estimate of overweight and obesity for Aboriginal youth, using measured height and weight data and IOTF cut-offs (Shields, 2006). At that time, 21% of 12 to 17 year old Aboriginal youth were overweight and 20% were obese (total 41%), while fewer non-Aboriginal youth were affected by overweight or obesity (18% and 8%, respectively (total 26%)) (Shields, 2006). Among on-reserve FN youth, the concern of overweight and obesity is more severe. The 2008-2010 RHS reported that 30.0% of on reserve FN youth aged 12-17 years were overweight and 13.1% were obese (total 43.1%), using self-reported data and IOTF cut-points (FNIGC, 2012).

1.4.3 Consequences

High prevalence rates of overweight and obesity among youth are of concern because obesity is a risk factor for the development of a number of chronic diseases, both in childhood and later in life (Kelsey, Zaepfel, Bjornstad, & Nadeau, 2014). First Nations youth appear to also be predisposed to abdominal obesity (Pigford, Sanou, Ball, DyckFehderau, & Willows, 2011; Anderson, Baxter-Jones, Faulkner, Muhajarine, Henry, & Chad, 2010; Downs, Marshall, Ng, & Willows, 2008). High levels of abdominal adipose tissue may mean that many Aboriginal youth are at an increased risk of premature metabolic disorders (e.g., insulin resistance, metabolic syndrome). Early development and rising rates of type 2 diabetes and components of the metabolic syndrome among youth are significant concerns in many FN communities (Oster,

Johnson, Balko, Svenson, & Toth, 2012; Zorzi, Wahi, Macnab, & Panagiotopolous, 2009; Kaler, Ralph-Campbell, Pohar, King, Laboucan, & Toth, 2006). Overall, diabetes prevalence rates among FN people are about two-to-three times those seen in the general population (PHAC, 2011), and rates have reached epidemic proportions in certain FN communities (Dyck, Osgood, Gao, & Stang, 2012; Harris, Gittelsohn, Hanley, Barney, Wolever, Gao et al., 1997).

Beyond the physical consequences, overweight and obesity are believed to be linked to mental health problems, at least among the general population (Vander Wal & Mitchell, 2011; Wang, Wild, Kipp, Kuhle, & Veugelers, 2009). Whether or not this prediction would hold true for Aboriginal youth, given potential differences in body size norms and ideals (Davis, Northington, & Kolar, 2000; Gittelsohn, Harris, Thorne-Lyman, Hanley, Barnie, & Zinman, 1996), remains to be determined. In any case, given that the Aboriginal population is relatively young (Statistics Canada, 2013a), the increasing prevalence rates of overweight, obesity, and related comorbidities raise significant concerns for the future burden of chronic disease. There is strong evidence that overweight and obesity in youth persists into adulthood (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008) and is associated with an increased risk of adult morbidity and premature mortality (Park, Falconer, Viner, & Kinra, 2012; Reilly & Kelly, 2011; Franks, Hanson, Knowler, Sievers, Bennett, & Looker, 2010). Thus, work is needed to develop a good understanding of the factors influencing Aboriginal youth, and especially FN youth living on reserve, for whom little information is currently available.

1.5 Contributors to Obesity and Health Inequality

The various health concerns faced by Aboriginal populations each have unique influences. For example, an energy imbalance is the most simplistic explanation for excess weight (WHO, 2015a). However, the factors influencing behaviours that are linked to obesity are highly complex and attributable to a multitude of interacting factors (Willows, Hanley, & Delormier, 2012; Finegood, Merth, & Rutter, 2010). Beyond the unique contributors to obesity, it is understood that the many health disparities experienced by Aboriginal populations share common roots in the effects of colonialism (Frolich, Ross, & Richmond, 2006). Integral to the understanding of the health of Aboriginal people is that they are affected by unique social determinants associated with this history (e.g., loss of language, cultural connectedness) (Willows, Hanley, & Delormier, 2012; King, 2010; King, Smith, & Gracey, 2009). Additionally, this historical context has impacts at all levels of the socioecological model (Willows, Hanley, & Delormier, 2012).

Cultural connection can be described by various means, with knowledge of FN language being a commonly used proxy indicator, as it is believed to represent an integral connection to FN identity (King, Smith, & Gracey, 2009). Unfortunately, following a history of colonialism and lack of culturally competent education, knowledge of a FN language among youth is lower than among FN adults (FNIGC, 2012). Meanwhile, most (85.7%) youth continue to place a high importance on traditional cultural events in their community (FNIGC, 2012). Teachers and grandparents have been identified as important sources of influence from whom youth can learn about their culture (FNIGC, 2012). This cultural connection is believed to be an important influence on the health of Aboriginal youth (First Nations Health Authority, 2015; FNIGC, 2012;

National Aboriginal Health Organization, 2003), but at this time little is known about the specific influence of cultural and historical factors on weight status for FN youth in particular.

1.5.1 Inequities in the Broader Social Determinants of Health

Within the broader context of colonization, the systematic disparities in health outcomes experienced by Aboriginal Canadians continue to exist largely due to inequity in the distribution of opportunities and resources (King, Smith, & Gracey, 2009; Frolich, Ross, & Richmond, 2006). In 2011, education completion remained lower among Aboriginal people as compared to the non-Aboriginal population, with fewer Aboriginal people completing high school or pursuing higher education than those in the general population (Statistics Canada, 2013b). Related to this, there is a lower participation in the workforce among Aboriginal people, resulting in a greater depth of poverty compared to non-Aboriginal Canadians (Frolich, Ross, & Richmond, 2006). Income is lower for Aboriginal people compared to other Canadians (Statistics Canada, 2008), and a high proportion (18%) of urban Aboriginal households must rely on social assistance (Willows, Veugelers, Raine, & Kuhle, 2009). Conditions of inadequate and substandard housing, including crowding, continue to be more common among Aboriginal people than the rest of Canadians (Statistics Canada, 2008; Frolich, Ross, & Richmond, 2006).

The extent of socioeconomic marginalization is often more severe in remote (i.e., distant from major urban centres) and isolated (i.e., not accessible by road year-round) regions, as is the case for many FN reserves. Especially in smaller communities, relatively few economic opportunities may exist because there are only small numbers of local businesses or other chances for employment (FNIGC, 2012; Ferris, 2011). Thus, the 2008-2010 RHS reported that more than

half (57.6%) of FN adults living on reserve had an annual income of less than \$20 000 and about one-third relied on social assistance (FNIGC, 2012). The issue is compounded by limited training opportunities and access to education.

Low income, often compounded by a high cost of living in northern and remote areas, contributes to high rates of food insecurity, which impacts diet quality and contributes to obesity (Egeland, Pacey, Cao, & Sobol, 2010; Willows et al., 2009; Monsivais & Drewnowski, 2007). About 40% of those living on reserve report being unable to purchase adequate food at least at some point during the year (FNIGC, 2012), and in some communities, especially those in the north, the prevalence of food insecurity may be significantly higher and the degree more severe (Chan, Receveur, Batal, David, Schwartz, Ing, et al., 2014; Skinner, Hanning, & Tsuji, 2014a).

1.6 Potentially Modifiable Health Behaviours

While recognizing the important role of higher-level health determinants, individual-level health behaviours can be important targets for health improvement initiatives because they are amenable to change. Aboriginal people are affected by an increased prevalence of certain behavioural risk factors, such as smoking and heavy drinking (Gionet & Roshanafshar, 2013), but these are not the focus of this dissertation. Physical activity [PA] and sedentary behaviour among youth were chosen as a focus of this dissertation, as they are believed to have impacts on obesity and various aspects of health. The following sections will provide a brief background on the effects of PA and sedentary behaviour on health, including specific roles for Aboriginal youth and potential barriers to PA experienced in many communities.

1.6.1 Impact of Physical Activity and Sedentary Behaviour on Health

Among Aboriginal people, a relatively recent shift away from traditional lifestyles is a contributor to declining levels of PA (Haman, Fontaine-Bisson, Batal, Imbeault, Blais, & Robidoux, 2012; Kuhnlein, Receveur, Soueida, & Egeland, 2004). Additionally, access to screen-based sedentary pursuits has increased in recent years, as satellite television and the Internet have become more widely available to even remote FN communities (FNIGC, 2012). An analysis of 2004 CCHS data showed that high levels of television viewing and physical inactivity were significant predictors of obesity for off-reserve Aboriginal youth aged 12 to 17 years (Ng, Young, & Corey, 2010).

Low PA levels are concerning because there are numerous known physical and mental health benefits associated with being active, at least within the general population (Janssen & LeBlanc, 2010). Of particular interest to Aboriginal peoples is the consistent evidence that high levels of PA can reduce the risk of type 2 diabetes (Gill & Cooper, 2008). Among on-reserve FN (Tsimshian Nation) youth from British Columbia, Canada, time spent in MVPA was inversely associated with insulin resistance (Mitchell, Gaul, Naylor, & Panagiotopoulos, 2010). Related to the potential impact on diabetes, PA has been shown to have an independent impact on waist circumference in a population of FN children (Pigford et al., 2011). Further study will be needed in order to confirm these relationships in other FN populations. Additionally, high levels of PA appear to be associated with better self-rated physical, mental and holistic health (Lemstra, Rogers, Thompson, & Moraros, 2013; FNIGC, 2012; Smith, Findlay, & Crompton, 2010; Cargo, Peterson, Lévesque, & Macaulay, 2007) and lower BMI (Cooke, Wilk, Paul, & Gonneville, 2013; FNIGC, 2012; Ng, Young, & Corey, 2010; Katzmarzyk, 2008) among Aboriginal youth.

As with low levels of PA, spending large amounts of time in sedentary behaviour raises concern as it can produce distinct health effects (Saunders, Chaput, & Tremblay, 2014; Colley, Garriguet, Janssen, Wong, Saunders, Carson et al., 2013). Among Aboriginal youth, watching 15 or more hours of television per week, which would be in excess of current Canadian guidelines (Tremblay, LeBlanc, Janssen, Kho, Hicks, Murumets, et al., 2011a), is associated with a 32% increased odds of being affected by obesity (Ng, Young, & Corey, 2010). Sedentary behaviour has also been associated with numerous other health consequences, including metabolic syndrome, cardiovascular disease, lower self-esteem (Tremblay, LeBlanc, Kho, Saunders, Larouche, Colley, et al., 2011b) and reduced mental health (Harman, Hopman, & Sabiston, 2015; Van der Horst, Paw, Twisk, & van Mechelen, 2007) among the general population. The importance of limiting sedentary time is an emerging area of research, but little information is available for Aboriginal youth or FN youth living on reserve.

1.6.2 Importance of Physical Activity for Aboriginal People

Adequate opportunities for PA are integral to Indigenous peoples' holistic views of health, based on maintaining a balance between physical, spiritual, intellectual and emotional wellbeing (First Nations Health Authority, 2015; U.S. National Library of Medicine, 2015). Aboriginal adults participating in a culturally-relevant PA program described benefits including an increased sense of community, a reclaiming of their own identities, an improvement in self-esteem and emotional wellbeing, and an increased sense of belonging and spiritual growth (Lavallée, 2007, 2008).

Analyses of 2008-2010 RHS data showed that among FN youth living on reserve, higher participation in PA was predicted by a greater level of cultural connection, community support for learning about culture, and feeling in spiritual balance (Lévesque, Janssen, Xu, & FNIGC,

2015; Janssen, Lévesque, Xu, & FNIGC, 2014). It was suggested that participation in traditional PA may be a step toward promoting resilience against the negative impacts of colonialism and reclaiming FN cultural traditions (Lévesque et al., 2015).

Additional studies among both adults and youth have found that both ‘traditional’ and ‘non-traditional’ activities remain important for Aboriginal youth and their communities (Pigford, Willows, Holt, Newton, & Ball, 2012; Isaak & Marchessault, 2008; Findlay & Kohen, 2007; Kirby, Lévesque, & Wabano, 2001). However, qualitative studies in a number of communities have demonstrated concern over declining PA among youth as compared to older generations, perhaps related to a distancing from traditional ways of life (McHugh, Kingsley, & Coppola, 2013; Isaak & Marchessault, 2008; Kirby, Lévesque, & Wabano, 2001). These concerns are substantiated by recent analyses of 2008-2010 RHS data showing that only about half of children and youth had participated in at least one traditional activity in the previous year (Lévesque et al., 2015; Janssen et al., 2014). There exist a number of documented barriers that youth in FN communities experience when wishing to engage in PA, including economic constraints, geographical remoteness, resource limitations, a lack of desirable opportunities and the influence of traditional gender roles (especially for girls) (Mason & Koehli, 2012; Schinke, Yungblut, Blodgett, Eys, Peltier, Ritchie, et al., 2010; Cargo et al., 2007; Skinner, Hanning, & Tsuji, 2006; Kirby, Lévesque, & Wabano, 2001).

1.7 Initiatives to Promote Physical Activity

In view of the barriers to PA participation experienced by many Aboriginal youth, Sport Canada has proclaimed a commitment to “*contributing, through sport, to the health, wellness, cultural identity and quality of life of Aboriginal Peoples*” (Government of Canada, 2005). In 2002 (renewed in 2012), federal, provincial and territorial governments supported Sport Canada’s Policy for Aboriginal People in Sport, which acknowledged the challenges to sports participation for Aboriginal Canadians and aimed to increase access and equity in sport (Government of Canada, 2005). The renewed policy supports the Maskwachees Declaration (2000), which underscored Canada’s commitment “*to improving the health, wellness, cultural survival and quality of life of Aboriginal/Indigenous Peoples, through physical activity, physical education, sport and recreation*” (Government of Canada, 2005).

In recognition of the importance of sport for Aboriginal youth, the Aboriginal Sport Circle supports sports and cultural activities for Aboriginal people and communities in Canada and advocates for equality in access to sport programming (Aboriginal Sport Circle, 2015). They organize the North American Indigenous Games, an opportunity for youth to compete in a number of organized sports, and celebrate Indigenous cultural practices (North American Indigenous Games, 2015). In Ontario, the Aboriginal Sport and Wellness Council of Ontario is responsible for the promotion of PA among Aboriginal people (Aboriginal Sport and Wellness Council of Ontario, 2015). Their mandate includes the promotion of PA in ways that respect the values of Aboriginal people (Aboriginal Sport and Wellness Council of Ontario, 2015).

Sport Canada's national policy document, though intended to be inclusive of all Canadians, currently includes no specific reference to Aboriginal peoples (TRC, 2012; Government of Canada, 2012). Thus, calls for action within The Truth and Reconciliation Report reflect the view that the current policy is inadequate in its inclusion of Aboriginal peoples (TRC, 2012). Among these calls to action are recommendations for further amendment of the current policy, with a focus on reducing the barriers to participation and improving sports capacity and access to programming for Aboriginal people and communities (TRC, 2012). Viewing health and health behaviours through a socioecological lens, a reduction in these barriers will require action in numerous settings. It is acknowledged, however, that this may not be feasible for communities where few existing resources are available. When addressing the health behaviours of youth, the school environment can be an important starting point (Naylor & McKay, 2009), as initiatives in this setting can reach a large segment of the young population.

1.7.1 School-based Programs in Canadian First Nations Communities

The experiences and outcomes of several school- and community-based initiatives promoting PA for Aboriginal youth have been documented, and many other programs likely remain undocumented. In the Canadian context, the Kahnawake Schools Diabetes Prevention Project [KSDPP] (Adams, Receveur, Mundt, Paradis, & Macaulay, 2005; Paradis, Lévesque, Macaulay, Cargo, McComber, Kirby, et al., 2005), Action Schools! BC (refers to British Columbia) (Naylor, Scott, Drummond, Bridgewater, McKay, & Panagiotopoulos, 2010; Tomlin, Naylor, McKay, Zorzi, Mitchell, & Panagiotopoulos, 2012), Healthy Buddies™ (Santos, Durksen, Rabbanni, Chanoine, Lamboo, Mayer, et al., 2014; Ronsley, Lee, Kuzeljevic, & Panagiotopoulos, 2013; Naylor et al., 2010), and the Sandy Lake Health and Diabetes Project

[SLHDP] (Kakekagumick et al., 2013; Saksvig, Gittelsohn, Harris, Hanley, Valente, & Zinman, 2005) are community- or school-based programs developed in or adapted to FN communities. In general, these programs took multi-faceted approaches to promote of PA and other health behaviours.

The KSDPP is a relatively large-scale program in a Quebec Mohawk community that aimed to reduce overweight and obesity in youth; after four years, self-reported PA significantly increased, while television viewing declined, but improvements were not maintained in the long term (Adams et al., 2005). The SLHDP, initiated in 1998 in a remote Ontario FN to address type 2 diabetes, saw significant reductions in screen time over one year (Saksvig et al., 2005). After being reinitiated in 2005, two-year outcomes showed significant reductions in screen time, but increases in BMI, waist circumference and body fat percentage and a decrease in maximal aerobic capacity (Kakekagumick et al., 2013).

Both Action Schools! BC and Healthy Buddies™ are school-based initiatives more recently implemented in FN communities in northern British Columbia (Ronsley et al., 2013; Tomlin et al., 2012; Naylor et al., 2010), with Healthy Buddies™ also being recently implemented in FN schools in Manitoba (Santos et al., 2014). Action Schools! BC aims to increase opportunities for PA and healthy eating, while Healthy Buddies™ employs a peer-based approach to PA, healthy eating and self-esteem promotion (Ronsley et al., 2013; Tomlin et al., 2012; Naylor et al., 2010). Both programs have been moderately successful; Action Schools! BC resulted in significantly increased aerobic fitness in participants after one year (Tomlin et al., 2012), while Healthy Buddies™ resulted in significant reductions in mean BMI z-score and waist circumference

(Ronsley et al., 2013). More recently, a large cluster-randomized trial in 19 Manitoba schools showed that Healthy Buddies™ was effective at attenuating increases in waist circumference, especially within FN schools (Santos et al., 2014). Authors attributed the effectiveness of the program to various potential factors: exposure to the curriculum itself, the relatively novel peer mentoring approach, and the cultural adaptation of the program for FN students (Santos et al., 2014).

Clearly, previous programs in schools and communities specific for Aboriginal youth have achieved some success in terms of increased PA and fitness, reduced sedentary behaviour, and in some cases reductions or attenuated increases in BMI and waist circumference. The longer-standing programs in Kahnawake and Sandy Lake demonstrate that sustaining significant changes in PA and sedentary behaviour over time can be a challenge (Kakekagumick et al., 2013; Adams et al., 2005; Saksvig et al., 2005).

2.0 Opening Remarks

2.1 Rationale

As a result of historical injustices and ongoing inequities in a number of health determinants, Aboriginal Canadians experience far worse health than the general population (Kmetz, Reading, & Etsey, 2008; Frolich, Ross, & Richmond, 2006; Young, 2003). Of particular concern, prevalence rates of overweight, obesity (Gionet & Roshanafshar, 2013) and associated comorbidities such as type 2 diabetes (PHAC, 2011) far exceed what is seen in the general population. The issue is particularly pressing among youth, who make up a large proportion of the Aboriginal population (Statistics Canada, 2013a). Because overweight and obesity in youth tends to persist into adulthood (Singh et al., 2008), the issue should be addressed preventatively at this stage of the lifecycle when lifelong health habits are forming.

Though obesity is a complex, multifactorial issue (Finegood, Merth, & Rutter, 2010), PA and sedentary behaviour are immediate, potentially modifiable contributors. In the past 60 years, participation in traditional activities among Aboriginal people has declined, and lifestyles have become more sedentary (Pal, Haman, & Robidoux, 2013). Participation in PA is thought to have important cultural benefits for Aboriginal people (Lévesque et al., 2015; Janssen et al., 2014; Lavallée, 2008; Cargo et al., 2007; Lavallée, 2007), but there are oftentimes many barriers to youth being active (Mason & Koehli, 2012; Schinke et al., 2010; Cargo et al., 2007; Skinner, Hanning, & Tsuji, 2006; Kirby, Lévesque, & Wabano, 2001). Information specific to FN people is needed on the factors influencing obesity and the behaviours that contribute to it, in order to inform health promotion initiatives.

Unfortunately, exclusion or underrepresentation of FN people in national surveillance studies means that information about the health of FN youth is relatively limited. The RHS may be a valuable source of health information for FN people and may provide direction for health promotion, but it remains an underused resource in health research. The availability of this wealth of data makes it possible to begin to understand the influences on obesity among FN youth, taking an ecological approach. Though recent studies have used the data to elucidate some factors associated with PA among FN children and youth living on reserve (Lévesque et al., 2015; Janssen et al., 2014), this may be complemented by an improved understanding of the influences on sedentary behaviour. Such information may inform the programs and policies that are needed that facilitate PA engagement and a reduction in sedentary behaviour among youth.

In addition to information from national data, individual communities, which may experience unique influences, challenges and opportunities for PA, need the opportunity to obtain data specific to their youth. This, in addition to findings from the RHS, may allow for the tailoring of health-promotion initiatives to local circumstances. Though multi-level approaches will be needed to make a significant impact on prevalence rates of obesity, schools are a setting where most youth in the population can be relatively easily reached, and may be an important milieu to begin to promote health. Testing local initiatives will provide feedback to communities on the effectiveness of their programs, which may help to advocate for increased funding and resources.

2.2 Thesis Organization and Broad Aims

The aim of this thesis was to begin to identify and address some of the gaps in understanding about overweight and obesity among Canadian FN youth, with emphasis on two modifiable health behaviours, PA and sedentary behaviour (notably, screen time) (**Figure 2.1**).

A synthesis of relevant background information about the health of Aboriginal people (see **Background**) and the research rationale provided a basis for the five studies that followed. In **Study 1** a systematic review of the peer-reviewed quantitative research on PA, sedentary behaviour and physical fitness of Canadian Aboriginal youth, and their associations with health outcomes such as obesity, is presented. While this study includes information about all Aboriginal people, the rest of the thesis is focused exclusively on FN youth living on reserve.

Using the systematic review as a starting point, the next two studies utilized data collected as part of the 2008-2010 RHS, which included a large sample of FN youth living in reserve communities across Canada. In **Study 2**, these data were used to begin to understand the relationship of socioeconomic, cultural, and health behaviour factors with overweight and obesity among FN youth living on reserve. In **Study 3** the relationships of socioeconomic, cultural and health-related factors with high levels of television viewing were explored.

Building on this knowledge, **Studies 4** and **5** are a demonstration of the outcomes of a university-community research collaboration. In response to the desires of the FN community with which the author and her colleagues partnered, in **Study 4** the findings of a needs assessment regarding PA and sports for youth living in a remote and isolated FN community in

subarctic Ontario, are presented. This study informed a locally operated school sports program in that community. Finally, in **Study 5** the results of process and outcome evaluations of the school sports program after nine months of operations (i.e., one school year), are presented.

Following the main studies, a general discussion of the key findings and contributions is presented, along with commentary on potential future directions and conclusions.

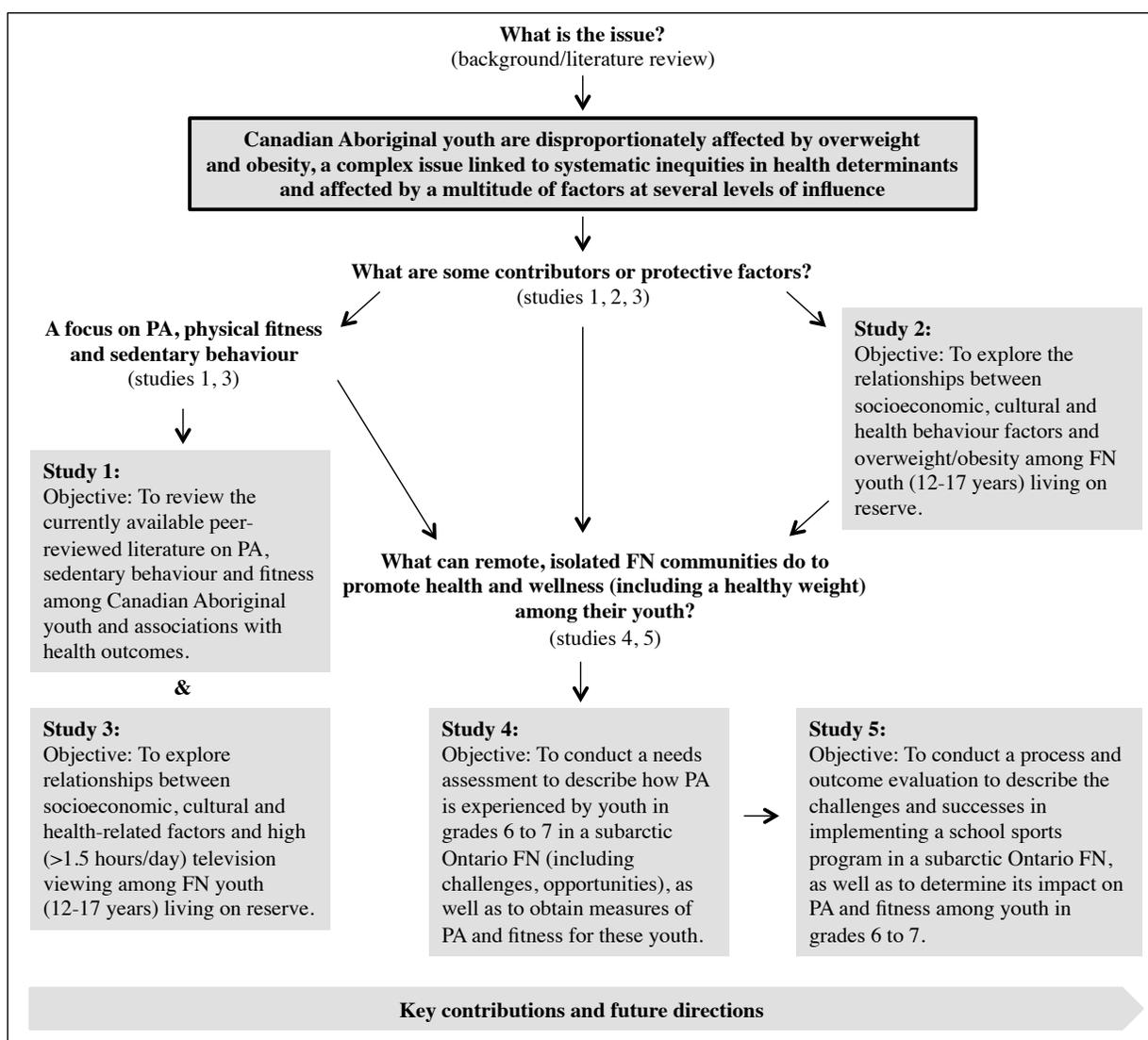


Figure 2.1 Organization of studies within the dissertation^a

^aPA: physical activity; FN: First Nations

2.3 Theoretical Framework

While much of this thesis focuses on physical health outcomes, it is acknowledged that these are only a small component of overall wellness. For FN people, a holistic view of wellness reflects the complex relationship between a number of factors that interact to achieve a balance between physical, mental, emotional and spiritual realms (First Nations Health Authority, 2015; FNIGC, 2012). Within this view, influences on the health and wellness of an individual can include social, environmental, cultural and economic factors (First Nations Health Authority, 2015). Socioecological models are congruent with this view and provide a framework for understanding the factors at multiple levels of influence that can interact to affect the behaviour and consequently the health of a target group (Glanz & Bishop, 2010; McLeroy, Bibeau, Steckler, & Glanz, 1988). Thus, such models can strike a balance between familiarity in the field of public health and sensitivity toward Aboriginal worldviews and conceptions of health.

The socioecological model for childhood obesity among Aboriginal youth developed by Willows, Hanley and Delormier (2012), used to frame this dissertation, acknowledges multiple levels of influence and includes factors that are of relevance to Aboriginal youth (Willows, Hanley, & Delormier, 2012). Specifically, the factors included in the model are the individual (e.g., age, sex, attitudes, motivation), interpersonal factors (e.g., family and peer influence), community, home and sociocultural environments (e.g., school PA environment, geographic remoteness), the built environment (e.g., recreation facilities) and society (e.g., media, local and provincial policies) (Willows, Hanley, & Delormier, 2012). These are situated within a broader historical context that is specific to Aboriginal youth that has an impact at all levels (Willows, Hanley, & Delormier, 2012).

The studies within this dissertation in themselves do not address every component of the socioecological model, but they begin to explore some of the levels of influence. Following the literature review in **Study 1**, in both **Studies 2** and **3** an ecological perspective was used to explore various factors that may be associated with obesity and screen-based sedentary behaviour among FN youth living on reserve. While in some cases these relationships are well known for the general population, it is recognized that the historical context as well as current inequities in a number of health determinants mean that such relationships cannot be directly applied to FN youth. It was expected that the identification of associated factors would help to direct resources and tailor health promotion policies and programs. In particular, factors within individual (age, sex, personal health-related variables), interpersonal (peer and family influences), community and sociocultural contexts (socioeconomic status, influence of community members) were explored in these studies. Importantly, an examination of cultural factors (knowledge of FN language, attendance of cultural events, support to understand culture) specific to FN youth was included.

In **Studies 4** and **5** a number of factors with the potential to influence youths' PA were examined in one subarctic FN community. At the needs assessment stage (**Study 4**), individual (sex, attitudes, motivation, PA and fitness levels), interpersonal (influence of peers and role models), community, home and sociocultural (role of school, teachers) and built environment (facilities, terrain, weather) factors are investigated. This relatively comprehensive approach allowed for an improved understanding of several of the influences on FN youths' involvement in PA in this community.

Building upon the findings, in **Study 5** a school sports program was implemented with the intention of enhancing the school environment. Although it would have been preferable to address multiple levels of influence in the PA initiative, the location is remote and there were few pre-existing resources and limited programming. Thus, it was important to test a pilot program that was likely to be sustainable within these conditions. Further, community ownership is important, and the program allowed community members to capitalize on the resources that they had available to implement an initiative that was desired and deemed feasible. The program had potential to indirectly influence other levels of the socioecological model (e.g., family or community environment) and may be viewed as a starting point that can, in the future, be complemented by addressing other levels of influence.

2.4 Research Ethics and Approach

Until relatively recently (the 1990s), research was most often practiced *on* rather than *with* Aboriginal people and their communities (Wilson, 2008). Studies were carried out by non-Aboriginal researchers, oftentimes using inappropriate methods and practices that were, at best, not useful to Aboriginal people nor their communities (Canadian Institutes of Health Research [CIHR], Natural Sciences and Engineering Research Council of Canada [NSERC], & Social Sciences and Humanities Research Council of Canada [SSHRC], 2014; Cochran, Marshall, Garcia-Downing, Kendall, Cook, McCubbin, et al., 2008; Wilson, 2008). In many cases, rather than being used to benefit Aboriginal people and their culture, results perpetuated colonialism and stigmatized individuals and communities (Cochran et al., 2008). Thus, it is understandable that there may continue to exist a general mistrust of research from the perspective of Aboriginal people (CIHR, NSERC, & SSHRC, 2014; Kovach, 2009).

The research within this dissertation took an approach that respected the CIHR Guidelines for Health Research Involving Aboriginal People (CIHR, NSERC, & SSHRC, 2014) and the FN principles of OCAP[®] (FNIGC, 2014). **Studies 2** and **3** employed RHS data that were collected by the FNIGC, based on an Indigenous research framework that acknowledged the values of the FN participants and their communities (FNIGC, 2012). The information collected was of direct relevance to FN people and reflected the issues that they had interest in (FNIGC, 2012). In recognition that population-based data remains one of the most important ways to begin to close the many gaps that exist in the knowledge about the health of FN youth (Willows, 2013a), the project aimed to inform initiatives that would promote health equity. The research proposal was supported by our FN community-based partners. Once submitted, the research plan underwent methodological, technical and ethical review by the Data Review Access Subcommittee at the FNIGC. All statistical outputs were vetted by FNIGC personnel, and reports were reviewed to ensure that they would benefit the health of FN people in a non-stigmatizing way. The analytical information remains owned by the FNIGC, who represent the FN communities from whom the data was obtained.

To ensure that community-based stakeholders would be involved at all stages (Willows, 2013a; Cochran et al., 2008), the community-based projects in **Studies 4** and **5** followed a community based participatory research approach [CBPR] (Fletcher, 2003). The CBPR approach emphasizes that the issues addressed in the research relationship should be community-driven and aim to improve the social conditions in the community (Fletcher, 2003). The first step in the CBPR process is to develop trusting relationships (CIHR, NSERC, & SSHRC, 2014; Maar, Lightfoot, Sutherland, Strasser, Wilson, Lidstrone-Jones, et al., 2011, Wilson, 2008; Fletcher, 2003). Thus,

the project herein developed from a longstanding partnership between the community and the research team. Importantly, impetus for the project came from community partners and not solely the researchers (Cargo, Delormier, Lévesque, McComber, Macaulay, 2011; Fletcher, 2003). This ensured that the community obtained desired information about the health of their youth that would be of direct benefit to them (Willows, 2013a; Kovach, 2009; Fletcher, 2003). Roles of community partners and the university-based researchers, and the methods used to address research questions, were determined collaboratively in advance, to ensure that the values of both groups were respected (Simonds & Christopher, 2013; Willows, 2013a; Cochran et al., 2008; Fletcher, 2003).

The sports programming was conceived, developed and implemented locally. Prior to the project, ethics approval was obtained from the Waterloo Office of Research Ethics, with support from the local school and Education Authority (equivalent to a FN-administered municipal school board). In respecting community rights to dictating how information is shared (Simonds & Christopher, 2013; Cochran et al., 2008; Fletcher, 2003), community advisors were involved in deciding the results dissemination plan, which included materials that were acceptable and understandable to community members, and were likely to have a wide reach (Willows, 2013a; Maar et al., 2011). In acknowledgment of the important contributions of the community partners, they were included as authors on manuscripts, presentations, and all other dissemination materials (Fletcher, 2003). Finally, the CBPR approach stipulates that relationships do not end at the finalization of a single research project, but should be ongoing (Fletcher, 2003). Indeed, the project herein was part of an ongoing relationship with the community, such that new projects can be initiated as community capacity grows and new issues of interest are identified.

2.5 Author's Biases and Positionality

The declaration of Helsinki presents ethical standards for research involving human participants, and stipulates that authors have a responsibility to disseminate research results, both positive and negative (i.e., null findings), while being accountable for the accuracy of research reports (World Medical Association, 2013). Adherence to these principles requires disclosure of potential sources of bias and conflicts of interest (World Medical Association, 2013). In cross-cultural research, positionality of the author, or their relationship with the participants and the research, can also be important.

The author's past experiences had the potential to affect the research plans undertaken (Pannucci & Wilkins, 2010; Kaptchuck, 2003; Norris, 1997). Given that the author of this dissertation is non-Aboriginal, it is not possible to fully understand the challenges that Aboriginal populations have faced and continue to experience, as the author has not personally lived them. Thus, it was important to be mindful that as an 'outsider', it is possible to impose a power imbalance that could further stigmatize Aboriginal people and communities. Thus, it was imperative that the author's motivations be known to participating individuals and communities from the outset.

In this case, the author is a registered dietitian trained primarily in quantitative research methodologies, but has also completed a graduate level qualitative research course. The research presented in this dissertation is primarily quantitative, and the choice to take this approach was likely influenced by the author's prior experience and perceived expertise. In an effort to triangulate the findings and include the voices of the participants, who likely hold different

worldviews than the author, qualitative approaches were used within the primarily quantitative studies.

Hypotheses for each study were presented in advance and were retained in the final version of this thesis, such that preconceived beliefs about potential outcomes remain disclosed. While these hypotheses may have been influenced by the author's prior experiences, they were substantiated by the present body of literature. However, especially for the analyses of RHS data, it should be acknowledged that the hypotheses themselves impacted the choice of independent variables that were likely to feature within the results. The author's prior experience has been exclusively with subarctic FN communities located on the west coast of James Bay, in Ontario. These communities are remote, isolated and are generally socioeconomically disadvantaged. The author does not have experience working with urban or southern FN populations.

The data used in **Studies 2** and **3** were relatively conveniently available, had not previously been analyzed, and filled a gap in the research literature, which made them appealing in terms of addressing research questions about the factors affecting the odds of overweight/obesity and sedentary behaviours among FN youth. It is acknowledged that as an 'outsider' it is not possible to speak for Aboriginal people and their needs. Thus, it should be emphasized that plans for these projects were supported by FN collaborators (via letter of support) and were accepted by the FNIGC. A previous relationship with the community involved in **Studies 4** and **5** played a role in determining the direction of these projects, because the community was interested in partnering on a PA initiative. The author previously worked with the community during her MSc work

(starting in 2009), which facilitated further collaboration. As such, the author and community members had a solid understanding of each others' motivations at the outset of the research. The author was accepted to work with the community because she was viewed by community members as contributing skills that would help in moving toward a common goal. There was an understanding that the author was not in the community to 'research them', but rather to collaborate on an initiative that both parties deemed important. While the author was not an academic expert on PA at the outset of the research, the project was decided based on the desires of the community, and built upon previous work. The author's prior experience with program evaluation, and discussions with community partners, drove the methodologies used in these two studies. Input from FN collaborators was included at all stages, such that their voices would be prominent in the research.

Certain mitigating strategies were employed in an attempt to maintain objectivity. The analyses of data and resultant reports from the RHS were reviewed and released by the FNIGC. In the community-based studies, a predetermined data collection protocol was used to collect anthropometric, PA and fitness information, in an attempt to reduce inter-rater variation. In some cases, such as the collection of fitness data, information was collected by two observers and later compared for accuracy. Established standards were used to categorize the data. Two facilitators were present at focus groups and interviews, and debriefed following the sessions to ensure accuracy of the notes taken. Analyses of qualitative data were repeated by a second researcher and reviewed by community advisors. Review of the findings from a FN perspective was important, because as a non-Aboriginal person, it was not possible to speak from an Aboriginal perspective. Rather, it was important that their voices be incorporated in a way that they viewed

as acceptable. The author's relationship with the community meant that youth felt comfortable sharing their views, as did the FN advisors who reviewed the findings and contributed valued input.

The author has no conflicts of interest to declare. The data used in **Studies 2** and **3** were collected by the FNIGC, who approved the research plan. However, the author takes sole responsibility for these studies. The community-based studies (**Studies 4** and **5**) were funded by a CIHR grant held by Drs. Rhona Hanning and Len Tsuji, and the author was funded by scholarships from the University of Waterloo, the Heart and Stroke Foundation, and CIHR. The funding sources had no influence on the research plan, study design, data collection, interpretation or presentation of results.

3.0 Physical Activity and Fitness of Canadian Aboriginal Youth: A Systematic Review

3.1 Overview

Background: There are gaps in the understanding of PA and fitness of Canadian Aboriginal youth and the factors that may be associated with these variables. Importantly, FN youth living on reserve and Aboriginal populations living in the northern territories are often excluded from national surveillance studies. There is a need for a more recent review of the topic that integrates regional data to provide a single, up-to-date source on the PA levels and physical fitness of Canadian Aboriginal youth.

Objectives: To review quantitative studies reporting on PA and physical fitness of school-aged (5 to 18 year old) Canadian Aboriginal youth published between January 2004 and January 2014 and summarize results in terms of (a) current standards, (b) age and sex differences and (c) relationships to health outcomes.

Methods: A systematic review of relevant databases (Medline/Pubmed, Scopus, ERIC, Web of Science) was conducted, in addition to a scan of Google Scholar and reference lists. Studies were summarized for purpose and design, sample population and size, and measures used. Physical activity, sedentary behaviour and cardiorespiratory endurance were described and presented in terms of relationships to other variables.

Results: The literature search identified 23 records that met the inclusion criteria. Eight studies (35%) examined data from national surveys. The remainder of studies (n=15, 65%) reported regional data from FN subpopulations. In national data, about half of youth were considered active and up to two-thirds spent more than 15 hours per week in sedentary behaviour. In regional reports, PA varied from 48 minutes of overall PA to 152 minutes of moderate-to-vigorous PA [MVPA] per day, and television viewing varied from 1.2 to 3.2 hours per day.

Higher PA and lesser sedentary behaviour reduced the odds of obesity in national samples; MVPA was negatively associated with waist circumference and insulin resistance in some FN groups. Cardiorespiratory endurance was low for 57% to 83% of the population among three regions. Limited data suggested inverse associations between cardiorespiratory endurance and both waist circumference and presence of insulin resistance.

Conclusion: Large proportions of youth did not meet Canadian standards for PA nor sedentary behaviour. Limited data suggest that higher levels of PA and lesser time in sedentary behaviour confer health benefits for Canadian Aboriginal youth, thus should be the targets of health promotion initiatives.

3.2 Introduction

Colonization has resulted in Canadian Aboriginal people experiencing years of systematic discrimination, oppression and marginalization (AANDC, 2013; Frolich, Ross, & Richmond, 2006). As a consequence of continuing inequalities in several health determinants, Aboriginal Canadians experience poorer health than non-Aboriginal Canadians (Frolich, Ross, & Richmond, 2006; Young, 2003; Barton, Thommasen, Tallio, Zhang, & Michalos, 2005). The high prevalence rate of overweight and obesity among Aboriginal youth (Shields, 2006) is a highly complex issue influenced by a multitude of factors (Willows, Hanley, & Delormier, 2012; Finegood, Merth, & Rutter, 2010), but physical activity is a direct, potentially modifiable contributor (WHO, 2015a).

Aboriginal youth are thought to be somewhat more active than their non-Aboriginal peers (Ng, Young, & Corey, 2010), but levels of PA may still be inadequate for optimal health. It is possible

that many of the negative health consequences of obesity in youth may be counteracted by high cardiorespiratory endurance, associated with adequate MVPA (Ortega, Ruiz, Castillo, & Sjöström, 2008). Unfortunately, there is little recent information on PA among Aboriginal youth in Canada, its determinants and effects on health.

In 2007, Young and Katzmarzyk provided a comprehensive overview of PA among Canadian Aboriginal adults and youth. Additionally, a systematic review by Foulds, Warburton and Bredin (2013) reported on the PA levels of Native American populations in the United States and Aboriginal populations in Canada. This review, however, did not investigate determinants or correlates of PA, sedentary pursuits, nor cardiorespiratory endurance. Given that Canadian Aboriginal populations have distinct histories, health and social circumstances as compared to Native Americans, there is a need for updated information on the prevalence and correlates of PA and cardiorespiratory endurance among Canadian Aboriginal youth. This more recent review of the topic integrates regional data to provide a single, up-to-date source on the PA levels, sedentary behaviour, and cardiorespiratory endurance of Canadian Aboriginal youth.

3.3 Objective

The aim of the current study was to review quantitative research reporting on the PA and cardiorespiratory endurance of school-aged (5 to 18 year old) Canadian Aboriginal youth published between January 2004 and January 2014 and to summarize results in terms of (a) current standards, (b) age and sex differences and (c) relationships to health outcomes.

3.4 Methods

A systematic review of online peer-reviewed published literature reporting quantitative data on the PA of school-aged (5 to 18 year old) Aboriginal youth in Canada was conducted in January 2014, following the guidelines set by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher, Liberati, Tetzlaff, Altman, & The Prisma Group, 2010; Liberati, Altman, Tetzlaff, Mulrow, Gøtzche, Ionnidis, et al., 2009). The review protocol was set by the authors in advance of the study. Sources, search terms, eligibility criteria and a sample search are listed in **Table 3.1**. Articles were first selected by title and abstract, and later by scanning the full text article. Google Scholar and reference lists were used to locate records not identified during the database search. Data were extracted from each study and summarized in tabular format; each study was described for: purpose and design, sample population and size, methodology and findings in terms of amount or type of PA, sedentary behaviour or cardiorespiratory endurance (e.g., descriptive information, mean minutes, step counts, frequencies or prevalence rates of meeting a standard) and relationships to other variables (e.g., correlations, associations, odds ratios, relative risks). In the case of studies reporting on community or school-level initiatives, only pre-program data were reported to reflect the baseline values without intervention. Due to the nature and variability of study outcomes and methodologies, the primary sources of bias within studies were the method used to measure PA and timeframe of measurement. Though other sources of bias are likely to exist, these were not considered during this review. To ensure transparency and accuracy of the results, the database search, results identification and summary procedures were repeated by a second researcher in March 2014. Disagreements were resolved via discussion until consensus was reached.

Table 3.1 Sources, search terms, eligibility criteria and sample search for the literature review

Sources ^a	Search Terms	Inclusion and Exclusion Criteria
<ul style="list-style-type: none"> ▪ Pubmed (Medline) ▪ Scopus ▪ ERIC ▪ Web of Science ▪ Google Scholar ▪ National surveys ▪ Reference lists 	<ul style="list-style-type: none"> ▪ Physical Activity ▪ Activity ▪ Sport ▪ Exercise ▪ Fitness ▪ Aboriginal ▪ Indigenous ▪ First Nation ▪ Métis ▪ Inuit ▪ Child ▪ Teen ▪ Youth ▪ Adolescent 	<p>Inclusion</p> <ul style="list-style-type: none"> ▪ Quantitative observational and correlational (descriptive) studies^b ▪ Peer reviewed ▪ Published from January 2004 to January 2014 ▪ Described First Nations, Métis or Inuit youth of school age (5 to 18 y) ▪ Canadian ▪ English language <p>Exclusion</p> <ul style="list-style-type: none"> ▪ Qualitative studies ▪ Not peer reviewed ▪ Published before January 2004^c or after January 2014 ▪ Participants not Aboriginal (First Nations, Métis or Inuit) ▪ Not school age (<5 y or >18 y) ▪ Not Canadian ▪ Language other than English

Sample search for Pubmed (Medline):

(physical activity or activity or sport or exercise or fitness) and (indigenous or First Nation* or Aboriginal or Métis or Inuit) and (child* or teen* or youth* or adolescen*), restricted to records after January 2004. Here, * denotes a truncation.

^aHealth and biomedical sciences databases were included. ERIC was a potential source of results for physical education programs. Google Scholar was searched for articles that were not indexed within the searched databases. Results of known national surveys were sought via relevant websites. Reference lists were searched for studies missed during the database and Google Scholar searches.

^bWhile some intervention studies were included, only the pre-intervention baseline findings have been reported.

^cStudies published earlier than January 2004 were excluded due to the potential for historical bias, and as to not replicate results of a 2007 review by Young & Katzmarzyk.

3.5 Results

3.5.1 Study Characteristics

The literature search identified 23 studies (**Figure 3.1**), as described in **Table 3.2**, that investigated PA (**Table 3.3**). Some also reported on sedentary behaviour (**Table 3.4**) and cardiorespiratory endurance (**Table 3.5**). Eight studies (35%) examined data from national surveys, including reports on the 2001 (n=1) (Findlay & Kohen, 2007) or 2006 (n=2) (Cooke et al., 2013; Smith, Findlay, & Crompton, 2010) APS, the 2004 (n=2) (Ng, Young, & Corey, 2010; Katzmarzyk, 2008) or 2005 (n=1) (Findlay, 2011) CCHS, Statistics Canada's Longitudinal Survey of Children and Youth (n=1) (Rawana & Ames, 2012), and the 2008-2010 RHS (n=2)

(FNIGC, 2012). The remainder of studies (n=15, 65%) reported regional data from eight distinct populations. The regions represented are shown in **Table 3.2**; of note, the western coast of James Bay, Ontario (n=3 reports) (Gates, Hanning, Gates, Martin, & Tsuji, 2013a; Skinner, Hanning, Sutherland, Edwards-Wheesk, & Tsuji, 2012a; Sutherland, Skinner, Hanning, Montgomery, & Tsuji, 2007); Kahnawake, Quebec (n=3 reports) (Cargo et al., 2007; Adams et al., 2005; Paradis et al., 2005); northern Quebec (n=2 reports) (Downs et al., 2008; Ng, Marshall, & Willows, 2006); and Tsimshian Nation, British Columbia (n=3 reports) (Ronsley et al., 2013; Tomlin et al., 2012; Mitchell et al., 2010); were represented more than once. There were only six reports from four populations that investigated cardiorespiratory endurance (Kakekagumick et al., 2013; Tomlin et al., 2012; Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall, & Willows, 2006; Paradis et al., 2005). Finally, there were 12 reports that included investigation of sedentary behaviours; these included two reports using data from the 2004 CCHS (Ng, Young, & Corey, 2010; Katzmarzyk, 2008), one of Métis youth from the 2006 APS (Cooke et al., 2013), two from the 2008-2010 RHS (FNIGC, 2012 – one report for children and one for youth), as well as seven regional reports from three distinct FN populations (Gates et al., 2013a; Kakekagumick et al., 2013; Skinner et al., 2012a; Cargo et al., 2007; Sutherland et al., 2007; Adams et al., 2005; Paradis et al., 2005).

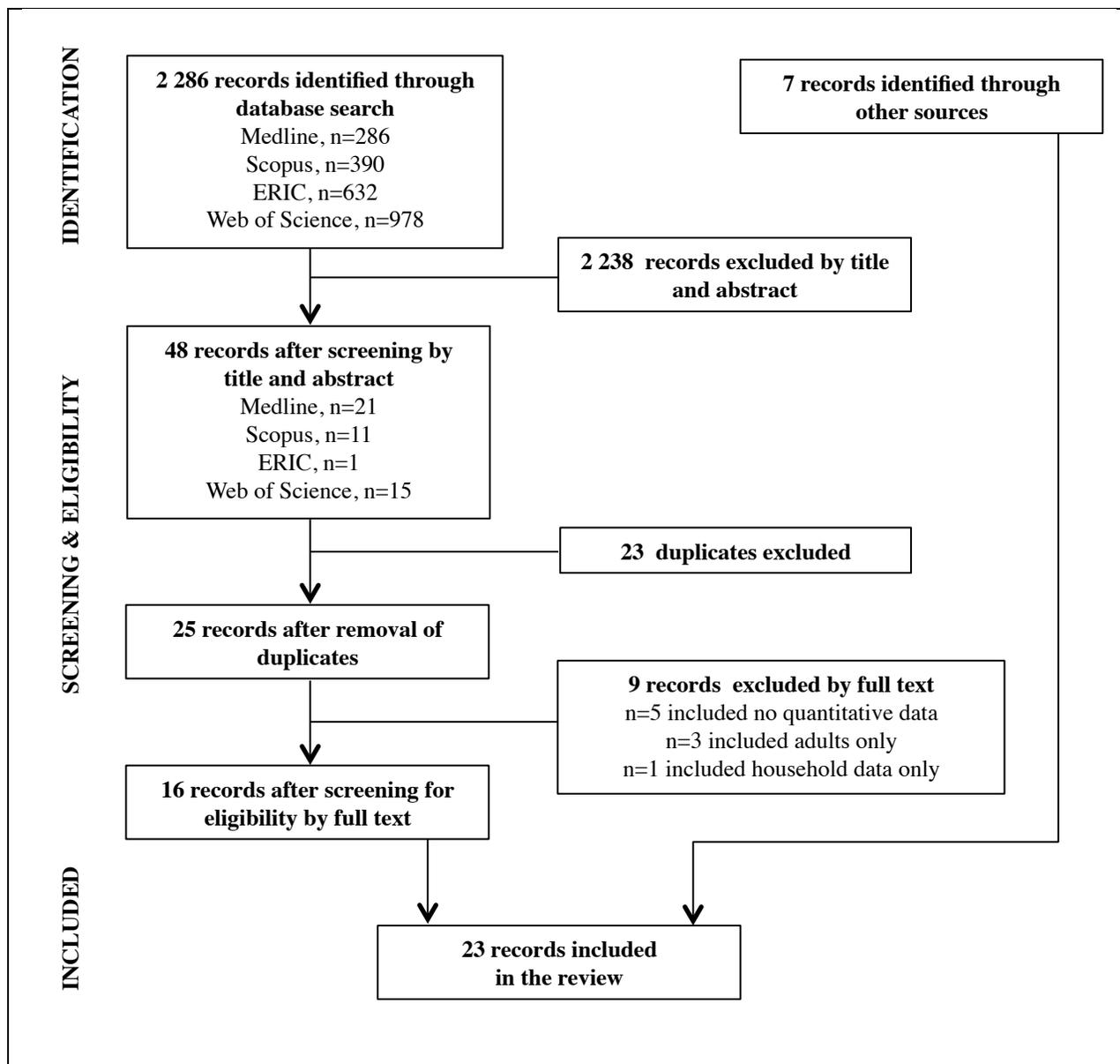


Figure 3.1 Flow diagram of study selection

3.5.2 Comparison to Available Standards

A variety of standards were used to describe adequacy of PA. Using daily energy expenditure from PA (where ≥ 3.0 kcal/kg/day is considered active), two separate investigations of 2004 CCHS data yielded vastly different results, ranging from a mean 1.1 kcal/kg/d (females) and 1.6 kcal/kg/d (males) (Katzmarzyk, 2008) to 4.2 kcal/kg/d (Ng, Young, & Corey, 2010). Both on-

and off-reserve, about half of youth from national samples were considered active (FNIGC, 2012; Ng, Young, & Corey, 2010). Among regional analyses, comparison to step count recommendations (n=3) yielded prevalence rates of adherence ranging from 36% to 59% (Pigford et al., 2011; Downs et al., 2008). Five regional studies reported on daily minutes of PA in three distinct populations, where amounts ranged from 48 minutes of overall PA (includes all intensities) (Paradis et al., 2005) to 152 minutes of MVPA (Tomlin et al., 2012).

National data showed that up to 65.8% of Aboriginal youth spend at least 15 hours per week in sedentary behaviours (Ng, Young, & Corey, 2010; Katzmarzyk, 2008), while 26.7% of Metis youth spend more than 2 hours per day watching television (Cooke et al., 2013). On-reserve data showed that 38.6% of FN youth aged 12 to 17 years spend more than 1.5 hours watching television (FNIGC, 2012). Regional reports of television watching ranged from 1.2 hours per day among FN girls in Fort Albany, Ontario (Skinner et al., 2012a) to 3.2 hours per day in Sandy Lake, Ontario (Kakekagumick et al., 2013).

The only fitness measure reported was cardiorespiratory endurance. There have been no national investigations, though regional samples showed risk of low cardiorespiratory endurance among large proportions of youth. For example, 83% were considered at risk in a sample from northern Quebec (Downs et al., 2008), as compared to Tsimshian Nation, British Columbia, where 57% of youth were classified as having low cardiorespiratory endurance (Tomlin et al., 2012).

3.5.3 Sex and Age Differences

Physical activity and sports participation were almost universally higher among males. National data showed higher mean PA in boys (1.6 ± 0.1 kcal/kg/d) compared to girls (1.1 ± 0.1 kcal/kg/d) (Katzmarzyk, 2008), and that boys were more likely to participate in sports (Smith, Findlay & Crompton, 2010; Findlay & Kohen, 2007). On-reserve FN data showed that higher proportions of boys than girls were considered active (FNIGC, 2012). Reports from five distinct regional analyses all reported FN males being more active and often being more likely to meet PA standards (Lemstra et al., 2013; Pigford et al., 2011; Mitchell et al., 2010; Sutherland et al., 2007; Ng, Marshall, & Willows, 2006). Few studies ($n=2$) reported on sex differences for sedentary behaviour (Skinner et al., 2012a; Katzmarzyk, 2008), though the 2004 CCHS showed that a higher proportion of males (71.7%) compared to females (59.0%) spent more than 20 hours weekly in screen time (included computer use, video games, and television viewing) (Katzmarzyk, 2008). Data on cardiorespiratory endurance differences by sex were severely limited.

There were limited investigations of age-related variation in PA and sedentary behaviour. Findings from the 2006 APS showed that older youth were more likely to participate in sports than younger youth (Smith, Findlay, & Crompton). One study of Mi'kmaq youth in Prince Edward Island suggested that organized activity appears to increase with age while unstructured PA declines (Critchley, Walton, Timmons, Bryanton, McCarthy, & Taylor, 2006). Only the 2008-2010 RHS reported on age differences in sedentary behaviour, where the proportion spending more than 1.5 hours daily using computers or video games increased with age (FNIGC, 2012). No reports of variation in cardiorespiratory endurance by age were identified.

3.5.4 Health Outcomes

Though results were mixed, national data as well as three of five regional studies found that being physically active was protective against obesity (Cooke et al., 2013; Gates et al., 2013a; FNIGC, 2012; Mitchell et al., 2010; Ng, Young, & Corey, 2010; Downs et al., 2008; Katzmarzyk, 2008). Large, representative samples from the 2004 CCHS (Ng, Young, & Corey, 2010; Katzmarzyk, 2008) and the Métis subset of the 2006 APS (Cooke et al., 2013) showed reduced odds of obesity in those who were considered active or engaged in sports more often. The 2008-2010 RHS data showed that on-reserve FN youth aged 12 to 17 years who were considered active were less likely to be obese; this did not hold true for younger youth (FNIGC, 2012). Regional reports showed either a null (Ng, Marshall, & Willows, 2006; Adams et al., 2005) or inverse association between PA and BMI (Gates et al., 2013a; Mitchell et al., 2010; Downs et al., 2008). Moderate-to-vigorous PA, as well as step counts, were inversely associated with waist circumference in the two populations where it was investigated (Pigford et al., 2011; Downs et al., 2008), and insulin resistance among Tsimshian Nation youth (Mitchell et al., 2010).

In national samples, lesser amounts of television viewing reduced the odds of obesity in Aboriginal youth as well as Métis youth in particular (Cooke et al., 2013; Ng, Young & Corey, 2010). Among Métis youth, spending less than 2 daily hours on video games and using computers decreased the odds of obesity in boys only (Cooke et al., 2013). Few regional studies investigated the link between sedentary behaviour and health, and those that did had conflicting results.

Relationships between cardiorespiratory endurance and health were investigated in northern Quebec (n=2) (Downs et al., 2008; Ng, Marshall, & Willows, 2006) and Tsimshian Nation, British Columbia (Mitchell et al., 2010). In northern Quebec, shuttle run times were negatively associated with waist circumference and BMI z-score (Downs et al., 2008; Ng, Marshall, & Willows, 2006). In Tsimshian Nation youth, cardiorespiratory endurance was also negatively associated with Homeostatic Model Assessment of Insulin Resistance [HOMA-IR] scores ($p < 0.005$) (Mitchell et al., 2010).

Table 3.2 Characteristics of quantitative studies describing the physical activity, sedentary behaviour and cardiorespiratory endurance of Canadian Aboriginal youth of school age, by population^a

Reference	Study Design and Purpose	Sample Population
National Survey Data (off reserve)		
Cooke et al., 2013	Cross-sectional examination of socioeconomic, behavioural and Métis-specific factors predicting obesity	n=4 060 Métis youth (50% girls, age range 6-14y) from the 2006 Aboriginal Peoples Survey, Child and Youth component
Findlay, 2011	Cross-sectional examination of leisure time PA, factors associated with being active, and associations with health	n=359 Inuit, 1 533 Métis and 1 522 FN individuals (aged ≥ 12 y) from the 2005 Canadian Community Health Survey
Findlay & Kohen, 2007	Cross-sectional description of rates and correlates of participation in sports	n=33 623 Inuit, Métis and on- and off-reserve FN youth (50% girls, aged 0-14y) from the 2001 Aboriginal Peoples Survey, Child component
Katzmarzyk, 2008	Cross-sectional examination of lifestyle and demographic variables in relation to obesity prevalence	n=589 Aboriginal youth (51% girls, mean age 9.5 ± 0.5 y for boys and 9.1 ± 0.7 y for girls) from the 2004 Canadian Community Health Survey
Ng, Young, & Corey, 2010	Cross-sectional examination of associations between diet, PA, television viewing and obesity in conjunction with socioeconomic variables	n=198 Aboriginal youth (49% girls, mean age 14.0y) from the 2004 Canadian Community Health Survey
Rawana & Ames, 2011	Longitudinal identification of protective predictors of alcohol use trajectories	n=330 Aboriginal youth (49.7% female, aged ≥ 12 y) from Statistics Canada's National Longitudinal Survey of Children and Youth

Reference	Study Design and Purpose	Sample Population
Smith, Findlay, & Crompton 2010	Cross-sectional exploration of correlates and participation in sports and cultural activities	n=11 940 off-reserve Aboriginal youth (age range 6-14y) from the 2006 Aboriginal Peoples Survey, Child component
National Survey Data (on reserve)		
FNIGC, 2012 (1)	Cross-sectional description of the health of FN youth living on reserves	n=4 837 on-reserve FN youth (aged 12-17y) for the 2008/10 First Nations Regional Health Survey
FNIGC, 2012 (2)	Cross-sectional description of the health of FN youth living on reserves	n=5 877 on-reserve FN children aged 0-11y (results presented for 6-11y) from the 2008/10 First Nations Regional Health Survey
Regional Data		
<i>James Bay Coast, Ontario</i>		
Gates et al., 2013a	Cross-sectional examination of relationships between after school screen time, PA and BMI	n=212-277 (dependent on question) FN youth (48.9% to 56.3% girls, mean age 12.9±1.5y to 13.1±1.6y) from five remote northern, and one southern community in Ontario
Skinner et al., 2012a	Cross-sectional analysis of strengths, weakness, opportunities and threats to healthy eating and PA in youth	n=66 FN youth in grades 6-11 from Fort Albany, Ontario
Sutherland et al., 2007	Cross-sectional description of PA to inform community programming	n=41 FN youth (age range 12-15y) in grades 6-9 from Attawapiskat, Ontario
<i>Kahnawake, Quebec</i>		
Adams et al., 2005	Cross-sectional examination of associations between dietary habits, PA, TV viewing and body mass index	n=150 Kanien'kehá:ka (FN) youth (53% girls, mean age 9.9y) in grades 4-6 from two schools
Cargo et al., 2007	Cross-sectional assessment of the relationship of perceived wholistic health with PA and TV watching	n=35 Kanien'kehá:ka (FN) youth (46% girls, mean age 14.4y) in grades 7-11
Paradis et al., 2005	Cross-sectional baseline information for an evaluation of the Kahnawake Schools Diabetes Prevention Project	n=322 (questionnaires) and n=393 (run/walk test) Kanien'kehá:ka (FN) youth (age range 6-11y)

Reference	Study Design and Purpose	Sample Population
<i>Northern Quebec</i>		
Downs et al., 2008	Cross-sectional examination of lifestyle and behavioural risk factors associated with abdominal obesity	n=178 Cree (FN) youth (49.4% girls, mean age 10.5±1.1y) in grades 4-6 from the Emiyuu Ayayaachiit Awaash Project, in northern Quebec
Ng, Marshall, & Willows, 2006	Cross-sectional description of PA and fitness of youth	n=82 Cree (FN) youth (59% girls, mean age 10.1±0.9y for boys; 10.4±1.1y for girls) in grades 4-6 from Mistissini, northern Quebec
<i>Tsimshian Nation, British Columbia</i>		
Mitchell et al., 2010	Cross-sectional exploration of the association between PA and insulin resistance	n=39 on-reserve FN youth (58% girls, mean age 12.3±1.9y for boys and 11.4±2.4y for girls) from 2 communities
Ronsley et al., 2013	Cross-sectional descriptive information prior to the Healthy Buddies™ school diabetes prevention program	n=79 youth in grades 4-12
Tomlin et al., 2012	Cross sectional descriptive information prior to implementing Action Schools! BC, a PA and healthy eating program	n=134 (PA) and n=114 (fitness) youth (mean age 12.4±2.2y) in grades 4-12 from 3 rural communities; subset of n=30 for accelerometry
<i>Other Regions</i>		
Critchley et al., 2006	Cross-sectional study to identify health behaviours and needs; exploration of perceptions and determinants of health	n=68 Mi'kmaq (FN) youth (age range 16-18y) from 2 communities (Lennox Island and Abegweit) in Prince Edward Island, Canada
Kakekagumick et al., 2013	Cross-sectional descriptive baseline information for an evaluation of the Sandy Lake Health and Diabetes Project	n=27 (aerobic fitness), n=34 (sedentary activity log) and n=35 (TV/video game questionnaire) FN youth in grades 3-4 from Sandy Lake, Ontario
Lemstra et al., 2013	Cross-sectional description of adequacy and correlates of PA participation	n=204 Saskatoon Tribal Council FN youth (aged 10-16y) in grades 5-8
Pigford et al., 2011	Cross-sectional description of PA compared to normative data, weight, abdominal obesity	n=86 Cree (FN) youth (age range 5-12y) in kindergarten to grade 6 from a rural community in Alberta

*FN: First Nation; FNIGC: First Nations Information Governance Centre; PA: physical activity; y: years; TV: television

Table 3.3 Physical activity of Canadian Aboriginal youth and relationships to health and other variables, by population^a

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
National Survey Data (off reserve)			
Cooke et al., 2013	'Person most knowledgeable' report of child's frequency of sports participation	22.7% participated in sports \geq 4 times/week, 27.9% participated <1 time/week	Lower likelihood of obesity for: sports \geq 4 times/week ($p < 0.0001$); Protective effect on obesity risk in those 6-10y ($p \leq 0.05$) for: sports \geq 4 times/week (OR: 0.89 boys, 0.45 girls); Protective effect on obesity risk in those 11-14y ($p \leq 0.05$) for: sports 1-3 times (OR: 0.79 boys, 0.48 girls) or \geq 4 times/week (OR: 0.33 boys, 0.34 girls).
Findlay, 2011	Interviewer-administered questionnaire on frequency, type and duration of leisure time PA over the past 3 months	No analyses specifically for youth \leq 18 y	Compared to the reference group (aged 18-34y), both FN youth aged 12-17y (OR=3.97, $p < 0.05$) and Métis youth aged 12-17y (OR=3.88, $p < 0.05$) had greater odds of being physically active in leisure time.
Findlay & Kohen, 2007	'Person most knowledgeable' report of child's frequency of sports participation	65% participated in sports outside of school hours at least once/week; specifically, 39% never participated, 12% less than once per week, 39% 1-3 times per week, 26% \geq 4 times per week	At least once weekly participation in sports associated with ($p < 0.0001$): male gender, parents with \geq high school education, greater income, two parent households, fewer siblings, Métis or Inuit identity (vs. FN), FN living off reserve (vs. on reserve), fewer hours of television, more hours of videogames ($p < 0.01$), age (those aged 5-11 y more likely than others (12-14 or 0-4 y)).
Katzmarzyk, 2008	Interviewer-administered questionnaire on frequency and duration of leisure time PA over the past 3 months; average daily energy expenditure calculated	Mean PA of 1.6 ± 0.1 kcal/kg/d for boys, 1.1 ± 0.1 kcal/kg/d for girls	Physical inactivity associated with greater odds (OR=1.6) of being obese (as compared to 'active' youth) independent of age and sex.

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
Ng, Young, & Corey, 2010	Questionnaire on frequency and duration of leisure time PA over the past 3 months	52.1% considered 'active' (≥ 3.0 kcal/kg/d); mean PA of 4.2 kcal/kg/d	Logistic regression showed PA was a predictor of obesity: each 1 kcal/kg/d increase in PA associated with 19% lower odds of obesity; Association remained in multivariate adjusted model (covariates: sex, age, education, income).
Rawana & Ames, 2011	Question on frequency of participation in a variety of sport and other activities	87% participated in activities (PA and otherwise) at least once per week	Those who participated in at least one weekly activity had less steep increases in alcohol use between 12y and 23y ($p < 0.05$).
Smith, Findlay, & Crompton, 2010	Parental report of youth's weekly sports participation	69% participated in sports ≥ 1 time/week	Boys more likely to participate in sports than girls ($p < 0.05$); FN and Métis: those 9-11 y more likely to participate vs. younger youth ($p < 0.05$); Inuit: 12-14 y more likely to participate vs. younger ($p < 0.05$); After controlling for covariates, sports participation associated with ($p < 0.05$): very good or excellent health, two parent households, parents with \geq high school education, household income $> \$30\,000$ /y, < 4 hours per week screen time, participating in cultural activities, participating in music/art lessons, clubs, groups, or volunteering

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
National Survey Data (on reserve)			
First Nations Information Governance Centre, 2012 (1) (aged 12-17y)	Computer-assisted questionnaire on frequency and duration of PA in the past 12 months; categorized as active (≥ 3 kcal/kg/d), moderately active (1.51-2.99 kcal/kg/d) or inactive (< 1.5 kcal/kg/d)	49.3% considered active, 22.6% moderately active, 28.1% inactive	Higher proportion of boys (56.6%) than girls (41.5%) were active; More boys than girls ($p < 0.05$) participated in competitive sports, bicycling, weights/exercise equipment, fishing skating, hunting/trapping, gardening, hiking, golf, skiing/snowboarding; More girls than boys ($p < 0.05$) participated in walking, dancing; Higher proportion of 'active' youth in those who reported ($p < 0.05$): excellent/very good health, sometimes/always eating nutritiously, non-obese, non-smokers, no alcohol use, participating in sports teams, never thinking about suicide, being 'physically balanced' most or all of time, having perceived strengths in community; PA level not associated with TV, computer or internet use.
First Nations Information Governance Centre, 2012 (2) (aged 6-11y)	Proxy response to computer-assisted questionnaire on frequency and duration of PA in the past 12 months; categorized as active (≥ 3 kcal/kg/d), moderately active (1.51-2.99 kcal/kg/d) or inactive (< 1.5 kcal/kg/d)	61.9% considered active, 20.2% moderately active, 17.9% inactive;	Higher proportion (65.9%) of older youth were active compared to younger ones (57.5%); More boys than girls ($p < 0.05$) participated in competitive sports, fishing, hunting/trapping, golf; More girls than boys ($p < 0.05$) participated in swimming berry picking/food gathering, dancing, aerobics/fitness; Higher proportion of 'active' youth in those who reported ($p < 0.05$): parents with higher education level, often eating/sharing traditional food, participating in sports teams, participating in traditional activities, difficulties getting along with family; No association between PA and BMI.

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
Regional Data			
<i>James Bay Coast, Ontario</i>			
Gates et al., 2013a	Web-based questionnaire with two questions on after-school PA	56.0% spent 'most' or 'all of the time' outside after school; 75.5% active in the evening ≤ 3 d/week, 24.5% 4-7 times/week	Negative association between time outside after school and BMI in boys ($p=0.033$): 43.3% of normal weight, 44.1% of overweight, 9.5% of obese boys spent 'most of the time' being active; Positive association between using internet/playing video games after school and BMI in boys ($p=0.022$): 30.6% normal weight, 27.5% overweight, 56.7% obese boys spend >2 h/d
Skinner et al., 2012a	Web-based questionnaire with two questions on PA frequency, time spent outside	36% boys and 31% girls were active ≥ 5 times/week; 67% boys and 67% girls spent 'most' or 'all' of their time outside in past week	Not applicable
Sutherland et al., 2007	Web-based questionnaire, including questions extracted (or modified) from the Physical Activity Questionnaire for Older Children	PA level over past week: 61% sometimes active ($\leq 2x$), 13% often (3-4x), 10% quite often (5-6x), 16% very often ($\geq 7x$); In physical education class, 60% 'sometimes' or 'hardly ever' active	Boys appear less frequently active than girls (72% of boys and 50% of girls were active ≤ 2 times/week); Boys more likely to report playing hockey, active games, jogging; Girls more likely to report ice skating, walking, soccer, basketball
<i>Kahnawake, Quebec</i>			
Adams et al., 2005	Adaptation of the Weekly Activity Checklist (previous week); adequate PA defined as ≥ 30 min/d	71% took part in ≥ 30 min PA/d	Those with higher diet quality were more physically active ($p<0.05$); No relationship between PA and BMI

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
Cargo et al., 2007	Survey questions on frequency, intensity, type of activity in past week; frequency of exercise outside of school scored on a scale of 1-5 (1=most of the time, 5=never)	Mean PA (past week): 4.38±2.2d exercise to strengthen/tone muscles, 4.26±1.9d sweating/breathing hard, 3.53±1.9d participation in ≥30 min light PA; Mean score of 1.49±0.66 for exercise outside of school	Higher perceived wholistic health for sweating for ≥20 min/day (p<0.001), participating in strengthening and toning muscles (p<0.001), regular PA outside of school (p<0.05)
Paradis et al., 2005	Response (proxy for grades 1-3) to a 7-d recall on the number of 15-min episodes of PA	Participation in PA (adjusted for age and sex): 22.53 ±0.93 15-min episodes in past week	Not applicable
<i>Northern Quebec</i>			
Downs et al., 2008	Waist-mounted pedometer (Yamax SW-200 Digiwalker) for 3 school days; comparison to recommendations (15 000 steps/d for boys, 12 000 steps/d for girls)	59% met step recommendations	Negative correlation (controlled for covariates) between step counts and waist circumference, BMI z-score; Those with abdominal obesity walked fewer steps/d (p=0.017), were less likely to meet step recommendations (51% vs. 68% met recommendation, p=0.016); Reduced odds of abdominal obesity for those who met step recommendations (OR=0.476)
Ng, Marshall, & Willows, 2006	Waist-mounted pedometer (Yamax SW-200 Digiwalker) for 2 days; comparison to recommendations (15 000 steps/d for boys, 12 000 steps/d for girls)	49% met step recommendations	Boys took more steps per day than girls (p≤0.001); PA level did not differ by BMI category

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
<i>Tsimshian Nation, British Columbia</i>			
Mitchell et al., 2010	Waist-mounted accelerometer (Actigraph GT1M) for at least 3 days	Mean 139.8±33.8 min/d spent in MVPA	Males accumulated more activity counts and MVPA than females (p=0.008); Amount of MVPA inversely associated with the homeostasis model assessment estimate of insulin resistance (HOMA-IR) (p<0.05) and BMI z-score (p<0.001); Each 30 min of MVPA corresponded to 15% lower HOMA-IR
Ronsley et al., 2013	Modified Physical Activity Questionnaire for Older Children or Adolescents; scored from 1 (low active) to 5 (very active)	Mean PA score of 3.05±0.94 in intervention group	Not applicable
Tomlin et al., 2012	Modified Physical Activity Questionnaire for Older Children or Adolescents; scored from 1 (low active) to 5 (very active) Waist-mounted accelerometer (Actigraph GT1M) for 5-7 days	Mean score of 2.75±0.72 on the Physical Activity Questionnaire; Overall activity level of 152.3±36.2 min/d	6.3 greater minutes/day of MVPA on weekend vs. weekdays (166.5±40.4 min/d on weekdays and 120.2±41.9 min/d on weekends, p<0.001)
<i>Other Regions</i>			
Critchley et al., 2006	Face-to-face interviews with youth; interviews with caregivers	Not Applicable	Organized PA appears to increase with age: 77.8% of those 6-8y, 81.8% of those 9-12y, 89.3% of those 13-18y participate; Unstructured PA appears to decrease with age: 94.4% of those 6-8y, 86.4% of those 9-12y, 78.6% of those 13-18y participate; Proportion of youth reporting that participating in sports or PA makes them proud: 59% of those aged 6-8y, 46% of those aged 9-12y, 13-18 of those aged 13-18y

Reference	Measure	Findings	
		Amount and Type	Relationships with other Variables
Lemstra et al., 2013	School Health Action Planning and Evaluation Survey; PA Stages Questionnaire; National Longitudinal Survey of Children and Youth	7.4% met 60 min/d MVPA standard every day, 14.2% met 5 d/week, 26.5% met 3 d/week	Males (13.9%) more likely to meet MVPA standard than females (4.1%) (p=0.019) Meeting 60 min MVPA/d standard associated with (p<0.05): parents watching youth participating, parents providing transportation, having friends who ask to bike/walk to school daily, having enough sports equipment, doing sports with a coach/instructor, participating in structured classes; A greater proportion of youth meeting the standard rated their health as very good or excellent (64.3% vs. 50.3%)
Pigford et al., 2011	Waist-mounted pedometer (Yamax SW-200 Digiwalker) for 3 school days; comparison to recommendations (15 000 steps/d for boys, 12 000 steps/d for girls)	36% met step recommendations	Boys took more steps than girls (p=0.02) but no difference in proportion meeting recommendations; Abdominally obese youth appeared less active than non-abdominally obese youth (ns); Negative correlation between waist circumference and steps/d (p=0.01); In multiple linear regression, PA was negatively associated with waist circumference (p=0.009); Age and daily step counts explained 42.6% of the variance in waist circumference

^aBMI: body mass index; d: day; FN: First Nations; h: hours; min: minutes; OR: odds ratio; MVPA: moderate-to-vigorous physical activity; PA: physical activity; y: years

Table 3.4 Sedentary behaviour of Canadian Aboriginal youth and relationships to health and other variables, by population^a

Reference	Measure	Findings	
		Amount and Type	Relationships with Other Variables
National Survey Data (off reserve)			
Cooke et al., 2013	Three questions on frequency of TV, computer, video game use	26.7% watched >2h of TV/d; 4.0% spent >2h on video games/d; 6.9% spent >2h on computer/d	Lower likelihood of obesity for: ≤2h TV/day (p=0.0021), ≤2 h video games/d (p=0.0008), ≤2h on computer/d (p=0.0149); Protective effect on obesity risk in those 6-10y (p≤0.05) for: ≤2h TV/d (OR: 0.75 boys, 0.65 girls), ≤2h video games/d (OR: 0.74) or on computer (OR: 0.41) in boys; Protective effect on obesity risk in those 11-14y (p≤0.05) for: ≤2h TV/d (OR: 0.80 boys, 0.66 girls), ≤2h video games/d (OR: 0.63) in boys; Increased risk of obesity (p≤0.05) for <2h/day on computer in girls 6-10y (OR: 1.67) and 11-14y (OR:1.38)
Katzmarzyk, 2008	Interviewer administered questionnaire on frequency and duration of leisure activities over the past 3 months	65.8% spent ≥20 h/week in sedentary behaviour	Greater percentage of boys (71.7%) appeared to spend ≥20 h/week in sedentary behaviour than girls (59.0%)
Ng, Young, & Corey, 2010	Questionnaire including questions on TV time over the past 3 months	46.6% of Aboriginal youth were ‘high’ TV watchers (≥15h/week); PA participation not different in ‘high’ (51.5% active) compared to ‘low’ TV watchers (52.7% active)	Logistic regression showed that ≤14h of TV/week associated with 32% lower odds of obesity; Associations remained in multivariate adjusted model (covariates: sex, age, education, income)

Reference	Measure	Findings	
		Amount and Type	Relationships with Other Variables
National Survey Data (on reserve)			
First Nations Information Governance Centre, 2012 (1) (aged 12-17y)	Computer-assisted questionnaire with questions on sedentary behaviour	38.6% watched >1.5h and 24.5% watched 1-1.5h TV/d; 27.0% spent >1.5h and 19.8% spent 1-1.5h on computer/d; 29.7% spent >1.5h and 16.8% spent 1-1.5h playing video games/d	Not applicable
First Nations Information Governance Centre, 2012 (2) (aged 6-11y)	Proxy response to computer-assisted questionnaire with questions on sedentary behaviour	37.0% watched >1.5h and 24.6% watched 1.0-1.5h TV/d; 8.3% spent >1.5h and 11.4% spent 1.0-1.5h on computer/d; 20.6% spent >1.5h and 14.2% spent 1.0-1.5h playing video games/d	Proportion spending >1.5h/d on computer/video games appeared to increase with age
Regional Data			
<i>James Bay Coast, Ontario</i>			
Gates et al., 2013a	Web-based questionnaire with questions on screen time	25.6% spent >2 h/d on TV after school; 33.9% spent >2 h/d using internet/video games after school	Positive association between internet/playing video games after school and BMI in boys (p=0.022): 30.6% normal, 27.5% overweight, and 56.7% obese boys spent >2 h/d
Skinner et al., 2012a	Web-based questionnaire with questions on TV time	Mean TV time of 1.6 h/d for boys and 1.2h/d for girls	Not applicable
Sutherland et al., 2007	Web-based questionnaire with question on sedentary behaviour	Sedentary behaviour (e.g., standing around, sitting): 70% at recess, 73% at lunch	Not applicable

Reference	Measure	Findings	
		Amount and Type	Relationships with Other Variables
<i>Kahnawake, Quebec</i>			
Adams et al., 2005	Adaptation of the Weekly Activity Checklist (previous week) with one frequency question on TV viewing	36% watched <2h TV/d	Those with higher diet quality watched less TV (p<0.01); Independent of diet, those who watched less TV were more physically active (p<0.01); No relationship between TV viewing and BMI
Cargo et al., 2007	Average TV time based on Youth Behavioral Risk Survey	Mean 2.76 ±1.6h spent watching TV on weekdays, 3.04 ±1.7h on weekend days	Higher perceived wholistic health for those watching less TV on weekdays (p<0.0001) and weekends (p<0.001)
Paradis et al., 2005	Response (proxy for grades 1-3) sedentary behaviour questions	Mean 2.81 ±0.04h of TV/video games on Saturdays, 2.62 ±0.06h of TV/video games on weekdays	Not applicable
<i>Other Regions</i>			
Kakekagumick et al., 2013	Sedentary behaviour self-reported in a logbook and via a questionnaire; scale of 1 (more) to 4.5 (less) screen time	Mean 192.6 min/d of TV watching or video games; Mean score of 2.9 for TV/video game habits	Not applicable

^aBMI: Body Mass Index; d: day; FN: First Nations; h: hours; min: minutes; OR: odds ratio; TV: television; y: years

Table 3.5 Cardiorespiratory endurance of Canadian Aboriginal youth and relationships to health and other variables, by population

Reference	Measure	Findings	
		Description	Relationships with Other Variables
Regional Data			
<i>Northern Quebec</i>			
Downs et al., 2008	Léger 20-metre shuttle run	Majority (83%) had poor cardiorespiratory endurance (below 20 th percentile)	More youth with abdominal obesity (96%) had poor cardiorespiratory endurance as compared to those without (69%) (p<0.001); Negative correlation between shuttle run time and waist size (p<0.001), body mass index z-score (p<0.001); Those with abdominal obesity had shorter (worse) shuttle run times (p<0.001); Reduced odds of abdominal obesity for being ≥20 th percentile for the shuttle run (OR=0.155)
Ng, Marshall, & Willows, 2006	20-metre shuttle run	Mean 2.29 ±1.20 shuttle stages completed	No difference in shuttle stage achievement by sex; Obese children had lower cardiorespiratory endurance scores than overweight and normal children (p≤0.001)
<i>Kahnawake, Quebec</i>			
Paradis et al., 2005	Run/walk test for physical fitness	Mean run/walk time (adjusted for age and sex): 540.5±8.7 seconds	Not applicable
<i>Tsimshian Nation, British Columbia</i>			
Mitchell et al., 2010	20-metre Léger-Boucher shuttle run		Higher maximal aerobic capacity associated with lower homeostatic model assessment of insulin resistance (p<0.05)
Tomlin et al., 2012	20-metre shuttle run	Mean 25.4±15.8 aerobic fitness “laps” completed; 57% ‘at risk’ for low fitness	
<i>Other Regions</i>			
Kakekagumick et al., 2013	20-metre shuttle run	Mean maximal aerobic capacity 34.4 ml/kg/min	

3.6 Discussion

This study reviewed 23 articles published between January 2004 and January 2014 that reported quantitative data on the PA of school aged Canadian Aboriginal youth. Additionally, some reports included information on sedentary behaviour and cardiorespiratory endurance. Data were relatively sparse, representing four national samples of off-reserve Aboriginal youth, one national sample of on-reserve FN youth and 15 regional-level studies that reported data from only eight distinct communities in six provinces. While data from national samples offered valuable information, they were limited in that they only used subjective reports of PA and sedentary behaviour, did not report on any aspects of physical fitness, and did not present regional analyses.

Regional investigations of FN populations, though sometimes hindered by small sample sizes, were more likely to have collected objective data and to have reported on cardiorespiratory endurance. These provided some insight into regional variation, though very few regions were represented; the only provinces where more than one population was investigated were Ontario and Quebec, and no publications were found originating from the maritime provinces (except Prince Edward Island), Manitoba, nor the Territories. Aside from aggregate national data, this review did not detect any reports describing Inuit youth, and only one report focused particularly on Métis youth (Cooke et al., 2013). Given the great diversity of Aboriginal populations, and the known impact of physical environments (among others) on PA (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011), regional and subgroup analyses would be of value in future investigations. It is likely that the effects of geographic remoteness, latitude, weather, proximity to urban centres

and availability of facilities and resources play a role in the PA level of youth from various locations.

3.6.1 Physical Activity

The Canadian Physical Activity Guidelines for youth recommend a minimum of 60 minutes of MVPA daily (Tremblay et al., 2011b). In light of these recommendations, the PA levels reported for Aboriginal youth in both national and regional samples could be improved for a large proportion of the population. National samples showed that both on- and off-reserve, up to one-half of youth are not considered to be active (FNIGC, 2012; Ng, Young, & Corey, 2010). However, CCHS data indicated that Aboriginal youth were more active than their peers in the general population (Ng, Young, & Corey, 2010). It is possible, due to reporting error and social desirability effects related to the self-reported nature of the data, that activity level in these surveys has been overestimated. However, results are in agreement with an earlier review by Foulds, Warburton and Bredin (2013) describing low levels of PA amongst both Native American and Canadian Aboriginal youth, where less than 50% met step-count or PA recommendations.

Findings for FN youth varied significantly by region; for example, only 7% of Saskatoon Tribal Council youth were considered active (Lemstra et al., 2013) and one-third of youth in a rural Alberta community (Pigford et al., 2011) met step count recommendations, but almost two-thirds met the same recommendation in northern Quebec (Downs et al., 2008). Similarly, youth from Kahnawake, Quebec were reported to participate in 48 minutes of overall PA per day (Paradis et al., 2005), while those from Tsimshian Nation, British Columbia participated in more than three

times that amount of MVPA, greatly exceeding recommendations (Tomlin et al., 2012). The large range of variation in PA participation may be due to a number of community-level factors, which have not been described. Further investigation of the environments and resources available for PA, and the determinants of this activity in various regions will be needed in order to implement local health promotion activities.

Only three investigations in two distinct regions reported specifically on MVPA (Lemstra et al., 2013; Tomlin et al., 2012; Mitchell et al., 2010). In the rest of cases, the type and intensity of PA has not been specified, though it can be assumed that time spent in MVPA would be significantly lower than the total PA that has been reported. The use of accelerometry would be useful in accurately categorizing the PA intensity of youth, however, this method was only used in two studies in a single region (Tomlin et al., 2012; Mitchell et al., 2010). While the method is more resource-intensive and burdensome than subjective accounts, it would help to understand the influence of various intensities of activity on health outcomes.

Beyond mean minutes of PA, national and regional samples showed that less than one-third of youth are active on a daily basis (Cooke et al., 2013; Pifgord et al., 2011; Downs et al., 2008; Findlay & Kohen, 2007; Ng, Marshall, & Willows, 2006). In fact, Lemstra et al. (2013) reported that only 7.4% of youth from a Saskatchewan FN completed 60 minutes of daily MVPA. Similarly, only 24.5% of youth from the western James Bay coast in Ontario reported being active four or more days per week (Sutherland et al., 2007). These results are perhaps not surprising, as it has been estimated that only 7% of Canadian youth as a whole meet this standard (Colley, Garriguet, Janssen, Craig, Clarke, & Tremblay, 2011). The findings suggest that not

only is the amount of PA inadequate for many youth, but frequency is also lacking. Moving forward, there is a need for locally feasible and acceptable programs and policies to make regular bouts of PA a desirable choice for individuals and groups.

Similar to findings from the general population, PA participation was reported to be almost universally higher among Aboriginal males as compared to females, and sex influenced preferences for different types of activities (Lemstra et al., 2013; FNIGC, 2012; Skinner et al., 2012a; Pigford et al., 2011; Smith, Findlay, & Crompton, 2010; Mitchell et al., 2010; Katzmarzyk, 2008; Findlay & Kohen, 2007; Ng, Marshall, & Willows, 2006). The reasons for this have not been elucidated, and are likely to be multifaceted. The differences in preferences underscore the need to develop a better understanding of the influences on PA for both boys and girls, and the need to tailor PA initiatives to be sensitive to the needs and interests of all children.

Contrary to trends in the general population for youth to become less active with age, national data from the 2006 APS showed that older Aboriginal youth tended to have a higher sports and organized PA participation than younger youth (Smith, Findlay, & Crompton, 2010). One regional sample from Prince Edward Island revealed that participation in organized activities (e.g., sports) increased with age while participation in unstructured PA declined (Critchley et al., 2006). That being said, the scales used in many of the studies did not necessarily allow for differentiation between the types of activities that youth engaged in, and it may be the case that such questionnaires included mostly structured activities (e.g., sports). Thus, general play may be more difficult to capture. In the future, more in depth analysis of the specific types of activity that contribute to total PA level among Aboriginal youth may be of interest. There may be great

value in unstructured PA, especially in regions where resources are scarce, as it requires only very limited inputs in terms of infrastructure, funding and human resources. Scales that include cultural activities of specific interest to Aboriginal youth should also be employed.

3.6.2 Sedentary Behaviour

Even when PA levels are adequate, excess time spent in sedentary pursuits such as television viewing, computer use and video gaming can negatively influence health (Dunstan, Howard, Healy, & Owen, 2012; Tremblay et al., 2011b; Tremblay, Colley, Saunders, Healy, & Owen, 2010a). For this reason, the Canadian guidelines recommend limiting screen time to two hours per day or less (Tremblay et al., 2011a). Compared to their non-Aboriginal peers, Aboriginal youth were more likely to be considered ‘high’ television watchers (≥ 15 h/week) (Ng, Young, & Corey, 2010).

Additionally, national data showed that up to two-thirds of Aboriginal youth spend 15 hours or more each week in sedentary behaviour (Ng, Young, & Corey, 2010; Katzmarzyk, 2008), which exceeds guidelines. For FN youth aged 12 to 17 years living on reserve, it has been reported 39% partake in at least 1.5 hours of daily television viewing (FNIGC, 2012). In regard to regional data, sedentary behaviour has only been investigated in three regions, those being the James Bay coast of Ontario (Gates et al., 2013a; Skinner et al., 2012a; Sutherland et al., 2007), Kahnawake (Quebec) (Cargo et al., 2007; Adams et al., 2005) and Saskatoon (Saskatchewan) (Lemstra et al., 2013). Here, television watching varied from a low of 1.2 hours per day in Fort Albany, Ontario (Skinner et al., 2012a) to over three hours per day in Saskatoon, Saskatchewan (Lemstra et al., 2013). In remote regions, lesser or only more recent access to satellite television may mean that

youth spend less time in sedentary behaviour. Research in Kahnawake, Quebec suggested that the advent of satellite television in the community likely contributed to increasing amounts of sedentary time among youth (Paradis et al., 2005). Access to computers and Internet has also increased in recent years, which may contribute to increasing sedentary time for youth in communities where these resources may not have previously been available. Climate is an additional factor that may play a role in northern regions; long, harsh winters and relatively limited daylight in some northern areas may make indoor, sedentary pursuits more desirable.

Few studies have reported on age and sex differences for sedentary behaviours. Though males are thought to be more active than females, the 2004 CCHS reported that males also spend more time in sedentary pursuits (Katzmarzyk, 2008). Reasons for this have not been extensively described and may or may not mirror those reasons seen in the non-Aboriginal population. It is possible that television, computer and video games are more appealing to boys than girls, and that the types of sedentary behaviours that girls may partake in are not being adequately captured by usual measures. It is possible that some types of sedentary behaviour, such as reading and doing homework, do not confer the same degree of health risk as screen time. A recent review by Saunders, Chaput and Tremblay (2014) indicated that sedentary behaviour is associated with cardiometabolic risk in youth, but that this association was most consistent for screen time in particular. The risk associated with various types of sedentary behaviour needs to be further investigated among Aboriginal youth. Much more research is needed to discover details on its determinants and health impacts in a variety of settings. Further, age effects have not been thoroughly investigated and represent an area where research is needed.

Realistically, levels of PA and sedentary activities are not exclusive to one another; although Aboriginal youth may spend more time watching television, they also tend to participate in higher levels of PA as compared to non-Aboriginal youth (Ng, Young, & Corey, 2010). The limited findings from the current review showed conflicting results. Analysis of the 2005 CCHS (Findlay, 2011) and 2006 APS (Smith, Findlay, & Crompton, 2010) showed that sports participation tended to be associated with lesser time spent watching television, however an analysis of the 2004 CCHS found that high (>15h/week) and low television watchers were similarly active (Ng, Young, & Corey, 2010). On-reserve data from the 2008-2010 RHS also found no association between PA and sedentary time (FNIGC, 2012). Only one regional study in Kahnawake, Quebec investigated the relationship, finding that those who watched less television were also more active (Adams et al., 2005). Saunders, Chaput and Tremblay's (2014) recent review suggested that sedentary time in itself may promote negative health outcomes, and that reduced PA level is not the major factor linking sedentary time to health risk. That being said, research investigating the health impact of excessive sedentariness along with adequate PA has yet to be explored in Aboriginal youth and would be of interest given the conflicting findings of the current review. Furthermore, it is important that health promotion initiatives target not only activity level and physical fitness, but also aim to limit sedentary pursuits.

3.6.3 Cardiorespiratory Endurance

This review did not capture any national data on the physical fitness of Aboriginal youth. Using data from the 2007-2009 CHMS, the fitness of Canadian youth has recently been described (Tremblay, Shields, Laviolette, Craig, Janssen, & Connor Gorber, 2010b), but information about the Aboriginal subset of the population is yet to be reported. This is of concern because it is

possible that physical fitness has different or additional health effects for Aboriginal youth as compared to PA. Further, without this information, it is impossible to thoroughly understand how PA, sedentary behaviour, and fitness interact. National data are needed as a baseline for Aboriginal youth and to act as a starting point for initiatives aiming to impact physical fitness. Only six regional studies reported on physical fitness in four distinct FN populations, all finding low cardiorespiratory endurance among a large proportion (57% to 83%) of participants, using the 20-metre shuttle run or a run/walk test (Kakekagumick et al., 2013; Tomlin et al., 2012; Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall & Willows, 2006; Paradis et al., 2005).

These findings appear more severe than what has been reported for the general population, where of those aged 15 to 19 years, 20% of girls and 32% of boys fell into the ‘fair’ or ‘needs improvement’ range for cardiorespiratory endurance (Tremblay et al., 2010b). However, given that each study used its own reference standard, the results may not be directly comparable across studies. Unfortunately, among the limited available data, no associations between PA and fitness were described. Other types of fitness, such as flexibility, muscular strength and endurance, were not reported for Canadian Aboriginal youth among the studies reviewed. Because the limited data showed that cardiorespiratory endurance may reduce the risk of obesity, abdominal obesity and insulin resistance in FN youth, further research into all facets of fitness, its determinants, and relationship to PA level and health outcomes is required.

3.6.4 Health Outcomes

The current review offers evidence that being physically active is protective against obesity for Aboriginal youth, though there were some population subsets where this effect was not shown (e.g., on-reserve FN youth aged 6 to 11 years) (FNIGC, 2012). In an analysis of national data, Ng, Young, and Corey (2010) found that each 1 kcal/kg/day of activity reduced the odds of obesity by 19%. A separate analysis using similar data showed that being inactive (as compared to active) was associated with 60% greater odds of obesity (Katzmarzyk, 2008). Similarly, watching less than 15 hours of television weekly reduced the odds of obesity by 32% among youth from the 2004 CCHS (Ng, Young, & Corey, 2010). It is not known whether those who are considered inactive also spend excess time in sedentary activity. However, in this particular sample, high and low television watchers were not different in terms of PA participation (Ng, Young, & Corey, 2010). Analysis of a national sample of Métis youth produced similar findings, where more frequent participation in sports seemed to reduce the odds of obesity to a greater extent than lower levels of television viewing (Cooke et al., 2013). The national studies reported here did not specifically report on MVPA, which is important because vigorous PA has specifically been negatively associated with adiposity in youth (Parikh & Stratton, 2011). The results here offer the potential that any type of PA, even at lower intensities, may be able to impact the development of obesity among Aboriginal youth. Clearly, both PA and sedentary behaviour appear to have opposing effects on obesity for these youth. However, given the health risks known to be associated with excess time spent in sedentary pursuits, more investigation into both PA and sedentary activity is needed.

It has been shown that many of the negative health consequences of obesity may be lessened via high levels of cardiorespiratory endurance (Ortega et al., 2008). With only one regional study investigating the relationship between cardiorespiratory endurance and obesity, strong conclusions cannot be drawn. Since cardiorespiratory endurance is correlated with participation in MVPA (Parikh & Stratton, 2011), there is potential that higher cardiorespiratory endurance levels would reduce the odds of obesity. In one population of FN youth from northern Quebec, obese youth were shown to have significantly lower fitness scores than normal weight youth, though PA level did not differ (Ng, Marshall, & Willows, 2006). This suggests the possibility that physical fitness has greater effects on BMI (or vice versa) as compared to PA, however much more investigation is needed to draw conclusions in this regard. Further, since most investigations measured PA in general and not specifically MVPA, more research is needed on the effects of various types of PA on the health of Aboriginal youth.

Aboriginal youth appear to be predisposed to abdominal obesity and type 2 diabetes (Harris, Bhattacharyya, Dyck, Hayward, & Toth, 2013; Anderson et al., 2010; Shields, 2006; Young, Dean, Flett, & Wood-Steiman, 2000). In the general population, adequate PA has been demonstrated to reduce the long-term risk of type 2 diabetes (Reiner, Niermann, Jekauc, & Woll, 2013). At this time, a negative association between PA and waist circumference has been demonstrated among FN youth in northern Quebec and rural Alberta (Pigford et al., 2011; Downs et al., 2008). Among FN youth in northern Quebec, meeting step recommendations was associated with two times reduced odds of abdominal obesity as compared to those not meeting recommendations, showing that even low-to-moderate activity may have benefit (Downs et al., 2008). In this same population, falling above the 20th percentile of cardiorespiratory endurance

was associated with more than six times reduced odds of abdominal obesity, as compared to those in lower percentile rankings (Downs et al., 2008). Additionally, the relationship between MVPA, cardiorespiratory endurance and insulin resistance has been investigated among Tsimshian Nation youth in British Columbia (Mitchell et al., 2010). In this population, both increased PA and better cardiorespiratory fitness were associated with lower markers of insulin resistance, where each half-hour of additional daily MVPA was associated with a 15% reduction in HOMA-IR values (Mitchell et al., 2010). While these studies provide some insight into possible relationships between PA, cardiorespiratory endurance and diabetes risk, far more research is needed in larger, representative samples to improve understanding. Of interest would be to investigate whether lower intensities of activity would also be able to reduce the risk of insulin resistance.

3.6.5 Methodology and Generalizability

Most of the studies reviewed, including all of the national surveys, used subjective measures of PA (e.g., questionnaires). Although most were modified to be culturally appropriate and to include locally relevant activities, the national surveys oftentimes estimated PA level using the response to a single or very few questions. The validity of these questions for use in Aboriginal populations is unknown; further, few validated measures to estimate the PA levels of Aboriginal youth exist. The time span for PA recall was also often short (e.g., a few days or weeks).

Objective measurement is preferred for estimating PA, with accelerometry being an appealing approach thanks to its validity and ability to provide information on time, duration and intensity (Rowlands & Eston, 2007). Although in some cases pedometers offer good validity and are cost-effective, they can measure activity in only one plane and offer no information on specific bouts

of activity, intensity or duration (McNamara, Hudson, & Taylor, 2010; Rowlands & Eston, 2007).

The use of accelerometry to measure PA among subgroups of Aboriginal youth would add strong evidence to the small body of literature, and ideally future research would employ objective measurement. However, the challenges of collecting this type of PA data must not be overlooked, especially among those living in geographically remote and/or isolated regions. When working collaboratively with Aboriginal communities, it is important to balance methodological rigor with cultural-appropriateness and respect for the practices of various Aboriginal groups (Simonds & Christopher, 2013; Cochran et al, 2008). Wearing accelerometers for several days imposes a relatively high participant burden and can require significant resources in terms of time, training and travel to remote locations. Using questionnaires has the potential to be the least burdensome approach and could therefore attract larger sample sizes, though the lower accuracy and validity of the resultant data must be acknowledged. It is difficult to assess intensity of activity from such measures. Still, there is a need to adapt and test the validity of standardized questionnaires such as the International Physical Activity Questionnaire (Craig, Marshall, Sjöström, Bauman, Booth, Ainsworth, et al., 2003) for various Aboriginal populations.

Although many of the studies in this review present the findings from national samples, FN youth living on reserves were excluded from these surveys and the far north was underrepresented. Regional studies have focused on select FN communities in only eight distinct populations. Further, this review revealed only one study that focused specifically on Métis

people, and none focused specifically on Inuit youth, such that the findings cannot be generalized to these populations.

3.7 Limitations

Regional studies typically had small sample sizes, which limits the power to detect effects as well as generalizability of the findings, especially given the diversity within Aboriginal populations. Because few studies employed objective measurements of PA the findings may have been affected by social desirability and recall biases. The ability to evaluate differences in the effects of various PA intensities was also limited. Most self-reported measures utilized relatively short time periods (e.g., past 3 days or past week), and many did not account for differences by day of the week (e.g., weekend vs. weekday), thus results may not be indicative of usual PA level. Additionally, few studies indicated the season or weather during the time of the PA assessment, which may have an impact on amounts and types of PA reported (Bélanger, Gray-Donald, O'Loughlin, Paradis, & Hanley, 2009). Finally, it is possible that relevant studies were overlooked during the literature search, however, replication of the search and data extraction by a second researcher, scanning of reference lists and searches of the grey literature have likely minimized this possibility.

3.8 Conclusion

This review of recent online, published literature revealed that relatively little is known about the PA level of Canadian Aboriginal youth and its determinants, particularly for Métis and Inuit youth. In general, the PA level of Canadian Aboriginal youth requires improvement and sedentary behaviours should be reduced, especially given associations with health outcomes such

as obesity. There is need for further study on the cardiorespiratory endurance levels of Aboriginal youth, as well as other measures of fitness and their relationships to health. It would be preferred that studies employ objective measurement using accelerometers, in order to determine the effects of PA intensity. Regional and subgroup data is generally lacking, especially for Metis and Inuit youth. Further data on the factors influencing PA among Aboriginal subgroups will be useful in tailoring health promotion initiatives to various populations and to help to overcome the inequities in opportunities for PA that continue to be experienced by many Aboriginal people.

3.9 Additional Publications Since 2014

Since completing this review in 2014, two important reports of direct relevance to this thesis were published. Because these studies are important in the context of the dissertation, they have been summarized here. These publications reported on correlates of PA and traditional PA for on-reserve FN children (Janssen et al., 2014) and youth (Lévesque et al., 2015) who participated in the 2008-2010 RHS (FNIGC, 2012).

Among FN children aged 6-11 years (n= 3 184, 49.2% male), 72% participated in at least 60 minutes of MVPA per day and 54% participated in at least one traditional activity in the past year (e.g., berry picking, hunting/trapping, canoeing), as calculated based on parent responses on a PA recall of 20 common activities (Janssen et al., 2014). The highest odds of completing at least 60 minutes of MVPA/day were among those being in the older age category (9-11 years), being in a larger household size, and having a greater number of community members helping youth to understand their culture (Janssen et al., 2014). The highest odds of participating in

traditional PA were for those attending school, understanding and often using a FN language, having parents with post-secondary education, living in a smaller community (<300 people), and having more community members helping them to understand their culture (Janssen et al., 2014).

Among FN youth aged 12-17 years (n=4 837, 51.3% male), 65% participated in at least 60 minutes of MVPA per day and 48% participated in at least one traditional activity in the past year, according to self-report to a PA recall of 20 common activities (Lévesque et al., 2015). The highest odds of completing at least 60 minutes of MVPA/day were among those being male, having more than one chronic condition, attending school, often using a FN language, feeling in balance most or all of the time, having parents who graduated from high school or with post-secondary education, having more relatives to help them understand their culture, having 6 or more challenges in their community, and perceiving the recreation facilities in their community as a strength (Lévesque et al., 2015). The highest odds of engaging in traditional PA were for being male, understanding or often using a FN language, feeling in balance most or all of the time, being in the younger age category (12-14 years), having one or at least three individuals helping to understand their culture, and living in a smaller community (<1500 people) (Lévesque et al., 2015).

The findings of these studies suggest that FN youth living on reserve may be more active than youth in the general population, among whom only 7% meet Canadian PA guidelines 6 days per week (Tremblay, Warburton, Janssen, Paterson, Latimer, Rhodes, et al., 2011c). However, because PA level was self-reported and averaged over a fairly long recall period, it is quite possible that PA participation and intensity were overestimated as compared to daily values

presented in the 2007-2009 CHMS which directly measured PA via accelerometry (Colley et al., 2011). Though information on traditional PA engagement was interesting, it provided only a very vague picture of the situation, since participation could have varied from once per year to daily or more, but frequency was not reported. Overall, higher parental education level, community strengths, and connection to culture and social support appeared to be among the most important factors in PA and traditional PA engagement among FN children and youth living on reserve (Lévesque et al., 2015; Janssen et al., 2014).

4.0 Study 2: Overweight and Obesity Among First Nations Youth Living On Reserve in Canada: An Exploration of Relationships with Socioeconomic, Cultural and Behavioural Factors

DISCLAIMER: This study presents the results of the author's analysis and interpretation of 2008-2010 First Nations Regional Health Survey data. The analyses contained herein of data from the First Nations Regional Health Survey do not necessarily reflect the views of the First Nations Information Governance Centre. Statistics reproduced from this document must be accompanied by a citation of this document, including a reference to the page on which the statistic in question appears.

4.1 Overview

Objective: To explore the relationships between a number of socioeconomic, cultural and health behaviour factors with the presence of overweight and obesity among 12 to 17 year old FN youth living on reserve in Canada.

Methods: This study utilized secondary data collected during the 2008-2010 RHS. Youth from 216 northern FN communities responded to a computer-assisted survey related to health and wellness. Body mass index was computed within the RHS, based on self-reported height and weight, and categorized according to IOTF cutoffs. For this study, youth were dichotomized as: normal (includes underweight) vs. overweight or obese (i.e., overweight/obese). Descriptive characteristics (frequencies) were computed for each of the independent variables, and bivariate associations with overweight/obesity were initially explored for all youth using Pearson's Chi-square tests. Due to the presence of significant age and sex interactions, subsequent analyses were stratified for these variables. Relationships between each of the independent variables and overweight/obesity were tested using bivariate logistic regression. Subsequently, these relationships were tested when controlled for all of the other independent variables, using

multivariate logistic regression. The sampling strategy was incorporated into the analysis utilizing a plan file supplied by the FNIGC in SPSS Complex Samples version 20 ($p \leq 0.05$).

Thus, all analyses are reflective of the weighted sample.

Results: After the exclusion of participants with missing data, 2 888 FN youth, representing 29 988 individuals in the weighted sample (56.4% male, 51.3% aged 12-14 years and 48.7% aged 15-17 years) were included in the analysis, 45% of whom were overweight/obese. For the group, overweight/obesity was associated with younger age ($p=0.024$), knowledge of a FN language ($p=0.015$), lower PA level ($p=0.001$) and lower levels of video game use ($p=0.042$). Among boys aged 12-14 years ($n=792$, representing 8 952 boys in the weighted sample) no significant effects of the independent variables were detected. Among girls aged 12-14 years ($n=638$, representing 6 438 girls in the weighted sample), reduced odds of overweight/obesity were observed for those who were moderately active (OR=0.48, 95% CI=0.26, 0.88) or active (OR=0.56, 95% CI=0.32, 0.96) as compared to inactive ($p=0.048$), and who engaged in higher amounts (>1.5 hours/day) of computer time (OR=0.66, 95% CI=0.45, 0.96, $p=0.028$) as compared to lesser amounts. Among boys aged 15-17 years ($n=745$, representing 7 927 boys in the weighted sample), the odds of overweight/obesity were increased among those having parents in the middle education level (OR=1.77, 95% CI=1.15, 2.76, $p=0.032$) as compared to the lowest level of education, and who almost or almost always participated in cultural events (OR=2.06, 95% CI=1.23, 3.44, $p=0.005$) as compared to rare participation, but were reduced among those with high (>1.5 hours/day) video game use (OR=0.69, 95% CI=0.47, 0.99, $p=0.044$) as compared to lower use. Among girls aged 15-17 years ($n=713$, representing 6 650 girls in the weighted sample), the odds of overweight/obesity were increased among those who were able to speak a FN language (OR=1.67, 95% CI=1.15, 2.42, $p=0.007$) as compared to those

who could not, but reduced for those with high levels of video game use (OR=0.49, 95% CI=0.28, 0.84, p=0.009) as compared to lower levels of use, and those who sometimes (OR=0.43, 95% CI=0.27, 0.67) or always (OR=0.51, 95% CI=0.30, 0.87) reported eating a nutritious diet (p=0.001) as compared to those who rarely or never did. In all cases, the significant relationships remained in the multivariate adjusted analyses.

Conclusions: Among this population of 12 to 17 year old FN youth, factors having significant effects on the odds of overweight/obesity varied significantly by age and sex and included a number of behavioural and cultural factors. This suggests that health promotion initiatives should be tailored to each age and sex group. There is a need to build upon these findings to investigate a multitude of other factors potentially influencing overweight and obesity, and to develop a better understanding of the relationships observed.

4.2 Introduction

Overweight and obesity have reached epidemic proportions among Canadian youth (Roberts et al., 2012), with Canadian Aboriginal youth, and particularly FN youth living on reserve, also being affected (FNIGC, 2012). It is generally accepted that obesity, as well as other challenges to the health and wellbeing of FN people, are the result of colonisation and persistent inequities in the determinants of health (Kmetz, Reading, & Etsey, 2008; Frolich, Ross, & Richmond, 2006; Young, 2003). Meanwhile, FN people and communities can demonstrate remarkable resilience in the face of these inequities (Canadian Council of the Social Determinants of Health, 2013).

There remains a need for an improved understanding of the factors that may promote healthy weights or be protective against overweight/obesity among FN youth, including community and cultural factors for which little is currently known.

What is known is that higher socioeconomic status (Shrewsbury & Wardle, 2012; Wang & Lim, 2012) and health behaviours such as certain dietary factors (Cutler, Flood, Hannan, Slavin, & Neumark-Sztainer, 2012; Moreno & Rodriguez, 2007), lesser sedentary behaviour and high levels of PA (Katzmarzyk, Barreira, Broyles, Champagne, Chaput, Fogelholm, et al., 2015) are likely to be protective against overweight/obesity. Among off-reserve Aboriginal youth, those from families with higher household education were less likely to be obese after controlling for several lifestyle factors (Ng, Young, & Corey, 2010). In contrast, lower household income also appeared to be protective (Ng, Young, & Corey, 2010). These relationships demonstrate the importance of investigating the role of a number of protective factors specifically for the FN population, because these relationships may not always operate congruently to what is observed in the general population.

Unfortunately, many FN reserve communities, due to circumstances imposed by colonialism (e.g., forced relocation to lands with scant access to traditional and other resources), are socioeconomically disadvantaged (FNIGC, 2012; Wilson & Macdonald, 2010). Despite the best efforts of individuals and communities, the limited resources available to many families living in FN communities may act as a common barrier to healthy eating and PA (Ferris, 2011), behaviours believed to promote a healthy weight. National data and reports from select FN communities suggest that poor diet quality (Khalil, Johnson-Down, & Egeland, 2010; Receveur, Morou, Gray-Donald, & Macaulay, 2008; Downs et al., 2008; Hanley, Harris, Gittelsohn, Wolever, Saksvig, & Zinman, 2000), low levels of PA (Gates et al., 2013a; Pigford et al., 2011; Mitchell et al., 2010; Ng, Young, & Corey, 2010; Downs et al., 2008; Horn, Paradis, Potvin, Macaulay, & Dersosiers, 2001) and excess sedentary behaviour (e.g., screen time) (Ng, Young,

& Corey, 2010; Gates et al., 2013a; Horn et al., 2001) may be just as prevalent as in the general population. At this time, there is not strong evidence to link health behaviours with weight status for First Nations youth across the country, as most studies report only on small groups of youth from individual communities. An improved understanding of these relationships can be a first step toward encouraging the behaviours that are found to be protective.

It has been suggested that addressing macro-level determinants such as community, social and cultural factors are likely to have the greatest influence on reducing the health inequities experienced by FN people (Garner, Carrière, Sanmartin, & Longitudinal Health and Administrative Data Research Team, 2010); thus, these factors may be the most effective areas of focus when promoting optimal weights among FN youth (Swinburn, Sacks, Hall, McPherson, Finegood, Moodie, & Gortmaker, 2011). Indeed, the view of health and wellness held by FN people reflects a balance that is achieved through consideration of a range of physical, mental, emotional and spiritual factors (FNIGC, 2012; First Nations Health Authority, 2015).

Encouraging a connection to culture is believed to positively influence the health of FN youth (FNIGC, 2012; National Aboriginal Health Organization, 2003). However, specific protective effects on weight status have not yet been thoroughly investigated.

Similar to the holistic view of health held by FN people (FNIGC, 2012; First Nations Health Authority, 2015), socioecological frameworks support that an array of factors in numerous settings interact to influence weight (Willows, Hanley, & Delormier, 2012). In order for FN communities to implement programs and policies that promote healthy weights among their youth, there is a need for information on a range factors that may affect the issue, reflecting a

holistic perspective. The availability of data from the 2008-2010 RHS provides an opportunity to further understand the relationships between various demographic, socioeconomic, cultural and health behaviour characteristics and overweight/obesity among on-reserve FN youth in Canada.

4.3 Theoretical Framework

In addition to the socioecological framework developed by Willows, Hanley and Delormier (2012) that informed this dissertation, the 2008-2010 RHS was guided by the First Nations Cultural Framework (FNIGC, 2012). This framework is described as being similar to other variations of the social ecological model, based on the understanding that health and wellness are affected by influences at multiple levels, including intrapersonal (i.e., individual), interpersonal (i.e. social), organizational, community, physical environmental and policy levels (FNIGC 2012). The FN Cultural Framework informed data collection, interpretation and analysis to ensure that the findings would be culturally informed, relevant, usable for FN people, and reinforcing of FN culture (FNIGC, 2012).

The circular model includes four quadrants (directions) that work to encompass FN health and wellness: vision (ways of seeing), relationships (ways of relating), reason (analysis) and action (behaviours) (FNIGC, 2012). The 2008-2010 RHS focused primarily on *relationships*, though factors from all aspects of the model were included within the survey. The current study investigated factors related to *relationships* (cultural factors), *reason* (demographic factors, socioeconomic factors) and *action* (health behaviour factors) directions. While important, to maintain focus, the *vision* (physical health factors and health care utilization) direction of the framework has not been specifically addressed in this study.

4.4 Objective and Hypotheses

4.4.1 Objective

This study aimed to take an ecological approach to understanding overweight and obesity (referred to as ‘overweight/obesity’ within this chapter) among FN youth by addressing factors at various levels of the socioecological model and directions of the FN cultural framework. Using a national sample of 12 to 17 year-old FN youth from the 2008-2010 RHS (FNIGC, 2012), the main objective was as follows:

Objective 1: To identify the (a) independent, and (b) multivariate adjusted, relationships between a number of demographic (age, sex), socioeconomic (parents’ highest level of education, household size), cultural (number of people helping youth to understand their culture, participation in community cultural events, knowledge of a FN language), and health behaviour characteristics (PA level, screen time [television, computer and video games], nutritious diet) and the presence of overweight/obesity.

4.4.2 Hypotheses

Each of the independent variables was chosen because it was believed to be a factor with potential to affect the odds of being overweight/obese (i.e., potential protective or risk factor). A paucity of data makes it challenging to develop strong hypotheses about the magnitude and direction of potential relationships for this particular population. Nevertheless, *a-priori* hypotheses regarding each of the independent variables were as follows:

1. Overweight/obesity will be inversely associated with age and associated with male sex, thus the prevalence of overweight/obesity will be higher among those in the 12-14 year old category versus older youth, and also higher among boys as compared to girls.
2. The odds of overweight/obesity will be reduced for youth with parents having higher educational attainment, as compared to the lowest level of education (<high school).
3. The odds of overweight/obesity will be increased for youth living in larger household sizes, as compared to the smallest household size (<3 individuals).
4. The odds of overweight/obesity will be reduced for youth with a greater number of people helping them to understand their culture, as compared to those with the fewest (<2 individuals).
5. The odds of overweight/obesity will be reduced for youth who participate in their community's cultural events more frequently, as compared to those with the least frequent participation (rarely or never).
6. The odds of overweight/obesity will be reduced for youth who understand a FN language, as compared to those who do not.
7. The odds of overweight/obesity will be reduced for youth who engage in higher levels of PA, as compared to those categorized as inactive.
8. The odds of overweight/obesity will be increased for youth spending more than 1.5 hours per day in either of television, video game or computer time, as compared to those participating in these activities for 1.5 hours or less per day.
9. The odds of overweight/obesity will be decreased for youth who more often report eating a nutritious balanced diet, as compared to those who rarely or never do so.

In-depth reasoning for each of these hypotheses was as follows:

Demographic Characteristics

Recent trends among non-Aboriginal Canadian youth suggest that the prevalence of overweight/obesity may remain relatively constant between the ages of 5 to 17 years (Roberts et al., 2012). There is little information to predict whether FN youth will experience a similar trend, though Ng, Young, & Corey (2010) failed to find a significant effect of age on the odds of obesity among Aboriginal youth living off reserve. Meanwhile, Cooke et al. (2013) reported that Métis youth aged 6-10 years were more likely to be obese than older youth, showing that the relationship could vary by sub-group of Aboriginal peoples. Though the age categories used in this study differ, it is predicted that overweight/obesity will be associated with younger age, such that a greater proportion of younger (12-14 years) youth will fall into this BMI category than older (15-17 years) youth.

Among youth in the general population, there is a higher prevalence of obesity among boys than girls (Roberts et al., 2012). Among Aboriginal youth living off reserve this relationship has not been detected (Ng, Young, & Corey, 2010), though once again Cooke et al. (2013) reported that Métis boys were more likely to be obese than girls. Similarly, it is expected that overweight/obesity will be associated with being male, such that a greater proportion of males will fall into this BMI category than females. It is expected that age and sex may interact with other independent variables such that the associations with overweight/obesity may differ between age and sex categories.

Socioeconomic Characteristics

Higher parent education level, as an indicator of socioeconomic status, is expected to be protective against overweight/obesity because this relationship is strongly supported across numerous populations (Shrewsbury & Wardle, 2012; Wang & Lim, 2012). However, among adults, it has been shown that the relationship between socioeconomic status and obesity may differ for the Aboriginal as compared to the non-Aboriginal population (Ng, Corey, & Young, 2011). In one study, the odds of obesity increased at higher levels of education among off-reserve Aboriginal women (Ng, Corey, & Young, 2011). However, among youth this relationship has not been supported (Ng, Young, & Corey, 2010). In light of conflicting information, strong hypotheses are difficult to develop. In this case, it is expected that for on-reserve FN youth, the odds of overweight/obesity will decrease at higher levels of parental education as compared to the lowest level of education.

A smaller household size is expected to be protective against overweight/obesity as compared to larger household sizes. This hypothesis is based on the assumption that larger household sizes are more likely to be affected by inadequate income, which has been linked to obesity (Shrewsbury & Wardle, 2012; Wang & Lim, 2012). Thus, access to high quality foods and the equipment and supports (e.g., access to sports teams) for PA are likely to decline. Indeed, families with three or more children are more likely to be affected by food insecurity than those without or with fewer children (Willows, et al., 2009a). Additionally, among FN youth, greater participation in sports activities has been associated with having fewer siblings (Findlay & Kohen, 2007). Though a greater number of adults in the household may mean that a larger number of people are contributing to household income, it may also indicate poorer housing

conditions and overcrowding. Thus, as compared to the smallest household size, the odds of overweight/obesity are expected to be higher among larger household sizes.

Cultural Characteristics

The number of people who help youth to understand their culture, participation in cultural events and ability to understand a FN language were used as proxies of youths' understanding of their culture. A connection to culture is expected to be protective against overweight/obesity. It is possible that a distancing from FN culture would be related to an increased intake of market foods (Willows, 2005; Kuhnlein et al., 2004), and less PA as compared to the traditionally physically demanding lifestyle practices of many FN people (Pal, Haman, & Robidoux, 2013; Young & Katzmarzyk, 2007). There is limited information on the potential impact of such cultural factors on overweight/obesity in FN youth, though a distancing from culture is generally understood to have negative health effects (FNIGC, 2012; National Aboriginal Health Organization, 2003). Meanwhile, among Métis youth, it has been reported that frequent participation in cultural activities and time with Elders is associated with an increased odds of obesity, though the cause of this relationship was difficult to elucidate (Cooke et al., 2013). Aboriginal groups may have a preference for larger body sizes (Willows, 2005), and this relationship may be reflective of this preference. As such, it is difficult to predict how the effect of culture will impact the odds of overweight/obesity for FN youth living on reserve and strong hypotheses cannot be drawn. However, it is expected that closeness to culture (i.e., greater number of people helping youth to understand their culture, more frequent participation in traditional cultural events, and knowledge of a FN language) will be beneficial for health and

therefore decrease the odds of overweight/obesity as compared to those with lesser cultural connection.

Health Behaviour Characteristics

In the general population, it is well established that high levels of PA are protective against obesity (Katzmarzyk et al., 2015). This relationship has been demonstrated among other Aboriginal populations (Cooke et al., 2013; Gates et al., 2013a; Pigford et al., 2011; Mitchell et al., 2010; Ng, Young, & Corey, 2010; Downs et al., 2008; Horn et al., 2001), thus it is expected that youth who are more active will have a decreased odds of overweight/obesity as compared to those categorized as inactive.

Sedentary time has independently been associated with obesity among youth (Katzmarzyk et al., 2015), however, various types of screen time may have different effects. Among Aboriginal youth, higher levels of television viewing have been demonstrated to increase the odds of obesity (Ng, Young, & Corey, 2010). Thus, among FN youth on reserve, a similar relationship is expected. Predictions for video game use and computer time are more difficult to make, given that they are less studied. Among Métis girls, Cooke et al. (2013) found that higher levels of computer use decreased the odds of obesity, which would not be expected. Still, in this case it is expected that those in the higher television, video game and computer use categories will be at increased odds of overweight/obesity as compared to those in the lowest use categories.

Though diet is complex and difficult to measure, a 'healthy' diet is believed to protect against overweight/obesity, and various aspects of diet (e.g., sugar-sweetened beverages, some dietary

behaviours like breakfast skipping) are known to be risk factors that may vary by age and sex (Cutler et al., 2012; Moreno & Rodriguez, 2007). Diet ‘quality’ or ‘balance’ is self-reported in the RHS, so it is difficult to predict the relationships that may exist. However, it is expected that those reporting always or almost always eating a balanced diet will have reduced odds of overweight/obesity as compared to those who rarely or never report eating a balanced diet.

4.5 Methods

4.5.1 Participants and Survey Methodology

The RHS reports on various aspects of health and wellbeing of FN children, youth and adults living on-reserve in Canada (FNIGC, 2012). The survey began in response to the fact that national surveys in Canada, including the CCHS, NHS, and CHMS, exclude FN people living on reserves or in northern locations (FNIGC, 2012). The RHS provides information on FN people that is comparable to national surveillance data, while acknowledging FN peoples’ right to own, control, access and possess (OCAP[®]) their health information (FNIGC, 2012, 2014). Following a pilot phase in 1997, the first phase of the RHS took place in 2002-2003, the second phase in 2008-2010, and most recent (third) phase began in 2015.

Data collection for the 2008-2010 RHS included 216 northern (above the 60th parallel) FN communities across 10 regions, including all provinces and territories except for Nunavut (FNIGC, 2012). Population sampling occurred in two stages. First, communities of different sizes were selected in order to obtain a representative sample of the population within each region and sub-region (FNIGC, 2012). Next, participants were randomly selected to represent four age and two gender groups using local band membership lists (FNIGC, 2012). The response

rate was 72.5%, resulting in 5.3% of the target population being surveyed (FNIGC, 2012). Youth responded to the computer-assisted survey related to their health and wellness (FNIGC, 2012). Local FN fieldworkers administered the 30-minute surveys using Computer Assisted Personal Interviewing software [CAPI] on laptop computers in their communities (FNIGC, 2012).

4.5.2 Classification of Overweight and Obesity

During data collection, youth were asked to self-report their height (feet, inches) and weight (pounds) with two open-ended questions (FNIGC, 2008): (a) How tall are you without shoes on? Approximate if necessary, and (b) How much do you weigh (lbs)? Approximate if necessary. From these values, BMI was computed and youth were categorized as being underweight, normal weight, overweight or obese in accordance with IOTF standards (Cole et al., 2000). Overweight and obesity were grouped as the outcome variable in this study, as it facilitated adequate cell sizes for the analysis.

4.5.3 Independent Variables

A number of independent variables were chosen, as shown in **Table 4.1**. These fell into the categories of demographic, socioeconomic, cultural and health behaviour characteristics. The questions used in the RHS and potential response options for each variable are shown (FNIGC, 2008). In some cases, the number of response options was reduced such that the cell sizes would be adequate for analysis, while the findings could still be described meaningfully.

Table 4.1. Questions and associated response options related to demographic, socioeconomic, cultural and health behaviour factors on the 2008-2010 First Nations Regional Health Survey for 12 to 17 year old youth (FNIGC, 2008)

Independent Variable	Question	Response Options	Categories Used in the Analysis
Demographic Factors (REASON)			
Age	What is your date of birth?	Day, month, year	1 = 12-14 years* 0 = 15-17 years
Sex	Are you male or female?	Male, female	1 = Male* 0 = Female
Socioeconomic Factors (REASON)			
Parent education level	What is the highest level of formal schooling that your parents or guardians have completed? (mother, father)	Some elementary school, elementary school, some high school, high school diploma, diploma/certificate from trade or vocational school, diploma/certificate from community college, CEGEP, professional degree, university degree, masters degree, earned Doctorate (PhD), not applicable	Based on highest level achieved by either parent: 3 = less than a high school diploma* 2 = high school diploma 1 = some post-secondary education
Household size	(a) Including yourself, how many children and youth live in this household? (b) How many adults live in the household?	(a) # 0-5 years, # 6-11 years, # 12-18 years (b) includes all adults who live in household at least half the time	3 = <3 individuals* 2 = 3-4 individuals 1 = >4 individuals
Cultural Factors (RELATIONSHIPS)			
Number of people who help youth to understand culture	Who helps you in understanding your culture?	Grandparents, parents (mother and/or father), aunts and uncles, other relatives (siblings, cousins, etc.), my friends, school teachers, community elders, other community members, no one, don't know, refused, other.	3 = <2 individuals* 2 = 2-4 individuals 1 = >4 individuals

Independent Variable	Question	Response Options	Categories Used in the Analysis
Participation in traditional cultural events	Do you take part in your community's cultural events?	Always/almost always, sometimes, rarely, never, don't know, refused	3 = rarely or never* 2 = sometimes 1 = always/almost always
Understanding a First Nations language	Can you understand or speak a First Nations language?	Yes, no, don't know, refused	1 = No* 0 = Yes
Health Behaviour Characteristics (ACTION)			
Physical Activity	Questionnaire outlining participation (frequency, duration) in a list of 20 common activities.	Open-ended. Categorized as inactive (≤ 1.50 kcal/kg/d), moderately active (1.51-2.99 kcal/kg/d), active (≥ 3.00 kcal/kg/d)	3 = inactive* 2 = moderately active 1 = active
Television time	During the past week, how much time did you spend watching TV?	Less than 30 minutes, 30 minutes to 1 hour, 1 hour to 1 ½ hours, more than 1 ½ hours, don't know, refused	1 = $\leq 1 \frac{1}{2}$ hours* 0 = $> 1 \frac{1}{2}$ hours
Video game time	During the past week, how much time did you spend playing video games?	Less than 30 minutes, 30 minutes to 1 hour, 1 hour to 1 ½ hours, more than 1 ½ hours, don't know, refused	1 = $\leq 1 \frac{1}{2}$ hours* 0 = $> 1 \frac{1}{2}$ hours
Computer time	During the past week, how much time did you spend working at your computer?	Less than 30 minutes, 30 minutes to 1 hour, 1 hour to 1 ½ hours, more than 1 ½ hours, don't know, refused	1 = $\leq 1 \frac{1}{2}$ hours* 0 = $> 1 \frac{1}{2}$ hours
Nutritious diet	Do you eat a nutritious balanced diet?	Always/almost always, sometimes, rarely, never, don't know, refused	3 = rarely or never* 2 = sometimes 1 = always/almost always

*Reference Category

4.5.4 Data Use and Ethics Approval

In a proposal to the FNIGC by the research team, the data were requested based on a predetermined study protocol and methodology. Following an independent ethics and methodological review by the FNIGC, the research team was authorized to access the data and were provided a dataset with only the requested variables. The principal author undertook the data analysis at a secure workstation within the FNIGC's First Nations Data Centre in Ottawa, Ontario. The statistical output tables were vetted by the FNIGC and later released, as appropriate (e.g., some values may have been suppressed), to the research team.

4.6 Data Analysis and Interpretation

Before undertaking data analysis, the sample was investigated for instances of missing responses (included 'refused', 'I don't know'); these participants were excluded listwise from subsequent analyses. The dependent variable (BMI category) was grouped as one of two possible outcomes: (a) normal weight (including underweight) and (b) overweight/obese. Descriptive characteristics (i.e., frequencies) were computed for normal weight compared to overweight/obese youth for each of the independent variables previously shown in **Table 4.1**. To explore the bivariate association between the presence of overweight/obesity and each of the independent variables, Pearson's Chi-square statistics were computed. Potential age- and sex- interactions were also tested, and several of these existed. For this reason, later analyses were stratified by age and sex. Potential relationships between each of the independent variables and overweight/obesity were then tested via bivariate logistic regression. Subsequently, the relationships between the independent variables and overweight/obesity were tested while controlling for the effect of all the other variables, via multivariate logistic regression. All analyses were conducted using SPSS

Complex Samples version 20 (IBM Corporation, Armonk, NY). To reduce the risk of bias resulting from the sampling strategy, a plan file was utilized that enabled the previously described sample design to be incorporated into the analysis. Thus, all analyses were conducted on the weighted sample. The significance level was set at $p \leq 0.05$ *a priori*.

4.7 Results

4.7.1 Participant Characteristics

Participant characteristics, as well bivariate associations between each of the independent variables and the presence overweight/obesity are shown in **Table 4.2**. A total of 4 837 FN youth participated in the survey, representing a weighted population of 54 006 youth. Cases of missing data ranged from 0% (sex) to 16.4% (video game frequency), and 6.9% for BMI. After exclusion of these youth, the final sample included 2 888 individuals, representing a population of 29 988 youth in the weighted sample (56.4% male). Representation of the two age groups was nearly equal, with 51.3% being 12 to 14 years and 48.7% being 15 to 17 years.

Among the weighted sample, 45.2% were overweight/obese, while the rest were considered of normal weight or underweight. Overweight/obesity was associated with younger age (12-14 years) (47.9% vs. 42.4% of 15-17 year olds, $p=0.024$), but the prevalence of overweight/obesity did not differ by sex. The socioeconomic factors tested were not significantly associated with the presence of overweight/obesity. Among the cultural factors, having understanding of a FN language was associated overweight/obesity (57.9% vs. 42.0% of those who did not understand a FN language, $p=0.015$). Among the health behaviour factors, overweight/obesity was associated with being inactive (53.0% vs. 42.4% of those who were moderately active and 43.1% of those

who were active, $p=0.001$). Paradoxically, overweight/obesity was also associated with spending less than 1.5 hours playing video games per day (46.8% vs. 41.6% of those spending 1.5 hours or more on video games/day, $p=0.042$). The other variables tested were not significantly associated with overweight/obesity among the group.

Table 4.2 Characteristics of the subset of youth from the 2008-2010 First Nations Regional Health Survey and bivariate associations with overweight/obesity ($n=2\ 888$)^{a,b}

Variable	Proportion missing data (%)	Proportion of sample (%)	Overweight or Obese (%) ^c	P^d
Total	-	-	45.2	-
Age	0.3 ^e			0.024
12-14 years		51.3	47.9	
15-17 years		48.7	42.4	
Sex	0.0			0.064
Male		56.4	47.1	
Female		43.6	42.7	
Parent education	7.9			0.076
<High school diploma		38.7	42.0	
High school diploma		26.2	48.7	
Some post-secondary education		35.2	46.1	
Household size	0.3 ^e			0.201
<3 individuals		18.5	46.7	
3-4 individuals		40.1	47.0	
>4 individuals		41.4	42.8	
Number of people who help youth understand their culture	2.9			0.522
<2 community members		38.9	46.7	
2-4 community members		43.5	43.7	
>4 community members		17.6	45.8	
Participation in traditional cultural events	2.0			0.058
Rarely or never		24.4	40.6	
Sometimes		50.5	45.9	
Always/almost always		25.1	48.3	
Understanding a First Nations language	4.9			0.015
No		45.3	42.0	
Yes		54.7	47.8	

Variable	Proportion missing data (%)	Proportion of sample (%)	Overweight or Obese (%) ^c	P ^d
Physical Activity	5.7			0.001
Inactive		23.1	53.0	
Moderately active		22.4	42.4	
Active		54.5	43.1	
Television viewing	6.8			0.734
≤1 ½ hours per day		59.2	44.9	
>1 ½ hours per day		40.8	45.7	
Videogames	16.4			0.042
≤1 ½ hours per day		70.2	46.8	
>1 ½ hours per day		29.8	41.6	
Computer time	13.5			0.241
≤1 ½ hours per day		73.2	46.1	
>1 ½ hours per day		26.8	42.9	
Nutritious Diet	3.7			0.103
Rarely or never		19.5	50.2	
Sometimes		54.6	43.5	
Always/almost always		25.9	45.0	

^aSource: The First Nations Information Governance Centre, microdata abstract: 2015-GATM-001, July 9, 2015.

^bProportions presented reflect analysis of the weighted sample, including 29 988 youth.

^cOverweight and obesity was defined utilizing self-reported height and weight data and the cut-offs suggested by the International Obesity Task Force (Cole et al., 2000).

^dAs assessed via the Pearson Chi-square statistic. Variables where significant differences in responses by BMI category (normal weight (including underweight) versus overweight/obese) are shown in bold.

^eThis estimate is associated with high sampling variability.

Exploratory bivariate logistic regression analyses for overweight/obesity (outcome) were subsequently conducted to test for the presence of age- and sex-based interactions, which revealed that these effects were significant for several variables. Specifically, in bivariate models, age interacted with parent education level (p=0.018), household size (p=0.004), knowledge of FN language (p=0.014), PA level (p=0.001), television viewing (p=0.050), video game use (p=0.001), computer time (p=0.010) and diet (p=0.007); sex interacted with knowledge of FN language (p=0.021), PA level (p=0.002) and video game use (p=0.008). Thus, all

subsequent analyses were stratified by age and sex category, four ways (boys 12-14 years, girls 12-14 years, boys 15-17 years, girls 15-17 years).

4.7.2 Bivariate and Multivariate Adjusted Relationships for Youth Aged 12 to 14 Years

The bivariate and multivariate relationships between each of the tested variables and the presence of overweight/obesity for youth aged 12-14 years are shown in **Table 4.3**. Among boys aged 12-14 years, there were no significant effects of any of the independent variables on the odds of overweight/obesity, thus multivariate associations were not tested. However, among girls aged 12-14 years, the odds of overweight/obesity were reduced among those who were moderately active (OR=0.48, 95% CI=0.26, 0.88) or active (OR=0.56, 95% CI=0.32, 0.96) as compared to inactive (p=0.048), and among those who spent more than 1.5 hours using a computer per day (OR=0.66, 95% CI=0.45, 0.96), as compared to those with lesser use (p=0.028). In the multivariate analysis, the effects of PA level (p=0.026) and computer use (p=0.023) remained significant.

Table 4.3 Bivariate and multivariate relationships between socioeconomic, cultural and health behaviour factors and the presence of overweight/obesity among youth aged 12 to 14 years from the 2008-2010 First Nations Regional Health Survey^a

Variable	Boys 12-14 years (n=792) ^b		Girls 12-14 years (n=638) ^c		
	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}
Parent educational attainment					
<High school diploma	46.6	1.00	45.5	1.00	1.00
High school diploma	55.6	1.43 (0.90, 2.29)	48.8	1.14 (0.74, 1.74)	1.10 (0.73, 1.67)
Post-secondary education	52.3	1.26 (0.82, 1.92)	37.5	0.72 (0.45, 1.15)	0.69 (0.42, 1.13)
Household size					
<3 individuals	43.4	1.00	43.8	1.00	1.00
3-4 individuals	55.6	1.64 (0.96, 2.78)	47.2	1.15 (0.70, 1.90)	1.03 (0.60, 1.74)
>4 individuals	48.9	1.25 (0.77, 2.04)	39.7	0.85 (0.52, 1.39)	0.67 (0.40, 1.15)
Number of people who help youth to understand their culture					
<2 community members	53.2	1.00	48.8	1.00	1.00
2-4 community members	46.9	0.78 (0.54, 1.11)	39.9	0.70 (0.47, 1.03)	0.60 (0.42, 0.88)
>4 community members	55.4	1.09 (0.57, 2.09)	40.9	0.73 (0.43, 1.25)	0.61 (0.36, 1.04)
Participation in traditional cultural events					
Rarely or never	49.6	1.00	36.3	1.00	1.00
Sometimes	50.4	1.03 (0.70, 1.51)	45.1	1.44 (0.93, 2.23)	1.44 (0.93, 2.21)
Always/almost always	53.1	1.15 (0.75, 1.76)	47.8	1.61 (1.00, 2.57)	1.71 (1.04, 2.82)
Understanding a First Nations language					
No	48.3	1.00	41.4	1.00	1.00
Yes	53.0	1.21 (0.85, 1.72)	45.3	1.17 (0.80, 1.70)	1.36 (0.94, 1.98)

Variable	Boys 12-14 years (n=792) ^b		Girls 12-14 years (n=638) ^c		
	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}
Physical activity level					
Inactive	57.7	1.00	55.8	1.00	1.00
Moderately active	53.7	0.85 (0.51, 1.43)	37.6	0.48 (0.26, 0.88)	0.46 (0.25, 0.84)
Active	47.7	0.67 (0.41, 1.10)	41.2	0.56 (0.32, 0.96)	0.53 (0.31, 0.89)
Television time					
≤1 ½ hours per day	53.2	1.00	43.2	1.00	1.00
>1 ½ hours per day	47.6	0.80 (0.55, 1.15)	44.3	1.05 (0.72, 1.51)	1.08 (0.74, 1.57)
Videogame time					
≤1 ½ hours per day	54.6	1.00	43.3	1.00	1.00
>1 ½ hours per day	46.8	0.73 (0.50, 1.08)	45.4	1.09 (0.63, 1.89)	1.18 (0.66, 2.12)
Computer time					
≤1 ½ hours per day	52.8	1.00	46.2	1.00	1.00
>1 ½ hours per day	44.3	0.71 (0.43, 1.17)	36.1	0.66 (0.45, 0.96)	0.63 (0.42, 0.94)
Eating a nutritious diet					
Rarely or never	56.5	1.00	40.9 ^f	1.00	1.00
Sometimes	51.3	0.81 (0.53, 1.26)	44.5	1.16 (0.63, 2.14)	1.55 (0.87, 2.76)
Always/almost always	47.4	0.69 (0.40, 1.20)	43.2	1.10 (0.58, 2.07)	1.45 (0.80, 2.65)

^aSource: The First Nations Information Governance Centre, microdata abstract: 2015-GATM-001, July 9, 2015.

^bValues presented reflect analysis of the weighted sample, representing 8 952 boys.

^cValues presented reflect analysis of the weighted sample, representing 6 438 girls.

^dAssessed using logistic regression. Statistically significant odds ratios are shown in bold typeface.

^eAdjusted for all other variables in the table.

^fThis estimate is associated with high sampling variability (CV=21.1%). Interpret with caution.

4.7.3 Bivariate and Multivariate Adjusted Relationships for Youth Aged 15 to 17 Years

The bivariate and multivariate relationships between each of the tested variables and the presence of overweight/obesity for youth aged 15-17 years are shown in **Table 4.4**. Among boys, the odds of overweight/obesity were increased among those with parents who had a high school diploma (OR=1.78, 95% CI=1.15, 2.76) as compared to the lowest education category (p=0.032) and those who frequently participated in community cultural events, with the highest odds for those participating always or almost always (OR=2.06, 95% CI=1.23, 3.44) as compared to infrequent participation (p=0.005). The odds of overweight/obesity were reduced among youth spending more than 1.5 hours per day playing video games (OR=0.69, 95% CI=0.47, 0.99) as compared to lesser time (p=0.044). In the multivariate analysis, the effects of parent education level (p=0.028), participation in cultural events (p=0.024) and video game use (p=0.008) remained significant.

Among girls, the odds of overweight/obesity were increased among those having knowledge of a FN language (OR=1.67, 95% CI=1.15, 2.42) as compared to those who did not (p=0.007). Meanwhile, the odds of overweight/obesity were reduced among those following a nutritious diet more often, with the lowest odds for those reporting ‘sometimes’ following a nutritious diet (OR=0.43, 95% CI=0.27, 0.67) as compared to those who rarely or never did (p=0.001), as well as among those spending more than 1.5 hours per day playing video games (OR=0.49, 95% CI=0.28, 0.84) as compared to lesser use (p=0.009). In the multivariate analysis, the effects of understanding of a FN language (p=0.002), video game use (p=0.002), and diet (p=0.001) remained significant.

Table 4.4 Bivariate and multivariate relationships between socioeconomic, cultural and health behaviour factors and the presence of overweight/obesity among youth aged 15 to 17 years from the 2008-2010 First Nations Regional Health Survey^a

Variable	Boys 15-17 years (n=745) ^b			Girls 15-17 years (n=713) ^c		
	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}
Parent educational attainment						
<High school diploma	36.3	1.00	1.00	39.3	1.00	1.00
High school diploma	50.3	1.77 (1.15, 2.76)	1.85 (1.17, 2.93)	38.3	0.96 (0.65, 1.42)	1.06 (0.71, 1.59)
Post-secondary education	44.8	1.42 (0.92, 2.21)	1.35 (0.86, 2.11)	47.3	1.39 (0.94, 2.05)	1.47 (0.97, 2.22)
Household size						
<3 individuals	51.2	1.00	1.00	46.3	1.00	1.00
3-4 individuals	42.1	0.69 (0.44, 1.10)	0.71 (0.45, 1.13)	40.2	0.78 (0.49, 1.24)	0.68 (0.41, 1.11)
>4 individuals	38.7	0.60 (0.38, 0.94)	0.72 (0.45, 1.14)	41.0	0.81 (0.51, 1.27)	0.82 (0.51, 1.33)
Number of people who help youth to understand their culture						
<2 community members	43.0	1.00	1.00	40.4	1.00	1.00
2-4 community members	41.4	0.94 (0.62, 1.41)	0.86 (0.56, 1.31)	45.6	1.24 (0.85, 1.82)	1.19 (0.78, 1.82)
>4 community members	46.5	1.15 (0.68, 1.96)	1.13 (0.66, 1.94)	35.3	0.81 (0.48, 1.35)	0.80 (0.46, 1.39)
Participation in traditional cultural events						
Rarely or never	31.7	1.00	1.00	43.5	1.00	1.00
Sometimes	45.1	1.78 (1.19, 2.64)	1.68 (1.11, 2.53)	41.5	0.92 (0.59, 1.44)	0.88 (0.54, 1.42)
Always/almost always	48.8	2.06 (1.23, 3.44)	1.76 (1.03, 3.01)	40.9	0.90 (0.53, 1.53)	0.84 (0.46, 1.52)
Understanding a First Nations language						
No	41.5	1.00	1.00	35.4	1.00	1.00
Yes	44.0	1.11 (0.78, 1.58)	1.18 (0.80, 1.76)	47.7	1.67 (1.15, 2.42)	1.83 (1.24, 2.71)

Variable	Boys 15-17 years (n=745) ^b			Girls 15-17 years (n=713) ^c		
	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}	Overweight or obese (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}
Physical activity level						
Inactive	49.4	1.00	1.00	48.8	1.00	1.00
Moderately active	41.9	0.74 (0.44, 1.25)	0.82 (0.47, 1.43)	38.6	0.66 (0.42, 1.03)	0.70 (0.43, 1.12)
Active	40.3	0.69 (0.41, 1.17)	0.63 (0.37, 1.07)	40.8	0.72 (0.45, 1.16)	0.70 (0.43, 1.15)
Television time						
≤1 ½ hours per day	40.2	1.00	1.00	40.7	1.00	1.00
>1 ½ hours per day	46.4	1.29 (0.92, 1.81)	1.57 (1.06, 2.33)	43.6	1.13 (0.81, 1.58)	1.05 (0.74, 1.50)
Videogame time						
≤1 ½ hours per day	46.6	1.00	1.00	43.9	1.00	1.00
>1 ½ hours per day	37.4	0.69 (0.47, 0.99)	0.56 (0.37, 0.86)	27.5 ^f	0.49 (0.28, 0.84)	0.41 (0.23, 0.74)
Computer time						
≤1 ½ hours per day	42.4	1.00	1.00	40.1	1.00	1.00
>1 ½ hours per day	44.1	1.07 (0.72, 1.61)	1.10 (0.70, 1.74)	45.6	1.25 (0.89, 1.76)	1.54 (1.05, 2.26)
Eating a nutritious diet						
Rarely or never	44.9	1.00	1.00	57.0	1.00	1.00
Sometimes	40.3	0.83 (0.52, 1.31)	0.92 (0.58, 1.45)	36.2	0.43 (0.27, 0.67)	0.43 (0.27, 0.68)
Always/almost always	47.4	1.11 (0.63, 1.95)	1.26 (0.73, 2.16)	40.3	0.51 (0.30, 0.87)	0.49 (0.27, 0.87)

^aSource: The First Nations Information Governance Centre, microdata abstract: 2015-GATM-001, July 9, 2015.

^bValues presented reflect analysis of the weighted sample, representing 7 947 boys.

^cValues presented reflect analysis of the weighted sample, representing 6 650 girls.

^dAssessed using logistic regression. Statistically significant odds ratios are shown in bold typeface.

^eAdjusted for all other variables in the table.

^fThis estimate is associated with high sampling variability (CV=17.2%). Interpret with caution.

4.8 Discussion

Information related to potential risk and protective factors for overweight/obesity among FN youth is at this time predominantly limited to select community-based reports (e.g., Gates et al., 2013a; Downs, Arnold, Marshall, McCargar, Raine, & Willows, 2009; Downs et al., 2008; Receveur et al., 2008; Ng, Marshall, & Willows, 2006; Horn et al., 2001; Hanley et al., 2000). This study has the advantage of utilizing data from a national sample of FN youth to explore the potential relationships of socioeconomic, cultural and behavioural factors with overweight/obesity. The findings demonstrate that within this population, boys and girls were equally affected by overweight/obesity, and younger youth surprisingly experienced a higher prevalence than older youth. Health behaviours and some cultural variables most commonly had significant effects on the odds of overweight/obesity, but these relationships varied by sex. The direction of these relationships was often counter to expectations, highlighting that it should not be assumed that these relationships operate as they do in the general population. There is a need to build upon these exploratory findings such that policies and programs that promote healthy weights can address the protective factors demonstrated to have the strongest influence.

4.8.1 Socioeconomic Factors

Among the general population, considerable evidence supports the existence of a socioeconomic gradient related to obesity among youth (Shrewsbury & Wardle, 2011; Oliver & Hayes, 2005). However, among the FN youth in this study, socioeconomic status (using parental education and household size as proxy indicators) did not appear to be one of the most important factors influencing overweight/obesity; only among boys aged 15-17 years did parental educational attainment have a significant effect on the odds of overweight/obesity, and not necessarily as

expected. Indeed, the evidence linking socioeconomic factors and obesity among Aboriginal youth is sparse and inconclusive. In an analysis of 2004 CCHS data, Ng, Young and Corey (2010) found no independent relationship between obesity status and household education for Aboriginal youth living off-reserve. However, low income adequacy was associated with decreased odds of obesity in these youth (Ng, Young, & Corey, 2010). Meanwhile, an analysis of 2006 APS data showed that lower socioeconomic position was generally associated with increased odds of being obese among Métis youth (Cooke et al., 2013). These differences underscore the importance of exploring such relationships for each distinct Aboriginal group, as aggregate data introduce the potential to mask differences that exist between subgroups (Smylie, 2009).

Only among older (15-17 years) FN boys did parental education have a significant effect on the odds of overweight/obesity. While it would be expected that higher levels of education would reduce the odds of obesity, as seen among the general population (PHAC & CIHI, 2011; Shrewsbury & Wardle, 2008) and Métis youth (Cooke et al., 2013), this was not the case. For these youth, the odds of overweight/obesity were significantly increased for the middle educational attainment category (i.e., high school diploma) as compared to those with lesser education. It is a challenge to explain why this may have been the case. Boys from the least formally educated households had the lowest prevalence of overweight and obesity (36%), a relationship that could potentially be confounded by multiple factors. There is the potential that those from the least formally educated households are less able to afford food due to poverty, and are thus affected by hunger. Further study would be needed to determine if this is truly the case.

There is no question that the socioeconomic disadvantage resulting from colonialism and marginalization is an important determinant of the health of FN youth (Frolich, Ross, & Richmond, 2006; Adelson, 2005). Still, it should be acknowledged that more than one-third of youth in this study had parents with some degree of post-secondary education, which one would expect to protect against overweight/obesity. Nonetheless, the socioeconomic gradient does not appear to be the most important factor influencing overweight/obesity *within* FN communities. Given that overweight/obesity prevalence was quite high (45%), the lack of socioeconomic gradient for most subgroups may simply be reflective of the widespread nature of excess weight, extending equally to all parental education groups and household sizes.

The suggested reasoning for the lack of (in most cases) relationship between socioeconomic indicators and overweight/obesity among these FN youth living on reserve are purely speculative, and more research is needed to the exact issues at play. Only two potential indicators of socioeconomic status were tested in this analysis, parental education attainment and household size. To maintain adequate cells sizes for analysis, the socioeconomic indicator variable, household size, was categorized such that the largest size was ‘more than four individuals’. Knowing that overcrowding can be an issue in many FN communities (FNIGC, 2012; Statistics Canada, 2008), this categorization was less than ideal, and it would be of interest to be able to investigate the effect of much larger household sizes on overweight/obesity status. Further, knowing that each socioeconomic indicator may have independent effects on health and weight status that vary by population (McLaren, 2007), testing the effect of other indicators such as household income and parental employment will be of value.

4.8.2 Cultural Factors

A reclaiming of cultural identities is known to be an important aspect of holistic health (TRC, 2012; King, Smith, & Gracey, 2009), however, there is limited research on the protective effects of cultural connectedness on health outcomes. It was quite surprising that the odds of overweight/obesity were significantly increased among youth with higher participation in community cultural events (boys 15-17 years) and who were able to speak and understand a FN language (girls 15-17 years). While the findings are counterintuitive, Cooke et al. (2013) found similar relationships among Métis youth. Using 2006 APS data, Métis girls who spent more time with Elders and participated in cultural activities more often were at increased odds of being obese; the relationships among boys appeared similar though less conclusive (Cooke et al., 2013). Similarly, Wilson and Rosenberg (2002) found that participating in traditional hunting activities was associated with poorer health among FN adults. In neither case were the authors able to provide conclusive explanations for the unexpected outcomes.

The findings should in no way take away from the fact that FN rights to self-determination, and a connection to culture, traditional lands, language and heritage are essential aspects of wellness for Aboriginal, and specifically FN people (Brown, McPherson, Peterson, Newman, & Cranmer, 2012; Greenwood & de Leeuw, 2012; King, Smith, & Gracey, 2009; McIvor, Napoleon, & Dickie, 2009). Language is believed to be an expression of cultural identity and a vehicle through which traditional knowledge is passed through generations (Brown et al., 2012; McIvor, Napoleon, & Dickie, 2009), and youth require the support of community in order to develop an understanding of their culture. Brown et al. (2012) explain that cultural strength and connections are essential to FN wellbeing. Indeed, cultural continuity and in particular, knowledge of FN

language, has been shown to be protective toward the development of mental health problems (Hallett, Chandler, & Lalonde, 2007) and diabetes (Oster, Grier, Lightning, Mayan, & Toth, 2014). Thus, work remains to be done in Canada to encourage and facilitate self-determination and cultural continuity for FN people. While the relationships found herein were counter to expectations, they do not tell the whole story, because the quantitative data do not allow for conclusive explanations for the findings.

As previously described, the reasoning for knowledge of FN language and attendance at community cultural events to increase the odds of overweight/obesity among these youth is difficult to explain, and the relationship cannot be interpreted as being causal. There is a need for qualitative information from a First Nations perspective in order to provide an improved explanation of the quantitative findings of the current study. One possible explanation lies in the potential differences in body size ideals between FN youth and their non-Aboriginal peers. Though not all studies demonstrate a preference for larger body sizes (Willows, Ridley, Raine, & Maximova, 2013b), Gittelsohn et al. (1996) showed a preference for larger body sizes as compared to 'Western' ideals among the Oji-Cree of northern Quebec, especially for older adults. Among women, those who spoke their traditional language were more likely to choose a larger body size to represent a healthy FN woman (Gittelsohn et al., 1996). More recently, Gates et al. (2014) showed that many normal weight Cree youth from subarctic Ontario desired to gain weight (Gates, Hanning, Martin, Gates, & Tsuji, 2014). This suggests that overweight/obesity had been normalized in light of high prevalence rates. Thus, it is plausible that traditional body size ideals are playing a role in the increased prevalence of overweight/obesity among youth in this study who appeared to have greater cultural connection and who may be less influenced by

‘Western’ ideals. Once again, this potential explanation is only speculative. First-hand information will be needed to begin to provide an explanation for the findings from the perspective of those FN youth who experience the relationships described.

4.8.3 Health Behaviours

Physical activity (Gates et al., 2013a; Pigford et al., 2011; Mitchell et al., 2010; Downs et al., 2008; Horn et al., 2001), lower participation in sedentary behaviours (Gates et al., 2013a; Horn et al., 2001), and better diet quality (Gates, Hanning, Gates, Martin, & Tsuji, 2012a; Khalil, Johnson-Down, & Egeland, 2010; Receveur et al., 2008; Hanley et al., 2001) are believed to protect against overweight/obesity among First Nations youth. Indeed, a transition from traditional ways of life toward a more Westernized lifestyle is believed to have had deleterious effects on the activity levels, diets and conversely the health of FN peoples (Haman et al., 2010). Among girls, higher PA level (12-14 years) and frequently choosing a nutritious diet (15-17 years) were associated with reduced odds of overweight/obesity; these factors were not significant for boys. Though few studies have investigated potential differences in effects of behavioural factors among FN boys and girls, those that have do show that sex-based differences can exist (Gates et al., 2013a; Horn et al., 2001).

The fact that frequently following a nutritious diet reduced the odds of overweight/obesity among 15-17 year old girls was as expected, and in agreement with other studies of FN youth (Khalil, Johnson-Down, & Egeland, 2010; Downs et al., 2008; Hanley et al., 2000). Though this behaviour was not protective against overweight/obesity among other age-sex categories, it should be acknowledged that this variable is quite subjective. Perceptions of a ‘nutritious

balanced diet' may vary (Paquette, 2005), as does an individual's interpretation of the response options. Additionally, overweight/obese individuals may be more inclined to over-report the frequency of healthy eating, as a result of social desirability bias (Livingstone, Robson, & Wallace, 2004). All of these possibilities may have attenuated the odds ratios observed among youth in the other age-sex categories where significant relationships were not observed.

Similar factors may be at play for PA, though for girls aged 12-14 years the observed relationship between PA and overweight/obesity was generally as expected and concurred with other research (Janssen & LeBlanc, 2010; Mitchell et al., 2010; Downs et al., 2008). The lowest odds of obesity were for girls who were moderately active. The effect of increased muscle mass among the most active girls may have played a role in more 'active' girls being overweight/obese as compared to those who were 'moderately active'. Body mass index does not distinguish body composition, thus some active girls could have been categorized as overweight without having excess fat. Since the data are cross sectional, it is not possible to distinguish whether low PA levels are causing overweight/obesity or vice versa. While it is reasonable to believe that being physically active would lower one's odds of becoming overweight/obese (Janssen & LeBlanc, 2010; Mitchell et al., 2010; Downs et al., 2008), the direction of this relationship cannot be assumed. Youth who are affected by overweight/obesity may also face significant barriers and stigma that discourage them from being active (Stankov, Olds, & Cargo, 2012), though it is uncertain whether this is the case for FN youth. Gathering FN perspectives on the issue would help to determine all of the factors involved in the relationship.

A low level of video game use was commonly associated with increased odds of overweight/obesity among both boys and girls aged 15-17 years, while lower computer time increased the odds of overweight/obesity for girls aged 12-14 years, as compared to those spending more time in these activities. These findings were contrary to much of the available evidence (Katzmarzyk et al., 2015), thus the reasoning is difficult to conceptualize, and once again would benefit from qualitative data reflecting a FN perspective. The results should be interpreted cautiously in light of the fact that relatively few youth were in the high video game use category, resulting in low sampling variability in one case (girls 15-17 years). The dichotomization of screen time variables also led to a loss of information about lower levels of use. In any case, the findings should not be interpreted as reasoning to encourage participation in video games, seeing as sedentary time has been shown to have a number of adverse health effects beyond obesity status (Tremblay et al., 2011b). Similar to youth in this study, Cooke et al. (2013) found that the odds of obesity were increased for Métis girls spending less than 2 hours per day using a computer. While much of the available research is concerned with television viewing, there is research to suggest that some other screen-based behaviours may be less damaging to health (Rey-López et al., 2008). Finally, though high television viewing is commonly believed to be associated with obesity (Tremblay et al., 2011b; Rey-López, Vicente-Rodríguez, Biosca, & Moreno, 2008), it had no significant effects on the odds of overweight/obesity among the FN youth in this study.

4.8.4 Implications for First Nations Communities

The relative paucity of data for various Aboriginal groups (data are often grouped) remains a significant limitation to developing a thorough understanding of the factors influencing health among FN youth (Greenwood & de Leeuw, 2012; Smylie, 2009). Population-based data are an important source of information for FN communities (Smylie, 2009; Willows, 2005), and though survey data has its limitations, this exploratory analysis adds to the current understanding of the factors increasing or decreasing the odds of overweight/obesity specific to youth living in FN communities in Canada. Given the high prevalence in this sample (45%), overweight/obesity is likely to be a costly health concern for FN communities. This improved understanding of the factors affecting weight can aid in tailoring health promotion activities to affect these factors.

Among the factors explored in this study, the findings suggest a relationship between a number of lifestyle factors and the presence of overweight/obesity. Thus, these health behaviours may be prime targets for health promotion. Unfortunately, many of the lifestyle modification programs that have been implemented in FN communities have been unable to impact overweight/obesity rates (Towns, Cooke, Rysdale, & Wilk, 2014). However, obesity is a complex issue (Finegood, Merth, & Rutter, 2010), thus comprehensive action in multiple settings will be needed to successfully promote healthy weights across the population. Additionally, the findings herein show significant differences in the factors affecting the odds of overweight/obesity by age and sex group, suggesting that programming needs to be specifically tailored to each subgroup. While the relationships between cultural factors and overweight/obesity were not as expected, cultural connectedness needs to be encouraged as an important facet of FN wellness.

Despite elucidating significant effects of several behavioural and cultural factors on the odds of overweight/obesity among FN youth, these remain only a very small contribution to the multitude of factors (Willows, Hanley, & Delormier, 2012) influencing the weight status. Among younger boys, none of the independent variables explored had significant effects on the odds of overweight/obesity. Far more research is needed, to further understand the many contributors to weight status. Importantly, research that aims to clarify some of the observed relationships from the perspectives of FN people and their communities (i.e., qualitative studies) would be valuable, as many of the relationships found in this study were difficult to explain. Access to such information is just one step in empowering FN communities who would like to implement initiatives that ensure the health of their youth in ways that they believe to be appropriate, relevant, feasible and sustainable.

4.9 Study Strengths and Limitations

Though similar relationships have been investigated among off-reserve Aboriginal Canadians (Ng, Corey, & Young, 2011) and among Métis youth (Cooke et al., 2013), there is limited information on how socioeconomic, cultural and behavioural factors may affect the odds of overweight/obesity among FN youth living on reserve. This study fills the need for data specific to youth in FN communities. The findings may help to inform potential health-promoting initiatives among this particular population. The use of a relatively large sample of FN youth living on reserve from across Canada is a strength. The research has been designed to be holistic in terms of exploring factors from three directions of the FN Cultural Framework.

It is recognized that this research is limited by a number of factors. The exclusion of youth with missing data means that the sample may no longer be representative of the population, as these youth may have been somehow systematically different. The self-reported survey responses can be biased due to social desirability and the need to recall information in ways that may be difficult to conceptualize. Height and weight were self-reported and IOTF cutoffs were used, thus overweight and obesity rates are likely to be underestimated (Shields, Gorber, & Tremblay, 2008; Roberts et al., 2012; Reilly, Kelly, & Wilson, 2010). Additionally, there is debate over the appropriateness of the use of BMI to define overweight in Aboriginal populations, but it remains used in the absence of other appropriate measures. Additionally, overweight and obesity were combined to maintain adequate cell sizes for analysis, which may have affected the findings. The survey response options may be limiting. Options such as ‘sometimes’ or ‘often’ are subjective and options for some questions were few. The categorical nature of responses, as well as the need to collapse categories, led to a loss of information. The cross-sectional nature of the data means that cause-and-effect cannot be inferred. The lack of regional and community size information may have masked some potential relationships or mean that others are not fully explained. Without qualitative data, only a partial understanding of the relationships among overweight/obesity and the independent variables could be elucidated, and research incorporating FN perspectives remains needed.

4.10 Conclusion

Among this population of 12-17 year old FN youth, it was demonstrated that the effect of socioeconomic, cultural and behavioural factors on the odds of overweight/obesity vary significantly by age and sex, suggesting that programs supporting healthy weights should be

tailored to particular groups. A number of behavioural factors affected the odds of overweight/obesity among these youth, and these may be important targets for health promotion initiatives. There is a need to build upon these exploratory, and sometimes unexpected, findings to include qualitative information from the experiences of FN youth. There remains a need to address a multitude of other potentially associated factors, such that policies and programs promoting healthy weights may address those factors having the strongest influence.

4.11 Acknowledgements

The authors would like to thank Maria Santos at the First Nations Data Centre for her assistance in the planning, data analysis and manuscript preparation phases, Dr. Ian Martin for statistical support, the participants and the FNIGC for collecting and granting access to the data. This study was supported by the research allowance portion of a CIHR Frederick Banting and Charles Best Doctoral Research Award held by Michelle Gates.

5.0 Study 3: Relationships of Socioeconomic, Cultural and Health-related Factors with Television Viewing among First Nations Youth Living On Reserve in Canada

DISCLAIMER: This study presents the results of the author's analysis and interpretation of data from the 2008-2010 First Nations Regional Health Survey. Analyses contained herein of data from the First Nations Regional Health Survey do not necessarily reflect the views of the First Nations Information Governance Centre. Any statistics reproduced from this document must be accompanied by a citation of this document, including a reference to the page on which the statistic in question appears.

5.1 Overview

Objective: Among 12 to 17 year old FN youth living on reserve in Canada, to explore the potential relationships between 'high' (>1.5 hours/day) television viewing and a number of demographic, socioeconomic, cultural and health-related factors.

Methods: Secondary data collected during the 2008-2010 RHS were employed. First Nations youth completed a computer-assisted survey related to health and wellness, administered by trained local FN fieldworkers. Participation in television viewing was dichotomized as 'high' (>1.5 hours/day) or 'low' (≤ 1.5 hours/day). Frequencies were computed for each of the independent variables, and bivariate associations with television viewing were initially explored using Pearson's Chi-Square tests. Relationships between each of the independent variables and high television viewing were then tested using bivariate logistic regression, stratified by age and sex. Later, these relationships were tested using multivariate logistic regression to control for all of the other independent variables. A plan file supplied by the FNIGC allowed the RHS sampling strategy to be incorporated into the analysis, using SPSS Complex Samples version 20 ($p \leq 0.05$). Thus, all analyses were completed on the weighted sample.

Results: A total of 3 658 youth (representing 40 462 youth in the weighted sample, 53.1% male) were included in the analysis; 39.9% watched more than 1.5 hours of television daily. Only attendance at community cultural events was significantly associated with television viewing for the group ($p=0.005$). After stratifying by age and sex, no significant effects for any of the independent variables on the odds of high television viewing among younger (12-14 year old) youth were detected. Among older (15-17 year old) boys, the odds of being a high television watcher were increased for among those with parents having higher levels education (OR=1.73, 95% CI=1.11, 2.69 for high school diploma; OR=1.74, 95% CI=1.16, 2.60 for post-secondary education) as compared to the lowest level ($p=0.010$), those who always or almost always participated in community cultural events (OR=1.84, 95% CI=1.23, 2.75) as compared to less frequent participation ($p=0.003$), and among those who were overweight or obese (OR=1.44, 95% CI=1.04, 2.00) as compared to normal weight ($p=0.028$). Among older (15-17 year old) girls, the odds of being a high television viewer were reduced among those in the largest household size (OR=0.64, 95% CI=0.46, 0.89, $p=0.030$) as compared to the smallest households, and those reporting very good or excellent mental health (OR=0.63, 95% CI=0.45, 0.86, $p=0.004$) as compared to poorer mental health. In each case, the relationships between the tested factors and television viewing remained significant in the multivariate analyses.

Conclusions: High levels of television viewing were prevalent across all age and sex groups. Among older youth the effect of socioeconomic, cultural and health-related factors on the odds of high television viewing differed by sex, and relationships were not always as expected. Thus, initiatives to reduce sedentary behaviour should be tailored to the various age and sex groups. Information from the perspectives of FN youth is needed to clarify the observed relationships.

5.2 Introduction

Obesity is an important health concern among Canadians, including Aboriginal youth (Gionet & Roshanafshar, 2013; Shields, 2006). Among myriad contributors to weight status (Finegood, Merth, & Rutter, 2010), time spent being sedentary (Sedentary Behaviour Research Network, 2012) has recently emerged as distinct health behaviour worthy of consideration (Owen, Bauman, & Brown, 2009; Spanier, Marshall, & Faulkner, 2006). Of primary concern is screen time (i.e., television, video games and computer use); as a result, the Canadian sedentary behaviour guidelines for children and youth suggest that recreational screen-based behaviours be limited to two hours daily (Tremblay et al., 2011a). Because sedentary and active behaviours can coexist, it is recommended that both be targeted in health promotion initiatives (Colley et al., 2011; Tremblay et al., 2010a; Janssen, Katzmarzyk, Boyce, Vereeken, Mulvill, Roberts et al., 2005).

The few available recent studies suggest that a large proportion of Canadian youth, including Aboriginal and on-reserve FN youth, are exceeding recommended screen time limits (Kakekagumick et al., 2013; FNIGC, 2012; Ng, Young, & Corey, 2010; Katzmarzyk, 2008). Canadian Community Health Survey (2004) data showed that 47% of Aboriginal youth watch more than 15 hours of television per week, equivalent to more than two hours daily (Ng, Young, & Corey, 2010). Among FN youth living on reserve, the 2008-2010 RHS reported that 37% of those aged 12-17 years watch more than 1.5 hours of television daily (FNIGC, 2012). It has been suggested that an increased availability of electronic media and the perceived importance of computer literacy, among other factors, may have contributed to rising screen time among youth

in some FN communities (FNIGC, 2012; Paradis et al., 2005). Satellite television is now available even in remote areas where it may not have been a decade ago.

Sedentary behaviour is of concern because it can independently increase youths' risk for negative health effects, even among those who are otherwise physically active (Saunders, Chaput, & Tremblay, 2014; Colley et al., 2013). A review by Tremblay et al. (2011b) indicated a dose-response relationship of two or more hours of daily screen time with several health concerns including overweight and obesity, risk of metabolic syndrome and cardiovascular disease markers among the general population (Tremblay et al., 2011b). Relatively little is known about these potential relationships for FN youth, and it can be argued that consideration of the potential factors contributing to screen time would be of benefit to communities who may desire to implement health promotion strategies that encourage an increase in PA and decrease in sedentary time.

Among youth in the general population, lower screen time has been consistently reported for female gender (Leatherdale & Ahmed, 2011; Leatherdale, Faulkner, & Arbour-Nicitopoulos, 2010; He, Harris, Piché, & Beynon, 2009; Leatherdale & Wong, 2008; Van der Horst et al., 2007), certain parental and peer influences (He et al., 2009; Leatherdale & Wong, 2008), higher socioeconomic status (Coombs, Shelton, Rowlands, Stamatakis, 2013; Leatherdale & Ahmed, 2011; He et al., 2009; Van der Horst et al., 2007) and higher parental education (LeBlanc, Broyles, Chaput, Leduc, Boyer, Borghese, et al., 2015; Atkin, Shaprt, Corder, & van Sluijs, 2014, Van der Horst et al., 2007). In some cases, age (Leatherdale & Ahmed, 2011) or ethnicity (Leatherdale, Faulkner, & Arbour-Nicitopoulos, 2010; Ng, Young & Corey, 2010; Van der Horst

et al., 2007) seem to play a role. Additionally, national-level data for off-reserve Aboriginal (Ng, Young, & Corey, 2010) and Métis youth (Cooke et al., 2013) have demonstrated lower odds of obesity among those engaging in lesser amounts of television viewing. However, only a handful of studies in FN communities have explored the predictors or health effects of various levels of screen time (Cargo et al., 2007; Adams et al., 2005; Horn et al., 2001; Hanley et al., 2000). Beyond these few studies, very little is known about potential influences on the sedentary behaviour of FN youth.

Recently, an analysis of RHS data delineated a number of factors influencing overall PA and participation in traditional activities among FN children (Janssen et al., 2014) and youth (Lévesque et al., 2015) living on reserve. However, the recognition of sedentary time as a distinct health behaviour supports that it is likely to have separate determinants that do not simply work in opposition to how they would be related to PA (Van der Horst et al., 2007). The holistic view of wellness held by FN people (FNIGC, 2012; First Nations Health Authority, 2015) underscores the importance of examining a variety of factors that may influence youths' health behaviour. The availability of a national sample of on-reserve FN youth provides the opportunity to complement the aforementioned research by exploring the relationship between potential socioeconomic, cultural, and health-related characteristics and high television viewing.

5.3 Theoretical Framework

As described in detail in **Study 2**, knowledge from the First Nations Cultural Framework (FNIGC, 2012) and the socioecological framework presented by Willows, Hanley and Delormier (2012) were used to frame the study. The current study investigates factors potentially affecting the odds of high (>1.5 hours/day) television viewing from three directions of the FN cultural framework, those being *Relationships* (community and personal wellness and cultural factors), *Reason* (demographic factors, socioeconomic factors) and *Vision* (physical health factors).

5.4 Objective and Hypotheses

5.4.1 Objective

This study aimed to take an ecological approach to understanding television viewing behaviour in FN youth by addressing factors with potential to affect the issue at various directions of the FN cultural framework. Using a national sample of 12 to 17 year-old FN youth from the 2008-2010 RHS (FNIGC, 2012), the main objective was as follows:

Objective 1: To identify the potential (a) independent, and (b) multivariate adjusted, relationships of a number of demographic, socioeconomic, cultural, and health-related factors with ‘high’ television viewing (i.e., >1.5 hours per day).

5.4.2 Hypotheses

As in **Study 2**, each of the potential independent variables was chosen because it was believed that it could have a significant effect on the odds of high television viewing among on-reserve FN youth. *A-priori* hypotheses regarding each of the independent variables were as follows:

1. High television viewing will be positively associated with age and male sex, thus the prevalence of high television viewing will be higher among those in the 15-17 year old category versus younger youth, and also higher among boys as compared to girls.
2. The odds of high television viewing will be reduced for youth with parents having higher educational attainment, as compared to the lowest level of education (<high school).
3. The odds of high television viewing will be increased for youth living in larger household sizes, as compared to the smallest household size (<3 individuals).
4. The odds of high television viewing will be reduced for youth with a greater number of people helping them to understand their culture, as compared to those with the fewest (<2 individuals).
5. The odds of high television viewing will be reduced for youth who always or almost always participate in their community's cultural events, as compared to those with the least frequent participation (sometimes, rarely or never).
6. The odds of high television viewing will be reduced for youth who understand a FN language, as compared to those who do not.
7. The odds of high television viewing will be increased for youth affected by overweight or obesity, as compared to those of normal weight.

8. The odds of high television viewing will be reduced for those reporting very good or excellent physical health, as compared to those reporting poorer health (good, fair or poor).
9. The odds of high television viewing will be reduced for those reporting very good or excellent mental health, as compared to those reporting poorer health (good, fair or poor).

In-depth reasoning for each of these hypotheses was as follows:

1. Demographic Characteristics

In the general population, it has been reported that boys and girls tend to participate in different types of sedentary activities (Liwander, Pederson, & Boyle, 2013; Carson & Janssen, 2012; Leatherdale & Ahmed, 2011; Leatherdale et al., 2010; Leatherdale & Wong, 2008; Shields & Tremblay, 2008). For example, boys may spend more time in screen-related behaviours whereas girls spend more time reading and doing homework (Leatherdale & Wong, 2008). Consistent with the associations reported in the general population (Leatherdale & Ahmed, 2011), it is expected that high television viewing will be associated with being male, such that a greater proportion of males will be high television viewers than females. Based on trends in the general population (Leatherdale & Ahmed, 2011) and observed within the RHS (FNIGC, 2012), it is expected that high television viewing will also be associated with being in the older (15-17 years) age category.

2. Socioeconomic Characteristics

Within the general population, higher parental education level appears to be protective against excess screen time among youth (Atkin et al., 2014; Van der Horst et al., 2007). Within this study, parent education level was used as a marker of socioeconomic status. Higher socioeconomic status (LeBlanc et al., 2015; Coombs et al., 2013; He et al., 2009; Van der Horst et al., 2007) and having larger amounts of spending money (Leatherdale & Ahmed, 2011) are believed to be associated with lesser screen time among youth. Possible explanations include the fact that youth of lower socioeconomic status have less available funds to participate in other activities, or may not have access to the equipment and facilities to be active in their free time (Coombs et al., 2013). Neighbourhoods with lower socioeconomic status may have other barriers, such as lesser safety, which can discourage youth from participating in outdoor activities (Carson & Janssen, 2012). For these reasons, it is expected that youth with parents who have higher education will be at reduced odds of high television viewing compared to those with the lowest level of education.

There is little data linking household size to screen time. However, adequate income is more common among smaller as opposed to larger household sizes, and income is generally negatively associated with screen time (Shrewsbury & Wardle, 2012; Wang & Lim, 2012). Thus, being in a small household could be hypothesized to protect against high levels of television viewing. As described previously, poverty may mean that equipment for PA and the ability to participate in other paid activities will be limited (Coombs et al., 2013). For this reason, it is expected that youth from larger household sizes will be at increased odds of high television viewing as compared to smaller household sizes.

3. Cultural Characteristics

As previously described in **Study 2**, the number of people who help youth to understand their culture, participation in cultural events and understanding of a FN language were used in this study to describe closeness to and understanding of FN culture. There is little information on the link between the importance of culture and engagement in screen-related behaviours, however screen time is not likely to be viewed as a culturally important activity. There is the potential that a distancing from FN culture would be related to a more sedentary lifestyle in general because engagement in traditional lifestyle practices is thought to be physically demanding (Pal, Haman, & Robidoux, 2013; Young & Katzmarzyk, 2007). A potentially related factor is that peer and parental influences have been shown to be associated with screen time among youth, both positively and negatively (Leatherdale et al., 2010; He et al., 2009; Leatherdale & Wong, 2008). For this reason, it is possible that having a greater number of individuals helping youth to understand their culture will lower the odds of high television viewing as compared to those with fewer individuals helping them to understand their culture. With little information available, strong hypotheses cannot be drawn, but it is predicted that participation in cultural events and knowledge of a FN language will be associated with a decreased odds of being a high television watcher, as compared to those who participate infrequently or do not understand a FN language.

4. Health-related Characteristics

High screen time has been associated with obesity in a variety of populations (Tremblay et al., 2011b), including Aboriginal Canadian youth living off reserve (Ng, Young & Corey, 2010). High Internet and video game use was associated with obesity among boys in one study of FN youth living on reserve (Gates et al., 2013a), but these activities may differ from television

viewing. Given the available evidence, it is predicted that being overweight or obese will increase the odds of being a high television viewer as compared to normal weight youth.

Excess time spent in screen behaviours has been associated with a variety of chronic health conditions in youth (Tremblay et al., 2011b). Further, Harman, Hopman, & Sabiston (2015) reported that among Canadian youth who participated in the 2011-2012 CCHS, those who exceeded screen time guidelines were 30% more likely to report sub-optimal physical health and 30-50% more likely to report sub-optimal mental health. Given this information, it is predicted that those reporting very good or excellent mental or physical health will be at decreased odds of being high television viewers as compared to those reporting poorer physical or mental health.

5.5 Methods

5.5.1 Participants and Survey Methodology

As previously described in **Study 2**, data from the 2008-2010 phase of the RHS were used in the analysis, collected from a representative sample of FN youth from communities across Canada. Detailed information on the participants and survey methodology can be found within **Study 2**.

5.5.2 Television Viewing

Levels of television viewing were assessed by one question within the RHS, as follows: During the past week, how much time in an average day did you spend watching TV, working at a computer, reading or playing video games? Available responses for each behaviour were (a) less than 30 minutes, (b) 30 minutes to an hour, (c) 1 hour to 1 ½ hours, (d) more than 1 ½ hours, (e) don't know, (f) refused (FNIGC, 2008). The categorical nature of the responses made it

unfeasible to determine a total amount of screen time that was comparable to Canada's sedentary behaviour guidelines (Tremblay et al., 2011a). Given that an aggregate screen time variable could not be calculated, only television viewing was used as a focus of this study. Television viewing is the most studied of the screen-based behaviours at this time, thus represents a contribution that would be most relevant and comparable to the available evidence. Because it was the highest option available, more than 1.5 hours of daily television viewing was considered 'high' usage, while any other response was considered low usage. Because the types of screen time are additive, and the RHS reported that 27.0% of youth participated in more than 1.5 hours of computer time and 29.7% participated in more than 1.5 hours of video games daily (FNIGC, 2012), youth watching more than 1.5 hours of television were likely to also be exceeding Canadian guidelines for total screen time. Additionally, though it does not exceed Canadian guidelines, more than 1.5 hours in any type of screen time is likely to be excessive, and the guidelines recommend limiting such activities to the least possible (Tremblay et al., 2011a).

5.5.3 Independent Variables

A number of variables (all categorical) that could potentially have effects on the odds of high television viewing were chosen, as shown in **Table 5.1**. These fell into the categories of demographic, socioeconomic, cultural and health-related characteristics. In some cases, response options were collapsed for the analysis, to maintain adequate cells sizes while allowing for meaningful interpretation of the results. For example, responses for BMI, general physical and mental health, and participation in cultural events were each reduced to two categories as to maintain adequate cell sizes.

Table 5.1. Questions and associated response options related to demographic, socioeconomic, cultural and health-related characteristics on the 2008-2010 First Nations Regional Health Survey for 12 to 17 year old youth (FNIGC, 2008)

Independent Variable	Question	Response Options	Variable Labels used in Analysis
Demographic Characteristics (REASON)			
Age	What is your date of birth?	Day, month, year	1 = 12-14 years* 0 = 15-17 years
Sex	Are you male or female?	Male, female	1 = Male* 0 = Female
Socioeconomic Characteristics (REASON)			
Parent education level	What is the highest level of formal schooling that your parents or guardians have completed? (mother, father)	Some elementary school, elementary school, some high school, high school diploma, diploma/certificate from trade or vocational school, diploma/certificate from community college, CEGEP, professional degree, university degree, masters degree, earned Doctorate (PhD), not applicable	Based on highest level achieved by either parent: 3 = Less than a high school diploma* 2 = High school diploma 1 = Some post-secondary education
Household size	(a) Including yourself, how many children and youth live in this household? (b) How many adults live in the household?	(a) # 0-5 years, # 6-11 years, # 12-18 years (b) includes all adults who live in household at least half the time	3 = <3 individuals* 2 = 3-4 individuals 1 = >4 individuals
Cultural Characteristics (RELATIONSHIPS)			
Number of people who help youth to understand culture	Who helps you in understanding your culture?	Grandparents, parents (mother and/or father), aunts and uncles, other relatives (siblings, cousins, etc.), my friends, school teachers, community elders, other community members, no one, don't know, refused, other.	3 = <2 individuals* 2 = 2-4 individuals 1 = >4 individuals

Independent Variable	Question	Response Options	Variable Labels used in Analysis
Participation in traditional cultural events	Do you take part in your community's cultural events?	Always/almost always, sometimes, rarely, never, don't know, refused	2 = Sometimes, rarely or never* 1 = Always/almost always
Understanding a First Nations language	Can you understand or speak a First Nations language?	Yes, no, don't know, refused	1 = No* 0 = Yes
Health-related Characteristics (ACTION)			
Body mass index	Self-reported height and weight	Open-ended. Body mass index calculated and categorized according to the age- and sex-specific cut-offs suggested by the International Obesity Task Force (Cole et al., 2000)	2 = Underweight or normal* 1 = Overweight or obese
General physical health	In general, would you say that your health is?	Excellent, very good, good, fair, poor	2 = Good, fair or poor* 1 = Very good or Excellent
General mental health	How would you rate your mental health?	Excellent, very good, good, fair, poor	2 = Good, fair or poor* 1 = Very good or Excellent

*Reference Category

5.5.4 Data Use and Ethics Approval

The data and methodology used in the study were suggested in a proposal that was submitted to the FNIGC. The FNIGC reviewed the proposed study protocol and provided ethical and methodological approval for the planned project. Two members of the research team (i.e., the author and an assistant) were allowed access to the FNIGC's First Nations Data Centre in Ottawa, Ontario, where a dataset including the requested variables was analyzed in accordance with OCAP[®] (FNIGC, 2014) and usual ethical protocols. Following analysis, desired output tables and figures were vetted by the FNIGC and then released to the research team.

Interpretation of the results was the responsibility of the study author.

5.6 Data Analysis and Interpretation

Prior to analysis, participants with a response that was missing, 'refused' or 'I don't know' for any variable were excluded listwise. The sample was dichotomized for television viewing category as high (>1.5 hours/day) or low (≤ 1.5 hours /day). Descriptive characteristics (i.e., frequencies) were computed for low versus high television viewing for each of the independent variables in **Table 5.1**. At this stage, a similar procedure to what has been previously described in **Study 2** was followed in order to model the bivariate, and later multivariate relationships of each of the independent variables and the outcome (high television viewing). As with **Study 2**, based on observed interactions, the analyses were stratified by age and sex. A plan file supplied by the FNIGC was used in order to incorporate the RHS sampling design into the analysis. Thus, all statistical procedures were carried out on the weighted sample, which allowed for statistically valid population and error estimates, using SPSS Complex Samples version 20 (IBM Corporation, Armonk, NY), at a significance level of $p \leq 0.05$.

5.7 Results

5.7.1 Participant Characteristics

The characteristics of youth in the weighted sample and bivariate associations between each of the independent variables and high television viewing are shown in **Table 5.2**. The RHS had a 72.5% participation rate, resulting in a total 4 837 FN youth participating in the survey (5.3% of the target population). The prevalence of missing data ranged from 0% (sex) to 7.9% (parent education level), and 6.8% for television viewing. This resulted in a final sample of 3 658 youth, representing 40 462 youth in the weighted sample (53.1% male) who were included in the analysis. Of these, 50.7% were aged 12-14 years and 49.3% were aged 15-17 years.

Among the weighted sample, 39.9% reported watching more than 1.5 hours of television daily. Of the variables tested, only attendance at community cultural events was associated with television viewing at the group level ($p=0.005$). Those who always or almost always attended community cultural events were more likely to be high television viewers than those who attended less often (45.2% vs. 38.1%). Subsequent exploratory bivariate regression analyses for high television viewing revealed age- and sex-based interactions for attendance at cultural events and general mental health. Specifically, general mental health interacted with sex ($p=0.048$), while attendance at cultural events interacted with both sex ($p=0.013$) and age ($p=0.041$). Subsequent analyses were stratified by age and sex category in order to further understand potential relationships within each age-sex category (males 12-14 years, females 12-14 years, males 15-17 years, females 15-17 years).

Table 5.2 Characteristics of the subset of youth from the 2008-2010 First Nations Regional Health Survey and associations with high television viewing (n=3 658)^{a,b}

Variable	Proportion missing data (%)	Proportion of sample (%)	Proportion high TV viewers (%)	P ^c
Total	-	-	39.9	-
Age	0.3 ^d			
12-14 years		50.7	39.6	0.723
15-17 years		49.3	40.3	
Sex	0.0			
Male		53.1	40.4	0.662
Female		46.9	39.4	
Parent education	7.9			0.411
<High school diploma		41.1	38.4	
High school diploma		25.9	40.2	
Some post-secondary education		32.9	41.7	
Household size	0.3 ^d			0.376
<3 individuals		18.8	43.2	
3-4 individuals		39.7	39.7	
>4 individuals		41.6	38.7	
# of people helping youth understand culture	2.9			0.270
<2 community members		40.8	40.3	
2-4 community members		43.0	41.0	
>4 community members		16.2	36.3	
Participation in traditional cultural events	2.0			0.005
Sometimes, rarely or never		74.6	38.1	
Always/almost always		25.4	45.2	
Understanding a First Nations language	4.9			0.422
No		43.4	40.9	
Yes		56.6	39.2	
Body mass index category	6.9			0.198
Underweight or normal		56.0	38.6	
Overweight or obese		44.0	41.7	
General physical health	0.5 ^d			0.194
Good, fair or poor		32.0	42.3	
Very good or excellent		68.0	38.8	
General mental health	0.9 ^d			0.948
Good, fair or poor		33.4	40.1	
Very good or excellent		66.6	39.9	

^aSource: The First Nations Information Governance Centre, microdata abstract: 2015-GATM-001, July 9, 2015.

^bProportions presented reflect analysis of the weighted sample, including 40 462 youth.

^cAs assessed via the Pearson Chi-square statistic. Significant differences by television viewing are shown in bold.

^dEstimate is associated with high sampling variability.

5.7.2 Bivariate and Multivariate Relationships

The stratified analyses revealed that among FN youth aged 12-14 years, none of the factors that were explored had significant effects on the odds of high television viewing (data not shown). Thus, only the relationships for youth aged 15 to 17 years have been presented. Among these youth, the effect of the various socioeconomic, cultural and health-related factors differed by sex (**Table 5.3**).

Among boys aged 15 to 17 years, the odds of being a high television watcher were increased among those with parents having higher levels of education (OR=1.73, 95% CI=1.11, 2.69 for high school diploma; OR=1.74, 95% CI=1.16, 2.60 for post-secondary education) as compared to the lowest level (p=0.010), those who always or almost always participated in their community's cultural events (OR=1.84, 95% CI=1.23, 2.76) as compared to lesser participation (p=0.003), and among those being overweight or obese (OR=1.44, 95% CI=1.04, 2.00) as compared to normal weight (p=0.028). In the multivariate analysis, the effects of parental education level (p=0.008), attendance at community cultural events (p<0.001), and weight status (p=0.018) remained significant.

Among girls aged 15 to 17 years, the odds of being a high television watcher were reduced among those in the largest household size (>4 individuals) (OR=0.64, 95% CI=0.46, 0.89) as compared to the smallest household size (p=0.030), and among those reporting very good or excellent mental health (OR=0.63, 95% CI=0.45, 0.86) as compared to good, fair or poor mental health (p=0.004). When adjusted for all of the other potential independent variables, the effects of household size (p=0.016) and mental health status (p=0.025) remained significant.

Table 5.3 Bivariate and multivariate relationships between socioeconomic, cultural and health-related factors with high television viewing among youth aged 15 to 17 years from the 2008-2010 First Nations Regional Health Survey^a

Variable	Boys 15-17 years (n=911) ^b			Girls 15-17 years (n=969) ^c		
	Proportion 'high' TV watching (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}	Proportion 'high' TV watching (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}
Parent education						
<High school diploma	32.3	1.00	1.00	42.2	1.00	1.00
High school diploma	45.2	1.73 (1.11, 2.69)	1.72 (1.10, 2.70)	40.5	0.93 (0.64, 1.36)	0.96 (0.64, 1.44)
Post-secondary education	45.3	1.74 (1.16, 2.60)	1.79 (1.20, 2.67)	40.2	0.92 (0.63, 1.34)	0.92 (0.62, 1.35)
Household size						
<3 individuals	45.8	1.00	1.00	48.8	1.00	1.00
3-4 individuals	38.6	0.74 (0.47, 1.19)	0.70 (0.45, 1.09)	40.1	0.70 (0.48, 1.03)	0.71 (0.48, 1.04)
>4 individuals	37.1	0.70 (0.43, 1.13)	0.72 (0.47, 1.12)	37.8	0.64 (0.46, 0.89)	0.62 (0.44, 0.86)
Number of people who help youth understand their culture						
<2 community members	40.9	1.00	1.00	44.7	1.00	1.00
2-4 community members	38.7	0.91 (0.61, 1.35)	0.98 (0.65, 1.46)	38.4	0.77 (0.57, 1.05)	0.73 (0.53, 1.02)
>4 community members	39.1	0.93 (0.55, 1.56)	0.97 (0.56, 1.68)	40.5	0.84 (0.55, 1.30)	0.82 (0.52, 1.31)
Participation in traditional cultural events						
Sometimes, rarely or never	35.9	1.00	1.00	41.4	1.00	1.00
Always/almost always	50.7	1.84 (1.23, 2.76)	2.17 (1.43, 3.30)	40.2	0.95 (0.67, 1.37)	0.92 (0.61, 1.38)
Understanding a First Nations language						
No	40.7	1.00	1.00	38.4	1.00	1.00
Yes	38.9	0.93 (0.65, 1.31)	1.09 (0.75, 1.59)	43.2	1.22 (0.90, 1.66)	1.25 (0.91, 1.71)
Body mass index category						
Underweight or normal	36.1	1.00	1.00	40.6	1.00	1.00
Overweight or obese	44.9	1.44 (1.04, 2.00)	1.47 (1.06, 2.04)	41.6	1.04 (0.79, 1.37)	0.99 (0.75, 1.31)

Variable	Boys 15-17 years (n=911) ^b			Girls 15-17 years (n=969) ^c		
	Proportion 'high' TV watching (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}	Proportion 'high' TV watching (%)	Bivariate OR (95% CI) ^d	Multivariate adjusted OR (95% CI) ^{d,e}
General physical health						
Good, fair or poor	42.7	1.00	1.00	44.6	1.00	1.00
Very good or excellent	38.3	0.83 (0.56, 1.23)	0.86 (0.58, 1.28)	38.5	0.77 (0.58, 1.04)	0.89 (0.63, 1.27)
General mental health						
Good, fair or poor	36.8	1.00	1.00	48.0	1.00	1.00
Very good or excellent	41.3	1.21 (0.85, 1.73)	1.28 (0.88, 1.86)	36.7	0.63 (0.45, 0.86)	0.67 (0.46, 0.95)

^aSource: The First Nations Information Governance Centre, microdata abstract: 2015-GATM-001, July 9, 2015.

^bValues presented reflect analysis of the weighted sample, representing 10 536 boys.

^cValues presented reflect analysis of the weighted sample, representing 9 418 girls.

^dAssessed using logistic regression. Statistically significant odds ratios are shown in bold typeface.

^eAdjusted for all other variables in the table.

5.8 Discussion

In the past decade, sedentary behaviour has emerged as a significant public health concern (Spanier et al., 2006). Much research has been dedicated to understanding the factors affecting these behaviours such that measures can be taken to begin to reduce the youths' engagement in sedentary lifestyle behaviours (Atkin et al., 2014; Van der Horst et al., 2007). First Nations youth have been left out of much of this research, leaving communities with limited evidence for action to promote the health of their youth. The current study shows that among 15 to 17 year old FN youth, socioeconomic, cultural and health-related factors can have significant effects on the odds of participating in high amounts of television viewing. Significant variation in these relationships was seen across sex categories, and this exploratory study was unable to pinpoint significant effects for younger youth. The findings herein may begin to facilitate the direction of resources toward health promotion strategies in FN communities.

5.8.1 High Levels of Television Viewing

The work of Ng, Young, and Corey (2010), showed that Aboriginal youth living off reserve were more likely to be 'high' (>15 hours per week, or roughly 2 hours per day) television viewers as compared to their non-Aboriginal peers. Indeed, 47% of these youth reported watching more than 15 hours of television per week (Ng, Young, & Corey, 2010). The evidence specific to FN youth is quite limited, having been reported for select communities in Quebec and Ontario.

These studies showed a wide variation in viewing time, ranging from 1.2 to more than 3 hours per day (Kakekagumick et al., 2013; Skinner et al., 2012a; Paradis et al., 2005; Hanley et al., 2000). This study suggests that levels of screen time among FN youth are congruent with much of these earlier findings, as 40% watched more than 1.5 hours of television daily. Though the

nature of the data makes it impossible to directly compare to Canadian sedentary behaviour guidelines (Tremblay et al., 2011a), it is reasonable to believe that these youth are likely to be also participating in various other screen and non-screen based sedentary behaviours that would add up to concerning levels. It has been reported that youth in the general population may spend up to 6 hours per day watching television (Freeman, Coe, & King, 2014). Thus, it would be of interest to gather continuous data to determine the true extent of television viewing among these youth that cannot be captured by categorical data.

Among Canadian youth in the general population, it is suggested boys may spend more time in screen-related behaviours, while girls show more interest in other sedentary behaviours (e.g., reading) (Leatherdale & Ahmed, 2011; Leatherdale & Wong, 2008). Similarly, Katzmarzyk (2008) reported that Aboriginal boys living off reserve appear to participate in greater amounts of sedentary time than girls. Additionally, it has been shown that screen time tends to increase with age (Leatherdale & Ahmed, 2011). Contrary to these trends, the prevalence of high television viewing appeared to occur ubiquitously across age and sex categories among FN youth in this study. Potential differences may have been limited by the ceiling effect; had higher television viewing categories had been available, or a total screen time variable been possible to calculate, there is the potential that differences would have been detected. Regardless, the apparent high levels of television viewing across the population demonstrate that this behaviour may be a worthy target for health promotion initiatives.

5.8.2 Socioeconomic Factors

Review studies have demonstrated evidence of protective effect of higher socioeconomic status for engagement in excess screen-based behaviours, based on indicators such as income and parental education (Coombs et al., 2013; Salmon, Tremblay, Marshall, & Hume, 2011; Van der Horst et al., 2007). Given this, it was surprising that among youth in this study, the odds of being a high television viewer increased for boys with parents at higher levels of education, as compared to the lowest level. However, this is not the only population where such a relationship has been observed. LeBlanc et al. (2015) reported that among a group of Canadian children, screen time was positively associated with their father's education level; the highest screen times were seen for those with a father having greater than high school education (LeBlanc et al., 2015). Interestingly, this relationship was true of the group as well as for girls, while in the current study it was detected only for FN boys.

One cannot make assumptions as to the reasoning for higher education increasing the odds of being a high television viewer. However, Gaudin et al. (2014)'s discussions on traditional food consumption with the Cree of northern Quebec suggest a view that those with higher levels of formal education are more 'Westernised', which could begin to explain a greater participation in screen-based behaviours (Gaudin, Receveur, Walz, Girard, & Potvin, 2014). Though purely speculative, those youth from families with higher education are likely to also have higher income (Statistics Canada, 2009), making television a more affordable option to these families than ones with lower levels of education. It is also possible that FN parents who had access to higher education live closer to urban areas where access to television is more widespread. Unfortunately, the effect geographic location was not addressed within this study and would be

an area of interest for future research. A logical next step would be to gather information from the perspective of FN people themselves, who are experiencing the observed relationship.

Meanwhile, the relationships seen among girls were different but also in opposition to what would be expected based on the bulk of the literature (Coombs et al., 2013; Salmon et al., 2011; Van der Horst et al., 2007). Among girls, parent education level appeared unrelated to television viewing level. However, contrary to expectations, girls in larger household sizes had reduced odds of being a high television viewer. There is not extensive research on the effects of household size on the health behaviours of youth. However, larger household sizes are likely to experience lower household income, as total income must be spread over a larger number of people. It would be expected that lower income would be associated with higher levels of television viewing (Coombs et al., 2013), but this did not appear to be the case. One explanation is that cable television is expensive and likely to be unaffordable to those in larger household sizes. Another is that youth with more siblings may be watching less television if they do not enjoy the shows watched by other family members. In terms of methodology, the largest household size examined in this study included four or more people. In order to fully parse out the relationship, further research into the much larger household sizes that are prevalent in many FN communities (FNIGC, 2012) would be of value.

5.8.3 Cultural Factors

According to Kirmayer, Simpson, and Cargo (2003), collective identity, cultural awareness and knowledge of traditional ways of living on the land are beneficial to FN youth and foster resilience. Additionally, social support and community connectedness are believed to be

important determinants of FN people's health (Richmond & Ross, 2008). Thus, it was surprising that among boys in this study, high television watching was most prevalent among those who attended their community's traditional cultural events most often. The quantitative nature of the survey data makes it difficult to elucidate the reasoning behind the observed relationship, but it is quite unlikely that it is causal. On the contrary, it has been suggested that cultural erosion is an important determinant of other risk behaviours (e.g., smoking) among FN people, and that strengthening cultural identity may have positive impacts on all aspects of health (Varcoe, Botorff, Carey, Sullivan, Williams, 2010), including the health behaviours that youth choose to partake in.

Once again, it will be necessary to gain information from the perspectives of FN people before the relationships between the cultural variables and television viewing can be fully explained. It is likely that some other community-level factor is responsible for the observed relationship between community event attendance and television viewing among boys in this study, or that the collapsing of response categories led to a loss of information that affected the findings. The lack of information about community size, remoteness, or geographic location makes it impossible to determine if these factors are involved in the relationship. It remains clear that cultural and community connectedness should be encouraged. Richmond and Ross (2008) described how social support from various sources (e.g., family, community) can influence the health behaviours of FN people. The authors described community events as beneficial toward resolving social problems that can exist in FN, or any other communities (Richmond & Ross, 2008). Given the relatively small amount of research linking cultural connectedness to the health behaviours of youth, it would be of value for future studies to explore the issue in further depth.

5.8.4 Health-related Factors

Considerable evidence suggests that high levels of screen time are associated with obesity in the general population (Tremblay et al., 2011b; Janssen et al., 2005). Among older (15-17 years) boys in this study, being overweight or obese was associated with increased odds of being a high television viewer as compared to those of normal weight, though this relationship was not observed among other age-sex groups. Data from the 2007-2009 CHMS had similar findings, where sedentary time was only associated with obesity among boys aged 11-14 years and not other age-sex categories (Colley et al., 2013). Though it is difficult to determine why this may be the case, the link between television viewing and obesity may be explained by various mechanisms. In addition to the metabolic consequences of prolonged uninterrupted periods of inactivity (Saunders, Chaput, & Tremblay, 2014), television viewing may also displace PA and provide enticing advertising that acts as an impetus for passive overeating, especially of energy-dense foods (Boulos, Vikre, Oppenheimer, Chang, & Kanarek, 2012). Health behaviours tend to cluster (Leech, McNaughton, & Timperio, 2014), and it has been shown that youth who engage in higher amounts of screen time may have poorer quality, potentially obesogenic diets (LeBlanc et al., 2015; Borghese, Tremblay, Leduc, Boyer, Bélanger, LeBlanc, et al., 2014). Additionally, the relationship may be bidirectional; in the general population, overweight and obese youth may be affected by stigma, low self-esteem, and depression (Puhl & Latner, 2007), all of which have been linked to higher levels of screen time (Tremblay et al., 2011b). However, there is not enough information to suggest whether or not these relationships hold true for FN youth.

Given the available evidence (Tremblay et al., 2011b; Van der Horst et al., 2007), it was unsurprising that among girls aged 15-17 years, reporting very good or excellent mental health

was associated with reduced odds of being a high television viewer as compared to those reporting poorer health. Similarly, studies of Canadian youth in the general population show that those reporting less than 2 hours per day of screen-based behaviours are more likely to report favourable mental health (Harman, Hopman, & Sabiston, 2015) and self-esteem (Leatherdale & Ahmed, 2011). The literature linking screen time to mental health is inconclusive on the directionality of the relationship (Suchert, Hanewinkel, & Isensee, 2015), and the cross-sectional nature of the data herein makes it impossible to determine. However, screen-based behaviours may cause harm by exposing youth to unhealthy or violent messages propagated in the media (Browne & Hamilton-Giachritsis, 2005), by displacing PA (Suchert, Hanewinkel, & Isensee, 2015), or by encouraging social isolation (Thoits, 2011). Conversely, youth with pre-existing poor mental health may be predisposed to prefer to spend time in screen-based behaviours rather than other pursuits, perhaps as a means of escape from the issues they are experiencing.

5.8.5 Implications for First Nations Communities and Continued Knowledge Gaps

Over the past 20 to 30 years, Canadian homes have seen unprecedented levels of access to electronic media (Salmon et al., 2011). The findings herein confirm that high levels of television viewing are relatively prevalent and are likely to pose similar health risks to FN youth as those seen in the general population. It has been suggested that health promotion strategies be directed toward sedentary behaviour, as these require few resources in terms of equipment and facilities, and therefore may be more feasible than programs addressing PA (Tremblay et al., 2010a). Imperative to the development of these strategies is an improved understanding of the factors that are protective against high engagement in television viewing, a few of which have been elucidated in this study. Consistent with other research (LeBlanc et al., 2015), the factors

significantly affecting the odds of high television viewing differed significantly across age and sex categories, suggesting that no one program or initiative is likely to impact all youth. Further investigation of other independent variables will enable FN communities to tailor programs and policies to various age and sex groups.

Though this study elucidated some risk and protective factors for high television viewing, much more study is needed to clarify the relationships, especially for younger youth, among whom no significant relationships were detected. Future studies employing qualitative methodologies would be able to capture the views of FN youth, which would add valuable perspective to the relationships observed here. Other types of sedentary behaviour may have different determinants and health effects (Rey-López et al., 2008), thus, there is a need to further investigate these other behaviours, including video game and computer use, reading and homework. Because the link between screen-based behaviours and health effects often follows a dose-response relationship (Tremblay et al., 2011b), data investigating high amounts of television time (beyond the >1.5 hours used in this study) would be of value and may facilitate the detection of relationships that were not seen here. Continuous data allowing for calculation of total screen time would also be of interest.

5.9 Study Strengths and Limitations

This study adds to the limited literature on screen time behaviours among FN youth living on reserve, as well as the factors that may impact the odds of high television viewing. The investigation herein can help to inform initiatives that promote health by discouraging sedentary behaviour. Strengths of this study include that it comprises a large sample of FN youth and

allowed for the investigation of several potentially associated variables. The findings add to the expanding literature on the topic of sedentary behaviour, and either confirm that the relationships seen in the general population are shared by the FN population or are distinct and thus need to be addressed differently.

Some limitations of this study include the self-reported nature of the responses, which lead to concerns about social desirability and response bias. Because a number of youth were excluded based on missing data, the sample investigated may no longer be fully representative of the population. The screen time behaviours reported reflect only the past week and did not take into account seasonal variation, thus may not be representative of usual screen time use. Additionally, relationships may have been subject to the ceiling effect, because the categorical nature of responses means that no information about television viewing of more than 1.5 hours is available. Substantial variability may have existed at higher levels of television viewing, but this cannot be discerned from the data. A lack of regional information means that some potential relationships related to region of the country, urban or rural status, and community size have been obscured or may be confounding other apparent relationships.

The fact that this is a secondary data analysis means that the questions were not chosen specifically for the purpose of this study, which may impose certain limitations. For example, the categorization of 'high' television or video game use does not align with Canadian guidelines. Further, the nature of the data meant that a total screen time variable could not be calculated. Finally, the need to collapse certain response categories led to a loss of information, which may have affected the relationships detected. However, this was necessary to ensure adequate cell

sizes for analysis. The purely quantitative nature of the study means that reasoning for the observed relationships can be only speculative, and there remains a need to capture the perspectives of FN youth.

5.10 Conclusion

Among this group of FN youth, high levels of television viewing were prevalent, suggesting that sedentary behaviour can be an important target for health promotion strategies. This study was unable to detect effects of any of the tested factors on high television viewing among younger youth, prompting a need for further research into other potentially associated factors. Among older youth the effects of socioeconomic, cultural and health-related variables differed by sex, and relationships were not always in the expected direction. The findings suggest that health promotion initiatives encouraging reductions in sedentary behaviour will need to be tailored to the various age and sex groups to be effective. There is a need to build upon these findings to include the perspectives of FN youth who experience the relationships observed in this study.

5.11 Acknowledgements

The author would like to thank Maria Santos, the First Nations Data Centre coordinator, for her help in planning the project as well during data analysis and manuscript preparation phases, Dr. Ian Martin for statistical advice, and finally the participants and the FNIGC for allowing access to the data. This study was supported by the research allowance portion of a CIHR Frederick Banting and Charles Best Doctoral Research Award held by Michelle Gates.

6.0 Study 4: Physical Activity and Fitness of First Nations Youth in a Remote and Isolated Northern Ontario Community: A Needs Assessment

A version of this study has been published as:

Gates, M., Hanning, R.M., Gates, A., Stephen, J., Fehst, A., & Tsuji, L.J.S. (2015). Physical activity and fitness of First Nations youth in a remote and isolated northern Ontario community: A needs assessment. *Journal of Community Health*. doi: <http://dx.doi.org/10.1007/s10900-015-0063-8>

6.1 Overview

Objectives: Among a group of FN youth from a remote and isolated community on the western James Bay coast, Ontario, to obtain measures of anthropometry, PA and fitness; to identify group-level differences by (a) sex, (b) BMI, (c) waist circumference and (d) body fat categories; to qualitatively assess the barriers and supports to PA.

Methods: Anthropometric variables (BMI, waist circumference, body fat percentage via bioelectrical impedance) were measured using standard protocols. School-day PA (minutes of MVPA/day, steps/day) was measured via three consecutive days of accelerometry (Actigraph GT3X), and fitness (cardiorespiratory endurance, muscular strength and endurance, flexibility) was measured using the Léger 20-m shuttle run as well as field tests informed by the Canadian Physical Activity, Fitness and Lifestyle Approach. Resting blood pressure was measured with an automated device (BpTRU BPM-100). Barriers and supports were assessed qualitatively via environmental scan and focus groups (teachers, youth). Descriptive statistics for quantitative data were compared to reference or normative values. Group differences in PA and fitness by sex, BMI category, presence of abdominal obesity, and presence of excess body fat were tested using

the Mann-Whitney U (continuous) and Pearson's Chi-square (categorical) tests ($p \leq 0.05$). The qualitative data were assembled into one file and coded manually for categories and themes. The analysis was repeated by a second researcher, and disagreements were resolved via discussion.

Results: Seventy-two youth (12.1 ± 1.1 years, 61.1% male) participated in at least one measure (93.5% participation rate); 36 youth (12.0 ± 1.1 years, 52.8% male) completed the accelerometry. Sixty-three percent of participants were overweight or obese, 51% were abdominally obese and 21% had excess body fat. Most (86.1%) met Canada's PA guidelines, where boys were more active (149.3 ± 59.9 vs. 105.8 ± 47.6 minutes/day MVPA, $p=0.025$), had greater maximal aerobic power (38.7 ± 5.8 vs. 32.9 ± 5.2 mL/kg/minute, $p=0.003$) and muscular strength (55.0 ± 10.7 vs. 49.6 ± 10.6 kg, $p=0.034$) than girls. Time in MVPA did not differ across categories of the anthropometric variables, however, overweight or obese youth had lower cardiorespiratory endurance than normal weight youth (33.9 ± 4.6 vs. 41.2 ± 5.7 mL/kg/minute, $p < 0.001$); abdominally obese youth also had lower cardiorespiratory endurance (33.0 ± 4.4 vs. 41.0 ± 5.2 mL/kg/minute, $p < 0.001$) and flexibility (23.5 ± 7.8 vs. 27.9 ± 7.5 cm, $p=0.049$) than those of normal waist circumference. Those with excess body fat did not differ from those with normal body fat percentage in terms of PA nor fitness, except that they had higher systolic blood pressure (131.0 ± 25.2 vs. 112.2 ± 13.0 mmHg, $p=0.030$). However, boys with excess body fat had lower cardiorespiratory endurance than their normal body fat peers (34.2 ± 4.9 vs. 42.4 ± 7.8 mL/kg/minute, $p=0.035$). Barriers and supports to youth PA fell under the main themes: motivation, role models, personnel and facilities, environment and programs.

Conclusion: Youth in this community are active, but not sufficiently physically fit. Of greatest concern is low cardiorespiratory endurance among girls, and those in the highest risk groups (i.e., overweight or obese, abdominally obese, or carrying excess body fat). The findings, in addition

to the numerous barriers to PA, are supportive of the community's desire for school-based PA programming.

6.2 Introduction

The health of Aboriginal Canadians is a concern, and is believed to be poorer than other ethnic groups due to ongoing inequalities in several determinants of health (Kmetz, Reading, & Etsy, 2008; Frolich, Ross, & Richmond, 2006; Young, 2003). High and rising prevalence rates of overweight and obesity are a concern for all Canadians (Roberts et al., 2012; Shields, Carroll, & Ogden, 2011), but Aboriginal people remain more gravely affected. This is especially the case for FN youth living on reserve (FNIGC, 2012). While it is recognized that obesity is a complex problem affected by a host of interacting factors (Willows, Hanley, & Delormier, 2012), PA level is a known direct, modifiable contributor to energy expenditure at the individual level (WHO, 2015a).

Engaging in high levels of PA, especially moderate-to-high intensity aerobic exercise, can offer a number of physical and mental health benefits for youth including positive effects on blood lipids, blood pressure and insulin sensitivity (Janssen & LeBlanc, 2010). Specifically for Aboriginal youth, research has shown an inverse association between PA level and BMI, where youth who are more active are less likely to be obese (Cooke et al., 2013; FNIGC, 2012; Mitchell et al., 2010; Ng, Young, & Corey, 2010; Downs et al., 2008; Katzmarzyk, 2008). Among discrete FN populations, PA has further been negatively associated with the presence of abdominal obesity (Pigford et al., 2011; Downs et al., 2008) and insulin resistance (Mitchell et al., 2010).

Though there is limited research on the physical fitness of Aboriginal youth, the few existing studies in FN populations suggest that, as with PA, high levels of cardiorespiratory endurance may be inversely associated with obesity (Downs et al., 2008; Ng, Marshall, & Willows, 2006), abdominal obesity (Downs et al., 2008; Ng, Marshall, & Willows, 2006), and markers of insulin resistance (Mitchell et al., 2010). Canadian data show that Aboriginal youth are more active than their peers in the general population (Ng, Young, & Corey, 2010), however, recent reviews have concluded that much of the population is still considered to be inadequately active as compared to established guidelines (**Study 1**, herein; Foulds, Warburton, & Bredin, 2013; Young & Katzmarzyk, 2007).

First Nations youths' participation in PA is likely to be affected by several community-specific factors. Disempowerment, socioeconomic status, the availability of local resources (e.g., equipment, personnel, programming), geographic remoteness and perceptions of community safety are just some of the possible contributors to PA participation that have been identified (DyckFehderau et al., 2013; Lemstra et al., 2013; FNIGC, 2012; Mason & Koehli, 2012; Skinner et al., 2012a; Smith, Findlay, & Crompton, 2010; Sutherland et al., 2007; Kirby, Lévesque, & Wabano, 2001). Despite what appears to be an increasing interest in understanding the PA behaviour of Aboriginal youth within the past decade, there are only a few small regional studies that have measured PA directly (e.g., pedometry, accelerometry) (Pigford et al., 2011; Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall, & Willows, 2006), only a handful of studies that have assessed cardiorespiratory endurance (Kakekagumick et al., 2013; Tomlin et al., 2012; Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall & Willows, 2006; Paradis et al., 2005), and to the author's knowledge, no recent studies that have reported other facets of physical

fitness, such as musculoskeletal fitness. In addition to limited national-level data on the PA and fitness of FN youth living on reserve (FNIGC, 2012), a lack of locally relevant data can make it difficult for communities to identify needs and to implement feasible local solutions that promote PA and fitness among their youth.

6.3 Study Context

The current project emerged as part of a more than 10 year partnership between the research group led by Drs. Rhona Hanning (University of Waterloo) and Len Tsuji (University of Toronto Scarborough), and a number of northern Ontario FNs on the coast of James and Hudson Bays. Working with the communities, this partnership has resulted in communities gaining information about the health and diet habits of their youth (Gates et al., 2012a; Gates, Hanning, Gates, Skinner, Martin, & Tsuji, 2012b; Gates et al., 2013a, 2014; Hlimi, Skinner, Hanning, Martin, & Tsuji, 2012), the prevalence of food security and related community coping strategies (Skinner, Hanning, & Tsuji, 2014a; Skinner, Hanning, Desjardins, & Tsuji, 2013), the development of a community-tailored dietary assessment tool (Hanning, Royall, Toews, Blashill, Wegener, & Driezen, 2009), and an understanding of the barriers and facilitators to PA and a healthy diet from the perspective of community members (Skinner et al., 2012a; Skinner, Hanning, & Tsuji, 2006; Sutherland et al., 2007).

Building upon this knowledge, communities have engaged in implementing and evaluating local initiatives intended to improve the health of their youth, including a school greenhouse project (Skinner, Hanning, Metatawabin, & Tsuji, 2014b), school food provision programs (Gates, Hanning, Gates, Stephen, & Tsuji, in press; Gates, Hanning, Gates, McCarthy, & Tsuji, 2013b;

Gates, Hanning, Gates, Skinner, McCarthy, & Tsuji, 2012c; Isogai et al., 2012; Skinner et al., 2012b), comprehensive school nutrition programs (Gates, Hanning, Gates, Isogai, Metatawabin, & Tsuji, 2011; Gates, Hanning, Gates, Isogai, Tsuji, & Metatawabin, 2013c; Hanning, Skinner, Gates, Gates, & Tsuji, 2011) and a harvest sharing initiative (Gates, Hanning, Gates, & Tsuji, submitted manuscript). The programs, whenever possible, employed local individuals in order to improve sustainability and relevance.

It is acknowledged that rapport building is an important step in the participatory research process. The research team has been working closely with the western James Bay, northern Ontario community involved in this study since 2009 when, based on the desires of the community to gain understanding of factors impacting their health, the diets of local youth were assessed (Gates et al., 2012a, 2012b). Following the dietary assessment, which indicated low intakes of important food groups (i.e., vegetables and fruit, milk and alternatives) school food provision programming was initiated and evaluated for process and outcomes over the short- (Gates et al., 2012c, 2013b) and long-term (Gates et al., in press). Though there were many initial challenges, after four years, the program was thought to have contributed to improving the dietary intakes of youth and building community capacity for operating these types of programs (Gates et al., in press; Gates, Gates, Stephen, Hanning, & Tsuji, 2013d). A school health committee was struck and many of the initial barriers to success were overcome as the community gained capacity to run the program. Over this time, a relationship of mutual trust was developed between community partners (who included Band Councillors, elected members of the local government, school principals and teachers) and university researchers.

Continuity in university-community research relationships is important as it allows communities to build upon results of past and current projects as capacity for each initiative grows. As such, contact between the research team continued in the years following the initiation and evaluation of the school snack program. About three years later (in 2012), the community had made sufficient progress with the nutrition program that they felt ready to build upon this school health programming. The school principal and physical education teacher identified PA and fitness amongst youth as an emerging concern for which further knowledge was desired, because they had noticed the heavy burden of diabetes and cardiovascular disease in their community.

Currently, only extremely limited regional-level information has been published on the PA or fitness patterns of FN youth from the James Bay region of Ontario (Gates et al., 2013a; Skinner et al., 2012a; Sutherland et al., 2007) and none of these studies has focused specifically on the community involved in the current study. Prior to implementing PA programming, locally relevant information was needed and desired. University researchers collaborated with school officials to conduct a needs assessment that would ultimately be used to inform and tailor the PA program to the specific needs of community youth. In doing so, the information obtained would not only have value locally, but would also begin to fill research gaps in the understanding of how PA may be experienced by youth in remote, isolated northern FN communities such as the one involved in this project.

6.4 Evaluation Framework

6.4.1 Evaluation Type and Approach

A utilization-focused evaluation approach was used to begin to understand the nature and scope of the situation regarding PA and fitness for youth in the community. Utilization-focused evaluation is a participatory approach that involves program stakeholders at all stages of the evaluation and places emphasis on the utility of the findings for those involved (Patton, 2012; Rossi, Lipsey, & Freeman, 2004). Beginning in the Fall of 2012, a needs assessment was conducted to develop a meaningful description of the issue to be addressed and to establish programming needs (Rossi, Lipsey, & Freeman, 2004). As a first step, potential program stakeholders were identified. Information from a number of sources (e.g., quantitative data on anthropometrics, PA, and fitness; qualitative data to gain insight on supports and barriers) was triangulated to develop a description of the target population, their needs, and the environment in which the program would be implemented (Rossi, Lipsey, & Freeman, 2004). As a final stage of the needs assessment, the results were presented to the stakeholder groups. Local advisors reviewed the dissemination documents to ensure that the interpretation was accurate and that the results were presented in a way that would be useful to a diverse group of stakeholders.

Emphasizing a participatory approach, the community advisors were involved at all stages of the process to ensure relevance and cultural appropriateness; the study protocol and methodologies were agreed upon prior to submission for ethics approval. All documents (e.g., focus group scripts, consent forms) and measures were reviewed and approved by the local advisors before being used. Contact between the university-based research team and community collaborators

was maintained via telephone and email between data collections, given the high cost of travel to the community.

6.4.2 Identification of Stakeholders

The main stakeholder groups for the evaluation were identified and their relationships to the potential program have been described in **Figure 6.1**. Under the umbrella of national, provincial and local governments, the local elementary school is located within the greater community. The potential sports program would take place within the school, whose operation is overseen by the local education authority (FN administered; equivalent to a municipal school board). Within the context of the school the administrators, the potential program coordinator, teachers and students continually interact. They are likely to be directly affected by potential programming. Those most invested in, and most likely to be directly affected by, the program were included in the evaluation (i.e., students, the potential program coordinator, teachers).

The nearby high school has direct interest in the potential program, as this is where the community gymnasium is located. Parents and family members of community youth, as well as local coaches, may be directly involved or have a keen interest in the potential program. On the right side of **Figure 6.1** are external individuals and organizations who, though unlikely to be directly impacted, may be interested in findings of the evaluation.

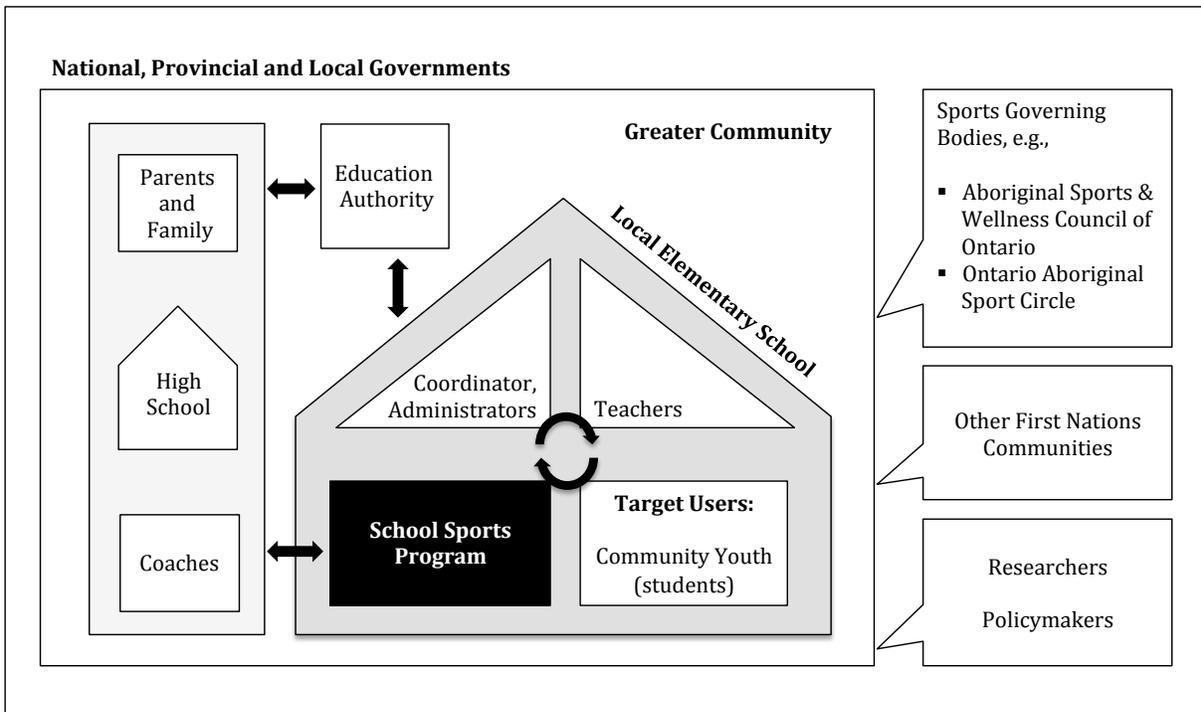


Figure 6.1 Stakeholder map for a potential school sports program in a subarctic Ontario First Nations community

6.5 Evaluation Questions, Objectives and Hypotheses

6.5.1 Evaluation Questions and Objectives

In order to inform a school sports program in a remote and isolated western James Bay, Ontario FN community, a needs assessment was employed to address two main evaluation questions, each with associated objectives, as follows. Further detail on the evaluation questions, along with the associated indicators and methods used to answer them are shown in **Table 6.1**.

1. Is there a need for a school sports program in the community?

Objective 1a: Among youth in grades 6-7 from a remote, isolated James Bay FN community in northern Ontario, to obtain baseline measures of anthropometry (BMI, waist circumference, body fat percentage), PA (minutes of MVPA/day, steps counts/day), and physical fitness (cardiorespiratory endurance, muscular strength and endurance, flexibility).

Objective 1b: In these same youth, to identify differences in anthropometrics, PA and physical fitness measures between youth when they were dichotomized as being (a) male vs. female, (b) normal weight vs. overweight or obese, (c) normal waist circumference vs. abdominally obese, or (d) normal body fat vs. excess body fat percentage.

2. What barriers and supports currently exist to sports and PA participation for school aged youth in the community?

Objective 2: To qualitatively assess the barriers and supports to PA and sports participation for school-aged youth in the community.

Table 6.1 Questions, indicators, information sources and methods for a needs assessment for school sports program in a subarctic Ontario First Nation community^a

Indicators	Information Sources	Methods	Objectives
1. Is there a need for a school sports program in the community?			
<ul style="list-style-type: none"> ▪ Evidence of high prevalence of obesity, abdominal obesity, excess body fat ▪ Evidence of low PA compared to national guidelines ▪ Evidence of low physical fitness levels 	<ul style="list-style-type: none"> ▪ Community youth ▪ Existing literature 	<ul style="list-style-type: none"> ▪ Review of literature ▪ Anthropometry ▪ Accelerometry ▪ Field tests for physical fitness 	1a, 1b
2. What barriers and supports currently exist for youth wishing to participate in PA in the community?			
<ul style="list-style-type: none"> ▪ Number and type of facilities available for PA ▪ Amount and type of equipment available for PA ▪ Number of personnel available to run programs ▪ Extent of funding available for PA ▪ Perceptions of key informants 	<ul style="list-style-type: none"> ▪ Community youth ▪ Community teachers ▪ Observation notes 	<ul style="list-style-type: none"> ▪ Focus group with youth ▪ Focus group with teachers ▪ Environmental scan 	2

^aAdapted from the framework presented by Langevin (2001).

6.5.2 Hypotheses

The *a-priori* hypotheses associated with each of the aforementioned objectives were as follows:

Hypothesis 1a:

1. There will be a high prevalence of overweight, obesity, abdominal obesity and excess body fat.
2. Most (>75%) youth will meet Canada's PA guidelines and age- and sex-specific step count recommendations.
3. Physical fitness will appear low when compared to data available for the general population (CHMS).

Hypothesis 1b:

1. BMI z-score is expected to be similar among both boys and girls, but boys will have higher waist circumference while females have higher levels of body fat. Boys will be more active than girls and have higher cardiorespiratory endurance. Boys will have greater muscular strength and endurance than girls, but girls will have greater flexibility.
2. Youth who are overweight, obese, abdominally obese, or who have excess body fat, will be less physically active and less physically fit than their normal weight peers.

Hypothesis 2a:

1. Numerous barriers are expected, related to resource limitations, but some existing supports are also likely to exist.

In-depth reasoning for each of these hypotheses was as follows:

Hypothesis 1a: Baseline measures of anthropometry, PA, fitness and sports participation for grades 6 to 7 youth will be similar to what has been reported in the literature for Aboriginal youth, where this information is available. Given previous self-reported estimates of overweight and obesity in the same region (Gates et al., 2013a) prevalence rates of measured overweight and obesity are expected to be high (>50% of the population). First Nations youth are disproportionately affected by elevated waist circumference (Anderson et al., 2010). For this reason, elevated waist circumference is expected to be prevalent, as reported in other FN communities (Pigford et al., 2011; Downs et al., 2008). Though body composition is not well

studied for FN youth, given that obesity prevalence is expected to be high, the prevalence of high body fat is also expected to be elevated (>30% of the population).

Though reviews of the literature show that the PA level of Aboriginal youth tends to be low (Foulds, Warburton, & Bredin, 2013; Young & Katzmarzyk, 2007), studies in discrete regions have shown high levels of measured PA among FN youth (Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall, & Willows, 2006). In addition, personal observation in the community predicts a relatively high level of MVPA among the youth. It is likely that most youth will meet Canada's PA guidelines (Tremblay et al., 2011b) as well as age- and sex-specific step count recommendations (Tudor-Locke, Craig, Beets, Belton, Cardon, Duncan et al., 2011).

Levels of cardiorespiratory endurance are expected to be low, based on concerns of local collaborators and the few available studies that document low levels of cardiorespiratory endurance among populations of FN youth (Tomlin et al., 2012; Downs et al., 2008; Ng, Marshall, & Willows, 2006). Performance on other fitness measures is difficult to predict due to the limited literature on the topic for this particular population.

Hypothesis 1b:

1. Differences by Sex

As has been observed among youth in the general population (Tremblay et al., 2010b) it is expected that boys will have similar BMI z-scores as compared to girls, and a similar proportion are expected to fall into overweight and obese categories. While waist circumference among boys is expected to be higher than girls (Tremblay et al., 2010b), the presence of abdominal obesity

is not expected to differ by sex. However, as has been demonstrated among the general population (Tremblay et al., 2010b), it may be expected that girls will have higher body fat percentages than boys (this is to be expected).

As in the general population and among populations of FN youth, boys are expected to be more active (FNIGC, 2012; Katzmarzyk, 2008), therefore accumulating greater time in MVPA each day and more steps compared to girls. As demonstrated in other communities, more boys are expected to meet Canadian standards for PA as compared to girls (Lemstra et al., 2010; Mitchell et al., 2010; Ng, Marshall, & Willows, 2006). However, it is possible that adherence to step count recommendations will not differ (the standards for boys and girls are different), as with the findings of Pigford et al. (2011) in a northern Alberta FN.

Though information on the topic is severely limited, the higher activity level expected among boys may mean that they also have higher cardiorespiratory endurance. This would follow the trends seen in youth aged 11 to 14 years in the general population (Tremblay et al., 2010b). Differences in the other measures of fitness by sex are more difficult to predict, and may also follow trends seen in the general population. For example, boys and girls are likely to have similar muscular endurance, but girls may possess lesser strength and greater flexibility than boys (Tremblay et al., 2010b).

2. Differences by BMI, Waist Circumference and Body Fat

As compared to those of normal weight, waist circumference or body fat percentage, those who are categorized as overweight or obese, abdominally obese or as having excess body fat are expected to be less physically active (less time spent in MVPA, fewer steps per day) and less physically fit (lower cardiorespiratory endurance in particular). Among the general population, boys who are overweight or obese are less active than their normal weight peers, but the relationship is not seen in girls (Colley et al., 2011). There are few data available to substantiate these hypotheses among FN youth in particular, though inverse associations between BMI and PA (Gates et al., 2013a; Mitchell et al, 2010; Ng, Young, & Corey, 2010; Downs et al., 2008; Katzmarzyk, 2008) among Aboriginal youth as well as FN youth in specific have been documented. Two discrete studies have demonstrated an inverse association between waist circumference (or presence of abdominal obesity) and PA among FN youth (Pigford et al., 2011; Mitchell et al., 2010).

Hypothesis 2a: Given previous knowledge about the community and experience in implementing a school snack program (Gates et al., 2012c, 2013b), numerous barriers to PA are expected. Some of the barriers to PA may include limitations in resources and facilities, inadequate and inconsistent funding for organized PA, limited staff and volunteers to run activities, a harsh climate and safety concerns, and other competing activities that take time away from PA. Supports may include the enthusiasm of teachers and students, the availability of positive role models, and the use of the school as a hub for PA and sports.

6.6 Methods

6.6.1 Setting and Recruitment of Participants

As previously mentioned, this study took place in a subarctic FN community, located near James Bay, in Ontario. A member of the Mushkegowuk Tribal Council, the community is home to approximately 1700 Cree people (Five Nations Energy, 2012). The community is remote, with the closest urban centre being Timmins at a distance of about 450 km, and the closest large metropolitan area being Toronto at a distance of more than 950 km by air. The community is also isolated, being accessible only by air year-round, by barge in the ice-free months and by ice road for two-to-three months of the year, weather permitting. Situated in the subarctic climate zone, winters are long and very cold (average maximum temperature in February 2015 was -18.5°C) while summers are short and mild (average maximum temperature in July 2015 was 23.3°C) (Environment Canada, 2015).

The community has one elementary school, consisting of portable classrooms, that serves approximately 400 students. The nearby high school has a gymnasium that is shared with the elementary students. Because the gymnasium needs to be shared by many students, youth in the elementary school have access to only one-to-two 30-minute sessions of physical education weekly. The community has one main store to purchase groceries and all other goods, as well as a few local businesses (e.g., convenience stores, restaurants, bed and breakfasts), but is generally socioeconomically disadvantaged, in part because of the few available chances for employment. The community is prone to major flooding in the spring, often prompting community-wide evacuations for weeks to months. At the time of this project, the community had Internet

connectivity but no mobile phone service; power outages and Internet connection problems occurred relatively regularly.

All school attending youth in grades 6 and 7 were eligible to participate in the study. Information letters were sent home to parents/guardians of potential participants two weeks prior to the arrival of the university-based collaborators in the community, both for the full project as well as specifically for focus groups (**Appendix A** and **Appendix B**). Along with the letter, parents were asked provide informed written consent for their child's participation by returning the signed consent form to the school by the first day of data collection. Students for whom signed consent forms were not received were deemed ineligible to participate. Students themselves also provided verbal assent, thus could decline participation in any or all measures at any time (see **Appendix C**). Teachers in grades 6-7 were invited to participate in a focus group, both via information letters and during an informal planning meeting after the arrival of university researchers in the community (**Appendix D**). Informed consent from grades 6 to 7 teachers who participated in the focus group was obtained at the time of the discussion. Ethics approval was obtained from the University of Waterloo Office of Research Ethics (#18309). The data collection and consent methods were chosen in close collaboration with school officials who liaised with the local Education Authority. As an incentive for participation, youth were entered into a draw to win an Apple iPod[®] if they participated in the measurements and returned their accelerometer.

6.6.2 Anthropometry

Anthropometric measurements were completed in October 2012, by two registered dietitians (i.e., the author and a graduate-level assistant). These individuals had training in anthropometric assessment, and performed the measures according to a predetermined protocol (**Appendix E**). As the school consists of portable classrooms, students were measured one-to-two at a time (depending on preference) in the open space outside of the classrooms, inside the portable. Participant height (without shoes) was measured to the closest 0.5 cm using the Seca 213 portable stadiometer (Seca, Chino, CA). Body mass (i.e., weight) was measured to the closest 0.1 kg using the Tanita BC-568 digital scale (Tanita Corporation of America, Arlington Heights, IL). Participants wore light indoor clothing and socks, and were asked to remove heavy sweaters prior to the measurement. From the measured height and weight values, BMI was computed to the closest 0.1 kg/m² and participants were categorized as wasted (<3rd percentile), normal weight (3rd to 85th percentile), overweight (>85th percentile) or obese (>97th percentile) in accordance with the WHO growth reference for children and adolescents (DC & CPS, 2010; de Onis et al., 2007). Body mass index for age z-score was calculated for each youth (WHO, 2015b).

Waist circumference, used as a proxy measure of abdominal fat deposition (Health Canada, 2003), was measured to the closest 0.5 cm using a standard non-stretchable measuring tape, at the midpoint between the bottom of the ribcage and the iliac crest, while the participant was lightly clothed (e.g., t-shirt) and standing with their arms hanging loosely by their sides. Waist circumference was chosen as it is a known predictor for diabetes, and available data show that current thresholds are appropriate for use in Aboriginal people (Lear et al., 2007). Participants

were categorized as being abdominally obese if their waist circumference exceeded the 85th percentile of CDC growth standards, developed using age- and gender-matched youth from the Third National Health and Nutrition Examination Survey [NHANES III] cohort (McDowell, Fryer, & Ogden, 2009).

Body fat percentage was measured to the closest 0.1% of body weight using the Tanita BC-568 digital scale (Tanita Corporation of America, Arlington Heights, IL), which employs eight electrodes (two per limb) to estimate fat mass and fat-free mass via bioelectrical impedance analysis [BIA]. This method uses a mild electric current to estimate total body water, which in turn can be used to estimate body fat percentage via age- and sex-specific predictive equations (Whitney, Rolfes, Hammond, Piché, 2013). Though dual-energy x-ray absorptiometry [DEXA] is the gold standard for body composition assessment (Whitney et al., 2013), it is relatively expensive and the necessary machinery is not portable nor available in the remote setting in which this project took place. Currently available field methods for body composition assessment, including skinfold thickness measurements and BIA, although less accurate and more prone to error, are considerably more practical and realistic in remote settings where DEXA is not a possibility (Talma, Chinapaw, Bakker, HiraSing, Terwee, & Altenberg, 2013). Specifically, the BIA method was chosen for this study because it is easily portable, minimally invasive, and relatively quick to perform (i.e., <30 seconds). Compared to skinfolds, this method is less prone to measurement error attributable to the researcher and imposes lesser burden on participants. Based on the BIA findings, youth were categorized as having excess body fat if measurements exceeded the 85th percentile of CDC growth standards, developed using whole

body DEXA scans from age- and gender-matched youth in the NHANES IV cohort (Ogden, Li, Freedman, Borrud, & Flegal, 2011).

6.6.3 Physical Activity

School day PA was measured quantitatively using waist-mounted accelerometers. Given youths' limited ability for accurate recall, measured PA (e.g., using accelerometry or pedometry) is generally preferred (Rowlands & Eston, 2007). Participants were loaned Actigraph GT3X (Actigraph, Pensacola, FL) accelerometers and given instructions on how and when they were to be worn. Specifically, the devices were worn on the hip, using the attached adjustable belt and at all times over a period of three consecutive school days, other than when sleeping or in situations where the device could become damaged. The Actigraph GT3X is among the most commonly used research grade accelerometers; it measures acceleration in three planes and provides information on the accumulated time, intensity and duration of bouts of activity (Cain, Sallis, Conway, Van Dyck, & Calhoun, 2012). Participants were encouraged to take part in their usual activities throughout the wear period, and not to exaggerate daily activity levels because the device was being worn. Since the accelerometers themselves do not provide any information to the participant, there was likely minimal motivation to alter usual activities. The accelerometers were initialized to start recording activity one hour following their distribution, to allow time for the participants to become accustomed to wearing them. During the three days of wear, observed weather conditions were documented and temperatures were obtained via weather data available online (Environment Canada, 2015). This was important because season, air temperature and precipitation are known to affect the PA level of adolescents (Bélanger et al., 2009).

Following three full days of data collection, the accelerometers were collected from the participants by the university-based collaborators who were present in the community. It has been suggested that four to nine days of wear is an ideal time span to accurately measure PA (Troost, McIver, & Pate, 2005). That being said, for the purposes of this study, the three day time span was chosen as a compromise between data validity and participant burden; while more days of wear would increase the validity of the data, compliance decreases significantly with longer wear periods (Corder, Ekelund, Steele, Wareham, & Brage, 2008; Trost, McIver, & Pate, 2005). Given the age range of participating youth, the three-day wear period was deemed to be feasible and realistic.

The recorded accelerometry data were downloaded using ActiLife 6 data processing software (Actigraph, Pensacola, FL). To optimize the small sample size, participants were included in the analysis if they had at least one day of valid wear, with acknowledgement that one day cannot represent 'usual' PA level. Though the criterion used to describe a day of valid wear is highly variable in the literature, 10 hours is the most commonly used cut-point and was therefore chosen for this study (Cain et al., 2013). A 10-second epoch time was used, given that short epoch times have been shown to be most valid for use in children, who tend to accumulate multiple short bursts of intense activity (McClain, Abraham, Brusseau, & Tudor-Locke, 2008). Time in MVPA was compared to Canadian Physical Activity Guidelines, which recommend 60 minutes of daily MVPA (Tremblay, Warburton, Janssen, Paterson, Latimer, Rhodes, et al., 2011c). Additionally, daily step counts were compared to age- and sex-specific reference standards, 1500 steps/day for females and 1800 steps/day for males (Tudor-Locke et al., 2011).

For the days when accelerometers were worn, youth also completed pen and paper-based 24-hour PA recalls (**Appendix F**), adapted from the Pathways Physical Activity Recall Questionnaire (Going, Levin, Harrell, Stewart, Kushi, Cornell, et al., 1999), which assesses PA using a checklist format. The questionnaire was chosen as it has been shown to be a feasible tool for subjective PA assessment in a comparable group of American Indian children (Going et al., 1999). The main objective of the questionnaire was to gain insight into the types of activities that youth participated in. Participants completed the recalls in the classroom, with the help and supervision of a teacher or teaching assistant. From the checklist of physical and sedentary activities, participants were asked to circle the amount (0-15 minutes, 15-30 minutes, 30+ minutes) and intensity (easy, medium, hard) for each activity they participated in during three distinct time periods (before, during, and after school). Participants were also encouraged to add activities that were not present on the checklist.

6.6.4 Physical Fitness

Physical fitness is the set of attributes possessed or achieved by an individual that allows them to perform PA, and is characterized by five health-related components as described by Casperson, Powell, and Christenson (1985): aerobic (or cardiorespiratory) endurance, muscular strength, muscular endurance, flexibility and body composition. In this study, physical fitness was measured, when possible, in accordance with the Canadian Physical Activity, Fitness and Lifestyle Approach [CPAFLA], a standardized evidence-based approach to fitness assessment used in Canada (PHAC, 2004). Testing took place during physical education classes in the gymnasium of a nearby high school, with the aid of supervising teachers and/or teaching

assistants. Prior to each test, researchers physically demonstrated the procedure, verbal explanations were provided and participant questions were answered.

To approximate cardiorespiratory endurance, participants completed the multistage 20-metre shuttle run to exhaustion (i.e., until they were unable to continue or could not complete two laps before the signal) (Léger, Mercier, Gadoury, & Lambert, 1988). This method was used as it is relatively simple and does not require the specialized equipment needed for the testing procedure described by CPAFLA (PHAC, 2004). This field test is a reliable ($r=0.89$) and valid ($r=0.71$; $SE=5.9$ mL/kg/min) predictor of maximal aerobic power (VO_{2max} , mL/kg/min) among children and adults, when compared to the gold standard (Castro-Piñero, Artero, España-Romero, Ortega, Sjöström, Suni, et al., 2010; Léger et al., 1988). Participants wore regular street clothes and socks (without shoes) during the run, as is customary in the community. Throughout the test, students were encouraged to achieve their best possible performance. The final shuttle run stage completed was used along with the participant's age, sex and BMI to predict VO_{2max} using the equation suggested by Mahar et al. (2011), $VO_{2max} = 41.76799 + (0.49261 \times \text{Shuttle laps}) - 0.0029 \times \text{Shuttle laps}^2 - (0.61613 \times \text{BMI (kg/m}^2)) + (0.34787 \times \text{Sex} \times \text{Age})$, where sex was dichotomised as 1=male and 0=female. This equation has been shown to be valid for youth aged 10 to 16 years, with a correlation coefficient of 0.75 to directly measured maximal aerobic power, slightly higher than what has been reported for other predictive equations (Mahar, Guerieri, Hanna, & Kemble, 2011).

Resting blood pressure was also measured as a proxy for cardiovascular health. For convenience and to assure a relaxed, confidential atmosphere, blood pressure was assessed at the time of the

anthropometric measurements using the BpTRU BPM-100 (BpTRU Medical Devices, Coquitlam, BC) automated blood pressure monitor. The preferred method for blood pressure testing is by auscultation (i.e., the cuff is filled and emptied by hand while listening via stethoscope at the point of the brachial artery) (National High Blood Pressure Education Program Working Group on Blood Pressure in Children and Adolescents [NHBPEP], 2004), however, the automated technique was used because it would reduce variation associated with the researcher, as well as for ease of use in a setting where noise was an issue. Otherwise, standard protocols for blood pressure measurement were followed (NHBPEP, 2004). Researchers encouraged participants to relax prior to the measurements, and following a brief period of rest, the device performed a series of three readings over a period of three minutes. The first reading was discarded and the remaining two readings were averaged and recorded. Though one-time blood pressure measurements cannot be used to diagnose hypertension (NHBPEP, 2004), these measurements were used as a possible predictor at the group level. Using average blood pressure values, participants were categorized as potentially pre-hypertensive or hypertensive if they met or exceeded the 90th and 95th percentile, respectively, according to age, sex, and height-based standards of the National Heart, Lung and Blood Institute, developed using National Health and Nutrition Examination Survey [NHANES] data (NHBPEP, 2004).

To estimate muscular endurance, participants completed the 1-minute partial curl-ups test (PHAC, 2004). Though there exists limited literature to ascertain the validity of this test, it is commonly used in fitness batteries in order to estimate trunk muscular endurance, and was chosen due to being directly comparable to 2007-2009 CHMS findings (Tremblay et al., 2010b). In a supine position with legs bent at a 90-degree angle and arms on the floor, students were

instructed to complete the curl-ups at set intervals (50 beats/minute, as signalled by a CD-ROM) to exhaustion (maximum of 25 curl-ups or one minute). Participants were encouraged to complete as many curl-ups as possible. The maximum number of curl-ups completed by each participant was recorded.

Muscular strength was estimated via handgrip dynamometry using the Smedley dynamometer (AMG Medical, Montreal, QC). This method has strong evidence of validity as an indicator of muscular strength, with strong correlations to total body muscular strength ($r=0.9$ in boys, $0.7-0.8$ in girls) (Castro-Piñero et al., 2010; Wind, Takken, Helders, & Engelbert, 2010). Participants were instructed to hold the dynamometer with their hand slightly away from their body, at the level of the thigh (the instrument was adjusted to hand size) (PHAC, 2004). The participant was then asked to squeeze the dynamometer, applying their maximum force, while exhaling. Both hands were measured alternately, with two trials per hand (PHAC, 2004). The maximum score from each hand was recorded to the nearest kilogram, and these scores were combined for the total score (PHAC, 2004).

Finally, flexibility was estimated using the sit-and-reach test, with the aid of a flexometre (Fit Systems Inc., Calgary, AB) designed for this purpose. Though more accurate testing procedures exist for use in clinical settings, the sit-and-reach test has acceptable moderate validity for estimating hamstring flexibility ($r=0.55-0.83$ in males, $r=0.41-0.70$ in females) and is therefore a useful tool for field tests (Mayorga-Vega, Merino-Marban, & Viciano, 2014). Participants were warmed up from performing the shuttle run prior to the testing. One at a time, each participant was asked to rest their feet against the cross-boards of the flexometre, with their legs extended

fully (PHAC, 2004). Participants were then encouraged to lean forward, pushing the sliding marker on the flexometre as far as possible with their fingertips (PHAC, 2004). The procedure was repeated and the furthest of the two attempts was recorded to the closest 0.1 cm.

6.6.5 Supports and Barriers

The local context, supports and barriers to PA were assessed qualitatively by various means. Since the physical setting is a known determinant of PA and sports participation, two university-based collaborators (i.e., the author and a graduate-level assistant) conducted an environmental scan to identify possible supports and barriers (Loprinzi, Cardinal, Loprinzi, & Lee, 2012). A community walk-around (i.e., unobtrusive observation) during daytime hours was completed and written observations were recorded. Attention was paid to the availability and condition of recreation facilities and resources, types of terrain available, walking environment, aesthetics and safety (Brownson, Chang, Eyster, Ainsworth, Kirkland, Saelens, et al., 2004). The community schools (i.e., elementary and high school) were visited, as these are locations where many youth congregate and spend a large portion of the day.

Two separate focus groups were conducted to gain insight into the barriers and supports for PA and sports participation from those with the greatest knowledge and experience on the topic (i.e., students and teachers). Focus groups took place either during or directly following school hours, as convenient to participants, in the school setting. One facilitator (the author) led the focus group discussions using pre-determined scripts, which included open-ended questions and probes to elicit conversation (see **Appendix H** and **Appendix I** for specific questions). The discussions were not audio recorded, however a second facilitator (graduate-level assistant) observed the

focus groups and took detailed notes. Directly following the sessions, the author and the graduate-level assistant debriefed to ensure the accuracy and completeness of the recorded information.

6.7 Data Analysis and Interpretation

6.7.1 Quantitative Data

Baseline anthropometric, PA and fitness measures were described (mean±SD) and compared to available standards (**Table 6.2**) for each measurement, as applicable (frequencies). The sample was then dichotomized in four separate ways: (a) male vs. female, (b) normal vs. overweight or obese (categories collapsed due to small sample size), (c) normal waist circumference vs. abdominally obese and (d) normal body fat vs. excess body fat percentage. In each case, variables were tested for normality using the Shapiro-Wilk test. Due to the non-normal distribution of a number of variables, group-level differences for continuous variables were assessed using the Mann-Whitney U test. Differences in categorical variables were tested using the Pearson's Chi-square test or Fisher's exact test when there were cell counts of less than five. All analyses were conducted using SPSS version 21.0 (IBM Corporation, Armonk, NY) with $p \leq 0.05$ chosen as the level of significance *a priori*.

Table 6.2 Standards used to classify anthropometric, physical activity and health data^a

Measure	Standard for Comparison
Anthropometry	
Body mass index (kg/m ²)	WHO growth reference (percentiles) ^b : <ul style="list-style-type: none"> ▪ Wasted: <3rd ▪ Normal: 3rd to 85th ▪ Overweight: >85th ▪ Obese: >97th
Waist circumference (cm)	CDC growth reference (percentiles) ^c : <ul style="list-style-type: none"> ▪ Normal: ≤85th ▪ Abdominally obese: >85th
Body fatness (% weight)	CDC growth reference (percentiles) ^d : <ul style="list-style-type: none"> ▪ Normal: ≤85th ▪ Excess body fat: >85th
Physical Activity	
Moderate-to-vigorous physical activity (minutes/day)	Canadian Physical Activity Guidelines ^e <ul style="list-style-type: none"> ▪ ≥60 minutes MVPA/day
Sports participation	Not Applicable
Cardiovascular Health	
Resting blood pressure (% borderline or elevated)	National Heart, Lung and Blood Institute standards (percentiles) ^f : <ul style="list-style-type: none"> ▪ Normal: <90th ▪ Prehypertension: ≥90th ▪ Hypertension: ≥95th

CDC: Centers for Disease Control and Prevention; WHO: World Health Organization

^aNote that standards for physical fitness based on the Canadian Physical Activity, Fitness and Lifestyle Approach (PHAC, 2004) were not applicable to the age group in this study.

^bdeOnis et al., 2007; ^cMcDowell, Fryer & Ogden, 2009; ^dOgden et al., 2011; ^eTremblay et al., 2011c; ^fNHBPEP, 2004

6.7.2 Qualitative Data

Data from the environmental scan and two focus groups were combined to develop a description of the perceived community supports and barriers to PA. In doing so, qualitative notes from the environmental scan and the focus groups were compiled into one data file so that the source of the information would not be a factor in the analysis. The findings were coded by hand, because the amount of data was manageable (Creswell, 2007). The analysis was inductive, such that an

attempt was made to remain open and to allow the categories and themes to emerge from the data without being influenced by pre-existing theories or ideas (Charmaz, 2006).

First, each piece of data was coded as an action, and therefore assigned a simple and precise gerund (Charmaz, 2006; Creswell, 2007). The process was intended to be performed with spontaneity, to remain close to the data, and to reduce the chance of imposing personal biases on the data interpretation (Charmaz, 2006). In the focused coding stage, the initial codes, written on small pieces of paper, were arranged into logical categories on a tabletop (Charmaz, 2006; Creswell, 2007). Then, categories were further organized into themes (Creswell, 2007). It is acknowledged that it is impossible to remain completely objective, as any individual will have biases (see **Author's Biases and Positionality**) (Charmaz, 2006; Shenton, 2004; Glaser & Strauss, 1967). Accordingly, to minimize the effects of investigator bias and to improve reliability, the themes were confirmed by a graduate-level researcher, and disagreements in interpretation were resolved via discussion (Shenton, 2004). The results were further confirmed by the community partners prior to dissemination.

6.8 Results

6.8.1 Characteristics of the Target Population

The characteristics of community youth in grades six and seven who participated in the project are shown in **Table 6.3**. A total of 72 youth (61.1% male; mean \pm SD age of 12.1 \pm 1.1 years) participated in at least one measurement (93.5% of eligible youth). Participation in the different tests varied based on presence at school on the day of the testing, as well as willingness to participate in each test (participation rate was 55.8% for body fat percentage to 77.9% for the sit-

and-reach test). A subset of 41 youth (56.9% of the total sample) participated in the accelerometry and 36 (87.5%) of those had at least one day of valid wear time (52.8% male, 12.0±1.1 years). These youth did not differ from those who did not participate in the accelerometry in terms of anthropometric variables nor physical fitness level. The mean air temperature was 8.1 °C (range: 5.9 to 11.2 °C) at the nearest weather station (about 130 km south of the community) on the accelerometry days (Environment Canada, 2015). While it was cloudy, it did not rain on these days, thus weather is not likely to have negatively impacted PA engagement.

The mean BMI z-score for the participating youth was 1.42±1.69, where 36% were normal weight, 25% were overweight and 38% were obese according to the WHO growth reference (de Onis et al., 2007). The prevalence of overweight and obesity appeared to be slightly higher among boys (64.8%) than girls (57.9%), though this was not statistically significant. The mean waist circumference was 87.3±15.0 cm and about half (51%) of youth were considered to be abdominally obese, according to the CDC reference values (McDowell, Fryer, & Ogden, 2009). This prevalence did not differ by sex. The mean body fat percentage was 30.6±8.4% and about one-fifth (21%) of youth were considered to have excess body fat according to CDC reference values (Ogden et al., 2011). While body fat percentage did not differ by sex, no girls in the study were classified as having excess body fat, while a significantly greater proportion (31%) of boys were (p=0.020).

Youth engaged in a mean 128.7±58.0 minutes of MVPA and took 14 085±5 043 steps daily, where boys accumulated a mean additional 43.5 daily minutes of MVPA (p=0.025) and 4 412

steps ($p=0.006$) as compared to girls. Though there appeared to be a trend for a greater proportion of boys as compared to girls to meet Canadian PA recommendations, the proportion did not differ significantly; overall, 86.1% of youth met Canada's PA guidelines, while 52.8% met step count recommendations. Meanwhile, youth spent 479.3 ± 189.6 daily minutes in sedentary time, a quantity that did not differ by sex.

There was high variability in cardiorespiratory endurance among participating youth. Overall, youth achieved 15.1 ± 9.6 stages on the shuttle run, which translated to a mean maximal aerobic power of 36.8 ± 6.2 mL/kg/minute. Boys achieved a higher mean level on the shuttle run than girls (16.5 ± 8.4 stages vs. 12.5 ± 11.2 stages, $p=0.023$), which translated to boys having greater maximal aerobic power than girls (38.7 ± 5.8 mL/kg/min vs. 32.9 ± 5.2 mL/kg/min, $p=0.003$).

Overall 46.4% of youth were classified as potentially pre-hypertensive or hypertensive, a proportion that did not differ by sex. However, results should be interpreted with caution because a single blood pressure measurement cannot be used to confirm hypertension (NHBPEP, 2004).

Muscular strength was measured at 53.1 ± 10.9 kg for the group, where strength was significantly higher among boys as compared to girls (55.0 ± 10.7 kg vs. 49.6 ± 10.6 kg, $p=0.034$). Meanwhile, flexibility was measured at 25.9 ± 8.0 cm and youth were able to complete 16.6 ± 9.3 curl-ups (muscular endurance). Measures of muscular endurance and flexibility did not differ by sex.

A total of 126 PA recalls were collected from 50 (68.3% male) youth, with 72% having completed three days of recalls. Among the days of recall, both boys and girls reported walking to school about 60% of the time. The most commonly reported activities among boys were running (reported on 46.5% of recalls); mixed walking/running (39.5%); push-ups, sit-ups or

jumping jacks (37.2%), basketball (25.6%) and ball sports such as dodgeball (24.4%). Among girls, mixed walking/running (50%), running (37.5%), indoor chores (25.0%) and outdoor play including climbing and hide-and-seek (25.0%) were the most frequently reported. Among boys, 25.6% of recalls reported watching more than 30 minutes of television after school and 22.1% reported spending more than 30 minutes playing video games. Girls appeared to more often report watching more than 30 minutes of television (42.5%) but less frequently (12.5%) report spending more than 30 minutes on video games (not tested statistically).

Table 6.3 Group anthropometric, physical activity and fitness characteristics, by sex^a

Variable	N (% male)	Total	Male	Female	P ^b
Age (y)	72 (61.1)	12.1±1.1	12.3±1.1	11.9±1.1	0.210
Anthropometry					
Body Mass Index z-score	56 (66.1)	1.42±1.69	1.53±1.98	1.20±0.92	0.109
Severe thinness (n (%)) ^c		1 (1.8)	1 (2.7)	0 (0.0)	0.174
Thinness (n (%))		0 (0.0)	0(0.0)	0 (0.0)	
Normal (n (%))		20 (35.7)	12 (32.4)	8 (42.1)	
Overweight (n (%))		14 (25.0)	7 (18.9)	7 (36.8)	
Obese (n (%))		21 (37.5)	17 (45.9)	4 (21.1)	
Waist Circumference (cm)	57 (70.6)	87.3±15.0	90.1±15.9	82.4±12.1	0.057
Abdominal obesity (n (%)) ^d		29 (50.9)	19 (52.8)	10 (47.6)	0.707
Body fat percentage (%)	43 (86.0)	30.6±8.4	30.1±9.7	31.8±5.1	0.282
Excess body fat (n (%)) ^e		9 (20.9)	9 (31.0)	0 (0.0)	0.020
Physical activity					
Time in MVPA (minutes/day)	36 (52.7)	128.7±58.0	149.3±59.9	105.8±47.6	0.025
% meeting guidelines ^f		31 (86.1)	18 (94.7)	13 (76.5)	0.167
Step count (steps/day)	36 (52.7)	14085±5043	16168±4463	11756±4723	0.006
% meeting guidelines ^g	36 (52.7)	19 (52.8)	11 (57.9)	8 (47.1)	0.516
Sedentary time (minutes/day)	36 (52.7)	479.3±189.6	470.3±213.9	489.3±164.2	0.594
Cardiorespiratory endurance and health					
Shuttle run level (#)	58 (65.5)	15.1±9.6	16.5±8.4	12.5±11.2	0.023
Maximal aerobic power (mL/kg/min)	47 (68.1)	36.8±6.2	38.7±5.8	32.9±5.2	0.003
Systolic blood pressure (mmHg)	56 (66.1)	117±18	118±20	114±13	0.441
Diastolic blood pressure (mmHg)	56 (66.1)	77±19	77±22	77±11	0.669
Normal (n (%)) ^h		30 (53.6)	19 (51.4)	11 (57.9)	0.887
Prehypertension (n (%))		6 (10.7)	4 (10.8)	2 (10.5)	
Hypertension (n (%))		20 (35.7)	14 (37.8)	6 (31.6)	
Muscular strength, endurance, flexibility					
Handgrip (kg)	61 (63.9)	53.1±10.9	55.0±10.7	49.6±10.6	0.034
Curlups completed (#)	50 (66.0)	16.6±9.3	17.3±8.4	15.2±11.0	0.730
Sit-and-reach distance (cm)	60 (63.3)	25.9±8.0	25.8±7.2	26.0±10.4	0.565

^aValues are presented as mean±SD, unless otherwise specified.

^bTested via the Mann Whitney U and Pearson Chi-Square tests. Significant differences are shown in bold typeface.

^cWorld Health Organization growth reference (de Onis et al., 2007) was used in determination of categories.

^dCenters for Disease control reference data (McDowell, Fryer, & Ogden, 2009) were used to determine categories.

^eCenters for Disease control reference data (Ogden et al., 2011) were used to determine categories.

^fAs compared to Canadian Physical Activity Guidelines (Tremblay et al., 2011c).

^gAs compared to normative reference data for children and youth (Tudor-Locke et al., 2011).

^hCategories based on the NHBPEP's report on blood pressure in children and adolescents (NHBPEP, 2004).

6.8.2 Group-level Differences by Weight Status, Abdominal Obesity and Body Fat Percentage

Group-level differences by weight (BMI) status are shown in **Table 6.4**. Compared to youth of normal BMI, those who were overweight or obese had higher waist circumferences by a mean 21.0 cm ($p < 0.001$) and were more often categorized as being abdominally obese (80.0% vs. 5.0%, $p < 0.001$). Further, overweight or obese youth possessed a mean 11.5% more body fat ($p < 0.001$) as measured by BIA, and were more often categorized as having excess body fat in comparison to CDC reference values versus their normal weight peers (31% vs. 0%, $p < 0.001$). While PA level and performance on the shuttle run did not differ across BMI categories, overweight or obese youth had lower cardiorespiratory endurance than normal weight youth in terms of maximal aerobic power, which is normalized by weight (33.9 ± 4.6 mL/kg/min vs. 41.2 ± 5.7 mL/kg/min, $p < 0.001$). When stratified by sex, significant differences by BMI category for boys were the same as seen in the total population (data not shown), except that overweight or obese boys also achieved a lower level on the shuttle run as compared to normal weight boys (21.0 ± 11.1 stages vs. 13.2 ± 5.6 stages, $p = 0.030$). Among girls, areas of significant difference between BMI categories were the same as shown for the total population of youth.

Table 6.4 Group-level differences in anthropometry, physical activity and fitness by weight category^{a,b}

Variable	N (% normal weight)	Normal weight (n=22)	Overweight or obese (n=35)	P ^c
Sex distribution (% male)		59.1	68.6	-
Anthropometry				
Body Mass Index z-score ^d	56 (37.5)	-0.01±1.87	2.28±0.74	<0.001
Waist Circumference (cm)	55 (36.4)	74.6±5.9	95.6±12.7	<0.001
Abdominal obesity (n (%)) ^e		1 (5.0)	28 (80.0)	<0.001
Body fat percentage (%)	43 (32.6)	22.9±3.9	34.4±7.4	<0.001
Excess body fat (n (%)) ^f		0 (0.0)	9 (31.0)	0.020
Physical activity				
Time in MVPA (minutes/day)	32 (46.9)	139.2±68.1	130.5±49.5	0.823
% meeting guidelines ^g		12 (80.0)	16 (94.1)	0.319
Step count (steps/day)	32 (46.9)	14730±5993	14227±4177	0.911
% meeting guidelines ^h		10 (66.7)	8 (47.1)	0.265
Sedentary time (minutes/day)	32 (46.9)	520.3±192.3	446.0±205.4	0.216
Cardiorespiratory endurance and health				
Shuttle run level (#)	47 (40.4)	18.5±11.3	12.5±7.8	0.052
Maximal aerobic power (mL/kg/min)	47 (40.4)	41.2±5.7	33.9±4.6	<0.001
Systolic blood pressure (mmHg)	52 (57.6)	116.3±17.9	118.6±18.7	0.556
Diastolic blood pressure (mmHg)	52 (57.6)	78.5±20.6	76.3±19.2	0.441
Normal (n (%)) ⁱ		11 (57.9)	16 (48.5)	0.804
Prehypertension (n (%))		2 (10.5)	4 (12.1)	
Hypertension (n (%))		6 (31.6)	13 (39.4)	
Muscular strength, endurance, flexibility				
Handgrip (kg)	51 (41.1)	51.6±12.1	54.0±9.3	0.168
Curlups completed (#)	42 (40.5)	16.1±10.3	16.6±8.8	0.979
Sit-and-reach distance (cm)	50 (42.0)	26.4±8.3	25.6±7.3	0.592

^aValues presented as mean±SD, unless otherwise specified.

^bWhen analyses were stratified by sex, areas of significant difference by BMI category were the same as for the total population, except that among boys, those who were overweight or obese achieved a lower level on the shuttle run as compared to those of normal weight (21.0±11.1 stages vs. 13.2±5.6 stages, p=0.030).

^cAs measured by the Mann Whitney U or Pearson's Chi-square tests. Areas of significant difference by BMI group are shown in bold.

^dBMI z-score according to the World Health Organization growth reference (de Onis et al., 2007)

^eCenters for Disease control reference data (McDowell, Fryer, & Ogden, 2009) were used to determine categories

^fCenters for Disease control reference data (Ogden et al., 2011) were used to determine categories.

^gAs compared to Canadian Physical Activity Guidelines (Tremblay et al., 2011c).

^hAs compared to normative reference data for children and youth (Tudor-Locke et al., 2011).

ⁱCategories based on the NHBPEP's report on blood pressure in children and adolescents (NHBPEP, 2004).

Group-level differences by waist circumference status (i.e., presence or absence of abdominal obesity) are shown in **Table 6.5**. Compared to youth with a normal waist circumference, as defined by CDC reference data (McDowell, Fryer, & Ogden, 2009), abdominally obese youth not surprisingly had higher BMI z-scores (0.36 ± 1.83 vs. 2.41 ± 0.73 , $p < 0.001$) and more often fell into categories of overweight or obesity ($p < 0.001$). In addition, abdominally obese youth possessed a mean 10.7% more body fat ($p < 0.001$) than those who were not abdominally obese and more often had excess body fat (36.0% vs. 0.0%, $p = 0.006$). For the population as a whole, PA level did not differ by waist circumference category, but boys with a normal waist circumference engaged in more daily MVPA than those who were classified as being abdominally obese (174.2 ± 63.3 minutes/day vs. 117.6 ± 39.7 minutes/day, $p = 0.031$). Overall, those who were abdominally obese reached a lower level on the shuttle run (11.8 ± 8.2 stages vs. 17.8 ± 10.4 stages, $p = 0.027$) and consequently were estimated to have lower maximal aerobic power (33.0 ± 4.4 mL/kg/min vs. 41.0 ± 5.2 mL/kg/min, $p < 0.001$) than those of normal waist circumference. Further, abdominally obese youth demonstrated lesser flexibility than those of normal waist circumference (23.5 ± 7.8 cm vs. 27.9 ± 7.5 cm, $p = 0.049$). Other measures of physical fitness (muscular strength, endurance) did not differ across waist circumference categories. It should be noted that when stratified by sex, trends in body fat percentage and flexibility across waist circumference categories for girls were similar to those observed in the total population but these trends no longer reached significance ($p = 0.108$ and $p = 0.762$, respectively).

Table 6.5 Group-level differences in anthropometry, physical activity and fitness by presence of abdominal obesity^{a,b}

Variable	N (% normal waist circumference)	Not abdominally obese (n=28)	Abdominally obese (n=29)	P ^c
Sex distribution (% male)		60.7	65.5	
Anthropometry				
Body Mass Index z-score ^d	56 (46.4)	0.36±1.83	2.41±0.73	<0.001
Severe thinness (n (%))		1 (3.8)	0 (0.0)	<0.001
Thinness (n (%))		0 (0.0)	0 (0.0)	
Normal (n (%))		18 (69.2)	1 (3.4)	
Overweight (n (%))		6 (23.1)	8 (27.6)	
Obese (n (%))		1 (3.8)	20 (69.0)	
Waist Circumference	57 (49.1)	75.2±6.9	98.9±10.9	<0.001
Body fat percentage	42 (40.5)	24.6±5.1	35.3±7.1	<0.001
Excess body fat (n (%)) ^e		0 (0.0)	9 (36.0)	0.006
Physical activity				
Time in MVPA (minutes/day)	31 (51.6)	140.2±66.8	122.2±43.1	0.423
% meeting guidelines ^f		13 (81.3)	14 (93.3)	0.600
Step count (steps/day)	31 (51.6)	14036±5248	14272±4422	0.861
% meeting guidelines ^g		9 (32.1)	8 (53.3)	0.870
Sedentary time (minutes/day)	31 (51.6)	508.9±216.0	454.9±191.0	0.423
Cardiorespiratory endurance and health				
Shuttle run level (#)	48 (50.0)	17.8±10.4	11.8±8.2	0.027
Maximal aerobic power (mL/kg/min)	46 (47.8)	41.0±5.2	33.0±4.4	<0.001
Systolic blood pressure (mmHg)	53 (49.1)	115.6±16.3	119.5±19.9	0.504
Diastolic blood pressure (mmHg)	53 (49.1)	79.4±18.3	75.0±40.4	0.972
Normal (n (%)) ^h		14 (56.0)	13 (48.1)	0.804
Prehypertension (n (%))		3 (12.0)	3 (11.1)	
Hypertension (n (%))		8 (32.0)	11 (40.7)	
Muscular strength, endurance, flexibility				
Handgrip (kg)	50 (48.0)	51.0±13.6	53.8±6.1	0.069
Curlups completed (#)	42 (47.6)	16.0±9.9	15.77±9.2	0.803
Sit-and-reach distance (cm)	49 (49.0)	27.9±7.5	23.5±7.8	0.049

^aValues presented as mean±SD, unless otherwise specified.

^bWhen stratified by sex, significant differences remained the same for males, and boys of normal waist circumference completed more MVPA than those who were abdominally obese (174.2±63.3 minutes/day vs. 117.6±39.7 minutes/day, p=0.031). Among females, trends in body fat and flexibility were no longer significant.

^cAs measured by the Mann Whitney U or Pearson's Chi-square tests. Areas of significant difference are bolded.

^dWorld Health Organization growth reference (de Onis et al., 2007) was used in determination of categories.

^eCenters for Disease control reference data (Ogden et al., 2009) were used to determine categories.

^fAs compared to Canadian Physical Activity Guidelines (Tremblay et al., 2011c).

^gAs compared to normative reference data for children and youth (Tudor-Locke et al., 2011).

^hCategories based on the NHBPEP's report on blood pressure in children and adolescents (NHBPEP, 2004).

Those categorized as having excess body fat had a higher waist circumference than those with normal body fat levels (100.9 ± 6.8 vs. 85.1 ± 11.3 cm, $p < 0.001$). Otherwise, youth with elevated body fat did not differ from those with normal body fat in terms of PA nor fitness variables (data not shown), except that they had higher systolic blood pressure values (131.0 ± 25.2 vs. 112.2 ± 13.0 mmHg, $p = 0.030$). However, when the data was stratified by sex, boys with excess body fat had lower cardiorespiratory endurance than their normal body fat peers (34.2 ± 4.9 vs. 42.4 ± 7.8 mL/kg/minute, $p = 0.035$).

6.8.3 Supports and Barriers for Youth to Participate in Physical Activity

Qualitative data included notes from a community environmental scan, a focus group with community youth in grades six and seven ($n = 11$, 6 female and 5 male), and a focus group with their teachers ($n = 5$, 3 female and 2 male). The analysis revealed four main themes that have been shown in **Figure 6.2**: *motivation, role models, personnel and facilities, and environment and programs*. Within each theme, a variety of barriers and supports to PA were identified. Focus group participants were quick to discuss a variety of barriers that exist to youth being active, but some supports were also raised. Many of the supports arose from the environmental scan. It became clear that the barriers and supports within each theme interacted (as demonstrated by arrows in the figure) to explain the current PA situation for youth in this FN community. From these barriers and supports, a number of programming needs were identified.

When asked about barriers and supports to being physically active, *personal motivation* was one of the main themes described by youth. Though they described having few positive role models, youth had a strong belief that participation in PA was important, and conveyed a number of

desires for improvements within the built environment, such as facilities and equipment. The lack of structured programming such as team sports was a barrier to motivation, especially since competition seemed to be an important motivator. Still, youth described having competing interests for sedentary activities. Some youth were simply not interested in the activities available, especially those who were too shy to participate. Girls, specifically, wanted to see more girls-only activities or teams being offered, such as dancing, hacky-sack and volleyball.

The influence of *role models* was another theme that was raised by participants, who indicated that few positive influences existed for PA (e.g., family, peers). While some teachers represented positive (i.e., active) role models, others described that lack of time and competing interests meant that they were not always positive influences. Youth described families and the greater community as having competing interests that reduced their participation in PA, such as television or video games. The relative lack of female role models (e.g., coaches) was a topic that recurred frequently in the focus groups. This was thought to be a limiter to the motivation of girls to participate in the currently offered activities.

Another set of barriers and supports fell under the theme of *personnel and facilities*. While there were some facilities available at the time of the needs assessment (e.g., playground, ice rink, walking trail) within the built environment and in close proximity to the school, youth and adults desired other facilities that would enhance PA for community youth (e.g., running track, swimming pool, additional gymnasiums). The high school gymnasium and weight room were identified as supports for youth, acting as a hub where youth convened and where most activities were offered. However, the limited number of facilities and personnel meant that only a few

activities could be offered over the course of a given time period and the preferences of all youth could not be met. There was not enough space, time or personnel support to offer sex-specific activities. Further, most coaches were male, which was a factor that was identified as a potential deterrent for girls to participate.

The final theme identified was *environment and programs*. The community was generally perceived as safe (e.g., limited traffic on streets) by youth and is easily walkable in the warmer months due to its small size. However, a harsh climate for much of the year and geographic remoteness, when combined with limited available facilities, were barriers. Stray dogs and other potentially threatening wildlife were also commonplace, though youth did not report these as being a concern. Both youth and adults described the desire to participate in more organized team sports (e.g., leagues) but the small number of youth in the community and distance from other communities made this logistically difficult. Further, facilities to run all of these activities were limited. The activities offered were also limited by the equipment available, owing to the high cost of procuring and shipping in equipment for a wider variety of sports. Teachers noted that many youth did not have the footwear (e.g., running shoes) needed to comfortably participate in outdoor PA (youth typically wear only socks indoors).

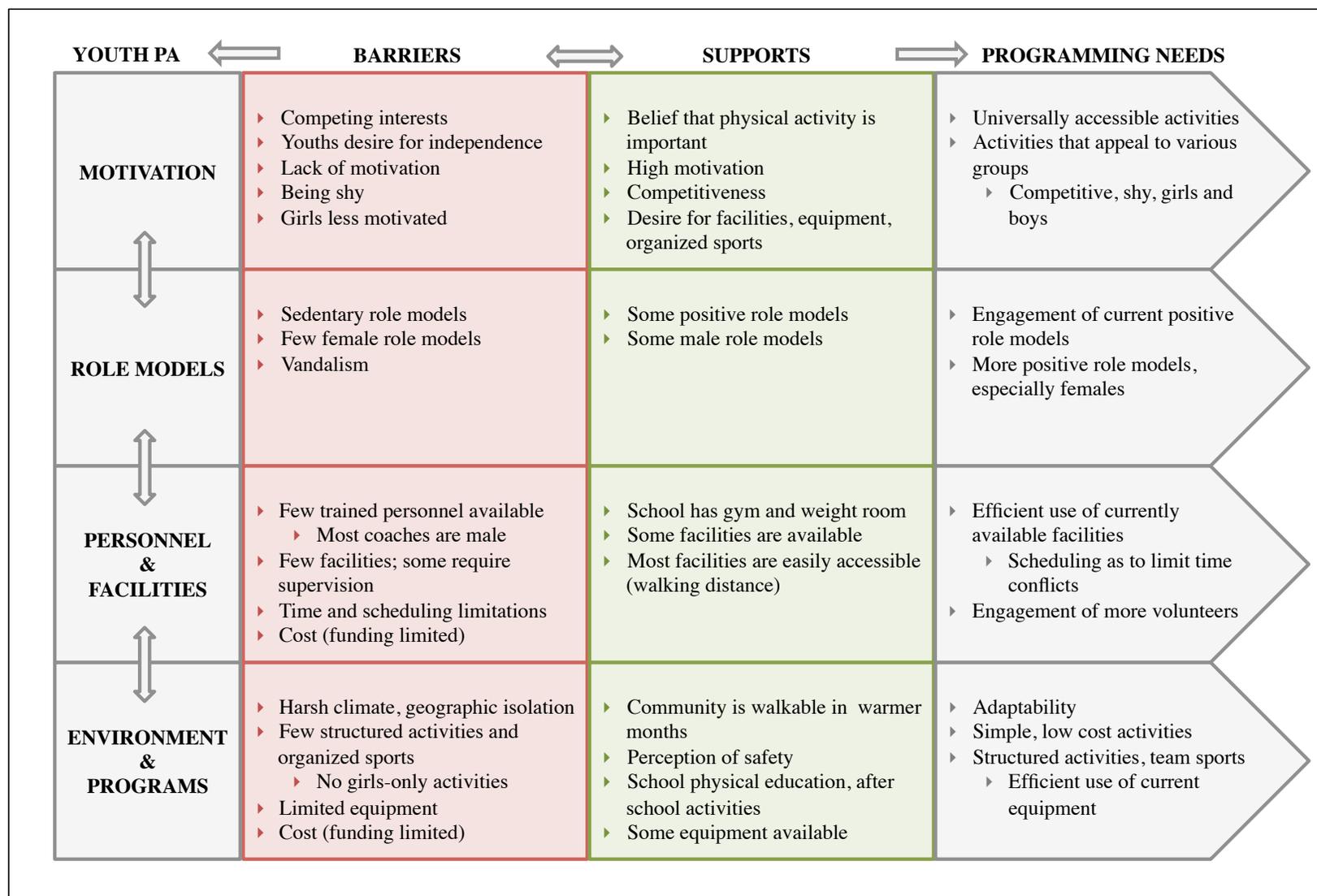


Figure 6.2 Themes and associated barriers and supports to physical activity for youth in a subarctic Ontario First Nation and identified programming needs (developed from data from an environmental scan, focus groups with n=11 youth and n=5 teachers)

6.9 Discussion

The current study contributes to the limited available knowledge about how PA is experienced by youth in a remote, northern FN community, by presenting measured PA and elaborating on facets of physical fitness that have rarely been previously mentioned in literature for this population. Using a mix of qualitative and quantitative methods, this research demonstrated that despite the numerous barriers to PA and sports participation for youth that mirror what is seen in many isolated and remote communities, youth were able to accumulate large amounts of measured MVPA. Nevertheless, the high prevalence rates of overweight, obesity, abdominal obesity and excess body fat, concomitant with low cardiorespiratory fitness are concerning. Considering the existing supports and the community's strong desire for programming, there is a clear opportunity to improve measures of body composition and fitness in this population. The enthusiasm of youth for PA and sports programming in their community provides additional support for such an initiative to have a positive impact.

6.9.1 Anthropometric Measures

The anthropometric data confirmed the community members' concerns and support the need for community-level efforts to increase PA among youth. The 63% prevalence rate of overweight and obesity, defined by the WHO growth reference (de Onis et al., 2007), is higher than previously self-reported prevalence rates for FN youth from northern and southern Ontario (52%) (Gates et al., 2012a), and exceeds the national rate reported for on-reserve FN youth in the 2008-2010 RHS by 20% (FNIGC, 2012). Because the RHS used self-reported height and weight data and categorized BMI using IOTF cutoffs (FNIGC, 2012), the prevalence of obesity is likely underestimated. Thus, the actual difference in prevalence rates between this FN and the mean

reported in the RHS may be slightly lesser than it appears at face value. Still, the prevalence of overweight and obesity among youth in this community demonstrates that they have not been spared, and in fact the prevalence reported herein exceeds that reported in a number of FN communities across the country (Ronsley et al., 2013; Pigford et al., 2010; Khalil, Johnson-Down, & Egeland, 2010). As compared to reports from the CHMS, the prevalence of obesity is more than three times greater among youth in this community as compared to their peers in the general population (11 to 14 years, 37.5% vs. 11.7%) (Roberts et al., 2012).

Indicators of body composition further substantiate the need for desirable community-level approaches to support the health of these youth. Unsurprising given FN youths' predisposition to abdominal fat deposition, about half (51%) of youth in the community were considered to be abdominally obese. In fact, as compared to the 2007-2009 CHMS (11 to 14 years), the mean waist circumference of the participating youth appeared to be about 20 cm higher for boys and 12 cm higher for girls (Tremblay et al., 2010b). An elevated waist circumference is concerning because excess abdominal fat has been associated with increased cardiometabolic risk in children and adolescents (Staiano, Gupta, & Katzmarzyk, 2014). Among FN youth in particular, studies in two discrete communities have pinpointed waist circumference as the primary predictor of metabolic syndrome in FN youth (Kaler et al., 2006; Zorzi et al., 2009). The literature supports increased PA as a potential avenue to begin to address obesity (FNIGC, 2012; Ng, Young, & Corey, 2010; Katzmarzyk, 2008; Ng, Marshall, & Willows, 2008) and abdominal obesity (Pigford et al., 2011; Downs et al., 2008) among Aboriginal youth and FN youth in particular.

Despite the high rates of abdominal obesity, comparatively fewer (21%) participating youth carried excess total body fat, suggesting that it is the location of body fat that is a concern for most youth, not the amount. Williams et al. (1992) suggested more stringent guidelines for health risk related to abdominal obesity in youth. Their report suggested that among 15 to 18 year old youth, a body fat percentage of >25% in males and >30% in females is associated with elevated blood pressure and cardiovascular disease risk factors (Williams, Going, Lohman, Harsha, Srinivasan, Webber, et al., 1992). Among youth in this community, 63% fell within this range of risk. Increased participation in MVPA may be one way to reduce cardiovascular risk among these youth (Janssen & LeBlanc, 2010).

6.9.2 Physical Activity and Sedentary Behaviour

As expected, participation in PA was high among community youth, more so among boys than girls. The participants in this study who completed the accelerometry accumulated 128.7 minutes of MVPA per day over the assessment period, more than double the amount reported among similarly aged youth (11 to 14 years) from the 2007-2009 CHMS (61 minutes/day for boys and 47 minutes/day for girls) (Colley et al., 2011). Resultantly, 86% of youth were considered 'active' as compared to Canadian recommendations (Tremblay et al., 2011c). Further substantiating the high participation among youth in this community, comparison to normative reference data from a large sample of Canadian youth shows that (Craig, Cameron, & Tudor-Locke, 2012) the mean daily steps taken by boys fell above the 80th percentile for 12 year old youth, while girls fell above the 55th percentile (Craig, Cameron, & Tudor-Locke, 2012).

These findings may be somewhat surprising given that only 49% of FN youth living on reserve across Canada are considered active (FNIGC, 2012). However, studies in remote, northern FN communities in Quebec and British Columbia have reported similarly high levels of measured PA among local youth (Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall, & Willows, 2006), suggesting that the findings are not exclusive to youth in this study. While remote regions may not have abundant resources (e.g., facilities, equipment) and experience numerous barriers to PA, youth appeared to be able to accumulate relatively large amounts of unstructured activity (e.g., playing). While this is encouraging, the limitations of the data should also be acknowledged, as many youth had incomplete data and some were represented by only one day of accelerometry, which may not reflect usual PA. Meanwhile, time in sedentary pursuits remains a concern, with 25.6% of boys and 42.5% of girls reporting watching more than 30 minutes of television after school. Even in the existence of relatively high levels of MVPA, initiatives to maintain and improve upon current levels would be of value given the dose-response relationship between PA and beneficial health outcomes (Janssen & LeBlanc, 2010). Such programming may entice youth to engage in active pursuits instead of the sedentary behaviours that are known to impart health risks (Dunstan et al., 2012; Tremblay et al., 2011b; Owen, Bauman, & Brown, 2010).

Contrary to findings reported for Aboriginal youth (Ng, Young, & Corey, 2010; Katzmarzyk, 2008) as well as a number of FN communities (Gates et al., 2013a; Pigford et al., 2011; Mitchell et al., 2010; Downs et al., 2008), this study did not support a relationship between PA participation and any measure of anthropometry (i.e., BMI, waist circumference, nor body fat). This may have been at least in part related to sample size limitations. Despite the findings, the

benefits of high levels of PA remain important for these youth. In fact, for those at the highest level of risk (i.e., those who are obese), even small amounts of PA can have important health benefits (Janssen & Leblanc, 2010). In addition, available evidence supports the association between PA participation in youth and later participation in adulthood (Telama, Yank, Leskinen, Kankaanpää, Hirvensalo, Tammelin, et al., 2014), as well as the ability of PA to attenuate of age-related increases in waist circumference over adolescence and into later life (Yang, Telama, Leskinen, Mansikkaniemi, Viikari, & Raitakari, 2007). Unfortunately, participation in PA tends to decrease over adolescence (Colley et al., 2011), reinforcing the need to take action to continue to support these youth in remaining physically active throughout this critical period. The inclusion of structured activities (i.e., organized sports) would be recommended as they were both desired by community youth and have the potential to promote self-esteem, social skills and self-confidence (Eime, Young, Harvey, Charity, & Payne, 2013).

The need for PA initiatives focused at youth is especially true for girls, who were less active than boys. Similarly to FN people from other communities (Mason & Koehli, 2012; Kirby, Lévesque, & Wabano, 2001), girls reported having fewer positive role models and less interest in the currently offered structured after-school activities. Though not emphasized by youth in this community, girls may also be limited by traditional gender roles (Mason & Koehli, 2012; Kirby, Lévesque, & Wabano). The literature supports taking a gender-focused approach to encouraging PA (Simen-Kapeu & Veugelers, 2010; Kirby, Lévesque, & Wabano, 2001), because girls' and boys' motivations for PA are likely to differ (Sweeting, 2008; Sirard, Pfeiffer, & Pate, 2006). As was reflected in the qualitative focus groups in this study, boys tend to be motivated by competition, girls are often more interested in participating in sports for social reasons (Sirard,

Pfeiffer, & Pate, 2006). By providing gender-specific opportunities that appeal to girls, it may be possible to begin to close the PA gap such that girls may equally benefit from a physically active lifestyle.

6.9.3 Physical Fitness

Despite relatively high levels of MVPA, low physical fitness among youth in this community further supports the need for programming to address the issue. Among community youth, mean cardiorespiratory endurance fell below the 50th percentile for their peers in the general population, appearing to be about 15 mL/kg/min lower (Tremblay et al., 2010b). This difference may be, at least in part, a function of the high prevalence of overweight and obesity among the participating youth. In this case, increased mass in the form of body fat is not contributing to the work being performed and therefore lowers maximal aerobic power when adjusted by weight (Goran, Fields, Hunter, Herd, & Weinsier, 2000). The different methodology used to estimate maximal aerobic power in the CHMS (the modified Canadian Aerobic Fitness Test) should also be acknowledged as a potential reason for the observed difference (Tremblay et al., 2010b). Regardless of the reason, the low cardiorespiratory endurance exhibited by community youth mirrors what has been observed in other FN communities (Kakekagumick et al., 2013; Tomlin et al., 2012; Downs et al., 2008; Ng, Marshall, & Willows, 2006) and is a concern because this type of physical fitness has been associated with cardiovascular health in adolescents (Ruiz, Huybrechts, Cuenca-Garcia, Artero, Labayen, Meirhaeghe, et al., 2014).

The findings of this study supported the limited available evidence for FN youth suggesting that cardiorespiratory endurance is lower in those who are overweight or obese (Ng, Marshall, &

Willows, 2006) or have an elevated waist circumference (Downs et al., 2008). In addition, boys who were considered to have excess body fat also had lower cardiorespiratory endurance than their normal body fat peers, though the association did not hold for girls. Since PA participation did not vary across categories of the anthropometric variables, the findings suggest that for youth in high risk categories (i.e., overweight or obese, abdominally obese, or carrying excess body fat), the physical fitness benefits associated with PA are weakened by the need to carry excess body mass that does not contribute to fitness as lean mass would (Goran et al., 2000). While all youth should be included in PA programming, overweight and obese youth are an important target population, for whom even small increases in MVPA may be of benefit to cardiorespiratory endurance, body composition and health (Janssen & LeBlanc, 2010). While the specific activity patterns of youth were not a focus of this study, there is evidence that longer bouts of PA (which may be supported by organized sports) should be promoted, as these have been linked to a lower risk of being overweight (Mark & Janssen, 2009).

Muscular strength, endurance and flexibility (musculoskeletal fitness, collectively) have rarely been previously studied in Canadian Aboriginal youth, therefore there is little basis for direct comparison. However, the youth participating in this study appeared similar to the general population on these fitness measures. Muscular strength, as measured by handgrip dynamometry, appeared to be slightly higher than the mean reported for youth aged 11 to 14 years in the 2007-2009 CHMS (Tremblay et al., 2010b), perhaps related to the relatively larger body size that accompanies overweight and obesity (Ervin, Fryar, Wang, Miller, & Ogden, 2014). Results for muscular endurance were also promising; it appeared that a similar proportion of boys were able to complete 25 curlups as compared to the general population (42% versus 44%) and a greater

proportion of girls were able to complete 25 curlups (53% versus 38%) (Tremblay et al., 2010b). Finally, flexibility, as measured by the sit-and-reach test appeared comparable to youth in the general population (Tremblay et al., 2010b). Still, there likely remains room for improvement given that fitness levels of Canadian youth have declined in recent decades and are generally suboptimal for a large proportion of the population (Tremblay et al., 2010b).

While recognizing that high levels of muscular strength and body fat can coexist, there is strong evidence that muscular strength, endurance and power are inversely associated with body fat, abdominal obesity, cardiovascular disease and metabolic risk factors such as insulin resistance (Smith, Eather, Morgan, Plotnikoff, Faigenbaum, & Lubans, 2014). For this reason, improving muscular strength may be useful for youth in this study. Supervised resistance training is believed to be safe for youth (Faigenbaum, Kraemer, Blimkie, Jeffreys, Micheli, Nitka et al., 2009), improves muscular strength above normal changes accompanied by growth (Faigenbaum et al., 2009; Payne, Morrow, Johnson, & Dalton, 1997), and does not necessarily require significant resources. Bodyweight exercises are easily accessible, can be conducted in a group setting, and may be appealing to youth. Unfortunately, the link between muscular flexibility and health is understudied and possible links between these variables in children are not well understood (Plowman, 2014). Nevertheless, adequate flexibility is required to accomplish the activities of daily living and to participate in PA, and therefore stretching activities would be recommended for inclusion in PA programming.

6.9.4 Supports, Barriers and Programming Needs

There is limited comprehensive information on the determinants, barriers and supports to PA for Aboriginal groups across the country (Willows, Hanley, & Delormier, 2012; Young & Katzmarzyk, 2007). This study adds to the current understanding and describes the barriers and supports for youth in a remote and isolated FN community in northern Ontario. Similar to the findings of a study in Fort Albany, Ontario, the community schools (i.e., elementary and high school) were supports to PA, a source of positive role models, and the location where many activities took place (Skinner et al., 2006). It is possible that this may be the case for many small communities, where the school becomes a hub where youth and others can congregate for activities and events. Given that well planned after-school physical education programs have demonstrated the ability improve PA, fitness and body composition in children and adolescents (Beets, Beighle, Erwin, & Huberty, 2009), the school is likely an ideal locale to continue to promote PA among youth.

Disempowerment has been identified as an overarching barrier to PA and healthy eating in the nearby FN community of Fort Albany, Ontario (Skinner et al., 2006). Similarly, though youth in the participating community appeared to have a strong desire to be physically active, extremely limited resources in terms of funding, time, and available facilities and equipment meant that they were not necessarily able to reach their goals. This situation is not unique to this community; other studies have described economic disparity as a barrier to both traditional land-related activities (e.g., hunting, gathering, fishing) and non-traditional activities such as organized sports (McHugh, Kingsley, & Coppola, 2013; Kirby, Lévesque, & Wabano, 2001). Similarly, if adults feel disempowered then they may be limited in their ability to act as positive

role models for youth or to run programs. Resource limitations may also function to facilitate participation in sedentary behaviour (Mason & Koehli, 2012). In such cases, improving the accessibility of other types of activity (Kirby, Lévesque, & Wabano, 2001) and providing social support (i.e., positive role models) for PA participation (Silva, Lott, Mota, & Welk, 2014) via initiatives such as school-based programs, becomes increasingly important.

Girls especially indicated that they would like more sex-specific activities, but this was impeded by limitations in terms of availability of personnel, facilities and time. Perceived barriers to girls' PA may include being self-conscious of their appearance, lack of motivation, preferences for other activities, a dislike of competition, and a lack of peer support (Dwyer, Allison, & Goldenberg, 2006; Robbins, Pender, & Kazanis, 2003). Among the FN population, it is possible that a lower level of PA among females has been normalized due to prevailing gender-constructed roles (Kirby, Lévesque, & Wabano, 2001). In the current study, girls desired activities that were separate from boys. The social aspects of PA and having same-sex peers to participate with can be an important motivation for girls to engage in PA (Sirard, Pfeiffer, & Pate, 2006; Flintoff & Scraton, 2011; Dwyer, Allison, & Goldenberg, 2006) and may be something to capitalize on when implementing PA programming.

Environmental and geographical barriers also impacted the PA of youth in the participating community. For example, a harsh climate and soil conditions meant that grassy fields for sports were not feasible. Meanwhile, the small population size, remote location and equipment limitations meant that relatively few team and competitive sports were available. While the data are not directly comparable, the most commonly reported activities for youth in this community

(i.e., walking, running, certain sports) appeared similar to those reported by on-reserve youth from the 2008-2010 RHS (FNIGC, 2012). However, the complementary qualitative findings showed that youth desired for more structured, organized activities and competitive sports (e.g., with teams from nearby communities), because only very few were offered in the community. The available evidence supports that these types of activities would be an important addition to potential programming because they promote the development of fundamental movement skills (Lubans, Morgan, Cliff, Barnett, & Okely, 2010); these are the basic skills that may promote continued participation in PA, improved cardiorespiratory endurance, and a lower BMI (Lubans et al., 2010).

While not specifically discussed by youth in this study, the continuing cultural importance of traditional land-based activities (e.g., hunting, trapping, fishing, foraging) should not be overlooked. The high financial cost of these traditional activities (e.g., procuring ammunition, travel to hunting sites), make them inaccessible to those who are socioeconomically disadvantaged (Kirby, Lévesque, & Wabano, 2001). For example, snowshoeing is a popular activity in the community (described as ‘traditional’ by FN collaborators), but group trips were not feasible because of inadequate financial resources to replace old and damaged snowshoes. The history of colonialism that has been experienced by FN populations has been accompanied by reduction in participation in traditional activities, which are now typically limited to a few discrete periods per year (Isaak & Marchessault, 2008; Kirby, Lévesque, & Wabano, 2001). Indeed, the limited mention of such activities by youth in the study may be reflective of a decreased participation, but may also simply reflect that youth view these activities as a normal part of community life and not ‘exercise’ per se. These activities remain important for FN youth

(Pigford et al., 2012), and provide cultural benefits (Lévesque et al., 2015; Lavallée, 2008; Cargo et al., 2007; Lavallée, 2007). Thus, it should be emphasized that while youth desire sports programming, this would not act as a replacement to traditional pursuits. To ensure that the desires of the community are respected, programming should be community-driven, such that community members decide what types of activities they would prefer to include, be they ‘traditional’ (e.g., dance, snowshoeing) or ‘non-traditional’ (McHugh, Kingsley, & Coppola, 2013).

It is acknowledged that programs that affect the numerous settings in which youth may have the opportunity to be active or engage in other health-promoting behaviours will be needed to make significant impacts on overweight and obesity prevalence (Willows, Hanley, & Delormier, 2012; Story, Kaphingst, Robinson-O’Brien, & Glanz, 2008). However, in communities with relatively few resources, it is necessary to test small, pilot initiatives even if they may impact only one level of influence. For the participating community, the school environment can have an important influence on youth as they spend much of the day there, and the school is a community hub for both social and physical activities. A program promoting PA, in addition to the presently operating nutrition program, is desired by the community and has the potential to make an impact on the current and future health of local youth.

6.10 Study Strengths and Limitations

In the past 10 years, few studies have reported on measured PA (Tomlin et al., 2012; Pigford et al., 2011; Mitchell et al., 2010; Downs et al., 2008; Ng, Marshall, & Willows, 2006) and cardiorespiratory endurance (Kakekagumick et al., 2013; Tomlin et al., 2012; Mitchell et al.,

2010; Downs et al., 2008; Ng, Marshall & Willows, 2006; Paradis et al., 2005) among FN youth. This study begins to fill a significant gap that exists in the literature by providing measured data on the PA and fitness of FN youth living in a remote, isolated northern community. This study is among the first to report on three other aspects of fitness in FN youth: muscular strength, endurance and flexibility.

Direct measurement of PA confers numerous benefits such as reducing reporting bias and recall error (Reilly, Penpraze, Hislop, Davies, Grant, & Paton, 2008). By including qualitative data on the unique context, barriers, and supports to PA and sports participation, the results of this study provide a picture of the current situation from the perspective of youth and other community members. The use of utilization-focused approach places priority on the target users of potential programs, and results presented here were used to tailor a school sports program for youth of the participating community, with the goal of increasing sports participation, PA and fitness (see **Study 5**). Sustainability of programming will be encouraged because the resultant program will be acting upon initiatives that community stakeholders deem to be important.

The potential limitations of the study are also acknowledged. The small sample size is a limitation in this research, due to the community's population size. This has likely reduced the power to detect statistically significant results even though the participation rate was high and included most of the target group. Still, the findings are useful to the community and perhaps to similar or nearby communities. The data in this study are cross sectional, so while associations have been found, cause-and-effect cannot be inferred. Data were collected on school days and may not reflect differences in PA on weekends. In addition, measurements were taken in the Fall

season to permit pre- and post- measures over a school year intervention that followed the needs assessment phase of the project. Seasonal variation in activities that will influence PA and fitness is entirely possible but was beyond the scope of the current investigation. The environmental scan may have been more reflective of the views of community youth had they been involved, rather than the researcher undertaking this aspect independently.

Body composition, PA, and fitness variables were compared to reported data from the 2007-2009 or 2009-2011 CHMS, but this comparison was not accomplished statistically. Though statistical analysis of raw data would be preferable, the sample size difference in the datasets meant that this was not feasible. Some field tests (e.g., days of accelerometer wear, BIA for body fatness, some fitness tests) were chosen as a compromise between methodological rigour and feasibility, given the age of the participants and the remote location of the participating community. Compromises to rigour in favour of feasibility and reduced participant burden are common when working in remote and isolated locations, and should not be viewed as a limitation if the results remain useful and relevant for the community (Simonds & Christopher, 2013; Cochran et al., 2008).

6.11 Conclusion

The current study adds to the limited information on directly measured PA and fitness levels of FN youth living on reserve in remote, isolated locations. Youth in the community experience numerous barriers to being active, but these should not overshadow the enthusiasm and motivation of community youth and adults who desire PA programming, and are invested in the success of potential initiatives. Despite these constraints, the participating youth exhibited high

levels of PA. The health of youth remains a concern due to alarmingly high rates of overweight, obesity and abdominal obesity occurring concomitantly with low levels of cardiorespiratory endurance. While the cultural importance of traditional activities should not be overlooked, youth have great potential for improvement through engagement in organized sports, which are desired by the community. There is a need to direct specific efforts toward girls, who were less active, had poorer cardiorespiratory endurance, and described being less motivated to engage in the activities currently available.

6.12 Acknowledgments

The authors would like to thank the community that collaborated in this research, including the youth and teachers who participated in the measures, as well as the school officials who were involved in planning and organizing the project. Thanks to Dr. Ian Martin for statistical advice. The study was funded by a CIHR grant (#178424).

7.0 Study 5: A Pilot School Sports Program in a Remote Canadian First Nation: Evaluation of Process and Outcomes

A version of this study has been accepted for publication:

Gates, M., Hanning, R.M., Gates, A., Stephen, J., Fehst, A., & Tsuji, L.J.S. (in press). A pilot school sports program in a remote Canadian First Nation: Evaluation of process and outcomes.

Health Behavior and Policy Review.

7.1 Overview

Objectives: To (a) assess the challenges and successes to the implementation of a pilot school sports program over one school year, and (b) examine its impact on PA, fitness and body composition among boys and girls in grades 6 and 7.

Methods: A pilot school sports program was implemented over the 2012-2013 school year in a subarctic Ontario FN. The main facets included (a) training for teachers and coaches, (b) increased availability of equipment and (c) increased availability of after-school sports.

Quantitative measures were collected at the beginning and end of one school year:

anthropometrics (BMI z-score, waist circumference, body fat percentage via BIA) utilizing standard protocols, school-day PA (minutes of MVPA/day, steps/day) via three days of accelerometry (Actigraph GT3X), and fitness (cardiorespiratory endurance, muscular strength and endurance, flexibility) via the Léger 20-m shuttle run and field tests informed by CPAFLA.

A focus group and questionnaire (youth), interview (program coordinator) and survey (teachers) were used to collect information on participation, satisfaction, successes strategies and challenges. Changes in quantitative variables between time points were assessed using bootstrapped paired-samples t-tests ($p \leq 0.05$). Responses to the youth questionnaire were

presented as frequencies; differences between sexes were assessed using Pearson Chi-square tests. Qualitative data were assembled into one file and coded manually for themes. This analysis was repeated by a second researcher, and disagreements resolved via discussion.

Results: A total of 57 youth (12.8 ± 1.0 years, 59.6% male) participated in at least one measure (74.0% participation rate) and 30 had at least one day of valid accelerometry data (12.6 ± 0.9 years, 53.3% male). Of the 48 youth completing the post-program questionnaire, 42.1% reported regular program attendance. Boys reported higher self-efficacy than girls based on two questions; they more often were ‘very sure’ that they could perform 60 minutes of PA daily ($p=0.016$) and could be active even if they were tired ($p=0.034$). The qualitative data were organized under the themes: daily operations, resources, satisfaction and reach, and sustainability. Barriers to running the program were related largely to having very few resources, though a number of success strategies were developed to sustain the program. At post-program, youth increased their participation in MVPA by a mean 47.9 minutes/day (110.8 ± 48.7 minutes/day vs. 158.7 ± 71.3 minutes/day, $p=0.016$). Boys completed an additional 10.5 shuttle run stages (17.5 ± 9.4 stages vs. 28.0 ± 21.3 stages, $p=0.006$), and showed a non-significant trend toward improved cardiorespiratory endurance (38.6 ± 5.8 mL/kg/minute vs. 41.1 ± 7.4 mL/kg/minute, $p=0.057$). Girls did not experience this improvement. However, boys and girls improved their muscular strength by 8.2 kg ($p=0.002$) and 5.6 kg ($p=0.012$), respectively. Flexibility improved for the group (26.2 ± 7.9 cm vs. 28.4 ± 7.8 cm, $p=0.015$), but when dichotomized by sex these changes no longer reached significance.

Conclusion: School sports programs can be implemented in remote and isolated FN communities with limited available resources. Following one year of programming, youth showed increased PA levels and improvements in some aspects of physical fitness. There is a

need for continuity in personnel support and increased funding for facilities and equipment to overcome the barriers to implementation and sustainability. In the future, it will be important to focus on programming for girls, who did not experience the same cardiorespiratory endurance improvements as boys, and who participated less frequently. There will also be a need to compliment this initiative with others at various socioecological levels.

7.2 Introduction

High rates of overweight, obesity and chronic health conditions such as type 2 diabetes (FNIGC, 2012) are a reality for Canadian FN youth. Health disparities are particularly apparent for those living in reserve communities, where 43% are overweight or obese (FNIGC, 2012).

Socioecological health frameworks support that the behaviours contributing to the development of obesity are affected by numerous interrelated factors (Willows, Hanley, & Delormier, 2012; Glanz & Bishop, 2010). First Nations people, in particular, have experienced a lifestyle shift, which has included distancing from traditional ways of life that has been accompanied by lower levels of PA (Haman et al., 2012; Kuhnlein et al., 2004).

These lower PA levels are of concern because, as demonstrated in **Study 1**, they appear to be associated with obesity among FN youth (Gates et al., 2013a; FNIGC, 2012; Mitchell et al., 2010; Ng, Young, & Corey, 2010; Katzmarzyk, 2008; Ng, Marshall, & Willows, 2006). Indeed, review articles have shown that Aboriginal Canadian and Native American youth tend to be inadequately active to achieve health benefits or meet health-related guidelines (Foulds, Warburton, & Bredin, 2013; Young & Katzmarzyk, 2007). To address these concerns, preventative programs for youth are needed (Willows, Hanley, & Delormier, 2012; Craigie,

Lake, Kelly, Adamson, & Mathers, 2011; Telama, 2009) to promote healthy lifestyle behaviours. The Canadian clinical practice guidelines on obesity recommend schools as a setting to promote healthy lifestyles (Lau, Douketis, Morrison, Hramiak, Sharm, & Ur, 2007) as here, almost all youth can be relatively easily reached (Fox, Cooper, & McKenna, 2004). Schools can be a source of influential personnel, and in some subarctic communities, they may be a pre-existing support to youth PA (Skinner et al., 2006). While numerous school-based programs are likely occurring across Canada, few have been formally evaluated (Santos et al., 2014; Kakekagumik et al., 2013; Ronsley et al., 2013; Tomlin et al., 2012; Naylor et al., 2010; Paradis et al., 2005; Adams et al., 2005; Saksvig et al., 2005). These programs have demonstrated promise in terms of either increasing PA, improving cardiorespiratory endurance or decreasing BMI at least in the short term (Kakekagumick et al., 2013; Ronsley et al., 2013; Tomlin et al., 2012; Adams et al., 2005; Saksvig et al., 2005).

In order to design relevant and feasible initiatives for their individual circumstances, communities require local information on the PA and health of their youth. This will allow them to take advantage of local supports and to inform strategies aimed at surmounting the numerous barriers to youth PA that often exist in remote and isolated locations (Mason & Koehli, 2012; Skinner et al., 2006). Program sustainability is frequently a concern because initiatives tend to require substantial inputs in terms of personnel and resources. Indeed, the KSDPP and the SLHDP, two longstanding Canadian programs, have encountered challenges in maintaining the positive outcomes achieved in the shorter-term (Adams et al., 2005; Saksvig et al., 2005; Kakekagumick et al., 2013). Thus, programming should be accompanied by locally acceptable evaluation activities to guide continued program development and continuous improvement,

build a case for financial support (Teufel-Shone, Fitzgerald, Teufel-Shone, & Gamber, 2009), and facilitate the dissemination of promising practices.

In 2012, a school sports program was implemented and administered locally in a remote and isolated FN community situated in the James Bay region of northern Ontario. The need for PA programming as an adjunct to pre-existing school health initiatives (primarily nutrition) (Gates et al., 2012c, 2013b, 2013c) was raised by school officials who were concerned about the health, PA and fitness of local youth. A needs assessment directly prior to program initiation (see **Study 4**; Gates, Hanning, Gates, Stephen, Fehst, & Tsuji, 2015), along with available evidence supporting the potential for after-school physical education programs to positively impact youths' PA and fitness levels (Beets et al., 2009), substantiated the need for programming.

7.3 Study Context

The current project continued to build upon the partnership between a James Bay Coast FN community and the research group led by Drs. Rhona Hanning (University of Waterloo) and Len Tsuji (University of Toronto Scarborough), previously described in **Study 4**. A timeline that shows the research team's activities in the community since 2009, with emphasis on the most recent project, is shown in **Figure 7.1** to provide context. Building upon the desires of school leaders, the needs assessment in October 2012 demonstrated that while youth were active, this co-existed with high rates of obesity (Gates et al., 2015). In addition, youth faced numerous barriers to the activities that they were interested in participating in.

University researchers continued to collaborate with the local school leaders, to both facilitate program implementation and to conduct a process and outcome evaluation of the program over its first year of implementation. It was intended that this information would facilitate tailoring the program to the community’s needs, increase awareness of the successes and challenges encountered during implementation, and demonstrate the outcomes of the program. This information would be useful in informing future modifications to the program as well as to provide a demonstration that may be beneficial for other communities.

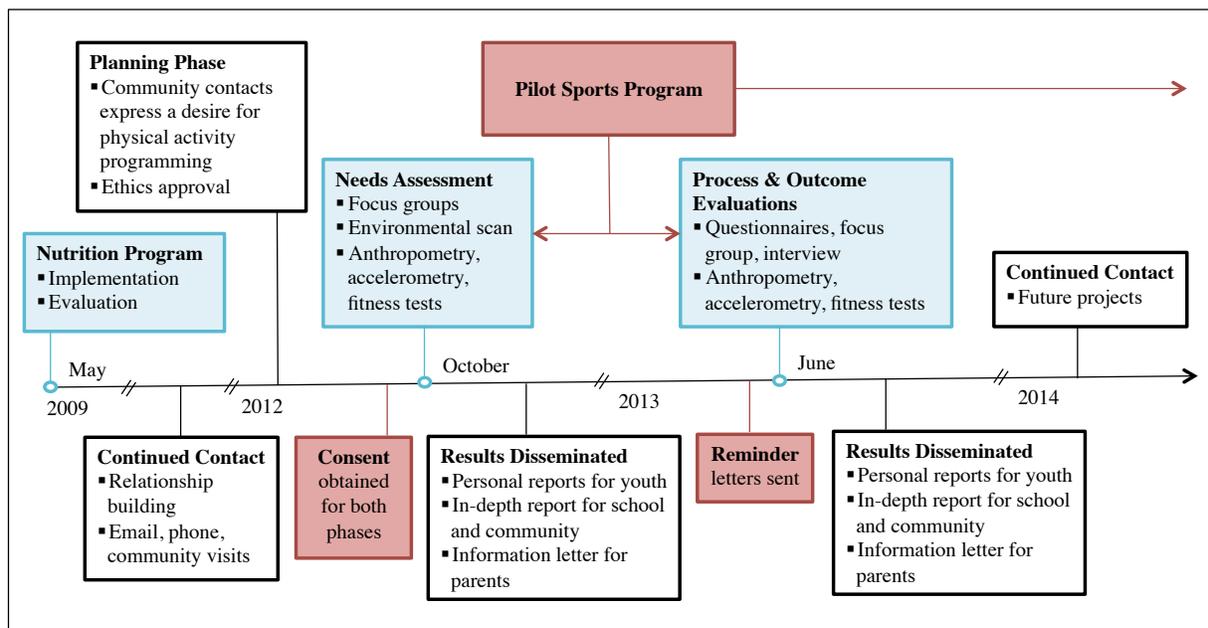


Figure 7.1 Timeline for the project involving the process and outcome evaluation of a pilot school sports program in a subarctic Ontario First Nations community

7.3.1 Program Description

The pilot school sports program, which took place over the 2012-2013 school year, was focused specifically on the school PA environment. The main facets of the program included (a) fundamental skills training for teachers and coaches, (b) increased availability of equipment for a number of sports and (c) increased access to after-school sports and activities. The program was administered locally, because local leadership fosters improved program sustainability (Tueffel-Shone et al., 2009), community ownership and program relevance. It also ensured that the program was realistic, given known community-level constraints. The pilot initiative was targeted toward all youth from kindergarten to grade 7 who attended the community's elementary school, though most activities were geared toward the older age groups. Participation in the program was voluntary.

At the beginning of the school year, interested teachers completed a one-day Community Leaders Fundamental Movement Skills Workshop, provided by the Coaching Association of Canada (www.coach.ca). This workshop focused on how to effectively teach movement skills to youth, these being the foundational skills needed to participate in a variety of physical activities and organized sports (e.g., jumping, throwing, running, balancing). The one-day workshop included in-class learning following a training manual, demonstrations, and hands-on activities designed to provide examples of the step-by-step process used to teach movement skills and offering feedback. Funding support from a CIHR research grant was used to procure equipment for softball and field hockey, two sports identified by school officials as being of interest to community youth, but that were inaccessible due to the lack of available resources. Running shoes and a variety of miscellaneous PA equipment were also provided (e.g., balls for basketball

and soccer, coloured mesh athletic jerseys for team sports). While improvements to the local facilities were also needed, enhancement of the availability of equipment was a comparatively low-cost first step to improving the PA environment for community youth.

The main responsibility for the program fell on the physical education teacher and other volunteer teachers and teaching assistants who had completed the aforementioned training. While physical education classes were already mandatory for all youth and occurred during school hours, indoor and outdoor sports (depending on the season) began being offered every day after school. These included field hockey, softball, volleyball and soccer. Activities were usually accompanied by warm-up jogs and general stretching activities. Most activities took place in a gymnasium at a nearby high school in the community. A small number of students also began running on a community trail after school, under the supervision of teachers, with the goal of completing a 10 km road race. There was also a weight room available in the nearby high school that some students chose to use, under supervision.

Before starting the program, youth had listed a lack of desirable organized activities (i.e., sports) and competing priorities (e.g., screen-based behaviours) as reasons for not being active after school (Gates et al., 2015). Thus, by garnering personnel support, and by beginning to offer the activities that youth desired and were scarcely previously available, it was believed that youth would participate in the newly available programming. As a result, an increase in PA engagement and improvement in physical fitness was an expected outcome.

7.4 Evaluation Framework

7.4.1 Evaluation Type and Approach

Process and outcome evaluations of the pilot program were undertaken in June 2013, approximately nine months (i.e., one school year) after the original implementation. A utilization-focused approach was adopted because it emphasizes the use of evaluation findings by the program's target users and stakeholders and is participatory in nature (Patton, 2012; Rossi, Lipsey, & Freeman, 2004). Community advisors were involved in deciding the evaluation protocol and approved all evaluation activities and documents prior to the project being submitted for ethics approval. Continued communication over the course of the pilot program, and thereafter, was maintained via email and telephone, while the evaluation took place on-site. Results were disseminated in various forms that were deemed acceptable to local officials including reports, summaries, informal discussions and immediate feedback for youth.

The relevant stakeholders and their relationships to the program were previously identified at the needs assessment stage (see **Study 4**, Gates et al., 2015, and **Figure 6.1**), and those most closely involved with the program (i.e., teachers, students, program coordinator) participated in the evaluation activities.

7.4.2 Program Logic Model

As a first step in the process and outcome evaluations, a program logic model was developed. Logic models demonstrate the program in its intended operation and are useful to guide the development and prioritization of evaluation questions (Rossi, Lipsey, & Freeman, 2004).

The logic model for the pilot school sports program (**Figure 7.1**) visually links the steps between its activities and intended outcomes (Rossi, Lipsey, & Freeman, 2004). The main activity, after school sports, is represented at the bottom-left of the diagram. The inputs, including volunteer personnel, training for teachers and coaches, and new equipment for floor hockey and softball are also shown. The arc of the softball depicts the trajectory between the program's activities and the short- and long-term outcomes. The short-term objectives were intended to be accomplished within the school year, whereas the long-term objectives will take longer to achieve (i.e., several years). In between, the outputs of the program, which include the number of available activities, proportion of youth participating and number of teachers and coaches trained, are shown. The ultimate goal of the program is depicted below the short- and long-term objectives. Finally, the overarching context within which the program operates has been accounted for. As described by Willows, Hanley and Delormier (2012), the ability of the program to meet its objectives will be affected by these interacting factors that influence behaviour.

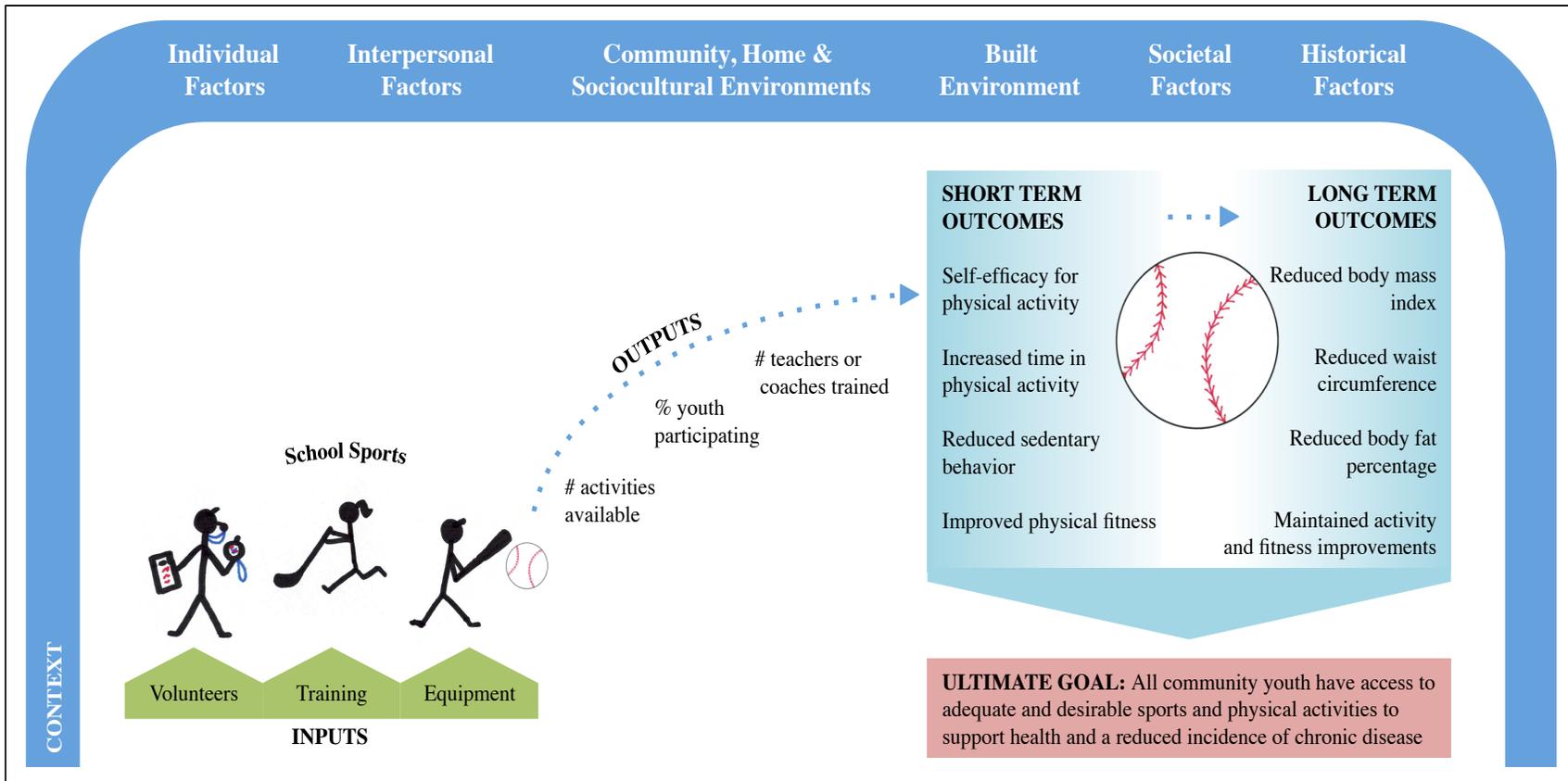


Figure 7.2 Logic model for a pilot school sports program in a subarctic Ontario First Nations community

7.5 Evaluation Questions, Objectives and Hypotheses

7.5.1 Evaluation Questions and Objectives

In order to understand whether a pilot sports program implemented in a subarctic Ontario FN community was operating as intended and achieving its intended outcomes, process and outcome evaluations were employed to address the main evaluation questions, as follows. Further detail on the evaluation questions, along with the associated indicators and methods used to answer them are shown in **Tables 7.1** and **7.2**.

1. Process Evaluation: An assessment of the program’s daily operations, availability of resources, reach and satisfaction, sustainability

Objective 1a: To qualitatively assess success strategies and challenges encountered during the implementation of a pilot school sports program from the perspective of the program coordinator, teachers and students.

Objective 1b: To, both qualitatively and quantitatively, assess youths’ self-efficacy for PA, satisfaction with and participation in the program activities.

Table 7.1 Questions, indicators, information sources and methods for a process evaluation of a pilot sports program in a subarctic Ontario First Nation^{a,b}

Evaluation Questions	Indicators	Information Sources	Methods
<i>Daily operations</i>			
1. Is the program being delivered as it was originally designed?	<ul style="list-style-type: none"> ▪ Degree to which program adheres to original design ▪ Opinion of support staff 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers
2. Is the program being delivered consistently?	<ul style="list-style-type: none"> ▪ Interruptions to normal program operations ▪ Opinion of support staff 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers
3. Do any of the program's activities <i>not</i> contribute to its objectives?	<ul style="list-style-type: none"> ▪ Number and type of activities that do not contribute to objectives ▪ Opinion of support staff 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers
<i>Resources available to run the program</i>			
4. Are the facilities and equipment adequate to run the program as intended?	<ul style="list-style-type: none"> ▪ Amount and type of facilities and equipment ▪ Opinion of support staff ▪ Opinion of youth 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers ▪ Youth 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers ▪ Focus group with youth
5. Are there sufficient personnel (i.e., volunteers) to run the program as intended?	<ul style="list-style-type: none"> ▪ Number of volunteers engaged ▪ Opinion of support staff ▪ Opinion of youth 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers ▪ Youth 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers ▪ Focus group with youth
<i>Program reach and satisfaction</i>			
6. Does the program reach all school-attending youth (both girls and boys)?	<ul style="list-style-type: none"> ▪ Participation rate ▪ Opinion of support staff ▪ Opinion of youth 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers ▪ Youth 	<ul style="list-style-type: none"> ▪ Questionnaire for youth ▪ Interview with program coordinator ▪ Questionnaire for teachers ▪ Focus group with youth
7. Are youth satisfied with the way the program is being delivered (both girls and boys)?	<ul style="list-style-type: none"> ▪ Opinion of youth 	<ul style="list-style-type: none"> ▪ Youth 	<ul style="list-style-type: none"> ▪ Questionnaire for youth ▪ Focus group with youth
<i>Program sustainability</i>			
8. Is the program sustainable according to its original design <i>or</i> as it is being delivered?	<ul style="list-style-type: none"> ▪ Opinion of support staff 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers

^aAdapted from the framework presented by Langevin (2001).

^bThough the program was offered to all school-attending children, it was geared toward older youth, thus only those in grades 6 and 7 were included in the evaluation measures.

2. Outcome Evaluation: An assessment of the impact of the program, with an emphasis on the intended short-term outcomes

Objective 2a: To assess changes in anthropometric variables, PA and physical fitness of FN youth in grades 6 and 7 over the course of a nine-month pilot school sports program in a subarctic community in northern Ontario, Canada.

Objective 2b: To assess possible differences in the aforementioned changes in Objective 2a between sex groups.

Table 7.2 Questions, indicators, information sources and methods for an outcome evaluation of a pilot school sports program in a subarctic Ontario First Nation^{a,b}

Evaluation Questions	Indicators	Information Sources	Methods
1. What impact does the program have on the body composition, PA and physical fitness of youth? ^c	<ul style="list-style-type: none"> ▪ Evidence of improved PA, fitness 	<ul style="list-style-type: none"> ▪ Youth 	<ul style="list-style-type: none"> ▪ Anthropometry ▪ Accelerometry ▪ Fitness tests
2. Is the impact of the program different for boys vs. girls? ^c	<ul style="list-style-type: none"> ▪ Evidence of improved PA, fitness 	<ul style="list-style-type: none"> ▪ Youth 	<ul style="list-style-type: none"> ▪ Analyses conducted by sex group
3. What subjective impacts (including that that are unintended) has the program had on youth?	<ul style="list-style-type: none"> ▪ Opinion of support staff ▪ Opinion of youth 	<ul style="list-style-type: none"> ▪ Program coordinator ▪ Teachers ▪ Youth 	<ul style="list-style-type: none"> ▪ Interview with program coordinator ▪ Questionnaire for teachers ▪ Focus group with youth

^aAdapted from the framework presented by Langevin (2001).

^bThough the program was offered to all school-attending children, it was geared toward older youth, thus only those in grades 6 and 7 were included in the evaluation measures.

^cAny findings should be interpreted in light of the fact that there was no control group, thus changes in the outcome variables cannot unambiguously be attributed to the programming.

7.5.2 Hypotheses

The *a-priori* hypotheses associated with each of the aforementioned objectives were as follows:

Hypothesis 1a:

1. There will be numerous barriers to program operations, and perhaps the program will operate inconsistently.
2. It is expected that the challenges will be partly overcome during the first year, but some will remain.

Hypothesis 1b:

1. Most (>75%) youth will participate at least half of the days of the week.
2. Most (>75%) youth will be satisfied with the program's activities.

Hypothesis 2a:

1. Anthropometry variables (BMI, waist circumference, body fat percentage) will not change over the course of the program.
2. Time spent in MVPA will increase significantly over the course of the program.
3. Cardiorespiratory endurance will improve over the course of the program. Changes in other measures of fitness are difficult to predict, but are likely to also improve.

Hypothesis 2b:

1. Expected improvements in MVPA and fitness may be lesser among girls than boys, though such differences are difficult to predict.

In-depth reasoning for each of these hypotheses was as follows:

Hypothesis 1a: Based on previous experience in the community (e.g., implementing nutrition programs) and the knowledge that resources are scarce, numerous challenges to program operation are expected. These may range from environmental constraints (e.g., weather conditions) to lack of staff, inadequacy in resources (e.g., facilities, funding) and time constraints. Sustainability is expected to be a challenge, as it has been with other programs (Adams et al., 2005; Saksvig et al., 2005; Kakekagumick et al., 2013). However, because the program was desired by the community, it is expected that perceived benefits and successes of the program will be viewed as outweighing the challenges.

Hypothesis 1b: The impressions of youth are difficult to predict. However, since the program's activities were informed by a needs assessment, it is believed that youth will be satisfied with the program and that most will participate regularly.

Hypothesis 2a: Based on short-term school-based programs that have been implemented in other, similar populations (Ronsley et al., 2013; Tomlin et al., 2012; Naylor et al., 2010), anthropometric variables are unlikely to change significantly throughout the study. Eight months is likely not long enough to see significant changes in these variables, which are affected by numerous other factors that have not been addressed by the program. The literature suggests that school-based programs can result in increases in PA participation (Dobbins, Husson, Decorby, & LaRocca, 2013), however among documented programs in FN populations, significant increases in PA have been more difficult to achieve (Tuefel-Shone et al., 2009). Nevertheless, daily

minutes of MVPA are expected increase significantly, because the program is expected to increase accessibility of sports to youth in the community. Other school-based programs in FN communities have demonstrated improvements in cardiorespiratory endurance (Tomlin et al., 2012; Paradis et al., 2005). For this reason, and given the relatively low baseline fitness, it is predicted that cardiorespiratory endurance will improve over the course of the program. Other recent studies of programs in FN populations have not tested other aspects of fitness, however, with the increase in PA via a variety of sports, it is expected that other facets of physical fitness will also improve.

Hypothesis 2b: During the needs assessment phase (see **Study 4**; Gates et al., 2015), boys were identified as being more motivated than girls to be physically active. For this reason, it is possible that girls will participate in the program less frequently than boys. Additionally, there is the potential that the main activities offered by the program (i.e., softball, hockey) may be less appealing to girls. Should this be the case, it could be expected that girls may experience lesser improvements in terms of PA and physical fitness as compared to boys. However, given that they were less active and physically fit than boys at baseline, they also show greater potential for improvement. Though it is difficult to predict with any certainty, it was expected that the program would be associated with equal effects on MVPA and fitness for both boys and girls.

7.6 Methods

7.6.1 Study Design and Recruitment of Participants

The study took place in a subarctic FN community on the western coast of James Bay, Ontario that has been previously described (see **Study 4**; Gates et al., 2015). Following the needs assessment, the pilot program was initiated. All school-attending youth from kindergarten to grade 7 were eligible to participate in the pilot program, where attendance was voluntary, but activities were geared toward older youth (i.e., grades 6-7). Only youth in grades six and seven were eligible to participate in the evaluation process, as they were deemed able to participate in all of the measures.

Informed written consent for both phases of the study (pre- and post-program) was obtained in advance of the first phase (October 2012), by sending information letters with attached consent forms home to parents/guardians two weeks before the arrival of researchers (evaluation facilitators) in the community (**Appendix A**). At the end of the school year (June 2013), facilitators returned to the community to perform the measures involved in the process and outcome evaluations. Prior to this data collection, reminder letters were sent home to parents/guardians using the same protocol. As with the needs assessment phase, youth could decline to participate in any measure, without consequence. Teachers of grades 6 to 7 students were invited to participate in a post-program questionnaire, at which time study information was provided and informed consent information was provided. Informed consent for the interview with the sports program coordinator was obtained at the time of the interview. Ethics approval for the study was achieved in advance of data collection from the University of Waterloo Office

of Research Ethics (#18309). As an incentive for participation, youth were entered into a draw to win a digital camera if they participated in the measurements and returned their accelerometer.

7.6.2 Youth Participation, Satisfaction and Self-efficacy

While it was intended that program activities and participation would be documented (program integrity), this ended up being overly burdensome. Thus, program participation, satisfaction, as well as some facets of the self-efficacy, were assessed quantitatively at the end of the school year, using a short questionnaire. The self-efficacy questions tested perceived ability to be physically active, while the satisfaction questions measured enjoyment of the program's activities among youth. The questions used by Rosenkranz et al. (2011) in their study of psychosocial correlates of after school PA among children in grades 3 and 4 were employed (Rosenkranz, Welk, Hastmann, & Dzewaltowski, 2011). The sets of questions had reasonable internal consistency (Chronbach's alpha 0.49 to 0.72 depending on the construct), thus were deemed appropriate to measure the similar constructs of this study (some were slightly adapted to reflect the particular circumstances of the present study) (Rosenkranz et al., 2011).

All questions were reviewed and approved by local personnel for readability and appropriateness prior to being used. The questionnaire was mounted on an online platform (<https://peaceworks.ca/web-q>) (Hanning et al., 2009), such that it could be completed via computer during school hours. Students were provided with confidential usernames and passwords to enter the anonymous online questionnaire. Student assent was provided based on information provided on the first screen of the questionnaire, where they could click 'yes' to enter the questionnaire or 'no' to decline. Response to each of the questions was voluntary, such

that youth could skip any that they did not want to answer. Two facilitators (i.e., the author and an assistant) as well as at least one local teacher or teaching assistant were available to help youth with the questionnaire, if needed. The questions and response options, as presented by Rosenkranz et al. (2011), are shown in **Table 7.3**.

Table 7.3 Questions and response options used to assess participation, satisfaction and self-efficacy after a pilot school sports program (Rosenkranz, 2011)^a

Question	Response Options
<i>Participation</i>	
1. During the past year, how often did you participate in after-school sports?	<ul style="list-style-type: none"> ▪ Every school day ▪ More than half the week ▪ Less than half the week ▪ Rarely or never
<i>Satisfaction</i>	
2. I enjoy the different kinds of physical activities or sports offered after school.	<ul style="list-style-type: none"> ▪ Yes ▪ No ▪ I don't know
3. There are a lot of chances for kids to get involved in physical activity after school.	<ul style="list-style-type: none"> ▪ Yes ▪ No ▪ I don't know
4. I am satisfied with the physical activities or sports offered at the school (after school).	<ul style="list-style-type: none"> ▪ Yes ▪ No ▪ I don't know
<i>Self-efficacy</i>	
5. How sure are you that you can do physical activity 60 minutes each day?	<ul style="list-style-type: none"> ▪ Not sure at all ▪ Somewhat sure ▪ Very sure
6. How sure are you that you can be physically active, no matter how tired you may feel?	<ul style="list-style-type: none"> ▪ Not sure at all ▪ Somewhat sure ▪ Very sure

^aThe questions presented here were originally published by Rosenkranz et al. (2011) in their study of the psychosocial correlates of after school PA among children, except for question 1, which is unique.

7.6.3 Success Strategies, Challenges and Perceived Outcomes

In order to elucidate the success strategies, challenges and perceived outcomes from the pilot program, a mix of qualitative techniques were used. An interview with the sports program coordinator (n=1) was conducted after school hours in the school setting. One facilitator (i.e., the author) led the interview using a pre-determined script, which included open-ended questions and probes (**Appendix J**). The interview was not audio recorded, thus, direct quotes are not available. A second facilitator (i.e., a graduate level assistant) was present and recorded detailed notes throughout the 45-minute interview. Directly following the interview, the two facilitators debriefed and reviewed the notes for accuracy and completeness.

While a focus group had been planned with teachers of the grades 6 and 7 students (similar consent letters as in **Appendix D**), the teachers were very busy and finding a suitable time to convene was a challenge. Being the end of the school year (assessment period), and given that much of the community had recently returned following a community-wide evacuation due to flooding, this was understandable. An e-mail discussion with the teachers revealed that an online questionnaire that could be completed at their convenience was a desirable alternative. Open-ended questions were compiled using Survey Monkey (www.surveymonkey.com) (**Appendix K**), and a link to the questionnaire was sent to participating teachers (n=5), along with information about confidentiality and informed consent. Participation was voluntary and teachers were given two weeks to complete the questionnaire, during which time two e-mail reminders were sent to encourage participation. The questionnaire was estimated to take about 20 minutes to complete.

A focus group was also conducted with students in grades 6 and 7 (n=8), using similar procedures as those described in detail in **Study 4**. The size of the youth focus group was chosen to facilitate engagement and discussion (typically 6 to 12 individuals) (Krueger, 1994), and included youth from each grade who were chosen by teachers, based on their willingness to participate. The predetermined script is shown in **Appendix L**.

7.6.4 Anthropometry, Physical Activity and Fitness

Quantitative measures performed at the post-program phase included anthropometry, PA and fitness testing. Each of these measures corresponded to the same measures collected at baseline, which have been previously described in depth in **Study 4** (Gates et al., 2015). Briefly, participant height and body mass (i.e., weight) were used to compute BMI z-score (WHO, 2015b; de Onis et al., 2007). Waist circumference was measured and body fat percentage estimated using bioelectrical impedance analysis (Tanita TBF-522 digital scale, Tanita Corporation of America, Arlington Heights, IL). Physical activity was measured over three consecutive school days utilizing accelerometry (Actigraph GT3X, Pensacola, FL); physical fitness was measured using field tests including the 20-meter shuttle run (Léger et al., 1988) for aerobic power, a measure of cardiorespiratory endurance, and the measures described by the CPAFLA for muscular strength, endurance and flexibility (PHAC, 2004).

7.7 Data Analysis and Interpretation

7.7.1 Quantitative Data

Accelerometry data were downloaded using ActiLife 6 software (Actigraph, Pensacola, FL) and youth were included in the analysis if they had at least one day (i.e., 10 hours) (Troost, McIver, & Pate, 2005) of valid wear. Time in MVPA and sedentary behaviour were calculated using 10-second epochs (McClain et al., 2008) and step counts were computed via the software.

The sample of participating youth at the time of baseline or post-program measurements, were described for age- and sex distribution. Changes in body composition, PA and fitness from baseline to post-program (June 2013) were tested using bootstrapped paired samples t-tests, with 1000 bootstrap resamples, to account for potential bias owing to the non-normal distribution of the data. Sample size changed for each variable, dependent on which students participated in each measure, based upon whether they were at school at the time of each measurement (these took place over two weeks) and whether they desired to participate. The comparison data included only those who had both pre- and post-data for a particular measure. Categorical responses to the youth questionnaire were described using frequencies. All analyses were conducted for the group as well as by sex. The Statistical Package for the Social Sciences version 23.0 (IBM Corporation, Armonk, NY) was used for all analyses, with $p \leq 0.05$ chosen as the level of significance.

7.7.2 Qualitative Data

Data from the interview, questionnaires and student focus group were combined into one file.

The data analysis was performed following a similar procedure as in **Study 4** (Gates et al., 2015). The analysis was performed by hand (Creswell, 2007) and was initially inductive, where themes were allowed to emerge from the data (Charmaz, 2006). Subsequently, themed data were analyzed deductively, whereby data were placed into categories according to the main facets of the process evaluation. The analysis was confirmed by a second, independent graduate-level researcher (Shenton, 2004). Disagreements were resolved in a consensus meeting.

7.8 Results

7.8.1 Characteristics of the Target Population

Characteristics of all community youth in grades six and seven who participated in the evaluation, both at baseline and post-program are shown in **Table 7.4**. The baseline data have previously been reported in **Study 4** (Gates et al., 2015), but have been included here for comparison. Fewer youth participated post-program for several reasons (e.g., some students had not yet returned following community-level evacuation due to a major flood).

Table 7.4 Characteristics of the total sample population before and after a pilot school sports program

Variable	Baseline (October 2012) ^a			Post-program (June 2013)		
	Total	Male	Female	Total	Male	Female
N (%)	72 (100.0)	44 (61.1)	28 (38.9)	57 (100.0)	34 (59.6)	23 (40.4)
Participation in the evaluation (%) ^b	93.5	-	-	74.0	-	-
Mean age \pm SD (years)	12.1 \pm 1.1	12.3 \pm 1.1	11.9 \pm 1.1	12.8 \pm 1.0	12.9 \pm 1.1	12.6 \pm 0.8

^aBaseline data have been previously reported (see **Study 4**; Gates et al., 2015), however, post-program data are novel.

^bRepresents the proportion of youth enrolled in grades 6 and 7 who participated in any of the evaluation measures.

7.8.2 Youth Participation, Satisfaction and Self-efficacy

A total of 48 youth (62.5% male) participated in the survey questions at post-program. Overall, 42.1% of youth reported participating in the sports programs regularly (i.e., more than half the week or every day), while about one-third (31.6%) participated rarely or never (**Figure 7.3**). An analysis of those with PA data who also completed the survey (n=30, 53% male) showed that compared to those who rarely or never participated, those who participated often completed a mean 58.6 minutes of additional MVPA per day (175.0 ± 58.8 minutes/day vs. 116.3 ± 59.1 minutes/day, $p=0.037$). However, it should be acknowledged that this may not be totally representative, since the PA level of the remaining 18 youth without accelerometry data is unknown. There was a non-significant trend for girls to participate less than boys; 53.8% of girls rarely or never participated in the program as compared to 20.0% of boys. Only 15.4% of girls reported daily participation, while 28.0% of boys participated daily.

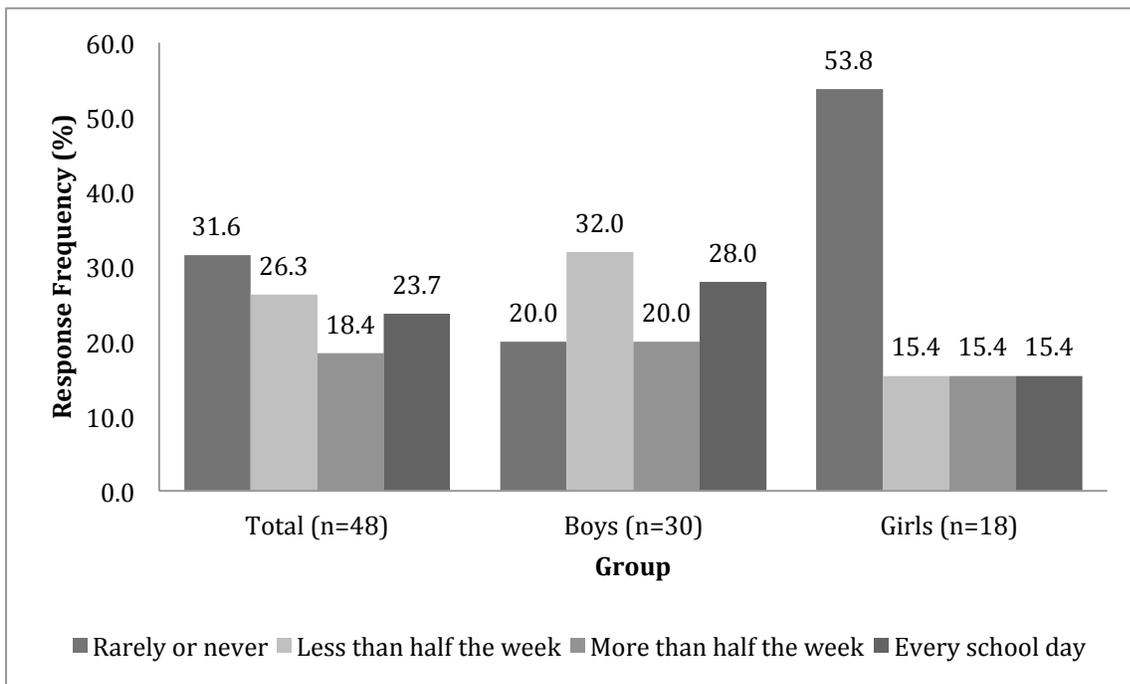


Figure 7.3 Youth participation frequency in a pilot school sports program, by sex

In terms of program satisfaction, two-thirds (66.0%) of youth reported enjoying the activities offered after school, and nearly half (45.7%) of youth agreed that there were many chances to be involved in PA after school (**Table 7.5**). Finally, more than half (57.8%) of youth were satisfied with the activities offered in the pilot program, while 17.8% were not. While potential differences in satisfaction between males and females did not reach statistical significance, it appeared that a smaller proportion of girls than boys enjoyed the after-school activities (58.8% vs. 70.0%), believed there were many chances to be active after school (31.3% vs. 53.3%) and reported being satisfied with the after-school activities that were available (43.8% vs. 65.5%).

Table 7.5 Youth responses to survey questions on participation, satisfaction and self-efficacy after a pilot school sports program, by sex^a

Questions and response options ^a	Response Frequencies (%)			p
	Total n=48	Male n=30	Female n=18	
<i>I enjoy the different kinds of physical activities or sports offered after school.</i>				
Yes	66.0	70.0	58.8	0.493
No	8.5	10.0	5.9	
I don't know	25.5	20.0	35.3	
<i>There are a lot of chances for kids to get involved in physical activity after school.</i>				
Yes	45.7	53.3	31.3	0.329
No	6.5	6.7	6.3	
I don't know	47.8	40.0	62.5	
<i>I am satisfied with the physical activities or sports offered after school.</i>				
Yes	57.8	65.5	43.8	0.274
No	17.8	17.2	18.8	
I don't know	24.4	17.2	37.5	

^aQuestions originally presented by Rosenkranz et al. (2011).

Responses to the two self-efficacy questions showed that after one year of the pilot program, 74.5% of youth were either 'somewhat sure' (42.6%) or 'very sure' (31.9%) that they could accomplish 60 minutes of PA daily (**Figure 7.4**). However, this differed significantly by sex. Girls were more likely to report that they were 'not sure at all' and less likely to report that they

were ‘very sure’ that they could accomplish 60 minutes of PA per day ($p=0.016$). When asked whether they were sure that they could be physically active even if they were tired, most (86.4%) youth were ‘somewhat sure’ (43.2%) or ‘very sure’ (43.2%) (**Figure 7.5**). Once again, this differed significantly by sex, where boys more often responded that they were ‘somewhat sure’ and girls more often responded that they were ‘not sure at all’ ($p=0.034$).

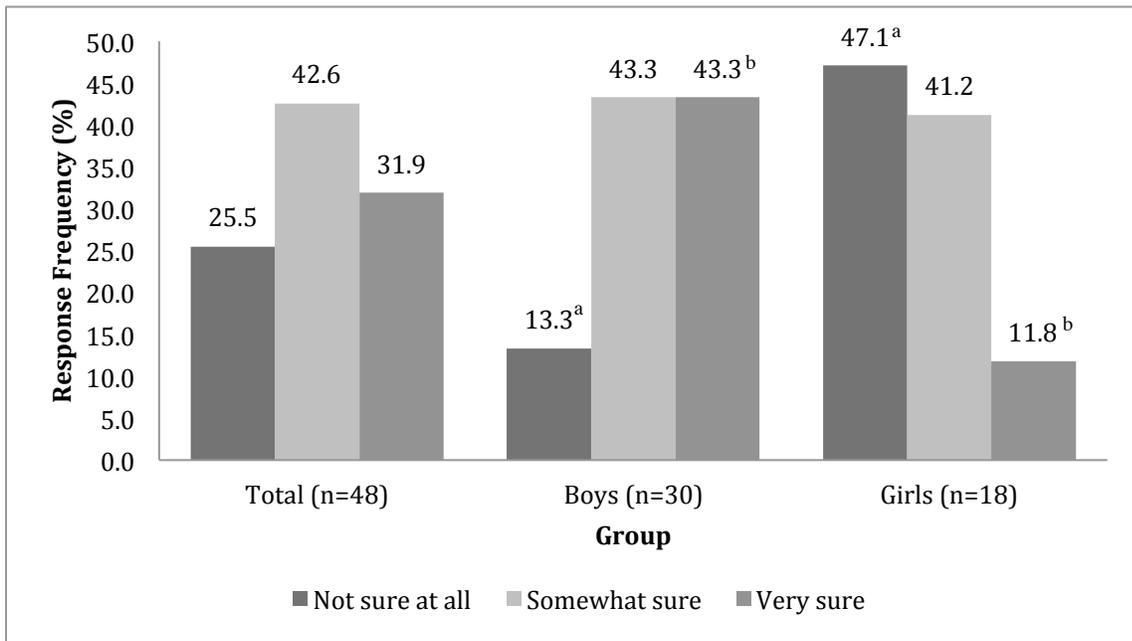


Figure 7.4 Youth frequency of responses to the question ‘How sure are you that you can do physical activity for 60 minutes each day?’ after a pilot school sports program

^{a,b} Indicate areas of significant difference ($p=0.016$) between groups as determined by adjusted standardized residuals, using the Pearson’s Chi-Square test.

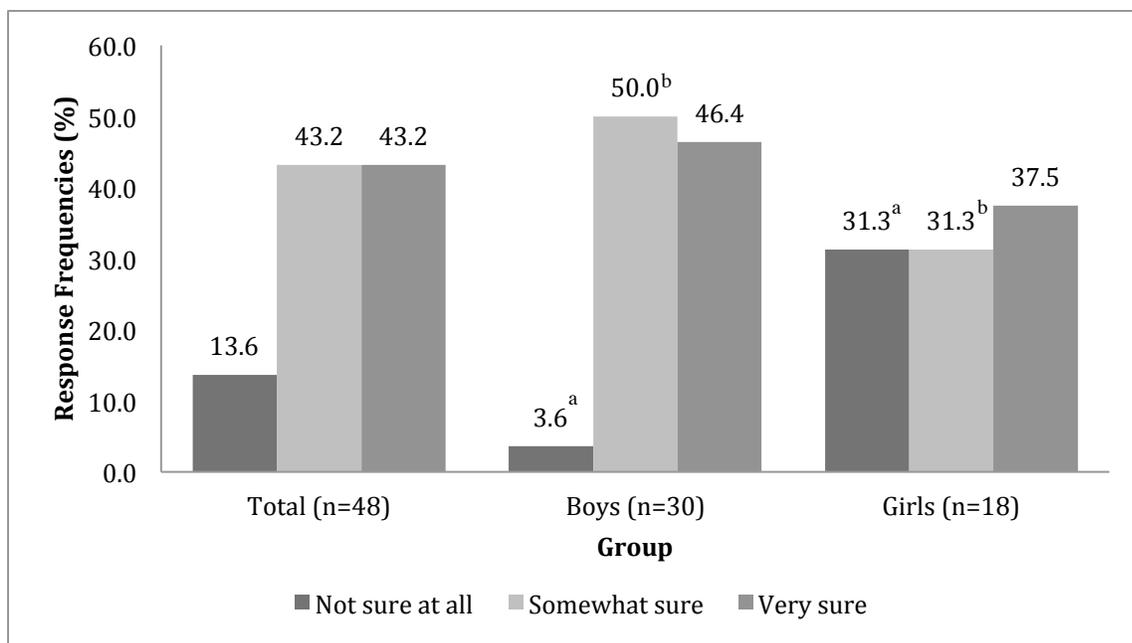


Figure 7.5 Youth frequency of responses to the question ‘How sure are you that you can be physically active, no matter how tired you feel?’ after a pilot school sports program

^{a,b} Indicate areas of significant difference ($p=0.034$) between groups as indicated by adjusted standardized residuals, using the Pearson’s Chi-Square test.

7.8.3 Success Strategies and Barriers Encountered During Implementation

Qualitative data included an interview with the program coordinator ($n=1$), a survey for teachers ($n=3$) and a focus group with youth ($n=8$, 50% male). These revealed a number of supports and barriers to program operations, which were organized according to the four main aspects of the process evaluation: *daily operations*, *resources*, *satisfaction and reach*, and *sustainability* (**Table 7.6**). There was an overarching and easily identifiable challenge related to attempting to run a program with very few resources. However, a number of success strategies that were developed throughout the program’s first year in operation were also described.

Discussions about the *daily operations* of the program revealed that it operated less consistently and with fewer activities than was hoped. Some unanticipated environmental factors (e.g.,

extreme cold weather, flooding) forced the school to be closed or the community to be evacuated, thus the program could not operate. Beyond these uncontrollable situations, a main barrier to consistent operations was difficulty in scheduling. This was mostly related to the fact that most activities took place in the high school gymnasium, which also needed to be used for a wide range of community events. However, planning in advance, recordkeeping and scheduling were strategies used to ensure that sports could still take place. Volunteer support was often inadequate, however school staff who could have helped with the program reported being unaware that this additional help to run the program was needed.

In terms of available *resources*, limited facilities and the need to share these facilities among other community events was a hindrance. Also, some facilities, such as the arena, were often inaccessible or required supervision. Effective use of the school gymnasium, including careful scheduling and sharing of the available space, was a support. That being said, the need to operate the program using volunteers sometimes was a barrier, because teachers and coaches had a number of competing responsibilities. While students' appreciation for the new equipment was a support, these resources were limited to only a few sports. Youth desired a large number of facilities and equipment that they did have access to (e.g., soccer field, running track, recreation centre, swing sets, badminton, archery, tennis).

Despite previously mentioned limitations, there were a number of supports to program *satisfaction and reach*. The inclusion of structured activities that were popularly desired by youth (i.e., hockey, volleyball, soccer, softball, jogging, stretching) was a support, however limits on the number and variety of activities that could be offered meant that some subgroups participated

less. Girls, as well as shy and less athletic youth, may not have been attracted to the available sports. Lower confidence in their proficiency to perform the activities in comparison to boys appeared to be a barrier for girls to participate. Youth described competing interests and a number of inactive role models as barriers to participation. However, youth also described the social aspect of the available organized sports as a reason to attend the program.

In terms of program *sustainability*, the program coordinator had a strong belief that despite the many barriers, the pilot program could and should be sustained for the benefit of youth. Both youth and adults described high levels of enthusiasm, and the fact that the programming was highly valued by the greater community. Limitations in available facilities, equipment and personnel were aspects described as being difficult to overcome without bolstered funding. The presence of key individuals who were strongly invested in the program, and community ownership of the program, both supported sustainability. However, the need for continuity was raised, because personnel turnover from year-to-year would add a barrier to program.

Table 7.6 Supports and barriers to the daily operations, resources, satisfaction, reach and sustainability of a pilot school sports program in a subarctic Ontario First Nations community

Aspect of Process Evaluation	Success Strategies	Barriers
Daily Operations <i>Consistent delivery of the program that conforms to the original design</i>	<ul style="list-style-type: none"> ▪ Planning ahead; scheduling ▪ Record keeping ▪ Mobilization of select, trained teachers and volunteers 	<ul style="list-style-type: none"> ▪ Environmental factors (e.g., cold climate, flooding) ▪ Scheduling difficulties ▪ Unclear expectations for personnel
Resources <i>Adequacy of facilities and resources to operate the program</i>	<ul style="list-style-type: none"> ▪ Effective use of available facilities ▪ Efficient sharing of available space ▪ Appreciation and respect for equipment 	<ul style="list-style-type: none"> ▪ Few available facilities and infrequent accessibility ▪ Equipment limited to a few sports ▪ Insufficient funding ▪ Reliance on volunteers
Satisfaction & Reach <i>Participation of subgroups of target users and satisfaction with program delivery</i>	<ul style="list-style-type: none"> ▪ Inclusion of popular activities ▪ Inclusion of structured activities ▪ Universal program (i.e., no youth are excluded) ▪ Social aspects of the program 	<ul style="list-style-type: none"> ▪ Limited variety of activities ▪ Competing interests ▪ Inactive role models ▪ Poor self-efficacy (girls) ▪ Inability to participate used as punishment for behaviour problems
Sustainability <i>Ability of the program to continue under current conditions</i>	<ul style="list-style-type: none"> ▪ Community champions ▪ Community ownership of the program ▪ Enthusiasm and morale ▪ Perceived value of the program 	<ul style="list-style-type: none"> ▪ Limitations in terms of facilities and equipment that will be difficult to overcome ▪ Inconsistent personnel support ▪ Limited funding and resources to scale up

7.8.4 Comparisons from Baseline to Post-program

A total of 57 youth (12.8±1.0, 59.6% male) participated in at least one measurement at post-program (74% participation rate). To optimize the size of the sample (which was already small), individuals did not require complete data (all measures) to be included, and therefore the sample size ranged from subpopulations of 25 to 41 pairs depending on the variable. These pairs did not differ significantly from those who were excluded due to missing data at either time point, except that as a group the paired sample had higher waist circumference at baseline (90.5±15.5 cm vs. 81.2±12.2 cm, p=0.023). Thirty-six youth participated in the accelerometry (63% of the total sample) and 30 of those had at least one day of valid wear time (12.6±0.9 years, 53.3% male).

On the days of accelerometry, the average temperature was 10.2°C (range: 1.4°C to 25.2°C on an unusually warm day), slightly warmer than during the collection of baseline information in October 2012 (Environment Canada, 2015). There were a mix of sunny days and cloudy days during this time.

Group-level paired changes in anthropometric, PA and physical fitness variables are presented in **Table 7.7**. Between baseline (October 2012) and June 2013, there were no significant changes in any of the measured anthropometric variables (i.e., BMI z-score, waist circumference, body fat percentage). There were, however, significant improvements in PA and fitness level over this time period. As a group, youth spent a mean 47.9 additional minutes in MVPA/day (110.8±48.7 minutes/day vs. 158.7±71.3 minutes/day, $p=0.016$), and reduced the time spent in sedentary behaviour ($p=0.001$). Youth also achieved a mean 6.6 additional stages on the shuttle run (16.4±12.3 stages vs. 23.0±19.3, $p=0.008$), improved their handgrip by a mean 7.2 kg (54.3±9.9 kg vs. 61.5±11.7 kg, $p=0.001$) and increased their sit-and-reach distance by a mean 2.2 cm (26.2±7.9 vs. 28.4±7.8 cm, $p=0.015$). Other measures of fitness were unchanged.

Changes in cardiorespiratory endurance differed between males and females. While no improvement in cardiorespiratory endurance was seen among girls, boys were able to complete 10.5 additional stages on the shuttle run (17.5±9.4 stages vs. 28.0±21.3 stages, $p=0.008$), which translated to a trend toward improved maximal aerobic power that approached significance (38.6±5.8 mL/kg/minute vs. 41.1±7.4 mL/kg/minute, $p=0.057$). Boys and girls increased their handgrip, a measure of muscular strength, by 8.2 kg (56.1±10.4 kg vs. 64.3±11.9 kg, $p=0.002$) and 5.6 kg (51.3±8.6 kg vs. 56.9±10.3 kg, $p=0.012$), respectively.

Table 7.7. Paired comparison of anthropometric, physical activity and fitness variables before and after a pilot school sports program^a

Variable	N pairs (% male)	Baseline (October 2012) ^b			Post-program (June 2013)			p ^c		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
Anthropometry										
BMI z-score ^d	38 (65.8)	1.55±1.92	1.74±2.27	1.20±0.92	1.78±1.07	1.98±1.12	1.40±0.90	0.388	0.469	0.075
Waist circumference (cm)	38 (65.8)	90.1±15.6	92.9±16.6	84.7±12.3	91.7±13.0	93.2±14.3	88.7±9.6	0.197	0.824	0.063
Body fat percentage (% fat)	25 (72.0)	32.1±8.7	31.9±9.8	32.6±5.3	31.8±9.7	30.4±11.0	35.2±4.1	0.682	0.119	0.077
Physical activity										
Time in moderate-to-vigorous PA (minutes/day)	17 (47.1)	110.8±48.7	130.0±46.9	93.8±46.2	158.7±71.3	180.8±42.8	139.1±87.5	0.016	0.098	0.168
Step count (steps/day)	17 (47.1)	14237±5237	16094±4457	12586±5563	16801±5344	18956±3550	14887±6109	0.101	0.141	0.408
Time in sedentary activity (minutes/day)	17 (47.1)	492.1±169.3	422.2±152.9	554.2±166.3	226.3±62.8	214.7±18.9	236.6±85.6	0.001	0.027	0.001
Physical fitness										
Cardiorespiratory endurance										
Shuttle run level (stage)	39 (66.7)	16.4±12.3	17.5±9.4	14.2±11.9	23.0±19.2	28.0±21.3	13.0±7.7	0.008	0.006	0.623
Maximal oxygen capacity (mL/kg/minute)	27 (66.7)	37.0±6.0	38.6±5.8	33.6±5.0	38.2±7.8	41.1±7.4	32.4±5.1	0.195	0.057	0.305
Muscular strength, endurance										
Handgrip (kg)	42 (61.9)	54.3±9.9	56.1±10.4	51.3±8.6	61.5±11.7	64.3±11.9	56.9±10.3	0.001	0.002	0.012
Curl-ups completed (#)	37 (62.2)	17.0±9.4	17.5±8.5	16.1±11.0	17.6±8.8	17.5±8.3	17.8±9.9	0.718	0.980	0.621
Flexibility										
Sit-and-reach distance (cm)	41 (63.4)	26.2±7.9	26.7±6.9	25.4±9.6	28.4±7.8	28.6±7.0	28.1±9.3	0.015	0.101	0.181

^aData are presented as mean±SD.^bBaseline data for the unpaired sample have been previously reported (**Study 4**; Gates et al., 2015); paired data and post-program data are novel.^cTested using the bootstrapped dependent samples t-test with 1000 resamples. Significant differences are shown in bold typeface.^dCalculated according to the World Health Organization growth reference (de Onis et al., 2007).

7.9 Discussion

Despite relatively few resources, the current study demonstrates that these were sufficient in a remote, isolated FN community, to initiate and carry out after school PA programming. The findings indicate that following one school year of programming, improvements in PA and some aspects of fitness were seen among youth, especially boys, suggesting a positive impact of the initiative. Notwithstanding common barriers to the maintenance of such programs, by making efficient and effective use of the resources available to them and by mobilizing motivated local champions, the program was received with great enthusiasm and was ultimately projected to be sustainable in the long term. This study represents an important contribution to the current limited knowledge on the potential impact of organized sports programs on the health of FN youth through examination of sex-level differences and by employing objective measures of PA.

7.9.1 Success Strategies and Challenges During Implementation

Both the implementation, and the continuation, of the school sports program were initially threatened by multiple barriers. This was unsurprising given that the program was operating in the context of severely limited resources. While some barriers were unavoidable (e.g., floods, cold weather), others were manageable and some were at least partly overcome through a number of mitigating strategies. Despite being limited by the facilities and equipment available to them, which were relatively few, both youth and adults spoke favourably about the program. Similar to a nearby community (Skinner et al., 2006), disempowerment was identified as an overarching issue that impeded participation in PA. Youth appeared highly motivated and desired a vast array of different activities, yet their ability to participate in PA and sports was hindered by a lack of equipment, facilities and local resources. Nonetheless, both youth and

adults maintained a positive outlook of what could be possible should further resources become available.

Being among the largest gathering places within the community, the school gym was understandably sometimes reserved for other occasions and thus would not be available for after school sports. Both youth and adults brought up a need for a dedicated recreation centre in the community, but of course this would require substantial funding and personnel not only to be built but also to be maintained. Particularly during the cold winter months, activities could not reasonably or safely take place outdoors and a venue for indoor PA would undoubtedly help encourage greater participation. Nevertheless, by planning ahead and efficiently sharing the available space, the program was able to operate relatively regularly after school. The dedication of key local champions who were central to running the program was a clear strength, and it is probable that without the commitment and enthusiasm of these few individuals, the fate of the program throughout its first year would have been far less favourable.

The need for continuity in personnel was raised; although teachers held a keen interest in the program and clearly recognized its value, they were also already juggling numerous other day-to-day responsibilities. High staff turnover is not uncommon in remote regions and can be a barrier to sustainability (Naylor et al., 2010). Thus, availability of local, consistently available, dedicated personnel would be an asset to future programming. Despite this, and the other aforementioned barriers, the program took place because the community capitalized on the few resources that they did have. Strengths were similar to those described for other programs (Kakekagumik et al., 2013; Naylor et al., 2010; Tuefel-Shone et al., 2009; Adams et al., 2005; Caballero, Clay, Davis,

Ethelbah, Holy Rock, Lohman, et al., 2003), including the relative ease of implementation, strong support from the school and community ownership. Fundamental skills training for teachers and school staff also helped to build morale early on and may have facilitated sustainability (Naylor et al., 2010; Scheirer, 2005).

7.9.2 Achievement of Short-term Outcomes

A recent review suggested that PA increases can reasonably be expected through school PA programming (Dobbins et al., 2013). Success in this regard in programs directed at Canadian Aboriginal and American Indian youth, however, has been relatively elusive (Tuefel-Shone et al., 2009). In many cases, it is possible that the use of self-reported measures of PA may have masked potential increases (Tuefel-Shone et al., 2009). In the current study, objective measurement of PA showed that time spent in MVPA increased substantially among boys, despite them being relatively active at baseline. While the improvement seems more dramatic than would be expected, an analysis of the KSDPP demonstrated that the proportion of youth being active for at least 30 minutes daily increased from 71% to 94% over four years, showing that such improvements are achievable (Adams et al., 2005). Any increase in PA, even if lesser than observed among the few youth in this study, will have a positive health impact (Janssen & Leblanc, 2010).

The substantial change in the time spent in MVPA among boys may be partly attributable to activities beyond those formally included in the program. Some teachers made efforts to encourage PA during class time, an emerging approach that has shown promise in changing PA behaviour, while being low cost (Kibbe, Hackett, Hurley, McFarland, Schubert, Schultz, et al.,

2011; Erwin, Beighle, Morgan, & Noland, 2010). The large increase in PA among boys should be interpreted in light of the fact that the sample of youth that participated in the accelerometry was small, with some being represented by a single day of valid data. The results cannot be generalized to reflect 'usual' activity, nor the activity level of all youth, and post-program PA participation was likely impacted by myriad factors. Post-program data were collected when the weather was slightly warmer, at a time when youths' academic workload was comparatively low. It is acknowledged that sustaining such a large increase in PA would be an immense challenge, especially during the summer when fewer resources are available (though swimming and biking are popular) or during the winter months when harsh weather makes outdoor activity undesirable. Since 2013, the community has had new playground equipment installed, which hopefully can contribute to increased PA outside of the program (J Stephen - school principal, personal communication, July 2015).

A 2013 review of school PA programs by Dobbins et al. and the results of Action Schools! BC and the KSDPP showed that school programs can be associated with improved cardiorespiratory endurance (Tomlin et al., 2012; Paradis et al., 2005). Boys experienced a remarkable 60% improvement on the shuttle run, likely due to improved cardiorespiratory endurance and perhaps increased motivation. The trend toward improvement in cardiorespiratory endurance among boys should not be understated, as it may help to counteract the deleterious health outcomes associated with obesity (Ortega et al., 2008), which is highly prevalent among these youth. Meanwhile, the lack of improvement among girls is a cause for concern that has not been reported among the findings presented for other programs (Kakekagumick et al., 2013; Ronsley et al., 2013; Tomlin et al., 2012; Adams et al., 2005; Paradis et al., 2005; Caballero et al., 2003),

but deserves attention. It is reasonable to postulate that this lack of improvement could be related to inadequate program engagement, because more than half of girls reported participating ‘rarely or never’. This presents a problem because girls were already less active and physically fit at baseline (see **Study 4**; Gates et al., 2015), and tend to experience steeper declines in PA over adolescence (Sweeting, 2008). Additionally, girls reported a lower perceived self-efficacy for PA, a factor that may mediate the ability of programming to impact their participation (Taymoori & Lubans, 2008; Dishman, Dunn, Sallis, Vandenberg, & Pratt, 2010).

To ensure that girls accrue the cardiorespiratory benefits that boys did, they likely require exposure to initiatives of greater intensity. For this to happen, programming must be attractive to them. An issue that was often raised was that the activities offered by the program did not cater to girls, a factor that may influence girls to stop participating in sports (Slater & Tiggemann, 2010). Meanwhile, social networks and having friends who participate, have been shown to be important facilitators of PA participation in girls (Flintoff & Scraton, 2011; Voorhees, Murray, Welk, Birnbaum, Ribisi, Johnson, et al., 2005). In the current study, youth cited ‘being with friends’ as an important motivator for PA. It is possible that the availability of less competitive activities, a focus on the social aspects of sport and the inclusion of non-sport fitness activities, like dance, may help to attract more girls.

Beyond cardiorespiratory endurance, this is among the first studies to have demonstrated improvements in other aspects of physical fitness among FN youth over the duration of a school program. The improvement in muscular strength, 8.2 kg in boys and 5.6 kg in girls, can be postulated to be beyond what may be expected in this age group as a result of growth alone when

compared to available reference data (Ploegmakers, Hepping, Geertzen, Bulstra, & Stevens, 2013). There is evidence that improving musculoskeletal fitness is negatively associated with obesity and abdominal obesity (Ruiz et al., 2009). The improvements observed are therefore encouraging.

Available literature demonstrates that it may not be realistic to expect a change in BMI or body composition over the course of school PA programming, which acts in a single setting (Towns et al., 2014; Dobbins et al., 2013; Harris, Kuramoto, Schulzer, & Retallack, 2009). To the authors' knowledge, Healthy Buddies™ is among the first Canadian school PA programs for Aboriginal youth to positively impact BMI and waist circumference (Santos et al., 2014; Ronsley et al., 2013). Even longstanding multi-component programs (Kakekagumick et al., 2013; Saksvig et al., 2005; Caballero et al., 2003) have been unable to affect BMI. However, the lack of change in anthropometric variables should be viewed positively; normative reference data show trends in these variables between the ages of 12 and 13 years (as in the study population) that do not appear substantially different than youth in this study (Ogden et al., 2011; McDowell, Fryer, & Ogden, 2009). A unique aspect of Health Buddies™ believed to be integral to its effectiveness was peer mentoring (Santos et al., 2014; Ronsley et al., 2013), an approach that is gaining popularity and seems feasible to implement (Story, Lytle, Birnbaum, Perry, 2002). A recent review supports that this method can be successful in impacting health behaviour (e.g., diet) (Yip, Gates, Gates, & Hanning, 2015), and a case study in Garden Hill FN, Manitoba has shown such programming to be effective in attenuating weight gain among youth (Eskicioglu, Halas, Sénéchal, Wood, McKay, Villeneuve, et al., 2014). Thus, this may be a useful way forward in continuing to tailor the current programming.

7.9.3 Sustainability and Next Steps

The sustainability of school-based health promotion programs is often a concern. This is especially true in remote and isolated locations where resources are scarce and staff turnover may be high, because these programs typically require continuous inputs of time, training, funds, and personnel. It is noteworthy that the school requested running shoes for children – a fundamental resource and one that is rarely identified as a limitation in PA intervention research. Two PA programs in Canada that are aimed at youth, the SLHDP and the KSDPP, have successfully been sustained, though the achievement of intended outcomes attenuated over time (Kakekagumick et al., 2013; Paradis et al., 2005). There has been an increased interest in studying the sustainability of such programs, especially those emerging from community-university partnerships which typically have funding that is limited to a short time span (Friend, Flattum, Simpson, Nederhoff, & Neumark-Sztainer, 2013; Scheirer, 2005). Kakekagumick et al. (2013) stated that the SLHDP was originally funded by a research grant, but that the research findings led to greater recognition of the problem and as a result, permanent funding was later established.

Factors enhancing the sustainability of school- or community-based PA programs in FN communities have been identified to include community ownership, shared decision making, willingness to adapt the intervention to keep it relevant, and the fact that over time, the programs became embedded within the school and greater community (Kakekagumick et al., 2013; Adams et al., 2005; Paradis et al., 2005). The important role of a local program champion, an individual with a vested interest in the program who can oversee its operations, has been identified as a key factor (Scheirer et al., 2005). Belief that the program is important among those closely involved

is another contributor to success over the long term (Friend et al., 2014). It was clear from the qualitative data that both adults and youth greatly valued the program and believed in its importance. The coordinator of the pilot sports program strongly believed that, even when faced with numerous barriers, the program should and could be sustained. Community stakeholders were involved in the evaluation process, had control of the program's operations and adapted the activities to the local circumstances, which are considered strengths (Tuefel-Shone et al., 2008).

Evaluation of the sustainability of the programming is of value given that this has been rarely addressed in the literature. It has been suggested that local leaders be trained in evaluation techniques so that they can take ownership of the process and improve upon the ability to expand start-up projects (Naylor et al., 2010). With the promising outcomes demonstrated from the pilot program in the short-term, continued evaluation would be valuable. Unfortunately, local training in evaluation was not a component of the current project, but would be a valuable approach moving forward. Despite this, community ownership of the program has allowed local leaders to continue to run the program and adapt its components over time. As of 2015, the program continues to run despite resource limitations, which have included not having access to a physical education teacher on a consistent basis. Most recently, the program has been expanded to include a greater emphasis on traditional cultural activities (J Stephen - school principal, personal communication, July 2015).

The barriers to program sustainability that were raised, including inconsistent personnel support, limited facilities and equipment, and inadequate funding to scale up are not dissimilar from those that have been encountered in other remote locations (Naylor et al., 2010). Having a continuous

source of funding is an important facilitator (Tueffel-Shone et al., 2009), and it would help to be able to hire local personnel who could be continuously involved. It is hoped that the findings of the evaluation can be used to advocate for the funding needed to promote health equity and access to PA resources for FN youth.

7.10 Study Strengths and Limitations

This study is one of few reporting on PA or sports programs for FN youth in Canada, and the first reporting on such a program for FN students in the specific region in this study. This research offers a comprehensive view of program impact by combining both quantitative and qualitative findings. Additionally, body composition, PA, and fitness were objectively measured in this study, meaning that the data were not biased by recall error or social desirability (Reilly et al., 2008). The study also used sex-based analyses, which helped to parse out differences in outcomes among boys and girls. The school setting was ideal for conducting this study, and participation rate was high. The results of this research provided valuable feedback to the community and can aid in sustainability. Results may also be a useful starting point for nearby communities facing similar circumstances.

That being said, this study has potential limitations. Even with a high participation rate, the study was limited by a small sample size, especially for the accelerometry. The use of a paired sample, however, was an asset because the same individuals could be tracked over time. To maximize sample size, slightly different samples were used for each variable, meaning that inferences between changes in the individual variables were not possible. Because this study lacked a comparison group, cause and effect could be ascertained unambiguously. In addition, though

documentation of program integrity was planned, it became too burdensome. Alternate subjective methods were employed to obtain at least some information on program integrity. The community in which the study occurred is small and has only one school, making it impossible to have a local control group. Also, the high degree of diversity among FN populations in terms of culture and available resources means that even nearby communities would not provide suitable controls. For this same reason, results of this study are not generalizable to all FN populations, though components of the results may be useful to other communities.

7.11 Conclusion

Despite a number of implementation challenges, a school sports program in a remote and isolated northern Ontario FN community appeared to be associated with numerous benefits. Improvements were seen in youth PA and fitness following one year of programming, especially among boys. The program was well received by both adults and youth, though it operated under extremely constrained resources. A need for continuity in personnel support and increased funding for facilities and equipment to overcome the barriers to implementation and sustainability was identified. In the future, there will need to be an increased focus on the types of programming that are attractive to girls, who participated less often and experienced fewer benefits over the first year. Adaptation to include traditional cultural activities and initiatives at other socioecological levels, as resources allow, will likely be beneficial.

7.12 Acknowledgments

The authors would like to thank the collaborating community, including the youth and teachers who took part in the measures, and the champions who initiated and ran the sports program. We would like to acknowledge the statistical support of Dr. Ian Martin. The study was funded by a CIHR grant (#178424).

8.0 General Discussion

The studies within this thesis have begun to provide some information on the factors affecting the health and health behaviours for FN youth in Canada. What is clear is that a range of data from various sources is needed to provide insight on the factors influencing obesity and health behaviours (particularly PA, sedentary time) for these youth. There is a place for both national survey data and local community-based studies in continuing to fill knowledge gaps and informing health-promoting initiatives that will benefit FN people and their communities.

Following a review of the literature, the studies within this thesis took advantage of the strengths of both types of studies. First, national data from the RHS were used to begin to understand potential factors at various socioecological levels that may influence obesity and sedentary behaviour. Then, the results of a community partnership that provided one community with data on the health of their youth, and informed a school program that enhanced the PA environment, was described.

A review of available data on PA and fitness among Aboriginal youth confirmed that low levels of PA and excess engagement in sedentary behaviour, principally screen time, are concerns for the health of youth, particularly in terms of being associated with overweight and obesity (**Study 1**). Some studies also highlighted the importance of PA in enhancing holistic wellness and contributing to cultural connection (Lévesque et al., 2015; Janssen et al., 2014; Cargo et al., 2007). Meanwhile, disaggregate data for Aboriginal subgroups were sparse (especially for Inuit and Métis). It cannot be assumed that these subgroups are affected similarly by the various health determinants within the socioecological model (Willows, Hanley, & Delormier, 2012) used to frame this dissertation, as grouped data would imply. Indeed, data from several distinct FN

populations showed great diversity in PA levels (**Study 1**) because youth in various communities are likely to be experiencing unique influences that are not always easy to capture in national survey data.

Still, national-level data for FN youth living on reserve can be a powerful resource for FN communities. The wealth of data available (in terms of the variety of factors explored) from surveys such as the RHS provide an ideal starting point for socioecological explorations that can inform health-promoting initiatives specific to FN people. The analyses of RHS data (**Studies 2 and 3**) herein have begun to elucidate some individual, interpersonal, community, and cultural/historical influences that may have impact on overweight/obesity and engagement in sedentary behaviours. This subgroup-specific analysis was important, as it revealed that the effects of a number of sociodemographic determinants operated differently than would be expected by simply extending the results of studies of the general population. However, the results are also incomplete, with one reason being that many factors at various socioecological levels (e.g., policy, built environment) were not explored.

There is value in this national-level data in providing information specific to FN youth living on reserve, but surveys such as the RHS are limited in that they lack qualitative information reflecting a FN perspective, thus explanation of the findings remains speculative and uncertain. In particular, unexpected and counterintuitive effects were found for the role of community cultural factors in the odds of obesity and engagement in sedentary behaviour. With few studies evaluating the links between cultural connection, health behaviours and outcomes, one cannot draw strong conclusions from these findings. In the future, mixed-methods approaches that

include FN perspectives may help to begin to understand these relationships, though the challenges in utilising this approach in a large population is acknowledged. Additionally, the nature of surveillance studies makes it difficult to collect objective data, as survey questions may be affected by several biases. Additionally, results generated from these survey questions may provide only a partial description of PA engagement, because they may limit responses to a list of relatively few activities.

While RHS data are generalizable to FN youth across Canada, local research collaborations can be complementary, as they can provide information in ways that overcome some of the limitations of survey data. These collaborations also provide recognition of the fact that all communities are affected by unique socioecological influences and may desire information specific to their circumstances. Still, national data may act as a starting point, and results of the studies herein suggest that health behaviours may be important targets for obesity prevention. Meanwhile, current evidence suggests that systems-level approaches (Wilk & Cooke, 2015) addressing higher socioecologic levels (Garner et al., 2010) and the promoting resilience, cultural connection and self-determination (Canadian Council on Social Determinants of Health, 2013; King, Smith, & Gracey, 2009) are the ways forward, rather than focusing on isolated programs that target individual health behaviours.

Community-level data specific to the health of local youth can allow communities to identify and capitalize on existing community strengths. An exploration of PA and fitness in one FN community (**Study 4**) allowed for an assessment of the issue from a perspective that was not possible via analyses of survey data. While national datasets have generally shown low levels of

PA among Aboriginal youth utilizing self-reported PA data (**Study 1**), this smaller-scale study allowed for direct measurement, which showed that in fact, most youth in the community met Canadian guidelines for MVPA (Gates et al., 2015). This local study also allowed for an assessment of various aspects of fitness, information that is not currently available in national data. Close partnership with the community also provided an opportunity for the voices of FN youth to be incorporated via qualitative methods. While the knowledge gained from this study has more limited generalizability as compared to surveillance data, it had direct utility for the community involved in that it identified local strengths and barriers that enabled tailoring of a school-based program, and garnered local interest and engagement in a PA initiative.

Current research suggests that systems-level approaches to health promotion are needed to address challenges such as obesity, which is the result of numerous interrelated influences (Finegood, Merth, & Rutter, 2010; Wilk & Cooke, 2015). Systems-level approaches acknowledge the complexity of health issues such as obesity (Finegood, Merth, & Rutter, 2010) and align with the holistic view of wellness held by FN people (Wilk & Cooke, 2015). Though the sports program documented in **Study 5** did appear to have some success in that it was associated with increased PA and improvements in some aspects of fitness (Gates, Hanning, Gates, Stephen, Fehst, & Tsuji, in press), there remain several barriers to PA participation for youth in the community, because the program acted in a single setting and relied on a few dedicated local champions. Not to discount the great value of these individuals, the results of this research as well as previous collaborations with the community (Gates et al., 2012c, 2013b; Hanning et al., 2011) clearly show that such programming is necessary but insufficient to provide significant and sustained improvements in rates of obesity. This is because discrete

school-level programs do not address the numerous community-level and systematic barriers that continue to exist. For example, on weekends and during the summer months, the school is closed, leaving youth with the same barriers to PA that existed before the implementation of the program. Nonetheless, the challenges in implementing even relatively simple pilot programs, let alone systems-level change, in remote regions with limited resources needs to be acknowledged. As such, these pilot programs should still be tested, as they can begin to build community morale and work as a small step toward the future ideal of systems change.

In some ways, this dissertation is limited because the approach was somewhat problem-based, in that it emphasized reducing the ‘issue’ of overweight and obesity. In hindsight, fostering resilience and taking a strengths-based approach may have been preferable, as it is believed to be beneficial in engaging youth, fostering leadership, and emphasizing maximizing positive outcomes rather than attempting to suppress negative ones (Crooks, Chiodo, Thomas, & Hughes, 2010). Indeed, strength-based community-driven approaches that foster self-determination have been shown to be effective in enhancing health in several FN communities (Canadian Council on Social Determinants of Health, 2013). Moving forward, these types of approaches should be strongly considered. Finally, the largely quantitative nature of this dissertation is a limitation that is acknowledged, nevertheless, this was balanced in the final two studies by incorporating the voices of FN community members and youth to triangulate the objectively measured PA and fitness outcomes.

8.1 Key Contributions

The findings from the five studies presented herein make meaningful contributions to the available literature on obesity, PA, sedentary behaviour, and the programs that may potentially affect the health of FN youth. The following is a brief overview of those key contributions:

Study 1 provided a recent review of the PA, fitness, and sedentary behaviour of Aboriginal youth in Canada that integrated national and regional data, and reported on associations with health-related and other variables. Previous reviews by Foulds, Warburton and Bredin (2013) and Young & Katzmarzyk (2007), provided information about the PA levels of both Canadian Aboriginal and American Indian youth. The review herein added to the knowledge generated by these studies, and had the strength of incorporating the available regional data from FN communities, which, in many cases, would not be included in national surveillance studies. The review substantiated concerns about the PA and fitness levels of Aboriginal youth, and was novel in that it described differences between boys and girls, as well as associations with health-related variables, which have not been presented previously.

Study 2 provided a preliminary exploration of the relationships between demographic, socioeconomic, cultural and health behavioural factors and overweight/obesity among on-reserve FN youth. There exist few reports that have utilized the data collected in the RHS, which has the advantage of including a representative sample of on-reserve FN youth across Canada. The availability of these data allowed for this study to build upon the currently available information in taking an ecological approach to elucidate the effects of certain socioeconomic, cultural and health behaviour characteristics on the odds of overweight and obesity among FN

youth living on reserve. The study had the strength of demonstrating differences in the factors predicting the odds of obesity in various age-sex groups. Since relatively little previous information was available on the topic, this study may act as a starting point for future research investigating the multitude of other factors likely affect obesity for this population. The findings suggested that health behaviours may be an important target for obesity prevention initiatives.

Study 3 provided a preliminary exploration of the relationships between demographic, socioeconomic, cultural and health-related factors and high television viewing among on-reserve FN youth. The investigation of the deleterious effects of sedentary lifestyles is an emerging area of research, even for the general population. Few community-based studies have described factors associated with screen-based sedentary behaviours among FN youth. This study utilized RHS data to begin to explore the relationships between just some potentially influential factors and high television viewing specific to on-reserve FN youth aged 15-17 years. It was shown that the effect of these factors on the odds of high television viewing differ significantly by sex, and the relationships did not always operate in the expected direction given the associations seen in the general population. Links between television viewing and several aspects of health suggest that it will be important to direct resources toward reducing the prevalence of these behaviours.

Study 4 described a needs assessment with the goal of informing school-based programming for PA in a remote and isolated northern Ontario FN community. This study had the strengths of utilizing objective measures, describing facets of fitness beyond cardiorespiratory endurance and presenting selected results by sex, which is relatively novel

based on what is currently available. Since the measurement of PA was objective, all types of activity were included, and the report was not limited to a list of activities as would be found on a questionnaire. Further, the research presented the results of some qualitative information that helped to fill gaps in the ‘story’ that would exist if only quantitative information were presented. It was interesting that all youth appeared to be equally active, but overweight, obese and abdominally obese youth seemed to be more likely to have low cardiorespiratory endurance than normal weight youth. The findings suggested that youth in this community would benefit from programming to improve cardiorespiratory endurance, and reduce the prevalence of overweight, obesity and abdominal obesity. It is recognized that the findings from this community cannot be generalized to FN youth across the country.

Study 5 described a process and outcome evaluation of a community-driven school sports program for youth in a remote and isolated northern Ontario FN community. This study is one of few to show that relatively simple sports programs can be implemented and have success in terms of PA and fitness in remote and isolated regions with few existing resources. This study was novel in that it reported on the different effects associated with sports programming on FN boys and girls, and described effects on aspects of fitness beyond cardiorespiratory endurance. The study also had the strength of presenting objective PA data and describing potential challenges and success strategies from a number of stakeholders.

8.2 Future Directions

As previously described, the research studies presented within this document make a number of contributions to the literature. However, this work is only one small piece of a much larger story that remains to be told. Though each study describes potential future directions in some degree of detail, some future research needs are summarized, as follows:

1. Continuing review of the emerging evidence on PA, fitness and sedentary behaviour among Aboriginal youth, with emphasis on the need for a review of qualitative studies, which has not been addressed herein. In the near future, the review presented in this thesis will also need to be updated to include the most recent findings. Further, there is a need for a comprehensive review of health promotion or obesity prevention programming that has taken place in FN communities. Though a review on this topic was recently published (Towns et al., 2013), it reported on relatively few studies. Continuing review of the topic will enable for the identification of promising practices.

2. Further study on the risk and protective factors for overweight and obesity among FN youth. The results presented here are only a start for several reasons. The relationships that were detected are based on limited quantitative data and the effects of only a few potentially influential factors were investigated. Since it is well known that myriad factors influence the development of obesity, much research remains to be done in order to more fully understand the factors involved for FN youth living on reserve. Several of the relationships differed from what would be expected, and qualitative information from the perspective on FN people would be of

value to help to further understand all of the factors involved (i.e., a mixed-methods approach would be useful).

3. Further study on the risk and protective factors for sedentary behaviour among FN youth, including other behaviours such as computer use, and ‘productive’ sedentary behaviour (e.g., reading). While the effects of several factors on the odds of high television viewing were elucidated, the scope of this research only allowed for the investigation of screen-based behaviour and a few potential predictor variables. As discussed previously, a mixed-methods approach in the future would allow for greater inclusion of the experiences of FN people and improved understanding of observed relationships. Not only do other potentially associated factors need to be investigated, but research into other types of sedentary behaviours is needed because productive sedentary behaviours like homework and reading may be influenced by different factors and also may be associated with different health effects.

4. Continued university-community partnerships that enable FN communities to obtain information about the health of their youth. Ownership of this information by communities empowers them to take action and to advocate for the direction of resources toward initiatives and resources that they believe are important. These partnerships should be collaborative and, when possible, include training of local individuals in order to contribute to community capacity building. Even when sample sizes are small, since various communities are affected by different circumstances, local information on the health of youth can be valuable to these communities and help to inform health promotion initiatives. Qualitative information should also be sought,

because it tells the story from the perspectives of those who experience it. If possible, sex-based comparisons should be presented.

5. Continued evaluation of community-driven programs, no matter how simple or complex.

Evaluation not only enables communities to substantiate the power of these programs to impact the health of their youth, but also increases sustainability by elucidating what works and what does not. Though the program in this thesis mainly involved after-school sports (at the request of the community) future programs may also aim to enhance involvement in traditional activities. Further, it has been suggested that programs supporting holistic health (Cargo et al., 2007) and higher socioecological levels (Garner et al., 2010), rather than directly targeting behaviours such as PA and sedentary behaviour, will be an important way forward (Cargo et al., 2007). It will be important that, for the program described in this thesis, multiple other settings and actors be engaged and connected in the future, reflecting the systems-level approach and acknowledging that health behaviour must be supported by influences in multiple settings (Wilk & Cooke, 2015; Willows, Hanley & Delormier, 2012).

9.0 Concluding Remarks

The available evidence shows that behaviours such as low levels of PA and excess sedentary time appear to be relatively prevalent among Canadian Aboriginal youth, contributing to high rates of overweight and obesity and sub-optimal levels of physical fitness. It was promising that the bulk of the literature suggested that health behaviours, including higher PA and lesser sedentary behaviour, are inversely associated with obesity. Among FN youth living on reserve who participated in the 2008-2010 RHS, the odds of overweight/obesity were affected by a number of behavioural and cultural factors, but not always as would be expected. Further investigation into television viewing revealed an unexpected relationship with socioeconomic status among older (15 to 17 year old) youth. There were also significant effects for certain cultural and health-related factors on the odds of high television viewing among these youth. In the case of both obesity and television viewing, observed relationships differed by age and sex. Further study including the perspectives of FN youth will be needed to fully understand these relationships. As a conglomeration, the findings suggest that health promotion programs are needed to address overweight and obesity among FN youth, and that targeting health behaviour (e.g., PA, sedentary time, diet) may be a useful starting point.

Work in one subarctic Ontario FN showed that, as opposed to the low levels of PA demonstrated by national data, youth in some communities may be quite active, despite being faced with numerous barriers. These findings underscore the importance of local data for communities wishing to implement health promotion strategies. However, among many youth, especially those affected by obesity, cardiorespiratory fitness levels were in need of improvement. In this community, though existing resources were low, simple sports programming that capitalized on

existing supports was feasible, sustainable, was associated with improvements in the PA and physical fitness of the youth who participated.

On a personal note, working on health-related research with FN people for the past seven years has been both enlightening and rewarding. Prior to embarking on these projects I knew relatively little about the challenges faced by FN Canadians. Working with a culture other than my own, in remote and isolated locations, presented a number of challenges over the years. More importantly, it taught me a number of valuable lessons in terms of relationship building, patience and adaptability. I learned to set aside my own values in order to fully appreciate those of others, and can be proud that beyond the academic requirements of publications and presentations, this collaborative work truly helped to build capacity and sovereignty for health in the community with which I partnered. Of course, the experiences that I've gained are only a start and I still have a lot to learn.

It is clear that there remains a lot of room for improvement in terms of health determinants and equitable access to PA resources for FN people, and these changes will not come from a single thesis with a relatively narrow focus. However, seeing the tangible benefits of the partnership with the community involved in this research has been the most rewarding outcome of this project. The dedication of key individuals to the youth in their community is admirable. It can only be hoped that the story that has been told within this thesis can bring greater attention to the issues that exist, and contribute at least in a small way to the changes needed to begin to reduce the health inequities experienced by Canada's FN youth

Letters of Copyright Permission

Study 4: Published in the *Journal of Community Health*

RightsLink Printable License

<https://s100.copyright.com/CustomerAdmin/PLF.jsp?ref=87c95...>

SPRINGER LICENSE TERMS AND CONDITIONS

Oct 28, 2015

This is a License Agreement between Michelle Gates ("You") and Springer ("Springer") provided by Copyright Clearance Center ("CCC"). The license consists of your order details, the terms and conditions provided by Springer, and the payment terms and conditions.

All payments must be made in full to CCC. For payment instructions, please see information listed at the bottom of this form.

License Number	3737691493455
License date	Oct 28, 2015
Licensed content publisher	Springer
Licensed content publication	Journal of Community Health
Licensed content title	Physical Activity and Fitness of First Nations Youth in a Remote and Isolated Northern Ontario Community: A Needs Assessment
Licensed content author	Michelle Gates
Licensed content date	Jan 1, 2015
Type of Use	Thesis/Dissertation
Portion	Full text
Number of copies	1
Author of this Springer article	Yes and you are the sole author of the new work
Order reference number	None
Title of your thesis / dissertation	Obesity, physical activity and sedentary behaviour among Canadian First Nations youth: An exploration of associated factors and evaluation of a school sports program
Expected completion date	Dec 2015
Estimated size(pages)	340
Total	0.00 CAD

Terms and Conditions

Introduction

The publisher for this copyrighted material is Springer Science + Business Media. By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the Billing and Payment terms and conditions established by Copyright Clearance Center, Inc. ("CCC"), at the time that you opened your Rightslink account and that are available at any time at <http://myaccount.copyright.com>).

Limited License

With reference to your request to reprint in your thesis material on which Springer Science

and Business Media control the copyright, permission is granted, free of charge, for the use indicated in your enquiry.

Licenses are for one-time use only with a maximum distribution equal to the number that you identified in the licensing process.

This License includes use in an electronic form, provided its password protected or on the university's intranet or repository, including UMI (according to the definition at the Sherpa website: <http://www.sherpa.ac.uk/romeo/>). For any other electronic use, please contact Springer at (permissions.dordrecht@springer.com or permissions.heidelberg@springer.com). The material can only be used for the purpose of defending your thesis limited to university-use only. If the thesis is going to be published, permission needs to be re-obtained (selecting "book/textbook" as the type of use).

Although Springer holds copyright to the material and is entitled to negotiate on rights, this license is only valid, subject to a courtesy information to the author (address is given with the article/chapter) and provided it concerns original material which does not carry references to other sources (if material in question appears with credit to another source, authorization from that source is required as well).

Permission free of charge on this occasion does not prejudice any rights we might have to charge for reproduction of our copyrighted material in the future.

Altering/Modifying Material: Not Permitted

You may not alter or modify the material in any manner. Abbreviations, additions, deletions and/or any other alterations shall be made only with prior written authorization of the author(s) and/or Springer Science + Business Media. (Please contact Springer at (permissions.dordrecht@springer.com or permissions.heidelberg@springer.com))

Reservation of Rights

Springer Science + Business Media reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.

Copyright Notice:Disclaimer

You must include the following copyright and permission notice in connection with any reproduction of the licensed material: "Springer and the original publisher /journal title, volume, year of publication, page, chapter/article title, name(s) of author(s), figure number(s), original copyright notice) is given to the publication in which the material was originally published, by adding; with kind permission from Springer Science and Business Media"

Warranties: None

Example 1: Springer Science + Business Media makes no representations or warranties with respect to the licensed material.

Example 2: Springer Science + Business Media makes no representations or warranties with respect to the licensed material and adopts on its own behalf the limitations and disclaimers established by CCC on its behalf in its Billing and Payment terms and conditions for this licensing transaction.

Indemnity

You hereby indemnify and agree to hold harmless Springer Science + Business Media and CCC, and their respective officers, directors, employees and agents, from and against any and all claims arising out of your use of the licensed material other than as specifically authorized pursuant to this license.

No Transfer of License

This license is personal to you and may not be sublicensed, assigned, or transferred by you to any other person without Springer Science + Business Media's written permission.

No Amendment Except in Writing

This license may not be amended except in a writing signed by both parties (or, in the case of Springer Science + Business Media, by CCC on Springer Science + Business Media's behalf).

Objection to Contrary Terms

Springer Science + Business Media hereby objects to any terms contained in any purchase order, acknowledgment, check endorsement or other writing prepared by you, which terms are inconsistent with these terms and conditions or CCC's Billing and Payment terms and conditions. These terms and conditions, together with CCC's Billing and Payment terms and conditions (which are incorporated herein), comprise the entire agreement between you and Springer Science + Business Media (and CCC) concerning this licensing transaction. In the event of any conflict between your obligations established by these terms and conditions and those established by CCC's Billing and Payment terms and conditions, these terms and conditions shall control.

Jurisdiction

All disputes that may arise in connection with this present License, or the breach thereof, shall be settled exclusively by arbitration, to be held in The Netherlands, in accordance with Dutch law, and to be conducted under the Rules of the 'Netherlands Arbitrage Instituut' (Netherlands Institute of Arbitration). **OR:**

All disputes that may arise in connection with this present License, or the breach thereof, shall be settled exclusively by arbitration, to be held in the Federal Republic of Germany, in accordance with German law.

Other terms and conditions:

v1.3

Questions? customer@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777.

Study 5: Accepted for publication in *Health Behavior and Policy Review*

From: [REDACTED]
Subject: [REDACTED]
Date: [REDACTED]
To: [REDACTED]

R

There is no conflict.

Robert J. McDermott, PhD
Senior Consulting Editor
Health Behavior and Policy Review
Paris Scholar Publishing Ltd
[REDACTED]

----- Original Message -----
Subject: Re: Health Behavior and Policy Review - HBPR-2015-46/R2 - (105): Accept
From: Michelle Gates [REDACTED]
Date: Tue, October 27, 2015 11:56 am
To: Health Behavior and Policy Review
<[REDACTED]>

Hello Dr. McDermott,

Thank you for the update on the status of this manuscript. I had a question about copyright, because a version of this manuscript (though much longer) will appear in my PhD thesis. These are generally posted online by the university. I wanted to obtain permission for this, or clarify about whether this is permissible, as to not violate the eventual copyright on the manuscript. Thank you very much for your help,

Michelle Gates
PhD Candidate, School of Public Health and Health Systems
University of Waterloo
Waterloo, Ontario, Canada
[REDACTED]

References

- Aboriginal Affairs and Northern Development Canada. (2013). Aboriginal peoples and communities: First Nations in Canada. Ottawa, ON: Her Majesty the Queen in Right of Canada. Retrieved 16 July 2015 from <http://www.aadnc-aandc.gc.ca/eng/1307460755710/1307460872523>
- Aboriginal Affairs and Northern Development Canada. (2012). Aboriginal peoples and communities: Terminology. Retrieved 16 July 2015 from <http://www.aadnc-aandc.gc.ca/eng/1100100014642/1100100014643>
- Aboriginal Sport Circle. (2015). About the ASC. Retrieved 7 August 2015 from www.aboriginalsportcircle.ca/main/about.html
- Aboriginal Sport and Wellness Council of Ontario. (2015). About ASWCO. Retrieved 15 September 2015 from <http://aswco.ca/about-aswco/>
- Adams, A., Receveur, O., Mundt, M., Paradis, G., & Macaulay, A.C. (2005). Healthy lifestyle indicators in children (grades 4 to 6) from the Kahnawake Schools Diabetes Prevention Project. *Canadian Journal of Diabetes*, 29(4), 403-409.
- Adelson, N. (2005). The embodiment of inequity: Health disparities in Aboriginal Canada. *Canadian Journal of Public Health*, 96(Suppl 2), S45-S61.
- Anderson, K.D., Baxter-Jones, A.D., Faulkner, R.A., Muhajarine, N., Henry, C.J., & Chad, K.E. (2010). Assessment of total and central adiposity in Canadian Aboriginal children and their Caucasian peers. *International Journal of Pediatric Obesity*, 5(4), 342-350.
- Atkin, A.J., Sharp, S.J., Corder, K., & van Sluijs, E.M.F., on behalf of the International Children's Accelerometry Database (ICAD) Collaborators. (2014). Prevalence and correlates of screen time in youth, an international perspective. *American Journal of Preventive Medicine*, 47(6), 803-807.
- Barton, S.S., Thommasen, H.V., Tallio, B., Zhang, W., & Michalos, A.C. (2005). Health and quality of life of Aboriginal residential school survivors, Bella Coola Valley, 2001. *Social Indicators Research*, 73(2), 295-312.
- Beets, M.W., Beighle, A., Erwin, H.E., & Huberty, J.L. (2009). After-school program impact on physical activity and fitness: A meta-analysis. *American Journal of Preventive Medicine*, 36(6), 527-537.

- Bélanger, M., Gray-Donald, K., O'Loughlin, J., Paradis, G., & Hanley, J. (2009). Influence of weather conditions and season on physical activity in adolescents. *Annals of Epidemiology, 19*(3), 180-186.
- Borghese, M.M., Tremblay, M.S., Leduc, G., Boyer, C., Bélanger, P., LeBlanc, A.G., et al. (2014). Independent and combined associations of total sedentary time and television viewing time with food intake patterns of 9- to 11-year-old Canadian children. *Applied Physiology, Nutrition and Metabolism, 39*(8), 937-943.
- Boulos, R., Vikre, E.K., Oppenheimer, S., Chang, H., & Kanarek, R.B. (2012). ObesiTV: How television is influencing the obesity epidemic. *Physiology and Behavior, 107*(1), 146-153.
- Brown, H.J., McPherson, G., Peterson, R., Newman, V., & Cranmer, B. (2012). Our land, our language: Connecting dispossession and health equity in an Indigenous context. *Canadian Journal of Nursing, 44*(2), 44-63.
- Browne, K.D., & Hamilton-Giachritsis, C. (2005). The influence of violent media on children and adolescents: A public health approach. *Lancet, 365*(9460), 702-710.
- Brownson, R.C., Chang, J.J., Eyler, A., Ainsworth, B.E., Kirkland, K.A., Saelens, B.E., et al. (2004). Measuring the environment for friendliness toward physical activity: A comparison of the reliability of 3 questionnaires. *American Journal of Public Health, 94*(3), 473-483.
- Caballero, B., Clay, T., Davis, S.M., Ethelbah, B., Holy Rock, B., Lohman, T, et al. (2003). Pathways: A school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. *American Journal of Clinical Nutrition, 78*(5), 1030-1038.
- Cain, K.L., Sallis, J.F., Conway, T.L., Van Dyck, D., & Calhoun, L. (2013). Using accelerometers in youth physical activity studies: A review of methods. *Journal of Physical Activity and Health, 10*(3), 437-450.
- Canadian Council on the Social Determinants of Health. (2013). Roots of resilience: Overcoming inequities in Aboriginal communities. Retrieved 15 September 2015 from http://ccsdh.ca/images/uploads/Roots_of_Resilience.pdf
- Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, & Social Sciences and Humanities Research Council of Canada. (2014). Tri-council policy statement: Ethical conduct for research involving humans. Ottawa, ON: Her Majesty the Queen in Right of Canada. Retrieved 17 July 2015 from http://www.pre.ethics.gc.ca/pdf/eng/tcps2-2014/TCPS_2_FINAL_Web.pdf

- Cargo, M.D., Delormier, T., Lévesque, L., McComber, A.M., & Macaulay, A.C. (2011). Community capacity as an “inside job”: Evolution of perceived ownership within a university-Aboriginal community partnership. *American Journal of Health Promotion*, 26(2), 96-100.
- Cargo, M., Peterson, L., Lévesque, L., & Macaulay, A.C. (2007). Perceived wholistic health and physical activity in Kanien’kehá:ka youth. *Pimatisiwin*, 5(1), 97-109.
- Carson, V., & Janssen, I. (2012). Neighborhood disorder and screen time among 10-16 year old Canadian youth: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 9(1), 66. doi: 10.1186/1479-5868-9-66
- Casperson, C.J., Powell, K.E., & Christenson, G.M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports*, 100(2), 126-131.
- Castro-Piñero, J., Artero, E.G., España-Romero, V., Ortega, F.B., Sjöström, M., Suni, J., et al. (2010). Criterion-related validity of field-based fitness tests in youth: A systematic review. *British Journal of Sports Medicine*, 44(13), 934-943.
- Chan, L., Receveur, O., Batal, M., David, W., Schwartz, H., Ing, A., et al. (2014). First Nations Food, Nutrition and Environment Study [FNFES]: Results from Ontario [2011/2012]. Ottawa, ON: University of Ottawa. Retrieved November 11, 2016 from http://foodsecurecanada.org/sites/default/files/fnfnes_ontario_regional_report_2014_final.pdf
- Charbonneau-Roberts, G., Saudny-Unterberger, H., Kuhnlein, H.V., & Egeland, G.M. (2005). Body mass index may overestimate the prevalence of overweight and obesity among the Inuit. *International Journal of Circumpolar Health*, 64(2), 163-169.
- Charmaz K. (2006). Coding in grounded theory research (Pp. 42-71). In *Constructing grounded theory: A practical guide through qualitative analysis*. London, UK: Sage Publications.
- Cochran, P.A.L, Marshall, C.A., Garcia-Downing, C., Kendall, E., Cook, D., McCubbin, L., et al. (2008). Indigenous ways of knowing: Implications for participatory research and community. *American Journal of Public Health*, 98(1), 22-27.
- Cole, T.J., & Lobstein, T.. (2012). Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatric Obesity*, 7(4), 284-294.
- Cole, T.J., Flegal, K.M., Nicholls, D., & Jackson, A.A. (2007). Body mass index cut offs to define thinness in children and adolescents: International survey. *British Medical Journal*, 18(Suppl), 31-36.

- Cole, T.J., Bellizzi, M.C., Flegal, K.M., & Dietz, W.H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal*, *320*(7244), 1240-1243.
- Colley, R.C., Garriguet, D., Janssen, I., Wong, S.L., Saunders, T.J., Carson, V., et al. (2013). The association between accelerometer-measured patterns of sedentary time and health risk in children and youth: Results from the Canadian Health Measures Survey. *BMC Public Health*, *13*, 200. doi:10.1186/1471-2458-13-200
- Colley, R.C., Garriguet, D., Janssen, I., Craig, C.L., Clarke, J., & Tremblay, M.S. (2011). Physical activity of Canadian children and youth: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, *22*(1), 15-23.
- Cooke, M.J., Wilk, P., Paul, K.W., & Gonneville, S.L.H. (2013). Predictors of obesity among Métis children: Socio-economic, behavioural and cultural factors. *Canadian Journal of Public Health*, *104*(4), e298-e303.
- Coombs, N., Shelton, N., Rowlands, A., & Stamatakis, E. (2013). Children's and adolescents' sedentary behaviour in relation to socioeconomic position. *Journal of Epidemiology and Community Health*, *67*(10), 868-874.
- Corder, K., Ekelund, U., Steele, R.M., Wareham, N.J., & Brage, S. (2008). Assessment of physical activity in youth. *Journal of Applied Physiology*, *105*(3), 977-987.
- Craig, C.L., Cameron, C., & Tudor-Locke, C. (2012). CANPLAY pedometer normative reference data for 21, 271 children and 12, 956 adolescents. *Medicine and Science in Sports and Exercise*, *45*(1), 123-129.
- Craig, C.L., Marshall, A.L., Sjöström, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381-1395.
- Craigie, A.M., Lake, A.A., Kelly, S.A., Adamson, A.J., & Mathers, J.C. (2011). Tracking of obesity-related behaviours from childhood to adulthood: A systematic review. *Maturitas*, *70*(3), 266-84.
- Creswell, J.W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications.
- Critchley, K.A., Walton, F., Timmons, V., Bryanton, J., McCarthy, M.J., & Taylor, J. (2006). Personal health practices around physical activity as perceived by the Aboriginal children of Prince Edward Island. *Journal of Aboriginal Health*, *3*(1), 26-33.

- Crooks, C.V., Chiodo, D., Thomas, D., & Hughes, R. (2010). Strengths-based programming for First Nations youth in schools: Building engagement through healthy relationships and leadership skills. *International Journal of Mental Health and Addiction*, 8(2), 160-173.
- Cutler, G.J., Flood, A., Hannan, P.J., Slavin, J.L., & Neumark-Sztainer, D. (2012). Association between major patterns of dietary intake and weight status in adolescents. *British Journal of Nutrition*, 108(2), 349-356.
- Davis, S.P., Northington, L., & Kolar, K. (2000). Cultural considerations for treatment of childhood obesity. *Journal of Cultural Diversity*, 7(4), 128-132.
- de Onis, M., & Lobstein, T. (2010). Defining obesity risk status in the general childhood population: Which cut-offs should we use? *International Journal of Pediatric Obesity*, 5(6), 458-460.
- de Onis, M., Onyango, A.W., Borghi, E., Siyam, A., Nishida, C., & Siekmann, J. (2007). Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*, 85(9), 660-667.
- Department of Justice Canada. (2013). Laws: Indian Act. Retrieved 16 July 2015 from <http://laws-lois.justice.gc.ca/eng/acts/I-5/page-10.html#h-13>
- Dietitians of Canada & The Canadian Paediatric Society. (2010). Promoting optimal monitoring of child growth in Canada: Using the new WHO growth charts. *Canadian Journal of Dietetic Practice and Research*, 71(1), e1-e3.
- Ding, D., Sallis, J.F., Kerr, J., Lee, S., & Rosenberg, D.E. (2011). Neighbourhood environment and physical activity among youth: A review. *American Journal of Preventive Medicine*, 41(4), 442-455.
- Dishman, R.D., Dunn, A.L., Sallis, J.F., Vandenberg, R.J., & Pratt, C.A. (2010). Social-cognitive correlates of physical activity in a multi-ethnic cohort of middle-school girls: Two-year prospective study. *Journal of Pediatric Psychology*, 35(2), 188-198.
- Dobbins, M., Husson, H., DeCorby, K., & LaRocca, R.L. (2013). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews*, 2, CD007651. doi: 10.1002/14651858.CD007651.pub2
- Downs, S.M., Arnold, A., Marshall, D., McCargar, L.J., Raine, K.D., & Willows, N.D. (2009). Associations among the food environment, diet quality and weight status in Cree children in Quebec. *Public Health Nutrition*, 12(9), 1504-1511.

- Downs, S.M., Marshall, D., Ng, C., & Willows, N.D. (2008). Central adiposity and associated lifestyle factors in Cree children. *Applied Physiology, Nutrition, and Metabolism*, 33(3), 476-482.
- Dunstan, D.W., Howard, B., Healy, G.N., & Owen, N. (2012). Too much sitting—a health hazard. *Diabetes Research and Clinical Practice*, 97(3), 368-376.
- Dwyer, J.J.M., Allison, K.R., & Goldenberg, E.R. (2006). Adolescent girls' perceived barriers to participation in physical activity. *Adolescence*, 41(161), 75-89.
- Dyck, R., Osgood, N., Gao, A., & Stang, M.R. (2012). The epidemiology of diabetes mellitus among First Nations and non-First Nations children in Saskatchewan. *Canadian Journal of Diabetes*, 36(1), 19-24.
- DyckFehderau, D., Holt, N.L., Ball, G.D., Alexander First Nation community, & Willows, N.D. (2013). Feasibility study of asset mapping with children: Identifying how the community environment shapes activity and food choices of Alexander First Nation. *Rural and Remote Health*, 13(2), 2289. Retrieved 17 July 2015 from <http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=2289>
- Egeland, G.M., Pacey, A., Cao, Z., & Sobol, I. (2010). Food insecurity among Inuit preschoolers: Nunavut Inuit Child Health Survey, 2007-2008. *Canadian Medical Association Journal*, 182(3), 243-248.
- Eime, R.M., Young, J.A., Harvey, J.T., Charity, M.J., & Payne, W.R. (2013). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: Informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity*, 10, 98. doi: 10.1186/1479-5868-10-98
- Environment Canada. (2015). Climate: Daily data report for February 2015, July 2015. Retrieved 31 July 2015 from http://climate.weather.gc.ca/climateData/dailydata_e.html?StationID=48950
- Ervin, R.B., Fryar, C.D., Wang, C.Y., Miller, I.M., & Ogden, C.L. (2014). Strength and body weight in US children and adolescents. *Pediatrics*, 134(3), e782-789.
- Erwin, H.E., Beighle, A., Morgan, C.F., & Noland, M. (2010). Effect of a low-cost, teacher-directed classroom intervention on elementary students' physical activity. *Journal of School Health*, 81(8), 455-461.

- Eskicioglu, P., Halas, J., Sénéchal, M., Wood, L., McKay, E., Villeneuve, S., et al. (2014). Peer mentoring for type 2 diabetes prevention in First Nations children. *Pediatrics*, *133*(6), e1624-e1631.
- Faigenbaum, A.D., Kraemer, W.J., Blimkie, C.J.R., Jeffreys, I., Micheli, M., et al. (2009). Youth resistance training: Updated position statement paper from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research*, *23*(Suppl 5), S60-S79.
- Ferris, M.A. (2011). Preventing obesity in Canada's Aboriginal children: Not just a matter of eating right and getting active. *The International Indigenous Policy Journal*, *2*(1). Retrieved 16 July 2015 from <http://ir.lib.uwo.ca/iipj/vol2/iss1/2/>.
- Findlay, L.C. (2011). Physical activity among First Nations people off reserve, Métis and Inuit. *Health Reports*, *22*(1), 47-54.
- Findlay, L.C., & Kohen, D.E. (2007). Aboriginal children's sport participation in Canada. *Pimatisiwin*, *5*(1), 185-206.
- Finegood, D.T., Merth, T.D.N., & Rutter, H. (2010). Implications of the foresight obesity systems map for solutions to childhood obesity. *Obesity Journal*, *18*(Suppl 1), S13-S16.
- First Nations Health Authority. (2015). First Nations perspective on wellness. Retrieved 30 September 2015 from <http://www.fnha.ca/wellness/wellness-and-the-first-nations-health-authority/first-nations-perspective-on-wellness>
- First Nations Information Governance Centre. (2014). Ownership, control, access and possession (OCAP™): The path to First Nations information governance. Ottawa, ON: First Nations Information Governance Centre. Retrieved 17 July 2015 from http://fnigc.ca/sites/default/files/docs/ocap_path_to_fn_information_governance_en_final.pdf
- First Nations Information Governance Centre. (2012). First Nations Regional Health Survey 2008/10: National report on adults, youth and children living in First Nations communities. Ottawa, ON: First Nations Information Governance Centre. Retrieved 16 July 2015 from <http://fnigc.ca/sites/default/files/First%20Nations%20Regional%20Health%20Survey%200%28RHS%29%202008-10%20-%20National%20Report.pdf>
- First Nations Information Governance Centre. (2008). First Nations Regional Health Survey. Youth Questionnaire. Ottawa, ON: First Nations Information Governance Centre. Retrieved 15 September 2015 from http://fnigc.ca/sites/default/files/ENpdf/RHS_2008/RHS-Y2.pdf

- Five Nations Energy. (2012). Fort Albany and Kashechewan. Retrieved 31 July 2015 from <http://www.fivenations.ca/index.php/community/fort-albany-and-kashechewan>
- Fletcher, C. (2003). Participatory research relationships with Aboriginal communities in Canada: An overview of context and process. *Pimatisiwin*, 1(2), 27-62.
- Flintoff, A., & Scraton, S. (2001). Stepping into active leisure? Young women's perceptions of active lifestyles and their experiences of school physical education. *Sport, Education and Society*, 6(1), 5-21.
- Foulds, H.J.A., Warburton, D.E.R., & Bredin, S.S.D. (2013). A systematic review of physical activity levels in Native American populations in Canada and the United States in the last 50 years. *Obesity Reviews*, 14(1), 593-603.
- Fox, K.R., Cooper, A., & McKenna, J. (2004). The school and promotion of children's health-enhancing physical activity: Perspectives from the United Kingdom. *Journal of School Health*, 23(4), 338-358.
- Franks, P.W., Hanson, R.L., Knowler, W.C., Sievers, M.L., Bennett, P.H., & Looker, H.C. (2010). Childhood obesity, other cardiovascular risk factors, and premature death. *The New England Journal of Medicine*, 362(6), 485-493.
- Freeman, J.G., Coe, H., & King, M. (2014). Health behaviour in school-aged children: Trends report 1990-2010. Ottawa, ON: Her Majesty the Queen in Right of Canada. Retrieved 27 July 2015 from <http://www.phac-aspc.gc.ca/hp-ps/dca-dea/prog-ini/school-scolaire/behaviour-comportements/assets/pdf/trends-tendances-eng.pdf>
- Friend, S., Flattum, C.F., Simpson, D., Nederhoff, D.M., & Neumark-Sztainer, D. (2014). The researchers have left the building: What contributes to sustaining school-based interventions following the conclusion of formal research support? *Journal of School Health*, 84(5), 326-333.
- Frolich, K.L., Ross, N., & Richmond, C. (2006). Health disparities in Canada today: Some evidence and a theoretical framework. *Health Policy*, 79(2-3), 132-143.
- Garner, R., Carrière, G., Sanmartin, C., & Longitudinal Health and Administrative Data Research Team. (2010). The health of First Nations living off-reserve, Inuit and Métis adults in Canada: The impact of socio-economic status on inequalities in health. Statistics Canada Catalogue no. 82-622-X. Ottawa, ON: Minister of Industry. Retrieved 18 July 2015 from <http://www.statcan.gc.ca/pub/82-622-x/82-622-x2010004-eng.pdf>

- Gates, A., Hanning, R.M., Gates, M., Stephen, J., & Tsuji, L.J.S. (in press). Four-year evaluation of a healthy school snack program in a remote First Nations community. *Health Behavior and Policy Review*.
- Gates, A., Hanning, R.M., Martin, I.D., Gates, M., & Tsuji, L.J.S. (2014). Body weight perceptions and eating-related weight control behaviors of on-reserve First Nations youth from Ontario, Canada. *Rural and Remote Health, 14*(3), 2665. Retrieved 21 July 2015 from <http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=2665>
- Gates, A., Hanning, R.M., Gates, M., Skinner, K., Martin, I.D., & Tsuji, L.J.S. (2012b). Vegetable and fruit intakes of on-reserve First Nations schoolchildren compared to Canadian averages and current recommendations. *International Journal of Environmental Research and Public Health, 9*(4), 1379-1397.
- Gates, A., Hanning, R.M., Gates, M., Skinner, K., McCarthy, D., & Tsuji, L.J.S. (2012c). Inadequate nutrient intakes in youth of a remote First Nation community: Challenges and the need for sustainable changes in program and policy. *ISRN Public Health, 2012*. doi: <http://dx.doi.org/10.5402/2012/504168>
- Gates, A., Hanning, R.M., Gates, M., Isogai, A.D., Metatawabin, J., & Tsuji, L.J.S. (2011). A school nutrition program improves vegetable and fruit knowledge, preferences, and exposure in First Nation youth. *The Open Nutrition Journal, 5*(1), 1-6.
- Gates, M., Hanning, R.M., Gates, A., Stephen, J., Fehst, A., & Tsuji, L.J.S. (in press). A pilot school sports program in a remote Canadian First Nation: Evaluation of process and outcomes. *Health Behavior and Policy Review*.
- Gates, M., Hanning, R.M., Gates, A., Stephen, J., Fehst, A., & Tsuji, L.J.S. (2015). Physical activity and fitness of First Nations youth in a remote and isolated northern Ontario community: A needs assessment. *Journal of Community Health*. Online ahead of print. doi: 10.1007/s10900-015-0063-8
- Gates, M., Hanning, R.M., Martin, I.D., Gates, A., & Tsuji, L.J.S. (2013a). Body mass index of First Nations youth in Ontario, Canada: Influence of sleep and screen time. *Rural and Remote Health, 13*, 2498. Retrieved 17 July 2015 from <http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=2498>
- Gates, M., Hanning, R.M., Gates, A., McCarthy, D., & Tsuji, L.J.S. (2013b). Assessing the impact of pilot school snack programs on milk and alternatives intake in 2 remote First Nation communities in northern Ontario, Canada. *Journal of School Health, 83*(2), 69-76.

- Gates, M., Hanning, R.M., Gates, A., Isogai, A., Tsuji, L.J.S., & Metatawabin, J. (2013c). A pilot comprehensive school nutrition program improves knowledge and intentions for intake of milk and milk alternatives among youth in a remote First Nation. *Journal of Nutrition Education and Behavior, 45*(5), 455-459.
- Gates, M., Gates, A., Stephen, J., Hanning, R.M., & Tsuji, L.J.S. (2013d). Building community nutrition capacity through participatory research in a remote First Nation: Lessons learned from Kashechewan, Ontario. *Canadian Journal of Diabetes, 37*(Suppl 2), S286-S287.
- Gates, M., Hanning, R.M., Gates, A., Martin, I.D., & Tsuji, L.J.S. (2012a). Intakes of milk and alternatives among First Nations youth in northern and southern Ontario, Canada. *Public Health Nutrition, 16*(3), 515-523.
- Gaudin, V.L., Receveur, O., Walz, L., Girard, F., & Potvin, L. (2014). A mixed methods inquiry into the determinants of traditional food consumption among three Cree communities of Eeyou Istchee from an ecological perspective. *International Journal of Circumpolar Health, 73*, 24918. doi: 10.3402/ijch.v73.24918
- Gill, J.M.R., & Cooper, A.R. (2008). Physical activity and the prevention of type 2 diabetes mellitus. *Sports Medicine, 38*(10), 807-824.
- Gionet, L., & Roshanafshar, S. (2013). Select health indicators of First Nations people living off reserve, Métis and Inuit. Statistics Canada Catalogue no. 82-624-X. Retrieved 16 July 2015 from <http://www.statcan.gc.ca/pub/82-624-x/2013001/article/11763-eng.htm>
- Gittelsohn, J., Harris, S.B., Thorne-Lyman, A.L., Hanley, A.J., Barnie, A., & Zinman, B. (1996). Body image concepts differ by age and sex in an Ojibway-Cree community in Canada. *Journal of Nutrition, 126*(12), 2990-3000.
- Glanz, K., & Bishop, D. (2010). The role of behavioural science theory in development and implementation of public health interventions. *Annual Review of Public Health, 31*(1), 399-418.
- Glaser, B.G., & Strauss, A.L. (1967). The discovery of grounded theory: Strategies for qualitative research. New York, NY: Aldine De Gruyter.
- Going, S.B., Levin, S., Harrell, J., Stewart, D., Kushi, L., Cornell, C.E., et al. (1999). Physical activity assessment in American Indian schoolchildren in the Pathways study. *American Journal of Clinical Nutrition, 69*(Suppl 4), 788S-795S.
- Goran, M., Fields, D.A., Hunter, G.R., Herd, S.L., & Weinsier, R.L. (2000). Total body fat does not influence maximal aerobic capacity. *International Journal of Obesity, 24*(7), 841-848.

- Gotay, C.G., Katzmarzyk, P.T., Janssen, I., Dawson, M.Y., Aminoltejari, K., & Bartley, N.L. (2013). Updating the Canadian obesity maps: An epidemic in progress. *Canadian Journal of Public Health, 104*(1), e64-e68.
- Government of Canada. (2012). Canadian Sport Policy 2012. Ottawa, ON: Sport Information Resource Centre. Retrieved 7 August 2015 from http://sirc.ca/sites/default/files/content/docs/pdf/csp2012_en.pdf
- Government of Canada. (2005). Sport Canada's policy on Aboriginal peoples' participation in sport. 2005. Ottawa, ON: Minister of Public Works and Government Services Canada. Retrieved 16 July 2015 from <http://publications.gc.ca/collections/Collection/CH24-10-2005E.pdf>
- Greenwood, M.L., & de Leeuw, S.N. (2012). Social determinants of health and the future well-being of Aboriginal children in Canada. *Paediatric and Child Health, 17*(7), 381-384.
- Hallett, D., Chandler, M.J., & Lalonde, C.E. (2007). Aboriginal language knowledge and youth suicide. *Cognitive Development, 22*(3), 392-399.
- Halseth, G., & Ryser, L. (2006). Trends in service delivery: Examples from rural and small town Canada, 1998 to 2005. *Journal of Rural and Community Development, 1*(2), 69-90.
- Haman, F., Fontaine-Bisson, B., Batal, M., Imbeault, P., Blais, J.M., & Robidoux, M.A. (2012). Obesity and type 2 diabetes in northern Canada's remote First Nations communities: The dietary dilemma. *International Journal of Obesity, 34*(Suppl 2), S24-S31.
- Hanley, A.J.G., Harris, S.B., Gittelsohn, J., Wolever, T.M.S., Saksvig, B., & Zinman, B. (2000). Overweight among children and adolescents in a Native Canadian community: Prevalence and associated factors. *American Journal of Clinical Nutrition, 71*(3), 693-700.
- Hanning, R.M., Skinner, K., Gates, M., Gates, A., & Tsuji, L.J.S. (2011). School nutrition programs in remote First Nation communities of the western James Bay region: Impact, challenges, and opportunities. CIHR-IPPH and CIHI-CPHI Population Health Intervention Research Casebook. Ottawa, ON: Canadian Institutes of Health Research. Retrieved 20 September 2015 from <http://www.cihr-irsc.gc.ca/e/43475.html#s6>
- Hanning, R.M., Royall, D., Toews, J.E., Blashill, L., Wegener, J., & Driezen, P. (2009). Web-based food behaviour questionnaire: Validation with grades six to eight students. *Canadian Journal of Dietetic Practice and Research, 70*(4), 172-178.

- Harman, K.M., Hopman, W.M., & Sabiston, C.M. (2015). Physical activity, screen time and self-rated health and mental health in Canadian adolescents. *Preventive Medicine*, 73, 112-116. doi: 10.1016/j.ypmed.2015.01.030
- Harris, K.C., Kuramoto, L.K., Schulzer, M., & Retallack, J.E. (2009). Effect of school-based physical activity interventions on body mass index in children: A meta-analysis. *Canadian Medical Association Journal*, 180(7), 719-726.
- Harris, S.B., Bhattacharyya, O., Dyck, R., Hayward, M.N., & Toth, E.L. (2013). Canadian Diabetes Association 2013 clinical practice guidelines for the prevention and management of diabetes in Canada: Type 2 diabetes in Aboriginal peoples. *Canadian Journal of Diabetes*, 37(Suppl 1), S191-196. Retrieved 18 July 2015 from <http://guidelines.diabetes.ca/executivesummary/ch38>
- Harris, S.B., Gittelsohn, J., Hanley, A., Barney, A., Wolever, T.M., Gao, J., et al. (1997). The prevalence of NIDDM and associated risk factors in native Canadians. *Diabetes Care*, 20(2), 185-197.
- He, M., Harris, S., Piché, L., & Beynon, C. (2009). Understanding screen-related sedentary behaviour and its contributing factors among school-aged children: A socio-ecologic exploration. *American Journal of Health Promotion*, 23(5), 299-308.
- Health Canada. (2003). Canadian guidelines for body weight classification in adults. Ottawa, ON: Her Majesty the Queen in Right of Canada. Retrieved 16 July 2015 from http://preventdisease.com/pdf/weight_book-livres_des_poids_e.pdf
- Hlimi, T., Skinner, K., Hanning, R.M., Martin, I.D., & Tsuji, L.J.S. (2011). Traditional food consumption behaviour and concern with environmental contaminants among Cree schoolchildren of the Mushkegowuk territory. *International Journal of Circumpolar Health*, 71, 17344. doi: 10.3402/ijch.v71i0.17344.
- Horn, O.K., Paradis, G., Potvin, L., Macaulay, A.C. & Desrosiers, S. (2001). Correlates and predictors of adiposity among Mohawk children. *Preventive Medicine*, 33(4), 274-281.
- Isaak, C.A., & Marchessault, G. (2008). Meaning of health: The perspectives of Aboriginal adults and youth in a northern Manitoba First Nations community. *Canadian Journal of Diabetes*, 32(2), 114-122.
- Isogai, A., Gates, A., Gates, M., Hanning, R.M., & Tsuji, L.J.S. (2012). A qualitative evaluation of the efficacy of the delivery of the educational component of a nutrition program, in a remote First Nation community, 9(2), 349-362.

- Janssen, I., Lévesque, L., Xu, F., & First Nations Information Governance Centre. (2014). Correlates of physical activity among First Nations children residing in First Nations communities in Canada. *Canadian Journal of Public Health, 105*(6), e412-e417.
- Janssen, I., & LeBlanc, A.G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioural Nutrition and Physical Activity, 7*(40). doi: 10.1186/1479-5868-7-40
- Janssen, I., Katzmarzyk, P.T., Boyce, W.F., Vereecken, C., Mulvill, C., Roberts, C., et al. (2005). Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obesity Reviews, 6*(2), 123-132.
- Kakekagumick, K.E., Naqshbandi Hayward, M., Harris, S.B., Saksvig, B., Gittelsohn, J., Manokeesic, G., et al. (2013). Sandy Lake Health and Diabetes Project: A community-based intervention targeting type 2 diabetes and its risk factors in a First Nations community. *Frontiers in Endocrinology, 4*, 170. doi: 10.3389/fendo.2013.00170
- Kaler, S.N., Ralph-Campbell, K., Pohar, S., King, M., Laboucan, R., & Toth, E.L. (2006). High rates of the metabolic syndrome in a First Nations community in western Canada: Prevalence and determinants in adults and children. *International Journal of Circumpolar Health, 65*(5), 389-402.
- Kaptchuk, T.J. (2003). Effect of interpretive bias on research evidence. *British Medical Journal, 326*(7404), 1453-1455.
- Katzmarzyk, P.T. (2008). Obesity and physical activity among Aboriginal Canadians. *Obesity, 16*(1), 184-190.
- Katzmarzyk, P.T., Barreira, T.V., Broyles, S.T., Champagne, C.M., Chaput, J.P., Fogelholm, M., et al. (2015). Physical activity, sedentary time, and obesity in an international sample of children. *Medicine and Science in Sports and Exercise*. doi: 10.1249/MSS.0000000000000649
- Kelsey, M.M., Zaepfel, A., Bjornstad, P., & Nadeau, K.J. (2014). Age-related consequences of childhood obesity. *Gerontology, 60*(3), 222-228.
- Khalil, C.B., Johnson-Down, L., & Egeland, G.M. (2010). Emerging obesity and dietary habits among James Bay Cree youth. *Public Health Nutrition, 13*(11), 1829-1837.
- Kibbe, D.L., Hackett, J., Hurley, M., McFarland, A., Schubert, K.G., Schultz, A., et al. (2011). Ten years of Take 10!®: Integrating physical activity with academic concepts in classrooms. *Preventive Medicine, 52*(Suppl), S43-S50.

- King, M. (2010). Chronic diseases and mortality in Canadian Aboriginal peoples: Learning from the knowledge. *Chronic Diseases in Canada*, 31(1), 2-3.
- King, M., Smith, A., & Gracey, M. (2009). Indigenous health part 2: The underlying causes of the health gap. *Lancet*, 374(9683), 76-85.
- Kirby, A.M., Lévesque, L., & Wabano, V. (2001). A qualitative investigation of physical activity challenges and opportunities in a northern-rural, Aboriginal community: Voices from within. *Pimatisiwin*, 5(1), 5-24.
- Kirmayer, L., Simpson, C., & Cargo, M. (2003). Healing traditions: Culture, community and mental health promotion with Canadian Aboriginal peoples. *Australasian Psychiatry*, 11(Suppl 1), S14-S23.
- Kmetz, A., Reading, J., & Estey, E. (2008). Taking a life course perspective on cardiovascular disease and diabetes in First Nations peoples. *Canadian Journal of Nursing Research*, 40(3), 58-78.
- Kovach, M. (2009). *Indigenous methodologies: Characteristics, conversations, and contexts*. Toronto, ON: University of Toronto Press.
- Krueger, R.A. (1994). *Focus groups: A practical guide for applied research*. Second edition. Thousand Oaks, CA: Sage Publications.
- Kuhnlein, H.V., Receveur, O., Soueida, R., & Egeland, G.M. (2004). Arctic indigenous peoples experience the nutrition transition with changing dietary patterns and obesity. *The Journal of Nutrition*, 134(6), 1447-1453.
- Lackenbauer, P.W., Moses, J., Sheffield, R.S., & Gohier, M. (2009). *A commemorative history of Aboriginal people in the Canadian military*. Ottawa, ON: National Defence Canada. Retrieved 16 July 2015 from http://www.cmp-cpm.forces.gc.ca/dhh-dhp/his/docs/Sketch_e.pdf
- Langevin, C.M. (2001). An evaluation framework for the Maison Decision House substance abuse treatment program. *Canadian Journal of Program Evaluation*, 16(1), 99-129.
- LaRocque, E. (2007). *Aboriginal perspectives: Colonization and racism*. Retrieved 16 July 2015 from <http://www3.nfb.ca/enclasse/doclens/visau/index.php?mode=theme&language=english&theme=30662&film=16933&excerpt=612109&submode=about&expmode=2>

- Lau, D.C.Q.W., Douketis, J.D., Morrison, K.M., Hramiak, I.M., Sharma, A.M., & Ur, E. (2007). 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children. *Canadian Medical Association Journal*, 176(Suppl 8), 1-117.
- Lavallée, L. (2008). Balancing the medicine wheel through physical activity. *Journal of Aboriginal Health*, 4(1), 64-71.
- Lavallée, L. (2007). Physical activity and healing through the medicine wheel. *Pimatisiwin*, 5(1), 127-153.
- Lear, S.A., Humphries, K.H., Frolich, J.J., & Birmingham, C.L. (2007). Appropriateness of current thresholds for obesity-related measures among Aboriginal people. *Canadian Medical Association Journal*, 177(12), 1499-1505.
- Leatherdale, S.T., & Ahmed, R. (2011). Screen-based sedentary behaviours among a nationally representative sample of youth: Are Canadian kids couch potatoes? *Chronic Diseases and Injuries in Canada*, 31(4), 141-146.
- Leatherdale, S.T., Faulkner, G., & Arbour-Nicitopoulos, K. (2010). School and student characteristics associated with screen-time sedentary behaviour among students in grades 5-8, Ontario, Canada, 2007-2008. *Preventing Chronic Disease*, 7(6), A128. Retrieved 25 July 2015 from http://www.cdc.gov/pcd/issues/2010/nov/09_0188.htm
- Leatherdale, S.T., & Wong, S.L. (2008). Modifiable characteristics associated with sedentary behaviours among youth. *International Journal of Pediatric Obesity*, 3(2), 93-101.
- LeBlanc, A.G., Broyles, S.T., Chaput, J.-P., Leduc, G., Boyer, C., Borghese, M.M., et al. (2015). Correlates of objectively measured sedentary time and self-reported screen time in Canadian children. *International Journal of Behavioral Nutrition and Physical Activity*, 12(1), 197. doi: 10.1186/s12966-015-0197-1
- Leech, R.M., McNaughton, S.A., & Timperio, A. (2014). The clustering of diet, physical activity and sedentary behavior in children and adolescents: A review. *International Journal of Behavioral Nutrition and Physical Activity*, 11, 4. doi: 10.1186/1479-5868-11-4
- Léger, L.A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 meter shuttle run test for aerobic fitness. *Journal of Sports Science*, 6(2), 93-101.
- Lemstra, M., Rogers, M., Thompson, A., & Moraros, J. (2013). Prevalence and correlates of physical activity within on-reserve First Nations youth. *Journal of Physical Activity and Health*, 10(3), 430-436.

- Lévesque, L., Janssen, I., Xu, F., & The First Nations Information Governance Centre. (2015). Correlates of physical activity in First Nations youth residing in First Nations and northern communities in Canada. *Canadian Journal of Public Health, 106*(2), e29-e35.
- Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., Ioannidis, J.P.A., et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Clinical Journal of Epidemiology, 6*(10), e1-34. doi: 10.1016/j.jclinepi.2009.06.006
- Livingstone, M.B.E., Robson, P.J., & Wallace, J.M.W. (2004). Issues in dietary intake assessment in children and adolescents. *British Journal of Nutrition, 92*(Suppl 2), S213-S222.
- Liwander, A., Pederson, A., & Boyle, E. (2013). Why the Canadian Sedentary Behaviour Guidelines should reflect sex and gender. *Canadian Journal of Public Health, 104*(7), e479-e481.
- Loprinzi, P.D., Cardinal, B.J., Loprinzi, K.L., & Lee, H. (2012). Benefits and environmental determinants of physical activity in children and adolescents. *Obesity Facts, 5*(4), 597-610.
- Lubans, D.R., Morgan, P.J., Cliff, D.P., Barnett, L.M., & Okely, A.D. (2010). Fundamental movement skills in children and adolescents: Review of associated health benefits. *Sports Medicine, 40*(12), 1019-1035.
- Maar, M.A., Lightfoot, N.E., Sutherland, M.E., Strasser, R.P., Wilson, K.J., Lidstone-Jones, C.M., et al. (2011). Thinking outside the box: Aboriginal people's suggestions for conducting health studies with Aboriginal communities. *Public Health, 125*(2011), 747-753.
- Mahar, M.T., Guerieri, A.M., Hanna, M.S., & Kemble, C.D. (2011). Estimation of aerobic fitness from 20-m multistage shuttle run test performance. *American Journal of Preventive Medicine, 41*(4S2), S117-S123.
- Mark, A.E., & Janssen, I. (2009). Influence of bouts of physical activity on overweight in youth. *American Journal of Preventive Medicine, 36*(5), 416-421.
- Mason, C., & Koehli, J. (2012). Barriers to physical activity for Aboriginal youth: Implications for community health, policy, and culture. *Pimatisiwin, 10*(1), 97-108.
- Mayorga-Vega, D., Merino-Marban, R., & Viciana, J. (2014). Criterion-related validity of sit-and-reach tests for estimating hamstring and lumbar extensibility: A meta-analysis. *Journal of Sports Science and Medicine, 13*(1), 1-14.

- McClain, J., Abraham, T.L., Brusseau, T.A., & Tudor-Locke, C. (2008). Epoch length and accelerometer outputs in children: Comparison to direct observation. *Medicine and Science in Sports and Exercise*, 40(12), 2080-2087.
- McDowell, M.A., Fryer, C.D., & Ogden, C.L. (2009). Anthropometric reference data for children and adults: United States, 1988-1994. National Centre for Health Statistics. *Vital Health Statistics*, 11(249). Retrieved 31 July 2015 from http://www.cdc.gov/nchs/data/series/sr_11/sr11_249.pdf
- McHugh, T.-L.F., Kingsley, B.C., & Coppola, A.M. (2013). Enhancing the relevance of physical activity research by engaging Aboriginal peoples in the research process. *Pimatisiwin*, 11(2), 293-305.
- McIvor, O., Napoleon, A., & Dickie, K.M. (2009). Language and culture as protective factors for at-risk communities. *International Journal of Indigenous Health*, 5(1), 6-25.
- McLaren, L. (2007). Socioeconomic status and obesity. *Epidemiologic Reviews*, 29(1), 29-48.
- McLeroy, K.R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, 15(4), 351-377.
- McNamara, E., Hudson, Z., & Taylor, S.J. (2010). Measuring activity levels of young people: The validity of pedometers. *British Medical Bulletin*, 95(1), 121-137.
- Mitchell, M.S., Gaul, C.A., Naylor, P.-J., & Panagiotopoulos, C. (2010). Habitual moderate-to-vigorous physical activity is inversely associated with insulin resistance in Canadian First Nations Youth. *Pediatric Exercise Science*, 22(2), 254-265.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & The PRISMA Group. (2010). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery*, 8(5), 336-41.
- Monsivais, P., & Drewnowski, A. (2007). The rising cost of low-energy-density foods. *Journal of the American Dietetic Association*, 107(12), 2071-2076.
- Moreno, L.A., & Rodriguez, G. (2007). Dietary risk factors for development of childhood obesity. *Current Opinion in Clinical Nutrition and Metabolic Care*, 10(3), 336-341.
- National Aboriginal Health Organization. (2003). What First Nations people think about their health and health care: National Aboriginal Health Organization's public opinion poll on Aboriginal health and health care in Canada, summary of findings. Ottawa, ON: National Aboriginal Health Organization. Retrieved 18 July 2015 from http://www.naho.ca/documents/fnc/english/FNC_SummaryofNAHOPoll.pdf

- National Collaborating Centre for Aboriginal Health. (2011). Access to health services as a social determinant of First Nations, Inuit and Métis health. Prince George, BC: National Collaborating Centre for Aboriginal Health. Retrieved 16 July 2015 from http://www.nccah-ccnsa.ca/docs/fact%20sheets/social%20determinates/Access%20to%20Health%20Services_Eng%202010.pdf
- National High Blood Pressure Education Program Working Group on Blood Pressure in Children and Adolescents. (2004). The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*, *114*(Suppl 2), 555-576.
- Naylor, P.-J., & McKay, H.A. (2009). Prevention in the first place: Schools a setting for action on physical activity. *British Journal of Sports Medicine*, *43*(1), 10-13.
- Naylor, P.-J., Scott, J., Drummond, J., Bridgewater, L., McKay, H.A., & Panagiotopoulos, C. (2010). Implementing a whole school physical activity and healthy eating model in rural and remote First Nations schools: A process evaluation of Action Schools! BC. *Rural and Remote Health*, *10*(2), 1296. Retrieved 16 July 2015 from <http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=1296>
- Ng, C., Corey, P.N., & Young, T.K. (2011) Socio-economic patterns of obesity among Aboriginal and non-Aboriginal Canadians. *Canadian Journal of Public Health*, *102*(4), 264-268.
- Ng, C., Marshall, D., & Willows, N.D. (2006). Obesity, adiposity, physical fitness and activity levels in Cree children. *International Journal of Circumpolar Health*, *65*(4), 322-330.
- Ng, C., Young, T.K., & Corey, P.N. (2010). Associations of television viewing, physical activity and dietary behaviours with obesity in Aboriginal and non-Aboriginal Canadian youth. *Public Health Nutrition*, *13*(9), 1430-1437.
- Norris, N. (1997). Error, bias and validity in qualitative research. *Educational Action Research*, *5*(1), 172-176.
- North American Indigenous Games. (2015). Home Page. Retrieved August 7 2015 from <http://www.naigcouncil.com/culture.php>
- Ogden, C.L., Li, Y., Freedman, D.S., Borrud, L.G., & Flegal, K.M. (2011). Smoothed percentage body fat percentiles for US children and adolescents, 1999-2004. National Health Statistics Reports, no.43. Hyattsville, MD: National Center for Health Statistics. Retrieved 31 July 2015 from <http://www.cdc.gov/nchs/data/nhsr/nhsr043.pdf>

- Oliver, L.N., & Hayes, M.V. (2005). Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth. *Canadian Journal of Public Health*, 96(6), 415-420.
- Ortega, F.B., Ruiz, J.R., Castillo, M.J., & Sjörström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity*, 32(1), 1-11.
- Oster, R.T., Girer, A., Lightning, R., Mayan, M.J., & Toth, E.L. (2014). Cultural continuity, traditional Indigenous language, and diabetes in Alberta First Nations: A mixed methods study. *International Journal for Equity in Health*, 13, 92. doi: 10.1186/s12939-014-0092-4
- Oster, R.T., Johnson, J.A., Balko, S.U., Svenson, L.W., & Toth, E.L. (2012). Increasing rates of diabetes amongst status Aboriginal youth in Alberta, Canada. *International Journal of Circumpolar Health*, 71, 1-7. doi: 10.3402/ijch.v71i0.18501
- Owen, N., Healy, G.N., Matthews, C.E., Dunstan, D.W. (2010). Too much sitting: The population-health science of sedentary behavior. *Exercise and Sport Sciences Reviews*, 38(3), 105-113.
- Owen, N., Bauman, A., & Brown, W. (2009). Too much sitting: A novel and important predictor of chronic disease risk? *British Journal of Sports Medicine*, 43(2), 81-83.
- Pal, S., Haman, F., & Robidoux, M.A. (2013). The costs of local food procurement in two northern Indigenous communities in Canada. *Food and Foodways*, 21(2), 132-152.
- Pannucci, C.J., & Wilkins, E.G. (2010). Identifying and avoiding bias in research. *Plastic and Reconstructive Surgery*, 126(2), 619-625.
- Paquette, M.-C. (2005). Perceptions of healthy eating: State of knowledge and research gaps. *Canadian Journal of Public Health*, 96(Suppl 3), S15-9, S16-21.
- Paradis, G., Lévesque, L., Macaulay, A.C., Cargo, M., McComber, A., Kirby, R., et al. (2005). Impact of a diabetes prevention program on body size, physical activity, and diet among Kanien'kehá:ka (Mohawk) children 6 to 11 years old: 8-year results from the Kahnawake Schools Diabetes Prevention Project. *Pediatrics*, 115(2), 333-339.
- Parikh, T., & Stratton, G. (2011). Influence of intensity of physical activity on adiposity and cardiorespiratory fitness in 5-18 year olds. *Sports Medecine* 41(6):477-488.
- Park, M.H., Falconer, C., Viner, R.M., & Kinra, S. (2012). The impact of childhood obesity on morbidity and mortality in adulthood: A systematic review. *Obesity Reviews*, 13(11), 985-1000.

- Patton, M.Q. (2012). *Essentials of utilization-focused evaluation*. Thousand Oaks, CA: Sage Publications.
- Payne, C., Morrow, J., Johnson, L., & Dalton, S. (1997). Resistance training in children and youth: A meta-analysis. *Research Quarterly for Exercise and Sport*, 68(1), 80-88.
- Pigford, A.E., Willows, N.D., Holt, N.L., Newton, A.S., & Ball, G.D.C. (2012). Using First Nations children's perceptions of food and activity to inform an obesity prevention strategy. *Qualitative Health Research*, 22(27), 986-996.
- Pigford, A.E., Sanou, D., Ball, G.D.C., DyckFehderau, D., & Willows, N.D. (2011). Abdominal adiposity and physical activity in Cree First Nations children living on-reserve in an Alberta community. *Canadian Journal of Diabetes*, 35(4), 328-333.
- Ploegmakers, J.J.W., Hepping, A.M., Geertzen, J.H.B., Bulstra, S.K., & Stevens, M. (2013). Grip strength is strongly associated with height, weight and gender in childhood: A cross sectional study of 2241 children and adolescents providing reference values. *Journal of Physiotherapy*, 59(4), 255-261.
- Plowman, P.A. (2014). Top 10 research questions related to musculoskeletal physical fitness testing in children and adolescents. *Research Quarterly in Exercise and Sport*, 85(2), 174-187.
- Public Health Agency of Canada and the Canadian Institute for Health Information. (2011). *Obesity in Canada: A joint report from the Public Health Agency of Canada and the Canadian Institute for Health Information*. Ottawa, ON: Her Majesty the Queen in the Right of Canada. Retrieved 16 July 2015 from <http://www.phac-aspc.gc.ca/hp-ps/hl-mvs/oic-oac/assets/pdf/oic-oac-eng.pdf>
- Public Health Agency of Canada. (2011). *Diabetes in Canada: Facts from a public health perspective*. Ottawa, ON: Her Majesty the Queen in the Right of Canada. Retrieved 16 July 2015 from <http://www.phac-aspc.gc.ca/cd-mc/publications/diabetes-diabete/facts-figures-faits-chiffres-2011/highlights-saillants-eng.php#chp6>
- Public Health Agency of Canada. (2004). *The Canadian physical activity, fitness, and lifestyle approach: CSEP – health and fitness program's health-related appraisal and counselling strategy*, 3rd edition. Ottawa, ON: Canadian Society for Exercise Physiology.
- Puhl, R.M., & Latner, J.D. (2007). Stigma, obesity and the health of the nations' children. *Psychological Bulletin*, 133(4), 557-580.
- Rawana, J.S., & Ames, M.E. (2012). Protective predictors of alcohol use trajectories among Canadian Aboriginal youth. *Journal of Youth and Adolescence*, 41(2), 229-243.

- Razak, F., Anand, S., Vuksan, V., Davis, B., Jacobs, R., Teo, K.K., et al. (2005). Ethnic differences in the relationships between obesity and glucose-metabolic abnormalities: A cross-sectional population-based study. *International Journal of Obesity*, 29(6), 656-667.
- Receveur, O., Morou, K., Gray-Donald, K., & Macaulay, A. (2008). Consumption of key food items is associated with excess weight among elementary-school-aged children in a Canadian First Nations community. *Journal of the American Dietetic Association*, 108(2), 362-366.
- Reilly, J.J., & Kelly, J. (2011). Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. *International Journal of Obesity* 35(7), 891-898.
- Reilly, J.J., Kelly, J., & Wilson, D.C. (2010). Accuracy of simple clinical and epidemiological definitions of childhood obesity: Systematic review and evidence appraisal. *Obesity Reviews*, 11(9), 645-655.
- Reilly, J.J., Penpraze, V., Hislop, J., Davies, G., Grant, S., & Paton, J.Y. (2008). Objective measurement of physical activity and sedentary behavior: Review with new data. *Archives of Disease in Childhood*, 93(7), 614-619.
- Reiner, M., Neirmann, C., Jekauc, D., & Woll, A. (2013). Long-term health benefits of physical activity – a systematic review of longitudinal studies. *BMC Public Health*, 13, 813. doi: 10.1186/1471-2458-13-813
- Rey-López, J.P., Vicente-Rodríguez, G., Biosca, M., & Moreno, L.A. (2008). Sedentary behaviour and obesity development in children and adolescents. *Nutrition, Metabolism and Cardiovascular Diseases*, 18(3), 242-251.
- Richmond, C.A.M., & Ross, N.A. (2008). Social support, material circumstance and health behaviour: Influences on health in First Nations and Inuit communities of Canada. *Social Science and Medicine*, 67(2008), 1423-1433.
- Robbins, L.B., Pender, N.J., & Kazanis, A.S. (2003). Barriers to physical activity perceived by adolescent girls. *Journal of Midwifery and Women's Health*, 48(3), 206-212.
- Roberts, K.C., Shields, M., de Groh, M., Aziz, A., & Gilbert, J.-A. (2012). Overweight and obesity in children and adolescents: Results from the 2009 to 2011 Canadian Health Measures Survey. *Health Reports*, 23(3), 37-41.
- Ronsley, R., Lee, A.S., Kuzeljevic, B., & Panagiotopoulos, C. (2013). Healthy Buddies™ reduces body mass index z-score and waist circumference in Aboriginal children living in remote coastal communities. *Journal of School Health*, 83(9), 605-613.

- Rosenkranz, R.R., Welk, G.J., Hastmann, T.J., & Dzewaltowski, D.A. (2011). Psychosocial and demographic correlates of objectively measured physical activity in structured and unstructured after-school recreation sessions. *Journal of Science and Medicine in Sport, 14*(4), 306-311.
- Rossi, P.H., Lipsey, M.W., & Freeman, H.E. (2004). *Evaluation: A systematic approach*, 7th edition. Thousand Oaks, CA: Sage Publications.
- Rowlands, A.V., & Eston, R.G. (2007). The measurement and interpretation of children's physical activity. *Journal of Sports Science and Medicine, 6*(3), 270-276.
- Ruiz, J.R., Huybrechts, I., Cuenca-Garcia, M., Artero, E.G., Labayen, I., Meirhaeghe, A., et al. (2014). Cardiorespiratory fitness and ideal cardiovascular health in European adolescents. *Heart, 101*(10), 766-773.
- Saksvig, B., Gittelsohn, J., Harris, S.B., Hanley, A.J.G., Valente, T.W., & Zinman, B. (2005). A pilot school-based healthy eating and physical activity intervention improves diet, food knowledge, and self-efficacy for Native Canadian children. *Journal of Nutrition, 135*(10), 2392-2398.
- Salmon, J., Tremblay, M.S., Marhsall, S.J., & Hume, C. (2011). Health risk, correlates, and interventions to reduce sedentary behaviour in young people. *American Journal of Preventive Medicine, 41*(2), 197-206.
- Santos, R.G., Durksen, A., Rabbanni, R., Chanoine, J.P., Lamboo Miln, A., Mayer, T., et al. (2014). Effectiveness of peer-based healthy living lesson plans on anthropometric measures and physical activity in elementary school students: A cluster-randomized trial. *JAMA Pediatrics, 168*(4), 330-337.
- Saunders, T.J., Chaput, J.-P., & Tremblay, M.S. (2014). Sedentary behaviour as an emerging risk factor for cardiometabolic diseases in children and youth. *Canadian Journal of Diabetes, 38*(1), 53-61.
- Scheirer, M.A. (2005). Is sustainability possible? A review and commentary on empirical studies of program sustainability. *American Journal of Evaluation, 26*(3), 320-347.
- Schinke, R., Yungblut, H., Blodgett, A., Eys, M., Peltier, D., Ritchie, S., et al. (2010). The role of families in youth sport programming in a Canadian Aboriginal Reserve. *Journal of Physical Activity and Health, 7*(2), 156-166.
- Sedentary Behaviour Research Network. (2012). Letter to the editor: Standardized use of the terms "sedentary" and "sedentary behaviours". *Applied Physiology, Nutrition and Metabolism, 37*(3), 540-542.

- Shenton, A.K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*(2), 64-75.
- Shields, M. (2006). Overweight and obesity among children and youth. *Health Reports, 17*(1), 27-42.
- Shields, M., & Tremblay, M.S. (2008). Sedentary behaviour and obesity. *Health Reports, 19*(2), 19-30.
- Shields, M., Carroll, M.D., & Ogden, C.L. (2011). Adult obesity prevalence in Canada and the United States. NCHS Data Brief no. 56. Hyattsville, MD: National Center for Health Statistics. Retrieved 16 July 2015 from <http://www.cdc.gov/nchs/data/databriefs/db56.pdf>
- Shields, M., Gorber, S.C., & Tremblay, M.S. (2008). Estimates of obesity based on self-report versus direct measures. *Health Reports, 19*(2), 61-76.
- Shrewsbury, V., & Wardle, J. (2012). Socioeconomic status and adiposity in childhood: A systematic review of cross-sectional studies 1990-2005. *Obesity, 16*(2), 275-284.
- Silva, P., Lott, R., Mota, J., & Welk, G. (2014). Direct and indirect effects of social support on youth physical activity. *Pediatric Exercise Science, 26*(1), 86-94.
- Simen-Kapeu, A., & Veugelers, P.J. (2010). Should public health interventions aimed at reducing childhood overweight and obesity be gender-focused? *BMC Public Health, 10*, 340. doi: 10.1186/1471-2458-10-340
- Simonds, V.W., & Christopher, S. (2013). Adapting Western research methods to Indigenous ways of knowing. *American Journal of Public Health, 103*(12), 2185-2192.
- Singh, A.S., Mulder, C., Twisk, J.W., van Mechelen, W., & Chinapaw, M.J. (2008). Tracking of childhood overweight into adulthood: A systematic review of the literature. *Obesity Reviews, 9*(5), 478-488.
- Sirard, J.R., Pfiesser, K.A., & Pate, R.R. (2006). Motivational factors associated with sports program participation in middle school students. *Journal of Adolescent Health, 38*(6), 696-703.
- Skinner, K., Hanning, R.M., & Tsuji, L.J.S. (2014a). Prevalence and severity of household food insecurity of First Nations people living in an on-reserve, sub-arctic community within the Mushkegowuk Territory. *Public Health Nutrition, 17*(1), 31-39.

- Skinner, K., Hanning, R.M., Metatawabin, J., & Tsuji, L.J.S. (2014b). Implementation of a community greenhouse in a remote, sub-arctic First Nations community in Ontario, Canada: A descriptive case study. *Rural and Remote Health, 14*, 2545. Retrieved 31 July 2015 from <http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=2545>
- Skinner, K., Hanning, R.M., Desjardins, E., & Tsuji, L.J.S. (2013). Giving voice to food insecurity in a remote indigenous community in subarctic Ontario, Canada: Traditional ways, ways to cope, ways forward. *BMC Public Health, 13*, 427. doi:10.1186/1471-2458-13-427.
- Skinner, K., Hanning, R.M., Sutherland, C., Edwards-Wheesk, R., & Tsuji, L.J.S. (2012a). Using a SWOT analysis to inform healthy eating and physical activity strategies for a remote First Nations community in Canada. *American Journal of Health Promotion, 26*(6), e159-e170.
- Skinner, K., Hanning, R.M., Metatawabin, J., Martin, I.D., & Tsuji, L.J.S. (2012b). Impact of a school snack program on the dietary intake of grade six to ten First Nation students living in a remote community in northern Ontario, Canada. *Rural and Remote Health, 12*, 2122. Retrieved 20 September 2015 from <http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=2122>
- Skinner, K., Hanning, R.M., & Tsuji, L.J.S. (2006). Barriers and supports for healthy eating and physical activity for First Nation youths in northern Canada. *International Journal of Circumpolar Health, 65*(2), 148-161.
- Slater, A., & Tiggeman, M. (2010). “Uncool to do sport”: A focus group study of adolescent girls’ reasons for withdrawing from physical activity. *Psychology of Sport and Exercise, 11*(6), 619-626.
- Smith, J., Eather, N., Morgan, P., Plotkinoff, R., Faigenbaum, A., & Lubans, D. (2014). The health benefits of muscular fitness for children and adolescents: A systematic review and meta-analysis. *Sports Medicine, 44*(9), 1209-1223.
- Smith, K., Findlay, L., & Crompton, S. (2010). Participation in sports and cultural activities among Aboriginal children and youth. Statistics Canada Catalogue no.11-008-X. Retrieved 17 July 2015 from <http://www.statcan.gc.ca/pub/11-008-x/2010002/article/11286-eng.htm>
- Smylie, J. (2009). Achieving strength through numbers: First Nations, Inuit and Métis health information. Prince George, BC: National Collaborating Centre for Aboriginal Health. Retrieved 23 July 2015 from http://www.nccah-ccnsa.ca/docs/fact%20sheets/setting%20the%20context/NCCA_H_fs_context_EN.pdf

- Spanier, P.A., Marshall, S.J., & Faulkner, G.E. (2006). Tackling the obesity pandemic: A call for sedentary behaviour research. *Canadian Journal of Public Health*, 97(3), 255-257.
- Staiano, A.E., Gupta, A.K., & Katzmarzyk, P.T. (2014). Cardiometabolic risk factors and fat distribution in children and adolescents. *Journal of Pediatrics*, 164(3), 560-565.
- Stankov, I., Olds, T., & Cargo, M. (2012). Overweight and obese adolescents: What turns them off physical activity? *International Journal of Behavioral Nutrition and Physical Activity*, 9, 53. doi:10.1186/1479-5868-9-53
- Statistics Canada. (2015a). 2011 Census of the Population. Retrieved 16 July 2015 from <http://www12.statcan.gc.ca/census-recensement/index-eng.cfm>
- Statistics Canada. (2015b). Canadian Community Health Survey – Annual Component (CCHS). Retrieved 16 July 2015 from <http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226>
- Statistics Canada. (2015c). Canadian Community Health Survey: Data sources and methodology. Retrieved 16 July 2015 from http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&Item_Id=50653&lang=en
- Statistics Canada. (2014a) National Household Survey: Analytical Products, 2011. Retrieved 16 July 2015 from <http://www12.statcan.gc.ca/nhs-enm/2011/rt-td/index-eng.cfm#tabs1>
- Statistics Canada. (2014b). Canadian Health Measures Survey (CHMS). Retrieved 16 July 2015 from <http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5071>
- Statistics Canada. (2014c). Canadian Health Measures Survey: Definitions, data sources, and methods. Retrieved 16 July 2015 from http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5071&Item_Id=129548&lang=en
- Statistics Canada. (2013a). Aboriginal Peoples in Canada: First Nations People, Métis and Inuit, 2011 National Household Survey. Statistics Canada Catalogue no. 99-011-X2011001. Retrieved 16 July 2015 from <http://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-011-x/99-011-x2011001-eng.pdf>
- Statistics Canada. (2013b). The educational attainment of Aboriginal peoples in Canada. Statistics Canada Catalogue no. 99-012-X2011003. Retrieved 26 October 2015 from http://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-012-x/99-012-x2011003_3-eng.pdf

- Statistics Canada. (2012) Aboriginal Peoples Survey (APS). Retrieved 16 July 2015 from <http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3250>
- Statistics Canada. (2009). Average income by highest level of education attained, school/work status and gender. Retrieved 27 July 2015 from <http://www.statcan.gc.ca/pub/81-595-m/2009075/tbl/tbl7-eng.htm>
- Statistics Canada. (2008). Aboriginal Peoples in Canada in 2006: Inuit, Métis and First Nations, 2006 Census. Retrieved 16 July 2015 from <http://www12.statcan.ca/census-recensement/2006/as-sa/97-558/pdf/97-558-XIE2006001.pdf>
- Story, M., Lytle, L.A., Birnbaum, A.S., & Perry, C.L. (2002). Peer-led, school-based nutrition education for young adolescents: feasibility and process evaluation of the TEENS study. *Journal of School Health*, 72(3), 121-127.
- Story, M., Kaphingst, K.M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annual Review of Public Health*, 29, 253-272.
- Suchert, V., Hanewinkel, R., & Isensee, B. (2015). Sedentary behaviour and indicators of mental health in school-aged children and adolescents: A systematic review. *Preventive Medicine*, 76, 48-57. doi:10.1016/j.ypmed.2015.03.026
- Sutherland, C., Skinner, K., Hanning, R.M., Montgomery, M., & Tsuji, L.J.S. (2007). A Cree perspective on gathering community input for physical activity programming in the Mushkegowuk Territory. *Pimatisiwin*, 5(1), 169-183.
- Sweeting, H.N. (2008). Gendered dimensions of obesity in childhood and adolescence. *Nutrition Journal*, 7, 1. doi: 10.1186/1475-2891-7-1
- Swinburn, B.A., Sacks, G., Hall, K.D., McPherson, K., Finegood, D.T., Moodie, M.L., & Gortmaker, S.L. (2011). The global obesity pandemic: Shaped by global drivers and local environments. *Lancet*, 378(9793), 804-814.
- Talma, H., Chinapaw, M.J.M., Bakker, B., HiraSing, R.A., Terwee, C.B., & Altenburg, T.M. (2013). Bioelectrical impedance analysis to estimate body composition in children and adolescents: A systematic review and evidence appraisal of validity, responsiveness, reliability and measurement error. *Obesity Reviews*, 14(11), 895-905.
- Taymoori, P., & Lubans, D.R. (2008). Mediators of behaviour change in two tailored physical activity interventions for adolescent girls. *Psychology of Sport and Exercise*, 9(5), 615-619.

- Telama, R. (2009). Tracking of physical activity from childhood to adulthood: A review. *Obesity Facts*, 2(3), 187-195.
- Telama, R., Yank, K., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., et al. (2014). Tracking of physical activity from early childhood through youth into adulthood. *Medicine and Science in Sport and Exercise*, 46(5), 955-962.
- Tuefel-Shone, N.I., Fitzgerald, C., Tuefel-Shone, L., & Gamber, M. (2009). Systematic review of physical activity interventions implemented in American Indian and Alaska Native populations in United States and Canada. *American Journal of Health Promotion*, 23(6), S8-S32.
- The Truth and Reconciliation Commission of Canada. (2012). Canada, Aboriginal peoples, and residential schools: They came for the children. Winnipeg, MB: Library and Archives Canada. Retrieved 16 July 2015 from http://www.myrobust.com/websites/trcinstitution/File/2039_T&R_eng_web%5B1%5D.pdf
- Thoits, P.A. (2011). Mechanisms linking social ties and support to physical and mental health. *Journal of Health and Social Behavior*, 52(2), 145-161.
- Tjepkema, M., Wilkins, R., Sénécal, S., Guimond, E., & Penney, C. (2009). Mortality of Métis and Registered Indian adults in Canada: An 11-year follow-up study. *Health Reports*, 20(4), 31-51.
- Tomlin, D., Naylor, P.J., McKay, H., Zorzi, A., Mitchell, M., & Panagiotopoulos, C. (2012). The impact of Action Schools! BC on the health of Aboriginal children and youth living in rural and remote communities in British Columbia. *International Journal of Circumpolar Health*, 71, 17999 doi: 10.3402/ijch.v71i0.17999
- Towns, C., Cooke, M., Rysdale, L., & Wilk, P. (2014). Health weights interventions in Aboriginal children and youth: A review of the literature. *Canadian Journal of Dietetic Practice and Research*, 73(3), 125-131.
- Tremblay, M.S., LeBlanc, A.G., Janssen, I., Kho, M.E., Hicks, A., Murumets, K., et al. (2011a). Canadian sedentary behaviour guidelines for children and youth. *Applied Physiology, Nutrition and Metabolism*, 36(1), 59-64.
- Tremblay, M.S., LeBlanc, A.G., Kho, M.E., Saunders, T.J., Larouche, R., Colley, R.C., et al. (2011b). Systematic review of sedentary behavior and health indicators in school-aged children and youth. *Journal of Behavioral Nutrition and Physical Activity*, 21(8), 98. doi: 10.1186/1479-5868-8-98.

- Tremblay, M.S., Warburton, D.E., Janssen, I., Paterson, D.H., Latimer, A.E., Rhodes, R.E., et al. (2011c). New Canadian physical activity guidelines. *Applied Physiology, Nutrition and Metabolism*, 36(1), 36-46.
- Tremblay, M.S., Colley, R.C., Saunders, T.J., Healy, G.N., & Owen, N. (2010a). Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition and Metabolism*, 35(6), 725-740.
- Tremblay, M.S., Shields, M., Laviolette, M., Craig, C.L., Janssen, I., & Connor Gorber, S. (2010b). Fitness of Canadian children and youth: Results from the 2007-2009 Canadian Health Measures Survey. *Health Reports*, 21(1), 7-20.
- Tremblay, M.S., Katzmarzyk, P.T., Bryan, S.N., Perez, C.E., & Ardern, C.I. (2005). Obesity, overweight and ethnicity. *Health Reports*, 16(4), 23-34.
- Trost, S., McIver, K., & Pate, R. (2005). Conducting accelerometer-based activity assessments in field-based research. *Medicine and Science in Sports and Exercise*, 37(Suppl 1), S531-S543.
- Tudor-Locke, C., Craig, C.L., Beets, M.W., Belton, S., Cardon, G.M., Duncan, S., et al. (2011). How many steps/day are enough? For children and adolescents. *International Journal of Behavioral Nutrition and Physical Activity*, 8, 78. doi:10.1186/1479-5868-8-78
- Tuefel-Shone, N.I., Fitzgerald, C., Tuefel-Shone, L., & Gamber, M. (2009). Systematic review of physical activity interventions implemented in American Indian and Alaska Native populations in United States and Canada. *American Journal of Health Promotion*, 23(6), S8-S32.
- U.S. National Library of Medicine. (2015). Native peoples' concepts of health and illness: Medicine ways: Traditional healers and healing. Bethesda, MD: U.S. Nations Library of Medicine. Retrieved 16 July 2015 from <http://www.nlm.nih.gov/nativevoices/exhibition/healing-ways/medicine-ways/medicine-wheel.html>
- Van der Horst, K., Paw, M.J., Twisk, J.W., & van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine and Science in Sports and Exercise*, 39(8), 1241-1250.
- Vander Wal, J.S., & Mitchell, E.R. (2011). Psychological complications of pediatric obesity. *Pediatric Clinics of North America*, 8(6), 1393-1401.

- Varcoe, C., Bottorf, J.L., Carey, J., Sullivan, D., & Williams, W. (2010). Wisdom and influence of elders: Possibilities for health promotion and decreasing tobacco exposure in First Nations communities. *Canadian Journal of Public Health, 101*(2), 154-158.
- Voorhees, C.C., Murray, D., Welk, G., Birnbaum, A, Ribisl, K.M, Johnson, C.C., et al. (2005). The role of peer social network factors and physical activity in adolescent girls. *American Journal of Health Behavior, 29*(2), 183-190.
- Wang, F., Wild, T.C., Kipp, W., Kuhle, S., & Veugelers, P.J. (2009). The influence of childhood obesity on the development of self-esteem. *Health Reports, 20*(2), 21-27.
- Wang, Y., & Lim, H. (2012). The global childhood obesity epidemic and the association between socio-economic status and childhood obesity. *International Review of Psychiatry, 24*(3), 176-188.
- Whitney, E., Rolfes, S.R., Hammond, G., & Piché, L. (2013). *Understanding Nutrition, 1st Canadian Edition*. Toronto, ON: Nelson Education.
- Wilk, P, & Cooke, M. (2015). Collaborative public health systems interventions for chronic disease prevention among urban Aboriginal peoples. *International Indigenous Policy Journal, 6*(4). Retrieved Nov 2, 2015 from <http://ir.lib.uwo.ca/cgi/viewcontent.cgi?article=1248&context=iipj>
- Williams, D.P., Going, S.B., Lohman, T.G., Harsha, D.W., Srinivasan, S.R., Webber, L.S. et al. (1992). Body fatness and risk for elevated blood pressure, total cholesterol and serum lipoprotein ratios in children and adolescents. *American Journal of Public Health, 83*(3), 358-363.
- Willows, N.D. (2013a). Editorial: Ethical principles of health research involving Indigenous peoples. *Applied Physiology, Nutrition and Metabolism, 38*(11), iii-iv.
- Willows, N.D. (2005). Determinants of healthy eating in Aboriginal peoples in Canada: The current state of knowledge and research gaps. *Canadian Journal of Public Health, 96*(Suppl 3), S32-S36.
- Willows, N.D., Ridley, D., Raine, K.D., & Maximova, K. (2013b). High adiposity is associated cross-sectionally with low self-concept and body size dissatisfaction among indigenous Cree schoolchildren in Canada. *BMC Pediatrics, 13*, 118. doi: 10.1186/1471-2431-13-118.
- Willows, N.D., Hanley, A.J.G., & Delormier, T. (2012). A socioecological framework to understand weight-related issues in Aboriginal children in Canada. *Applied Physiology, Nutrition, and Metabolism, 37*(1), 1-13.

- Willows, N.D., Veugelers, P., Raine, K., & Kuhle, S. (2009). Prevalence and sociodemographic risk factors related to household food security in Aboriginal people in Canada. *Public Health Nutrition*, 12(8), 1150-1156.
- Wilson, D., & Macdonald, D. (2010). Growing gap project: The income gap between Aboriginal peoples and the rest of Canada. Ottawa, ON: Canadian Centre for Policy Alternatives. Retrieved 16 July 2015 from http://ywcacanada.ca/data/research_docs/00000121.pdf
- Wilson, K., & Rosenberg, M.W. (2002). Exploring the determinants of health for First Nations peoples in Canada: Can existing frameworks accommodate traditional activities? *Social Science and Medicine*, 55(11), 2017-2031.
- Wilson, S. (2008). *Research is Ceremony. Indigenous Research Methods*. Halifax, NS: Fernwood Publishing.
- Wind, A.E., Takken, T., Helder, P.J.M., & Engelbert, R.H.H. (2010). Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults? *European Journal of Pediatrics*, 169(3), 281-287.
- World Health Organization. (2015a). Obesity and overweight. Geneva, Switzerland: World Health Organization. Retrieved 16 July 2015 from <http://www.who.int/mediacentre/factsheets/fs311/en/index.html>
- World Health Organization. Computation of centiles and z-scores for height-for-age, weight-for-age and BMI-for-age. (2015b). Geneva, Switzerland: World Health Organization. Retrieved 31 July 2015 from www.who.int/growthref/computation.pdf?ua=1
- World Health Organization. (2000). *Obesity: Preventing and Managing the Global Epidemic*. Geneva, Switzerland: World Health Organization. Retrieved 16 July 2015 from http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/
- World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *Journal of the American Medical Association*, 310(20), 2191-2194.
- Yang, X., Telama, R., Leskinen, E., Mansikkaniemi, K., Viikari, J., & Raitakari, O.T. (2007). Testing a model of physical activity and obesity tracking from youth to adulthood: The cardiovascular risk in young Finns study. *International Journal of Obesity*, 31(3), 521-527.
- Yip, C., Gates, M., Gates, A., & Hanning, R.M. (2015). Peer-led nutrition education programs for school-aged youth: A systematic review of the literature. *Health Education Research*. doi: 10.1093/her/cyv063

- Young, T.K. (2003). Review of research on aboriginal populations in Canada: Relevance to their health needs. *British Medical Journal*, 327(7412), 419-422.
- Young, T.K., & Katzmarzyk, P.T. (2007). Physical activity of Aboriginal people in Canada. *Canadian Journal of Public Health*, 98(Suppl 2), S148-S160.
- Young, T.K., Dean, H.J., Flett, B., & Wood-Steiman, P. (2000). Childhood obesity in a population at high risk for type 2 diabetes. *Journal of Pediatrics*, 136(3), 365-369.
- Zorzi, A., Wahi, G., Macnab, A.J., & Panagiotopoulos, C. (2009). Prevalence of impaired glucose tolerance and the components of metabolic syndrome in Canadian Tsimshian Nation youth. *Canadian Journal of Rural Medicine*, 14(2), 61-67.

Appendices

Appendix A: Information and consent form for the physical activity program

Title of Project: Evaluation of a multi-component initiative to promote physical activity among youth in [REDACTED] First Nation

Organizers: Dr. Rhona Hanning, Dr. Leonard Tsuji, Allison Gates, Michelle Gates, [REDACTED]

INFORMATION LETTER – PHYSICAL ACTIVITY STUDY

September 4, 2012

Dear Parent(s) Or Guardian(s):

I am writing to ask permission for your child to participate in a research project. This project is being lead by Drs. Rhona Hanning and Len Tsuji at the University of Waterloo along with [REDACTED] School and the local Education Authority. During the 2012-2013 school year, [REDACTED] (principal) and [REDACTED] (Grade 8 teacher) will run a school-based physical activity program. University of Waterloo researchers will support and evaluate the program. The project plans to benefit youth by: 1) increasing physical activity, 2) promoting a healthy lifestyle, and 3) encouraging a healthy body image.

The objectives of the project are to:

1. Learn about the barriers and supports to being physically active for youth
2. Learn about the body image, eating and physical activity habits of youth
3. Work with [REDACTED] School to support a school-based physical activity program
4. Evaluate the impact of the program

The project will include the following. Measurements will be taken at two times. Once at the beginning and once at the end of the 2012-2013 school year:

1. **Web-based survey:** This will occur in class on school computers. It will include questions on diet and body image. Your child will have a unique username and password. This will ensure that their answers are confidential. The survey will take about 45 minutes. Your child will be able to skip any question they don't want to answer.
2. **Routine physical fitness testing:** This will include a four tests during physical education class. 1) 20-m shuttle run, 2) flexibility test, 3) muscular strength test, and 4) muscular endurance test. Results will be collected by [REDACTED] and given to the research team.
3. **Body composition:** Height, weight, body fat % (using a scale), waist circumference, heart rate and blood pressure (using an electronic blood pressure cuff). This will take less than 30 minutes. Each child will be measured individually (for confidentiality) on school grounds.
4. **Physical activity level:** Your child will be asked to wear an accelerometer (like a step-counter) around their waist. They will wear it for 3 full days. They will only take it off to take a shower or at other times when it could be damaged. Each day, information will be collected from the accelerometer (at school).

All students in grades 6 and 7 who have received parental permission (signed consent form) and verbally agree to the study will participate. Allison and Michelle Gates, from the University of Waterloo, will perform the measurements along with [REDACTED]. There will be no remuneration for participating. However, each child will receive a copy of their results to take home. Results for individual children will be kept strictly confidential. They will not be shared with school staff. Reports

will include only summary information. It will not be possible to identify any individual child. A written feedback report will be sent to [REDACTED] School and the local Education Authority. If you would like a copy of this report, you can obtain one by contacting the researchers or [REDACTED] School. Additional presentations will be made at the request of the community. All information collected will be kept in locked files on an encrypted laptop. These will be stored indefinitely on a CD in a locked filing cabinet within the School of Public Health and Health Systems at the University of Waterloo.

The physical activity program is planned to benefit youth and the community. It will likely increase physical activity. It may also promote physical fitness and a healthy body image. This study aims to confirm the benefits of this program. There are no known or anticipated risks to participation in this study. However, the decision about your child's participation is yours. By completing the attached consent form and having your child return it to [REDACTED] School within the next 10 days, you agree to have your child participate. Additionally, verbal consent from your child will be obtained prior to data collection. Children or parents may withdraw their permission at any time during the study. This can be done, without penalty, by contacting the researcher, [REDACTED] or [REDACTED] at [REDACTED] School, or the local Education Authority.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. In addition, it has been approved by the local Education Authority. It has the support of [REDACTED] (principal) and [REDACTED] (physical education teacher) at [REDACTED] School. Should you have any concerns or comments resulting from your child's participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at [REDACTED].

If you have any questions about the study, or if you would like additional information to help you reach a decision, please feel free to call me at the University of Waterloo, [REDACTED]. Thank you in advance for your interest and support of this project.

Yours sincerely,

Dr. Rhona Hanning
Associate Professor of Nutrition
University of Waterloo

[REDACTED]

[REDACTED]

Dr. Len Tsuji
Professor of Environment and Health
University of Waterloo

[REDACTED]

[REDACTED]

Allison Gates & Michelle Gates, PhD Candidates
School of Public Health & Health Systems
University of Waterloo

[REDACTED]

Title of Project: Evaluation of a multi-component initiative to promote physical activity among youth in [REDACTED] First Nation

Organizers: Dr. Rhona Hanning, Dr. Leonard Tsuji, Allison Gates, Michelle Gates, [REDACTED]

CONSENT FORM

By completing this consent form and having my child return it to [REDACTED] School by **September 21, 2012**, I agree to have my child participate in the described research project, lead by Drs. Rhona Hanning and Len Tsuji at the University of Waterloo, in partnership with [REDACTED] School and the local Education Authority. I have made this decision based on the information I have received in the information letter. I have had the opportunity to ask questions and request any additional details I wanted about this study.

I understand that as a participant in this study, my child will be involved in two phases of data collection. One phase will be at the beginning and one at the end of the 2012-2013 school year. My child will give verbal consent before participating. Each phase will include: 1) a routine physical fitness test (data given to research team), 2) wearing an accelerometer for three days, 3) testing body composition, and 4) a short web-based survey. I also understand that I may withdraw consent for my child's participation at any time. I may do so, without penalty, by indicating this decision to the researcher, [REDACTED] or [REDACTED] at [REDACTED] School, or the local Education Authority.

I am aware that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo, and that I may contact the Director at [REDACTED] if I have any concerns or comments resulting from my participation in this study.

I agree to have my child participate in this research project.

YES NO (Please circle your choice)

Child's Name: _____(Please print)

Parent or Guardian's Name: _____(Please print)

Parent or Guardian's Signature: _____

Date: _____

Appendix B: Information letter and consent form for student focus groups

Title of Project: Evaluation of a multi-component initiative to promote physical activity among youth in [REDACTED] First Nation

Organizers: Dr. Rhona Hanning, Dr. Leonard Tsuji, Allison Gates, Michelle Gates, [REDACTED]

INFORMATION LETTER – STUDENT FOCUS GROUPS

September 4, 2012

Dear Parent(s) Or Guardian(s):

I am writing to ask permission for your child to participate in a research project. This project is being lead by Drs. Rhona Hanning and Len Tsuji at the University of Waterloo along with [REDACTED] and the local Education Authority. During the 2012-2013 school year, [REDACTED] (principal) and [REDACTED] (Grade 8 teacher) will run a school-based physical activity program. As part of the current project, University of Waterloo researchers will try to find out what could help youth in [REDACTED] to be more active. The project plans to benefit youth by: 1) increasing physical activity, 2) promoting a healthy lifestyle, and 3) encouraging a healthy body image.

The objectives of the project are to:

1. Learn about the barriers and supports to being physically active for youth
2. Learn about the body image, eating and physical activity habits of youth
3. Work with [REDACTED] School to support a school-based physical activity program
4. Evaluate the impact of the program

As part of this project, students in grades 6 and 7 will be invited to take part in a focus group discussion. In this discussion, we will try to find out what could help youth in [REDACTED] to be more active. The discussion will be lead by Allison Gates and Michelle Gates of the University of Waterloo.

A selection of students in grades 6 and 7 who have received parental permission (signed consent form) and verbally agree to the discussion will participate. The discussion will take about 30 minutes. It will take place during school time, in the last week of September. We will discuss the physical activity environment in [REDACTED]. There is no remuneration for participating. There are no known or anticipated risks to your child's participation in this session. Your child's verbal consent will be obtained before the session. The discussion leader will take notes on a computer. These will be kept in a locked file on an encrypted laptop. If there is a question that your child does not want to answer, they do not have to. We will make this clear at the beginning of the discussion. All information discussed is considered confidential. In any reports, responses will be grouped with those from other participants. Your child's name will not be associated with any comments. A written feedback report will be sent to [REDACTED] School and the local Education Authority. If you would like a copy of this report, you can obtain one by contacting the researchers or [REDACTED] School. Additional presentations will be made at the request of the community. The information collected from the discussion will be kept indefinitely on a CD in a locked file cabinet within the School of Public Health and Health Systems at the University of Waterloo. Only study researchers will be able to access it.

Given the group format of the discussion, your child will be asked you to keep information that could identify another participant and their comments confidential. If you have any questions about your child's participation in this discussion, you can contact professor Rhona Hanning at [REDACTED]. If you want to withdraw your child from the study at any time, please contact the researcher, [REDACTED] or [REDACTED] at [REDACTED] School, or the local Education Authority.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. By completing the attached consent form and having your child return it to [REDACTED] School within the next 10 days, you agree to have your child participate. Additionally, verbal consent from your child will be obtained before the discussion, after we have explained the procedure. Should you have comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at [REDACTED].

If you have any questions about the study, or if you would like additional information to assist you in reaching a decision, please feel free to call me at the University of Waterloo, [REDACTED]. Thank you in advance for your interest and support of this project.

Yours sincerely,

Dr. Rhona Hanning
Associate Professor of Nutrition
University of Waterloo

[REDACTED]

Dr. Len Tsuji
Professor of Environment and Health
University of Waterloo

[REDACTED]

Allison Gates & Michelle Gates, PhD Candidates
School of Public Health & Health Systems
University of Waterloo

[REDACTED]

Title of Project: Evaluation of a multi-component initiative to promote physical activity among youth in [REDACTED] First Nation

Organizers: Dr. Rhona Hanning, Dr. Leonard Tsuji, Allison Gates, Michelle Gates, [REDACTED]

CONSENT FORM

By completing this consent form and having my child return it to [REDACTED] School by **September 21, 2012**, I agree to have my child participate in the discussion, lead by Allison Gates and Michelle Gates, from the University of Waterloo. I have made this decision based on the information I have received in the information letter. I have had the opportunity to ask questions and request any additional details I wanted about this study.

I understand that as a participant, my child will be involved in a group discussion about what would help them to be more active. The discussion will take place at school during the last week of September. My child will give verbal consent before participating. I also understand that I may withdraw consent for my child's participation at any time. I may do so, without penalty, by indicating this decision to the researcher, [REDACTED] or [REDACTED] at [REDACTED] School, or the local Education Authority.

I am aware that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo, and that I may contact the Director at [REDACTED] if I have any concerns or comments resulting from my participation in this study.

I agree to have my child participate in this discussion.

YES NO (Please circle your choice)

Child's Name: _____(Please print)

Parent or Guardian's Name: _____(Please print)

Parent or Guardian's Signature: _____

Date: _____

Appendix C: Child consent script for the physical activity program

CHILD CONSENT SCRIPT

Your parents have allowed me to talk to you about a project that I am working on with a couple of other people. The project is on physical activity, eating habits and body image in youth in your community. I am going to spend a few minutes telling you about our project, and then I am going to ask you if you are interested in taking part in the project.

Who are we?

Our names are Allison and Michelle Gates and we are PhD students at the University of Waterloo. We work in the School of Public Health and Health Systems.

Why are we meeting with you?

We want to tell you about a study that involves children like yourself. We want to see if you would like to be in this study too.

Why are we doing this study?

We want to find out what stops children from being more physically active. We also want to know if a new school program will help children be more physically active and feel better about their bodies.

What will happen to you if you are in the study?

If you decide to take part in this study there are some different things we will ask you to do. First, we will ask your physical education teacher to give us your physical fitness results. Second, we will collect some measurements of your body. These will include height, weight, body fat %, waist circumference, heart rate and blood pressure. These will be taken privately and will not hurt. We will give you your results to bring home. Third, you will wear an accelerometer, which is like a fancy step-counter, to measure your activity for three days. It is important that you don't take it off unless you are taking a shower. It is also important that you return it after three days. When you are wearing the accelerometer, don't feel like you have to do anything special. Just do what you would normally do day-to-day. Fourth, you will fill out a survey about your eating habits and body image on a computer. This will take about 45 minutes. You do not have to answer any questions that you do not want to. Finally, you will have the chance to take part in a 30-minute discussion with other children about why you are or are not physically active. During this school year, your school will have a physical activity program to help you be more active. At the end of the program, we will ask you to complete the same four tasks. You will have the chance to take part in another discussion about your thoughts on the program at that time.

Are there good things and bad things about the study?

What we find in this study will be used to help your community continue to try to help children become more active. As far as we know, being in this study will not hurt you and it will not make you feel bad.

Will you have to answer all questions and do everything you are asked to do?

If we ask you questions that you do not want to answer then tell us you do not want to answer those questions. If we ask you to do things you do not want to do then tell us that you do not want to do them.

Who will know that you are in the study?

The things you say and any information we write about you will not have your name with it, so no one will know they are your answers or the things that you did.

The researchers will not let anyone other than themselves see your answers or any other information about you. Your teachers, principal, and parents will never see the answers you gave or the information we wrote about you.

Do you have to be in the study?

You do not have to be in the study. No one will get angry or upset with you if you don't want to do this. Just tell us if you don't want to be in the study. And remember, if you decide to be in the study but later you change your mind, then you can tell us you do not want to be in the study anymore.

Do you have any questions?

You can ask questions at any time. You can ask now or you can ask later. You can talk to me, your physical education teacher, the principal, or someone else at any time during the study. All of our contact information is on your information letter.

Do you agree to be part of this study?*

*Student either says yes or no. If the student says no, the researchers will not proceed with the measurements.

Appendix D: Information letter and consent form for teacher focus groups

Title of Project: Evaluation of a multi-component initiative to promote physical activity among youth in [REDACTED] First Nation

Organizers: Dr. Rhona Hanning, Dr. Leonard Tsuji, Allison Gates, Michelle Gates, [REDACTED]

INFORMATION LETTER – TEACHER AND STAFF FOCUS GROUPS

September 4, 2012

Dear Teacher or Member of School Staff:

A research project is being conducted by Drs. Rhona Hanning and Len Tsuji at the University of Waterloo along with [REDACTED] School and the local Education Authority. During the 2012-2013 school year, [REDACTED] (principal) and [REDACTED] (Grade 8 teacher) will run a school-based physical activity program. As part of the current project, University of Waterloo researchers will try to find out what could help youth in [REDACTED] to be more active. The project plans to benefit youth by: 1) increasing physical activity, 2) promoting a healthy lifestyle, and 3) encouraging a healthy body image.

The objectives of the project are to:

1. Learn about the barriers and supports to being physically active for youth
2. Learn about the body image, eating and physical activity habits of youth
3. Work with [REDACTED] School to support a school-based physical activity program
4. Evaluate the impact of the program

As part of this project, you are invited to take part in a focus group. In this discussion, we will try find out what could help youth in [REDACTED] to be more active. The discussion will be lead by Allison Gates and Michelle Gates of the University of Waterloo.

Teachers and staff who have signed the attached consent form and returned it to the main office at [REDACTED] School will participate. The discussion will take about 30 minutes. It will take place during school hours (either directly after school or during the lunch break), in the last week of September. We will discuss the physical activity environment in [REDACTED]. There is no remuneration for participating. There are no known or anticipated risks to your participation in this session. The discussion leader will take notes on a computer. These will be kept in a locked file on an encrypted laptop. If there is a question that you do not want to answer, you do not have to. We will make this clear at the beginning of the discussion. All information discussed is considered confidential. In any reports, responses will be grouped with those from other participants. Your name will not be associated with any comments. A written feedback report will be sent to [REDACTED] School and the local Education Authority. If you would like a copy of this report, you can obtain one by contacting the researchers or [REDACTED] School. Additional presentations will be made at the request of the community. The information collected from the discussion will be kept indefinitely on a CD in a locked file cabinet within the School of Public Health and Health Systems at the University of Waterloo. Only study researchers will be able to access it.

Given the group format of the discussion, you will be asked you to keep information that could identify another participant and their comments confidential. If you have any questions about your

participation in this discussion, you can contact professor Rhona Hanning at [REDACTED].
If you want to withdraw from the study at any time, please contact the researcher, [REDACTED] or
[REDACTED] at [REDACTED] School, or the local Education Authority.

I would like to assure you that this study has been reviewed and received ethics clearance through the
Office of Research Ethics at the University of Waterloo. However, the final decision about
participation is yours. By completing the attached consent form and returning it to the main office at [REDACTED]
[REDACTED] School within the next 10 days, you agree to participate. Should you have comments or
concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the
Director, Office of Research Ethics, [REDACTED]
[REDACTED]

If you have any questions about the study, or if you would like additional information to assist you in
reaching a decision, please feel free to call me at the University of Waterloo, [REDACTED]
[REDACTED] Thank you in advance for your interest and support of this project.

Yours sincerely,

Dr. Rhona Hanning
Associate Professor of Nutrition
University of Waterloo

[REDACTED]

[REDACTED]

Dr. Len Tsuji
Professor of Environment and Health
University of Waterloo

[REDACTED]

[REDACTED]

Allison Gates & Michelle Gates, PhD Candidates
School of Public Health & Health Systems
University of Waterloo

[REDACTED]

Title of Project: Evaluation of a multi-component initiative to promote physical activity among youth in [REDACTED] First Nation

Organizers: Dr. Rhona Hanning, Dr. Leonard Tsuji, Allison Gates, Michelle Gates, [REDACTED]

CONSENT FORM

By completing this consent form and returning it to the main office at [REDACTED] School by **September 21, 2012**, I agree to participate in the discussion, lead by Allison Gates and Michelle Gates, from the University of Waterloo. I have made this decision based on the information I have received in the information letter. I have had the opportunity to ask questions and request any additional details I wanted about this study.

I understand that as a participant, I will be involved in a group discussion about what could help youth in [REDACTED] to be more active. The discussion will take place at school during the last week of September. I also understand that I may withdraw consent for my participation at any time. I may do so, without penalty, by indicating this decision to the researcher, [REDACTED] or [REDACTED] at [REDACTED] School, or the local Education Authority.

I am aware that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo, and that I may contact the Director at [REDACTED] if I have any concerns or comments resulting from my participation in this study.

I agree to participate in this discussion.

YES NO (Please circle your choice)

Name: _____(Please print)

Signature: _____

Date: _____

Appendix E: Protocol for anthropometric measures (adapted from PHAC, 2004)

Body Weight and Body Composition

1. Ensure that students are wearing light clothing and no shoes or socks.
2. After measuring the student's height, enter this information into the scale as directed in the instruction manual.
3. Have the student stand on the scale, feet over the metal plates, hands gripping the handheld device, and arms outstretched in front of them. Have them stand still until measurements are shown on the screen.
4. Record weight and body fat % as shown on the scale.
5. Have the student step off the scale. Repeat step 3 and record the weight and body fat % one more time.

Standing Height

1. Have students remove their shoes and stand with their feet together (touching the stadiometer), their back against the stadiometer. The top of the student's head should be at a 90 degree angle to the stadiometer.
2. Ask student to take a deep breath while the measurement is being taken. To take the measurement, move the headpiece such that it firmly touches the crown of the head on inhalation.
3. Record the measured height to the nearest 0.5 centimetre.

Waist Circumference

1. Have the student remove any bulky clothing and stand upright with their arms hanging loosely at their sides.
2. Position the measuring tape horizontally, midway between the bottom of the ribcage and the iliac crest (hip bone). Take the measurement at the end of normal expiration.
3. Record the waist circumference to the nearest 0.1 cm.

Appendix F: Physical activity recall questionnaire for students (adapted from Going et al., 1999)

Name: _____ Date: _____

Physical Activity Recall

1. Did you walk to school yesterday? Yes No
2. Did you walk home from school yesterday? Yes No
3. Try to think about all of the activities that you did **yesterday**.
 - Read the list and circle any activity that you did.
 - Circle the amount you did of it and your effort.
 - If you did not do an activity, skip it.

Effort: Easy = not breathing hard at all
 Medium = breathing a little bit hard
 Hard = breathing very hard

Activities	Before school		During school		After school	
	Amount	Effort	Amount	Effort	Amount	Effort
Bicycling	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard
Exercise: push-ups, sit-ups, jumping jacks	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard
Basketball	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard
Baseball or softball	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard
Football	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard
Soccer	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard
Volleyball	0-15 min	Easy	0-15 min	Easy	0-15 min	Easy
	15-30 min	Medium	15-30 min	Medium	15-30 min	Medium
	30+ min	Hard	30+ min	Hard	30+ min	Hard

Activities	Before school		During school		After school	
	Amount	Effort	Amount	Effort	Amount	Effort
Racket sports: badminton, tennis	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Ball playing: four square, dodge ball, kickball, Frisbee	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Games: catch, tag, hopscotch, hacky sack	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Outdoor play: climbing, hide and seek	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Water play: swimming in lake	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Jump rope	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Dance	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Outdoor chores: mowing, raking, gardening, playing	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Indoor chores: mopping, vacuuming, sweeping	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Mixed: walking/running	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Running	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Hiking	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
Watching TV or videos	0-15 min 15-30 min 30+ min		0-15 min 15-30 min 30+ min		0-15 min 15-30 min 30+ min	

Activities	Before school		During school		After school	
	Amount	Effort	Amount	Effort	Amount	Effort
Playing video games	0-15 min		0-15 min		0-15 min	
	15-30 min		15-30 min		15-30 min	
	30+ min		30+ min		30+ min	
Homework or reading	0-15 min		0-15 min		0-15 min	
	15-30 min		15-30 min		15-30 min	
	30+ min		30+ min		30+ min	
Playing board games	0-15 min		0-15 min		0-15 min	
	15-30 min		15-30 min		15-30 min	
	30+ min		30+ min		30+ min	
Arts and crafts	0-15 min		0-15 min		0-15 min	
	15-30 min		15-30 min		15-30 min	
	30+ min		30+ min		30+ min	
Riding in car or bus to school/home	0-15 min		0-15 min		0-15 min	
	15-30 min		15-30 min		15-30 min	
	30+ min		30+ min		30+ min	
You can add other activities here						
	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard
	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard	0-15 min 15-30 min 30+ min	Easy Medium Hard

Appendix G: Protocol for fitness testing (adapted from PHAC, 2004)

20-metre Shuttle Run (cardiorespiratory endurance)

1. Assessment will take place in gym. Measure the length of the gym; the test requires a 20 metre distance. Place one cone (or marker) at one end and another 20 metres away. Students will run between these lines. Depending on gym and class size, students can complete this all at once or in groups.
2. Explain the test to students. The CD provided will beep at set intervals. It will start quite slowly. Students must move from one end of the gym (line) to the other before the next beep.
3. The test starts slowly, and increases in speed at each level. Each level lasts one minute. If a student gets to the end of the gym before the beep, they must wait for the beep and then proceed to the next 20-m run.
4. When a student fails to reach the distance before the next beep, the test is done.
5. Record the number of shuttles the student has achieved.

Resting Blood Pressure (cardiorespiratory endurance)

1. Blood pressure and heart rate need to be taken at rest. Have students remain calm and seated for 5 minutes before measuring blood pressure and heart rate.
2. Blood pressure and heart rate will be measured using the BpTRU BPM-100 automated device.
3. Choose the appropriate cuff based on the size of the student's arm. Cuffs are marked so that you can be certain that you are using the right size.
4. Using the appropriate sized cuff, place the cuff around the student's arm, 2-3 centimetres above the elbow. The arm should be supported, the feet should be flat on the floor, and the legs should not be crossed.
5. Press the start button to start recording. The device will be set up to take 3 blood pressure readings over a period of 3 minutes. The first reading will be discarded, and the average of the remaining 2 readings should be recorded. The student should remain calm throughout the course of the testing.

One Minute Partial Curl-ups (muscular endurance)

1. Have students lie on their backs so that their hands are flat on the floor, palms facing down, with their legs bent at 90 degrees.
2. Students will perform partial curl-ups at the pace provided by a metronome (on a CD).
3. After starting the CD, ask students to perform partial curl-ups. Palms and heels should remain in contact with the floor. The head and back must touch the floor after each curl-up.
4. The test ends when students experience undue discomfort (cannot perform another curl-up), are unable to maintain the required pace, or are unable to maintain the proper technique over 2 consecutive repetitions (e.g., heels come off the floor).
5. Record the number of partial curl-ups completed in one minute.

Handgrip Dynamometry (muscular strength)

1. Muscular strength will be measured using the Smedley-type handgrip dynamometer.
2. Have the student grasp the dynamometer in one hand. The dynamometer is adjustable to different hand sizes. Adjust the dynamometer so that the second joint of the fingers fit snugly under the handle (they are holding it firmly).
3. Have the student hold their arm slightly away from their body, with the hand at the level of the thigh.
4. Ask the student to squeeze the dynamometer as hard as possible, while exhaling.
5. Take the measurement from the dynamometer and record it to the nearest kilogram.
6. Repeat steps 2 through 5 alternately on each hand, until you have recorded the results for each hand, twice (a total of 4 measurements).
7. Calculate the average of each hand and record it to the nearest kilogram.

Sit-and-Reach test (flexibility)

1. Flexibility will be measured using a flexometer.
2. Have students warm up by performing slow stretching movements.
3. Have students remove their shoes and sit with their legs fully extended and their feet placed flat against the flexometer.

4. Adjust the flexometer so that the balls of the feet rest against the upper crossboards, about 15 centimetres apart.
5. Keeping their knees fully extended, ask students to reach forward, pushing the sliding marker with the fingers as far forward as possible. Hold for 2 seconds. Record the distance reached to the nearest 0.1 centimeter.
6. Repeat step 5 once and record the distance reached. Keep the best of two attempts.

Appendix H: Questions included in the focus group with grades 6 and 7 students about the supports and barriers physical activity and sports participation

1. Knowing that youth should get 60 minutes (1 hour) of physical activity per day, how would you describe the physical activity level of youth in your community?
 - Do you think it should be higher or lower?
 - Do you think being physically active is important for youth in your community?
2. Do you think your parents, family, and teachers are physically active?
 - Why or why not?
 - How does this affect your physical activity level?
3. At your school, what chances do you have to be physically active?
 - PE class, after school programs, traditional activities, lunch programs, sports teams...
4. Do students tend to participate in school-run physical activities?
 - Is it different for boys vs. girls?
 - Why or why not?
5. What school-run physical activities would you like to see organized that you do not have now?
 - Includes facilities, equipment
6. Do most students walk or bike to school?
 - Why or why not? Weather, safety, distance, convenience, energy level...
7. Within the community, what types of places and equipment are there to help youth to be physically active?
 - Recreation centers, parks, walking trails, sports teams (out of school), playgrounds, fields...
8. Can anyone/everyone in your community use the physical activity places and equipment?
 - Cost, girls vs. boys...
9. Do youth tend to participate in community-run physical activities (outside of school)?
 - Is it different for boys vs. girls?
 - Why or why not?

10. What community-run (outside of school) physical activities would you like to see organized that you don't have now?

- Includes facilities, equipment

11. What do you think stops people from being physically active in your community?

- Safety (stray dogs), road conditions, environment (weather, light)
- Availability and accessibility of facilities

12. Any additional commentary

Appendix I: Questions included in the focus group with grades 6 and 7 teachers about the supports and barriers to physical activity for community youth

1. Knowing that youth should get 60 minutes of physical activity per day, how would you describe the physical activity level of youth in name of community?
 - Do you think it should be higher or lower?
 - Do you think being physically active is a priority among youth in the community?
2. Do you think that teachers and school staff are good role models for being physically active?
 - Why or why not?
 - How do you think this affects the physical activity level of youth?
3. At your school, what opportunities exist for student physical activity?
 - PE class, after school programs, traditional activities, lunch programs, sports teams...
4. Do students tend to participate in school-run physical activity opportunities?
 - Is it different for boys vs. girls?
 - Why or why not?
5. What school-run physical activities would you like to see organized that are not currently available?
 - Includes facilities, equipment
6. Do most students walk or bike to school?
 - Why or why not? Weather, safety, distance, convenience, energy level...
7. Within the greater community, what facilities exist for youth to be physically active?
 - Recreation centers, parks, walking trails, sports teams (out of school), playgrounds, fields...
8. Are the recreation facilities in your community equally accessible for all youth?
 - Cost, girls vs. boys...
9. Do youth tend to participate in community-run physical activities (outside of school)?
 - Is it different for boys vs. girls?
 - Why or why not?

10. What community-run (outside of school) physical activities would you like to see organized that are not currently available?

- Includes facilities, equipment

11. What do you consider the main barriers to youth being physically active in the community?

- Safety (stray dogs), road conditions, environment (weather, light)
- Availability and accessibility of facilities

12. Any additional commentary.

Appendix J: Interview questions for the sports program coordinator on the challenges and successes of a school sports program

1. Tell us about the after school PA program. How has the program been running since October?
 - What sports have been offered? Different by season? Time? Place? Any equipment necessary?
 - How often, how many days a week and for how long?
 - What has participation been like?
 - Which students participate? Which don't? Are there opportunities for all students? Targeted toward specific groups?
 - Were any other teachers involved? Volunteers?
2. What were the main challenges to sustaining the program over the year?
 - Funding, interruptions, volunteers, disciplinary issues?
 - Was the program consistent?
3. Of these challenges, were you able to overcome any? How?
4. What positive effects have you seen come out of the program?
 - Are students more active?
 - Better discipline/behaviour?
 - Greater attendance, greater attention? Other effects?
5. If you had to make a case for the continuation of the program, what are the main reasons that you think this program is valuable?
6. Hypothetically, for other communities facing similar challenges, what would be your advice to them for getting kids to be more active? What are the lessons learned from this program?
7. Given similar circumstances, do you see the program being able to continue into the future? i.e., is the program sustainable?
 - What would help the program be more successful?
 - What are the most important ingredients for the success of such a program?
8. In ideal circumstances, what future do you see for the program?
 - What would you change? What do you need to reach this ideal?
9. Any additional commentary.

Appendix K: Questionnaire for grades 6 and 7 teachers on the challenges and successes of a school sports program

1. Did you facilitate any of the after-school sports during the 2012-13 school year? Why or why not?
2. Do you feel that all students had an equal chance to participate in the after school sports that were offered? Why or why not? (e.g., girls vs. boys, grade level, shy students)
3. Are there any activities that you feel should be included in the after school sports program but were not?
4. As a result of the after school sports program, do you feel that students are more physically active?
5. Knowing that it is recommended that youth are physically active for 60 minutes each day, do you feel that youth in the community are adequately active? Why or why not?
6. Do you think that the school staff are good role models for being physically active? Why or why not?
7. Did you notice any benefits of the after school sports program beyond physical activity level? (e.g., attendance, attention, motivation)
8. Did you notice any challenges to running the after school sports program? If so, what were the main challenges? (e.g., resources, scheduling, funding, adequate personnel)
9. Any additional commentary.

Appendix L: Focus group questions for grades 6 and 7 students on their impressions of a school sports program

1. Did you participate in any part of the physical activity program (after school sports)?
 - Why or why not?
2. What were your favorite and least favorite activities?
 - What was it about these activities did you enjoy/not enjoy?
3. Do you think that all students had an equal chance to participate in the activities?
 - Boys vs. girls, grade level, variety
4. What activities would you have liked to do that were not included in the program?
5. After the program, do you feel like you are more active?
 - Are you more motivated?
 - Do you feel healthier?
6. It is recommended that youth be physically active for 60 minutes (1 hour) daily. Do you think that children in the community are active?
 - Why or why not?
7. Do you think that your parents, family, and teachers are good role models for being active?
 - Why or why not?
 - Does this affect your physical activity level?
8. If the program continues next year, what changes would you like to make?
 - What activities would you like to keep?
 - What activities would you like to add/take away?
9. Any additional commentary.