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Evaluation of acceptance and efficiency of exercise for Indigenous Australians to benefit physiological, anthropometric and metabolic syndrome outcomes

A thesis is presented for the degree of

Doctor of Philosophy

Tuguy Esgin

Edith Cowan University

School of Medical and Health Sciences

September 2017

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

i. incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;

ii. contain material previously published written by another person except where due reference is made in the text; or

iii. contain any defamatory material

Signature:

[redacted]

Date: 16th July 2016

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Dedication

This thesis is dedicated to my loving mother Lucy Ann Esgin and father Nami Ekrem Esgin (may you rest in peace) who encouraged and inspired me to pursue education. My children Hakan Esgin, Aleyna Esgin, Kayra Esgin and Attila Esgin and most of all my loving wife Vyvy.

……………………………

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To the loving memory of Dr Kevin Rowley who was more than a PhD co-supervisor. Thank you for your guidance through this long period of time but most of all thank you for your belief in me and my abilities to complete this PhD.

Presentations from this thesis

My research received considerable media exposure. I was invited to participate in several interviews. Some examples are listed below:

- SBS (NITV) filmed some of my research testing on the 5 July 2013. Refer http://www.sbs.com.au/news/article/1788040/Proving-exercise-works-for-indigenous-people
- On the 18 June 2013, I was interviewed by ABC News and video was recorded of my testing and training protocols. Refer http://www.abc.net.au/news/2013-07-08/tuguy-esgin-driven-to-prevent-chronic-disease/4805672
- A condensed 4-5-minute version of my ABC interview was created for the online sites and it was converted into a radio story for ABC 720. ABC News 24 also used a 90-120 second version to play during NAIDOC (National Aborigines and Islanders Day Observance Committee) week.
- Interview with Nerida Currey on *Strong Voices* about my research into exercise for Aboriginal people – Central Australia Aboriginal Media Association – refer http://caama.com.au/phd-candidate-and-nyoongar-man-tuguy-esgin-shares-his-journey

Conferences

Invited to speak

- 4th World Diabetes Congress Chicago August 2013
- Presented at Melbourne Convention Centre Non Communicable Disease Free Conference, October 2013

Attended

- 2011 NHMRC Indigenous Scientific Forum
- 2010 European College of Sports Science – Antalya Turkey
- 2009 Asia Pacific Conference on Metabolic Syndrome – Melbourne
- 2009 Indigenous Allied Health Association National Conference – Canberra

Table of contents

Use of Thesis iii

Declaration iv

Acknowledgements vi

Dedication vii

Presentations from this thesis viii

Table of contents ix

Abstract xx

Chapter 1- General introduction contemporary Australian Indigenous cultures and health xxi

Chapter 2 - General introduction of Metabolic Syndrome and how its risk factors impact the Australian Indigneous community. xxii

Chapter 3 – A review of the barriers and enablers of and best practice strategies for the implication of physical activity and exercise interventions in the Australian Indigenous community xxiii

Chapter 4 – Designing a culturally secure questionnaire to capture factors that relate to the motivators and barriers to physical activity in an Australian Indigenous population xxiv

Chapter 5 - Determining the motivators and barriers to physical activity in an urban Australian Indigenous population xxvi

Chapter 6 – Global Physical Activity Questionnaire: Measuring the activity in a Perth Australian Indigenous population xxvii

Chapter 7 - Feasibility and efficacy of exercise as medicine for reduction of risk of metabolic syndrome in sedentary Australian Indigenous people xxviii

Chapter 8 – Twelve week combined aerobic and resistance exercise intervention for Australian Indigenous males and females. xxix

Chapter 1 Contemporary Indigenous cultures and health 31

Introduction 31

Indigenous population 3

Noongar Community 5

Indicators of Indigenous social disadvantage 6

Education 7

Employment 7

Indigenous Life Expectancy 7

Rates and causes of morbidity 9

Closing the gap 11

Cardiovascular disease 13

Rates of cardiovascular disease 14

Rates of diabetes, obesity and metabolic syndrome 15

Reducing the cardiovascular morbidity rates 16

Physical activity and exercise 16

Physical activity, exercise and physical activity definitions 16

Physical activity, exercise and Indigenous populations 17

Previous literature investigating physical activity and exercise in the Indigenous population 17

Significance / purpose of the study 18

Research Questions 19

Chapter 2 Literature Review of Metabolic Syndrome 20

Metabolic syndrome defined 21

Metabolic syndrome prevalence in Indigenous communities 24

Obesity, fat distribution and their measurement ... 25
Obesity and measurements in the Indigenous community ... 26
Physical Activity, Exercise and Obesity ... 28
Physical activity and insulin sensitivity ... 29
Physical activity and dyslipidaemia ... 32
Physical activity and blood pressure ... 33
Physical activity and inflammation ... 37
Physical activity and endothelial function ... 38
Aerobic exercise for prevention and treatment of the metabolic syndrome ... 39
Resistance training for prevention and treatment of the metabolic syndrome ... 40
Exercise recommendations and the metabolic syndrome ... 40
Conclusion ... 41
Chapter 3 A review of the barriers and enablers of and best practice strategies for the implementation of physical activity and exercise interventions in the Australia Indigenous community ... 42
Introduction ... 42
Methods ... 45
Search Strategy ... 45
Results ... 45
Barriers and enablers to Indigenous participation in exercise studies ... 45
Studies of exercise interventions for Indigenous people ... 49
Common barriers to PA or exercise participation ... 52
Common themes that enhance the success of exercise programs ... 52
Culturally secure and community owned ... 53
Long term support from stakeholders ... 54

An Indigenous framework for physical activity 55
Application of the model to Indigenous PA interventions 60
Discussion and Conclusions from the literature review 61
Implications for physical activity program design 64
Chapter 4 65
Designing a culturally secure questionnaire to capture factors that relate to the motivators and barriers to physical activity in an Indigenous population in Australia. 65
Background 65
Introduction 68
Objectives 69
Methods 70
Survey design and study questions 71
Questionnaire design 71
Pilot validation of questionnaire 72
Ethics 72
Statistics 73
Results 73
Discussion 76
Conclusion 77
Chapter 5 Determining the motivators and barriers to physical activity in an Indigenous population in metropolitan Australia. 79
Introduction 79
Objectives 80
Methods 80
Study Setting and recruitment strategy 81

Ethics 81

Statistical Analyses 81

Results 81

Age categories and metabolic syndrome 83

Barriers and enablers for exercise 86

Exercise preferences and environment 94

Exercise and support 96

Exercise equipment and activities 99

Goals and commitment 102

Discussion 107

Motivators and barriers to physical activity 109

Exercise preferences and environment 110

Goals and commitment to exercise 112

Implications for program design 114

Strengths and limitations of this study 114

Conclusion 115

Chapter 6 Global Physical Activity Questionnaire: Measuring activity in a Perth Australian Indigenous population 117

Introduction 117

Questionnaire unit of measure 119

Statistics 120

Reliability and Validity 120

Methods 122

Participant Recruitment 122

Assessment of physical activity and sedentary behaviour 122

Metabolic Syndrome 123

Statistical Analysis 124

Results ... 124
Acceptability ... 124
Demographic and clinical characteristics of participants ... 124
Physical activity among Indigenous people in Noongar country ... 126
Intensity of Physical Activity ... 128
Discussion ... 133
Conclusion ... 136
Chapter 7 ... 138
Feasibility and efficacy of exercise as medicine for reduction of metabolic syndrome in inactive Australian Indigenous people. ... 138
Introduction ... 138
Aim ... 143
Method ... 144
Study design ... 144
Participant recruitment ... 144
Inclusion Criteria ... 144
Exclusion Criteria ... 144
Outcome measures ... 145
Anthropometry and body composition ... 145
Neuromuscular strength ... 145
Cardiorespiratory fitness ... 146
Vascular function – blood pressure, arterial compliance ... 147
Statistics ... 148
Results ... 148
Discussion ... 156
Cardiorespiratory fitness ... 158

Body composition.. 159
Neuromuscular Strength 160
Cardiovascular measures 161
Conclusion 163
Chapter 8 Effects of twelve weeks combined aerobic and resistance exercise on fitness and health of Indigenous men and women... 164
Background 164
Effects of exercise on measures of cardiovascular risk 165
Methods 167
Experimental Approach.. 167
Participants 167
Ethics 168
Inclusion Criteria 168
Exclusion Criteria 168
Aerobic Exercise Prescription 168
Resistance Exercise Prescription 169
Outcome measures... 170
Results 170
Strength and Aerobic Fitness 172
Body Composition and Anthropometric Measures...................................... 173
Discussion.. 174
Aerobic capacity.. 175
Neuromuscular strength.. 176
Body composition.. 176
Vascular function – blood pressure, arterial compliance............................... 178
Conclusion 181
Chapter 9 Summary, conclusions and recommendations.. 183

Recommendations.. 189

Future Research.. 190

Appendices 192

Appendix A - Questionnaires.. 192

Appendix B – Study information sheets... 203

References 218

List of figures

Figure 1-1 Map of Noongar Country South West Western Australian................................... 5

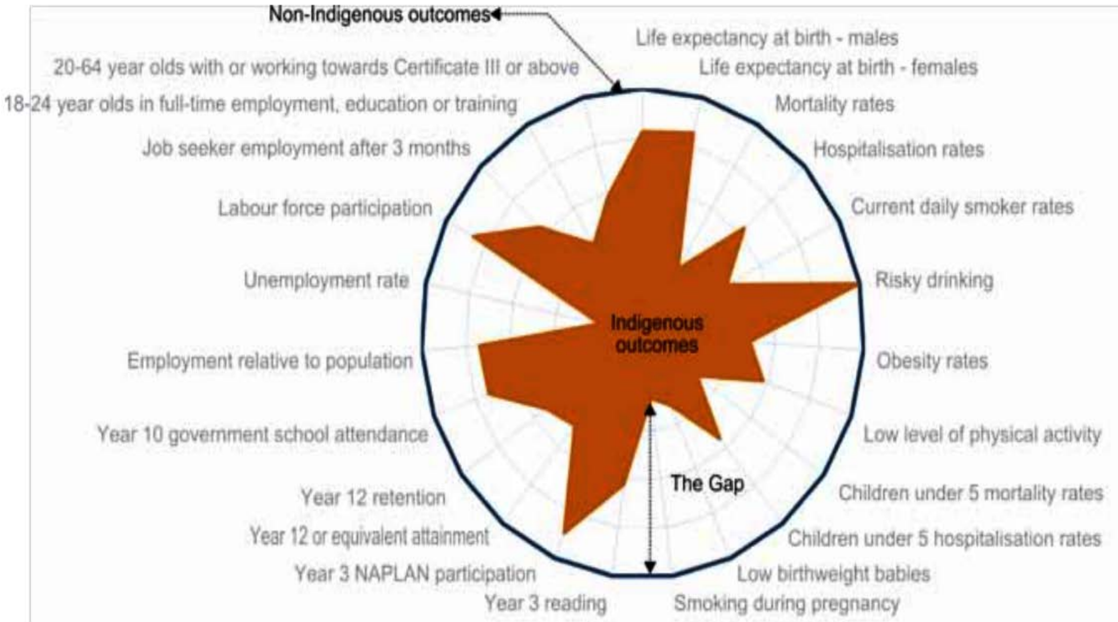

Figure 1-2 Closing the gap of disadvantage: Indigenous versus non-Indigenous outcomes.12

Figure 1-3 Closing the gap targets 13

Figure 3.3-1 Age-standardised prevalence of Indigenous and non-Indigenous physical activity categories for person aged over 15 years (Adapted from Australian Institute of Health and Welfare (2014)). 44

Figure 5-1. Responses to the statement 'Exercising more than 10 minutes vigorously is too hard'.. 87

Figure 5-2 'Is exercise too time consuming?' (Q11) 88
Figure 5-3 Responses to the statement 'Exercise is too expensive?' (Q12) 89
Figure 5-4 Response to 'What is the most convenient time of day for you to exercise?'...... 94
Figure 5-5 Responses to the statement 'Preferred exercise venues'. 97
Figure 5-6 Responses to the statement 'Do you prefer to exercise in; indoors, outdoors or both.......... 98
Figure 5-7 Participants' response to trying activities to improve fitness and activity levels. . 99
Figure 5-8 Traditional physical activities in which survey respondents participated 100
Figure 5-9 Gym attendance (Days per week) 101
Figure 5-10 Responses to the statement '(Q27) What was your favourite activity in the gym?' 101
Figure 5-11 Why did you join the gym? 102
Figure 5-12 Responses to the question 'Why did you quit the gym'?.......... 103
Figure 5-13 Commitment to attain fitness goals 103
Figure 5-14 If you were able to attend a gym that was flexible enough to meet your needs and the community's needs with other Indigenous participants and have access to a personal trainer all for free would you be willing to train in a gym? 104
Figure 5-15 Models of behaviour change 108
Figure 8-1 Consort diagram of participants' study inclusion 171

List of tables

Table 1-1 Estimated Indigenous population, by jurisdiction, Australia, 30 June 2013 (Australian Bureau of Statistics, 2012) 4
Table 1.1-2 Expectation of life at birth in years, by Indigenous status and sex, selected jurisdictions, Australia, (2010-2012). 8

Table 1-3 Median age (years) at death, by Indigenous status and sex, and jurisdictions (2012) 9
Table 1-4 Numbers and rates per 100,000 of the leading causes of Indigenous deaths and Indigenous: non-Indigenous rate ratios, NSW, Qld, WA, SA and the NT, 2012 10
Table 1-5 Prevalence of cardio-metabolic risk factors among adults. 11
Table 2-1 Criteria for clinical diagnosis of metabolic syndrome 22
Table 2-2 Metabolic syndrome waist circumference cut off points based on ethnicity 23
Table 2-3 Prevalence of metabolic syndrome and components using the International Diabetes Foundation criteria by ethnicity 24
Table 2-4 Pooled estimates of effect size (95% confidence intervals expressed as weighted mean difference for the effect of resistance training on risk factors). 34
Table 2-2-5 Resistance training, aerobic exercise and physiological changes 36
Table 3-1 Commonly identified barriers to exercise in the Australian Indigenous community 52
Table 3-2 Model illustration Western vs Indigenous view of exercise 57
Table 3-3 Publications illustrating use of Western vs Indigenous view of exercise methods 59
Table 4-1 Interpretation of Cronbach's alpha and internal consistency 73
Table 4-2. Results of reliability study for the draft questionnaire from question 10. (n = 19). 74
Table 5-1 Age and gender distribution of survey participants 82
Table 5-2 Age and gender distribution of Aboriginal communities in Perth 82
Table 5-3 Injuries that prevent participants from exercising 87
Table 5-4 Gender cross tabulation (Q11) Is exercise too time consuming 88
Table 5-5 Gender cross tabulation, is exercise too expensive? 90
Table 5-6 Participants' response to questions and gender cross tabulation 91
Table 5-7 Finding the time to exercise every day and gender cross tabulation. 91
Table 5-8 Participants' response to motivating yourself to exercise with gender cross tabulation 92

Table 5-9 Participants' response to exercising with an injury with gender cross tabulation (13d) 93
Table.5-10 Participants response to: How difficult are the following for you? - "putting up with the pain associated with exercise".. 93
Table 5-11 Exercising the next day as a result of pain associated from exercising the day before gender cross tabulation. 94
Table 5-12 Exercise habits and environments.. 95
Table 5-13 Any other reason you don't exercise with gender cross tabulation?.................. 96
Table 5-14 Questions surrounding participants' views on exercise support........................ 97
Table 5-15 Comparison of males' and females' responses to the question about ' Do you prefer to exercise in; indoors, outdoors or both'?.. 99
Table 5-16 Fitness equipment owned by gender... 100
Table 5-17 Metabolic Syndrome, anthropometric and physical activity correlations 106
Table 6-1 Participants by Gender and Age Group... 124
Table 6-2 Clinical characteristics of the participants.. 125
Table 6-3 Physical activity (minutes per day) stratified by type of activity and age category. Data are median (interquartile range)... 127
Table 6-4 Physical activity (minutes per day) stratified by gender and type of activity. Data are median (interquartile range). 128
Table 6-5 Frequency by Intensity of Physical Activity, Age Group and Gender (Participant numbers).. 129
Table 6-6 Level of activity by gender (METs per week) 130
Table 6-7 Activity volume in minutes stratified by risk factor status and gender................. 130
Table 6-8 Metabolic syndrome prevalence and median time for sedentary and activity time 133
Table 8-1 Strength and aerobic fitness (N=11).. 172
Table 8-2 Anthropometry and body composition (N=11) 173

Abstract

The proposed study will provide an increased understanding in a much-understudied area of how the Australian Indigenous community perceives physical activity and the beneficial effects for improving health outcomes.

The PhD will be made up of three studies:

1) To design an exercise prescription that is culturally appropriate and specifically addresses the major Indigenous health issues around metabolic syndrome.

The first will be a cross sectional study that surveys the motivators and barriers to physical activity within the Perth Noongar community. The results of this study will be used to enhance the intervention section of the PhD. It will provide a more accurate and the best means of ensuring not only a greater uptake, but also ways of developing positive lifelong physical activity habits.

2) Determining the amount of physical activity taking place within the Noongar community.

Utilising the Global Physical Activity Questionnaire to measure the amount of physical activity and sedentary rates within the Indigenous community.

3) Evaluate the compliance and effectiveness of the developed intervention to inform future exercise therapy programmes for this population.

The second study will be a randomised control trial looking at the physiological responses to a combination of aerobic and anabolic (resistance) exercise. The significance of this aspect of the PhD will be to capture and record physiological and quality of life measures some not previous recorded in the Indigenous community. This will inform policy relation to the most appropriate targets for eliciting successful behaviour change to improve health in Indigenous and non-Indigenous populations.

Chapter 1- General introduction contemporary Australian Indigenous cultures and health

Background: Traditionally, health was deeply interwoven with the interconnection of land and people, ensuring social and spiritual harmony. Colonisation fractured traditional practices and has forever adversely impacted on contemporary Indigenous physiology and psychological health.

Aim: To provide and understanding of contemporary Indigenous health, specifically Noongar health and culture.

Method: A Search Strategy, using EBSCO Host, a simultaneous search of SPORTDiscus with Full Text, Medline and CINAHL Plus with Full Text electronic databases was conducted to identify health and the social determinants of health within Indigenous communities. The key search terms used were ''Australia* or Noongar or Nyungar or Nyoongar or Indigenous or Aborigin* or Torres Strait Islander'' and ''Health".

Results: The chapter collected demographic data, socio-economic, mortality, morbidity and cardio-metabolic rates, policy related to closing the gap between the Indigenous and non-Indigenous communities, and information on how exercise can be used as a medium to improve the quality of lives of the Indigenous community.

Conclusion: Indigenous Australians are the most marginalised and disadvantaged communities in Australia. They are even the most marginalised and disadvantaged communities when compared to the Indigenous North American and New Zealand communities.

Chapter 2 - General introduction of Metabolic Syndrome and how its risk factors impact the Australian Indigenous community.

Background: As healthcare moves away from the one-size-fits-all and progresses toward individualised medicine, understanding how different racial groups respond to lifestyle interventions is valuable, particularly in the world's most marginalised communities (Faintuch, Marques, Bortolotto, Faintuch, & Cecconello, 2008b). Indigenous Australians are one of the world's marginalised communities, attaining lower education levels, and experiencing higher unemployment, and greater incarceration rates. They also have higher morbidity and mortality from practically all causes of disease and death. Most causes of chronic disease and premature death in the Indigenous communities are avoidable and it is becoming increasingly evident that one focus should be on reducing and eliminating the cardiometabolic risk factors that are associated with the metabolic syndrome.

Aim: To understand how the risk factors of metabolic syndrome impact the incidence and prevalence of non-communicable disease.

Methods: A Search Strategy, using EBSCO Host, a simultaneous search of SPORTDiscus with Full Text, Medline and CINAHL Plus with Full Text electronic databases was conducted to identify metabolic risk factors within the Indigenous community. The key search terms used were ''Australia* Indigenous or Aborigin* or Torres Strait Islander'' and ''metabolic syndrome".

Results: There is, however, a dearth of information relating to the relationship of exercise and the metabolic syndrome risk factors in the Australian Indigenous population. While, the World Health Organization BMI is a popular means to determine risk, the BMI ranges which were derived from Europeans will understate the cardiometabolic risk that is associated with weight gain in several other ethnic groups including Aboriginal Australians (Razak et al., 2007). The best predictor for diabetes, dyslipidemia and absolute coronary heart disease risk in Australian Aboriginal people and Torres Strait Islanders is hip to waist ratio.

Conclusion: Although current research supports the positive psychological outcomes (i.e. quality of life) there remain questions around how specific physiological outcomes, such as cardiorespiratory function, body composition, vascular function, blood pressure, lipids and glycaemic control are impacted. Some of these measures have never been recorded before in the Indigenous community.

Chapter 3 – A review of the barriers and enablers of and best practice strategies for the implication of physical activity and exercise interventions in the Australian Indigenous community

Background: Traditionally, physical activity played a crucial role in the everyday life of Indigenous Australians (Thompson, Gifford, & Thorpe, 2000). The physical ability to acquire food and participate in cultural activities meant that being physically active was essential if they were to fully engage with and contribute to the community in which they lived. However, the loss of land, culture and language through the impact of colonisation has had devastating effects on contemporary Indigenous society (King, Smith, & Gracey, 2009). The changes in diet and physical activity have had a profoundly negative impact on the health and well-being of contemporary Indigenous Australians.

Aim: To understand the barriers and enablers and incorporation of best practice approaches in order to increase recruitment and retention of Indigenous participants in exercise.

Methods: Search Strategy, using EBSCO Host, a simultaneous search of SPORTDiscus with Full Text, Medline and CINAHL Plus with Full Text electronic databases was conducted. The key search terms used were ''Australia* Indigenous or Aborigin* or Torres Strait Islander'' and ''exercise or physical".

Results: The key element in the barriers and enablers within Indigenous exercise participants is based upon the intervention: being community owned and run and having a connection to family and community kinship; incorporating cultural aspects; and being easily integrated into daily activities.

Conclusion:

It is evident that Indigenous people have differing experiences and preferences for exercising. Essentially, practitioners are in a pivotal position to advocate for the implementation and development of programs that reinforce cultural values and meet Indigenous expectations. More importantly, community owned interventions will ensure the inclusion of culturally secure practices that will enhance participant adherence.

Chapter 4 – Designing a culturally secure questionnaire to capture factors that relate to the motivators and barriers to physical activity in an Australian Indigenous population

Background: "The word itself 'research', is probably one of the dirtiest words in the Indigenous world's vocabulary". This has arisen because the research agenda has poked, prodded, and measured the Indigenous community for over 200 years. The research has traditionally served western socio-political agendas and has historical links associated with colonialism (Castleden & Garvin, 2008; Humphery, 2001) which is now acknowledged in a range of subject areas like the humanities, social sciences and sciences (Humphery, 2001). This chapter will consider some general background to Aboriginal people's experiences of, and attitudes to, research before describing, in detail, the processes involved in developing the questionnaire itself.

Aims: To design a questionnaire that would determine an Indigenous individual's perceptions of the barriers and motivators to aerobic and anabolic exercise with a series of questions designed to elicit 1) the factors that impact uptake and retention of regular physical activity and 2) potential sustainability of an intervention. For this purpose, a questionnaire was designed to capture information relating to motivators and barriers, traditional physical activities, preferred exercise environments, exercise goals, and levels of commitment to physical activity. This paper does not report the results of the questionnaire itself but the development process and preliminary reliability and internal consistency measures.

Design: Development of a culturally secure questionnaire

Methods: A series of consultation meetings were arranged between the first author, a Noongar Aboriginal researcher, with a range of people from the Noongar community to discuss priorities and develop questions. The drafted questionnaire was shaped with continuous Noongar community feedback to ensure the language, length and appropriateness of questions. Questionnaire reliability was assessed using interclass correlation.

Results: Most questions had excellent internal consistency. A consensus was reached on the utility of the questionnaire.

Conclusions: The personal contacts of the first author and nature of community involvement in the development of this questionnaire was helpful in assuring that it would be an acceptable tool for the Noongar community. The questionnaire underwent reliability testing, and was found to have excellent internal consistency. This paper provides a model and suggestions for researching physical activity and exercise in a culturally secure manner.

Chapter 5 - Determining the motivators and barriers to physical activity in an urban Australian Indigenous population

Background: Reducing the incidence and prevalence of preventable chronic diseases involves working to reduce a range of health risk factors. For Indigenous Australians, the biggest health gains can be achieved by tackling those risk factors which mediate the bulk of preventable chronic disease. These risk factors include: smoking, overweight and obesity, physical inactivity, high cholesterol, excessive alcohol consumption, high blood pressure and insufficient fruit and vegetable intake.

Aim: The aim of this research was to determine Indigenous individuals' perception of the barriers and motivators to aerobic and anabolic exercise with a series of questions designed to elicit 1) the factors that impact uptake and retention of regular physical activity and 2) potential sustainability of an intervention.

Design: Questionnaire

Methods: Participants were asked to undertake a questionnaire on barriers and enablers of participation in physical activity, with some additional open-ended questions and the opportunity to comment further if desired. The results were collated and ranked to determine the greatest motivators and barriers so that future exercise intervention studies can be implemented to overcome or reduce these barriers wherever possible.

Results: Participants indicated that while the cost of exercise is never too high, it can sometimes be too time consuming and difficult to stay motivated to exercise. Participants reported that a feeling of cultural security, and training in groups can be highly motivating.

Conclusion: The consistent theme is that programs and venues must be culturally secure and be as inclusive as possible to be successful.

Chapter 6 – Global Physical Activity Questionnaire: Measuring the activity in a Perth Australian Indigenous population

Background: The Global Physical Activity Questionnaire (GPAQ) is a reliable and effective means of capturing the amount of physical activity (PA) performed by the participant completing it. Although accelerometry based monitors are the gold standard for measuring PA, the cost can be prohibitive. Physical activity is defined as "any bodily movement produced by the skeletal muscle that results in energy expenditure". Inactivity is known to be associated with an increased risk for many chronic diseases including: cardiovascular disease, colon cancer, breast cancer, T2D, and osteoporosis, as well as premature death (Prince et al., 2008). Identifying the amounts of physical activity will lead to reducing the risk factors associated with the metabolic syndrome and improve the quality of life of the Noongar and other Indigenous communities.

Aim: To measure the amount of physical activity in a Perth Indigenous population

Design: GPAQ Questionnaire

Methods: The GPAQ study of PA and sedentary behaviour in the Noongar community was carried out in 2012 on 137 participants.

Results: Participants in this study achieved the minimum MET-minutes when participating in vigorous recreational activity. The results demonstrate differences in the prevalence of Low, Moderate and High levels of physical activity in the Perth Noongar population.

Conclusion: Irrespective of age and gender the 75th percentiles illustrate that total physical activity is in the High category, work and recreation are in the Moderate category and travel is in the Low category based on the level of physical activity as defined by the World Health Organization (Unknown).

Chapter 7 - Feasibility and efficacy of exercise as medicine for reduction of risk of metabolic syndrome in sedentary Australian Indigenous people

Background: A key strategy for improving the health status among Indigenous people is to increase their physical activity (Thomson & Kirov, 2006). Participation by Indigenous people in sport and physical recreational activities is much lower, compared to non-Indigenous people (Thomson & Kirov, 2006). Brighthope (2006) states that 'traditionally, physical activity was essential for procuring food. Getting enough to eat required considerable effort – well beyond the battle to get from the car park to the supermarket checkout'.

*Aim: T*o gain better oversight of risk factors which impact the health of Indigenous people and in particular contribute to risk of metabolic syndrome.

Design: Cross sectional

Methods: The study measured a range of anthropometric and physiological measures

Results: The studies obtain a range of measures previously unmeasured in the Indigenous community.

Conclusions: The Indigenous male participants in this study had the most adverse risk factors when compared to Indigenous males in other metropolitan cities, whereas the Indigenous females were somewhat healthier compared to other Indigenous females from other cities.

Chapter 8 – Twelve week combined aerobic and resistance exercise intervention for Australian Indigenous males and females.

Background: Australian Indigenous health and the life expectancy between the Indigenous and non-Indigenous population is bordering the worst in the world, second only to Nepal. Exercise has been shown to reduce the incidence and prevalence of avoidable non-communicable chronic diseases. To date there is a dearth of knowledge of the effect of exercise and physical activity and health on cardio-metabolic disease risk factors in Aboriginal people in an Australian metropolitan setting.

Aim: To examine the effects of twelve weeks combined aerobic and resistance training on fitness, arterial stiffness and body composition.

Methods: Fifteen previously inactive adults (55% female; mean age 32 ± 6.6 y) undertook supervised exercise involving three days per week of aerobic and progressive resistance training for 12 weeks.

Results: Eleven participants completed the exercise intervention with high exercise adherence rates (90% of sessions completed). Compared with baseline, there was a significant improvement with training in predicted aerobic fitness (25 ± 10 to 29.6 ± 11.2 ml/kg/min, p =0.000), pulse wave velocity (10.1 ± 1.2 to 8.6 ± 1.2 m/s, p =0.002) and percentage body fat (34.4 ± 8.2 to 32.4 ± 8.5%, p =0.033).

Conclusions: A supervised gym-based aerobic and resistance training program is associated with reduction in cardiovascular disease risk factors in Indigenous adults and can be delivered in a culturally competent manner in a metropolitan environment. Further studies are needed to examine the effect of exercise training on other known cardiovascular risk factors and the long-term sustainability of exercise for the management of non-communicable disease in Indigenous Australian adults.

List of abbreviations

1RM – 1 repetition maximum

ACSM – American College of Sport Medicine

AHA – American Heart Foundation

AIx – Augmentation Index

BMI – Body Mass Index

DBP – Diastolic blood pressure

ECU – Edith Cowan University

GPAQ – Global Physical Activity Questionnaire

HDL – High density lipoprotein

HRmax – Maximum heart rate

ICC – Intra class correlation

LDL – Low density lipoprotein

MET – Metabolic equivalent

PWV – Pulse wave velocity

SBP – Systolic blood pressure

TSI – Torres Strait Islander

T2D – Type 2 diabetes

VO_2max – maximal oxygen consumption

WHO – World Health Organization

Chapter 1
Contemporary Indigenous cultures and health

Introduction

The contemporary life of Indigenous Australians has been greatly impacted by the adverse effects of colonisation, by resistance and adaption to European culture, by government policy changes and by the struggle for recognition and status as traditional owners of their land.

Indigenous Australians belong to widely diverse cultural and language groups, so there is a danger in making generalisations about their traditions of living; in common, however, are their respect for, and relationship with their land, and their sense of obligation in fulfilling their roles within their communities.

Colonisation has fractured traditional ways of working which has adversely affected the health and socio-economic status of contemporary Indigenous people around the world. Because of the disparity between Indigenous and non-Indigenous health belief systems, non-Indigenous health professionals experience difficulties providing Indigenous people with effective health care (Maher, 1999).

Traditionally, the Indigenous model of health emphasised the interconnection of land, kinship and obligations to ensure social and spiritual harmony. From an Indigenous perspective, illness is defined as an individual not meeting these cultural obligations (Morgan et al., 1997). Illness can be categorised into natural, environmental, direct supernatural, indirect supernatural and emergent or Western causes (Maher, 1999).

Any supernatural intervention was regarded by Indigenous Australians as the main cause of serious illness and cure whereas the Western biomedical model of health focuses on the absence of disease (Maher, 1999; Sutton, 2012). The lack of effective, culturally appropriate communication can further impede the delivery of quality care. Examples of poor communication can include a lack of clear explanation of illness, not considering a traditional treatment option offered by the family or patient, not making an effort to understand the belief system of their patients to ensure they deliver treatment via an appropriate way, partitioners not taking the time to build a trusting relationship, and the fear of being culturally inappropriate (Durey et al., 2016; Maher, 1999).

As with Indigenous groups in other countries such as the USA, Canada and New Zealand (Axelsson, Kukutai, & Kippen, 2016), colonisation continues to have adverse effects on Australian Indigenous communities. The loss of land, language and culture gives rise to an urgent preoccupation with the need for a positive sense of identity. In this area, important gains have been made; three such examples include recognition of Aboriginal land rights: acknowledgement of the enormous damage done by the policy of removing children from their parents and placing them in harsh institutions and a formal apology by the Federal Government. However, there is still much ground to be made up. Indigenous Australian communities continue to lag behind the rest of the population in areas such as education, employment and health, and strategies are urgently needed to create remedial measures that will benefit rather than alienate the participants.

It is very important to have an understanding of how colonisation has adversely affected contemporary Australian Indigenous lifestyles. While the above few paragraphs aim to provide a brief introduction, and understanding of these factors, it is of the upmost importance to develop a much more profound understanding of these broad ranging issues when engaging with contemporary Indigenous cultures. This, however, moves beyond the scope of this thesis.

Finally, the descriptors Perth Indigenous (Aboriginal and Torres Strait Islanders in Perth), Noongar (Entire Noongar population beyond Perth), Perth Noongar (Noongar people from Perth) these are different and distinct communities and will be used according in the context of the thesis.

Indigenous population

According to the Australian Bureau of Statistics the Indigenous population comprised 698,583 people as of 30 June 2013 (Table 1.1) (Australian Bureau of Statistics, 2014b). While New South Wales has the largest Indigenous population, the Northern Territory has the largest percentage by proportion of jurisdiction. Western Australia has the third largest Indigenous population and has, as a proportion of jurisdiction, 3.6%, and as a proportion of the Australian population, 13.2%.

Table 1-1 Estimated Indigenous population, by jurisdiction, Australia, 30 June 2013 (Australian Bureau of Statistics, 2012)

Jurisdiction	Indigenous population (number)	Proportion of Australian Population (%)	Proportion of jurisdiction population (%)
NSW	216,612	31.0	2.9
Vic	49,715	7.1	0.9
Qld	198,206	28.4	4.3
WA	91,898	13.2	3.6
SA	38,981	5.6	2.3
Tas	25,269	3.6	4.9
ACT	6,517	0.9	1.7
NT	71,111	10.2	29.5
Australia	698,583	100	3.0

Approximately 90% of Indigenous people are Aboriginal, 6% are Torres Strait Islanders, and 4% identify as being both Aboriginal and Torres Strait Islander (Australian Bureau of Statistics, 2012). In terms of geographic locations approximately 33% of Indigenous people live in a metropolitan capital and slightly more than one half of the Indigenous population live in a major regional city or inner regional areas compared with 90% of the non-Indigenous population (Australian Bureau of Statistics, 2012).

Noongar Community

The Department of Aboriginal Affairs estimates that the Perth Metropolitan area (Whadjuk) has the largest number of Aboriginal people in Western Australia (34,600 or 39.2 percent of the Aboriginal population) (Department of Aboriginal Affairs, 2013).

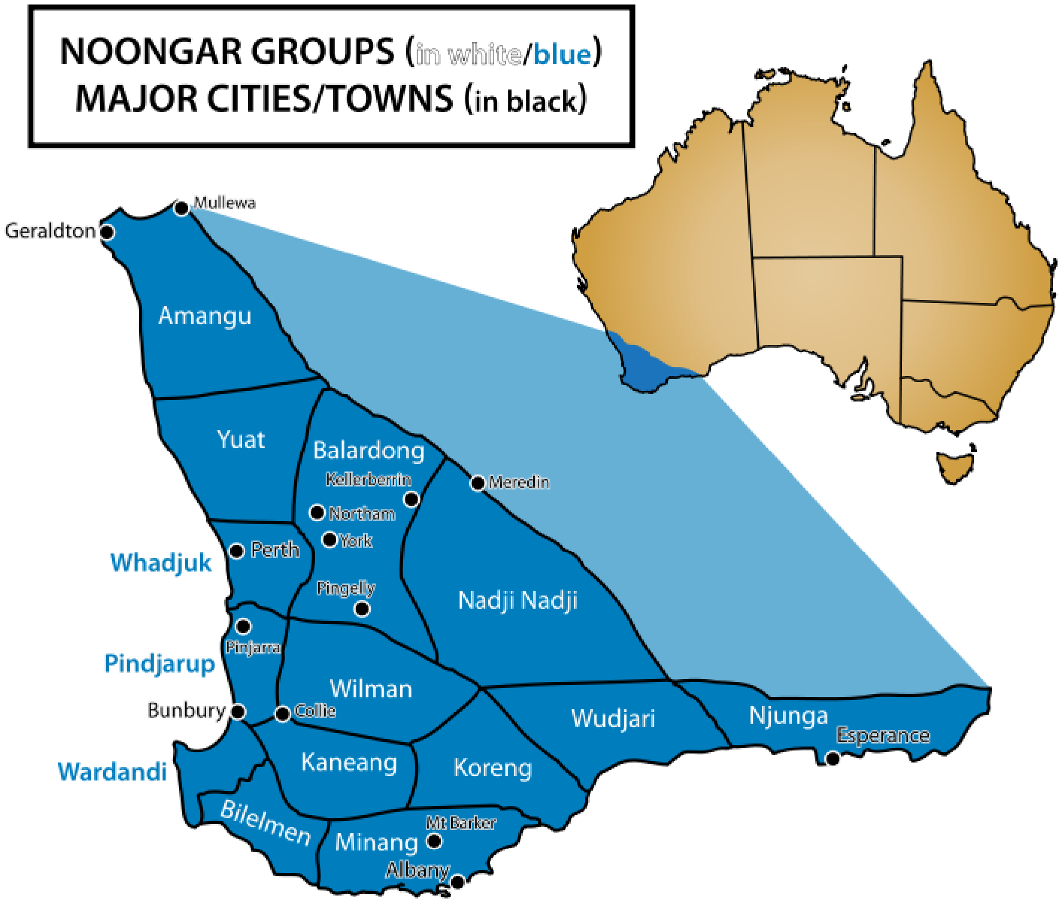

Figure 1-1 Map of Noongar Country South West Western Australian

Source: Mind Journey (2014)

The Noongar nation or country (Figure 1.1) is one of the largest Aboriginal cultural clans in Australia and is made up of fourteen different language groups each with its own unique knowledge, cultural history and ecological distinction (South West Aboriginal Land and Sea Council, 2013). Noongar means 'a person of the south-west of Western Australia,' or the name for the ‘original inhabitants of the south-west of Western Australia’ (South West Aboriginal Land and Sea Council, 2013).

Similar to other Aboriginal nations in Australia, the last 200 years have seen Noongars dislocated and dispossessed, decimated by introduced diseases, marginalised by poverty and racism, and suffering the breakup of families by the forced removal of children into institutions. The impact on culture, social structure and health has been severe, but nevertheless, despite the effects of colonisation by Europeans, Noongar people and culture have survived (Nyoongar Regional Planning Team, 2002). The effects are still felt today and are directly responsible for the high cardiovascular morbidity rates in Indigenous communities (Dimer et al., 2013).

Indicators of Indigenous social disadvantage

The social determinants of health encompass economic opportunity, physical infrastructure and socio-economic status. These broad terms can be measured by using indices such as education, employment, income, social networks, housing, access to services, land, racism, incarceration and the forced separation of children from their families (May, Carey, & Curry, 2013; O’Sullivan, 2012). Australia, Canada, and New Zealand are some of the most developed nations in the world but the Indigenous employment and income domains are almost as deprived as they were in 1981, whereas education is now actually worse than it was in 1981 (May et al., 2013). Currently health care providers are not deemed responsible for addressing the social determinants of health which are seen as too big for the health sector alone to work with (May et al., 2013). A shift in the paradigm and any effective means of closing the gap in the social determinants of health will need to take on a new approach to improve upon the 1981 rates (Mitrou et al., 2014).

Education

Analysis of the 2011 census reveals that 85% of Indigenous children aged 6 to 14 years attended primary or secondary school compared with 93% non-Indigenous children. Only 61% of Indigenous children aged 15 to 17 years attended secondary school compared with 81% of non-Indigenous children. While year 9 or below was reported by 25% as the highest level of schooling completed by Indigenous people, in the non-Indigenous population it was only 13%. Only about a quarter (26%) of Indigenous people reported graduating with a vocational training qualification as opposed to 49% of non-Indigenous people. Of these vocational training qualifications 77% were Certificate III or Certificate IV qualifications (Australian Bureau of Statistics, 2012).

Employment

According to the 2011 Australian Census 42% of Indigenous people aged over 15 years were employed compared with 61% of the non-Indigenous population. The unemployment rate for Indigenous people is about three times greater, 17% for Indigenous people compared with 5% for non-Indigenous. The highest Indigenous unemployment rate (31%) was for those aged 15 to 19 years' group while in the non-Indigenous population it was only 16%. The gross average income for an Indigenous person was $475 per week whereas for a non-Indigenous person it was $800 per week.

Indigenous Life Expectancy

Life expectancy varies in different jurisdictions in Australia (Table 1.2). The greatest difference between Indigenous and non-Indigenous males is in Western Australia (15.1 years); nationally it is 12.4 years. For females in the Northern Territory, the difference is also high (14.4 years), and nationally it is 10.9 years. When comparing Indigenous males to Indigenous females the difference in life expectancy for Australia is 4.9 years. This is similar when comparing non-Indigenous males to non-Indigenous females at 3.4 years. According to Phillips et al (2014) Indigenous identity is unreliably recorded in vital registration, therefore, accurate estimates are not feasible, regardless of the method used to calculate life expectancy between Indigenous and non-Indigenous people.

Table 1.1 Expectation of life at birth in years, by Indigenous status and sex, selected jurisdictions, Australia, (2010-2012).

Jurisdiction	Indigenous status/sex		
Males	Indigenous	Non-Indigenous	Difference
NSW	70.5	79.8	9.3
Qld	68.7	79.4	10.8
WA	65	80.1	15.1
NT	63.4	77.8	14.4
Australia	67.4	79.8	12.4
Females	Indigenous	Non-Indigenous	Difference
NSW	74.6	83.1	8.5
Qld	74.4	83	8.6
WA	70.2	83.7	13.5
NT	68.7	83.1	14.4
Australia	72.3	83.2	10.9

Source: Australian Bureau Statistics, (2013b).

The difference in median age at death in Australia for Indigenous males (55.0) is 23.7 years when compared to non-Indigenous males (78.7) (Table 1.3). South Australia (27.2) and Western Australia (23.1) have the highest difference in median age at death in their respective states. The difference in median age at death in Australia for Indigenous females (61.3) is 23.4 years when compared to non-Indigenous females (84.7). Again, South Australia (24.3) and Western Australia (23.3) have the highest difference in median age at death in their respective states.

Table 1-2 Median age (years) at death, by Indigenous status and sex, and jurisdictions (2012)

Jurisdiction	Indigenous		Non-Indigenous	
	Male	Female	Male	Female
NSW	60.6	63.9	79.3	84.9
Qld	56.1	63.9	77.6	84.2
WA	54.8	61.1	77.9	84.4
SA	53	61.3	80.2	85.6
NT	49.9	52.8	67.1	74
All jurisdictions	55	61.3	78.7	84.7

Source: Australian Bureau of Statistics, (2014a).

Rates and causes of morbidity

Coronary heart disease was the leading cause of Indigenous deaths in 2012, with 338 deaths leading to a rate of 165 per 100,000 (Table 1.4). This is over twice the rate (2.1 times) as that of non-Indigenous people. This is followed by diabetes mellitus, with 201 deaths and a rate of 106 per 100,000 which is a staggering 7 times that of non-Indigenous people.

Table 1-3 Numbers and rates per 100,000 of the leading causes of Indigenous deaths and Indigenous: non-Indigenous rate ratios, NSW, Qld, WA, SA and the NT, 2012

Cause of death	Number	Rate	Rate ratio
Coronary heart disease	338	165	2.1
Diabetes mellitus	201	106	7
Lung cancer	138	73	2.3
Chronic lower respiratory disease	123	74	2.9
Suicide	117	22	2
Cerebrovascular disease	108	67	1.5
Land transport accidents	88	20	3.4
Symptoms signs and ill-defined conditions	79	22	3.4
Cirrhosis and other liver diseases	72	23	4.1
Diseases of the urinary system	63	34	2.5

Source: Australian Bureau of Statistics (2014a).

Finally, a comparison of health statistics between Australia, New Zealand and the United States populations conducted by Lucero (2014) highlights the urgent need to find ways of improving the health of Indigenous Australians. The mortality rates for Maori New Zealanders and non-Indigenous New Zealanders were equal, Native American people of United States showed a lower mortality percentage rate than that of the benchmark population of the United States while Indigenous Australian had a much higher mortality percentage compared to benchmark populations in Australians. Numbers and rates per 100,000 death caused by coronary heart disease are presented in Table 1.5. As for life expectancy in years, all Indigenous communities were lower with Australia having the largest differential of 19 years. The diabetes incident percentage is double the figure for Indigenous people in New Zealand and the United States. When compared to their benchmark populations in Australia, however, the incidence is seven times as much in the Australian Indigenous population.

Table 1-4 Prevalence of cardio-metabolic risk factors among adults.

Group	Population		Life expect.	CVD		Body weight		Diabetes	High cholesterol.	HT
	million	%	yrs	Prev. %	Mortality %	Over %	Obese %	%	%	%
AU	20.8	100	81	17	9	29	22	4	7	10
White AU	20.3	98	81	17	9	29	22	4	7	10
Indigenous AU	0.52	2.5	62	22	27	35	27	12	6	15
NZ	4.03	100	80	5	31	36	27	5	8	14
White NZ	2.61	68	81	4	32	32	24	4	8	13
Indigenous NZ	0.57	15	73	7	32	32	42	8	9	17
U.S.	309	100	78	21	34	33	33	8	16	34
White U.S.	309	100	78	21	34	33	31	6	17	33
Indigenous U.S.	5.22	1.7	75	23	25	28	42	15	31	30

CVD: cardiovascular disease; HT: Hypertension; Over: Overweight

Source: Lucero (2014)

Closing the gap

In a bid to address Indigenous disadvantage (Figure 1.2), by increasing life expectancy, educational and employment status and decreasing child mortality, the Commonwealth and State governments collaborated to develop “Closing the Gap” targets that clearly identified measurable Indigenous outcomes to be achieved (Department of Indigenous Affairs, 2010).

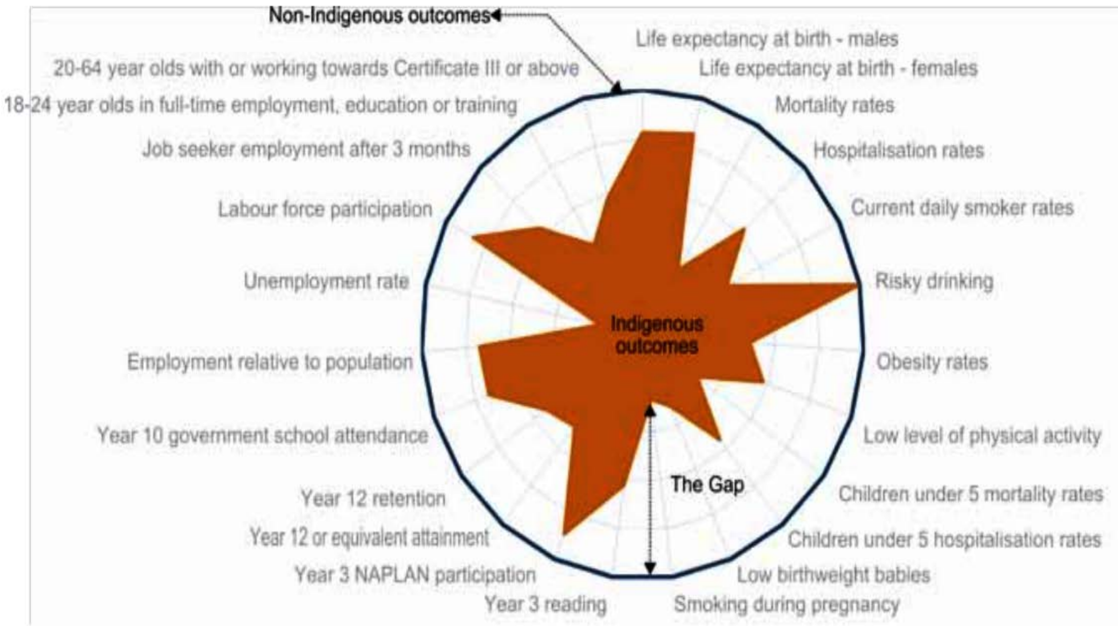

Figure 1-2 Closing the gap of disadvantage: Indigenous versus non-Indigenous outcomes. Source: Department of Indigenous Affairs (2010).

The “Government working as one” targets (Figure 1.3) are to: reduce the life expectancy gap within a generation, halve the mortality rates for Indigenous children under five, halve the disparity for Indigenous students in reading, writing and numeracy within a decade, halve the gap in employment outcomes between Indigenous and non-Indigenous Australians, within five years provide all four year olds in remote Indigenous communities with equal access to quality early childhood education programs, and finally, at least halve the disparity for Indigenous students in Year 12 or equivalent by 2015. Unfortunately, even with the right intentions of successive governments, the breadth of scientific inquiry, or with changes in policies, the socio-economic disparity between Indigenous and non-Indigenous people remains problematic (Mitrou et al., 2014).

Figure 1-3 Closing the gap targets

Source: Department of Aboriginal Affairs (2010)

Cardiovascular disease

The prevention, management and treatment of chronic disease is paramount in closing the gap and in improving Indigenous health and quality of life, in increasing life expectancy, and reducing early mortality (Department of Indigenous Affairs, 2010). Cardiovascular disease (Diseases of the circulatory system) includes all diseases and conditions that affect the heart and blood vessels (Waters, Trinh, Chau, Bourchier, & Moon, 2013). Cardiovascular disease presents a significant burden for Indigenous people in terms of prevalence, hospitalisation, and mortality (Waters et al., 2013). Coronary heart disease (or ischaemic heart disease), cerebrovascular disease (including stroke), hypertension and rheumatic heart disease (RHD) are of particular importance to Indigenous people. These preventable chronic diseases account for 70% of the difference of burden of disease between Indigenous and non-Indigenous Australians and they are currently one of the greatest causes of inequities in Indigenous health status (Vos, Barker, Begg, Stanley, & Lopez, 2009).

Risk factors for CVD are categorised as either modifiable, which can be behavioural and biomedical, or non-modifiable (risk factors that cannot be altered) (Huma, Tariq, Amin, & Mahmood, 2012). Modifiable behavioural factors for CVD (except for RHD) include tobacco use, physical inactivity, dietary behaviour, and excessive alcohol consumption (Huma et al., 2012). Modifiable biomedical factors include hypertension, hypercholesterolemia, overweight and obesity, and depression. Certain related health conditions, particularly diabetes and chronic kidney disease, can also increase the risk of developing CVD. Non-modifiable risk factors, such as age, sex, family history, and ethnicity, are also known to contribute to the risk of CVD (Pearson, 2007).

Rates of cardiovascular disease

Australia has a population of 23 million with 3.4 million people affected by cardiovascular disease. Cardiovascular disease kills one Australian every 11 minutes. This rate is 30% higher in Indigenous Australians (Kirby, 2014). Cardiovascular disease is the leading cause of death of Indigenous people internationally (Lucero et al., 2014). These rates are nearly three times higher for the Indigenous community than they are for non-Indigenous (Aspin, Brown, Jowsey, Yen, & Leeder, 2012). The next most common causes of death were neoplasms (mainly cancers), being responsible for 21% of deaths. In terms of specific conditions, coronary heart disease was the leading cause of death of Indigenous people living in all jurisdictions in 2012. This rate is 2.1 times higher than that of their non-Indigenous counterparts (Australian Bureau of Statistics, 2014a). The other leading specific causes of death of Indigenous people were diabetes (rate ratio: 7.0), lung cancer (2.3) and chronic lower respiratory disease (2.9).

Rates of diabetes, obesity and metabolic syndrome

The cause of obesity and being overweight is an imbalance between the amounts of calories consumed from energy dense food and the amount of calories expended, or the lack of physical activity (World Health Organization, 2013). Obesity is calculated by an individual's body mass index (BMI). BMI is based on the assumption that the ratio between body mass and height provides an indication of body fatness; however, this can be problematic and discriminates against individuals that have a higher proportion of muscle mass (Lucero et al., 2014).

Indigenous Australians are 1.2 times more likely to be overweight/obese than non-Indigenous Australians (62% cf. 51%). Indigenous males were also reported as more obese than Indigenous females. This disparity was more pronounced within remote geographical areas (Australian Bureau of Statistics, 2006). The World Health Organisation has reported the incidence of overweight or obese people has risen significantly around the globe in recent years and has become epidemic in first-world nations such as The United States, Canada, Australia and England (World Health Organization, 2013). Obesity is implicated in a number of conditions including cardiovascular diseases, diabetes, musculoskeletal disorders and some cancers (World Health Organization, 2013). The age-standardised prevalence of pre-diabetes and diabetes among Indigenous Australians was 3 times the rate of that observed in non-Indigenous Australians (12% cf. 4%). After the age of 35 years the prevalence of diabetes among Indigenous Australians increases rapidly, rising from 10% at age 35–44 years to 32% at age 55 years and over. By contrast, the prevalence increases from 2% to 12% for non-Indigenous people. Prevalence rates among Indigenous Australians are similar between genders, but those in remote areas are almost twice as likely to present with diabetes (Australian Bureau of Statistics, 2006).

Reducing the cardiovascular morbidity rates

There are several interventions designed to reduce morbidity in the Indigenous community. Ong, et al. (2014) conducted a study to evaluate the cost effectiveness of community and pharmacological interventions to prevent cardiovascular disease within the Australian Indigenous population. The results of the study indicated that poly-pill pharmacological interventions were the most cost effective intervention; however, the community based intervention produced the most health gain. Physical activity and exercise may have considerable potential for reducing risk and progression of cardiovascular disease in Australian indigenous people.

Physical activity and exercise

In 2010, physical inactivity and low physical activity accounted for 3.2 million (2.7 million to 3.7 million) deaths, and 2.8% (2.4 to 3.2%) of Disability-Adjusted Life Years (DALYs) globally (Lim et al., 2012). Worldwide, 31% of adults are estimated to be physically inactive and these levels are rising with major public health implications (Hallal et al., 2012). The WHO recommends adults aged 18 to 64 years should accumulate at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity weekly, in order to improve cardiorespiratory and muscular fitness, bone health and reduce the risk of non-communicable diseases and depression (Pate, Pratt, Blair, & et al., 1995). The American College of Sports Medicine (ACSM) also recommends at least 30 minutes of moderate-intensity physical activity (e.g., walking briskly, dancing, swimming, and bicycling) on at least 5 days per week and at least two resistance training sessions per week (Garber et al., 2011).

Physical activity, exercise and physical activity definitions

According to Thompson et al. (2003), physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure beyond resting expenditure. Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective. Physical fitness includes cardiorespiratory fitness, muscular strength, body composition, and flexibility, comprising a set of attributes that people have or achieve that relates to the ability to perform physical activity (Thompson, 2003; Thompson et al., 2003)

Physical activity, exercise and Indigenous populations

Important culturally appropriate definitions for exercise, everyday activities and sports have been introduced by Thompson, Gifford & Thorpe (2000) in the Indigenous context. Exercise is seen by urban and remote Indigenous people as an individual activity and is often separate from community and family. According to Thompson, Gifford & Thorpe (2000) everyday activity is seen as necessary and is done for family and the community. Sports are a means that connect individuals to kinship ties within their community. Non-Indigenous definitions of physical activity, exercise or sport do not look beyond the individual and do not incorporate family or community into their definitions.

Previous literature investigating physical activity and exercise in the Indigenous population

There have been studies conducted exploring the meaning of and barriers to physical activity in the Indigenous community. Hunt, Marshall & Jenkins (2008), in their seventeen focus groups involving 96 Indigenous adult participants, found that walking, domestic chores and sports are the most commonly reported physical activities whereas being embarrassed in public spaces, cost, and accessibility were the main barriers. There have been a number of cross sectional studies which have included community based interventions focused on obesity and diabetes (Rowley et al., 2000), healthier food, becoming more active (Paasse & Adams, 2011), and gym related interventions consisting of cardiovascular and resistance training (Canuto et al., 2012a).

Significance / purpose of the study

Reducing the incidence and prevalence of preventable chronic diseases involves working to reduce a range of health risk factors. For Indigenous Australians, the biggest health gains can be achieved by tackling those risk factors which mediate the bulk of preventable chronic disease. These risk factors include: smoking, overweight and obesity, physical inactivity, hypercholesterolaemia, excessive alcohol consumption, hypertension and insufficient fruit and vegetable intake.

A key strategy for improving the health status among Indigenous people is to increase their physical activity (Thomson & Kirov, 2006). Participation by Indigenous people in sport and physical recreation activities is much lower compared to non-Indigenous people (Thomson & Kirov, 2006). Brighthope (2006, 211) states that ‘traditionally, physical activity was essential for procuring food. Getting enough to eat required considerable effort – well beyond the battle to get from the car park to the supermarket checkout’.

Therefore, the purpose of this research is to explore the role of exercise as a potential strategy to reduce risk factors associated with cardiovascular disease and to reduce the incidence of co-morbidities associated with metabolic syndrome. (e.g. CVD, obesity, and diabetes) as well as improving quality of life. Further, the use of physical activity may be a simple and cost-effective strategy that provides similar benefits to pharmaceutical interventions (e.g. cholesterol and blood pressure lowering medications, etc.) without exposing participants to additional potential side effects and financial cost. Finally, this work will further refine position statements in the fields of exercise physiology and Indigenous health. Prescribing exercise as medicine in this population aims to reduce the risk factors associated with cardiovascular disease and has an important role to play in Aboriginal health.

Research Questions

1. What are the barriers preventing, and motivators contributing to, participation in physical activity in the Perth Indigenous community?

2. What effect does participation in a gym based exercise intervention have on strength, fitness and risk factors associated with metabolic syndrome?

3. Can exercise adherence be increased by an Elder led gym based exercise intervention?

Chapter 2
Literature Review of Metabolic Syndrome

This chapter will introduce the various concepts relating to the need to move beyond the biomedical model of health; the association between socioeconomic factors and health outcomes; chronic disease and premature death; define metabolic syndrome and its risk factors; the relationship between exercise and metabolic syndrome risk factors; and finally, the prevention of metabolic syndrome using exercises.

As healthcare moves away from the one-size-fits-all approach and progresses toward individualised medicine, understanding how different racial groups respond to lifestyle interventions is valuable, particularly in the world's most marginalised communities (Faintuch, Marques, Bortolotto, Faintuch, & Cecconello, 2008a). The world has more than 370 million Indigenous peoples with distinct differences in history, culture, geography, socio- political and economic status. But despite such differences these Indigenous peoples are still the most socially disadvantaged. In particular, they suffer most from the burden of disease compared to non-Indigenous communities in their respective countries (Brown, 2012). This situation is, unfortunately, all too common in countries with Indigenous fourth world nations such as Aboriginal and Torres Strait Islanders in Australia; a sub-population existing in a First World country, but with the living standards of a Third World, or developing country (Seton, 1999).

There is an association between socioeconomic factors and health outcomes. Those who are higher in the social hierarchy, the minority, have better access to a larger array of health services (Shepherd et al., 2011). Yet Australia's most disadvantaged community, Indigenous Australians, are subjected to factors that are detrimental to the social determinates of health (Mitrou et al., 2014). These social determinates of health include: lower education levels, higher unemployment, and greater incarceration rates. Detrimental impact on the social determinates of health lead to higher morbidity and mortality from practically all causes of disease and death (Shepherd, Li, & Zubrick, 2012). One cannot stress the urgency and importance of reducing the causes of disadvantage in the Indigenous population. The Indigenous population only accounts for 2.5% of the total population in Australia but a disproportionately high contribution to total illness and disease (Brown, 2012). Metabolic syndrome is of considerable concern because of its prevalence and its impact on morbidity and mortality for Indigenous Australians. The National Aboriginal Community Controlled Health Organisations (2014) website provides some alarming statistics relating to the prevalence of mortality and hospitalisation. There are higher rates (multiple compared to non-Indigenous community) of infant mortality (x2.3), hospitalisation (x1.95), and heart disease mortality for 25-34 year olds (x7). While stakeholders in Indigenous health have yet to agree on the life expectancy estimate gap there is consensus that it needs to be reduced (Rosenstock, Mukandi, Zwi, & Hill, 2013). The Australian Bureau of Statistics (2009) reports that the difference in life expectancy between Indigenous and non-Indigenous people in Western Australia, the second highest difference in Australia, is 14 years for males and 12.5 years for females (Australian Bureau of Statistics, 2009).

Most causes of chronic disease and premature death in Indigenous communities are avoidable. Focus should be on improving the social determinants of health thereby reducing and eliminating the cardiometabolic risk factors in particular that are associated with the metabolic syndrome. Improving the social determinants of health will ensure Indigenous Australians obtain a better quality of life and will contribute towards reducing the gap in life expectancy between Indigenous and non-Indigenous Australians.

Metabolic syndrome defined

Until 2006 several definitions for metabolic syndrome had been formulated. In 2006, to settle the resulting controversy, the International Diabetes Federation, and the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI), joined by the World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity, co-operated to arrive at a unified definition. Criteria for the clinical diagnosis of metabolic syndrome are provided in Table 2.1. The recommendation is that the International Diabetes Foundation cut-points be used for non-Europeans and either the International Diabetes Foundation or AHA/NHLBI cut-points be used for people of European origin until more data are available. These cut points are also contained in Table 2.1.

Table 2-1 Criteria for clinical diagnosis of metabolic syndrome

Risk factors	Categorical cut points
Increased waist circumference*	Population / country specific definitions (see table 2)
Increased triglycerides (drug treatment for elevated TG is alternate indicator†)	≥150 mg/dL (1.7mmol/L)
Reduced HDL cholesterol (drug treatment <50 mg/dL for reduced HDL cholesterol is alternate indicator†)	<40 mg/dL (1.0 mmol/L) in men; (1.3 mmol/L) in women
Increased blood pressure (antihypertensive drug treatment in patient with history of hypertension is alternate indicator)	Systolic ≥130 and/or diastolic ≥85 mm Hg
Increased fasting glucose‡ (drug treatment of increased glucose is alternate indicator)	> 100 mg/dL (5.5 mmol/L)

†Most commonly used drugs for increased triglycerides and reduced HDL cholesterol are fibrates and nicotinic acid. A patient on one of these drugs can be presumed to have high triglycerides and low HDL. Use of high-dose ω-3 fatty acids presume high triglycerides. ‡Most patients with type 2 diabetes will have the metabolic syndrome, measured by the proposed criteria. Adapted from Eckel et al. (2010).

The waist circumference MetS waist circumference cut off points vary on ethnicity and these points are contained in Table 2.2.

Table 2-2 Metabolic syndrome waist circumference cut off points based on ethnicity

Ethic Group	Waist Circumference (cm) (as measure of central obesity)
Europids	
Men	≥ 94
Women	≥ 80
South Asian	
Men	≥ 90
Women	≥ 80
Chinese	
Men	≥ 90
Women	≥ 80
Japanese	
Men	≥ 85
Women	≥ 90
Ethnic south and Central Americans	Use south Asian recommendations
Sub-Saharan Africans	Use European data
South Africa	
Men	92
Women	94
Eastern Mediterranean and middle east (Arab) population	Use European data

Source: Table adapted from Alberti, Zimmet & Shaw (2005). South Africa waist circumference update from Hoebel, Malan, Botha et al (2014).

Metabolic syndrome prevalence in Indigenous communities

A study (Li, McCulloch, & McDermott, 2012) conducted in Northern Queensland measured and reported the associated metabolic risk factors in the Aboriginal and TSI communities. The baseline prevalence of MetS and its components defined by IDF in the two ethnic groups are summarised in table 2.3.

Table 2-3 Prevalence of metabolic syndrome and components using the International Diabetes Foundation criteria by ethnicity

Ethnicity	Aboriginal	TSI
Number	1277	816
Elevated BP, n (%)	723 (56.6)	652 (79.9)
Elevated blood glucose, n (%)	570 44.6)	452 (55.5)
Low HDL, n (%)	603 (51.9)	225 (28.2)
Raised triglycerides, n (%)	490 (39.5)	457 (57.8)
MetS, n (%)	421 (33.0)	410 (50.3)

Source: adapted from (Li et al., 2012)

Using the IDF definition of MetS the non-Indigenous community in 1999- 2000 was 28.6% compared to the Aboriginal (33%) and TSI (50.3%) (Li et al., 2012). The same authors go onto suggesting when trying to predict a coronary episode, combining MetS risk factors was no more accurate than using individual MetS risk factors (Li et al., 2012). The study concluded by stating in Aboriginal communities combined increased triglycerides and WC better predicts incident coronary episodes. Whereas in TSIs, baseline diabetes and albuminuria could be used to detect those at risk (Li et al., 2012).

Obesity, fat distribution and their measurement

A growing body of literature now supports a causal relationship between visceral obesity and the metabolic syndrome (Phillips & Prins, 2008). The link between obesity and overt illness is not only profoundly important for the affected individual, but also represents a huge health and economic burden to the entire nation (Haslam, 2008; Rudisill, Charlton, Booth, & Gulliford, 2016). The World Health Organization describes obesity as 'one of the most blatantly visible, yet most neglected, public health problems on earth, challenging climate change in importance' (Haslam, 2008). Body Mass Index (BMI) has historically been applied to define obesity without considering either fat distribution or body shape in research and population studies. This has placed muscular athletes and individuals with skinny arms and legs but large abdomens similarly at high risk even though their BMI values are within the same limits (Haslam, 2008). Per Ashwell (2009), using BMI alone for screening health risk would incorrectly categorise the 35% of men and 14% of women in the UK who are within the normal BMI range (18.5-25 kg/m^2) but who have excessive central fat distribution. In fact, waist to hip circumference ratio was more closely associated with cardiovascular disease risk factors among both men and women when compared to BMI (Ashwell, 2009).

Another way to measure obesity is to use waist circumference. Although it is inaccurate in morbidly obese populations and does not take height into consideration, it uses a readily available instrument (tape measure) and is a more accurate predictor of metabolic syndrome risk (Haslam, 2008). A better way to measure obesity that is a non-invasive, simple and effective tool for cardiovascular disease risk factors is a waist to height ratio, with research suggesting that waist circumference should be kept at less than half of body height (Ashwell, 2009).

According to O'Dea (2008), particularly in women, waist to hip ratio appeared to be more strongly associated with diabetes than was waist circumference alone or BMI. A study conducted in North Queensland on Aboriginal and Torres Strait Islanders (TSI) reported the waist circumference of TSI was significantly higher than Aboriginal people. Aboriginal men's waist circumference was, on average, 89.4 (0.6) cms compared to TSI participants (mean 101.3 (0.8) cms) and Aboriginal women's waist circumference was an average of 92.1 (0.6) cm compared to TSI women (103 (0.8) cm) (Li et al., 2012). This may be because waist to hip ratio better reflects the differences in body build and body fat distribution, as waist circumference may be a better measure in populations that are more ethnically homogeneous (O'Dea et al., 2008). The study also found that waist to hip ratio is the best measure of central adiposity as it includes both hip and waist circumference and low hip circumference as measures of cardiovascular risk (O'Dea et al., 2008). Waist to hip ratio better reflects differences in body build, fat, and is the best measure of central adiposity and has been more strongly associated with diabetes in women.

Obesity and measurements in the Indigenous community

There are several means to obtain anthropometric measures within the Indigenous community with some having a stronger association to cardiovascular risk factors than others. Wang, Rowley, Piers, & O'Dea (2007) report that Australian Indigenous people have body-shape and cardiovascular risk profiles different from that of other ethnic populations. In their study, they investigated the association of anthropometric indices with diabetes, hypertension and dyslipidaemia, and determined which indices best predict these individual risk factors for cardiovascular disease. Waist to hip ratio was the best predictor for diabetes, dyslipidemia and absolute coronary heart disease risk in Australian Aboriginal people and Torres Strait Islanders. The authors concluded that measuring waist to hip ratio in routine health check-ups in Australian Indigenous people will enhance the evaluation of cardiovascular disease risk (Wang et al., 2007). Waist to hip ratio is the best anthropometric measure to predict several chronic diseases and their risk factors and medical check-ups would be of value in reducing the incidence of cardiovascular risk factors.

Per Piers, Rowley, Soars & O'Dea (2003), Aboriginal and European Australians, for a given body weight or BMI, have a significantly different body fat distribution and fat mass. Determining weight status using the World Health Organization recommended BMI ranges may be inappropriate in Australian Aboriginal people. Piers, et al. (2003) suggested that Aboriginal women and men were significantly shorter and weighed less than European Australians. Aboriginal women had a significantly larger waist circumference and waist-to-hip ratio compared to European Australian women. They measured anthropometric variables and body water content using a four-terminal bio-impedance system. This technique involves placing electrodes on the ankles and wrists and measuring electrical resistance (Piers et al., 2003). Trunk skinfold thickness was higher in Aboriginal women as compared to European Australian women, however, limb skinfold thicknesses tended to be lower but the difference was not significant. These authors went on to conclude that Aboriginal and European Australians have a significantly different body fat distribution and fat mass for a given body weight or BMI. Therefore, use of the World Health Organization recommended BMI ranges to determine weight status may be inappropriate in Australian Aboriginal people (Piers et al., 2003). Using the World Health Organization BMI ranges which were derived from Europeans will understate the cardiometabolic risk that is associated with weight gain in several other ethnic groups including Aboriginal Australians (Razak et al., 2007).

There are a number of anthropometric indices that can be used to predict metabolic disturbances and these vary even within Indigenous communities. Wang, Rowley, Piers and O'Dea (2007) have proposed that the best predictor of hypertension among five anthropometric indices was waist to height ratio for Australian Aboriginal people and waist circumference for Torres Strait Islanders. Waist to hip ratio was the best predictor for cardiometabolic risk factors in both populations (Ashwell, Gunn, & Gibson, 2012). In multivariate regression analyses, waist to hip ratio and body mass index were independently associated with the 10-year predicted absolute probability of coronary heart disease for Torres Strait Islanders. However, overall waist to hip ratio appeared to be the best predictor of the estimated coronary heart disease risk for both populations. The authors concluded that waist to hip ratio was the best predictor for diabetes, dyslipidemia and absolute coronary heart disease risk in Australian Aboriginal people and Torres Strait Islanders.

A study conducted in North Queensland on Aboriginal and Torres Strait Islanders (TSI) reported the waist circumference of TSI was significantly higher than Aboriginals. Aboriginal men waist circumference was 89.4 (0.6) cm compared to TSI 101.3 (0.8) cm and Aboriginal women waist circumference 92.1 (0.6) cm compare to TSI women 103 (0.8) cm (Li et al., 2012).

Physical Activity, Exercise and Obesity

There is an abundance of literature suggesting that regular physical activity prevents unhealthy weight gain. Sedentary lifestyle promotes weight gain and being already overweight or obese leads to even greater fat gain (Swinburn & Egger, 2004). There is, however, conflicting published data about the effect of physical activity or purposeful exercise on body composition and regional body fat (Irving et al., 2008).

It has been suggested from the UK Nurse's Health Study data that about 30% of new cases of obesity could be prevented by adopting a lifestyle which included more than 30 minutes brisk walking per day and less than 10 hours of watching television per week (Hu, Li, Colditz, Willett, & Manson, 2003). However epidemiological studies suggest 30 min of moderate intensity activity may not be sufficient to prevent unhealthy weight gain and obesity and although there is no definitive data, it is suggested that perhaps 45-60 min of moderate intensity physical activity per day is required (Saris et al., 2003).

Physical activity levels and intensities can have varying effects on anthropometric measures even without dieting. In a review conducted by Lakka & Laaksonen (2007), overweight men and women were able to reduce body mass and fat mass without dietary caloric restriction in several randomised controlled trials (RCT) lasting 3 – 12 months, and consisting of 3 – 5 exercise sessions of 30-60 minutes per week. Other RCT's have demonstrated that exercise reduces fat mass in a dose-dependent manner and that intensity of physical activity is not as important as the amount of physical activity; hence the larger the total energy expenditure, the stronger the effect in decreasing body adiposity, weight, BMI, percent body fat, fat mass and waist circumference (Irving et al., 2008; Lakka & Laaksonen, 2007). Overweight individuals could reduce body and fat mass without dieting in a dose dependent manner where amount not intensity of physical activity is important.

One such study on 52 obese men examined the effects of diet or exercise on subcutaneous fat, visceral fat, skeletal muscle mass, and insulin sensitivity. The four groups observed for 3 months comprised participants randomly assigned to one of the following; diet-induced weight loss, exercise-induced weight loss, exercise without weight loss, and control. The results were a body weight decrease of 7.5 kg (8%) in both weight loss groups, diet-induced weight loss and exercise-induced weight loss and cardiovascular fitness improved significantly (16%) in the exercise groups when compared with the control group. The researchers concluded that obesity can be substantially reduced by increased daily physical activity even without caloric restriction (Ross et al., 2000). An eight month program, was implemented to determine the effects of different amounts and intensities of exercise training in overweight sedentary men and women (aged 40 – 65 years) with mild to moderate dyslipidaemia with the conclusion that there was a significant dose-response relationship between amount of exercise and amount of weight loss and fat mass loss (Slentz et al., 2004). Despite all the research conducted in the area, the optimal exercise prescription to maximise fat loss remains unknown (Irving et al., 2008).

Physical activity and insulin sensitivity

A prothrombotic state and a proinflammatory state can also be considered to be an integral part of metabolic syndrome (Grundy, 2008). People with metabolic syndrome also have insulin resistance that predisposes them to either pre-diabetes or type 2 diabetes (T2D) (Grundy, 2008). Metabolic syndrome also predisposes them to dyslipidaemia characterised by low HDL cholesterol and elevated triglycerides. Metabolic syndrome is also linked to medical conditions such as fatty liver, cholesterol gallstones, obstructive sleep apnoea, gout, depression, musculoskeletal disease and polycystic ovarian syndrome (Grundy, 2008). Obesity, insulin resistance, T2D, dyslipidaemia and hypertension are all risk factors that are associated with abnormalities in cardiovascular structure and function. Arterial stiffness and impaired endothelial function are the result of these abnormalities (Braith & Stewart, 2006). Metabolic syndrome doubles the risk for cardiovascular disease and raises the risk for type 2 diabetes fivefold (Grundy, 2008). Cardiovascular disease is recognised as a primary contributor to premature morbidity and mortality. The metabolic syndrome definition is aimed to identify persons at high risk of cardiovascular disease so that appropriate intervention can be undertaken (Li & Ford, 2006).

The high prevalence of obesity, insulin resistance, T2D, dyslipidaemia and hypertension are all risk factors induced by the normal aging process and are in part a result of the metabolic effects of reduced muscle mass (Braith & Stewart, 2006). The reduction of muscle mass is driven not only by the normal ageing process but also results from decreases in physical activity performed.

Physical activity programs have been shown to improve insulin sensitivity through muscle contraction. Physical activity programs of sufficient intensity and volume lasting longer than 3 months have improved insulin sensitivity particularly if there is weight reduction (Lakka & Laaksonen, 2007). The improved insulin sensitivity is due to muscle contraction which causes changes in insulin signalling, therefore improving insulin sensitivity (Lakka & Laaksonen, 2007). Physical activity has demonstrated its positive effects in improving insulin sensitivity and the importance of increasing muscle mass.

Insulin resistance, fatty acid metabolism and resting metabolic rate are all determined by muscle mass (Kelley, 2005). Resistance training increases muscle mass and is beneficial in the improvement of insulin resistance and other risk factors associated with metabolic syndrome (Green, Maiorana, O'Driscoll, & Taylor, 2004). Resistance training itself does not result in weight loss; it increases lean body mass and decreases fat mass, including abdominal fat (Lakka & Laaksonen, 2007). A study of vigorous aerobic exercise training performed over 7 days showed even short-term exercise can induce significant improvements in insulin action in T2D. The improvements included increased peripheral insulin sensitivity and responsiveness as well as enhanced suppression of hepatic glucose production (Kirwan, Solomon, Wojta, Staten, & Holloszy, 2009). Resistance exercise can potentially increase body mass which in turn improves insulin resistance and can suppress hepatic glucose production.

Physical activity in the treatment of hyperglycaemia

The effects of normal aging or decreased physical activity result in metabolic and structural changes, in particular reduced muscle mass. The effects of reduced muscle mass lead to a high prevalence of obesity, insulin resistance, T2D, dyslipidemia, and hypertension (Braith & Stewart, 2006). These risk factors are associated with alterations in arterial stiffness and impaired endothelial function (Braith & Stewart, 2006). Braith and Stewart suggest that the primary metabolic “sink” for glucose and triglyceride disposal is skeletal muscle and this system is also an important determinant of resting metabolic rate.

There have been various studies suggesting that resistance training decreases glycosylated haemoglobin (HbA1c) levels in diabetic men and women regardless of age (Braith & Stewart, 2006). While cholesterol concentration, body mass index, and blood pressure are all predictive parameters for total mortality, HbA1c was the strongest predictor. The mortality risk of established diabetes seems to be mediated largely through HbA1c concentration (Khaw et al., 2001). It appears, however, that the beneficial effects of exercise occur when subjects exercise at 70 to 90% of 1 repetition maximum strength while resistance training (Braith & Stewart, 2006). Resistance training decreases HbA1c levels in all diabetics regards of age. The microvascular and macrovascular complications of diabetes are reduced through improved glycaemic control and decreased HbA1c levels (Braith & Stewart, 2006).

There are two studies that have reported HbA1c percentage point differences and health. The European Prospective Investigation of Cancer and Nutrition (EPIC) Norfolk prospective population study showed that a 1 percentage point increase in HbA1c was associated with a 28% increase in mortality risk, independent of other cardiovascular risk factors (Khaw, 2001). The second study, the UK Prospective Diabetes Study, reported that each percentage point reduction in HbA1c was associated with a 35% reduction in microvascular complications (Braith & Stewart, 2006). Clearly, appropriate exercise can have a highly beneficial effect on glycaemic control.

Physical activity and dyslipidaemia

A decrease in plasma triglyceride concentrations and increases in plasma HDL cholesterol concentration is seen after a single session of physical activity (Thompson et al., 2001) Moderate to vigorous exercise has been shown to increase HDL cholesterol, whereas lower intensity aerobic training is the best means to reduce plasma concentrations of LDL and to increase LDL particle size. It also reduces apolipoprotein B plasma concentrations and decreases plasma triglyceride concentrations (Kraus et al., 2002). Even with minimal weight change or improvement in fitness, widespread beneficial effects on the lipoprotein profile can be gained with the highest volume rather than the most intensive amount of exercise per week (Kraus et al., 2002). Improving fitness ensures favourable changes of blood pressure, lipid profiles and waist circumference, hence reducing the risk factors associated with cardiovascular risk (Lee et al., 2012). Gaining fatness, however, is correlated with the opposite effect and increases the risk associated with cardiovascular risk (Hillier et al., 2006).

A study involving an exercise program conducted on 20 sedentary men over 20 years old, examining plasma levels of total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides, showed that all lipid values improved, particularly during the first year of participation. These results lead to the conclusion that regular exercise has beneficial effects on plasma lipid levels which lead to reduction of risk of coronary heart disease in middle-aged and older adults (Teramoto & Golding, 2009). A study conducted on Greek participants evaluated the effect of adding resistance exercise to aerobic activities on lipoprotein profile including HDL and LDL, triglycerides, apolipoprotein-A1, apolipoprotein B and anthropometric indices as outcome measures. The conclusion was that combining aerobic and resistance-type activities may confer a better effect on lipoprotein profile in healthy individuals than aerobic activities alone (Pitsavos et al., 2009).

Physical activity and blood pressure

Improving fitness by exercise training may reduce blood pressure through reductions in catecholamines. Blood pressure is reduced by two means, through total peripheral resistance and alterations in vasodilators and vasoconstrictors (Franklin & Fagard, 2004). Aging is an independent risk factor, and hypertension and insulin resistance commonly co-exist in the elderly (Li et al., 2009). Hypertension increases the risk of cardiovascular disease mortality: both can be prevented and treated with exercise (Pescatello et al., 2004). Exercise decreases both systolic (8-10 mmHg) and diastolic (3-5 mmHg) blood pressure in healthy individuals. Further the decrease in diastolic blood pressure can be twice as much in patients with hypertension after just a single session of exercise (Lakka & Laaksonen, 2007). Exercise is the cornerstone management of hypertension although the prescription for exercise needs to be further refined (Pescatello et al., 2004).

There is an abundance of studies showing that aerobic exercise is associated with reduced arterial stiffness in healthy persons of all ages. The independent effects of resistance training however are less well delineated (Braith & Stewart, 2006). Although the mechanisms are different, both resistance training and aerobic exercise training decrease blood pressure (Collier et al., 2008). Aerobic exercise training decreases systolic (3.8 mmHg) and diastolic (2.6 mmHg) blood pressure (SBP and DBP) in adults with normal or elevated blood pressure according to a meta-analysis of RCTs (Whelton, 2002). Importantly, blood pressure responses to aerobic exercise training were more pronounced in hypertensive study groups (SBP –6.9

mmHg; 95% CI: –9.1, –4.6 mmHg and DBP –4.9 mmHg; 95% CI: –6.5, –3.3 mmHg) compared to normotensive groups (SBP –2.0 mmHg; 95%CI: –3.0, –0.9 mmHg and DBP –1.6 mmHg; 95% CI: –2.3,–1.0 mmHg), respectively (Strasser, 2013). Strasser (2010) (Table 2.3) conducted a meta-analysis showing that a weighted mean difference (WMD) change in SBP with resistance training was statistically significant (-6.19 mmHg, 95% CI -11.38, -1.00; p=0.02).

Table 2-4 Pooled estimates of effect size (95% confidence intervals expressed as weighted mean difference for the effect of resistance training on risk factors).

Measures	WMD	SD
Anthropometric		
Waist circumference (cm)	97.5	6.1
Hip circumference (cm)	100.5	10.8
Waist - Hip ratio	0.9	0.02
Weight (kg)	88	7.1
DEXA		
Body fat (%)	34.2	2.5
Fat mass trunk (kg)	21.7	4.2
Fat mass appendicular (kg)	24.37	1.79
Muscle trunk (kg)	30.3	2.3

Waist circumference (cm)	97.5	6.1
Hip circumference (cm)	100.5	10.8
Waist - Hip ratio	0.9	0.02
Weight (kg)	88	7.1
DEXA		
Body fat (%)	34.2	2.5
Fat mass trunk (kg)	21.7	4.2
Fat mass appendicular (kg)	24.37	1.79
Muscle trunk (kg)	30.3	2.3

I^2 =inconsistency. A value for I^2 >50% has been considered to be substantial heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003). [CIs]) expressed as weighted mean difference for the effect of resistance training on glycaemic control (glycosylated haemoglobin [HbA1c]), fat mass (FM), blood lipids (total cholesterol [CHOL], high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides and SBP and DBP in overweight/obese adults with type 2 diabetes mellitus. Table 2.3 adapted from Strasser et al., (2010)

Persons with hypertension benefit slightly more from undertaking at least 8 weeks of aerobic exercise than those without hypertension despite no weight reduction (Lakka & Laaksonen, 2007). Aerobic Exercise at 40% of maximal oxygen consumption (VO_{2max}) can acutely lower blood pressure despite it being a relatively low intensity (Lakka & Laaksonen, 2007). Decreases in blood pressure through physical activity are associated with improvements in body composition, insulin sensitivity, endothelial dysfunction and autonomic balance (Pescatello et al., 2004). There are several resistance training and aerobic exercise studies that have improved physiological outcomes (Table 2.4). Braith and Stewart (2008) conducted a 10 week study that resulted in reduction of both systolic and diastolic blood pressures by 13 mmHg. Stewart et al. (2005) demonstrated a 5.3 mmHg reduction in systolic and 3.7 mmHg reduction in diastolic blood pressures as a result of 6 months of supervised aerobic and resistance exercise as per the American Colleges of Sports Medicine guidelines. Further, Treuth et al (1995) reported 16 weeks of resistance training and dietary restriction produced a significant 40% decrease in visceral fat.

Table 2-2 Resistance training, aerobic exercise and physiological changes

Author	Year	Population	Outcomes
Braith & Stewart	2008	RT + AE aged hypertensive for 10 weeks	Reduction of 13 mm Hg for both systolic and diastolic BP
Stewart et al.	2005	RT +AE older hypertensive adults for 6 months	Reduction of systolic BP 5.3mm Hg and diastolic 3.7 mm Hg
Treuth Hunter et al	1995	RT 16 weeks	Significant 40% decreases in visceral fat in RT and diet group, 39% in endurance training and diet group 32% reduction in diet only group

RT = resistance training and AE = Aerobic training

Physical activity and inflammation

A single episode of strenuous physical exercise elicits a number of physiological responses. These physiological responses include an acute inflammatory release of pro-inflammatory cytokines, with concomitant leukocytosis and increased plasma concentration of C-reactive protein (CRP) (Lakka & Laaksonen, 2007). The most commonly utilized marker of inflammation is CRP and is a powerful independent risk marker for coronary heart disease events (Lavie, Church, Milani, & Earnest, 2011). C-reactive protein has been implicated in the pathogenesis of many chronic diseases including T2D, various cancers and cardiovascular diseases, ischemic stroke, peripheral arterial disease and hypertension (Lavie, 2011). Low-grade systemic inflammation demonstrated in overweight and obese individuals plays a role in metabolic syndrome, T2D, endothelial dysfunction, and cardiovascular diseases (Lavie, 2011). Given that systemic inflammation is intimately involved in the pathogenesis and progression of atherosclerosis and cardiovascular diseases, there has been interest in determining whether exercise has a significant impact on the inflammatory process (Lavie, 2011).

There is conflicting evidence regarding the maintenance of cardiorespiratory fitness (CRF) and whether this may decrease low grade inflammation (Lakka & Laaksonen, 2007). Although a single session of physical activity was shown to increase acute pro-inflammatory markers, other studies have shown it decreases low grade inflammation (Kasapis & Thompson, 2005; Lakka & Laaksonen, 2007). Studies have demonstrated an inverse association between exercise and concentrations of acute phase reactants such as CRP and fibrinogen (Lavie, 2011). The possible physiological mechanisms that may interplay include improved body composition through decreased body fat, decreased production of pro-inflammatory cytokines, increased production of anti-inflammatory cytokines, reduced expression of adhesion molecules, unregulated antioxidant and other increased cellular defences and improved dyslipidemia and endothelial function (Hansson, 2005; Lakka & Laaksonen, 2007).

Physical activity and endothelial function

Endothelial dysfunction is associated with obesity, hypertension, diabetes, hypercholesterolemia, cardiovascular disease, and heart failure (Hambrecht et al., 2000; Lakka & Laaksonen, 2007). Endothelial dysfunction has been defined as 'the inability or attenuated effect of the endothelial cells in participation in the relaxation of the adjacent smooth muscle, thus causing less vasodilation' (Sonne et al., 2007). Endothelial function is essential for maintenance of health of the vessel wall (Green et al., 2004). The most important and best characterised mediator which contains additional anti-atherogenic properties is an autocoid, nitric oxide (Green et al., 2004). Its intrinsic vasodilator function is commonly used as a surrogate index of endothelial function. Pressure exerted on the wall of the blood vessels known as shear stress stimulates the endothelial cells to produce nitric oxide (Green et al., 2004). This appears to be a major mechanism explaining the beneficial effect of exercise on endothelial function and in turn metabolic syndrome, as nitric oxide diffuses into and relaxes blood vessels allowing blood to flow more easily (Campbell, 2013). The metabolic syndrome risk factors, however impede endothelial function and cause highly specific cellular and molecular responses. These molecular responses play a role in endothelial dysfunction and in the pathogenesis of atherosclerosis (Tziomalos, Athyros, Karagiannis, & Mikhailidis, 2009).

While the effects of exercise training on endothelial function appear to be conflicting in healthy individuals, it seems likely that physical training improves endothelial function in individuals with metabolic syndrome (Lakka & Laaksonen, 2007). Other studies have shown that exercise training consistently results in improvement in endothelial function in non-diabetic populations. (Green et al., 2003; Higashi et al., 1999; Lavrencic, Salobir, & Keber, 2000; Ziccardi et al., 2002). The improvement is reflected in increased nitric oxide bioactivity and reduction in oxidative stress as blood pressure is exerted on the endothelium (direct shear-stress) (Green et al., 2004). These mechanisms may therefore provide an explanation for the reduction in coronary events associated with exercise training.

The mechanism by which exercise can improve endothelial function is still not fully understood (Maiorana, 2003). It has been postulated that changes in blood flow, and therefore endothelial shear stress, during exercise cause an increase in nitric oxide bioactivity throughout the vasculature by up-regulating nitric oxide synthase gene expression (the enzyme that uses L-arginine to generate nitric oxide), and thereby increases the endothelial production and release of nitric oxide (Maiorana, 2003). This change in hemodynamics during acute exercise provides a stimulus for both acute and chronic systemic changes in vascular function (Maiorana, 2003). An improvement in vascular function is achieved with the increased bioavailability of nitric oxide. Nitric oxide causes subjacent smooth muscle cells to vasodilate which acts to homeostatically regulate wall shear stress (Green et al., 2004).

Aerobic exercise for prevention and treatment of the metabolic syndrome

Epidemiological studies have shown and randomised control trials have confirmed that regular aerobic exercise is an effective means for improving metabolic and cardiovascular risk factors. Aerobic exercise also decreases the risk of developing metabolic syndrome, T2D, cardiovascular disease and premature mortality (Stensvold et al., 2011). Again the evidence about intensity and duration of exercise is conflicting. However, some epidemiological studies suggest that vigorous exercise reduces metabolic risk factors and prevents metabolic syndrome and coronary heart disease more effectively than does moderate physical activity. Other studies suggest that even light intensity activity appears to provide health benefits (Powell, Paluch, & Blair, 2011). Even less is known about the health benefits of moderate to vigorous unstructured physical activities of everyday living but RCTs have shown reductions in body mass, serum triglyceride levels (Andersen et al., 1999), blood pressure and improved cardiorespiratory fitness (Dunn et al., 1999).

Resistance training for prevention and treatment of the metabolic syndrome

Less is known about resistance training compared to aerobic training. Resistance training does have positive effects on individual metabolic and cardiovascular risk factors and the metabolic syndrome (Pattyn, Cornelissen, Eshghi, & Vanhees, 2013). What is known is that the total mass of muscle in the body is an important determinant of insulin resistance, fatty acid metabolism and resting metabolic rate. Resistance training increases muscle mass and may be beneficial for improving insulin resistance (Balducci et al., 2010) (McPherron, Guo, Bond, & Gavrilova, 2013) and related features of metabolic syndrome (Green et al., 2004; Lakka & Laaksonen, 2007; Pattyn et al., 2013) but in the absence of caloric restriction through diet it does not result in any significant weight loss (Lakka & Laaksonen, 2007).

Exercise recommendations and the metabolic syndrome

There is a need for improved and more affordable prevention and treatment strategies to improve cardiovascular health outcomes. The prevention of the metabolic syndrome from reaching global proportions and straining public health and the economy is also paramount (Tjonna et al., 2008). While exercise improves health, the different types of activity promote different types of physiological changes and in turn different health outcomes (Powell et al., 2011). In terms of the types of exercise and the effects on the metabolic syndrome, one method of exercise dose does not fit for all. The risk factors associated with the metabolic syndrome differ and so the recommendations should vary according to the different risk factors (Vanhees et al., 2012). It is therefore necessary to ensure that both aerobic and anabolic resistance training are prescribed to ensure the most optimal exercise programme is implemented and sustained. This will reduce the cluster of cardiovascular risk factors in patients with the metabolic syndrome (Pattyn et al., 2013).

Conclusion

In marginalised communities, a complex relationship exists between healthcare, socioeconomic factors and health outcomes. There is now an abundance of literature suggesting that exercise does reduce the risk factors associated with metabolic syndrome in non-Indigenous communities. There is, however, a dearth of information relating to the relationship of exercise and the metabolic syndrome risk factors in the Australian Indigenous population. Although current research supports the positive psychological outcomes (i.e. quality of life) there remain questions around how specific physiological outcomes, such as cardiorespiratory function, body composition, vascular function, blood pressure, lipids and glycaemic control are impacted. Some of these measures have never been recorded before in the Indigenous community. Evaluation of a combined aerobic and resistance training exercise intervention as recommended by the American College of Sports Medicine would be a means to capture, record and recommend future exercise prescription and policies that will continue to improve Indigenous health nationally and internationally.

Chapter 3

A review of the barriers and enablers of and best practice strategies for the implementation of physical activity and exercise interventions in the Australia Indigenous community

Introduction

Traditionally, physical activity played a crucial role in the everyday life of Indigenous Australians (Thompson et al., 2000). The physical ability to acquire food and participate in cultural activities meant that being physically active was essential if they were to fully engage with and contribute to the community in which they lived. However, the loss of land, culture and language through the impact of colonisation has had devastating effects on contemporary Indigenous society (King et al., 2009). The changes in diet and physical activity have had a profoundly negative impact on the health and well-being of contemporary Indigenous Australians.

As reviewed in Chapter Two, physical activity has a range of physiological and psychological benefits. These benefits include, lowered blood glucose, lipids, blood pressure and inflammation, and result in healthy weight and waist circumference maintenance. Increasing the amount of physical activity within the Indigenous community is one major strategy for improving the general quality of life (Shilton & Brown, 2004).

The Australian Bureau of Statistics conducted the 2004-2005 National Aboriginal and Torres Strait Islander Health Survey to determine the current levels of physical activity of 10,439 Aboriginal and Torres Strait Islanders from non-remote areas. This report made reference to the Australian Institute of Health and Welfare when defining the level of physical activity and the National Health Survey levels of physical activity were divided into two categories. It was either 'low or no exercise' or 'moderate or high levels of exercise' and aligned to correlate to either 'sufficient' or 'insufficient' levels (Table 3.1).

Table 3.1 Grouping of NHS levels of physical activity

		Score (Number of session x)
	Level	Average time per session x intensity (a)
Low or no exercise (Insufficient)	Sedentary	<100 (includes no physical activity)
	Low	≥100 to <1,600
Moderate or high levels of exercise (Sufficient)	Moderate	≥1,600 to <3,200 OR ≥3,200 including <2 hours of vigorous physical activity
	High	≥3,200 including ≥2 hours of vigorous physical activity

(a) Intensity defines the ratio (Metabolic Equivalent or MET) to apply for each type of activity as ratio of the energy spent when the body is at rest (Rest Metabolic Rate (Calories/Day)).

Source: Australian Institute of Health and Welfare (2014).

The results from this survey of Indigenous Australians revealed that the participants' level of exercise was 47% sedentary, 28% low, 18% moderate and 7% high. The age structure of the survey was adjusted and then compared to the non-Indigenous community. The new structure revealed that levels of exercise were 51% sedentary, 27% low, 21% moderate or high, compared with 33%, 36% and 31% respectively for non-Indigenous Australians (Figure 3.1).

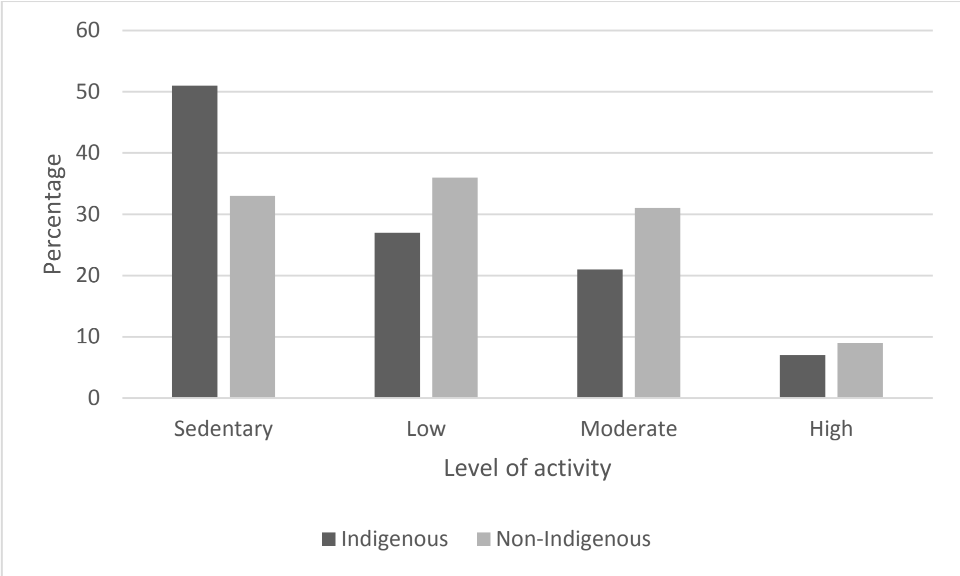

Figure 3 -1 Age-standardised prevalence of Indigenous and non-Indigenous physical activity categories for person aged over 15 years (Adapted from Australian Institute of Health and Welfare (2014)).

Shilton and Brown's (2004) review of physical activity among Aboriginal and Torres Strait Islander people and communities describes what the authors call the *epidemiological rationale for a focus on physical activity*. They stress that despite the powerful rationale for a focus on physical activity, and despite the contribution physical activity has on reducing chronic disease risk, improving physical and mental health and improving social factors, there has been a lack of research in the area. Shilton and Brown (2004) concluded by stressing that there is an urgent need for: 1) research into the effectiveness of innovative strategies for increasing physical activity among Indigenous people; 2) implementation of effective strategies into interventions; and 3) prioritising research in this area to enable it to be incorporated into the scientific literature.

In designing any interventions for the primary prevention of cardiovascular disease in the Indigenous community, the barriers associated with making diet and exercise changes need to be considered, as does the importance of promoting interventions in a culturally secure and relevant way. This chapter presents the peer-reviewed literature for physical activity or exercise research and the motivators and barriers that exist in supporting

Indigenous people to exercise. This information, and the author’s knowledge and experience as an Indigenous community member and athlete, are incorporated into a discussion of how best to design physical activity programs for Aboriginal people.

Methods

Search Strategy

Using EBSCO Host, a simultaneous search of SPORTDiscus with Full Text, Medline and CINAHL Plus with Full Text electronic databases was conducted. The key search terms used were ‘’Australia* Indigenous or Aborigin* or Torres Strait Islander’’ and ‘’exercise or physical”.

The search was limited to peer-reviewed journal articles; written in English; and Country: Australia; all adult; human. The search yielded 100 articles. Articles were excluded if the study sample was not predominantly Indigenous Australian adults or if physical activity measures or their determinants were not a primary outcome. Journal articles were included if they focused on the effects, motivators and barriers to exercise in Australian Indigenous people and if they provided strategies that may be effective in increasing their physical activity. A total of 15 articles remained for evaluation. Six articles focused on physical activity interventions and nine articles described the motivators and barriers to physical activity.

Results

Barriers and enablers to Indigenous participation in exercise studies

Hunt, Marshall and Jenkins (2008) conducted a study exploring the meaning of and barriers to physical activity among urban Indigenous Australians in Brisbane. The study involved 194 participants and the results indicated a clear understanding of the relationship between physical activity and health by the participants. Walking, domestic chores and specific sports were the commonly reported physical activities, whereas being judged by others (shame) when in public spaces, cost and accessibility, were indicated as barriers by the participants. The strong motivators for participation in physical activity were activities that included the family and community (Hunt et al., 2008). Alarmingly but not surprisingly, the authors stressed that, at that time, there had been just one study that attempted to understand the social and cultural context of physical activity among urban Indigenous people. The authors also examined urban Indigenous Australians' knowledge of the current Physical Activity Guidelines (PAG) and identified their preferred sources of assistance regarding physical activity. They reported that Indigenous Australians living in Brisbane have similar levels of knowledge regarding the current PAG as do other Australians. Most participants expressed a preference for advice about physical activity to be delivered via health professionals (Marshall, 2008).

Exercise within the Melbourne Aboriginal population was seen as an individual activity and was often separate from community and family (Thompson et al., 2000). In contrast, everyday activity was seen as necessary and was done for family and the community. Sports were a means to connect individuals and their kinship ties within their community. Isolation from family or community when exercise was performed individually could lead to feelings of shame, thus Melbourne Aboriginal people in this study rarely participated in 'exercise activities'. On the other hand, there was emphasis on an individual to maintain health since being ill burdens families and the community.

Since the publication of this paper (Thompson et al., 2000), other studies have identified social and cultural determinants of physical activity. These include structural environmental factors (Nelson, Abbott, & Macdonald, 2010a), acculturation (Ricciardelli et al., 2012), reducing cultural isolation (Paasse & Adams, 2011), ability to balance and maintain social connections (Thompson & Gifford, 2000), physical activity that either separates or mixes gender depending on community needs and domestic work (Hunt et al., 2008), and the importance of culturally safe environments (Aitken, 2007). Similar physical activity barriers exist in the social, emotional and physical wellbeing of young Aboriginal men in the Koori community in Melbourne (Thorpe, Anders, & Rowley, 2014b). The study identified concepts surrounding community connection, cultural values and identity, health, racism and discrimination.

Two notable studies illustrate the best means of engaging the Indigenous community into physical activity or exercise. Nelson et al. (2010) present what is currently known about physical activity habits of Indigenous Australians and challenge some of the commonly held opinions about promoting or researching physical activity in the Indigenous community. These commonly held opinions are similar to the ones addressed above (Thorpe et al., 2014b). Unfortunately only a few studies have examined an Indigenous perspective (Iwasaki & Barlett, 2006), in New Zealand (Burrows & Wright, 2004) and in Australia (Nelson, 2009; Thorpe et al., 2014b). The studies challenge the status quo by ascertaining that physical activity is part of a cultural lifestyle and should not be separated from the cultural practices. These underlying factors (environmental, occupational, nutritional, residential and experiential) are all associated with social relationships (Nelson et al., 2010a). Physical activity serves a variety of purposes as a means to protect health though the physical ability to maintain Indigenous natural and cultural resource management, customary spaces, seasonal timing and traditional education. The different views of physical activity in the Indigenous and non-Indigenous communities, highlights the necessity of involving Indigenous people in the design and implementation of physical activity in their own Indigenous communities. Nelson et al (2010) conclude by suggesting that, in preparing and delivering programs, an understanding of the way physical activity is perceived can assist health educators to arrive at a common ground or the intersection of Western and Indigenous knowledge sets. This can also assist health educators to understand the complexity and diversity of Indigenous culture (Nelson et al., 2010a)

Aitken (2007), in a Heart Health Project based in Shepparton, regional Victoria, screened for cardiovascular risk factors and developed protocols for evaluation of community directed interventions. The study identified work-based exercise programs (physical activity or exercise programs that take place in the workplace) as being one way of overcoming the physical activity barrier associated with lack of time. Overcoming factors that alienate community members continues to be a challenge. Building rapport and gaining an understanding of culture and identity enables culturally safe environments and is the means to overcoming many barriers. One such method could be as Paasse and Adams (2011) describe: a peer mentoring program, geared towards the prevention of disease, drawing on the skills and knowledge of the local Indigenous community to support other Indigenous people to stop smoking, eat healthier food and become more physically active. The programs need to be flexible and draw on the skills of the local community in partnership with local services.

Canuto et al. (2012b) used a mixed methods approach to understand the factors that influence the attendance in group based exercise classes for Aboriginal women. Perceived health benefits were the prime reason for joining the classes and the sessions provided a positive and comfortable environment. Illness and competing work and family obligations, venue location and class times were reported as the issues that affected their attendance.

Thompson, Chenhall and Brimblecombe (2013) suggest that not only is the Indigenous concept of physical activity not represented in the public health literature but there are also scarce examples of Indigenous involvement in physical activity. They do stress however, that the effective promotion and participation of the community in physical activity requires involvement of diverse Indigenous cultural perspectives. Their ethnographic and participatory action research qualitative study involved interviewing 23 purposively selected community members in a remote Northern Territory Indigenous settlement. The results indicated that physical activity is embedded in the social fabric of the community and that it is socially, culturally and economically significant. It concluded that it is necessary to collaborate with the Indigenous community before instigating any physical activity programs. It also stated within remote communities' intervention should take place on traditional country as a component within an integrated system.

Studies of exercise interventions for Indigenous people

Mendham, Coutts and Duffield (2012) studied the acute effects of two exercise modes, rugby and cycle ergometry, and their effects on inflammation and glucose regulation in Australian Indigenous people. Ten untrained Indigenous men free from cardiovascular or metabolic disorders were recruited to complete the two exercise modes randomised to a crossover design study. The exercise duration was 40 minutes separated by 7 days' recovery. Fasting venous blood was collected pre, post and several subsequent time intervals for analysis of glucose, insulin, cortisol and inflammatory markers of tumour necrosis factor (TNF), Interleukin (IL)-1b, IL-6, IL-1 receptor agonist and C-reactive protein. The 240-min post exercise period results, regardless of exercise mode, demonstrated a significant increase in IL-6 and IL-1ra, and there were no significant changes in TNF, IL-1 β and C-reactive protein. While the significant improvement occurred in both modes of exercise, the prescription of modified rugby was recommended by Mendham, Coutts and Duffield (2012) as a community based approach to promoting increased physical activity as opposed to a tailored exercise session using individually pursued stationary cycling.

In a more recent study Mendham, Duffield and Coutts (2014a) recruited 26 inactive Indigenous men who were randomised into an exercise (n=16) or control (n=10) group. The training consisted of 2 to 3 days of group sports and gym exercises. The exercise significantly reduced insulin resistance, body mass index, waist circumference and waist to hip ratio compared to the control group. The aerobic fitness of the exercise participants also improved.

Canuto et al. (2012b) conducted a 12 week intervention consisting of 2 x 1 hour cardiovascular and resistance training and 3 month follow up to assess if outcomes were maintained. One hundred Aboriginal and/or Torres Strait Islander women aged 18–64 years living in the Adelaide metropolitan area were recruited. The program included two 60-minute group cardiovascular and resistance training classes per week, and four nutrition education workshops. Participants were randomly assigned to an 'active' group or 'waitlisted' control group. Body weight, height, waist and hip circumference, blood pressure, fasting glucose, fasting insulin, HBA1C, lipid profile and C-reactive protein were assessed at baseline, immediately after the program and three months post program. The researchers reported that the community was invited to participate in the research project and ethics had been approved by the Aboriginal Health Council of South Australia. Consultation also took place with the Nunkuwarrin Yunti and the Aboriginal Sobriety Group Inc, Adelaide.

Compared to the waitlisted group, the active group had a statistically significant change in weight and body mass index from baseline assessments; at immediately after the program, -1.65 kg and -0.66 kg/m2 and at 3 months post, -2.50 kg and -1.03 kg/m2, respectively. Systolic and diastolic blood pressure also exhibited a statistically significant difference from baseline in the active group compared to the waitlisted group immediately after the program, -1.24 mmHg and -2.46 mmHg and at 3 months post, -4.09 mmHg and -2.17 mmHg, respectively. The findings were independent of the baseline measure of the outcome variables of age, households with children and employment status. Changes in waist circumference and other clinical measures were not significant immediately after the program or 3 months post. The primary outcome measure, waist circumference, proved problematic to assess reliably. Missing data and participants lost to follow-up were also major problems reported from the study. The study provided the opportunity for participants to obtain anthropometric measures but only half of the participants complied. The paper did not provide any reason as to why half of the participants did not wish to have their anthropometric measures taken. The authors concluded that this 12-week exercise program demonstrated modest reductions in weight, BMI and blood pressure immediately after the program, which improved further at 3-month follow-up. Positive intervention effects were observed despite low attendance at exercise classes. The authors of this study did not define what low attendance was. Structured exercise programs implemented in community settings require attention to understanding the barriers to participation for this high-risk group.

The only other randomised, experimental study of physical activity in Indigenous Australians focused on the reduction of chronic suppurative otitis media and associated bacteria in the nasopharynx and middle ear (2012). The randomised control trial, conducted on 89 children randomly assigned to either a swimming or non-swimming group, found that swimming lessons should be supported as swimming did not appear to be associated with an increased risk of ear discharge, although it is unlikely to reduce rates of chronic suppurative otitis media and associated bacteria in the nasopharynx and middle ear.

Ricciardelli et al (2012) published a study protocol for a physical activity intervention that will focus on developing effective strategies to improve health and develop a better understanding of how socio-cultural factors affect health attitudes aiming to promote fit bodies, healthy eating and physical activity among Indigenous Australian men. The outcomes of this study have not been published as yet.

Several observational studies of community-based physical activity interventions have also been reported. Looma community, an Aboriginal community in north-west Western Australia, implemented a program which included walking groups, appointment of a Sport and Recreation Officer to organise sporting competitions and was supported by interventions for nutrition, education, health policy and infrastructure (Rowley et al., (2000). The researchers assessed the sustainability and effectiveness of a community directed program for the prevention of obesity and diabetes by examining the diet and physical activity behaviours, body weight, fasting insulin and triglyceride concentration, tracked over two years. Significant changes included BMI and fasting plasma glucose concentrations, fasting insulin concentrations, among participants not only in exercise programs but also at a community wide level; there was no change in fasting plasma triglyceride concentrations, obesity or weight loss. The program was directed by the community over a period of time and developed a holistic, community wide approach to management and prevention of chronic disease.

Lehmann et al. (2003), examined the benefits of swimming pools in two remote Aboriginal communities in Western Australia. The aim of the study was to improve quality of life by reducing the high rates of pyoderma and otitis media. The researchers compared the prevalence of ear disease and skin infection before and at six monthly intervals after the opening of the swimming pools. The results demonstrated there was a significant reduction in the prevalence of pyoderma and tympanic membrane perforations which reduced the chronic disease burden and improved educational and social outcomes.

Common barriers to PA or exercise participation

There are several barriers to exercise identified by the research. These factors can be both extrinsic and intrinsic in nature. Intrinsic components are those where the individual has a degree of locus of control over their environment, whereas extrinsic components are those where control is beyond the individuals' locus of control. Overcoming barriers might include organising inexpensive sporting programs, free gym memberships, improving infrastructure, providing environments where whole of community could attend and where participants felt safe.

Table 3-1 Commonly identified barriers to exercise in the Australian Indigenous community

Extrinsic components	Intrinsic components
Time constraints	Time constraints
Expense of PA	Feeling too unfit to exercise
Lack of facility accessibility	Shame or feeling embarrassed to exercise
Environmental factors	Too individualistic
Family commitments	Family commitments
Feeling unsafe	

Source: This table has been extrapolated by the author of this thesis ((Shilton & Brown, 2004) (Hunt et al., 2008); (Marshall, 2008) (Nelson, 2009; Nelson, Abbott, & Macdonald, 2010b).

Common themes that enhance the success of exercise programs

There are three common themes that have emerged from all the successful Indigenous physical activity interventions. Interventions must be culturally acceptable and community owned; there must be long term support from all stakeholders of the intervention; and, most importantly, there must be an Indigenous framework from which to work.

The commonly-identified themes include both internal and external components (Table 3.1). The internal components were: a need for interventions/programs to be community owned and directed; that participants in PA programs have Kinship connections i.e. connections to individuals, family and community; incorporation of cultural aspects that provide a culturally secure environment; and most importantly, having activities that can be easily incorporated in daily life. The external component is long term support from stakeholders. Stakeholders are entities that share an interest in improving Indigenous health outcomes i.e. government agencies, universities, non-government agencies.

Culturally secure and community owned

Successfully implemented PA programs were often initiated and driven by community members. For example, two of the Indigenous authors of the Looma Healthy Lifestyle study (Rowley et al., 2000) were local community members who led the design and implementation of appropriate and potentially sustainable physical activity and dietary modifications. Aboriginal Health Workers were then employed and made responsible for the day to day running of the program. Employing local Aboriginal Health Workers ensured the program was a culturally safe environment for the participants, where there is no assault on, challenge to or denial of their identity (Australian Human Rights Commission, 2011). Cultural safety is recognised as a determinant of participation in any health-related activity. The community owned program now has widespread community support and is run entirely by community members. The program was not initiated overnight and can continue only with the long-term support of its stakeholders. As a result of this support there have been a number of culturally secure community initiatives since the commencement of the program, none of which could have happened without the support of community members, community store and community council.

In Victoria, sport, and ultimately the establishment of the Rumbalara and Fitzroy Stars Football and Netball Clubs, provided a platform that allowed the Indigenous community to strengthen spiritual, emotional and physical wellbeing; the fabric, sport and club have brought Indigenous players, supporters and family together which have strengthened cultural connections in Shepparton, Victoria (Doyle, Firebrace, Rachel, Crumpen, & Rowley, 2013a; Thorpe et al., 2014b). These Aboriginal sports teams foster a safe and culturally strengthening environment and they have the ability to make a profoundly positive difference to health, especially for the players but also more broadly.

Cultural security focuses on the obligation of the stakeholders working alongside Indigenous communities to ensure that there are policies and practices in place so that all interactions adequately meet cultural needs (Australian Human Rights Commission, 2011).

Anderson (2003, p. 196) states

> ‘‘In the postcolonial climate of Aotearoa/New Zealand, cultural safety extends the notion of transcultural nursing, with its focus on understanding the health beliefs and practices of different ethnocultural groups, to include an examination of power inequities, individual and institutional discrimination, and the dynamics of health care relations in the postcolonial context’’.

The above notion of transcultural nursing must diffuse into other health arenas in order to address the socio-cultural aspects as mentioned above and break down the barriers often associated with the dominant worldview.

Long term support from stakeholders

The Looma study (Rowley et al., 2000) discussed how the sustainability of the program and its contribution to empowerment of the local community are its most notable features. The study demonstrated effectiveness as a sustainable, effective obesity reduction program implemented in a community as described by the above components of a successful PA program. This was due to long term support of key stakeholders and the acceptance of the program by the community. Also the process that involves the community to actively contribute to initiatives, developing and implementing them, providing a sense of control over the process can by itself contribute to improve sustainable health outcomes.

An Indigenous framework for physical activity

While studies of Indigenous health address issues such as barriers to exercise and the cultural importance of physical education, it has not been possible to find a framework for an Indigenous standpoint pertaining to exercise in the literature. However, Thompson, Chenhall and Brimblecombe (2013) provide guidelines pertaining to physical activity promotion in remote Northern Territory communities. To use 'exercise as medicine', to improve Indigenous health outcomes, an Indigenous standpoint must be established. Who better equipped to understand the aspect of the Indigenous world view than an Indigenous person? An Indigenous standpoint makes the case that because the Indigenous communities' lives and roles are significantly different from the dominant western society, Indigenous persons hold a different type of knowledge. Their location as a subordinated group allows them to see and understand the world in ways that are different from and challenging to the existing dominant Western conventional wisdom. Nelson et al. (2010a) go further to explain that Western science deems what is acceptable and dictates how literature is presented using a Western conceptual framework. But where possible an 'Aboriginal lens' or use of Aboriginal expertise, knowledge or models should be adopted where available. Nakata's concept of the 'cultural interface' recognises that there are spaces where Western and Indigenous knowledge can come together in a productive manner (Nelson et al., 2010a). It appears critical to de-emphasise Western epistemologies and make the factors that relate to the motivators and barriers of exercise more 'visible' rather than invisible and normal. Walter, Taylor & Habbis (2011, p. 6) state that 'Decentring Whiteness requires recognition of epistemological and ontological assumptions so deeply embedded that they are invisible to those who carry them. This invisibility permits White privilege to exist unacknowledged and unchallenged within societal formations'. It is from this basis that potentially effective PA interventions can be designed and evaluated.

Based on the studies of enablers and barriers of PA cited above, on the author's research exposure to various Indigenous communities and on the author's knowledge and experience as a member of the Perth Noongar community, a number of characteristics relating to participation in physical activity can be identified and an illustration of Western versus Indigenous views of exercise can be derived. Key differences between these views are summarised in Table 3.3. Broadly speaking, the differences between the Indigenous and Western views of PA are the Indigenous ways of working which emphasise community based activities, focusing on community development and improving the socio-economic position of the whole community. This is in contrast to a very generalist Western view where the individual is the focus and the purpose of PA or exercise may go beyond health benefits and focus on improving physical appearance.

Table 3-2 Model illustration Western vs Indigenous view of exercise

	Indigenous	non-Indigenous
Focus	kinship	individual
Activities	traditional (e.g. swimming)	contemporary (e.g. gym)
Health Model	social (community wellbeing)	biomedical (absence of disease)
Assumption	cheaper	expensive (gym members)
Goals	community	individual
View	whole of community	certain demographic

Source: This table has been extrapolated by the author of this thesis from (Aitken, 2007; Nelson, 2009; Nelson et al., 2010b).

The following points are important to this model:

- Community – points out which interventions had Indigenous community direction.
- Focus – individual vs whole of community. Whether an exercise program is focused on improving the health and well-being of an individual or a community as a whole.
- Activity – traditional (swimming, fishing, hunting) vs those of contemporary society (gym or football). Focused on what exercise format is used to deliver the exercise, whether it be a traditional activity that involves the community or one that is individual.
- Assumptions – cost and accessibility of equipment for the intervention. Traditionally the procurement of food was a physically demanding one that did not need any financial resources as opposed to contemporary urban society where exercise is performed for recreation and can be impeded by financial costs i.e. gym membership.

- Health Model – Social community based holistic vs biomedical absence of disease model. The Indigenous model of health is an holistic one and focuses well beyond that of the biomedical one where the absence of disease is defined as healthy.
- Goals – Study focus individualistic or community based. Where the focus of the exercise program that improves health outcomes is focused on an individual or the community.
- View – Broad - potential for all of community regardless of age and gender or narrow focuses on sub population of community. If the program focuses on a particular demographic in the community or the whole community regardless of gender, age, fitness level etc. Gyms can tend to cluster the already fit demographic.

Incorporating an Indigenous view of PA in program design will ensure it provides a culturally safe environment by not only acknowledging differences between people but it also actively seeks to uncover the less obvious interpersonal behaviours. Cultural sensitivity or the ability to consider operating in different modes is based on an understanding that individuals are entitled to hold differing worldviews, values, knowledge and beliefs. It goes beyond leaving cultural foundations at the door in order to enhance PA. Meeting the needs of the recipients, reflecting on interactions and the impact of their own cultural identity involves recognition of power balances and historical, political, social and economic structures (Taylor & Guerin, 2010). These are the components that ensure the Indigenous PA framework is culturally appropriate.

Table 3-3 Western vs Indigenous views of social criteria surrounding exercise

Community	Focus	Activity	Assumption	Health Model	Goals	View
Rowley (2000)	Rowley (2000)	Rowley (2000)	Rowley (2000)	Rowley (2000)	Rowley (2000)	Rowley (2000)
	Lehmann (2003)	Lehmann (2003)	Lehmann (2003)	Lehmann (2003)	Lehmann (2003)	Mendham (2012)
	Mendham (2012)	Mendham (2014)	Mendham (2014)	Mendham (2014)	Mendham (2014)	
	Mendham (2014)	Stephen (2012)	Stephen (2012)	Stephen (2012)	Stephen (2012)	
	Stephen (2012)					
Lehmann (2003)	Canuto (2012)	Canuto (2012)	Canuto (2012)	Canuto (2012)	Canuto (2012)	Canuto (2012)
		Mendham (2012)	Mendham (2012)	Mendham (2012)	Mendham (2012)	Lehmann (2003)
Mendham (2014)						Mendham (2014)
Stephen (2012)						Stephen (2012)

Application of the model to Indigenous PA interventions

The six physical activity interventions conducted in an Australian Indigenous community; community health development program at Looma (Rowley et al., 2000), a study examining the benefits of swimming pools in remote Aboriginal communities in Western Australia (Lehmann et al., 2003) and Northern Territory (Stephen et al., 2012), and both studies conducted by Mendham (2014a; 2012) had a broad kinship focus and programs that were accessible to all community/family members. They utilised primary health care within a social (holistic) model of health to improve health equality for the whole community. The 12-week exercise and nutrition program (Canuto et al., 2012b) had an individual focus and was generally speaking very expensive, when compared to a sport or body weight resistance program which requires little or no equipment i.e. push-ups and squats. This intervention focused on reducing risk factors and was orientated towards utilisation of the biomedical model. The Women's Fitness program (Canuto et al., 2012a) reported modest reductions in weight, BMI and blood pressure, immediate post intervention with further improvement at the three-month follow-up assessment. There was no change in the primary outcome measure waist circumference. Summarising this section, the most effective means to ensuring effective exercise or physical activity interventions rely on many factors. These factors include the engagement of stakeholders' long-term support, designing models that foster culturally secure and community owned programs and most importantly programs that focus on kinship and whole of community wellbeing.

Discussion and Conclusions from the literature review

This chapter is a summary of research that focuses on the enablers and barriers of, and by implication, best practice principles, applied to exercise interventions in the Australian Indigenous community. Progressing culturally relevant exercise interventions takes on new significance in light of the 'closing the gap' agenda. Given that the lack of physical activity is an independent risk factor for the high prevalence of Metabolic Syndrome and subsequent heart disease and diabetes, relatively little is known about the physical activity patterns of the Indigenous community (Marshall, 2008). Developing and implementing effective, appropriate and sustainable exercise interventions within the Indigenous community presents unique challenges, that involve addressing various barriers (Hunt et al., 2008) and, most importantly, are driven by the Indigenous community (Shilton & Brown, 2004). Designing culturally relevant primary prevention can only be achieved through community direction and long term support from stakeholder partnerships (Aitken, 2007).

Sport and leisure are seen as important as they develop social and community links and provide a vehicle for positive self-expression, and family and peer influences are important in encouraging community participation (Thorpe et al., 2014b). Recreation is often promoted as a way of protecting against boredom and preventing crime, opportunity for relaxation and a reprieve from social issues. It can be viewed as distraction that allows one to escape from the day to day reality of family conflict and homelessness and avoid temptations such as alcohol and drugs. Providing the resources or opportunity for individuals to participate in physical activity is only a fraction of the cost when compared to interventions that need to be designed for the aforementioned social issues, hence, the cost-effective strategies are those that aid in the prevention of anti-social behaviour (Doyle et al., 2013a). According to the Foundation of Community Legal Centres Victoria (2014) housing a prisoner costs $87,000 a year and an estimated half a million per prison bed in construction cost. It would appear obvious that these funds could be better directed towards programs and services that aim at reducing the causes of crime,

However there are both extrinsic and intrinsic barriers to exercise participation. The extrinsic components include feeling unsafe, time constraints, the perceived expense of exercising, lack of facility accessibility and family commitments. The intrinsic components are feeling too unfit to exercise, shame or feeling embarrassed to exercise, the perception that exercise is too individualistic. The key element in the recruitment and retention of Indigenous exercise participants is based upon the intervention being community owned and run. It must have connection to family and community kinship, incorporate cultural aspects, and be easily integrated into daily activities. The external themes to recruiting and retaining community members as exercise participants pivot around long term support from stakeholders.

It is evident that there are also differences in the predominant Western and Indigenous viewpoints, which are the ways in which interventions are focused, the chosen activity, assumptions made, the health model selected, the goals of the intervention, and the viewpoint. The viewpoint is the way in which each of these communities perceives the same situation or solution differently. Successful development and implementation of exercise interventions in these populations will require utilising Western science and where possible adapted using an ‘Aboriginal lens’. The Indigenous view of exercise is that PA has a role in reducing health inequalities for the Indigenous community, it focuses on kinship ties, traditional activities rather than the conventional gym setting, it is accessible to most of the community and is very affordable. Thus, programs should focus on a social approach rather than implementing the biomedical model of health and aim to reduce health inequalities for all as opposed to preventing disease in individuals.

Finally, the principles of a successful program design and implementation are to ensure the exercise framework incorporates the 3 aspects of cultural sensitivity, cultural awareness and cultural safety. These components have to be in place and are essential for reducing barriers and increasing physical activity within the Indigenous community. Several of the programs identified in the literature were consistent with this approach.

In addition to the programs identified using a search strategy focused specifically on physical activity interventions, other reports appear in the literature of programs that, while not specifically focused on physical activity, do require increased physical activity of the participants. Homelands Living and Caring for Country in particular promote physical activity. For example, O'Dea's study of diabetic Aboriginal people returning to their Traditional Country found that the risk factors associated with type T2D had been reduced (O'Dea, 1984). These programs, based on traditional cultural practice and directed by Indigenous people probably work effectively because they take an Indigenous view of PA. Because of the differing view that exists in the Indigenous and non-Indigenous health models, an ecological approach may be the middle ground recognising that improvements in health will only take place when focus is placed on the physical, spiritual, cultural, emotional and social well-being, community capacity and governance (Johnston et al., 2013).

It is evident that Indigenous people have differing experiences and preferences for exercising. Essentially, practitioners are in a pivotal position to advocate for the implementation and development of programs that reinforce cultural values and meet Indigenous expectations. Interventions require close allegiances and partnerships with Indigenous communities and their representing agencies, who can advise on the relevance and appropriateness of the programs. Participatory styles of engagement, providing opportunities for Indigenous community members to inform the development of exercise programs are another method of meaningful engagement.

Implications for physical activity program design

There is a large body of literature that states that exercise improves health outcomes in non-Indigenous and Indigenous communities. However, there is a large gap in knowledge regarding what the best model is to recruit and retain Indigenous participants in physical activity programs. Research is urgently needed to determine the enablers and barriers for physical activity and structured exercise prescription by Indigenous people. Based on the limited research conducted, one may extrapolate that there are a number of components that must also be understood and will warrant inclusion into any successful Indigenous PA program. Generally speaking these are:

1) Participation in physical activity activities that include family and group based activities;

2) Utilising sports or other forms of physical activity as a vehicle that connects individuals to kinship ties within their community;

3) Activities that have widespread community support and are run by community members.

By understanding these barriers and enablers and incorporating best practice approaches, it may increase recruitment and retention of Indigenous participants in exercise participation. More importantly it will facilitate the inclusion of culturally secure practices that may enhance participation.

Chapter 4

Designing a culturally secure questionnaire to capture factors that relate to the motivators and barriers to physical activity in an Indigenous population in Australia.

Background

This chapter serves to introduce and provide a background to the administration of the questionnaire described in Chapter 5 which explored the motivators and barriers to engaging in physical exercise for the Noongar Aboriginal community in the Perth metropolitan area. While it may appear a straight-forward process to devise a questionnaire for this community on this topic, the care, planning and effort required was considerable. In addition, in this chapter, I am choosing to write in the first person because this reflects my personal role, as a Noongar researcher, in developing the relationships required to access this community. In this chapter I will consider some general background to Aboriginal people's experiences of, and attitudes to, research before describing, in detail, the processes involved in developing the questionnaire itself.

Unfortunately, the word 'research' has generated quite negative feelings for many Aboriginal people. According to Humphrey (2001, p 197):

"The word itself 'research', is probably one of the dirtiest words in the Indigenous world's vocabulary".

This has arisen because the research agenda has poked, prodded, and measured the Indigenous community for over 200 years. The research has traditionally served western socio-political agendas and has historical links associated with colonialism (Castleden &

Garvin, 2008; Humphery, 2001) which is now acknowledged in a range of subject areas like the humanities, social sciences and sciences (Humphery, 2001).

Research often engaged in “fly in fly out” (FIFO) practices, without Indigenous benefit or accountability. The main outcomes were to meet researchers’ own aims while acquiring Indigenous knowledge (Rigney, 1999). At every stage non-Indigenous researchers had full control, from design, monitoring and surveillance, surveys, statistics and the acquisition of cultural knowledge (Rigney, 1999). The same researchers would then exclusively have ownership, control, access and possession of data (Rigney, 1999).

While these practices are now considered unethical, the Indigenous response to research is divided into two camps. First, there is outright rejection to participating in or valuing research. Second, there is the attitude that Aboriginal people should grasp the reins, take control of research or take research back (Humphery, 2001). The term ‘research back’ (Humphery 2001, p197) is the process of reforming research practices to ensure cultural safety.

There are several peak bodies that set Indigenous research guidelines, and that fund research, including the National Health and Medical Research Council and the Australian Research council. There are also several state and territory Indigenous ethics research councils that researchers must seek ethics approval from. These bodies ensure the adoption of culturally sensitive research methods to pursue research that is needed and will benefit the Indigenous community while ensuring control over the dissemination of findings (Humphery, 2001).

Rebuilding trust, improved research quality and relevance, and decreasing bias are a few factors that ensure culturally safe practices. Ensuring meaningful capacity building, development and community empowerment to make change are also qualities that researchers should aspire to develop within Indigenous communities (Rigney, 1999; Schnarch, 2004). The removal of unethical practices and inclusion of culturally sensitive practices is a process that all richer western countries with an Indigenous population are adopting. These countries include Canada, Australia, New Zealand and the United States (CANZUS) (Cochran et al., 2008; Schnarch, 2004).

For example, a study involving Native Americans and HIV/Aids stressed the research should be cyclical and have continued community involvement (Baldwin, Johnson, & Benally, 2009). Baldwin et al (2009) provided 4 steps in the research process with Native Americans. First, they suggested that relationships should be sustaining and collaborative in nature. Second, it is important to design the research collaboratively. Third, they stressed the need to ensure that the research is implemented and evaluation is conducted in a culturally safe manner. Finally, research results should be disseminated from a tribal perspective.

This current PhD study has recognised how important it is for the community to feel a sense of ownership over this research so they can see it as useful and feel they have contributed to its development. This study, as with the study conducted by Baldwin et al (2009), has ensured the research was cyclical. I sought and received approval from the Aboriginal Health Council of Western Australia, and I engaged with and conducted the research in collaboration with the Noongar community. The research took place in Indigenous organisations and questions were vetted by Indigenous Elders and academics ensuring cultural security. The results of the study have been disseminated in Aboriginal organisations or Indigenous spaces within organisations such as universities.

Being Noongar and having an understanding of both worlds, I am able to treat western research as a toolbox from which to pluck tools that best serve the community and I can adopt Aboriginal terms of reference (Humphery, 2001) to ensure cultural sensitivity. Having lived experience and extensive networks with the Noongar community, I have an intimate understanding of the issues impacting the Noongar and other Indigenous communities.

There is a recent and fundamental shift in the approach to Indigenous research now in Australia. Indigenous academics are now becoming lead researchers resulting in the ever so slow shift from research ‘subjects’ to research participants. The research collaboration between Indigenous and non-Indigenous colleagues is even more important. Each brings to the table unique skill sets and cultural understandings. This mutual cooperation utilising the guidelines and ethics processes of peak bodies ushers in a new era of research, one that disassociates the words “dirty” and “research”.

This research arose because of a real need to tackle metabolic syndrome and inactivity in the Noongar community, but it has required the combination of academic support, and cultural engagement to build trust and collaboration in the community. Colonisation has fractured Indigenous cultural ways which has led to poor health and a distrust between the community and health practitioners, often accompanied by poor communication between them. This kind of research is a means to tackle this mistrust because of the way it is done collaboratively and respectfully. It seeks to increase trust levels between Indigenous and non-Indigenous people while raising awareness of sedentary behaviours and metabolic syndrome.

Introduction

There is a host of printed media in the form of journal articles and government reports which influence policies, programs and funding to combat the sedentary behaviour that underlies avoidable non-communicable chronic disease in the general Australian population. The 10,000 steps daily goal is one such program aimed at increasing physical activity, reducing obesity and hypertension (Iwane et al., 2000). There is however, a dearth of information relating to sedentary behaviour within the Australian Indigenous population when compared to the Australian benchmark population. Being able to capture the information about the motivators and barriers to exercise will enable more appropriate culturally safe initiatives that focus on decreasing sedentary behaviour and increasing levels of physical activity to reduce the incidence and prevalence of avoidable chronic diseases. To our knowledge there has not been any questionnaire designed by an Indigenous researcher to capture specific exercise and sedentary behaviour knowledge. I developed this questionnaire as an Aboriginal researcher in consultation with the Perth Noongar community and a leading Australian expert in questionnaire design. The Noongar community was selected for two reasons. Firstly, it is the largest single Aboriginal community in Australia. Secondly, I, the author and researcher, am Noongar and have extensive networks in the local Noongar community.

Objectives

The objective of this research was to design a questionnaire that would determine an Indigenous individual's perceptions of the barriers and motivators to aerobic and anabolic exercise with a series of questions designed to elicit 1) the factors that impact uptake and retention of regular physical activity and 2) potential sustainability of an intervention. For this purpose, a questionnaire was designed to capture information relating to the following research questions:

- What are the motivators of physical activity and exercise in the Noongar community?
- What are the barriers to physical activity and exercise in the Noongar community?
- Do questionnaire respondents participate in any traditional physical activities?
- What are the participants' preferred exercise environments?
- What are participants' exercise goals and what is their level of commitment to physical activity?
- If participants are offered free access to a culturally secure exercise environment would they take part in a physical activity program?

To be able to elicit a response from the Aboriginal community to these questions a novel approach was employed. The methodology for this research project has deliberately been approached carefully in order to gain support and trust from the community, both to counter the negative perceptions of research and also because I wanted people to adopt the exercise behaviours that the research is promoting. So, as a Noongar researcher, I built on my connections to test out the questions, used a reference group, piloted the questionnaire, and sought input and feedback from the community throughout the process. I have assured them that this research will be directly beneficial to them.

Methods

The questionnaire was drafted by the researcher with input from the Noongar community and then forwarded to several Indigenous academics for feedback. A reference group comprising Indigenous and non-Indigenous stakeholders was formed. Modifications based on feedback from stakeholders were made and then the questionnaire was emailed to a leading Australian researcher in questionnaire design, Professor Adrian Bauman from the University of Sydney for further refinement and improvement. It was then distributed to the Noongar community who were invited to comment on it. Any modifications were then presented to high profile Noongar academics (Professor Dawn Bessarab and Associate Professor Ted Wilkes) and organisations, such as the Centre for Aboriginal Studies Curtin University and the Marr Mooditj Foundation, for final approval. The community representatives were satisfied with all aspects of the questionnaire and deemed it appropriate for distribution into the community. Further modifications were made until the stakeholders were satisfied with the final version. Developing a physical activity questionnaire can be complicated in terms of knowing which aspects such as frequency, duration, intensity and type of physical activity, contribute to ensuring it is multi-dimensional (Terwee et al., 2016). Keeping the points noted above in mind, the language, length and appropriateness of the questionnaire were also addressed. It is hoped this questionnaire may be transferable to other Indigenous communities in Australia, and may even inform Indigenous researchers overseas. The valuable contribution by all stakeholders has been an essential part of the production of the first *questionnaire* of its kind within the Australian Indigenous population. For example, Hunt, Marshall & Jenkins (2008) conducted a focus group, rather than questionnaire study in a similar topic on the Murray community in Brisbane. Whatever research methods are employed, improving the quality of life of the Indigenous community is more than a scientific process or a research protocol. The essence of researching within Indigenous communities is also about preparing and taking the time to work within community and meeting their expectations.

Survey design and study questions

Exercise is the key to reducing many of the risk factors associated with metabolic syndrome. There is, however, very little information pertaining to appropriate exercise interventions in Indigenous populations. For Hunt, Marshall and Jenkins (2008), engaging with the Indigenous community in a culturally appropriate manner was considered critical to the methodology taken in their study. Similarly, here, stakeholders were consulted at all stages of the questionnaire design and had the opportunity to contribute to the questionnaire. This ensured the questionnaire was appropriate for the Perth Noongar community and other members of the Indigenous community living in Noongar country. The final questionnaire is presented in Appendix 1 - Determining the motivators and barriers to exercise in the Australian Indigenous community.

Questionnaire design

The questionnaire was designed specifically to be used in the Noongar Aboriginal community to elicit a better understanding of the motivators and barriers to exercise / PA. Advice and feedback was sought from the participants of the original questionnaire during the test-retest phase to ensure the questionnaire was culturally appropriate. Reliability and validity of the questionnaire was assessed using the test - retest method which involves administering the questionnaire twice by the same group of participants on two occasions after a particular time interval (Terwee et al., 2016). Intra Class Correlation (ICC) is the preferred statistical parameter of reliability (Terwee et al., 2016). Most of the questions in the survey had good agreement with ICC ranging from 0.618 to 0.990. For a questionnaire to be reliable, the measurement should be free from measurement error, and for it to be valid, it must measure the construct(s) it intends to measure (Terwee et al., 2016). The content of the questionnaire was not greatly different from what would be asked of non-Indigenous people, although it did ultimately contain questions specific to traditional physical activity (including activities like fishing and hunting). It also considered the issue about environment and where exercise occurs because of a potential to experience shame if seen in public. This shame can be associated with several factors including: being the only one or few Indigenous participants within a large group of non-Indigenous participants; being an overweight or obese person exercising in the same environment as fitter people or body builders; feeling unable to keep up with the high cost of fashion associated with looking good and assimilating at the gym. Finally, the questionnaire was designed to not only probe what exercise might be done but who it was done with, whether alone or in a group. All of these aspects were considered to be important in this cultural context. Overall, it was developed and tested with an Indigenous reference group of university staff and students to ensure the questions were culturally appropriate, robust and had the intended meaning for the Indigenous person. The majority of the questions proposed were found to be valid and reliable as indicated in Table 4.2.

Pilot validation of questionnaire

Nineteen participants from the Marr Mooditj Foundation and the Centre for Aboriginal Studies at Curtin University participated in this testing. Participants comprised both males (n = 9) and females (n = 10) of varying ages (age range 21 to 50 years), students (n = 2), and general (n = 10) and academic staff (n = 7). They each completed the questionnaire twice at an interval of one to two weeks. The reproducibility of each question was assessed by calculating the intra-class correlation (ICC) and Cronbach's alpha. An ICC value of 1 is perfect agreement and 0.6 is moderate agreement. The interpretation of Cronbach's alpha results is presented in Table 4.1. Most of the questions in the survey had good agreement. On this basis, the questionnaire was deemed valid and reliable and applied to the full survey sample.

Ethics

Ethics approval was obtained from the Edith Cowan University Ethics Committee and the Western Australian Aboriginal Health Information and Ethics Committee (WAAHIEC).

Statistics

All statistical analyses were performed using PASW SPSS version 17.0 statistical software package. Analysis included standard descriptive statistics and ICC coefficients to analyse internal consistency using Cronbach's alpha to assign values ranging from unacceptable to excellent.

Results

Table 4-1 Interpretation of Cronbach's alpha and internal consistency

Cronbach's alpha	Internal consistency	Utility
$\alpha \geq 0.9$	Excellent	Suitable for clinical diagnosis
$0.8 \leq \alpha < 0.9$	Good	Reliable for research purposes
$0.7 \leq \alpha < 0.8$	Acceptable	Suitable for surveys of the type reported here
$0.6 \leq \alpha < 0.7$	Questionable	Not suitable for survey use
$0.5 \leq \alpha < 0.6$	Poor	Unreliable for survey use
$\alpha < 0.5$	Unacceptable	Unacceptable for surveys

(George & Mallery, 2003)

Table 4-2. *Results of reliability study for the draft questionnaire from question 10. (n = 19).*

Questions	ICC Average*	Cronbach's alpha	Internal consistency
10. *Is exercising vigorously more than 10 mins continuously too hard for you?* Never Sometimes Occasionally Most times Always	0.923	0.990	Excellent
11. *Is exercise too time consuming?* Never Sometimes Occasionally Most times Always	0.814	0.923	Excellent
12. *Is exercising too expensive?* Never Sometimes Occasionally Most times Always	0.949	0.949	Excellent
13 *How difficult are the following for you?*			
A. Changing your diet Very difficult Difficult Easy Very Easy	0.969	0.969	Excellent
B. Find time to exercise every day Very difficult Difficult Easy Very Easy	0.774	0.770	Good
C. Motivating yourself to exercise Very difficult Difficult Easy Very Easy			
D. Current injury Very difficult Difficult Easy Very Easy	0.795	0.806	Good
E. Pain after exercise Very difficult Difficult Easy Very Easy	0.990	0.990	Excellent
14. *What is the most convenient time for you to exercise?* 9-5pm Early morning Early evening Does not matter			

	0.926	0.923	Excellent
	0.926	0.814	Good
17. *Do you feel uncomfortable exercising by yourself?* All times Most Sometimes Never Don’t mind	0.926	0.851	Good
19. *Do you feel uncomfortable exercising in groups?* All times Most Sometimes Never Don’t mind	0.918	0.851	Excellent
21. *Do you enjoy playing games involving sports equip (i.e Football, Netball, Rackets, Golf?* All times Most times Sometimes Never Don't Mind	0.851	0.939	Good
Questions 13D and 13E were slightly modified to provide clearer explanation as participants often required further explanation. Unfortunately, due to time restrictions ICC analysis was not conducted on the modifications.			
13. *How difficult are the following for you?* e. Putting up with the pain associated with exercise All times Most Sometimes Never Don’t mind			
f. Exercising the next day as a result of pain associated from exercising the day before All times Most Sometimes Never Don’t mind			

***Average measures**: this ICC is an index for the reliability of different respondents averaged together.

Questions 1 – 9 related to individual physiological and anthropometric measures and short question response which could not be validated.

The Intraclass Correlation Coefficients, Cronbach's alpha and internal consistency results for the questions are presented in the table (Table 4.2). Analysis for consistency was conducted with assistance from a statistician and on their advice, conducted on the questions specifically related to exercise. All questions tested were reliable, however after further discussions with stakeholders it was felt that certain questions may not be detailed enough and open to misunderstanding. One question needed a lot of clarification on behalf on the participants so the questions were changed to the following: 13e Putting up with the pain associated with exercise. There was not another opportunity to perform test-retest reliability for the new split question. All other questions had at least good reproducibility as indicated by ICC and Cronbach's alpha statistics (Table 4.2)**.**

Discussion

The process of developing the questionnaire for this study involved many conversations with a range of people and organisations. This allowed me to achieve a range of goals: to develop appropriate questions, to spread the word about the benefits of exercise and the need to prevent the risk factors associated with the metabolic syndrome, to promote the idea of research as something positive rather than something to be suspicious of, and finally to raise sufficient awareness in the Noongar community of the research to promote participation and recruitment for the study. These efforts may mean that the questionnaire results, and other aspects of the doctoral research, will be more likely to translate into a real benefit and may help to change behaviours and attitudes to exercise. They help to show the links between research methodologies, relationship building, and research translation.

Collaboration between Indigenous and non-Indigenous stakeholders in designing this questionnaire ensured while it met scientific scrutiny, it is also culturally secure for distribution into the Noongar community. It provided the community with ownership over the research and their feedback was extremely valuable. Any recommendations made by stakeholders were incorporated into the research design at every stage include initial design, testing for validity and reliability, distribution to data analysis and reporting of results back to the community. There were no major barriers or obstacles with the development of this questionnaire as the community and stakeholders engaged at all stages.

The emerging field of Healthy Lifestyle Medicine systematically approaches the prevention and management of chronic disease by adopting models such as the transtheoretical model of behaviour change to focus on reducing unhealthy behaviours such as smoking, poor dietary habits, stress, and physical inactivity (Stonerock & Blumenthal, 2017).

The questionnaire was found to be valid and in the future, may be used or adapted for other Indigenous communities. Many of the participants also expressed eagerness to commence some form of exercise while chatting to the researcher after completing the questionnaire. These included walking, gym and community based exercise programs. The participants found the questionnaire easy to read and believed it was the right length. The questions had good agreement which is suitable for research purposes. While Indigenous communities are not homogenous it is hoped that this questionnaire is transferable to other Indigenous communities so comparison studies can be conducted with the Noongar community.

Conclusion

This questionnaire was designed to obtain information pertaining to the motivators and barriers to exercise in the Indigenous community within the Perth urban Noongar population. There were a number of stakeholders both from the Aboriginal and non-Aboriginal communities who contributed collaboratively to design the questionnaire. The questionnaire was distributed to a small pilot group to undergo tests for reliability and validity and was found to be reliable and valid apart from one question. This question was then modified but due to time restrictions it did not undergo further scrutiny. The questionnaire may be as reliable and valid in other national and international Indigenous communities as a means of capturing the motivators and barriers to exercise. Further individualised pilot studies will need to be conducted in the communities to determine if it is appropriate for the particular community as a means of capturing exercise data.

Designing exercise programs around the needs and expectations of Indigenous participants is key to ensuring exercise compliance. Increasing the amount of exercise that the Indigenous community partakes in will encourage a decrease in the incidence and prevalence of non-communicable chronic diseases that plague the Indigenous community. The development of this questionnaire was the start of encouraging Exercise as Medicine which can be prescribed to improve strength and cardiovascular fitness thereby improving quality of life for Aboriginal people.

Determining the motivators and barriers to physical activity in an Indigenous population in metropolitan Australia.

Introduction

Reducing the incidence and prevalence of preventable chronic diseases involves working to reduce a range of health risk factors. For Indigenous Australians, the biggest health gains can be achieved by tackling those risk factors which mediate the bulk of preventable chronic disease. These risk factors include: smoking, overweight and obesity, physical inactivity, high cholesterol, excessive alcohol consumption, high blood pressure and insufficient fruit and vegetable intake. The merging field of Healthy Lifestyle Medicine systematically approaches on the prevention and management of chronic disease by adopting models such as the transtheoretical model of behaviour change to focus on reducing health behaviours such as smoking, dietary habits, coping with stress, and physical inactivity (Stonerock & Blumenthal, 2017).

Inappropriate diet and physical inactivity are the driving influences that underlie risk of metabolic syndrome and appropriate exercise has been reported to have favourable effects on risk factors that relate to metabolic syndrome (Brien, Janssen, & Katzmarzyk, 2007). Therefore, it is tenable that physical activity plays a key role in improving the health status of Indigenous people (Thomson & Kirov, 2006). However, cultural values and traditions may influence participation in physical activity by the Indigenous community. Understanding these influences is essential to designing intervention studies that enhance physical activity involvement (Kirby, Levesque, Wabano, & Robertson-Wilson, 2007). While there are similarities in the way physical activity is perceived by different Australian Indigenous communities there were differences that were also identified by these authors. One overarching theme identified for all the Australian Indigenous communities was that exercise/physical activity should be an instrument that connects individuals to kinship ties within their community.

This study was an examination of the motivators and barriers to engaging in physical exercise for the Noongar Aboriginal community in the Perth metropolitan area. The findings will be used to inform an exercise intervention designed to maximise participation and retention of Indigenous people from the Perth Noongar community. The data collected in this study will form the foundation for a second study, an intervention which focuses on reducing metabolic syndrome risk factors.

Objectives

The objective of this research was to determine Indigenous individuals' perception of the barriers and motivators to aerobic and anabolic exercise with a series of questions designed to elicit: 1) the factors that impact uptake and retention of regular physical activity; and 2) potential sustainability of an intervention. For this purpose, a questionnaire was designed to capture information relating to the following research questions:

Methods

While some of the questions relate to anthropometric measures, this chapter focuses on the questions relating to Indigenous peoples and exercise, including those from other Indigenous people, living in Noongar country. Clinical characteristics of participants are reported in Chapter 6. Participants were asked to undertake a questionnaire on barriers and enablers of participation in physical activity, with some additional open ended questions and the opportunity to comment further if desired. The results were collated and ranked to determine the greatest motivators and barriers so that future exercise intervention studies can be implemented to overcome or reduce these barriers wherever possible.

Participant Population

For this cross-sectional study, we recruited 137 Australian Aboriginal and Torres Strait Islander individuals aged between 18 – 60 years living in the Perth metropolitan area though established networks at Indigenous educational institutions, primary health centres, government departments and the private sector.

Study Setting and recruitment strategy

As a member of the Perth Noongar community the PhD candidate has extensive links into established Indigenous networks. The organisations selected were those that employ a large number of Indigenous people or provide services to large numbers of individuals in the Noongar community. The participating organisations included Derbarl Yerrigan Health Service, Marr Mooditj Foundation, Centre for Aboriginal Studies at Curtin University, Aboriginal Student Services at Challenger TAFE, Noongar Sports Association, Noongar Mia Mia, South West Aboriginal Land and Sea Council, Dumbertung, Clontarf College, PEEDAC, Kurongkurl Katitjin at Edith Cowan University, Kurlbardi at Murdoch University and Burdiya Aboriginal Corporation. The questionnaire was distributed to the Noongar community by a number of means. These included by email, mail out and personal dropoff. Emailing the questionnaire to participants proved to be the least effective method of having the questionnaires completed. Visiting organisations with Aboriginal people present proved to be the most effective method of having the questionnaires completed.

Ethics

Ethics approval was obtained from the Edith Cowan University Ethics Committee and the Western Australian Aboriginal Health Information and Ethics Committee (WAAHIEC).

Statistical Analyses

All statistical analyses were performed using PASW SPSS version 17.0 statistical software package. Analysis included standard descriptive statistics and prevalence's were compared using Chi-square tests.

Results

Participant demographic characteristics

For the full, revised questionnaire, 137 participants were recruited. Twenty percent of the participants in the full questionnaire were aged between 18 – 25 years, 48% from 26 – 45 years and 31% from 46 to 50+ (Table 5.1).

Table 5-1 Age and gender distribution of survey participants

Modified Age (years)	Male	Percentage	Female	Percentage	Total	Percentage
18-25	12	20.7%	14	18.7%	26	19.5%
26-45	28	48.3%	34	45.3%	62	46.8%
45-60	18	31.0%	27	36.0%	45	33.8%
All ages	58	100.0%	75	100.0%	133*	100.0%

*4 cases of missing data.

Table 5-2 Age and gender distribution of Aboriginal communities in Perth

Modified Age (years)	Male	Percentage	Female	Percentage	Total	Percentage
18- 25	1986	31.5%	1836	27.8%	3822	29.6%
26-45	3069	48.7%	3187	48.3%	6256	48.5%
46-60	1249	19.8%	1578	23.9%	2827	21.9%
All ages	6304	100.0%	6601	100.0%	12905	100.0%

*adapted Australian Bureau of Statistics Table Builder basic.

Males aged 18-25 years old in this study were under-represented as compared to the general Aboriginal population, in this study, by 11%. A similar shortfall existed in the 26 to 45 year old age group, and the 46 to 60-year-old male population was over-represented by 11%. When comparing the females in this study to the general Aboriginal Perth population, the 18 to 25-year-old groups were slightly over-represented. There was only a 3% difference between the 26 to 45-year-old females and the Perth population, but the 46 to 60-year-old bracket was under-represented in this study by 13%. The female sample group is more representative of the Noongar community with respect to age than were the male sample group. The ratio of women to men in this study (1.25 : 1) was slightly greater than for the Perth Aboriginal population (1.05 : 1) but whether a 15% difference in the survey sample compared to the Perth population can be deemed important for the purpose of this research is open to interpretation.

Age categories and metabolic syndrome

Hypertension expected counts for the 18 to 45 age group in this study were 30% to almost 50% lower than expected and 41 to 50+ age group have higher than expected counts, these figures are significant (0.010) (Table 5.3). Type 2 diabetes prevalence was lower than expected in the 18 – 33 year old age categories and almost 45% higher in age ranges from 34 years of age (P=0.006) (Table 5.3). Age and an inverse effect on cholesterol with participants in the younger age categories (18 – 40 years of age) reported higher than expected cholesterol, 41 to 50+ exhibited expected cholesterol levels (p=0.000) (Table 5.3).

Table 5.3 Age categories and self-reported metabolic syndrome risk factors actual and expected counts.

			no hypertension	hypertension	total
Age Categories	No response	Count	3	1	4
		Expected Count	2.9	1.1	4.0
		% within	75.0%	25.0%	100.0%
	18 - 25	Count	22	2	24
		Expected Count	17.5	6.5	24.0
		% within	91.7%	8.3%	100.0%
	26 - 33	Count	20	4	24
		Expected Count	17.5	6.5	24.0
		% within	83.3%	16.7%	100.0%
	34 - 40	Count	13	2	15
		Expected Count	10.9	4.1	15.0
		% within	86.7%	13.3%	100.0%
	41 - 45	Count	7	7	14
		Expected Count	10.2	3.8	14.0
		% within	50.0%	50.0%	100.0%
	50+	Count	7	3	10
		Expected Count	7.3	2.7	10.0
		% within	70.0%	30.0%	100.0%
Total		Count	86	32	118
		Expected Count	86.0	32.0	118.0
		% within	72.9%	27.1%	100.0%

Chi-Square = 0.010

			type 2 diabetes		
			no	yes	Total
Age categories	No response	Count	4	0	4
		Expected Count	2.9	1.1	4.0
		% within	100.0%	0.0%	100.0%
	18 - 25	Count	21	3	24
		Expected Count	17.7	6.3	24.0
		% within	87.5%	12.5%	100.0%
	26 - 33	Count	22	2	24
		Expected Count	17.7	6.3	24.0
		% within	91.7%	8.3%	100.0%
	34 - 40	Count	12	3	15
		Expected Count	11.1	3.9	15.0
		% within	80.0%	20.0%	100.0%
	41 - 45	Count	9	5	14
		Expected Count	10.3	3.7	14.0
		% within	64.3%	35.7%	100.0%

	46 - 50	Count	5	5	10
		Expected Count	7.4	2.6	10.0
		% within	50.0%	50.0%	100.0%
	50+	Count	14	13	27
		Expected Count	19.9	7.1	27.0
		% within	51.9%	48.1%	100.0%
Total		Count	87	31	118
		Expected Count	87.0	31.0	118.0
		% within	73.7%	26.3%	100.0%

Chi-Square = 0.006

			Cholesterol		
			no	yes	Total
Age categories	No response	Count	4	0	4
		Expected Count	2.9	1.1	4.0
		% within	100.0%	0.0%	100.0%
	18 - 25	Count	22	2	24
		Expected Count	17.7	6.3	24.0
		% within	91.7%	8.3%	100.0%
	26 - 33	Count	22	2	24
		Expected Count	17.7	6.3	24.0
		% within	91.7%	8.3%	100.0%
	34 - 40	Count	13	2	15
		Expected Count	11.1	3.9	15.0
		% within	86.7%	13.3%	100.0%
	41 - 45	Count	8	6	14
		Expected Count	10.3	3.7	14.0
		% within	57.1%	42.9%	100.0%
	46 - 50	Count	5	5	10
		Expected Count	7.4	2.6	10.0
		% within	50.0%	50.0%	100.0%
	50+	Count	13	14	27
		Expected Count	19.9	7.1	27.0
		% within	48.1%	51.9%	100.0%
	Total	Count	87	31	118
		Expected Count	87.0	31.0	118.0
		% within	73.7%	26.3%	100.0%

Chi-Square = 0.000

Barriers and enablers for exercise

Barriers to exercising were explored by a series of questions relating to physical difficulties, time, expense, equipment, and the social and physical environment. The results reported by participants indicated that, in general, exercise is not too time consuming and exercising in small groups in the morning were their most commonly preferred options. The specific details are reported below.

The most common injuries suffered by both male (16%) and female (14%) participants were knee injuries (Table 5.3). About two thirds of males (67%) and females (62%) experienced no injuries whatsoever.

Table 5-3 Injuries that prevent participants from exercising

Injury	Male	Female	Total
Knee	9 (15.8%)	11 (14.3%)	20 (14.9%)
Back	3 (5.3%)	7 (9.1%)	10 (7.5%)
Shoulder	4 (5.2%)	4 (7%)	8 (6%)
Hip	1 (1.8%)	1 (1.3%)	2 (1.5%)
Calf	2 (3.5%)	0 (0%)	2 (1.5%)
Hand	1 (1.8%)	0 (0%)	1 (0.7%)
Other	4 (7%)	4 (5.2%)	8 (6%)
No Injuries	38 (66.7%)	48 (62.3%)	86 (64.2%)

The majority of participants did not find exercising more than 10 min vigorously too hard (Figure 5.1). It is encouraging to observe the response to the statement ‘Exercising more than 10 minutes vigorously is too hard; ‘sometimes’ was the most common answer followed closely by ‘never’.

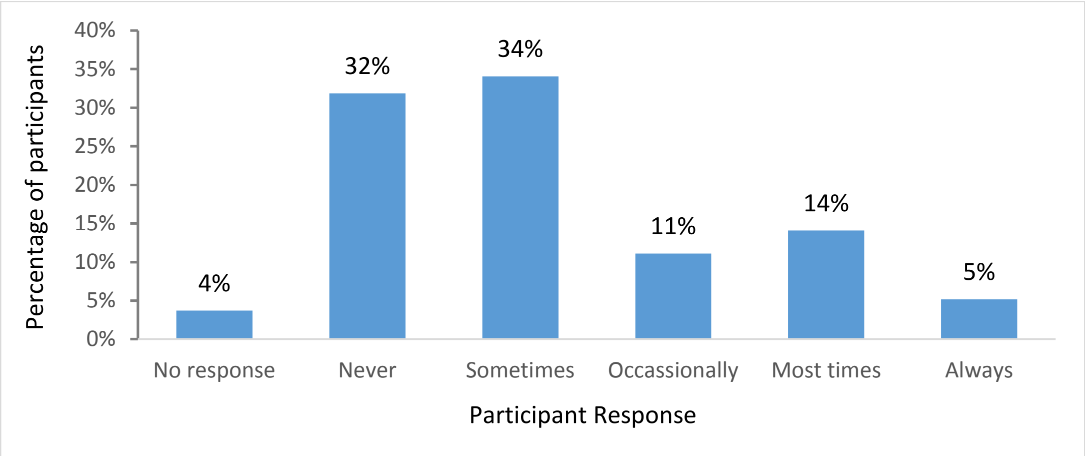

Figure 5-1. Responses to the statement ‘Exercising more than 10 minutes vigorously is too hard’.

In terms of exercise being too time consuming (Q11), 28% of participants responded that this was never the case and 16% said it was always or mostly the case (Figure 5.2).

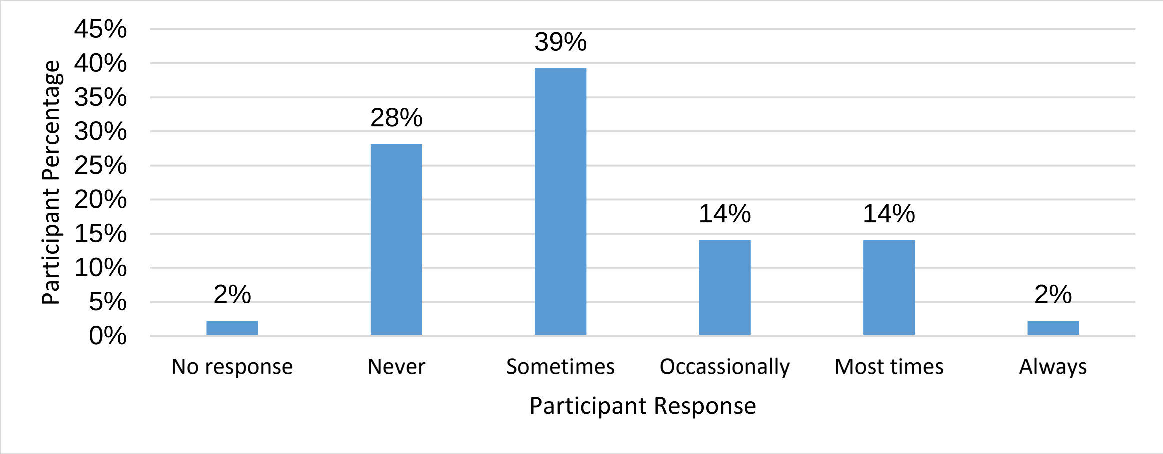

Figure 5-2 ‘Is exercise too time consuming?’ (Q11)

It is interesting to note marked differences in frequencies for particular responses to Q11. The majority of responses to this question indicated that it was difficult for females to find time to exercise every day. By comparison males (13%) responded almost 4 times more frequently to ‘very easy’ than did females (3%). However, there is no significance as overall there was no statistically significant difference between genders for finding exercise too time consuming (Pearson Chi-Square 0.646; Table 5.4).

Table 5-4 Gender cross tabulation (Q11) Is exercise too time consuming

Response	Males	Females	Total
Never	32.8%	27.3%	29.6%
Sometimes	32.0%	44.2%	39.3%
Occasionally	19.0%	11.7%	14.8%
Most times	13.8%	14.3%	14.1%
Always	1.7%	2.6%	2.2%
Chi Sq = 3.221	P= 0.620		

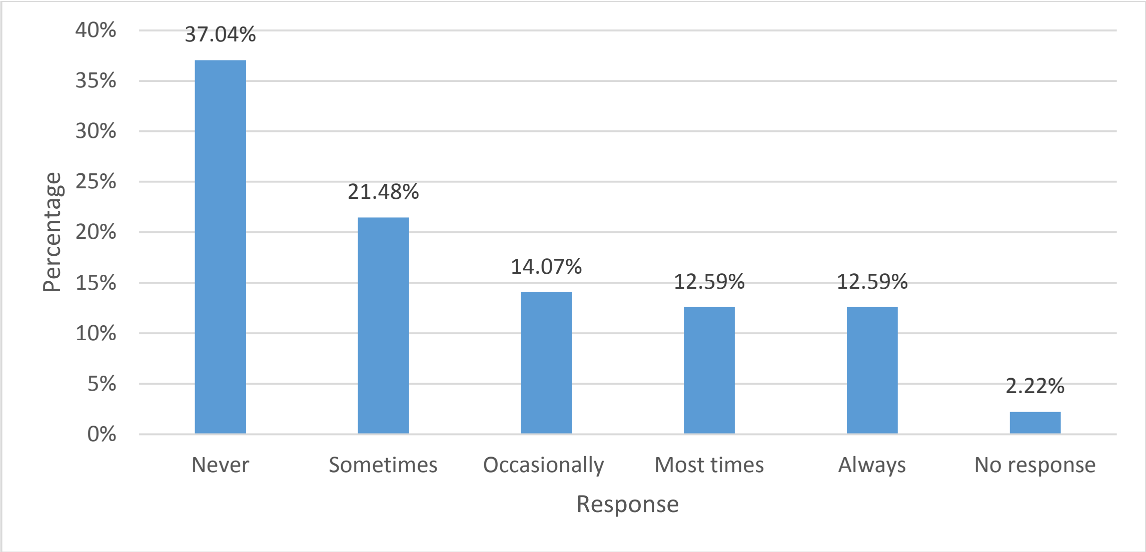

Figure 5-3 Responses to the statement ‘Exercise is too expensive?’ (Q12)

Over a third of the participants responded that they do not think exercising is too expensive, although twenty-five percent of participants indicated it was always or mostly too expensive (Figure 5.3). There was no significant difference between genders regarding whether exercise is too expensive (P=0.620; Table 5-5).

Table 5-5 Gender cross tabulation, is exercise too expensive?

Response	Males	Females	Total
Never	44.8%	33.8%	38.5%
Sometimes	22.4%	22.1%	22.2%
Occasionally	12.1%	15.6%	14.1%
Most times	12.1%	13.0%	12.6%
Always	8.6%	15.6%	12.6%

Chi Sq = 3.221 P= 0.620

When participants were asked about changing their diet, ‘Difficult’ was the most common response. In terms of the range of responses men had similar responses for both very difficult (9%) and very easy (10%) whereas females more often responded with very difficult (14%) as opposed to very easy (4%). There were no significant differences between genders regarding the participants’ response to difficulty changing their diet (P=0.239; Table 5.6).

Table 5-6 Participants' response to questions and gender cross tabulation

	Participants response to changing their diet (Q13a)						
			Very difficult	Difficult	Easy	Very easy	Total
Gender	No response	Count	0	1	3	0	4
		%	0	25%	75%	0%	100%
	Male	Count	5	23	22	6	56
		%	9%	41%	39%	11%	100%
	Female	Count	11	40	23	3	77
		%	14%	52%	30%	4%	100%
Total		Count	16	64	48	9	137
		%	12%	47%	35%	7%	100%

Response	Males	Females	Total
Very difficult	8.6%	13.9%	11.7%
Difficult	41.4%	50.6%	46.7%
Easy	39.7%	31.6%	35.0%
Very easy	10.3%	3.8%	6.6%

Chi Sq = 4.213 P= 0.239

Almost half of male participants (43%) found that exercising every day was easy but a similar proportion found it difficult (41%), a difference of less than 2% (P=0.043; Table 5.7). For females there was a 19% difference between the two most popular choices, difficult (51%) and easy (32%). There was also a significant difference between genders; males found it easier to exercise every day.

Table 5-7 Finding the time to exercise every day and gender cross tabulation.

Response	Males	Females	Total
Very difficult	3.4%	12.8%	8.8%
Difficult	41.4%	51.3%	47.1%
Easy	43.1%	32.1%	36.8%
Very easy	12.1%	3.8%	7.4%

Chi Sq = 8.169 P= 0.043

In response to the question regarding ‘motivating yourself to exercise’ (13c), ‘difficult’ was the most common response from both genders (P=0.370; Table 5.8). ‘Easy’ was the next most common response (37%) for both male and females. Overall, males recorded 6.9% for ‘very difficult’ and 13.8% for ‘very easy’, whereas, females recorded 13.9% for ‘very difficult’ and 7.3% for ‘very easy’. There was no statistically significant difference between genders regarding motivation to exercise.

Table 5-8 Participants’ response to motivating yourself to exercise with gender cross tabulation

Response	Males	Females	Total
Very difficult	6.9%	19.0%	13.9%
Difficult	43.1%	39.2%	40.9%
Easy	36.2%	38.0%	37.2%
Very easy	13.8%	2.5%	7.3%

Chi Sq = 10.221   P= 0.37

Question 13d was designed to ask for participants’ response to exercising with an injury (Q13d) (P=0.454; Table 5.9). While ‘difficult’ was the most common response to this question, ‘easy’ was the next most common response with 20% of both males and females returning this response. In terms of ranges between ‘very difficult’ and ‘very easy’, males recorded an average difference of approximately 2%. There was no significant difference between genders regarding ease of exercising with an injury.

Table 5-9 Participants' response to exercising with an injury with gender cross tabulation (13d)

Response	Males	Females	Total
Very difficult	10.5%	16.0%	13.6%
Difficult	57.9%	60%	59.1%
Easy	19.3%	18.7%	18.9%
Very easy	12.3%	5.3%	8.3%
Chi Sq = 2.618 P= 0.454			

The majority of males and females reported putting up with pain associated with exercise as difficult, however there was only a 4% difference between the prevalence of difficult and easy responses (P=0.556; Table 5.10). Almost 9% of males compared with 4% of females indicated it was 'very easy'. Nearly twice as many females find 'exercising with pain' 'very difficult', compared to males. Overall there was no significant difference between genders regarding putting up with the pain associated with exercise.

Table.5-10 Participants response to: How difficult are the following for you? - "putting up with the pain associated with exercise".

Response	Males	Females	Total
Very difficult	6.9%	11.8%	9.7%
Difficult	43.1%	44.7%	44.0%
Easy	41.4%	39.5%	40.3%
Very easy	8.6%	3.9%	6.0%
Chi Sq = 2.082 P= 0.556			

Half the participants suggested that it was difficult to exercise the next day as a result of pain from exercising; that is, delayed onset of muscle soreness (DOMS). Comparing genders males (10%), compared to females (1%), find it very easy to exercise with DOMS. There was no significant difference between genders regarding exercise and DOMS (P=0.138; Table 5.11).

Table 5-11 Exercising the next day as a result of pain associated from exercising the day before gender cross tabulation.

Response	Males	Females	Total
Very diff.icult	10.3%	11.7%	11.1%
Difficult	46.6%	50.6%	48.9%
Easy	32.8%	36.4%	34.8%
Very easy	10.3%	1.3%	5.2%
Chi Sq = 5.512 P= 0.138			

Exercise preferences and environment

Participants preferred to exercise early in the morning or early evening rather than any other time. Exercising between 9 am to 5 pm was the least preferred time of day; this is probably due to the participants being at work, 42% (Figure 5.4).

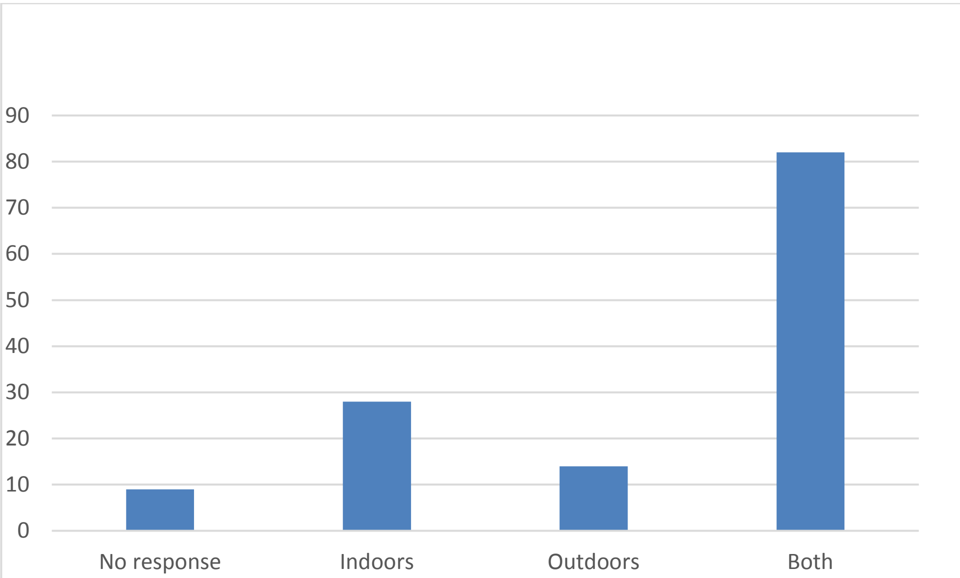

Figure 5-4 Response to ‘What is the most convenient time of day for you to exercise?’

The majority of participants indicated that they are comfortable exercising by themselves; as ‘sometimes’ and ‘most times’ were the two most common responses. However, a substantial minority indicated they were never or only sometimes comfortable exercising alone. A majority (60%) of participants had a preference for exercising in small groups ‘most times’ or ‘sometimes’. When participants were asked if they felt comfortable exercising in groups of 7 people or larger, sometimes (28%) was the most common response followed by never (26%). When asked, ‘do you feel uncomfortable exercising in groups? ‘don’t mind’ (29.6%) was the most frequent response and a minority of respondents (6.7%) were ‘always’ uncomfortable exercising in groups (Table 5.12).

Table 5-12 Exercise habits and environments

Question	All times	Most times	Sometimes	Never	Don’t Mind
Do you prefer to exercise?					
a – On your own?	11.10%	20.00%	28.90%	13.30%	21.50%
b – in small group (2-6)?	10.40%	21.50%	31.10%	12.60%	20.70%
c – in medium group (7+)?	5.20%	15.60%	29.60%	20.00%	19.30%
Do you feel uncomfortable exercising in groups?	6.70%	10.40%	21.50%	26.70%	29.60%
Chi sq = 4.893 P = 0.451					

Lack of motivation was the most common response for the question regarding any other reasons for not exercising for both genders (Q15). For females (26%) ‘family time constraints’ were indicated almost 3 times as frequently than for males (10%). Responses to work commitments were similar between males (13%) and females (11%). There was no significant difference between genders regarding reasons for not exercising (P=0.298; Table 5.13).

Table 5-13 Any other reason you don't exercise with gender cross tabulation?

Response	Males	Females	Total
Lack of motivation	33.3%	34.0%	33.7%
Family time constraints	10.3%	26.4%	19.6%
Work commitments	12.8%	11.3%	12.0%
Medical condition	7.7%	5.7%	6.5%
No excuse	20.5%	7.5%	13.0%
Not enough time	15.4%	15.1%	15.2%
Chi Sq = 6.082 P= 0.298			

Exercise and support

Participant responses to questions surrounding exercise and support were investigated using a series of questions about other commitments and motivators. Several factors that would support exercise on a regular basis are presented in the next six tables. Physical activity or exercise was not preferred by the participants during work hours in this study and a majority of them preferred activities which supported family inclusion, partner or group training, with the emphasis on improving health outcomes. Participants' most common response to the question surrounding exercise and support was group training. Group training was the highest response surrounding participants' view on exercise support being almost twice the preference of the next common response which was "other" followed closely by family inclusion of males and improved health for females (Table 5.14).

Table 5-14 Questions surrounding participants' views on exercise support

	Male (%)		Female (%)	
Response to:	No	Yes	No	Yes
PA in work hours	96	4	94	6
Family inclusion	89	11	88	12
Improved health	96	4	87	13
Constant timetable	98	2	97	3
Training partner	96	4	99	1
Group training	68	32	75	25
Chi Sq = 4.987 P = 0.342				

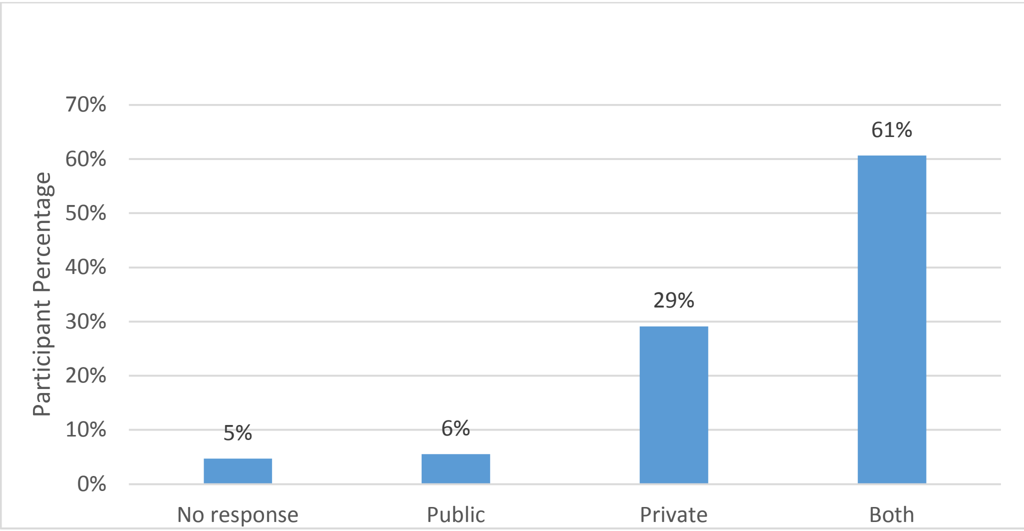

Figure 5-5 Responses to the statement 'Preferred exercise venues'.

Participants were asked about their preferences for exercising in public places or in private. Sixty-one percent of respondents indicated no preference, whereas exercising only in public was the least preferred option (6%). Males (13%) were more likely than females (4%) to prefer exercising in public (but this difference was not statistically significant), whereas males (14%) and females (36%) preferred to exercise in private. In terms of an exercise venue, two thirds of the participants preferred both private and public options (Figure 5.6).

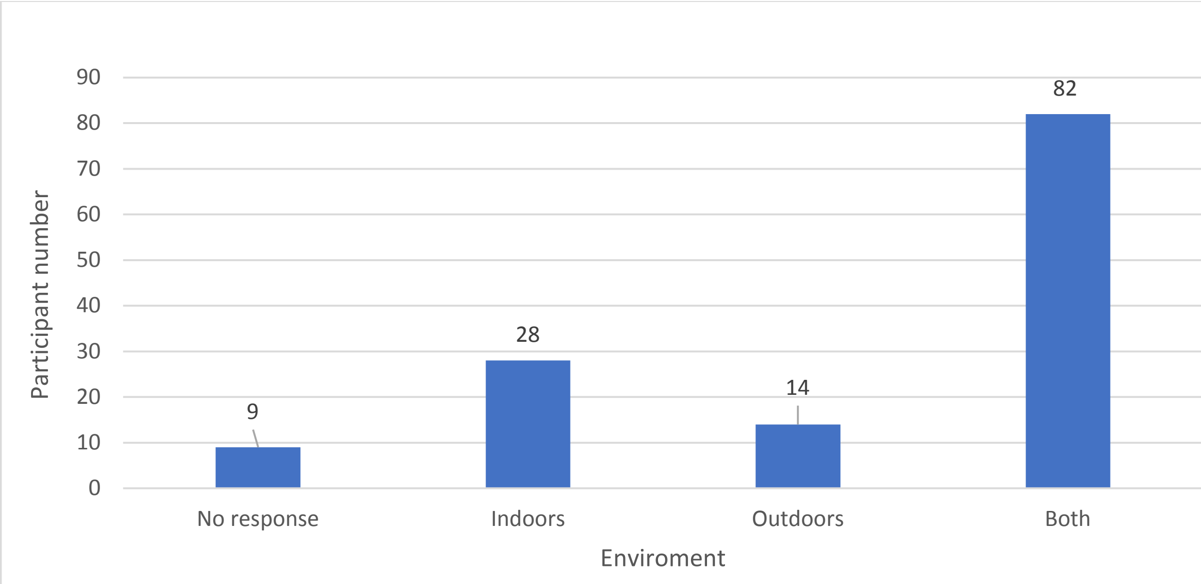

Figure 5-6 Responses to the statement 'Do you prefer to exercise in; indoors, outdoors or both.

There was little difference between males and females in terms of preference for indoor or outdoor exercise. An exception lies with indoor exercise for which women expressed a slight (8%) preference (Figure 5.7). It is not known whether they were referring to a gym or other type of indoor exercise environment. Most participants preferred exercising either indoors or outdoors, whereas exercising exclusively outdoors received the lowest response (10%) (Table 5.15).

Table 5-15 Comparison of males' and females' responses to the question about ' Do you prefer to exercise; indoors, outdoors or both'?

Location	Male (n=56)	Female (n=77)	P-value
Indoor	23%	18%	0.757
Outdoor	9%	10%	0.59
Both	64%	65%	0.81

Participants were asked about the types of exercise they would like to try in order to improve their fitness and physical activity levels. Walking was the most popular activity to improve fitness followed by traditional activities and gym exercise. The least preferred activities were Boot camp training (Figure 5.7).

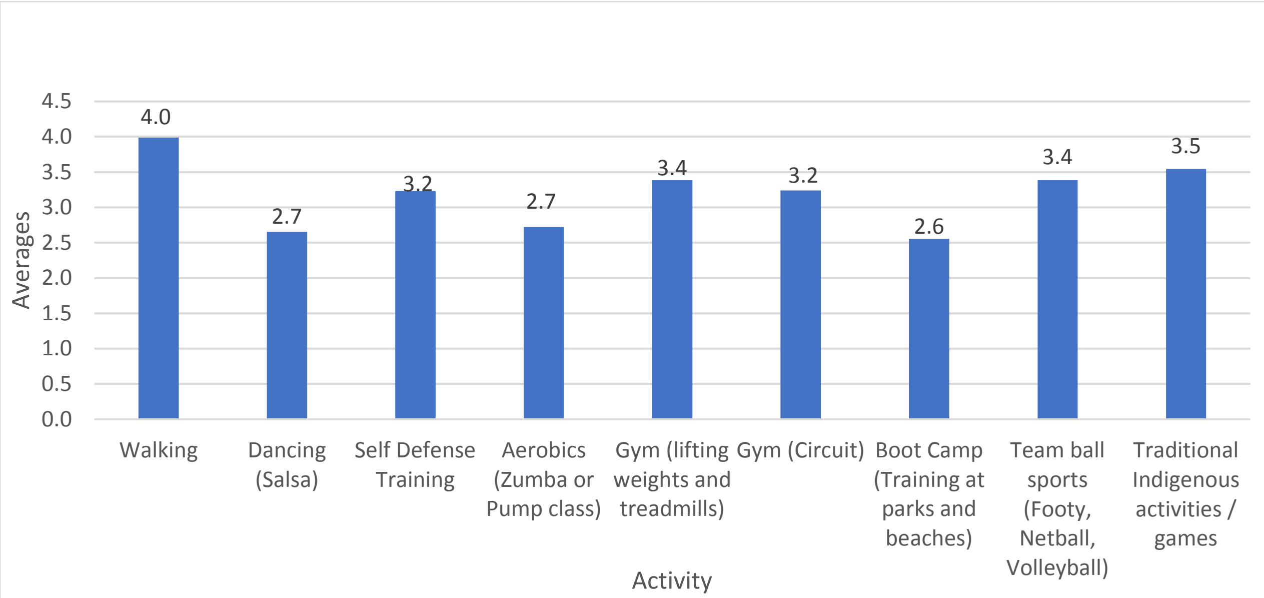

Figure 5-7 Participants' response to trying activities to improve fitness and activity levels.

Exercise equipment and activities

The most commonly owned exercise equipment among participants included a skipping rope and dumbbells. The least commonly owned fitness equipment was a stepper, with 64% of participants not owning any exercise equipment at all. An exercise bike was the most common, and fitness DVD the least common, piece of equipment owned by men. Among women dumbbells were the most common and resistance bands the least common items. There were no significant differences between men and women (Table 5.15).

Table 5-16 Fitness equipment owned by gender

Fitness equipment item	Male	Female	P value
Treadmill	6 (10%)	68 (12%)	0.764
Exercise bike	14 (25%)	15 (19%)	0.428
Stability ball	4 (8%)	13 (17%)	0.202
Skipping rope	12 (21%)	16 (21%)	0.978
Home gym	5 (9%)	10 (13%)	0.542
Stepper	2 (4%)	9 (12%)	0.197
Dumbbells	10 (18%)	20 (26%)	0.301
Fitness DVD's	0 (0%)	15 (19%)	0.001
Resistance bands	3 (5%)	2 (2%)	0.651
Other equipment	2 (4%)	5 (6%)	0.673
Any fitness equipment owned	20 (36%)	28 (36%)	0.848

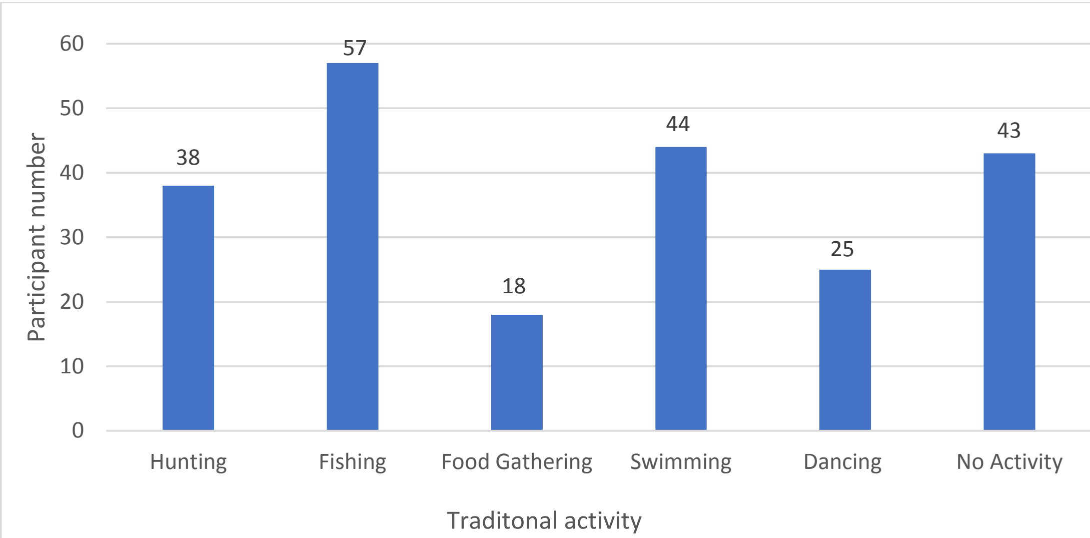

Figure 5-8 Traditional physical activities in which survey respondents participated

Fishing (42%) was the most frequent traditional activity conducted in the Perth Metropolitan area, followed by swimming (33%; Figure 5.8). Almost one third of respondents participated in no traditional activities (32%). Food gathering was the least frequent traditional activity (13%) (Figure 5.8).

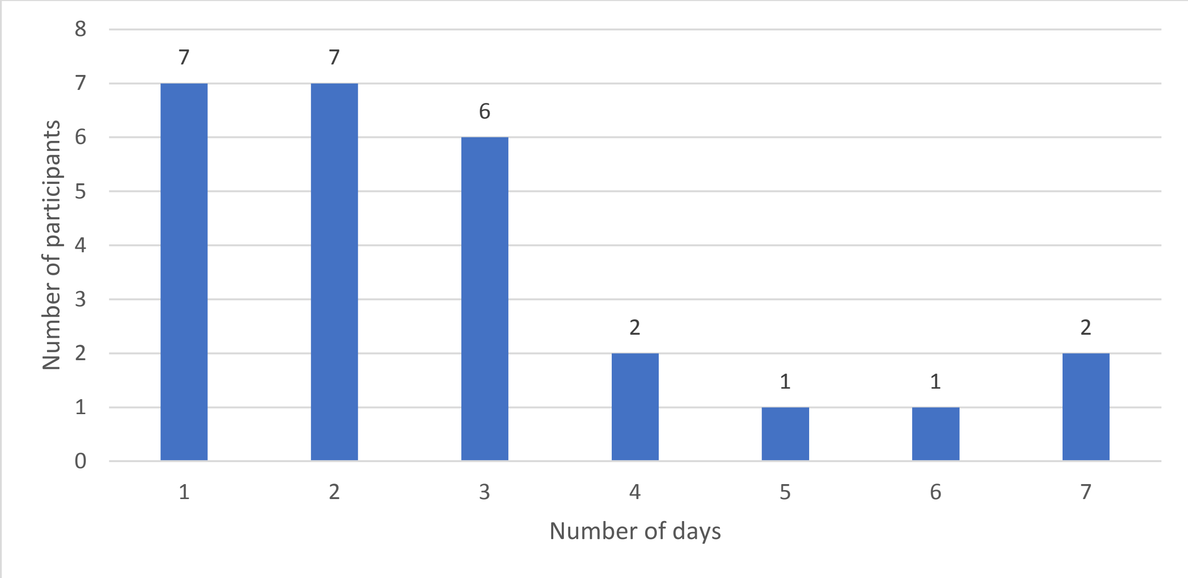

Figure 5-9 Gym attendance (Days per week)

The twenty-six participants (18%) who had or still attended the gym were asked to identify the number of days they trained per week. The most common number of days to train at gym per week was one to three days. The least common number of days training at the gym was 5 and 6 days (Figure 5.9).

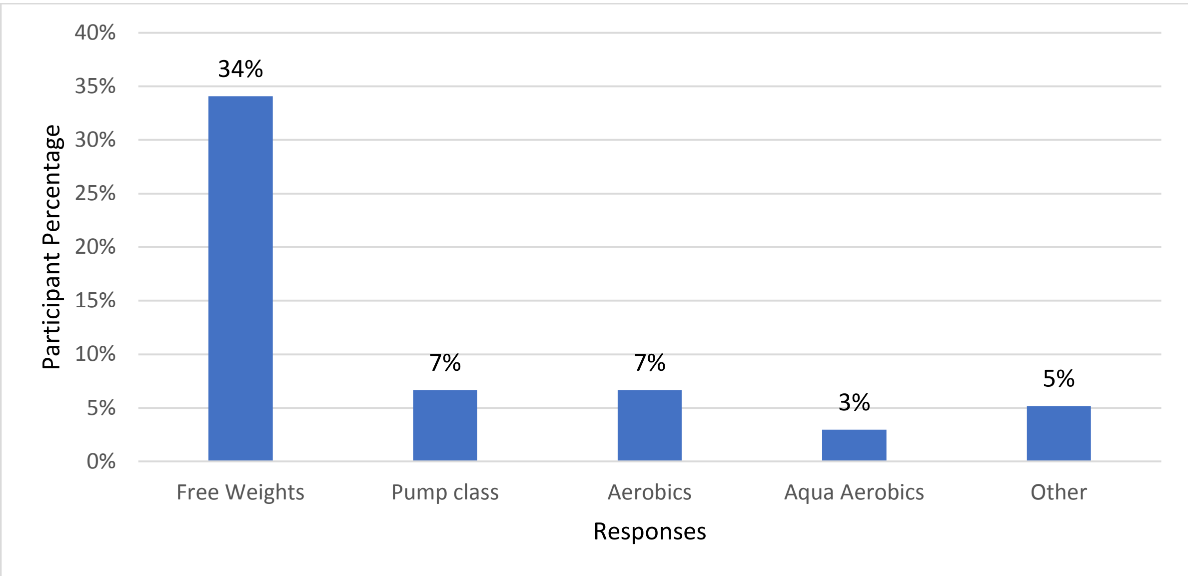

Figure 5-10 Responses to the statement ‘(Q27) What was your favourite activity in the gym?’

The response to the statement of (Q27) elicited a clear preference with other activities receiving similar responses. Of the 75 participants who had a gym membership, using weights by themselves was their favourite activity (61%) followed by pump class and aerobics (12%) (Figure 5.10).

Goals and commitment

The most common reason for joining the gym was to become healthier followed by improved fitness. The least common response was for body image (Figure 5.11). Forty one people reported that they had previously had a gym membership but had quit (Figure 5.12). The main reason the participants ceased gym attendance was the cost of gym membership.

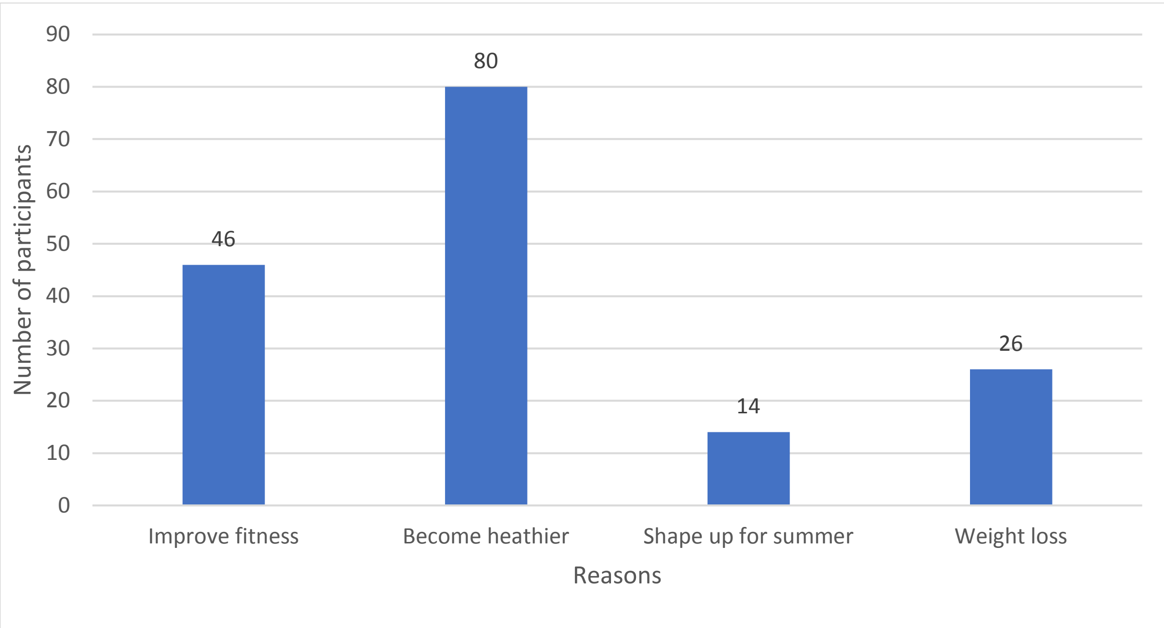

Figure 5-11 Why did you join the gym?

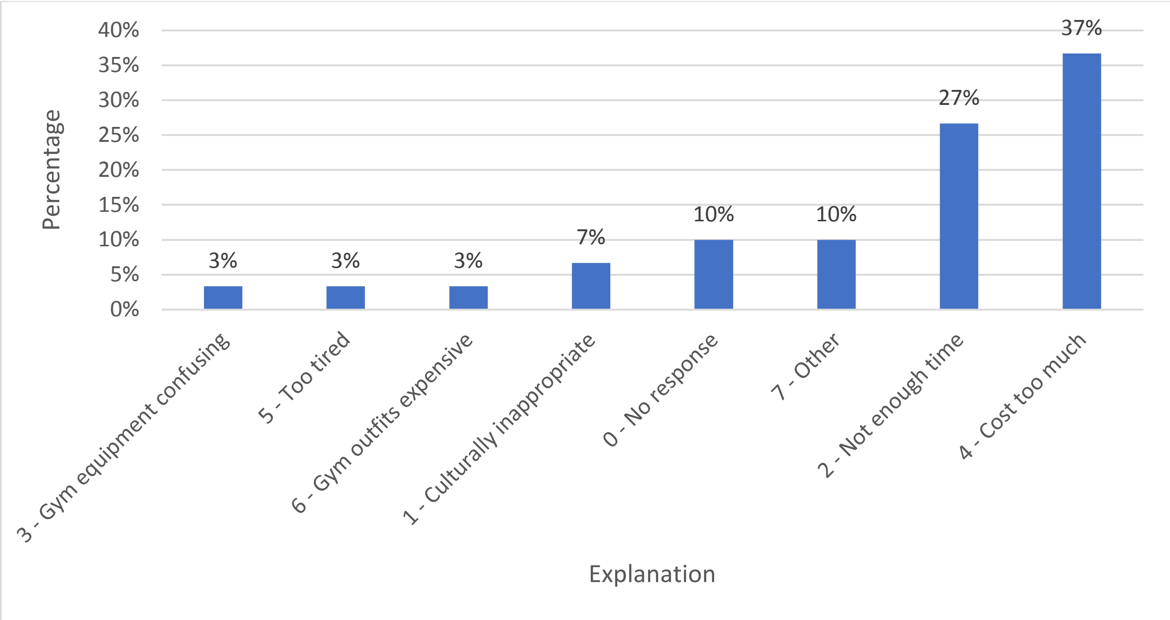

Figure 5-12 Responses to the question 'Why did you quit the gym'?

There was a mixture to the response of this question; (Q30) 'How committed are you to achieving fitness goals?' with a majority of responses in the committed categories (Figure 5.13).

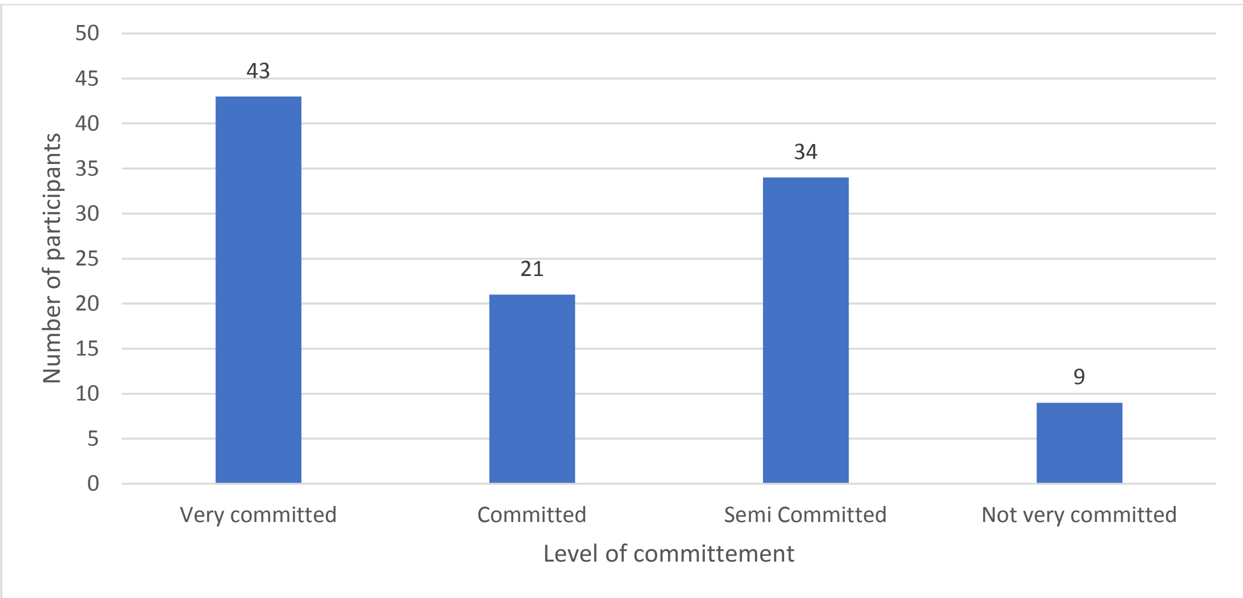

Figure 5-13 Commitment to attain fitness goals

Question 30 was ‘If you were able to attend a gym that was flexible enough to meet your communities’ needs with other Indigenous participants and have access to a personal trainer all for free would you be willing to train in a gym?’, a majority of the participants (80%) provided a yes response. A minority of participants indicated ‘maybe’ which was the next most common response to the question (15%) and a no (5%) response (Figure 5.14).

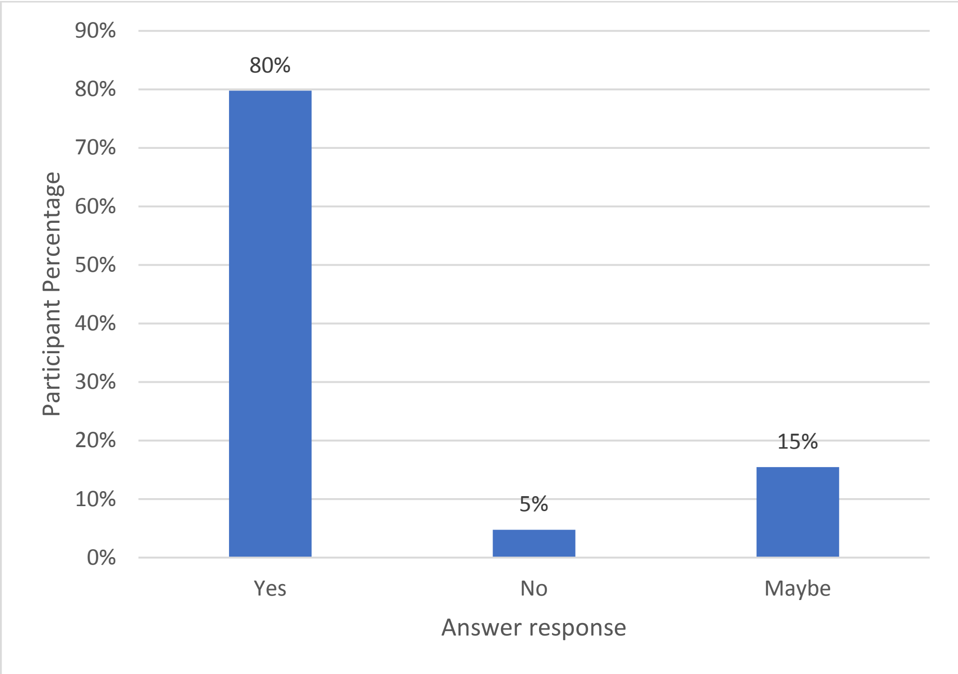

Figure 5-14 If you were able to attend a gym that was flexible enough to meet your needs and the community’s needs with other Indigenous participants and have access to a personal trainer all for free would you be willing to train in a gym?

There are a number of MetS, anthropometric and physical activity correlations in Table 5.17.that indicate significance relationships. These included:

Age

Older people had greater prevalence of metabolic syndrome, less recreational activity

Metabolic Syndrome

Those individuals with higher BMI and weighed heavier had greater prevalence of MetS.

Total physical activity

Activity at work, travel and recreation physical activity were significantly related to total physical activity. There was also a significant relationship between traveling actively to work and recreational activity in younger participants. Finally, the younger a participant was the greater the probability that physical recreation was completed.

Table 5-17 Metabolic Syndrome, anthropometric and physical activity correlations

		Age	MetS	BMI	Weight	Pant size	Total Physical Activity	Activity at work	Travel	Recreation
Age	Pearson Correlation	1	.644**	.198	.037	.016	-.129	-.033	.039	-.284**
	Sig.		.000	.095	.746	.889	.243	.768	.726	.009
	N	85	83	72	79	78	83	83	83	83
MetS	Pearson Correlation	.644**	1	.262**	.243**	.098	-.061	-.005	.015	-.158
	Sig.	.000		.006	.008	.306	.485	.954	.865	.066
	N	83	135	107	119	112	135	135	135	135
BMI	Pearson Correlation	.198	.262**	1	.866**	.280**	-.138	-.078	-.159	-.125
	Sig.	.095	.006		.000	.006	.156	.423	.103	.198
	N	72	107	107	107	96	107	107	107	107
Weight	Pearson Correlation	.037	.243**	.866**	1	.598**	-.038	.001	-.093	-.062
	Sig.	.746	.008	.000		.000	.684	.993	.315	.505
	N	79	119	107	119	107	119	119	119	119
Pants	Pearson Correlation	.016	.098	.280**	.598**	1	.160	.140	.002	.114
	Sig.	.889	.306	.006	.000		.092	.142	.987	.231
	N	78	112	96	107	112	112	112	112	112
Total Physical Activity	Pearson Correlation	-.129	-.061	-.138	-.038	.160	1	.899**	.443**	.496**
	Sig.	.243	.485	.156	.684	.092		.000	.000	.000
	N	83	135	107	119	112	135	135	135	135
Activity at work	Pearson Correlation	-.033	-.005	-.078	.001	.140	.899**	1	.196*	.089
	Sig.	.768	.954	.423	.993	.142	.000		.023	.306
	N	83	135	107	119	112	135	135	135	135
Travel	Pearson Correlation	.039	.015	-.159	-.093	.002	.443**	.196*	1	.376**
	Sig.	.726	.865	.103	.315	.987	.000	.023		.000
	N	83	135	107	119	112	135	135	135	135
Recreation	Pearson Correlation	-.284**	-.158	-.125	-.062	.114	.496**	.089	.376**	1
	Sig.	.009	.066	.198	.505	.231	.000	.306	.000	
	N	83	135	107	119	112	135	135	135	135

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Sig – significance N - Number

Discussion

Despite clear evidence that regular physical activity is associated with a reduction in risk and severity of numerous chronic diseases including diabetes and CVD, studies on the motivators and barriers for Australian Indigenous people to exercise are scarce. This aim of this study was to explore various aspects of exercise and physical activity among a group of metropolitan Indigenous people.

Understanding the barriers and motivators to exercise are crucial if an exercise intervention that improves health outcomes is to be sustainable in the Indigenous community. The rationale for the focus on physical activity is clear and innovative strategies which incorporate building pride, cultural identity and self-esteem as well as the ability to deliver on improving physiological and psychological health are critical. Prior to this study, there was no specific questionnaire in existence to evaluate such characteristics. The initial phase of the study was development and piloting of the questionnaire as described in chapter 4, and the results of the final questionnaire have been described here in chapter 5.

Models of change

Prochaska and DiClement proposed the transtheoretical model (TTM) of behaviour change to better understand and treat a wide range so health behaviours including physical inactivity, and is a model that aims to assist health professionals in the design, implementation and evaluation of interventions (Prochaska & Marcus, 1994). The four central concepts of TT are stages of change; processes of change; decisional balance and self-efficacy and the five stages of changes of TTM that individuals move through cyclically include periods of progression and relapse (Middelkamp, Rooijen, Wolfhagen, & Steenbergen, 2017). The five stages of changes of the TTM are provided in figure 5.15.

Stages	Characteristics
Precontemplation	Individual does not intend to change behaviour in the next six months
Contemplation	Individual is strongly inclined to change behaviour in the next six months
Preparation	Individual intends to act in a near future (generally next month)
Action	Behaviour has already been incorporated for at least six months
Maintenance	Action already happens for over six months and the chances to return to old behaviour are few

Source: Adapted from Prochaska and Marcus (1994).

Figure 5-15 Models of behaviour change

Participants of this study would certainly be at various stages and expressing diverse characteristics of the TTM model.

The 26 to 45-year-old age bracket made up almost half (48%) of the participants in this study and it is this group who are at high risk of developing the metabolic syndrome. Generally, the participants in this study found exercise not to be too time consuming and preferred to exercise in small groups in the morning. They were happy to exercise both publicly and privately as well as indoors and outdoors. Fishing was the most popular traditional activity undertaken and walking was the most popular physical activity. As a whole, 36% of male and female participants have access to dumbbells or other basic home exercise equipment which allow them to conduct a least 2 days of muscle strengthening exercising each week, which will afford them the opportunity to meet the ESSA recommended guidelines. Whether the participants in this questionnaire understood the relationship between exercise and health is unclear, but 48% of participants indicated they joined the gym to become healthier.

Motivators and barriers to physical activity

There is overwhelming support to that physical activity is beneficial both physically and mentally. Being able to understand the barriers to participating in physical activity and the means to overcome them is paramount to improving the quality of life for this or any other community. The following discussion addresses a number of barriers to physical activity that were identified by participants of this study and participants of other studies.

This was to ensure that any future interventions would include the most appropriate form of physical activity for the individuals and groups involved. The majority of physical injuries that prevented participants from exercising in this study were knee injuries which were almost double the frequency of the next most common site of injury, the back. Physical therapy treatments encourage the use of hydrotherapy particularly where the effects of weight bearing (gravity) cause pain (Silva et al., 2008). Identifying the most appropriate exercise medium is paramount for those who have pre-existing injuries; it ensures these injuries are not further aggravated while at the same time, ensuring participants are gaining the benefits associated with undertaking exercise.

Indigenous families are very large and extended beyond the average non-Indigenous benchmark population nuclear family (Memmott et al., 2012). These extended family members can sometimes bring both tangible and intangible constraints on time and resources. This study, however, did not identify work and family commitments as a major constraint to performing physical activity, which was dissimilar to the study by Hunt, Marshall & Jenkins (2008) exploring the meaning of and barriers to physical activity among urban Indigenous Australians (Murries) in Brisbane. The Hunt study involved 96 participants and the results indicated a clear understanding of the relationship between physical activity and health by the participants. The results of their study were that the burden of family or work responsibilities can sometimes impact on the participant's ability to participate in physical activity. However, there is a dearth of information relating to this study area in the published peer reviewed literature and more studies need to be conducted before any attempt to draw definitive conclusions.

The exercise industry is a multi-million-dollar industry which bombards us with a multitude of health, beauty and exercise products on a daily basis. It makes extraordinary promises, from losing weight to toning up to looking younger and stronger practically overnight. Gaining an understanding of Noongars' perceptions regarding the cost (and perceived benefits) of exercise is a pertinent question given the amount of exposure to advertisements, particularly for gym memberships. Just over a third (37%) of participants have never had a gym membership (Figure 5.9).

In terms of physical activity reported by participants in this study, walking, domestic chores and specific sports were common. We also found 14% of males and 36% of females preferred to exercise in private and 29%, when asked if exercise is too expensive, responded that "exercise is never too expensive". It is possible that this question was answered with home or community based exercises in mind, which is in stark contrast to the study by Hunt and colleagues (2008). The difference in the perception about the cost of exercise may be attributed to this study recruiting a majority of its participants from workplaces as well as targeting people of working age (18-60 years).

Exercise preferences and environment

There is growing consensus that while gyms are ideal places to work out for health purposes they are also becoming venues for athletes, not overweight/obese people. This can affect the cultural safety of the gym environment. Hence, the questions were structured around preferred exercise environments. Being judged by others (shame) when in public spaces, cost (gym based) and accessibility, were indicated as barriers by the participants.

Walking was identified as the most popular physical activity in both the study by Marshall, Hunt and Jenkins (Marshall, Hunt, & Jenkins, 2008) and this study. In terms of exercising venues there was no preference to either indoor or outdoor settings or a public or private setting, unlike the findings reported by Hunt, Marshall & Jenkins (2008). In their study, family was central to promoting physical activity (Hunt et al., 2008). We asked a question relating to exercising in groups although not specifically about family. Also of importance is the consideration that Australian Football is the most popular sport in Perth and local recreational football clubs in general have at least one Indigenous player. Therefore, a large number of related family members are often involved in their clubs, from players, or those assisting with administration or catering. In terms of relating physical activity to family the question, "Do you enjoy playing games involving sports equipment?" is perhaps the closest fit in terms of its ability to pick up this information. Indeed, most participants answered 'all times', to this question. In hindsight a question directly asking about family similar to that posed by (Marshall et al., 2008) would have elicited a more appropriate response.

Both Melbourne and Sydney have gyms specifically for Indigenous clientele. These environments are operated by Indigenous people and encourage both genders to attend. In Perth there is an exercise program based at Derlbarl Yerrigan Health Service targeting Elders. The group meets once a week where they exercise, attend an education session about healthy living and are provided with a healthy lunch. The compliance rate for attendance is very high and the program has proved to be effective. The results of the program are unpublished at this stage and the effectiveness is based on the number of Elders returning to the exercise sessions week after week. The information was obtained with a verbal conversation with the program director. It is important also that this program is focused on Elders, who may include people no longer in work, in contrast to the sample in the current study who were more restricted by working hours.

The American College of Sports Medicine (ACSM) guidelines for physical activity suggest 150 – 250 min/week of moderate intensity physical activity is needed for weight loss and 250 min of moderate intensity physical activity is needed for weight maintenance after weight loss thereby preventing weight regain. They also suggest two or more resistance training sessions per week (American College of Sports Medicine, 2015). Meeting the aerobic training component of the ACSM requires no equipment, however meeting the anabolic requirements can be achieved with an array of methods. Exercise resources are available on the Internet detailing how one can exercise with no equipment (body weight exercises), using basic fitness equipment (fitness ball, dumbbells, resistance bands) or improvised fitness equipment (empty milk cartons filled with sand, tractor tyres etc).

Having an insight into the fitness equipment the Noongar community has provided the means to develop better resources for the community. In this study it was found that two thirds of participants do not own any exercise equipment. Any community based program will have to consider either body weight exercises or securing funding to purchase basic equipment like resistance bands, hand weights and fitness balls.

Workplace fitness interventions were not favoured by the participants in this study. This is despite a number of studies (Baxter, Sanderson, Venn, Blizzard, & Palmer, 2014; Hammerback et al., 2015; Rongen, Robroek, van Lenthe, & Burdorf, 2013) that suggest workplace health and fitness is an effective health promotion strategy. At the time of writing only one published Australian Indigenous workplace intervention study was found (Reilly et al., 2011).

Goals and commitment to exercise

Most of the participants indicated that they were committed to attaining their fitness goals. This is particularly the case when afforded the question regarding access to a culturally safe exercise environment and program, to which the response was overwhelmingly positive. The acquisition of a purpose-built gym for the Noongar community would be beneficial for health outcomes. Preliminary discussions have been held with the Indigenous Land Council and Lotteries West about the means of how to do this.

Other studies have shown that sport and leisure are seen as important as they develop social and community links and provide a vehicle for positive self-expression (Hood & Carruthers, 2013). Family and peer influences are important in encouraging community participation (Nelson et al., 2010a; Thorpe, Anders, & Rowley, 2014a). Recreation is often promoted as a way of addressing boredom and preventing crime, an opportunity for relaxation and a reprieve from social issues (Doyle, Firebrace, Reilly, Crumpen, & Rowley, 2013b). In many ways it allows one to escape from the day to day reality of family conflict and homelessness and avoid temptations such as alcohol and drugs (Van Hout & Phelan, 2014).

Traditionally, Indigenous men and women had roles within their society. They would be steadfast in these roles or face their Elders for punishment. Traditionally, knowledge would be passed down from fathers to sons and mothers to daughters after initiation. Traditional knowledge is defined as local knowledge held by Indigenous peoples (Ohmagari & Berkes, 1997). The acquisition of food, performing ceremonies and daily living were time and labour intensive. This study has collated information on traditional cultural activities performed in contemporary society. Fishing is the most common activity with almost half of the participants still participating. Only 15% of the participants partake in hunting activities. The health of the Indigenous community is the worst in Australia and stems from a shift away from traditional practices (Patrick, Noy, & Henderson-Wilson, 2016). This is not a pattern that is unique to the Australian Indigenous population. The health and wellbeing of Australian Indigenous peoples are similar to those of other Indigenous communities around the world due to European invasions of traditional lands (Dew, Scott, & Kirkman, 2016). For example, the increase in adverse health outcomes and reduction in the quality of life has similarly resulted from the decline of the proportion of traditional foods in the diets of Indigenous Arctic residents (Nuttall et al., 2004).

Getting people to participate in physical activity has been shown to convey a number of positive effects both physically and psychologically. Physically, it improves both physical strength and fitness, and psychologically, it has the means to deliver people from social isolation and reduce stress and depression. Providing the resources or opportunity for individuals to participate in physical activity is only a fraction of the cost when compared to interventions that need to be designed for the aforementioned social issues, hence, the cost-effective strategies are those that aid in the prevention of anti-social behaviour (Utting, Fagan, & Eisenberg, 2012).

Implications for program design

The implication for designing exercise programs for the Indigenous community should go beyond simply the frequency, intensity, type and time required to exercise. It needs to take a holistic view on exercise prescription and incorporate both the Western and Indigenous views (see table 3.3). When designing a program, it is important to cater for all individuals. Exercise preferences vary between individuals, families, and communities. It may require designing programs for individuals so they are able to safely train by themselves or organising a personal trainer for 1 on 1 training. Some people prefer to train in small or large groups (football or netball teams). Some of these individuals may be injured and cannot perform certain exercises. Flexibility is the key to any successful program.

In terms of Indigenous programs, all stakeholders in the program must have cultural competence. The training environment must be a culturally safe space void of any vanity. It should focus on providing for the needs of the individual/group. More importantly it should focus on meeting the actual needs, not the program trainers' perceived needs.

Strengths and limitations of this study

A strength of this study is that the questionnaire could only be successfully designed with Noongar community input with many individuals and organisations contributing by sharing their thoughts, questions and feedback for the questionnaire. Second, participants of the questionnaire were recruited from many different places which included universities, students and staff, shopping centre food courts, public transport. A limitation of the research method is that most recruitment occurred at workplaces which could mean that the survey sample is more representative of the employed section of the Noongar community. Not incorporating a qualitative research methodology, such as in-depth interviews or focus groups, may have limited the depth and reliability of the findings and the opportunity to elicit some rich insights into the complexities of people's lives and its relation to physical activity and exercise.

Conclusion

This study was an examination of the motivators and barriers to exercise in the Noongar community. These were identified using a questionnaire that was designed by this same community. The purpose of the study was to ensure that any future exercise interventions maximise the participation and retention of participants. The questionnaire served as a means to identify the levels and intensities of exercise, and modes of exercise. Being able to perform exercise in an appropriate venue generates inquiry into perceived financial costs of exercise, exercise venues and environments. We also explored different modes and means of participating in contemporary vs traditional exercise and equipment owned to allow pursuit in the activity. Finally, we addressed issues of commitment of participants to achieving health and fitness goals. Because of the diversity within the Noongar community, programs must be tailored towards the participants. The consistent theme is that programs and venues must be culturally secure and be as inclusive as possible to be successful. This has provided considerable insight as to what a cultural secure physical activity or exercise activity within the Noongar community looks like. We now have a clear understanding that training and compliance to training will be more effective in group training sessions and there is no preference to indoor or outdoor, private or public training venues and that most participants feel exercise is too time consuming. High intensity interval training may be a means of reducing the time required to obtain equal or improved anthropometric and physiological health benefits while exercising for a third of the time (20 min per session). Most participants have indicated that exercising more than 10 minutes is not too hard for them.

A walking intervention was the most popular physical activity program identified by participants, followed by a traditional activity. Contemporary Noongar people still participate in fishing which is their most commonly identified traditional activity conducted. Exercising in the gym was closely behind in terms of the next exercise environment, with free weights being identified as their favourite gym activity. Reasons for joining the gym were most often to become healthier. While the participants found that exercising using body weight or simple equipment was not expensive it was revealed that cost of gym memberships was the most common reason why participants quit the gym.

Injuries do not appear to be a common barrier to exercise as two thirds of the participants identified having no injuries and being free from the most common injury site that was identified, the knee. Time appears to be a barrier to exercise particularly for females and persons with family commitments.

These components must be understood and will warrant inclusion into any successful Indigenous PA program design. These components include: family and group based exercise participation; utilising exercise as a vehicle that connects individuals to kinship ties within their community; activities that have widespread community support and run entirely by community members. Other key components include the flexibility to cater for participants at different levels of fitness, time commitments, preferred environments and even injury type. Where a mainstream environment is being used for a program then the selection of an appropriate one without the vanity or concern about a fashionable image should be prioritised. Depending on numbers the engagement of an Indigenous Exercise Physiologist and Personal Trainer should be considered.

Securing the support from other community fitness leaders, gym staff and management and access to an isolated room may be strategic initially then as confidence grows introduce participants to a more public venue. The ability to remain flexible, meet actual need of participants and provide continued support of participants is in essence what will lead to successful program outcomes.

Chapter 5
Global Physical Activity Questionnaire: Measuring activity in a Perth Australian Indigenous population

Introduction

Physical activity is defined as "any bodily movement produced by the skeletal muscle that results in energy expenditure (EE)" (Kumahara et al., 2004). Inactivity is known to be associated with an increased risk for many chronic diseases including: coronary artery disease, stroke, hypertension, colon cancer, breast cancer, Type 2 diabetes, and osteoporosis, as well as premature death (Prince et al., 2008). Physical inactivity is defined as either engaging in less than 20 min/day of vigorous-intensity physical activity on at least 3 days/week, or less than 30 min/day of moderate-intensity physical activity on at least 5 days/week, or less than 600 MET-min/week combining both criteria (Dumith et al., 2011). Modern lifestyles have resulted in people becoming less active and more overweight / obese. A great number of people are now sedentary, not only at home but also in front of computers at their workplaces. This increased sedentary lifestyle has an adverse effect on health, leading to a number of chronic lifestyle diseases (Kumahara et al., 2004).

The improvement of data collection on physical activity has been hampered by the lack of a suitable instrument. While good instruments exist, the financial burden of these can often make them prohibitive (Sallis, 2010); therefore gathering this data by other means have been devised. Gathering data on physical activity is important as these measures are used as a basis for community health promotion campaigns. Accelerometry-based monitors are considered the gold standard for assessing free living activity, but using such expensive equipment is not always feasible and participants are required to wear the devices during all waking hours for up to 7 days (Hoos, Espinoza, Marshall, & Arredondo, 2012). It is also important to recognise that accelerometers are unable to capture activity such as swimming or activities where the upper body is used. (2008) The easiest and most cost effective means of collecting measures of physical activity is through the use of questionnaire surveys (Sallis, 2010).

Reviews have been conducted comparing the use and validity of both questionnaires and gold standard physical activity monitors. The literature suggests caution when using questionnaires as they are not considered to be an accurate means of measuring physical activity. A systemic review conducted by Prince and colleagues (2008) assessed the extent of agreement between subjective (self-reporting; e.g., questionnaire, diary) and objective (directly measured e.g., accelerometry) measures of physical activity in adults. They suggested self-reporting measures of physical activity were not accurate, as estimates were much higher than those measured by accelerometry and they concluded by stating '…it is not possible to draw any definitive conclusions concerning the validity of self-report measurements compared to various direct methods, but caution should be exercised when comparing studies across methods' (Prince et al, 2008, p19). Other studies draw different conclusions on the use of questionnaires to measure physical activity; while they are inexpensive tools and reasonably accurate for assessing physical activity, they are deficient in their ability to measure the amount of light and moderate physical activity (Sallis, 2010). However, it is difficult to draw any definite conclusions from the literature between the methods and it is important to distinguish the usefulness of the instruments in various settings. Accelerometry measures within a research study or clinical setting are very accurate and can be very important in obtaining empirical information at an individual level; their results are however, not necessarily transferable into large group or community research. (2008)

There was a need to fill this void and develop an accurate means of capturing physical activity in different environments for research purposes. The World Health Organization (WHO) developed the Global Physical Activity Questionnaire (GPAQ) as a means to capture physical activity data (Bull, Maslin, & Armstrong, 2009a). This development was a result of the 'WHO STEPwise Approach to Chronic Disease Risk Factor Surveillance (STEPS), which has been widely introduced as a feasible approach to monitoring eight key risk factors of non-communicable diseases, particularly in developing countries (Bull et al., 2009a). The GPAQ comprises 16 questions grouped to capture physical activity in the workplace, in transport and in leisure activities (Singh & Purohit, 2011). Within the work and discretionary domains, questions are designed to measure the frequency and duration of two different categories of activity defined by the energy requirement or intensity (vigorous- or moderate-intensity). In the transport domain, the frequency and duration of all walking and cycling for transport is captured but no attempt is made to differentiate between these activities. One additional item included in the questionnaire is estimated time spent in sedentary activities (Bull, Maslin, & Armstrong, 2009b; Singh & Purohit, 2011). The GPAQ was designed to fill the void between gold standard physical activity monitors and the inaccuracies of standard questionnaires. It can be used to measure physical activity in a variety of domains and can be applied as a preliminary evaluation in population health research. This measures activity and sedentary lifestyles which will enable researchers to formulate strategies to combat the several risk factors associated with chronic disease.

The obesity epidemic is a worldwide burden and being able to compare the physical activity and sedentary levels of people from different countries and communities is important if policies are to be introduced to stem this epidemic. The International Physical Activity Questionnaire (IPAQ) is an instrument developed to better understand the health enhancing beneficial effects of physical activity and comes as a short form (9 questions) and long form (31 questions) (Hagstromer, Oja, & Sjostrom, 2006). It was developed by an International Consensus Group as a response to the rapidly increasing incidence of obesity and a means to compare populations across different countries and communities (Craig et al., 2003).

Questionnaire unit of measure

The metabolic equivalent of task (MET) is a physiological measure expressing the energy cost or calories of physical activities. One MET is the energy equivalent expended by an individual while seated at rest. While exercising, the MET equivalent is the energy expended compared to rest so MET values indicate the intensity of physical activity compared to being seated at rest. An activity with a MET value of 5 means you are expending 5 times the energy (kJoules per time) than you would at rest. MET minutes are simply the time engaged in an activity with consideration to the number of METs. So if you walked at a pace equivalent to 5 METs for 30 minutes it would be calculated as follows:

5 METs x 30 minutes = 150 MET minutes

MET minutes per week can then be calculated:

150 MET minutes per day X 5 days per week = 750 MET minutes per week.

Statistics

According to Bull and her colleagues (2009a), the nine country reliability and validity study found the reliability coefficients for the GPAQ items were of moderate to substantial strength (Kappa 0.67 to 0.73; Spearman's rho 0.67 to 0.81).

Consistent with the methods used by Brown and colleagues (2003) the level of the reliability coefficients calculated from the above statistics (Spearman rho, Kappa and Intra-class reliability) were characterised as:

≤0.40 poor agreement

>0.40 and ≤0.50 fair agreement

>0.50 and ≤0.75 good agreement

>0.75 excellent agreement (Marshall, 2004)

Reliability and Validity

Bull and colleagues (2009a) stated 'Reliability is the consistency or reproducibility of a response. It is most frequently assessed for measures of physical activity by the completion of an instrument/questionnaire on two separate occasions. Validity is 'the degree to which a test or instrument measures what it purports to measure'. There are a number of studies that found GPAQ to be a suitable, acceptable and effective instrument for the monitoring of physical activity in population health (Bull et al., 2009a), including physical activity among adult Latinos (Hoos et al., 2012), and Vietnamese (Trinh, Nguyen, van der Ploeg, Dibley, & Bauman, 2009). Thuy and colleagues (2010), however, suggested that, in relation to another Vietnamese population, GPAQ did not have superior validity to the IPAQ. Araujo, Matsudo and Matsudo (2005), with a Brazilian population, also suggested that GPAQ and IPAQ seemed to be equally effective for measuring physical activity levels. Further, they state that considering that IPAQ is shorter, it is probably a better option in population surveys to determine the physical activity level.

When the IPAQ was administered to 280 randomly selected adults in the Cree (indigenous) community in North America it was reported that researchers experienced difficulties in data collection (Egeland, Denomme, Lejeune, & Pereg, 2008). Likewise, according to Marshall (2004), the IPAQ was poorly received by their Australian Indigenous participants in Brisbane and ultimately abandoned by researchers after 32 participants, a significant number, had completed and on receiving advice from research assistants that the questionnaire was not well understood and led to participants being frustrated with the project. While Egeland (2008) suggested that a modified IPAQ would have the potential as a surveillance and research tool for administration with Indigenous peoples, they went on to state:

> *More work is needed to ensure the cultural adaptation of the IPAQ for Indigenous Peoples. Cultural adaptation requires conceptual equivalence (i.e., that people attach the same meaning to terms and concepts used); metric equivalence (i.e., that the substitute activities have the same intensity levels as the original activities); and linguistic equivalence (i.e., that the meanings rather than the words of the questions are translated appropriately).*

Overall, these researchers suggest that GPAQ is a more suitable surveillance system, although further replication of this work in other countries is warranted (Bull et al., 2009a). In contrast, Marshall (2004) stated that the Active Australia Questionnaire and the International Physical

Activity Questionnaire-long form (27 questions) are not valid for assessing physical activity among urban Indigenous Australians. To date, the use of GPAQ to investigate physical activity among Australian indigenous people has not been reported.

The purpose of this study was to address the following research questions:

Is the GPAQ an acceptable instrument for measuring the physical and sedentary activities of the Australian Indigenous community?

What is the prevalence of low, moderate and high levels of physical activity in the Perth Noongar population?

Do Indigenous people spend more time in sedentary activities when compared with other populations?

Do the physical and sedentary activities of Indigenous people vary by age and gender?

Do the physical and sedentary activities of Indigenous people vary by risk factor status?

Methods

Participant Recruitment

The GPAQ was included with the suite of questionnaires implemented with the first cross-sectional study of this thesis. As such participant recruitment is as described in Chapter 3. Briefly, the questionnaire was distributed to the Noongar community in the Perth metropolitan area by email, mail out and personal drop-off. The questionnaire was distributed to state and federal government organisations, non–government organisations, tertiary institutions and to Aboriginal individuals at shopping centres, on public transport and at recreational centres. See Appendix 1.

Assessment of physical activity and sedentary behaviour

Physical activity levels and sedentary behaviour was determined using the standardised GPAQ (Armstrong & Bull, 2006). The World Health Organisation developed the questionnaire for physical activity surveillance in developing countries. GPAQ was designed to assess sedentary behaviour and physical activity at work, travel to work and on recreational activities. The questionnaire consisted of 16 questions covering both vigorous and moderate intensity physical activity. The participant responses were processed according to the GPAQ Analysis Guide (World Health Organization, 2012b).

In accordance with the GPAQ Analysis Guide, the responses were converted to MET minutes per week. Moderate activity was assumed to involve 4 METs and vigorous activity 8 METs. Further, the respondents' physical activity was classified as high, moderate or low depending on their total MET minutes per week or other combination criteria (World Health Organization, 2012b).

In specific terms, each volume of physical activity was defined as follows:

High: Vigorous intensity activity on at least three days achieving a minimum of 1500 MET-minutes per week, *or* seven or more days of any combination of walking, moderate- or vigorous-intensity activities achieving a minimum of 3000 MET-minutes per week.

Moderate: A person not meeting the criteria for the 'high' category, but meeting either three or more days of vigorous-intensity activity of at least 20minutes per day, or five or more days of moderate intensity activity, or walking for at least 30 minutes per day, or five or more days of any combination of walking, moderate- or vigorous-intensity activities achieving a minimum of 600 MET-minutes per week.

Low: A person not meeting any of the abovementioned criteria falls in this category.

Sedentary behaviour was classified according to minutes per day of sitting at a desk, sitting with friends, travelling by car, bus, train, reading, playing cards or watching television, excluding the time spent for sleeping (World Health Organization, 2012b).

Metabolic Syndrome

The definition of metabolic syndrome was defined in Chapter 2 and the criteria for clinical diagnosis of metabolic syndrome is provided in Table 2.1. The metabolic risk factors obtained in this chapter were self-reported by the participants in this study.

Statistical Analysis

The data were analysed using *IBM SPSS v.22*. The prevalence of various levels of physical activity and sedentary behaviour in age (18–25, 26–44 and 45+ years) and gender groups were described. First, the proportion of 'highly active', 'moderately active' and 'low active' adult females and males in different age categories were described. Second, the median length (MET-minutes per day) of physical activity at work, travel to and from places, recreational physical activity, and sedentary behaviour in age and gender groups were described.

Physical activity at work, travel to and from places, recreational physical activity (MET-minutes per day) and sedentary behaviour (minutes per day) were used as dependent variables in statistical models of the determinants of physical activity. Age categories (18–25, 26–44 and 45+ years), gender (female and male) and risk factor status were used as independent variables. The Generalized Linear Model was used to estimate the effect of age, gender and clinical status in predicting levels of physical activity. The assumption of independence was used for this model. The probability distribution of the dependent variable, Intensity of physical activity, was specified as *multinomial*. That is, it was categorical (3) and ordered: Low, Moderate and High. The link function used in this model was *Cumulative Logit*.

Results

Acceptability

The Noongar (Aboriginal) researcher for this study found the administration of the GPAQ on urban Australian Indigenous people to be relatively straight-forward. Over 130 participants completed the questionnaire, either one to one with the researcher or in small groups with the researcher present to assist if they had any trouble. No participants refused to complete the questionnaire and all participants who started the questionnaire completed the questionnaire.

Demographic and clinical characteristics of participants

Table 6-1 Participants by Gender and Age Group

	Age Group (Years)			
Gender	18 – 25	26 – 44	≥ 45	Total
Male	12	26	18	56
Female	13	34	26	73
Total	25	60	44	129

The majority of the participants in the study were between 26 and 45 years of age (Table 6.1). The possible reason for this was that the survey was distributed within the local Aboriginal Medical Service in Perth and a majority of participants made the time and supported the research and believed the results to be important to improving Indigenous health outcomes. Of those completing the questionnaire, most were female and aged 26 to 45 years (Table 6.1).

The average age of the participants was 37.8 years and, the research participants were obese (that is, their BMI ≥ 30 kg/m2), based on self-reported figures on height and weight (Table 6.2). For risk factors, high blood pressure and type 2 diabetes were the most prevalent risk factors for females, whereas for males the prevalence of type 2 diabetes and high cholesterol were most prevalent (Table 6.2).

Table 6-2 Clinical characteristics of the participants

	Male		Female		All	
	Mean	SD	Mean	SD	Mean	SD
Age (yrs)	36.1	15.0	39.1	13.1	37.8	14.0
Height (cm)	173.0	9.7	163.5	9.1	168.0	10.5

Weight (kg)	90.5	20.4	83.7	21.6	86.8	21.3
BMI*(kg/m^2)	30.9	8.0	32.1	8.3	31.5	8.2
	%		%		%	
High Blood Pressure	18		33		26	
Type 2 Diabetes	23		30		27	
High Cholesterol	23		26		25	
Heart Disease	5		10		8	
Metabolic Syndrome	20		26		23	

*BMI = Body Mass Index

Physical activity among Indigenous people in Noongar country

Median time spent by participants in physical activity in different settings, and time spent being sedentary is presented instead of mean data because the data have skewed distributions (Table 6.3). The different intensities of physical activity the participants undertook across age categories is presented in Table 6.3. For activity at work, 25 of the 26 – 45-year-old participants reported 15 min or more which was the highest moderate activity. All other results were either 0 or close to 0 for vigorous and moderate for the other two age groups. Travel to and from places accounted for 25% of 18 to 25 year old's recording 11 min or more. Similarly, 25% of the 26 to 45 and 45+ recorded 13 min or 2 min higher than the younger group, however, there is no evidence indicating the difference is significant.

For recreational activities, only vigorous recreational activities varied significantly by age with the 45+ age category showing much lower median times of vigorous activity, 0 minutes at the 25th percentile (0,4) compared with the 26-45 year olds (0,26) and 18-25-year old's (0,18). The highest recorded recreational activity was within the 26 – 45-year-old range at 26 min or higher followed by the 18 – 25 year olds at 18 min or higher and the 45+ year old age category with 4 min of activity. Moderate activity saw both the top 25% of 26 – 45-year-olds and 45+ year olds equal and top the number of minutes at 17 or more. For sedentary time, the 26 – 45-year-olds performed the most activity while also recording the most sedentary time.

Table 6-3 Physical activity (minutes per day) stratified by type of activity and age category. Data are median (interquartile range)

	18 - 25 (years)	26 - 45 (years)	45+ (years)	p*
Activity at Work				
Vigorous	0 (0,1)	0 (0,0)	0 (0,0)	0.857
Moderate	0 (0,0)	0 (0,15)	0 (0,0)	0.883
Travel to and from places	0 (0,11)	0 (0,13)	0 (0,13)	0.858
Recreation activities				
Vigorous	0 (0, 18)	0 (0,26)	0 (0,4)	0.029
Moderate	0 (0,14)	0 (0,17)	0 (0,17)	0.453
All activity	29 (5,148)	32 (0,82)	21 (7,60)	0.310
Sedentary	200 (78, 435)	240 (120, 420)	180 (60,300)	0.973

*Kruskal-Wallis test of difference in median values

Activity at work, travelling to and from places, recreational activities and total time of all activity is presented in Table 6.4. For activity at work, only males recorded a time of 4 minutes for either vigorous or moderate exercise, but these differences were not significant. Traveling to and from places the top 25th percentile of females recorded 3 mins higher than males to obtain 13 minutes or more per day but this difference was not statistically significant.

For recreational activities, in the vigorous category a quarter of the males performed 26 minutes compared to only 9 minutes for females although this difference was not significant. Comparing all activities, males performed significantly more physical activity in total than did females, with average daily time spent active twice that of females ($p<0.05$). This was mainly due to greater time spent in moderate recreational activity ($p<0.05$). One quarter of men spent more than 32 minutes per day on average doing moderate recreational activity, but one quarter of women spent more than 9 minutes per day on average doing moderate recreational activity. There were however, no statistically significant differences between males and females in time spent active in the other settings. Most men and women were physically inactive at work.

Table 6-4 Physical activity (minutes per day) stratified by gender and type of activity. Data are median (interquartile range).

Activity and gender (minutes per day)

	Male	Female	P*	Pearson chi-square
Activity at Work				
Vigorous	0 (0,0)	0 (0,0)	0.837	0.502
Moderate	0 (0,4)	0 (0,0)	0.765	0.515
Travel to and from places	0 (0,10)	0 (0,13)	0.550	
Recreation activities				
Vigorous	0 (0,26)	0 (0,9)	0.161	0.479
Moderate	2.2 (0,32)	0 (0,9)	0.029	0.127
All activity	41 (18,140)	21.4 (0,69)	0.012	

*Mann-Whitney test of difference in median values

Intensity of Physical Activity

The GPAQ physical activity scores were used to divide the participants into three groups: inactive, moderately active and highly active using the criteria described above. Most of the participants who were in the high intensity physical activity range, were in the age group 26 to 44 years (see Table 6.5). These participants were more likely to be male (60%). The moderate and low activity groups tended to be female and younger.

Table 6-5 Frequency by Intensity of Physical Activity, Age Group and Gender (Participant numbers).

	Intensity			
Age Category	Low	Moderate	High	Total
18 – 25 yrs	12	6	7	25
26 – 44 yrs	29	14	17	60
45+ yrs	21	12	11	44
Gender				
Male	21	14	21	56
Female	41	18	14	73
Total	62	32	35	129

According to an advisory report produced by the Office of Disease Prevention and Health Promotion (2015), health benefits are achieved when the exercise range falls between 500 to 1000 MET-minutes per week. Participants in this study achieved the minimum MET-minutes when participating in recreational vigorous activity. Some significant differences between genders for level of activity (MET-minutes per week) are highlighted in Table 6.6. In terms of physical activity at work, the category “male moderate” was the only time identified at 120 MET-minutes per week, while work vigorous were 0. Recreational physical activity on the other hand was vigorous (1440) and moderate (900) MET-minutes per week for both. Males recorded vigorous recreation of 1440 MET-minutes per week four times more than for females but the difference was not significant. As for moderate recreation, males recorded almost four times that of females at 900 and 240 MET-minutes per week respectively and the difference was significant (p=0.029). Travelling to and from places we recorded the opposite in terms of females having higher METs per week; 360 compared to males 280. For the total time of all activity males at 435 MET-minutes per week also doubled that of the female at 240 MET-minutes per week but was not to be significant at p = 0.071.

Table 6-6 Level of activity by gender (METs per week)

Physical activity type	P	Gender	Median (25^{th}, 75^{th})
Work Vigorous	0.837	Male	0 (0,0)
		Female	0 (0,0)
Work Moderate	0.765	Male	0 (0,120)
		Female	0 (0,0)
Recreation Vigorous	0.161	Male	0 (0,1440)
		Female	0 (0,360)
Recreation Moderate	0.029	Male	60 (0,900)
		Female	0 (0,240)
Travel to and from places	0.550	Male	0 (0,280)
		Female	0 (0,360)
Total Time Work Travel Recreation	0.071	Male	150 (0,435)
		Female	90 (0,240)

Table 6-7 Activity volume in minutes stratified by risk factor status and gender

		N	Risk factor status		p
			Normotensive	Hypertensive	
Sedentary	Males	57	180 (143, 375)	270 (90, 465)	0.644
	Females	70	195 (64, 420)	180 (143, 375)	0.568
	All	127	195 (83, 413)	180 (120, 405)	0.497
Active	Males	57	43 (21, 167)	21 (0, 126)	0.141
	Females	70	21 (1, 58)	23 (0, 87)	0.591
	All	127	30 (10, 80)	21 (0, 88)	0.526
		N	nondiabetic	T2D	p
Sedentary	Males	57	210 (113, 413)	240 (45, 360)	0.717
	Females	70	180 (79, 420)	225 (128, 368)	0.681
	All	127	180 (105, 420)	225 (105, 323)	0.684
Active	Males	57	44 (21, 147)	221 (4, 102)	0.089
	Females	70	19 (0, 62)	26 (3, 71)	0.604
	All	127	30 (4, 85)	25 (5, 71)	0.969
			Normal Cholesterol	High Cholesterol*	p
Sedentary	Males	57	240 (113, 413	180 (75, 450)	0.717
	Females	70	180 (75, 450)	210 (120, 525)	0.514
	All	127	225 (109, 390)	180 (90, 510)	0.798
Active	Males	57	44 (21, 163)	21 (0, 74)	0.089
	Females	70	21 (2, 69)	13 (0, 69)	0.604

	All	127	31 (9, 92)	21 (0, 60)	0.130
			No heart disease	heart disease	*p*
Sedentary	Males	57	210 (105, 40	300 (0,180)	0.603
	Females	70	180 (113, 420)	150 (120, 240)	0.243
	All	127	195 (101, 420)	180 (120, 300)	0.971
Active	Males	57	41 (4, 69)	0 (0, 0)	0.107
	Females	70	21 (0, 69)	0 (0, 90)	0.702
	All	127	30 (9, 86)	0 (0, 26)	0.037

*These are self-reported risk factors which may account for high cholesterol results of zero or close to zero in active males, females and all.

The median sedentary time did not vary by risk factor status for men, women, or the whole survey sample. However, males without risk factors tended to have a higher median time physically active, but this did not reach statistical significance (p<0.1 for diabetes and high cholesterol). The only aspect of significance in these results is people without heart disease spent more time being physically active on average (p<0.05). Waist circumference results were that there was no significant difference in median time spent physically active between persons with normal waist circumference and those with elevated waist circumference, for either men or women.

The 25th percentile was zero for both those who had and those that did not have metabolic syndrome. Counter intuitively to what one might expect, those that had metabolic syndrome had lower sedentary time (120 min/day) than those who did not have the syndrome (180 min/day). Similarly, those who had the metabolic syndrome used physical activity to travel to work more than those that did not have metabolic syndrome. Recreation MET (min/week) and total physical activity MET (min/week) for physical activity was as expected higher in those without metabolic syndrome (Table 6.8).

Table 6-8 Metabolic syndrome prevalence and median time for sedentary and activity time

	Metabolic syndrome					
	no			yes		
	Median	P25	P 75	Median	P 25	P 75
Sedentary time (min/day)	60	0	180	35	0	120
Travel MET (min/week)	0	0	200	0	0	360
Recreation MET (min/week)	350	0	1440	0	0	320
Total physical activity MET (min/week)	900	0	3600	600	0	2520

P25 = 25% Percentile   P75= 75% Percentile

Discussion

The GPAQ was employed to elicit information about the amount of active and incidental physical activity performed by men and women of the Noongar community in the Perth Metropolitan area. The data obtained could be used to prescribe exercise that is appropriate and specifically addresses the major Indigenous health issues around metabolic syndrome. This study has demonstrated that GPAQ is an acceptable instrument for measuring the physical and sedentary activities of the Perth Noongar community. There is no foreseen reason why the GPAQ could not be utilised to measure the physical and sedentary activities of other urban and regional Indigenous communities given the equal amount of community engagement and support provided in this study.

Although some aspects of the form were initially confusing to older participants, after some simple explanation they were able to complete the form. A lot of participants found that each page of the GPAQ was just too busy, with a lot of text cramped onto the page. Once assisted with a few of the questions, they became familiar with the set-out of the form and were able to continue with less assistance.

This was in stark contrast to Marshall (2004), who described in her paper that "overall there seemed to be a large degree of confusion amongst the participants when answering the IPAQ-L." They could not understand that the questionnaire, and the questions themselves, were broken down into specific categories. They identified examples that the IPAQ long form uses, such as chopping wood and shovelling snow, and rightfully suggest that these examples were not appropriate for the Australian Indigenous community. The GPAQ questions seem to be more appropriate for the Indigenous community as dictated by the ease of completion of the questionnaire. The GPAQ provided examples that were more culturally appropriate, such as fishing and hunting for food as vigorous physical activity.

The participants in this study were on obese and 25% of them had high blood pressure, type 2 diabetes and high cholesterol. Overall 23% of the participants had MetS. This was calculated using the self-identified risk factors identified on the questionnaire. Females had higher percentages for MetS risk factors, almost doubling the men's heart disease (18%) and high blood pressure (33%) which is usual for this population.

This research did not demonstrate large differences between the types of physical activity, gender and age. The Australian Health Survey (Australian Bureau of Statistics, 2013a) suggested that levels of physical activity tended to decline in older ages. This was not necessarily the case in this study as in some cases the 26-45-year old's outperformed the 18 – 25-year-old age category. Why this was this case was beyond the scope of this study and perhaps warrants further investigation in the future.

Having an understanding of the levels of physical activity between genders is important to improve health outcomes. Hamrik and colleagues (2013) reported men are more engaged in physical activity at work, travel time and leisure-time activity than women. Travel related METS-minutes were the lowest physical activity for both genders (600 MET-minutes), males had the highest MET-minutes, 360 MET-minutes compared to the women's 300 MET-minutes (Hamrik et al., 2013). In this study, work related MET-minutes were lowest physical activity for both genders, travel related MET-minutes were 280 for males and 360 for females.

The frequency by intensity of physical activity by age group and gender demonstrated that the 26 to 44 year olds had the lowest intensity. Males in the study had the highest physical activity intensity. In terms of intensity males shared an equal number (21) for both low and high intensity physical activity whereas only 14 women were participating in high intensity physical activity. In total 56% (41 participants) participated in low levels of physical activity.

The results are indicative as they are the differences in the prevalence of low, moderate and high levels of physical activity in the Perth Noongar population. Irrespective of age and gender, the 75th percentiles illustrate that total physical activity is in the high category, work and recreation are in the Moderate category and travel is in the Low category based on the level of physical activity as defined by the World Health Organization (2012a). Hamrik (2013), conducted a similar GPAQ study on the prevalence of physical activity and sedentary behaviours, as well as age and gender differences in Czech adults. Their results were a significant effect of gender, and almost half of the population showed a high level of physical activity.

Ideally the amount of physical activity that Australians should accumulate each week should meet with the Australian Heart foundation and the American College Sport Medicine cardiovascular guidelines which are the same. The guidelines include 150 minutes of moderate-intensity exercise per week met through 30 – 60 minutes of moderate intensity exercise five days per week or 20 – 60 minutes of vigorous-intensity exercise three days per week of at least 10 min in length (Magal & Riebe, 2016). The Australian Health survey, Physical Activity 2011-12 produced by Australian Bureau of Statistics (2013a) reported that adults spent an average of just over 30 minutes per day doing physical activity. Of this only 43% of adults met the ACSM "sufficiently active" threshold of at least 30 minutes of moderate intensity physical activity on most days. In comparison to the current results, men exhibited a median of 2.2 and women 0 median minutes per day (Table 6.4). The median for all activity for men and women in this study were 41 and 21 minutes per day respectively.

Sedentary activity accounts for a significant amount of time in the average Australian's day. Sedentary activity occupied an average 39 hours per week (334 min / day) for adults, with close to 10 hours of this sitting at work. The median amount of sedentary time per day for Noongar participants in this study were 200, 240 and 180 for the 18 – 25, 26-45 and 45 + year old's respectively. The continuing increase in overweight and obesity is associated with a decrease in the level of physical activity in the Australian Indigenous community (Rowley et al., 2000). Greater emphasis needs to be placed on reducing sedentary behaviour and increasing physical activity to improve quality of life.

There are a number of communities that have reported the amount of sedentary behaviour in their populations. In relation to our objective, we described and compared the proportion of sedentary females and males in the Perth Noongar community. Sixty per cent of adults across the age categories spend four or more hours a day sedentary; the highest rate of sedentary behaviour was observed in the age category of >65. This corresponds with the European average of 64.1% and the world average is 41.5% (Hallal et al., 2012). The figures obtained from this study are similar to those figures found in Europe which are almost 20% higher than those found in the rest of the world.

Conclusion

Sedentary behaviour increases the risk of many chronic diseases such as coronary artery disease, stroke, hypertension, colon and breast cancer, type 2 diabetes, and osteoporosis, as well as premature death. The importance of being able to utilise an effective tool to gather physical activity and sedentary behaviour in Indigenous communities is important in any program, project or intervention to utilise physical activity to improve health outcomes. GPAQ has been demonstrated to be an effective means of collecting data on sedentary and physical activity levels in multiple international communities.

The current study utilised the GPAQ to report on the levels and types of physical activity and sedentary time in the Perth Noongar community. The low levels of physical activity contribute to the high prevalence of, and the increased incidence of chronic diseases within the Noongar community. Finally, the younger a participant was the greater the probability that physical recreation was completed The median for all activity was 27 minutes per day with moderate activity accumulating the most minutes with the exception of 26 – 45-year-old vigorous exercise and the median sedentary was 206 minutes per day for the Noongar Perth metropolitan community. This is very similar to other broader studies in Australian people indicating our participants are not very different in terms of physical activity and sedentary time albeit that these levels are too low for maintenance of health. Having identified the types, frequencies and intensities of physical activity, community placed strategies can be implemented to increase physical activity to reduce the risk factors associated with the metabolic syndrome and improve the quality of life of the Noongar and other Indigenous communities.

Chapter 6

Feasibility and efficacy of exercise as medicine for reduction of metabolic syndrome in inactive Australian Indigenous people.

Introduction

There is overwhelming International evidence attesting that the health of Indigenous communities are worse than their colonisation/invading mainstream counterparts. Of these western nations including the United States, Canada and New Zealand, the Australia Indigenous community has the lowest life expectancy. Colonisation has had a profoundly negative effect on Indigenous Australians as a result of fracturing traditional hunter gatherer practices.

Inappropriate diet and lack of physical activity play a major role in acquiring the risk factors associated with metabolic syndrome (MetS) and the risks of chronic diseases that are associated with MetS are reduced with improved physical fitness. While secondary and tertiary treatments of MetS receive a considerable amount of funding, primary prevention may be a less expensive strategy. Reduced burden on the individual, their family and the health system should perhaps be the main focus. Reducing the incidence and prevalence of the risk factors of MetS should reach beyond personal responsibility. MetS is most prevalent in those with low levels of health literacy and from low socioeconomic backgrounds which in Australia includes the Indigenous population (Sudore et al., 2006). Any intervention should involve coordinated actions by governments, the community and the individual. Ideally, the intervention should target diet and physical activity levels. There is however limited scientific information available pertaining to cardiorespiratory fitness, neuromuscular strength, anthropometric parameters and their effects on body composition and vascular function in Australian Indigenous people.

Reducing these metabolic risk factors is the key to reducing the incidence and prevalence of chronic disease. Technology and the advent of modern lifestyles has resulted in the majority of Australians being more sedentary which is translating to increased rates of overweight and obesity. The increased waist circumference, abdominal obesity or the amount of fat is associated with the potential for ‘atherogenic’ metabolic disturbances and waist circumference has been suggested as the simplest and best anthropometric index of obesity (Pouliot et al., 1994). A more recent systematic review and meta-analysis involving more than 300,000 adults in several ethnic groups reported waist/hip ratio is a better screening tool to predicting cardiometabolic risk than BMI (Ashwell, Gunn, & Gibson, 2012). According to Wang and Hoy (2004) however, who focused on measurement of obesity and cardiovascular disease in Aboriginal people, waist circumference is the best means to predict the risk of cardiovascular events. Based on various studies, waist circumferences over 100 cm are associated with potentially ‘atherogenic’ metabolic disturbances (Pouliot et al., 1994). The results of studies reporting waist circumference of Indigenous people are presented below all 99cm or higher. People with waist circumferences over 94 cm are much more apt to have hypertension, dyslipidaemia and the MetS than people with healthy waist circumferences (Janssen, Katzmarzyk, & Ross, 2004). Our society and technology encourage us to become more sedentary, waist circumferences and overweight/obesity steady increase contributing to the risk factors that are associated with the metabolic syndrome.

There are several risk factors associated with the metabolic syndrome. Sedentary behaviour is linked to obesity, and low levels of cardiorespiratory fitness has a direct link to cardiovascular disease. Obesity causes several avoidable chronic diseases and a fraction of the current funding needed to treat the disorder could be more appropriately allocated to primary health care to reduce severity and incidence. Poor diet and lack of physical activity are the triggers behind the obesity global pandemic and related multitude of social and economic costs (Caballero, 2007). Our modern day, fast paced lifestyles have left us time poor. Recent worldwide figures of obesity are that 1.4 billion people are affected with this number only increasing each year (O'Neill & O'Driscoll, 2015). The ability to obtain cheap highly processed, energy-dense, nutrient-poor food products has never been easier and Government leadership, accountability and community action is needed to address the global obesity epidemic (Crino, Sacks, Vandevijvere, Swinburn, & Neal, 2015). Western diets contain too few omega-3 fatty acids, too little fibre and micronutrients and too much omega-6 fatty acids, trans-fats, branched chain amino acids, ethanol and fructose (Lustig, 2015). This burden of disease is mostly avoidable; through community based efforts, locally tailored and multiple strategies, incorporating policies, individual and community capacity building, ownership and education have been proven highly effective (Pettman et al., 2015). Utilisation is best within multiple community settings such as health centres, schools, workplaces, parks, community centres and other public places (Pettman et al., 2015; Whelan et al., 2015). Employing community based interventions to focus on reducing the incidence and prevalence of obesity through improving diet and increasing physical activity is essential to improve the quantity and quality of life of individuals.

Obesity is a problem for all cultures and socioeconomic levels but perhaps especially for those from socioeconomically disadvantaged backgrounds with low levels of access to health literacy. Health literacy is defined as an individual’s capacity to obtain, process and understand health information in order to make an informed decision about their health with over 20% of Australians having very low health literacy (Lyons, O'Dea, & Walker, 2014). Of considerable concern is the fact that obesity incidence has tripled in the last 30 years (Buchmueller & Johar, 2015). In 2012, 62% of Australians were either overweight (35%) or obese (28%) (Whelan et al., 2015). Further, 70% of Australians aged 45 years and over are overweight or obese (Whelan et al., 2015). Those obese individuals with BMI ranging from 30 – 35 and 35+ are associated with an increased economic cost of 19% and 51% higher than that of a normal weight person respectively (Buchmueller & Johar, 2015). Improving the levels of health literacy will allow people to make more informed lifestyle decisions thereby reducing the economic burden of obesity and the avoidable chronic diseases that impact on the quality of life.

Sedentary behaviour results in overweight and obesity and has been linked to increased incidence of the risk factors associated with the metabolic syndrome. The storage of fat causes the waistline to increase, adversely affecting blood pressure, insulin sensitivity and causes cholesterol levels to increase, all risk factors associated with MetS (Kaur, 2014). The prevalence of MetS is currently approximately 25% of the Australian population (Blackford et al., 2015). One study has reported that men with middle and high sedentary behaviour have a 65% and 75% respectively, higher chance of developing MetS (Greer, Sui, Maslow, Greer, & Blair, 2015; Salonen et al., 2015) so there appears to be a strong protective effect of physical activity. MetS has also been associated with a number of cancers including breast, pancreatic, colon and liver cancer (O'Neill & O'Driscoll, 2015). In order to reduce the incidence of type 2 diabetes (T2D), cardiovascular disease (CVD) and premature death it is important to not only identity those individuals that are overweight/obese with MetS but to intervene with lifestyle modifications and management. The increase in the incidence of MetS is also associated with an economic cost. For example, this cost in 2012 in the United States alone was $245 billion for T2D and $109 billion for CVD annually (Blackford et al., 2015). Reducing the incidence and prevalence of the risk factors associated with the MetS will improve health outcomes, quality of life and reduce the staggering costs associated with this syndrome.

MetS adversely affects blood vessels and has been linked to increased mortality rates. It affects the dynamic relationship between the macro and micro circulation which in turn causes CVD. The mortality prevalence of CVD is 1.6 times greater for those Individuals with MetS due to microvascular dysfunction and increased arterial stiffness (O'Neill & O'Driscoll, 2015). MetS has been associated with endothelial dysfunction affecting both macro and micro systems (Walther et al., 2015). There are a number of circulating pro-inflammatory mediators which secrete adipokines which adversely affect the endothelium, resulting in the inability of the endothelium to serve its normal and protective function (Kaur, 2014) thus affecting the liver, skeletal muscle and vasculature (Wronkowitz, Romacho, Sell, & Eckel, 2014). Oxidative stress, hyperglycemia, advanced glycation products, free fatty acids, inflammatory cytokines, or adipokines are all factors that cause an inability of endothelium to serve its normal physiological and protective mechanisms (Kaur, 2014). This atherosclerotic cascade disrupts cell signalling and increases the risk of a cardiovascular event such as stroke or myocardial infarction (Avolio & Grassi, 2015; Ramos, Dalleck, Tjonna, Beetham, & Coombes, 2015). MetS is associated with increased CVD and mortality due to these negative effects on blood vessels resulting in the body's inability to perform its normal and protective functions.

Cardiovascular disease is one of the leading causes of mortality around the world and has staggeringly high human and financial costs. Increasing physical activity, modifying diet and quitting smoking are the primary methods for reducing the incidence of cardiovascular disease. Vascular homeostasis is governed by the condition of the endothelium in both the coronary and peripheral blood vessels. Most of the burden of disease is caused by avoidable risk factors such as high body mass index, tobacco use and physical inactivity (Nash, 2007). Developing healthy lifestyles is a cost-effective measure and could prevent about 80% of cases of heart disease, stroke and type 2 diabetes and 40% of cancers (De Feo, Boris, & Maffeis, 2014). Modifying lifestyles is the most effective means of reducing the human and financial burdens associated with cardiovascular disease.

Vascular function and cardiorespiratory fitness have been shown to have a strong relationship in many studies. Individuals with low cardiovascular fitness and low physical activity levels have also exhibited metabolic syndrome risk factors. In a study conducted on young Finnish adults the prevalence of MetS ranged between 8 – 10% and it was also reported that higher total mean volume (MET-hours) or intensity (MET) of physical activity were inversely associated with the incidence of MetS (Salonen et al., 2015). Other studies have suggested that the type of activity (without identifying which activity), not the total activity levels may be more strongly associated with MetS (Hastert, Gong, Campos, & Baylin, 2015).

Muscle loss (sarcopenia) and increased fat are all too common in age-related body composition changes. Muscle strength and muscle quality (muscle strength/muscle mass unit) is positively related to lowering metabolic risk and has become a more reliable measure of the body's ability to function (Mankowski, Anton, & Aubertin-Leheudre, 2015). It also serves an important role in the prevention of chronic disease and is associated inversely with CVD, peripheral artery disease, cancer, renal failure, chronic obstructive pulmonary disease, and rheumatoid arthritis (Volaklis, Halle, & Meisinger, 2015). Muscle mass is a ‘metabolic sink’ and resistance training should be a regular activity performed throughout life to prevent chronic diseases (Karthic, Kanimozhi, Karthick, Saravanan, & Padmavathi, 2016).

For Indigenous or 4th World Nations across the planet, colonisation has had a profoundly negative impact on health, stemming from the reduced need for energy expenditure. The change from a hunter-gatherer society, where an excellent cardiorespiratory fitness meant survival to a society based on agriculture where physical activity levels have become progressively lower, the resulting obesity pandemic and non-communicable metabolic diseases have developed (Myers et al., 2015). Australia has one of the best health care services in the world, yet the Australian Indigenous communities experience physical health on par with third world nations. There is an urgent need to ensure that health intervention programs are culturally secured and tailored to each individual Indigenous community and the ability to understand the relationship between body composition, vascular function, muscular strength, aerobic fitness and the metabolic syndrome in Indigenous Australians is crucial to quantify the contributing factors and inform interventions to “close the gap” with health of non-indigenous Australians.

There is a very limited number of peer reviewed studies that focus on waist and hip circumference; waist to hip ratio; body mass index; one publication on cardiovascular fitness and no papers on strength or body composition pertaining to exercise in the Australian Indigenous community. This study is an examination of these measures in an Australian indigenous population and where possible compares results to other studies involving Indigenous communities where it can or comparisons with non-Indigenous communities are made.

Aim

The aim of this cross-sectional study was to gain better understanding of the anthropometric and physiological measures which impact the health of Indigenous people and in particular contribute to risk of metabolic syndrome.

Method

Study design

We implemented a cross-sectional assessment of a range of anthropometric and physiological measures in both men and women of the Perth Noongar population. All the anthropometric and physiological tests were completed by the participants in a single session.

Participant recruitment

The primary method of recruitment involved visiting key community members and organisations and seeking their assistance in recruitment of participants. As a member of the Perth Noongar community, the researcher has extensive links and established Indigenous networks and was in an excellent position to recruit Indigenous participants for the study. Ethics approval was received from the University Human Ethics Committee and Western Australian Aboriginal Health Information and Ethics Committee (WAAHIEC). The protocol was fully explained to each participant and written informed consent was obtained from all participants prior to their participation in the study. A total of 41 Australian Aboriginal individuals from the Perth metropolitan area aged between 18 – 50 years participated in this study.

Inclusion Criteria

Participants needed to identify as either Australian Aboriginal or Torres Strait Islander or both and be over 18 years of age.

Exclusion Criteria

There were several exclusion criteria for the study. These included the participant not recognised by an Indigenous Australian community as either Aboriginal or Torres Strait Islander or both; a person that did not provide a medical clearance from a medical practitioner; women who were pregnant; people with any condition which would place them at risk from any of the tests that were implemented.

Outcome measures

Anthropometry and body composition

The participant removed shoes and was weighed on electronic scales (AND TB200, Tokyo, Japan) in light clothing to determine body mass and height was measured against a stadiometer (SECA 700, Brooklyn, NY). Body mass index (BMI) was determined as mass divided by height squared.

Whole body lean mass including appendicular skeletal muscle mass and fat mass was derived from whole body scan using DEXA (Hologic Discovery A, Waltham, MA). Participants were required to wear a hospital gown and remove all jewellery to ensure no metal was present. To ensure participants were in the standard position they were instructed and assisted in lying on the DEXA scanner bed. They were positioned within the cross-sectional scanning area in a supine position with the arms positioned and pronated to the side of the body, fingers and toes pointed and feet fastened with tape. The participants were then instructed to remain as still as possible for the duration of the DEXA scan. The same experienced technician performed all scans.

Girths at the waist and hips were measured at standard anatomical points, with an anthropometric tape in duplicate while participants were wearing light clothing. Waist circumference was measured in a horizontal plane one cm above the iliac crest, and hip circumference was measured as the greatest circumference of the buttocks at the height of the greater trochanters (World Health Organization, 2011). These measures were used to determine the waist-to-hip ratio (WHR) which was calculated as waist divided by hip circumference (Lohman, Roache, & Martorell, 1992).

Neuromuscular strength

Neuromuscular strength was assessed using the one repetition maximum (1RM). Prior to strength testing, the participants were familiarised with the testing procedures. The strength familiarisation consisted of demonstrating the exercise silently, then demonstrating the exercise with full explanation and finally having the participant conduct the exercise. Feedback about performance was provided back to the participations to ensure and correct form and above all, safety. In addition, they performed a warm-up consisting of aerobic activity which included walking or jogging on a treadmill or riding an exercise bike and dynamic stretching. One repetition maximum (1-RM) was used to determine the participants' dynamic concentric muscle strength for the leg press and chest press. 1-RM is the maximal weight an individual can move through a full range of motion without change in body position, other than that dictated by the specific exercise motion and has been found to be a reliable assessment of maximal strength (Hoeger, Hopkins, Barette, & Hale, 1990).

To determine 1RM, a low-intensity warm-up was conducted, participants performed four to five trials (separated by a 2-min resting interval) using varying moderate-heavy weights to determine the highest weight that could be lifted with only one repetition through the full range of motion with correct technique (Wycherley et al., 2010).

Cardiorespiratory fitness

Sub-maximal oxygen uptake (measure of aerobic capacity) was estimated by the Astrand-Ryhming test using a Repco cycle ergometer. Participants wore a Polar heart rate transmitter around their chests so that heart rate could be continuously monitored using a Polar watch (Polar Electra Oy, Finland). A target heart rate of between 130 – 150 bpm was selected. Workloads varied by gender with 75 to 100 W for women and 100 to 150 W for men. Before the test commenced, bike was adjusted to ensure the safety and comfort; testing and cool down protocol was also explained to the participant. Resting heart rate was recorded and then at each minute for six minutes. After the participants, had completed six minutes of cycling at the fixed workload, the difference in the heart rate at the end of the 5th and 6th minutes was required to be less than five beats per minute (bpm). If the difference was over five bpm, the participants continued to pedal until a steady state heart rate was achieved. The average heart rate during the last minute was recorded. VO2max was then estimated using the relevant nomogram for the Astrand test (Astrand & Rodahl, 1986).

Vascular function – blood pressure, arterial compliance

Brachial blood pressure was measured per the ASCOT protocol using a validated, semi-automated, oscillometric device (Omron 705CP, Omron, Japan). To ensure an accurate blood pressure measurement was obtained, participants rested for 5 minutes in a quiet room, after which time blood pressure was measured over the brachial artery 3 times at 5-minute intervals. The mean of the measurements was recorded as representative of brachial blood pressure. After the last measurement, radial artery pressure waveforms of the same arm were sampled over 10 seconds with a Millar tonometer (SPC-301, Millar Instruments, Houston, Texas, USA). A generalised transfer function was applied to the radial artery waveform to obtain the pressure waveform at the ascending aorta. Waveforms were then processed with dedicated software (SphygmoCor Version 7, AtCor, Sydney, Australia).

The software was used to calculate an averaged radial artery waveform and to calculate a corresponding central aortic pressure waveform employing previously validated functions. Aortic pressure waveforms were further analysed using the SphygmoCor software to determine the time to peak/shoulder of the first and second pressure wave components (T1, T2) during systole. The pressure at the peak/shoulder of the first component was identified as P1 height (outgoing pressure wave), and the pressure difference between this point and the maximal pressure during systole (P or augmentation) was identified as the reflected pressure wave occurring during systole. Augmentation index (AIx), defined as the ratio of augmentation to central pulse pressure, was expressed as a percentage: Aix (P/ PP) 100, where P is pressure and PP is pulse pressure. Pulse pressure amplification (PPA) was expressed as the ratio of central pulse pressure (CPP) to peripheral (brachial) pulse pressure (PPP): PPA = PPP/CPP. This method has been validated against invasive techniques for determination of central BP and the augmentation index (AIx) is a marker of systemic arterial stiffness.

Statistics

Means and standard deviations were calculated for all variables using SPSS version 22 (PASW, Chicago, IL.). These descriptive statistics and frequency distributions were used to characterise participant clinical presentation and demographics of the participants.

Results

Anthropometric and physiological measures are presented in Table 7.1. Body composition results are presented in Table 7.2.

Table 7.1 Participants anthropometric and physiological outcome measures.

Participant number	N	41	
Gender	% Male	40.0	
		Average	SD
Age	Age (years)	34.6	11.2
Anthropometrics	Waist (cm)	97.7	28.7
	Hip (cm)	105.9	27.8
	Waist to Hip ratio	0.9	0.1
	Height (cm)	166.2	8.4
	Weight (kg)	89.9	26
	Body mass index (kg m^2)	32.8	8.5
Strength	Bench press 1 rep max (kg)	45.9	16.6
	Bench Press relative strength	0.5	0.15
	Leg press 1 rep max (kg)	171.5	50.6
	Leg press relative strength	1.9	1.7
Fitness	MaxVO2 (ml/kg/min)	22.6	7.9
Blood pressure	Systolic BP (mmHg)	123.3	14.2
	Diastolic BP (mmHg)	72.5	10.3
	Pulse wave velocity (m/s)	9.9	2.8

Table 7.2 Body composition

	Average	SD		Average	SD
Percent body fat	28.8	8.2	Bone mineral content	2708	419
Left arm			Right arm		
fat (kg)	1.5	0.8	fat (kg)	1.6	0.8
lean (kg)	3.1	1.1	lean (kg)	3.3	1.0
mass (kg)	4.6	1.3	mass (kg)	4.9	1.3
percent fat	32.8	10.9	percent fat	31.8	10.4
Left leg			Right leg		
fat (kg)	4.7	2.3	fat (kg)	4.8	2.3
lean (kg)	8.8	2.1	lean (kg)	9.1	2.3
mass (kg)	13.5	3.3	mass (kg)	13.9	3.3
percent fat	33.9	10.2	percent fat	33.7	9.9
Android			Gynoid		
fat (kg)	2.8	1.6	fat (kg)	5.5	2.4
lean (kg)	0.4	0.1	lean (kg)	9.3	1.8
mass (kg)	7.1	2.4	mass (kg)	14.8	3.4
percent fat	36.8	9.0	percent fat	36.2	8.3
Trunk			Visceral fat		
fat (kg)	16.3	9.7	fat (kg)	1.5	0.8
lean (kg)	29.6	6.1	lean (kg)	2.4	0.5
mass (kg)	46	1.4	mass (kg)	3.8	1.3
percent fat	33.6	9.8	percent fat	35.8	8.7
Sub total			Whole body total		
fat (kg)	30.1	1.6	fat (kg)	31.3	1.6
lean (kg)	53.1	11.5	lean (kg)	60	1.2
mass (kg)	83.3	22.0	mass (kg)	88.2	22.2
percent fat	34.8	10.0	percent fat	34.2	9.6

Comparative results for men are presented in Table 7.3 and for women Table 7.4 with pooled results in Table 7.5. For comparison, normative data from the ACSM (Ratamess, 2012) for muscular strength is provided in Table 7.7 and the comparison with the current study population in Table 7.8. Percentile values for maximal aerobic power are provided in Table 7.8 for comparison.

Table 7.3 Age, anthropometric, strength, aerobic capacity fitness, blood pressure and body composition of the male study participants compared across studies. Data are mean (SD).

Males	Study	Mendham (2012)	Marshall (2004)	Mendham (2014)		Esgin (2016)	Average
Study Location		Melbourne	Brisbane	Regional NSW (Exercise)	(Control)	Perth	
Participant number	N	10	78	17	14	14	27
Age	Age (years)	38.5		39.5	35.0 (13.2)	35.0 (13.2)	37.5
Anthropometrics	Waist (cm)	103.6		103.5	99.2 (25.1)	99.2 (25.1)	103.2
	Hip (cm)			107.5	100 (21.9)	100 (21.9)	106
	Waist to Hip ratio	0.95		0.96	0.98 (0.1)	0.98 (0.1)	1
	Height (cm)		177	173.6	175 (5.6)	175 (5.6)	174.4
	Weight (kg)		90	95.4	98.8 (19.9)	98.8 (19.9)	96.2
	Body mass index (kg/m2)		29	31.6	32.5 (5.7)	32.5 (5.7)	31.8
Strength	Bench press 1 rep max (kg)				60.3 (13.0)	60.3 (13.0)	60
	Bench press relative strength				0.59 (0.14)	0.59 (0.14)	
	Leg press 1 rep max (kg)				189 (61.4)	189 (61.4)	189
	Leg press relative strength				1.84 (0.55)	1.84 (0.55)	
Fitness	MaxVO2 (ml/kg/min)	30.5		31	23.7 (2.3)	23.7 (2.3)	29.6
Blood pressure	Systolic BP (mmHg)			123.7	134 (12.5)	134 (12.5)	127.8
	Diastolic BP (mmHg)			79.9	76 (8.4)	76 (8.4)	79.1
	Pulse wave velocity (m/s)				9.51 (2.1)	9.51 (2.1)	9.6
Body composition	DEXA (% body fat)	27.8			28.8 (8.2)	28.8 (8.2)	27.9
	DEXA Bone mineral content				2708 (419)	2708 (419)	2708

Table 7.4 Strength, aerobic capacity fitness, anthropometric, blood pressure and body composition of the female study participants compared across studies. Data are mean (SD).

Females	Study	Canuto (2012) (Waitlist)	Canuto (2012) (Active)	Marshall (2004)	Esgin (2016)	Average
Location		Adelaide	Adelaide	Brisbane	Perth	
Participant number		49	51	116	27	60.8
Age	Age (years)	40.7	43.5		35	39.7
Anthropometrics	Waist (cm)	101.5	103.2		96.9 (30.9)	100.6
	Hip (cm)	117	120		109 (30.4)	115.3
	Waist to Hip ratio	0.87			0.895 (0.1)	0.9
	Height (cm)	161		164	162 (6.6)	162.3
	Weight (kg)	88.8	92.6	74	85.3 (27.9)	85.6
	Body mass index (kg m2)	33.5	35.5	28	32.9 (9.9)	32.3
Strength	Bench press 1 rep max (kg)				33.7 (5.9)	32.0
	Bench press relative strength				0.40 (0.09)	
	Leg press 1 rep max (kg)				157 (37.3)	146.0
	Leg press relative strength				1.87 (0.49)	
Fitness	MaxVO2 (ml/kg/min)				21.9 (10.1)	22.0
Blood pressure	Systolic BP (mmHg)	129.5	129.4		119 (11.7)	126.0
	Diastolic BP (mmHg)	87.5	88.3		72.0 (8.42)	82.6
	Pulse wave velocity (m/s)				9.61 (1.9)	10.0
Body composition	DEXA (% body fat)				33.7 (5.9)	39.0
	DEXA Bone mineral content				157 (37.3)	2288.0

Table 7.5 Anthropometric, strength, aerobic capacity fitness, blood pressure and body composition of all study participants compared across studies. Data are mean (SD).

	Study	Davis (2008)	Davis (2011)	Maple-Brown (2007)	Maple-Brown (2007)	Thompson (2003)	Esgin (2017)	Average
Location		Fremantle (Perth)		Darwin	Remote NT		Perth	
Participant number	N	19	106	79	90	194	41	181
Gender	% Male	36.8	34.9				34.6	35.4
Age	Age (years)	51.2	54.3	40	40		34.6 (11.2)	44
Anthropometrics	Waist (cm)			94	87		97.7 (28.7)	92.9
	Hip (cm)			104	93		105.9 (27.8)	101
	Waist to Hip ratio			0.91	0.93		0.9 (0.1)	0.91
	Height (cm)			167	167	169	166.2 (8.4)	167.3
	Weight (kg)			78	66	81	89.9 (26.0)	78.7
	Body mass index (kg m^2)	30	32	28	24	28	32.8 (8.5)	29.1
Strength	Bench press 1 rep max (kg)						45.9 (16.6)	45.9
	Bench Press relative strength						0.5 (0.15)	0.5
	Leg press 1 rep max (kg)						171.5 (50.6)	171.5
	Leg press relative strength						1.9 (1.71)	1.9
Fitness	MaxVO2 (ml/kg/min)						22.6 (7.9)	45.9
Blood pressure	Systolic BP (mmHg)	138	141	115	119		123.3 (14.2)	127.4
	Diastolic BP (mmHg)	79	81	74	72		72.5 (10.3)	75.8
	Pulse wave velocity (m/s)						9.9 (2.8)	9.6

Table7.6 Comparison of visceral and subcutaneous adipose measures compared across studies. Data are mean (SD).

	Esgin et al., 2017 (Perth WA n = 41)				Bredella et al., 2013, (US and women only)						Smith et al., 2001, (US) n=199			
	Male	SD	Female	SD	Anorexia (n=19)	SD	Normal (n = 27)	SD	Overweight (n = 89)	SD	Male	SD	Female	SD
Age (years	35.1	13.2	34.3	10	24.8	3.6	30.1	6.9	34.8	7.4	40.8	13.7	41.5	11.7
BMI (kg/m^2)	32.5	5.7	32.9	10	17.9	1.4	22	2	34	5.2	Not reported			
Percentage body fat	28.7	8.2	34.3	10	Not reported						29.4	13.7	45.2	7
Visceral fat - area (cm^2)	110.8	61.5	113.1	59.1	20.9	11.2	43.4	19	128.2	47.4	139	87.9	120.5	65.8
Total adipose tissue - area (cm^2)	499.2	218	496.1	191	157.2	41.8	309.1	96.2	651.6	157	435.9	222	554.2	177
Subcutaneous adipose tissue - area (cm^2)	388.4	177	383.1	152	136.3	32.5	265.7	83.4	523.4	126	297	153	433.8	138
Weight (kg)	98.8	19.9	85.3	27.9	47.7	5.1	61.4	7.7	90.7	14.8	94.4	20.1	82.4	15.3

This cross-sectional study obtained anthropometric and physiological measures of 41 Aboriginal people in the Perth metropolitan area (mean age 34.4; 56% male). Results pertaining to body circumference and associate measures included waist circumference (97.7 ± 28.7), hip circumference (105.9 ± 27.8) and waist to hip ratio (0.9 ± 0.1) (Table 7.1). Other anthropometrical measures included height (166.2 ± 8.4), weight (89.9 ± 26) and Body mass index (32.8 ± 8.5) (Table 7.1). The measures surrounding an individual's strength included 1 RM bench press (45.9 ± 16.6) bench press relative strength (0.5 ± 0.15) (Table 7.1). 1 RM leg press (171.5 ± 50.6), Leg press relative strength (1.9 ± 1.7) the participant cardiovascular fitness (22.6 ± 7.9) was also recorded (Table 7.1). Other physiological measures included systolic blood pressure (123.3 ± 14.2) diastolic blood pressure (72.5 ± 10.3) and pulse wave velocity (9.9 ± 2.8) (Table 7.3). The only other body composition measurements were obtained from a DEXA scan and included per cent body fat (34.9 ± 10.3) upper body lean mass (3.2 ± 1.0), lower body lean mass (8.9 ± 2.1) and trunk lean body mass (29.6 ± 6.1) (Table 7.1).

This study compared results with Bredella et al, (2013) a study involving DEXA scans on woman who have Anorexia, normal and are overweight and Smith et al., (2001) study conducted on obese US males and females. The males in this study were 5 years younger than the other study (Smith et al., 2001), although percentage body fat was similar 28.7 to 29.4%, visceral fat area was lower 110.8 cm2 vs 120 cm2, however, total adipose tissue area 499.2 to 439.9, subcutaneous adipose tissue 388.4 to 297 cm2 and weight 98.8 to 94.4 kg respectively (Table 7.6).

The female participants in this study were 5 kg lighter than the study on overweight women in the US (Bredella et al., 2013) it reported higher BMI 32.9 compared to 34.0, visceral fat 113.1 cm2 compared to 128.2 cm2 respectively and Smith (2001) study on obese women reported the same measure as 120.5 cm2; total adipose tissue for the 3 studies are 496.1, 651.6, 297 cm2 respectively; subcutaneous adipose tissue 383.1, 523.4 and 433.8 cm2 and weight 85.3, 90.7 and 82.4 kg respectively (Table 7.6).

Table 7.7 Sphygmocor measures, data are mean (SD).

	Wilkinson et al 2000	Munir et al 2008	Cecelja et al 2012	Esgin et al 2016
N (male)	22 (13)	25 (25)	411 (0)	41 (23)
Average age	under 60	19 - 35	48	34.4
Country	Wales	United Kingdom	United Kingdom	Perth
Health status		Healthy	Healthy twins	Sedentary
Measures				
Peripheral				
Systolic Blood Pressure (mm Hg)	128	117 (2.2)	119 (15.8)	124 (13.4)
Diastole Blood Pressure (mm Hg)	80	66 (1.7)	76 (11.1)	73 (8.8)
Mean Arterial Pressure (mm Hg)	98	84 (1.5)	92 (13.1)	90 (10.4)
Pulse Pressure (mm Hg)		50 (2.5)		51 (9.1)
Augmentation Index (%)	15.8 (5.3)	54 (3.9)		66 (18.9)
Central				
Systolic Blood Pressure (mm Hg)	117 (7)	104 (2.1)	110 (16.0)	110 (12.6)
Diastole Blood Pressure (mm Hg)	82 (5)		77 (11.3)	74 (9)
Pulse Pressure (mm Hg)		35 (1.6)		36 (6)
Mean Arterial Pressure (mm Hg)				90 (10.5)
Augmentation Index (%)		6.2 (2.0)	22.4 (14.9)	122 (22.3)
SEVR (%)				151 (26.0)
Ejection duration (ms)				322 (24.6)
Pulse wave velocity (m/sec)		7.1 (1.9)		9.5 (1.5)
PPP:CPP ratio				144 (19.5)

Although this study had relatively young participants some of the measures were worse than those reported in studies with older participants (Table 7.7).

Discussion

The aim of this cross-sectional study was to gain better insight into the anthropometric and physiological measures which impact the health of Indigenous people in Australia and contribute to risk of metabolic syndrome.

We evaluated key parameters of anthropometrics and body composition, neuromuscular strength, cardiorespiratory fitness and cardiovascular measures, for risk factors associated with metabolic syndrome and cardiovascular disease. While there have been numerous studies focusing on body composition (Canuto et al., 2012b; Cunningham, O'Dea, Dunbar, & Maple-Brown, 2008; Rowley et al., 2000) and cardiovascular pathology (Aitken, 2007), this is the first study to our knowledge to additionally include neuromuscular strength and cardiorespiratory fitness in the Indigenous community, factors with demonstrated strong relevance to MetS and overall morbidity and mortality (Jurca et al., 2005).

Table 7.8 Standard Values for Strength in 1RM / Body Weight Ratio according to ACSM (Ratamess, 2012).

			Males		
Age	20 - 29	30 – 39	40 – 49	50 -59	60+
			Bench Press		
Rating					
Excellent	>1.26	>1.08	>0.97	>0.86	>0.78
Good	1.17-1.25	1.01-1.07	0.91-0.96	0.81-0.85	0.74-0.77
Average	0.97-1.16	0.86-1.00	0.78-0.90	0.70-0.80	0.64-0.73
Fair	0.88-0.96	0.79-0.85	0.72-0.77	0.65-0.69	0.60-0.63
Poor	<0.87	<0.78	<0.71	<0.64	<0.59
			Leg Press		
Excellent	>2.08	>1.88	>1.76	>1.66	>1.56
Good	2.00-2.07	1.80-1.87	1.70-1.75	1.60-1.65	1.50-1.55
Average	1.83-1.99	1.63-1.79	1.56-1.69	1.46-1.59	1.37-1.49
Fair	1.65-1.82	1.55-1.62	1.50-1.55	1.40-1.45	1.31-1.36
Poor	<1.64	<1.54	<1.49	<1.39	<1.30
			Females		
Age	20 - 29	30 – 39	40 – 49	50 -59	60+
			Bench Press		
Excellent	>2.08	>1.88	>1.76	>1.66	>1.56
Good	2.00-2.07	1.80-1.87	1.70-1.75	1.60-1.65	1.50-1.55
Average	1.83-1.99	1.63-1.79	1.56-1.69	1.46-1.59	1.37-1.49
Fair	1.65-1.82	1.55-1.62	1.50-1.55	1.40-1.45	1.31-1.36
Poor	<1.64	<1.54	<1.49	<1.39	<1.30
			Leg Press		
Excellent	>1.63	>1.42	>1.32	>1.26	>1.15
Good	1.54-1.62	1.35-1.41	1.26-1.31	1.13-1.25	1.08-1.14
Average	1.35-1.53	1.20-1.34	1.12-1.25	0.99-1.12	0.92-1.07
Fair	1.26-1.34	1.13-1.19	1.06-1.11	0.86-0.98	0.85-0.91
Poor	<1.25	<1.12	<1.05	<0.85	<0.84

Table 7.9 Study participants' ratings compared to ACSM standard values

Gender	Exercise	Relative strength	Standard value	Rating
Male	Bench Press	0.6	<0.78	Poor
35 Average age	Leg Press	1.9	>1.88	Excellent
Female	Bench Press	0.4	<0.48	Poor
35 Average age	Leg Press	1.8	1.13-1.19	Fair

Table 7.10 Percentile values for maximal aerobic power (ml/kg/min) (Ratamess, 2012)

	Age				
Percentile	20 - 29	30-39	40-49	50-59	60+
		Men			
90	51.4	50.4	48.2	45.3	42.5
80	48.2	46.8	44.1	41	38.1
70	46.8	44.6	41.8	35.5	35.3
60	44.2	42.4	39.9	36.7	33.6
50	42.5	41	38.1	35.2	31.8
40	41	38.9	36.7	33.8	30.2
30	39.5	37.4	35.1	32.3	28.7
20	37.1	35.4	33	30.2	26.5
10	34.5	32.5	30.9	28	23.1
		Women			
90	44.2	41	39.5	35.2	35.2
80	41	38.6	36.3	32.3	31.2
70	38.1	36.7	33.8	30.9	29.4
60	36.7	34.6	32.3	29.4	27.4
50	35.2	33.8	30.9	28.2	25.8
40	33.8	32.3	29.5	26.9	24.5
30	32.3	30.5	28.3	25.5	23.8
20	30.6	28.7	26.5	24.3	22.8
10	28.4	26.5	25.1	22.3	20.8

Cardiorespiratory fitness

Public health recommendations emphasize the importance of active lifestyles as increased fitness and avoiding sedentariness promote feelings of wellbeing and decrease chronic disease. This study is the second study to our knowledge that has examined cardiovascular fitness in the Indigenous community. Mendham and colleagues (2014b) published cardiovascular fitness measures for Indigenous men in regional NSW. However, they used a maximal cycle cardiovascular fitness test whereas we used a submaximal cycle test. Their participants were on average 2.5 years older however they report 22% higher aerobic capacity of 27.5 ml/kg/min compared to 22 ml/kg/min for the current study. These figures do not reach the 10th percentile for normative values for maximal aerobic power (ml/kg/min^{-1}) reported for similar aged populations. One reason for this difference in aerobic capacity could be how familiar research participants were with cycling and differences in testing protocol however, regardless the participants in the Mendham et al (2014) study and the current research clearly demonstrate quite low cardiorespiratory fitness in Australian Indigenous people. Given that cardiorespiratory fitness is the most significant predictor of all-cause mortality (Kodama et al., 2009), these results are disturbing and provide strong rationale for interventions to improve this aspect of health within Indigenous communities.

Exercise is a cardiovascular disease deterrent whereas physical inactivity and the reduction of cardiorespiratory fitness have the opposite effect of increasing the risk of cardiovascular disease (Tambalis, Panagiotakos, Kavouras, & Sidossis, 2009). Similarly, other studies have shown a relationship between cardiovascular fitness and strength; demonstrating that any small increases in VO2max from for example cycling in older men, may be due to oxidative capacity adaptations and increased mass of strength trained muscle (Frontera, Meredith, O'Reilly, & Evans, 1990). As the participants in this study tended toward lower cardiovascular fitness and strength there appears scope for intervention programs to improve these qualities to benefit their quality of life and reduce the risk factors associated with the metabolic syndrome.

Body composition

In a study that compared Inuit, Africans and Europeans, Africans were found to have significantly lower waist circumference, body mass index and visceral adipose tissue and subcutaneous adipose tissue compared to Inuit and European, whereas Inuit had the highest mean subcutaneous adipose tissue values (Ronn, Andersen, Lauritzen, & Christensen, 2016). This is consistent with results of this study which reported that the male subcutaneous adipose tissue was higher than the non-Indigenous males from the other study (Smith et al., 2001). This was however not consistent with the female subcutaneous adipose tissue measure when comparing Indigenous to non-Indigenous.

In another cross-sectional study, DEXA was taken on 2 occasions with an average of 5.35 year follow up to examine the amount of visceral adipose tissue by ethnicity of Aboriginal Canadian, Chinese, European and South Asian health men and women (n=624) (Lear, Park, Gasevic, Chockalingam, & Humphries, 2013). The study found a significant ethnic difference in the increase in visceral adipose tissue over time and Aboriginals not only had greater visceral adipose tissue than either the Europeans and South Asians but also accumulated visceral adipose tissue at a faster rate than Europeans and South Asians. This may account for their higher prevalence of insulin resistance and diabetes in the Canadian Aboriginal community, hence more aggressive prevention needs to be focused on how to assist the slowdown of accumulation of visceral adipose tissue and consequent risks of cardiometabolic complications. (Lear et al., 2013). The measures of visceral adipose tissue in the Aboriginal community in the current study were lower when compared to the US participants in the other two studies (Bredella et al., 2013; Smith et al., 2001). The reason for the lower visceral adipose tissue and subcutaneous adipose tissue measures in this study can be attributed to the participants being a cross section of the community and not specifically overweight or obese. Within Indigenous populations, waist circumference appeared to be the best and WHR the worst predictor for cardiovascular risk factors (Wang & Hoy, 2004).

Neuromuscular Strength

While maintaining or increasing neuromuscular strength has been recognised as a means to prevent the prevalence and incidence of many chronic diseases in non-Indigenous research cohorts, there are no studies to our knowledge that have measured strength in Indigenous research cohorts. Essentially this denotes that the only means of comparison will be with non-Indigenous participants as there is no data in the literature with which to compare our current results. Indigenous male participants in this study were almost twice as strong in the upper body then the Indigenous females. For leg press strength, however, the Indigenous males only demonstrated a 17% difference over the Indigenous females in this study. Another study, of non-Indigenous people has found similar results; female upper body strength (1RM bench press 33.7kg) being half that of the men (1RM bench press 60.3kg, and leg strength of females being 66% (Miller, MacDougall, Tarnopolsky, & Sale, 1993). The higher strength may be attributed to men having larger muscle fibers due predominantly to high levels of anabolic hormones such as testosterone (Miller et al., 1993) but also potentially greater history of strength training or physical activity.

One of the effects of aging is muscle wasting or sarcopenia, the age related loss of muscle mass (Candow et al., 2012) This reduction in muscle strength which also results in the loss of bone and tendon strength can eventuate into a number of other medical conditions and even simple everyday tasks become more difficult (Goldspink, 2012). Other studies suggest that the decline in skeletal muscle mass associated with aging is attributed to the type II muscle fiber size reducing (Nilwik et al., 2013), however regardless of the mechanism, by increasing the amount of exercise Indigenous people perform should be highly beneficial. However, as discussed in previous chapters there are a variety of challenges to overcome even if the benefit of exercise is indisputable. Exercise that can drive muscle hypertrophy is important and has the potential to improve our overall quality of life and moreover is an important component of 'closing the gap' in life expectancy between Indigenous and non-Indigenous communities. While the participants' upper body strength was weak compared to the ACSM standards the lower body strength was relatively very good. Exercise interventions should be readily available to the Indigenous community as exercise opposes the deleterious structural and functional age related changes caused by diseases and lifestyle factors (Candow et al., 2012).

Cardiovascular measures

Cardiovascular measures can be used to assess the risk of morbidity and mortality of individuals. Blood pressure is a risk factor associated with the MetS and in this study the average blood pressure was normal for both the male and female participants. The females had the highest blood pressure of 134/77 however this is still within the normal range (Nash, 2007) .

Pulse wave velocity measured by the Sphygmocor averaged 9.5 m/s for the males and females had a higher velocity recorded at 10.0 m/s. To our knowledge there have been no previous studies reporting these measures in Australian Indigenous people for comparison. However, Sphygmocor measures have been reported in South Africans of African Ancestry (Shiburi et al., 2006). In this study conducted on 185 healthy (108 females) without hypertension, diabetes or cardiovascular disease, 8.0 m/s for PWV is estimated as a preliminary threshold to diagnose increased atrial stiffness in young Africans (mean age 33.5 years) (Shiburi et al., 2006).

Both male and female participants in this study exhibited PWV over 8 m/s for PWV and according to Shiburi et al. (2006) meet the preliminary threshold to diagnose increased arterial stiffness.

This study involved the measurement of several parameters to assess blood vessel compliance. In comparison with previous reports (Janner, Godtfredsen, Ladelund, Vestbo, & Prescott, 2012), participants in this study had much higher AIx, 19% for peripheral index and 180% for central index. A high AIx has been associated with organ damage (Shimizu & Kario, 2008) and raises concern for the long term health of the current cohort. Peripheral and central systolic, diastole, mean arterial, and pulse pressures were generally on par with what would be expected when compared to other studies.

It was found that in this study the pulse pressure was lower than that of Sharman et al., (2006), 33 compared to 59 mm Hg respectively. Pulse pressure is the difference between systolic and diastolic blood pressure and increases distinctly at the age of 50 years and over (Chae et al., 1999). The average age of the participants in this study was only 34 compared to 56 in the Sharman et al., (2006) study which could explain the 22 mmHg difference in PP. According to the Heart Foundation (2012) 70% more Indigenous people were likely to die from circulatory disease than non-Indigenous people. The results of this study provide some mechanistic explanation to reinforce the Heart Foundation statement. The strength of this study is that we provide a cross-sectional assessment of a wide range of factors contributing to cardiometabolic within the Australian Indigenous community and compare to other studies in Indigenous peoples or non-Indigenous populations when necessary. In particular, we have incorporated previously unmeasured parameters for this population such as Sphygmocor PWV measures.

An unavoidable weakness in the study may be the lack of peer reviewed articles that provide comparative data. New South Wales has the highest population of Indigenous people however blood vessel compliance data that was collected in this study has not be collected from that State. While we have reported on the existing published material we cannot adamantly state that this is indicative of all Indigenous communities in Australia. However, when comparing to non-Indigenous results there are some clear priorities to be pursued for ‘closing the gap’ guidelines, in particular, to close the gap in life expectancy. Reducing the risk factors associated with avoidable chronic disease certainly has the potential to reduce the life expectancy gap between Indigenous and non-Indigenous Australians and appropriate exercise has considerable potential to benefit the anthropometric, cardiovascular, physical fitness and body composition factors known to contribute to chronic disease and mortality.

Conclusion

To our knowledge this is the first study to characterise these key anthropometric and physiological measures in an Australian Indigenous community.

This study compared key representative measures obtained in this Perth population to other studies involving Indigenous participants in other urban and regional areas across Australia although available data was limited. The Indigenous male participants in this study had the most adverse risk factors when compared to other similar study cohorts, whereas the Indigenous females were somewhat healthier compared to other groups evaluated (Tables 7.3 and 7.4). These higher adverse measures were only marginal and overall, were comparable to those of other Indigenous communities in other studies. The outcomes of this study provide a more in depth understanding of cardiovascular and metabolic risk factors and can be used to inform future interventions including specific exercise to address deficiencies, reducing PWV, waist circumference and improve cardiopulmonary fitness.

Chapter 7
Effects of twelve weeks combined aerobic and resistance exercise on fitness and health of Indigenous men and women.

Background

Reducing the incidence, prevalence and severity of preventable chronic diseases involves working to ameliorate a range of health risk factors (Thompson et al., 2003). For Indigenous Australians, the biggest health improvements can be achieved by tackling those risk factors which mediate the bulk of preventable chronic disease. These risk factors include smoking, overweight and obesity, physical inactivity, high cholesterol, excessive alcohol consumption, high blood pressure and insufficient fruit and vegetable intake (Thompson et al., 2003).

A key strategy for improving health status among Indigenous people is to increase their physical activity (Thomson & Kirov, 2006). Participation by Indigenous people in sport and physical recreation activities is much lower compared to non-Indigenous people (Thomson & Kirov, 2006) and this may be an important lifestyle component driving their worsening levels of health in particular chronic disease. Sedentary level in the Indigenous communities is 40% compared to 30% in the non-Indigenous communities and 51% of the Indigenous community have been reported to not take part in any exercise or physical activity (Thomson & Kirov, 2006).

There appears to be a dearth of enquiry that quantifies the effects of physical inactivity in Indigenous people, and assesses the barriers and enablers to participation, and thus demonstrates or refutes the efficacy and effectiveness of strategies to increase exercise participation (Hodgson, 2008; Shilton & Brown, 2004). In chapter 5 of this thesis it was noted that 25% of the participants had high blood pressure, type 2 diabetes and high cholesterol. Overall 23% of the participants had MetS, women had higher percentages for MetS risk factors, in particular almost doubling the men’s high blood pressure percentage (18% vs 33%). Sedentary behaviour occupied an average of 39 hours per week in the Noongar community members studied which is similar to the non-Indigenous community. The continuing increase in overweight and obesity is associated with a decrease in the level of physical activity in the Australian Indigenous community (Rowley et al., 2000). This inactivity is known to be associated with an increased risk for many chronic diseases including: coronary artery disease, stroke, hypertension, colon cancer, breast cancer, Type 2 diabetes, and osteoporosis, as well as premature death (Prince et al., 2008).

Willis et al., (2012) in a randomised trial, compared aerobic training, resistance training, and a combination of the two to determine the optimal mode of exercise for obesity reduction. Participants were 119 non-Indigenous sedentary, overweight or obese adults who were randomised to one of three 8-month exercise interventions: 1) resistance training, 2) aerobic training, and 3) aerobic and resistance training (combination of aerobic training and resistance training). Primary outcomes included total body mass, fat mass, and lean body mass. The aerobic training and aerobic / resistance training groups reduced total body mass and fat mass more than resistance training ($P < 0.05$), but they were not different from each other. Resistance training and aerobic training / resistance training increased lean body mass more than aerobic training alone ($P < 0.05$). While requiring double the time commitment, a program of combined aerobic training and resistance training did not result in significantly greater fat mass or body mass reductions over aerobic training alone. Balancing time commitments against health benefits, it appears that aerobic training is the optimal mode of exercise for reducing fat mass and body mass, while a program including resistance training is needed for increasing lean mass in middle-aged, overweight/obese individuals.

Effects of exercise on measures of cardiovascular risk

Physical activity is a key behaviour modifying the determinants of chronic disease (Borjesson et al., 2011) and in most studies a dose–response relationship to cardiovascular outcomes has been demonstrated (Vanhees et al., 2012). Exercise has been shown to have positive impacts on the reduction in total cholesterol and is considered the gold standard in preventative cardiovascular medicine (Mann, Beedie, & Jimenez, 2014). Both the US Physical Activity Guidelines Advisory Committee and the Australian National Physical Activity Guidelines for Adults have recommendations, however, it is not known if these recommendations are adequate for improvement in cardiovascular disease risk factors (Ross, Hudson, Day, & Lam, 2013) in overweight and obese individuals (Ho, Dhaliwal, Hills, & Pal, 2012a; Slentz et al., 2004), in dyslipidaemia (Mann et al., 2014), or in type 2 diabetes (Yang, Scott, Mao, Tang, & Farmer, 2014). Unfortunately, there is a dearth of knowledge about the physiological effects of exercise on Indigenous participants although one would expect similar improvements to that reported in the numerous exercise intervention studies in other populations.

Ismail, Keating, Baker & Johnson (2012) in their systematic review and meta-analysis of the effect of aerobic vs. resistance exercise training on visceral fat found that it was increasingly being recognised that excess adiposity location, particularly increased deposition of visceral adipose tissue, is a key factor when determining the adverse health effects of overweight and obesity. While the prescription of exercise is important in obesity management, the most effective exercise prescription for the reduction of visceral adipose tissue has not been determined. The review concluded by suggesting that while further investigation is warranted regarding the efficacy and feasibility of multi-modal training, interventions should aim to reduce visceral adipose tissue, and that one can reduce visceral adipose tissue while participating in aerobic exercise below current recommendations (Ismail et al., 2012). The ACSM guidelines for physical activity suggest 250 min of moderate intensity physical activity is needed for weight maintenance after weight loss thereby preventing weight regain (American College of Sports Medicine, 2015).

According to Schjerve, Tyldum, Tjonna et al. (2008) who conducted a 12-week study, a moderate intensity aerobic exercise group (60 – 70% of HRmax) improved their VO2max by 16%. Flow mediated dilation and diastolic BP (decrease of 6 – 8 mmHg) also improved and LDL-cholesterol decreased significantly after moderate intensity aerobic exercise. However, no change was recorded in the systolic BP. In a 16 week intervention conducted by Tjonna, Lee, Rognmo et al (2008) the authors reported a 10mmHg reduction in systolic BP and decreases in body weight (3%) and waist circumference (5 cm), while triglycerides, HDL-cholesterol, total cholesterol, HbA1c and glucose remained unchanged. This research was conducted in 32 MetS patients, average age 52.3 +/- 3.7 years. However, there have only been a few studies (Canuto et al., 2012b; Mendham et al., 2014b) focusing on exercise interventions in Australian Indigenous peoples and were limited to investigating anthropometric measures and blood pathology.

The aim of this study was to determine the effects of implementing an exercise program incorporating the ACSM/AHA guidelines for physical activity and health on, physiological adaptations, among a sample of the Aboriginal people in an Australian metropolitan setting, while assessing efficacy in the reduction of metabolic syndrome risk factors.

Methods

Experimental Approach

This study was a single group design with all assessments completed at baseline and post a 12-week intervention. Post-testing occurred at least 3 but not more than 7 days after the last exercise session.

G-Power version 3.1.2 was used to calculate statistical power. The expected effect size of 0.42 for strength was obtained from the work of Stensvold (2010). Therefore, a sample size of 20 subjects per group is required to achieve an alpha level of 0.05 and a power of 0.8 allowing for the attrition outlined above. We have chosen strength as our primary outcome for calculating statistical power because of the strong predictive relationship to development of MetS (Stensvold, 2010).

Participants

Participants were recruited by meeting with key community members and organisations and seeking their assistance in recruitment of participants. As a member of the Perth Noongar community the researcher has extensive links and established Indigenous networks and was in an excellent position to recruit for the study. Thirty Australian Aboriginal and Torres Strait individuals aged between 18 – 50 years agreed to participate. The study sample was biased targeting Indigenous participants either employed or studying at Edith Cowan University or living in the local area where the intervention was implemented (Wanneroo Aqua Motion Complex) with 6 participants at this site. A Noongar Elder however approached the researcher and asked for the intervention to be conducted in the Southlake area so a separate cohort attended testing sessions at Joondalup but arrangements were made for them to train at Southlake's Recreation Centre.

Recruitment was exceptionally difficult in this population and it was not possible to have MetS as an inclusion criteria even though it would have greatly increased the importance of the research and provided much greater relevance.

Ethics

The protocol was fully explained to each participant and written informed consent was obtained prior to their participation in the study. This study was approved by the ECU Human Ethics Committee and Western Australian Aboriginal Health Information and Ethics Committee (WAAHIEC).

Inclusion Criteria

Participants identified as either Australian Aboriginal or Torres Strait Islander or both.

Exclusion Criteria

- A person not recognised by an Indigenous Australian community as either Aboriginal or Torres Strait Islander or both.
- A person that did not provide a medical clearance from a medical practitioner.
- Women who were pregnant
- People with any condition which would place them at risk from exercise or inhibit their exercise response and adaptation.

Aerobic Exercise Prescription

As per ACSM guidelines the goal was to accrue a minimum of 150 minutes of moderate intensity aerobic exercise each week. Used singularly or in combination, exercise such as walking, jogging, swimming, cycling etc. was carried out for 15 minutes before and after a resistance exercise program for an accumulation of 30 minutes per session or 60 minutes per week. Approximately a third of the aerobic exercise time was monitored with the remainder performed unsupervised. To meet the target of 150 minutes' total per week each participant was also required to perform aerobic exercise for 90 minutes each week under their own self-management. Guidelines and feedback were provided to assist the participants to pursue safe and effective aerobic exercise in their home, work or other suitable environment.

Resistance Exercise Prescription

As per ACSM guidelines, participants were requested to complete 2 or more resistance training sessions per week. The four exercises that were prescribed included leg press, bench press, lat pull-down and shoulder press. For weeks 1 – 2 the resistance intensity was 10-12 RM and for weeks 3-12 the resistance was 6-10RM. Repetition maximum (RM) is the maximum weight that can be lifted for the specified number of repetitions. For example, 10 RM is the maximum weight that can be lifted 10 times before neuromuscular fatigue precludes further repetitions (Braith & Beck, 2008). Rest periods of 60 – 90 seconds between sets and a 120-180 second interval between each exercise was enforced. Three sets were performed for all exercises at each training session. Once subjects could successfully perform a set of the target repetitions the training load was increased by approximately 5% to keep them within the target repetition range. For this study, there was a minimum of three supervised exercise sessions per group per week comprising of 7 – 8 participants. The gym in the northern Perth suburbs had a female key advocate so the group was comprised of females and the southern gym had a male Elder as a key advocate and recruited mostly males.

Participants were provided with an individualised program which included target heart rates for training aerobically and estimates of weight that should be lifted each week as a guide. The estimates of how much the participants should lift were calculated based on their 1RM results. Participants were also supplied with a diary and a pen and asked to record information pertaining to the weights they were lifting.

Outcome measures

All the protocols have been described in detail in the previous chapter but in brief these included cardiorespiratory fitness, neuromuscular strength, blood vessel compliance, body composition and anthropometric measures such as height, weight, hip and waist circumference. Cardiorespiratory fitness was assessed using a submaximal cycle ergometer test and the methods of Astrand and Rodahl (1986). Neuromuscular strength was measured using 1 RM (Wycherley et al., 2010) and Sphygmocor was used to measure blood vessel compliance. DEXA was used to measure body composition.

Results

Of the 37 participants that completed baseline testing only 16 commenced the exercise intervention. There were numerous reasons why 21 participants never commenced the intervention. Unable to be contacted once the intervention commenced, moving house and away from the intervention sites, work commitments, or no longer interested. Fifteen completed the intervention and part of the post-testing, and only 11 completed all post testing measures. There were 5 participants who withdrew from the study during the exercise intervention due to a number of reasons. One due to ill health, two others who depended on this person for transport, one obtained a job which required travel away from Perth, and one stated they were too busy. Of those that dropped out, only their baseline measures were included in chapter 7; they had no further involvement nor was their data included in chapter 8.

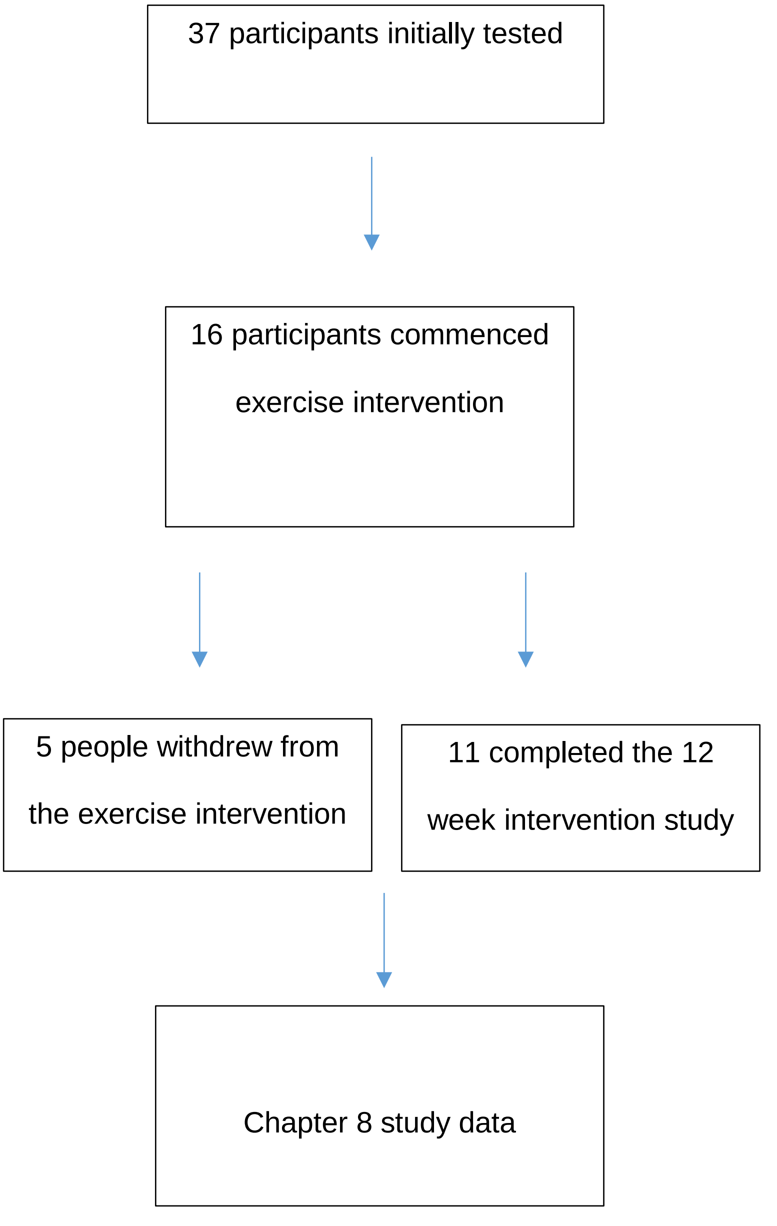

Figure 8-1 Consort diagram of participants' study inclusion

The participants received a pass for entry into the gym as part of the study. Compliance was measured using the information compiled at entry to the gym. Participants recorded 90% attendance at gym sessions. Unfortunately, on most occasions participants attended the gym without their diary to record weights lifted and aerobic activity completed. The participants found recording this troublesome in the gym environment and would gravitate towards socially engaging with other non-Indigenous gym members, explaining the study, exchanging training tips and gaining the support of non-Indigenous gym members. As the weeks, past, they continually engaged with the other gym members thereby creating their own community breaking down barriers often associated with exercise mentioned previously in this thesis. Because of this the recording of training information became the duty of the researcher. The researcher attended all gym sessions with the participants at the Southlakes complex and another Exercise Physiologist attended the training sessions at the Wanneroo exercise complex, supervised and recorded the activity that took place as part of the session.

Strength and Aerobic Fitness

Participants showed improvements in both upper and lower body strength as well as aerobic fitness as presented in Table 8.1 below. The pre-to post training results of paired t-test for strength were a statistically significant increase in bench press (31%), leg press (29%) and aerobic fitness (17%). While the participants' upper and lower strength increased their muscle appendicular mass only increased by 0.25kg which was not statistically significant (Table 8.2).

*T*able 8-1 Strength and aerobic fitness (N=11)

Test	Pre	Std err avg	Post	Std err avg	Differences	t	p	% Diff
Strength								
Bench press (kg)	41	(4)	59	(6)	18 (14-24)	7.524	.000	31
Leg press (kg)	168	(39)	235	(66)	67 (43-90)	5.997	.002	29
Aerobic fitness								
Estimated VO2 (ml/kg/min)	25	(2)	30	(2)	5 (4-6)	9.725	.000	17

Body Composition and Anthropometric Measures

The exercise program resulted in a loss of body fat and a reduction in abdominal adiposity. Specifically, there were significant reductions in total body fat (1.7%), waist (6.8%) and hip (2.8%) circumferences and WHR (4.4%) but total body weight did not change significantly (Table 8.2). Similar to waist circumference, the fat mass in the trunk region decreased by 6.54%. Fat mass in the appendicular region was not significantly altered.

Table 8-2 Anthropometry and body composition (N=11)

Test	Pre	Std err x	Post	Std err x	Differences	t	p	% diff
Anthropometric Measures								
Waist circumference (cm)	97.5	6.1	93.8	5.2	-3.7 (-6.3, -1.1)	-3.173	0.1	-3.7
Hip circumference (cm)	100.5	10.8	98.1	10.5	-2.3 (-3.7, -0.9)	-3.66	0.004	-2.3
Waist – Hip ratio	0.9	0.02	0.84	-0.03	0.1 (-01, 0.0)	-4.474	0.001	-8
Weight (kg)	88	7.1	80.9	8.7	7.1 (-20.1, 6.0)	-1.2	0.257	-8.8
DEXA								
Body fat (%)	34.2	2.5	32.4	2.6	1.8 (-3.4, -0.2)	-2.456	0.033	-5.6
Fat mass trunk (kg)	21.7	4.2	20.6	3.8	1.1 (-2.7, 0.5)	0.159	0.877	-5.3
Fat mass appendicular (kg)	24.37	1.79	25.1	1.65	0.7 (-2.97, 1.50)	-0.841	0.163	2.8
Muscle trunk (kg)	30.3	2.3	30.4	2.2	0.1 (-0.1, 1.8)	0.159	0.877	0.3
Muscle appendicular (kg)	22.6	1.6	23.2	1.7	1.2 (-1.2, 0.1)	-1.85	0.094	5.2

Alterations observed in vascular function included a reduction in all measures however, the only statistically significant reductions were pulse wave velocity and systolic blood pressure (Table 8.3).

Table 8.3 Vascular function – blood pressure, arterial compliance (N=11)

Measure	Pre	Std err x	Post	Std err x	Differences	t	p	% diff
Pulse wave velocity (m/s)	10.0	-0.4	8.6	-0.4	1.4 (0.7 - 2.3)	4.094	0.002	14.0
Aortic pulse pressure (mmHg)	34.0	-1.3	35.0	-3.0	-1.0 (-6.5-4.3)	-0.460	0.655	11.0
Aortic augmentation (mmHg)	4.6	-1.2	4.1	-1.6	0.5 (-1-2)	0.760	0.456	11.1
Blood pressure (mmHg)								
Systolic	125.0	-14.0	121.0	-9.0	4.0 (0.0-7.3)	2.140	0.048	3.2
Diastolic	75.0	-9.0	75.0	-8.0	0.0 (-1.7- 3.1)	0.620	0.542	0.0

Discussion

The aim of this study was to investigate the effects of 12 weeks of combined aerobic and resistance exercise on BP, arterial stiffness, strength, cardiorespiratory fitness, anthropometry, and body composition in sedentary Australian Aboriginal peoples. While potential participants did show interest in the study, socio-economic and time factors may have contributed to the low initial numbers commencing the baseline testing. Being able to run an intervention in a region within the Perth metropolitan area required local council support and in many cases councils offered subsided gym membership rates. It also required a minimum of 4 to 6 participants in each area of Perth to make the cohort feasible. While some participants were able to travel to the testing facility at Edith Cowan University, Joondalup located 30 km north of Perth CBD, for others in the southern suburbs it was a 50 to 70 km trip one way. As a result, recruitment was difficult and retention low compared to similar studies in non-Aboriginal populations. For those that complete the intervention there was an average 90% attendance rate for the scheduled exercise sessions which resulted in participants' health, body composition, strength and aerobic fitness improving significantly. In hindsight, we should have recruited solely from the Joondalup local area.

Alternatively, future interventions would benefit from incorporating resources and equipment from the various universities across the Perth metropolitan area so participants can more easily access testing facilities and could perhaps examine implementing the intervention using existing mine site facilities (given the high proportion of Indigenous people working in these environments in WA) or other logistical modifications to improve recruitment and retention. Most importantly the participants stated that they felt better and healthier and they have a better understanding of how to complete the exercises and what the benefits of exercises are. Historically, gyms were perceived as culturally unsafe, this study now sheds that perception, removing the historic barrier. By adopting the methodologies introduced in this paper, more Indigenous people can now access their local council gyms to improve health literacy, health outcomes and general wellbeing. It provides an avenue of entry for Indigenous people in a traditionally non-Indigenous environment thereby improving the efficiency of exercise in the Indigenous community. Specific physiologically improvements were numerous and will now be discussed in detail.

Aerobic capacity

Aerobic capacity is a strong predictor of mortality and is often poor in individuals with metabolic syndrome (Greely, Martinez, & Campbell, 2013). The exercise intervention implemented in this study resulted in a marked improvement in aerobic fitness for these participants from 25 to 30 ml/kg/min which is a 16% increase. This compares quite favourably with previous research such as Fargard (2006) who reported aerobic power to increase by an average of 10.5% across six similar research studies. This study provided an opportunity to investigate the relative benefits of combining resistance training and aerobic training and more importantly to report on the improved health outcomes. As expected, similar adaptations were observed in this Aboriginal population to previous research in other populations.

There have been a number of combined resistance and aerobic studies that have shown increases in VO2max (Church et al., 2010; Davidson et al., 2009; Ho et al., 2012a). This intervention employing both resistance and aerobic exercise modes demonstrates that improvements in cardiovascular fitness can be achieved in Aboriginal men and women by following the Australian physical activity recommendations.

Neuromuscular strength

Strength was determined as one repetition maximum in bench press and leg press. Strength gains showed a trend of less improvement as training progressed and this is consistent with the normal pattern of strength gains in accordance with the American College of Sports Medicine Position Stand on Progression Models in Resistance Training for Health Adults (Kraemer et al., 2002). The participants were not asked to modify their diet for the duration of the study. The non-significant change in weight and the significant increases in strength suggest that subjects consumed adequate kilocalories and macronutrients to bring about the necessary physiological changes. The exercise intervention resulted in a significant increase of 31% and 29% respectively for bench press and leg press. In a similar 8 month study on males (n = 17) measures were taken at baseline, 4 and 8 months, the difference between the baseline and 4 months measures were increases in strength of 23.9% for bench press and 17.5% for leg press (Serra et al., 2015). The training protocol was similar to the current study in that it included lat pulldown, leg press and shoulder press but also included bench press, leg extension, seated row, leg curl and abdominal crunch. The participants in this 3 month study were on average 10 years younger than those of Serra et al., (2015). Another 12 week study on untrained men (22 years of age, n=16) demonstrated a 39.4% and 21.2% increase in 1RM leg press and bench press respectively (Glowacki et al., 2004). A 6 month study involving older participants participating in resistance type exercise training 3 times per week, 1 RM leg press increased by 43% for men (70 years old, n=29 and 42% for women (71 years old, n=24) (Leenders et al., 2013b). All these studies including this study have demonstrated similar and meaningful strength gains.

Body composition

Aerobic exercise training is associated with much greater energy expenditure during an exercise session than that of resistance training (Strasser, Arvandi, & Siebert, 2012). The main effect of resistance training on body composition is a reduction in fat and increased muscle mass but body weight per se may not necessarily change appreciably (Strasser et al., 2012). In line with Strasser et al. (2012) the participants in this study averaged 7.1 kg (8.8%) reduction in total body weight however this was not statistically significant. In contrast, Ho et al.(2012a) reported significant decreases in body weight of 1.6 kg (1.7%) with participants required to exercise at a moderate intensity for 30 min, five days per week. Similar to this study Ho et al., (2012a) suggests that combined resistance and aerobic training produce the greatest improvements in body composition. Park and Ransone (2003) also observed that combination exercise was effective in decreasing visceral fat which is particularly problematic in terms of health. It has been consistently reported that high levels of visceral fat increase the risk of developing Type 2 diabetes and cardiovascular disease (Haffner, 2007). The excess of intra-abdominal visceral fat results in the reduction of adiponectin levels; adiponectin has anti-atherogenic and anti-inflammatory properties (Laakso, 2010). Thus, a combination training program involving both aerobic and resistance exercise can be beneficial in reducing this risk (Ho et al., 2012a).

There is an inverse relationship between physical activity, body mass index, waist-hip ratio and waist circumference (Berentzen et al., 2010; Golbidi, Mesdaghinia, & Laher, 2012). Maintaining lean body mass is essential for better glucose transport and fat metabolism, whereas, a reduction in fat mass aids in increasing adiponectin levels and improving cytokine profiles and these changes in adipokines and cytokines are associated with MetS risk (Golbidi et al., 2012). Reducing the percentage of body fat has considerable protective effects and importantly the result of this study was a significant reduction in percentage body fat of 1.8% from 34.1% to 32.3%. This is highly encouraging for the benefit of this relatively short duration exercise prescription for indigenous people.

Generally the measures of obesity are BMI and body mass, but, there is increasing evidence that suggests WHR is more strongly correlated with cardiovascular disease (Janssen, Katzmarzyk, & Ross, 2004; Mousavi et al., 2015; Willis et al., 2012). This intervention was successful in the reduction of hip circumference by 2.3% and waist circumference by 3.7%. As there is a well-established relationship between waist circumference and cardiovascular disease (Mousavi et al., 2015), being able to reduce waist circumference also has notable health benefits.

Whereas the reduction of WHR (8%) delivers both directly and indirectly the above stated healthy physiological changes, a 10% increase in the WHR doubles the incidence of mortality (Mousavi et al., 2015). Within Indigenous populations waist circumference appeared to be the best and WHR the worse predictor for cardiovascular risk factors (Wang & Hoy, 2004).

Numerous studies have shown that an increase in muscle mass is highly protective against the metabolic syndrome risk factors (Leenders et al., 2013a) and against non-communicable chronic diseases such as diabetes (Kalyani, Corriere, & Ferrucci, 2014) cancer (Pedersen & Febbraio, 2012) heart failure (Fulster et al., 2013) chronic obstructive pulmonary disease, kidney disease (Egerman & Glass, 2014). Unfortunately, the increase of muscle in this study was statistically insignificant with participants on average only gaining 250 grams in muscle mass. As this would seem an important goal other strategies of program design should be explored, perhaps in combination with nutritional support.

The protective effects of exercise could be governed by controlling the release and activity of at least two cytokines, tumor necrosis factor alpha (TNF-α) and Interleukine-6 (IL-6) (Golbidi et al., 2012). IL-6 secreted by T cells and macrophages exerts anti-inflammatory effects through its inhibitory effects on TNF-α, IL1β, and activation of interleukin – 1 receptor antagonist (1L-1ra) and IL-10) (Golbidi et al., 2012). The exercise prescription in this study serves to facilitate the protection against TNF-induced insulin resistance (Golbidi et al., 2012). Increases in epinephrine levels as a result of exercise can also reduce the effects of TNF-α response (Golbidi et al., 2012), thereby reducing the potential of insulin resistance and dyslipidaemia (Laakso, 2010). Overall, the reduction in the range of adiposity measures in the study population is very positive in particular given we did not implement any dietary changes. Future exercise studies in indigenous people should include measures of these factors.

Vascular function – blood pressure, arterial compliance

Cardiovascular disease results from several factors which lead to increased systolic blood pressure and pulse pressure as a result of higher arterial stiffness. Recently techniques have been devised to examine the compliance of the central arteries non-invasively which makes assessment of these key risk factors much simpler. Because pulse wave velocity (PWV) and aortic augmentation index (AIx) are considered the gold standard for measuring arterial stiffness (Janner et al., 2012) it was performed in this study. Encouragingly there was a significant reduction of 14% in PWV. There was a non-significant decrease (11.1%) in AIx. Previous research has been conducted on pre-and stage-1 hypertensives, with an average age of 48 years which examined the effects of four weeks of aerobic or resistance training on arterial stiffness, blood flow and blood pressure (Collier et al., 2008). The results were that aerobic training reduced arterial stiffness while resistance training increased arterial stiffness. However, it is suspected, because of vasodilation in microvasculature produced by resistance training, mean arterial pressure was decreased (Collier et al., 2008). These findings are similar to that of the current study as systolic blood pressure was reduced. A systematic review of the literature (n=41) surrounding exercise effects on arterial stiffness and wave reflection concluded that more intensive aerobic exercise produces greater reductions in arterial stiffness, whereas, PWV and AIx are not reduced for resistance exercise alone or combined exercise incorporating both resistance and aerobic exercise as was applied in this study (Ashor, Lara, Siervo, Celis-Morales, & Mathers, 2014). However, the authors of this review, state that resistance exercise plays an equally important role for improving cardio-metabolic parameters for people with MetS and both modes of exercise should be incorporated in any intervention to ensure the most effective vascular hemodynamic outcomes (Ashor et al., 2014). The reduction in PWV in this study could feasibly be attributed to the participants training beyond the minimum ACSM aerobic exercise guidelines and/or their initially low exercise background. Regardless, this relatively short exercise intervention has resulted in quite positive cardiovascular benefits for these Aboriginal and Torres Strait Islander participants.

The exercise intervention significantly reduced systolic blood pressure in our sample. In research conducted in overweight and obese adults by Ho, Radavelli-Bagatini, Hills & Pal, (2012b) they observed a significant decrease of 6.3% in SBP, whereas SBP was reduced by only 3.2% in the current study. Fagard (2006) identified nine randomised controlled trials on the effects of resistance training on blood pressure. Overall weighted net change of diastolic blood pressure of 3.5 mmHg ($P < 0.01$) and a non-significant reduction in systolic blood pressure of 3.2 mmHg ($P = 0.10$) was reported. This reduction in diastolic blood pressure was also reflected in the current study. In a study conducted on Aboriginal women focusing on exercise and diet, systolic and diastolic blood pressures were significantly decreased -1.24 mmHg and -2.46 mmHg respectively (Canuto et al., 2012b) which is similar to that achieved in the current study.

The present study could have been improved by implementing a randomized controlled two group design however this was not feasible as it was deemed unethical to withhold the exercise program from these sedentary Aboriginal people given the established benefits they would accrue. Further in our experience, the attrition is very high in participants allocated to a control group in an exercise intervention study. Another possible design was a cross-over with one group receiving a delayed intervention but the majority of participants wanted to start immediately and were not interested in delaying 3 months before starting the program. Perth is a hub for fly in and fly out workers in mining jobs and the intervention conflicted with participant's rosters and other time commitments making recruitment and retention difficult. Further studies could perhaps examine implementing the intervention using existing resources industry site facilities or other logistical modifications to improve recruitment and retention. The distance required for travel to and from the facilities at Edith Cowan University for pre-and post-testing participants also discouraged some participants from taking part in the study or staying in the study. Future interventions would benefit from incorporating resources and equipment from the various universities across the Perth metropolitan area so participants can more easily access testing and training facilities closer to their work or home.

The use of body weight exercises in a community placed intervention and health and performance testing that does not incorporate more laboratory based methods may also improve recruitment and retention if the assessments could also be done locally to the participants. This could possibly incorporate a high intensity interval training intervention according to the exercise prescription by Ross, Porter & Durstine (2016) for patients with chronic diseases. This involved a 2:1 work to recovery ratio, 30 seconds; pushups, squats, butt kicks, tricep dips, sides lunges, jumping jacks, sit-ups. Followed by 15 seconds between each activity with recovery of 1 minute rest between each of the 3 cycles (1 cycle = 30 s per exercise alternated with 15 s of recovery). Such a prescription would be very feasible in a community intervention and requires no equipment. However, this would lead to other problems such as consistency and validity across multiple testing and training sites. Despite the best efforts of the researcher, recruitment and retention was much lower than reported in other similar exercise intervention studies in other populations and similar to other Indigenous studies (refs). Clearly, further research is required to elucidate the reasons for this disparity so that much greater recruitment and retention can be achieved for Indigenous people.

It was encouraging to observe that most of the participants who started the intervention completed the exercise program with 90% compliance. This exercise intervention study is one of the first to examine physiological changes in Aboriginal people in response to the current physical activity guidelines and will hopefully be the catalyst to further research in this direction. Future research must address issues of adherence and retention to exercise programs in this population if benefit is to be realized for a significant proportion of the Aboriginal people. Most importantly the participants stated that they felt better and healthier and they have a better understanding of how to complete the exercises and what the benefits of exercises are.

Conclusion

This is the first study to our knowledge that recruited both Indigenous male and female participants for an exercise intervention implementing the ACSM guidelines for physical activity and involving close supervision by an exercise specialist in a commercial health and fitness setting. Numerous measures were recorded that have not been previously examined in the Indigenous community in particular more sophisticated outcomes as derived from DEXA and SphygmoCor for the in-depth evaluation of body composition and central cardiovascular function. Importantly, we demonstrated significant improvements in strength, aerobic fitness, percentage body fat, waist-hip ratio, pulse wave velocity, and systolic blood pressure. In particular, there were significant and clinically meaningful improvements in MetS risk factors including waist circumference, and blood pressure. By improving these measures of metabolic health, the participants can decrease the risk of developing metabolic syndrome and the risk of developing cardiovascular disease. This study has demonstrated that a mixed methods intervention combining aerobic and resistance exercise is effective in reducing the risk factors associated with the metabolic syndrome. However, attrition from the study was very high and future research should address strategies to improve recruitment and retention of indigenous people in such exercise interventions, given the now proven physiological benefit.

Chapter 8
Summary, conclusions and recommendations

The purpose of this chapter is to draw together the key outcomes from the entire body of research contained in this doctoral study. This will be followed by recommendations which may have implications for clinical care, service delivery or future research.

Exercise and improved health outcomes go hand to hand. In an Indigenous context, however, exercising as an individual and not in a community setting can been deemed as selfish. It is important to consult with the Elders and other community member to ensure the communities expectations and concerns are being met.

Traditionally, the physical and spiritual role of a community member played was very important and was incorporated in every aspect of their lives. The community member would have to be initiation, learnt language, and acquired knowledge that was passed down from one generation to the next (Lore). This provided individuals with a specific role in the community and a sense of identity. They knew what community responsibilities and obligations they needed to meet and the consequences for not adhering to these responsibilities and/or obligations. The roles they performed where physically very activity particularly the acquisition of food.

Colonisation ensuring the fracturing of these physically active practices resulting in adverse physical and psychological health outcomes. Essential not being able to learn language, culture, or traditional inherited knowledge (Lore), coupled with the horrific conditions that the Stolen Generation were exposed to, resulted in the adverse social, emotional, economic and health issues that contemporary Indigenous communities face today on a daily basis. The adverse impact of colonisation was particularly centred on the Stolen Generation who are our current grandparents. The trauma experienced by the Stolen Generation has been inherited by the next 2 and possibility 3 generations resulting in intergeneration trauma that severely impacts contemporary Indigenous lifestyles.

Because of this, carrying out research with Indigenous people can be a sensitive issue. Ensuring a respectful initial contact, and working collaboratively with community in research design, data collection, and reporting of data in culturally competent manner, are all essential (AIATSIS, 2013). While the NHMRC has published values and ethical guidelines for conduct in Indigenous health research, it is a generic guide that acts as a blanket to cover all communities.

Contemporary lifestyles have resulted in less physical activity and increased sedentary behaviour. It is on this basis that we need to have a deep understanding the motivators and barriers to exercise. This understanding is essential if there is any hope of running a successful sustainable exercise intervention focused on improved health outcomes and quality of life.

Despite all the literature about the benefits of increasing physical activity and reducing sedentary behaviour, the motivators and barriers to physical activity have not been measured in the Perth Noongar community. The Noongar nation has the largest single Aboriginal population in Australia encompassing over 40,000 people.

This initial study involved the design of the first questionnaire conceived by a Noongar researcher in consultation with the Noongar community to determine the motivators and barriers of exercise. The study itself promoted the idea of research as something positive rather than something to be suspicious of, and finally to raise sufficient awareness in the Noongar community of the research to promote participation and recruitment for the study. These efforts were important and may help to change behaviours and attitudes to exercise, physical activity, inactivity and sedentary behaviour. The researcher, stakeholders and study design assisted to demonstrate the links between research methodologies, relationship building, and research translation.

Employing strategies that are culturally component is fundamental to the success of any research, program or project with Indigenous communities. A recent publication using *Exercise as Medicine* has shifted the focus from the contemporary medical and health benefits to patient centred motivators, behaviours and goals (Segar, Guerin, Phillips, & Fortier, 2016). Adopting culturally competency provides a better understanding to what these motivators, behaviours and goals are within the Indigenous community, aspects which are relatively unexplored when compared to the non-Indigenous population. Using a cultural competent method also ensures a cultural context; the development and design of the questionnaire in collaboration with the community, in a manner that is sensitive to participants, and the research intention of the questionnaire is to benefit the community.

The questionnaire itself served to identify the levels and intensities of exercise, and modes of exercise. Being able to perform exercise in an appropriate venue generates inquiry into perceived financial costs of exercise, exercise venues and environments. The questionnaire has explored different modes and means of participating in contemporary ways versus traditional exercise, and type of equipment owned to allow pursuit in the activity. Finally, the questionnaire addressed issues of commitment of the participant to achieving health and fitness goals. Because of the diversity within the Noongar community, programs must be tailored towards the participants. The consistent theme is that programs and venues must be culturally secure and be as inclusive as possible to be successful. We are now better able to paint a picture as to what a culturally secure physical activity or exercise activity within the Noongar community looks like.

The current research showed that Indigenous participants from the Noongar nation preferred a gym based exercise intervention over a community based program. While we gathered information as to what mode of exercise the participants preferred, we also felt it was important to gather information pertaining to the quantity of physical activity and sedentary behaviour. This was information which had not previously been collected.

In terms of meeting the ESSA recommended guidelines, walking was the most popular physical activity. As a whole, participants have access to dumbbells or other makeshift exercise equipment which allow them to conduct a least 2 days of muscle strengthening exercising each week, which will afford them the opportunity to meet the ESSA recommended guidelines. Whether the participants in this questionnaire understood the relationship between exercise and health is unclear, but 48% of participants indicated they joined the gym to become healthier.

In order to measure the amount of physical activity and sedentary behaviour that is being conducted in the Perth metropolitan by the Indigenous community, an Australian leading expert in questionnaires was approached and the Global Physical Activity Questionnaire (GPAQ) was recommended and then hence, selected.

Previous studies (Marshall, 2004) have attempted to use International Physical Active Questionnaire – Long (IPAQ-L) questionnaire to measure the amount of exercise within the Aboriginal community but without success, stating that "overall there seemed to be a large degree of confusion amongst the participants when answering the IPAQ-L.".

This study successfully measured the amount of physical activity and sedentary behaviour in the Perth Noongar community. The GPAQ questions seem to be more appropriate for the Indigenous community as dictated by the ease of completion of the questionnaire. The median for all activity was 27 minutes per day with moderate activity accumulating the most minutes, with the exception of 26 – 45-year-olds for vigorous exercise, and the median sedentary time was 206 minutes per day for the Noongar Perth metropolitan community.

This is very similar to other broader studies in Australian people indicating our participants are not very different in terms of physical activity and sedentary time albeit that these levels are too low for maintenance of health. Having identified the types, frequencies and intensities of physical activity, community-based strategies can be implemented to increase physical activity to reduce the risk factors associated with the metabolic syndrome and improve the quality of life of the Noongar and other Indigenous communities. This knowledge can be added to the body of knowledge that exists on the Australian non-Indigenous community and can be used as evidence of the need to increase physical activity rates and reduce sedentary rates in the Noongar community.

The lack of anthropometric and physiological measures, some of which have never previously been taken in the Noongar community, proved compelling. So, a cross-sectional study was designed to capture the data and provided a means of comparison for those measures that exist in other Indigenous communities. This study showcased some concerning results in particular parameters that were taken for the first time such as vascular function assessed by Sphygmocor.

The measures from the cross-sectional study indicated that the Whadjuk (Perth) Noongar Country had largest waist circumference and one of the highest BMI and systolic blood pressures and lowest fitness levels amongst several Indigenous communities reported previously. This is despite having the youngest participants of all the study groups. Reducing these metabolic risk factors is the key to reducing the incidence and prevalence of chronic disease.

Now armed with feedback from the various studies (the community's preference to exercise in a group, preference for a gym based intervention, and baseline anthropometric and physiological measures) we implemented an intervention based on the ACSM/ESS physical activity guidelines. This was the first study that we are aware of in which an Aboriginal researcher conducted a gym based intervention with Aboriginal male and female participants.

Sixteen participants commenced the gym intervention and 11 completed the intervention. Reasons for drop-out included: inability to be contacted after baseline assessment; relocation of residence (two participants); inability to meet time commitments due to changing requirements; and change of mind.

This study is the second study that has examined cardiovascular fitness in the Indigenous community. Mendham and colleagues (2014b) are the only researchers to our knowledge who have published cardiovascular fitness measures for Indigenous men. However, they used a maximal cardiovascular fitness test whereas we used a submaximal test. Their participants were on average 2.5 years older however they report 22% higher aerobic capacity of 27.5 ml/kg/min compared to 22 ml/kg/min for the current study. These figures do not reach the 10^{th} percentile for normative values for maximal aerobic power ($ml/kg/min^{-1}$) reported for similar aged populations.

While maintaining or increasing neuromuscular strength has been recognised to prevent the prevalence and incidence of many chronic diseases in non-Indigenous research cohorts, there are no studies to our knowledge that have measured strength in Indigenous research cohorts. The outcome of our study is that males as expected were almost twice as strong as females with upper body strength. For leg press strength, however, males only demonstrated a

17% difference over the females. Another study, of non-Indigenous people has found similar results; female upper body strength (1RM bench press 33.7kg) is half that of the men (1RM bench press 60.3kg, and leg strength of females is 66% compared to males (Miller et al., 1993).

Carotid to radial pulse wave velocity measured by the Sphygmocor averaged 9.5 m/s for the males and females had a higher velocity recorded at 10 m/s. To our knowledge there have been no previous studies reporting these measures in Australian indigenous people for comparison. However, Sphygmocor measures have been reported in South Africans of African Ancestry (Shiburi et al., 2006). In this study conducted on 185 healthy (108 females) without hypertension, diabetes or cardiovascular disease, 8.0 m/s for PWV is estimated as a preliminary threshold to diagnose increased arterial stiffness in young Africans (mean age 33.5 years) (Shiburi et al., 2006). Both male and female participants in this study PWV were over 8 m/s for PWV and according to Shiburi et al. (2006) meet the preliminary threshold to diagnose increased arterial stiffness.

After the training intervention, there was a significant improvement in aerobic fitness (mean change 4.9 ± 2.4 ml/kg/min). There was a significant increase in upper (mean change 17.40 ± 11.48 kg) and lower (mean change 73.36 ± 54.61 kg) body strength with training. The exercise program resulted in a loss of per cent body fat (mean change -5.61%) and a reduction in average waist circumference (mean change -3.72 cm ± 3.84), hip circumference (mean change -2.55 ± 2.06 cm) and WHR (mean change 0.05 ± 0.04). Fat mass in the trunk region was not significantly changed (mean change 1.09 kg ± 2.26 kg). Pulse wave velocity was significantly reduced with exercise training (mean change -1.49 m/s) but there were no significant changes in all other vascular outcomes.

This is the first study to recruit both Indigenous male and female participants for an exercise intervention implementing current guidelines for physical activity and involving close supervision by an exercise specialist in a commercial health and fitness setting. Numerous measures were recorded that have not been previously examined in the Indigenous community including DEXA and Pulse Wave Velocity for the in-depth evaluation of body composition and central cardiovascular function. The study demonstrated that combined aerobic and resistance training led to significant improvements in aerobic fitness, body composition and strength, pulse wave velocity, and systolic blood pressure. The results show that supervised exercise led to high compliance and was effective for reducing risk factors associated with non-communicable disease in Aboriginal Australian adults. Future research should consider strategies to reduce drop-out and increase compliance to outcome measures in Indigenous Australians.

Recommendations

Health professionals who work with Aboriginal communities need to approach their work from a position of knowledge and understanding of the role of history, culture, community, and connection with the land. Health care delivery models need to shift away from the biomedical model and towards a holistic biopsychosocial model of health. The focus of health is not simply about the health of the individual but is on the health of the community. Researchers in this area may also need to help change the mindset of funding bodies to look beyond financial targets and budgetary issues to less tangible benefits from this kind of approach, such as relationship-building and developing trusting partnerships with communities to improve their control and management of their health.

It is important to develop better means that empower marginalised communities to better navigate the complex relationship between healthcare, socio-economic factors and health outcomes contributors. One way of doing this is to explore the most effective means of providing a range of educational and employment opportunities to the Indigenous community. Another may be using Indigenous expertise to ensure cultural competence and better translation of research to real world outcomes.

Further research needs to be conducted within the Indigenous community to fill the large gap in knowledge about the enablers and barriers for physical activity and structured exercise prescription. Emphasis should be beyond just capturing numbers and statistics but really delve into the issues encompassing how the social determinants of health impact on the amount of physical activity performed. Studies should most importantly focus on the inclusion of culturally secure practices to enhance participation without a ‘one size fits all’ approach.

More emphasis should be placed on developing a better understanding about the differences between cultural awareness, security and appropriateness in order to inform good practice. Non-Indigenous researchers conducting Indigenous research need to be educated, and mentored though these changes over time while empowering Indigenous researchers by educating and mentoring them in research best practices.

Although the health outcome measures were positive, an intervention like this is very difficult to sustain without large amounts of funding. Approaches should be made to funding bodies like Healthway, South West Aboriginal Land and Sea Council, Indigenous Land Council, and Lotteries West to secure a gym. This will have several positive health and socio-economic outcomes.   By providing a culturally secure gym environment, participants can feel comfortable to train. If the gym charged a heavily subsidised gym membership, then at least it could generate sustainable employment and health outcomes. Other forms of exercise interventions can be employed in the event a gym is not available. These interventions can include walking programs, CrossFit or High Intensity Interval Training perhaps in local parks or other council operated facilities.

Future Research

Future research could involve repeating studies like this one in various Indigenous communities to order to compare results and obtain a clear picture of what the motivators and barriers to physical activity are and provide more cultural component means of increasing physical activity. This could help to build a national picture of the amount of physical activity preformed. Studies could then be used to influence funding and policy ensuring appropriate and adequate resources are allocated.

There are a range of measures that can be taken to measure physiological outcomes of the Indigenous community. While these biomarkers may be relevant to the individual and funding bodies they may be appropriate health improvement markers for the Indigenous community. Being able to identify an average of 5 mmHg in systolic blood pressure or 5 cm reduction in waist circumference may both be considered significant measures by funding bodies, but how are these changes relevant to an Indigenous community? Reporting from a holistic health outcome may be a useful approach, for example, that Elders who had physiological changes were better able to engage with children's exercise or cooking classes in the community. Exploring alternative ways of reporting success, through both a biomedical and holistic lenses, may involve a large shift in paradigm, and will be more meaningful when working collaboratively.

Appendices

Appendix A - Questionnaires

Determining the motivators and barriers to exercise in the Australian Indigenous community.

This questionnaire is part of a PhD which will involve 2 studies.

Study 1- Identifying barriers and motivators for Indigenous People to engage and persist in an exercise program

This study will collect information relating to an Aboriginal individuals' perception of the barriers and motivators to aerobic and anaerobic exercise. A survey questionnaire with a sample of stakeholders (potential participants) and key informants with a series of questions designed to elicit the:

- Factors that impact uptake and retention
- Potential sustainability

The questionnaire will include broad questions relating to health and physical activity in general then focus on thoughts and perceptions of specific exercise types and settings. A second questionnaire the Global Physical Activity Questionnaire (GAPQ) attached to the back of this questionnaire will allow comparison of the Noongar community to other international Indigenous and non-Indigenous communities. This cross-sectional questionnaire will target approximately a minimum of 60 male and female adults aged between 18 – 60. There is no maximum number of participants that will be allowed to complete the survey.

Study 2 - The Intervention

The more people that complete the survey the better; the information from this questionnaire will help to identify the most appropriate form of exercise for an Aboriginal exercise intervention which forms the second study of this PhD. If the results indicate that the Aboriginal community prefer a gym or even a dance based intervention, then that will form the basis of the intervention. The study aims to have 40 male and female Indigenous participants aged between 18 – 50 complete the exercise intervention.

While this questionnaire has been designed to be completed individually, it can easily be delivered in group setting for those who may prefer to complete it that way. i.e having the questionnaire administrator reading the questions to the group.

1. How old are you?________or if you prefer indicate your age by ticking one of the boxes below

18 – 25 ☐ 26 – 33 ☐ 34 - 40 ☐ 41 – 45 ☐ 45 - 50 ☐ 50 + ☐

2. Male ☐ or Female ☐

3. When was the last time you visited your doctor in relation to high blood pressure, diabetes, cholesterol or heart disease?

Within 3 months☐ Within 6 months ☐ Within 12 months☐ Never ☐

3. Please tick the following box/es if you suffer from any of the following

High Blood pressure	Diabetes	Cholesterol	Heart Disease
Has a doctor told you, you have or are at risk of having high blood pressure? ☐	Has a doctor told you, you have or are at risk of getting diabetes? ☐	Has a doctor told you you have high cholesterol? ☐	Has a doctor told you you have a heart disease? ☐

4. What is your height? _____________cm

5. What is your weight?______kg

6. What is your waist size?______cm or pants / jeans size____________?

Barriers to exercise

7. Where do you get your advice on being more active?

☐ GP ☐ AMS ☐ Partner ☐ Personal trainer

other ___________________________

8. What injuries do you have that prevent you from exercising, if any please list

____

9. Is exercising vigorously more than 10 mins continuously too hard for you?

Never ☐ Sometimes ☐ Occasionally ☐ Most times ☐ Always ☐

10. Is excising too time consuming?

Never ☐ Sometimes ☐ Occasionally ☐ Most times ☐ Always ☐

11. Is exercising too expensive

Never ☐ Sometimes ☐ Occasionally ☐ Most times ☐ Always ☐

12. How difficult are the following for you?

a. Changing your diet

Very difficult ☐ Difficult ☐ Easy ☐ Very Easy ☐

b. Finding time to exercise every day

Very difficult ☐ Difficult ☐ Easy ☐ Very Easy ☐

c. Motivating yourself to exercise

Very difficult ☐ Difficult ☐ Easy ☐ Very Easy ☐

d. Exercising with an injury

Very difficult ☐ Difficult ☐ Easy ☐ Very Easy ☐

e. Putting up with the pain associated with exercise

Very difficult ☐ Difficult ☐ Easy ☐ Very Easy ☐

f. Exercising the next day as a result of pain associated from exercising the day before

Very difficult ☐ Difficult ☐ Easy ☐ Very Easy ☐

14. What is the most convenient time for you to exercise?

9 – 5pm ☐ Early morning ☐ Early evening ☐ Does not matter ☐

15. Any other reasons you don't exercise?

___

16. What types of things might encourage or support you to exercise more regularly?

___

Exercise habits and environment

17 . Do you feel uncomfortable exercising by yourself?

- All times ☐ Most Sometimes ☐ Never ☐ Don't mind ☐

If so why?

___

18. Do you prefer to exercise

	All times	Most	Sometimes	Never	Don't mind
On your own	☐	☐	☐	☐	☐
In small group (2-6)	☐		☐	☐	☐
In medium groups (7+)	☐	☐	☐	☐	☐

19. Do you feel uncomfortable exercising in groups?

All times ☐ Most ☐ Sometimes ☐ Never ☐ Don't mind ☐

If so why?

___

20 a. Do you prefer to exercise in

public ☐ or private ☐ or both ☐

Indoors ☐ or outdoors ☐ or both ☐

21. Do you enjoy playing games involving sports equipment (i.e Football, Netball, Rackets, Golf)?

All times ☐ Most times ☐ Sometimes ☐ Never ☐ Don't mind ☐

22. Do you do any of the following traditional physical activities?

Hunting ☐ Fishing ☐ Food gathering ☐ Swimming ☐ Dancing ☐

23. Would you like to try any of these activities to improve your fitness and activity levels? Please rate each one of these activities from 1 – 5. 5 being an activity you are interested in and 1 in activities you are not interested in.

Walking / Walking group	
Dancing (Salsa)	
Self defence training	
Aerobics (Zumba or Pump classes)	
Gym (lifting weights and running on treadmills)	
Gym (circuit training)	
Boot camp (training at parks and beaches)	
Team ball sports (Footy, Netball, Volleyball)	
Traditional Indigenous activities / games	

24. Do you own any of these exercise machines?

☐ Treadmill ☐ Stability Ball ☐ Home Gym ☐ Dumbbells

☐ Exercise bike ☐ Skipping Rope ☐ Stepper ☐ Fitness DVD's

Other____

25. Have you had a gym membership before? Yes ☐ No ☐

If not why not?

____

If yes, how often do you go to the gym? ________________

Why did you join the gym? ☐ Fitness ☐ Shape up for summer

☐ Health ☐ Weight loss

26. Why did you quit the gym? ☐ Culturally inappropriate ☐ Cost too much

☐ Not enough time ☐ Too tired

☐ Gym equipment to confusing ☐ Gym outfits expensive

Other____

27. What was your favourite activity in the gym?

☐ Using weights by yourself ☐ Pump class ☐ Aerobics ☐ Aqua Aerobics

Other____

28. If you were able to attend a gym that was flexible enough to meet your and the communities needs withother Indigenous participants and have access to a personal trainer all for free would you be willing to train in a gym?

☐ Yes ☐ No ☐ Maybe

Other comments– Please also indicate what suburb is most suitable for you to attend the exercise setting

____

____

29. Goals

1. Please list in order of priority 3 physical activity based goals you would like to achieve over the next 3-6 months?Eg being able to double amount of exercise or running 2.4 km in 12 min.

a) ____

b)____

c)____

30. How committed are you to achieving fitness goals? Please circle a number

Very Committed		Semi Committed		Not very Committed
1	2	3	4	5

Outline any obstacles, potential actions, behaviors or activities that could limit your progress towards accomplishing your goals (i.e. not training consistently, upcoming vacation, busy season at work, not following the program, allowing other responsibilities to become a priority over exercise etc.).

____

____

____

Please turn to appendix A at back of this questionnaire and complete the **Global Physical Activity Questionnaire (GPAQ).**

Global Physical Activity Questionnaire

Surveillance and Population-Based Prevention Department of Chronic Diseases and Health Promotion World Health Organization 20 Avenue Appia, 1211 Geneva 27, Switzerland For further information: www.who.int/chp/steps

Overview

Introduction The Global Physical Activity Questionnaire was developed by WHO for physical activity surveillance in countries. It collects information on physical activity participation in three settings (or domains) as well as sedentary behaviour, comprising 16 questions (P1-P16). The domains are:

- Activity at work
- Travel to and from places
- Recreational activities

Physical Activity			
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. *[Insert other examples if needed].* In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.			
Questions		**Response**	**Code**
Activity at work			
1	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like *[carrying or lifting heavy loads, digging or construction work*] for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P 4*	P1
2	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days –	P2
3	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes └──┴──┘ : └──┴──┘ hrs mins	P3 (a-b)
4	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking *[or carrying light loads*] for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P 7*	P4
5	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days –	P5
6	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes └──┴──┘ : └──┴──┘ hrs mins	P6 (a-b)
Travel to and from places			
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship.			
7	Do you walk or use a bicycle (*pedal cycle*) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 *If No, go to P 10*	P7
8	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days -	P8
9	How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes └──┴──┘ : └──┴──┘ hrs mins	P9 (a-b)
Recreational activities			
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure), [insert relevant terms].			
10	Do you do any vigorous-intensity sports, fitness or recreational (*leisure*) activities that cause large increases in breathing or heart rate like [*running or football,]* for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P 13*	P10
11	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (*leisure*) activities?	Number of days └──┘	P11
12	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes └──┴──┘ : └──┴──┘ hrs mins	P12 (a-b)

Physical Activity (recreational activities) contd.			
Questions		**Response**	**Code**
13	Do you do any moderate-intensity sports, fitness or recreational *(leisure*) activities that causes a small increase in breathing or heart rate such as brisk walking,(*cycling, swimming, volleyball*) for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P16*	P13
14	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (*leisure*) activities?	Number of days └──┘	P14
15	How much time do you spend doing moderate-intensity sports, fitness or recreational (*leisure*) activities on a typical day?	Hours : minutes └──┴──┘ : └──┴──┘ hrs mins	P15 (a-b)
Sedentary behaviour			
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent [sitting at a desk, sitting with friends, travelling in car, bus, train, reading, playing cards or watching television], but do not include time spent sleeping. *[INSERT EXAMPLES] (USE SHOWCARD)*			
16	How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes └──┴──┘ : └──┴──┘ hrs min s	P16 (a-b)

Appendix B – Study information sheets

School of Exercise and Health Sciences

Edith Cowan University
270 Joondalup Drive
Joondalup WA 6027

VOLUNTEER INFORMATION SHEET

A 12 week gym based or community based exercise program aiming to improve your health by reducing your waist size, blood pressure, and your blood sugar levels.

Chief Investigator: Mr Tuguy Esgin 0402 240 811 tuguy1@gmail.com

PhD Supervisor: Professor Robert Newton (08) 6304 5037 r.newton@ecu.edu.au

Thank you for your interest in this study funded by the Heart Foundation and Healthway. It will incorporate exercise programming which will assess a range of physical and quality of life measures for the reduction of risk factors associated with metabolic syndrome in Indigenous people in the Perth metropolitan area. These risk factors include obesity, blood pressure and blood sugar levels. The benefits of this program are healthier outcome which includes; improved quality of life, loss of body fat, increase strength and fitness. For this study we will compare a gym/fitness centre based program to one implemented as community physical activity program which does not require a special facility or equipment.

Forty participants will be recruited and assessed on a range of physical and quality of life measures. Participants will be randomly allocated to either a gym/exercise clinic based program or a community based program. Each of the two groups will have a target of 20 participants and at the completion of the 12 week exercise program; all participants will be tested before the start of the exercise program and then retested after the program. Participants will be required to participate in 2 exercise sessions, as well as, the accumulation of 150 minutes of aerobic exercise per week. The chief investigator and Ph.D. candidate Tuguy Esgin will be supervising all of the formal exercise training sessions however additional aerobic exercise at the participant's volition in their own time will be undertaken without supervision. All participants will be provided with information on how to exercise safely and effectively on their own. The testing will be conducted at the Health and Wellness Institute at Edith Cowan University Joondalup and the gym training programs will be conducted at a location most convenient for you

Specifically, the physiological testing will include:

- height, body weight, resting blood pressure, body composition (by Dual Energy X-ray Absorptiometry); heart rate variability, vessel compliance, and flow velocity (SphygmoCor); and cardiovascular fitness (Astrand sub max cycle test) and rate of perceived exertion will be conducted at the ECU Joondalup campus. Time commitment is estimated at 2 hours.
- Strength (1repetition maximum for chest and leg press) will be measured at the gym. Time commitment is estimated at 30 min.

  The total time commitment for testing is 2.5hours pre- and 2.5hours post the exercise intervention for a total of 5hours.

Participants will also be required to attend a pathology clinic and provide a fasting blood sample of 7ml the week before and 7ml a week after the exercise program.

The following blood tests will be ordered and completed by the commercial pathology laboratory: HbA1c plasma glucose levels, serum total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides, serum C-reactive protein (CRP), serum insulin.

Participants will also be required to complete a quality of life questionnaire (SF-36) before and after the program. The SF-36 questionnaire provides a physiological and mental health summary. The pre-testing and post-testing SF36 will be compared to determine if your quality of life has improved.

Ultimately there are 3 research questions for this PhD study:

1. What are the barriers preventing, and motivators contributing to participation in physical activity in the Perth Indigenous community?
2. What effect does participation in a gym or community-based exercise intervention have on strength, fitness and risk factors associated with metabolic syndrome?
3. Does exercise adherence differ between gym and community based exercise interventions?

There are always risks associated with any study, the risks you need to be aware of in the study are:

- bruising and infection when bloodsamples are being taken
- cardiovascular (heart) complications with exercising at high levels during fitness testing
- radiation exposure when being scanned by the DEXA body scanning machine
- change of muscle strain during vertical jumps

To minimise the risk:

- fasting bloodsample will be obtained from qualified people from your local commercial pathology laboratory centre
- heart rate will be monitored during strenuous exercise testing sessions

- the DEXA machine exposes you to a dose of 0.16 µSv which is very little compared to the radiation that you are already exposed tobetween 2 and 2.5 mSv per year during everyday living
- The vertical jump testing will be performed in the presence of exercise physiologists.

In order to be eligible to participate in this study,participantsmust:

- Be an Indigenous person from Australia
- Be aged between 18 to 60 years of age.
- Provide a medical clearance letter from your doctor which allows you to take part in the exercise program.

Participants are able to withdraw without disadvantage or prejudice from the study at any stage and that this will not affect your rights or the responsibilities of the researchers in any respect. All information collected during the study will remain confidential at all times. All information will be kept in a secure data storage facility. While the overall outcomes of the study will be reported in a research thesis and in scientific publication, results will be made available to the participants and the Indigenous community through a variety of sources (eg Koori mail newspaper, Indigenous Healthinfonet website, Derlbarl Yerrigan Health Service.

If you would like to participate in this study or have any enquires about the research please contact Tuguy Esgin on 0402240811 or tuguy1@gmail.com.

This study has been approved by the Aboriginal Health Council WA (AHCWA) and the Human Research and Ethics Committee at Edith Cowan University.

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Secretariat Aboriginal Health Council Western Australia.
Tel: (08) 9227 1631 or Email: ethics@ahcwa.org

Or

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: (08) 6304 2170
Email: research.ethics@ecu.edu.au

If you would like to participate in the exercise program study, please sign the informed consent document and return to the researcher (Tuguy Esgin).

School of Exercise and Health Sciences
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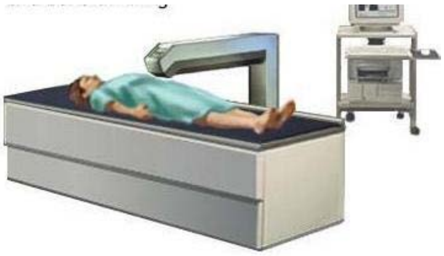
Testing Equipment

SphygmoCor

To measure heart rate variability, vessel compliance, and flow velocity will require the use of the SphygmoCor machine and sticking electrode to the area mark by the black circles above. The electrode can then be easily removed. The probe pictured below will be place against wrist and neck.

DEXA Scan

The DEXA machine will require you to wear a gown and lay still for 5 to 6 min. The results provide a breakdown of the percentage of muscle, fat and bone.



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Pre-exercise Medical Questionnaire

The following questionnaire is designed to establish a background of your medical history, and identify any injury and/ or illness that may influence your testing and performance. If you are under 18 then a parent or guardian should complete the questionnaire on your behalf or check your answers and then sign in the appropriate section to verify that they are satisfied the answers to all questions are correct to the best of their knowledge.

Please answer all questions as accurately as possible, and if you are unsure about anything please ask for clarification. All information provided is strictly confidential.

Personal Details

Name:____

Date of Birth (DD/MM/YYYY):__________________ Gender: Female/ Male

PART A

1. Are you a male over 45 yr, or female over 55 yr or who has had a hysterectomy or are postmenopausal?

Yes No

If YES, please provide details

2. Are you a regular smoker or have you quit in the last 6 months? Y N ________________

3. Did a close family member have heart disease or surgery, or stroke before the age of 60 years? Y N Unsure ________________

4. Do you have, or have you ever been told you have blood pressure above 140/90 mmHg, or do you current take blood pressure medication? Y N Unsure ________________

5. Do you have, or have you ever been told you have, a total cholesterol level above 5.2 mmol/L (200 mg/dL)? Y N Unsure ________________

6. Is your BMI (weight/height^2) greater than 30 kg/m^2? Y N Unsure ________________

PART B

1. Have you ever had a serious asthma attack during exercise? Y N ______________________

2. Do you have asthma that requires medication? Y N ______________________

3. Have you had an epileptic seizure in the last 5 years? Y N ______________________

4. Do you have any moderate or severe allergies? Y N ______________________

5. Do you, or could you reasonably, have an infectious disease? Y N ______________________

6. Do you, or could you reasonably, have an infection or disease that might be aggravated by exercise? Y N ______________________

7. Are you, or could you reasonably be, pregnant? Y N ______________________

PART C

1. Are you currently taking any prescribed or non-prescribed medications?

Y N ______________________

2. Have you had, or do you currently have, any of the following?

			If YES, please provide details
Rheumatic fever	Y	N	______________________
Heart abnormalities	Y	N	______________________
Diabetes	Y	N	______________________
Epilepsy	Y	N	______________________

Recurring back pain that would make exercise problematic, or where exercise may aggravate the pain	Y	N	______________________

PART C cont'd

Recurring neck pain that would make exercise problematic, or where exercise may aggravate the pain	Y	N	______________________
Any neurological disorders that would make exercise problematic, or where exercise may aggravate the condition	Y	N	______________________
Any neuromuscular disorders that would make exercise problematic, or where exercise may aggravate the condition	Y	N	______________________
Recurring muscle or joint injuries that would make exercise problematic, or where exercise may aggravate the condition	Y	N	______________________
A burning or cramping sensation in your legs when walking short distances	Y	N	______________________
Chest discomfort, unreasonable breathlessness, dizziness or fainting, or blackouts during exercise	Y	N	______________________

PART D

Have you had flu in the last week?	Y	N	______________________
Do you currently have an injury that might affect, or be affected by, exercise?	Y	N	______________________

*Is there any other condition not previously mentioned that may affect your ability to participate in this study?

Y N ____

Declaration (to be signed in the presence of the researcher)

I acknowledge that the information provided on this form, is to the best of my knowledge, a true and accurate indication of my current state of health.

Participant

Name:________________________ Date (DD/MM/YYYY):_______________

Signature:____________________________

Researcher:

Signature:_____________________________

Date (DD/MM/YYYY):_________________

Practitioner (only if applicable)

I, Dr ____ have read the medical questionnaire and information/ consent form provided to my patient Mr/Miss/ Ms_____________________________________, and clear him/ her medically for involvement in exercise testing.

Signature:____________________________________

Date (DD/MM/YYYY):_________________________

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VOLUNTEER CONSENT FORM

A gym based exercise program aiming to improve your health by reducing your waist size, blood pressure, and your blood sugar levels.

Chief Investigator: Mr Tuguy Esgin 0402 240 811 tuguy1@gmail.com

PhD Supervisor: Professor Robert Newton (08) 6304 5037 r.newton@ecu.edu.au

- I have read the Information Sheet, and the nature and the purpose of the research project and the risks inherent in my participation have been explained to me. I understand and freely agree to take part and understand how the information is to be used.
- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.
- I understand that the data will be stored in a locked data storage facility within Edith Cowan University until published, and then stored off-site at the commercial archive used by Edith Cowan University for data storage for a period of seven years.
- I understand that I can withdraw without disadvantage or prejudice from the study at any stage and that this will not affect my rights or the responsibilities of the researchers in any respect.
- I have had the opportunity to discuss taking part in this study with a family member or friend and understand that I am a volunteer in this project and will receive no payment for my participation.
- I confirm that I am over 18 years of age.
- I understand the data and/or samples collected for the purposes of this research project may be used in further approved research projects provided my name and any other identifying information is removed.

Name of Participant ……………………………………………………………

Signed……………………………………………………………………………..

Date ……………………………………………………………………………..

I have explained the study to the participant, the participant has been given the opportunity to ask questions and consider that he/she understands what is involved.

Signed…………………………………………………………………………….

Date ………………………………………………………………………………

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Final Checklist for Participant

	Please circle one	
1. Are you aware that if you feel uncomfortable with any testing procedure you should tell the researcher immediately, and that YOU CAN STOP your participation at any time?	YES	NO
2. Are you aware that, although very rare, maximal exercise can result in fainting, severe exhaustion or cardiac events leading to death?	YES	NO
3. Are you aware that the fatigue caused by the exercise can impair your ability to perform tasks such as driving for a short while after the cessation of exercise?	YES	NO

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Contact Information

Name: DOB:

Address:

Phone number: Email:

Profession:

Emergency contact

Name: Phone Number/s:

Address:

Data Recording Sheet for Astrand-Ryhming Test

Pre 12 week intervention

Name:

Age: Height: Weight: Gender: M

Physical activity level: Time elapsed since last exercise:

Smoker: Time elapsed since last cigarette:

Workload used in test (Kpm.min^{-1}):1.5

Minute of Test	Heat Rate (bpm)	Minute of Test	Heat Rate (bpm)
Rest		5	
1		6	
2		7	
3		8	
4		Average min 5 & 6	

Record HR in 7th and 8th minute only if steady state was not achieved by minute 6.

Predicted VO2Max in 1-min^{-1} (absolute) & ml·kg^{-1}·min^{-1} (relative):

Post 12 week intervention

Weight: Smoker: Time elapsed since last cigarette:

Workload used in test (Kpm.min^{-1})

Minute of Test	Heat Rate (bpm)	Minute of Test	Heat Rate (bpm)
Rest		5	
1		6	
2		7	
3		8	
4		Average min 5 & 6	

Record HR in 7th and 8th minute only if steady state was not achieved by minute 6.

Predicted VO2Max in 1-min^{-1} (absolute) & ml·kg^{-1}·min^{-1} (relative):

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Cardiovascular Exercise Prescription

Intensity of Exercise

1. **Estimate your own maximal heart rate (MHR)**

MHR= 220 minus age (220 – age)

MHR= 220 - ______________ = _______ bpm

2. **Resting Heart Rate (RHR)** = ________ bpm

3. **Heart Rate Reserve (HRR) = MHR – RHR**

HRR = _______ - _______ = _______ beats

4. **Training Intensities (TI) = HRR x TI + RHR**

60% TI = ______ x .60 + ______ = _______ bpm

70% TI = ______ x .70 + ______ = _______ bpm

85% TI = ______ X .85 + ______ = _______ bpm

5. **Cardiovascular Training Zone.** The optimum cardiovascular training zone is found between the 70 and 85 percent training intensities. However, individuals w ho have been physically inactive or are in the poor or fair cardiovascular fitness c ategories should use a 40-50% training intensity during the first few weeks of the exercise program.

Cardiovascular Training Zone: _______ (70% TI) to _______ (85% TI)

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Physiology Testing Data Sheet - Post

Name ________________ DOB__________ Date____________ Age __

Blood Pressure ___ / ___ ___ /___ ___ /___ ___ /___

Heart Rate ________ _______ _______ _______

Height ___________ Weight _____________ % Fat __________

Waist ___________ Hip _____________ BMC __________

Aortic BP______ / ______ PP _____________ HR __________

CHP HR Period _____ ED ____ms _____% Aortic T1____ T2____ Tr____

P1 Height_____ AP _____ AP/PP______% P2/P1_____% @75%_____

SEVR ____% PTI ____/____ mmHg ESP ____mmHg MP ____ / ____ mmHg

Pulse Wave Velocity __________ +/- __________

Max VO2______ CV Training Zone: _______ (70% TI) to _______ (85% TI)

Strength 1 RM

Bench Press __________ Leg Press __________

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Physiology Testing Data Sheet - Pre

Name ______________________ Date_____________ Age ____

Blood Pressure ___ / ___ ___ /___ ___ /___ ___ /___

Heart Rate ________ _______ _______

Height ___________ Weight _____________ % Fat __________

Waist ___________ Hip _____________ BMC __________

Aortic BP______ / ______ PP _____________ HR __________

CHP HR Period _____ ED ____ms _____% Aortic T1____ T2____ Tr____

P1 Height_____ AP _____ AP/PP______% P2/P1_____% @75%_____

SEVR ____% PTI ____/____ mmHg ESP ____mmHg MP ____ / ____ mmHg

Pulse Wave Velocity __________ +/- __________

Max VO2______ CV Training Zone: _______ (70% TI) to _______ (85% TI)

Strength 1 RM

Bench Press __________ Leg Press __________

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