# Partnerships in Aboriginal and Torres Strait Islander Health Research

**Tamara Riley**

A thesis submitted for the degree of Master of Philosophy in Applied Epidemiology of the Australian National University

November 2019


Supervisors: Dr Katherine Thurber and Associate Professor Raymond Lovett

Aboriginal and Torres Strait Islander Health Program,

National Centre for Epidemiology and Population Health,

Research School of Population Health,

College of Health & Medicine,

ANU

# Originality statement

I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree or diploma at ANU or any other educational institution, except where due acknowledgement is made in the thesis. Any contribution made to the research by others is explicitly acknowledged in the thesis.

Signed 

Date 8/11/19

# Acknowledgements

*I acknowledge the Traditional Owners of country throughout Australia and their continuing connection to land, sea and community, and pay my respects to Elders past, present and emerging.*

I would like to acknowledge the Aboriginal and Torres Strait Islander Health Program and the SEARCH CRE for funding my scholarship – I am grateful for the opportunity.

Thank you to the Aboriginal and Torres Strait Islander Health program for welcoming me into the team and supporting me during my placement. I would also like to thank my Supervisors, Dr Katie Thurber and Associate Professor Ray Lovett, for their guidance throughout the MAE. Thank you for all your time, advice and support, and for encouraging my ideas and allowing me to see them through. I would like to acknowledge Dr Jill Guthrie and Dr Phyll Dance who were always available to provide advice and valuable feedback. Thank you also to Dr Joanne Thandrayen who provided statistical assistance for my projects. Lachie Russell, Faye Irwin, and Jan Chapman were instrumental in providing administrative support, organising travel and helping day to day. The MAE team provided great learnings and opportunities and the MAE cohort offered support from all over the country at all times of the day and night – I look forward to hearing about all your adventures.

Associate Professor James Ward's guidance was invaluable in getting my outbreak study going and I appreciate all the time and expertise he put into it – Thanks James, I learnt a lot. Thank you also to Dr Bonny Cumming who was instrumental in getting my evaluation study started and who was always available to help me and answer all my queries.

The involvement of my research partners was vital in carrying out each study and making them meaningful. I have acknowledged research partners in each chapter throughout the thesis.

Last but not least, I would like to thank my family and friends for their continuing support.

I feel lucky to have had such great support throughout the MAE and am grateful for the opportunities and experiences.

# Thesis abstract

This thesis comprises a collection of applied epidemiological studies including an evaluation and epidemiological study, an outbreak investigation, and a data analysis. All studies are focused on Aboriginal and Torres Strait Islander One Health (which recognises that the health of people is related to the health of animals and their interaction with the environment), sexual health, and child health. All studies highlight the importance of partnerships and community involvement.

The first study is an evaluation of a community driven animal health and management program in the remote Aboriginal community of Wadeye in the Northern Territory. Wadeye has approximately 2300 residents and 650 dogs and cats. However, there is very limited access to veterinary care and animal medicines. To address community concerns regarding animal health, an animal health and management program was co-developed and implemented by Animal Management in Rural and Remote Indigenous Communities (AMRRIC) and the Thamarrurr Development Corporation (TDC) Rangers, with support from the West Daly Regional Council. This study is a quantitative epidemiological study that evaluated the impact of this animal health and management program in Wadeye. This included analysing animal and human health outcomes before and after program implementation to assess the impact of the animal program on the health of animals and people within the community. This study involved engagement and partnerships with AMRRIC and TDC, as well as the community of Wadeye.

The second study is an outbreak investigation analysing Human Immunodeficiency Virus (HIV) notifications among the Aboriginal and Torres Strait Islander population in Far North Queensland to determine if an outbreak has occurred. The Tropical Public Health Unit – Cairns observed an increase in HIV notifications since 2014 affecting the Aboriginal and Torres Strait Islander population. HIV has been notifiable in Queensland since 1984. This study is a quantitative descriptive analysis, using the Queensland Notifiable Conditions database, to analyse data on HIV notifications from 1 January 1984 – 30 June 2019, to quantify the history of HIV notifications and assess whether an outbreak has occurred. This study involved engagement and partnerships with local health organisations, Queensland Health, and the South Australia Health and Medical Research Institute (SAHMRI).

The third study is a data analysis focusing on chronic disease risk in Aboriginal children involved in the Study of Environment on Aboriginal Resilience and Child Health (SEARCH). SEARCH is a cohort study of Aboriginal children and adolescents and is conducted with four Aboriginal Community Controlled Health Services (ACCHS) in New South Wales. Chronic

disease affects Aboriginal and Torres Strait Islander adults at higher rates than non-Indigenous Australian adults. However, it is not clear if this risk emerges during childhood and/or adolescence. This study is a cross-sectional analysis that quantifies the distribution of chronic disease markers in the cohort overall, and in relation to age group, gender, and Body Mass Index (BMI). This study involved engagement and partnerships with two ACCHS including the Tharawal Aboriginal Medical Service (based in Western Sydney), and the Riverina Medical and Dental Aboriginal Corporation (based in Wagga Wagga), and also the SEARCH project team based at the Sax Institute.

The teaching requirements of the MAE are also detailed in this thesis including a lessons from the field session about the use of logic models in evaluations and a teaching session about One Health in field epidemiology.

# Contents

# Figures

# Tables

# Chapter 1

# Introduction

## 1.1 Abbreviations and acronyms

| | |
|---|---|
| ACCHS | Aboriginal Community Controlled Health Services |
| AMRRIC | Animal Management in Rural and Remote Indigenous Communities |
| ANU | Australian National University |
| BMI | Body Mass Index |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| FNQ | Far North Queensland |
| HIV | Human Immunodeficiency Virus |
| MAE | Masters of Philosophy in Applied Epidemiology |
| MK Study | Mayi Kuwayu Study |
| NAIDOC | National Aborigines and Islanders Day Observance Committee |
| NSW | New South Wales |
| NT | Northern Territory |
| OMOZ | Otitis Media Australia |
| RSPCA | Royal Society for the Prevention of Cruelty to Animals |
| SAHMRI | South Australia Health and Medical Research Institute |
| SEARCH | Study of Environment on Aboriginal Resilience and Child Health |
| TDC | Thamarrurr Development Corporation |

## 1.2 Introduction

Aboriginal and Torres Strait Islander peoples make up approximately 3.3% of the Australian population and have a continuing connection to culture, land and sea. The National Aboriginal and Torres Strait Islander Health Plan 2013 – 2023 was developed by the Australian government to demonstrate its commitment to improving health outcomes throughout Australia (1). However, inequities in health remain, and there continue to be inequities in access to adequate health care (2).

This thesis explores three different areas which have been identified as community and/or policy priorities: animal health and management in the remote Aboriginal community of Wadeye in the Northern Territory (NT), sexually transmissible infections in Far North Queensland (FNQ), and chronic disease risk in youth in New South Wales (NSW). The studies were undertaken in partnerships with community, not-for-profit organisations, government and research institutes.

Research in Aboriginal and Torres Strait Islander health can help with understanding the strengths and barriers in health; however, it is important that this research is undertaken appropriately. Conducting research in partnership includes engagement and involvement of the affected communities and local organisations. This ensures research is done with Aboriginal people rather than on them. Partnerships with government organisations can also assist with translating research findings into policy and/or practice change. These forms of engagement are designed to support research to lead to positive change for the community.

Community ownership over health interventions that respect local ways of doing, knowing and being, and focus on improving health rather than responding to disease, could be one step in addressing those health inequities. Health promotion can play a significant role in improving health outcomes and wellbeing in communities (3). Health promotion can allow individuals and communities control over improving their own health and addresses the importance of health through social, physical, economic and political environments (3). Health promotion does not only benefit individuals but has the potential to benefit the whole community, including animals and the environment. Health promotion can be undertaken collaboratively with families and local organisations (4). The concept is less about intervening and responding, and more about understanding, respecting, and collaborating with communities to empower local ownership of programs that promote good health (5).

Additionally, using a holistic approach to health can be referred to as One Health. One Health looks at the relationships between human, animal and environmental health (6). This is

important as human health and wellbeing outcomes can be impacted by animal and environmental health. Epidemiology fits well within One Health as it focuses on population level impacts at the human, animal and environmental interface (7). One Health is an example of a multi-disciplinary area of research and is an emerging field, particularly internationally. A One Health approach can strengthen people's connection to animals and improve the health of country leading to improved wellbeing for communities.

Health promotion and One Health go hand-in-hand and can be looked at through an Aboriginal lens, with the ability to utilise local knowledge and culture to strengthen health outcomes. These concepts can also allow communities to have ownership of their own health journey and recognise their connection to animals and the environment. The importance of community-driven approaches to improving health should be supported where possible. Additional funding and resources could help build capacity of communities to implement and maintain community driven health programs.

## 1.3 Thesis structure and requirements

This thesis meets the core competencies of the Masters of Philosophy in Applied Epidemiology (MAE) through the following chapters (see Table 1).

Chapter 2 meets the requirements of conducting an epidemiological study, evaluating a health program, analysing a health dataset, conducting a literature review, writing a report for a non-scientific audience and presenting at a conference. Chapter 2 is an evaluation of a One Health approach to animal health and management in the remote community of Wadeye in the NT, using an epidemiological study. This study was undertaken in partnership with the Thamarrurr Development Corporation (TDC) Rangers and Animal Management in Rural and Remote Indigenous Communities (AMRRIC).

Chapter 3 fulfils the outbreak investigation requirement and also involved the analysis of a health dataset and a literature review. Chapter 3 is an investigation of a potential outbreak of Human Immunodeficiency Virus (HIV) in the Aboriginal and Torres Strait Islander population of FNQ. This study was undertaken in partnership with the local Aboriginal Community Controlled Health Services (ACCHS) and Queensland Health, with supervision from South Australia Health and Medical Research Institute (SAHMRI).

Chapter 4 fulfils the data analysis requirement and is an advanced draft of a paper for publication. This chapter also includes a literature review and a report for a non-scientific audience. Chapter 4 is an analysis of the distribution of chronic disease markers in relation to

demographic factors and Body Mass Index (BMI) in Aboriginal youth aged 5 – 19 years in NSW involved in the Study of Environment on Aboriginal Resilience and Child Health (SEARCH). This study was undertaken in partnership with two ACCHS including Tharawal Aboriginal Medical Service and Riverina Medical and Dental Corporation, as well as the SEARCH project team based at the Sax Institute.

Chapter 5 fulfils the requirement to conduct teaching sessions during the MAE and includes lessons from the field and a first year MAE teaching session. For the lessons from the field, we teach our own cohort; for the teaching session we present a case study to first year MAE students. For the lesson from the field, I led a session on logic models and how they can be useful in evaluations. For the first year teaching session, I worked with a group to deliver a session on One Health in field epidemiology. This chapter includes the informal feedback from lessons from the field and evaluation results from the teaching session.

*Table 1: MAE chapters and requirements*

| Requirements | Chapter 2 – Evaluating a One Health approach to animal health and management in the remote community of Wadeye, NT | Chapter 3 – Investigating a potential HIV outbreak in FNQ | Chapter 4 – Markers for chronic disease risk in an urban cohort of Aboriginal children and adolescents in NSW: findings from the SEARCH | Chapter 5 – Teaching |
|---|---|---|---|---|
| Investigate a public health problem | | ✓ | | |
| Analyse health dataset | ✓ | ✓ | ✓ | |
| Evaluate health program | ✓ | | | |
| Design and conduct an epidemiological study | ✓ | | | |
| Literature review | ✓ | ✓ | ✓ | |
| Report to a non-scientific audience | ✓ | | ✓ | |
| Advanced draft of a paper for publication | | | ✓ | |
| Abstract and oral presentation at a national or international scientific conference | ✓ | | | |
| Lessons from the field | | | | ✓ |
| Prepare and conduct case study for first year students | | | | ✓ |

## 1.4 My MAE journey

My placement during the MAE was in the Aboriginal and Torres Strait Islander Health Program, at the National Centre for Epidemiology and Population Health, Research School of Population Health at the Australian National University (ANU). The team that makes up the Aboriginal and Torres Strait Islander Health Program conducts research in partnership with Aboriginal and Torres Strait Islander people, organisations and communities. The main research topics of the team include culture and health, family and community safety, cardiovascular health, smoking, alcohol and other drug use, and obesity and nutrition. While the team undertakes many studies, the study I worked on the most was the Mayi Kuwayu National Study of Aboriginal and Torres Strait Islander Health and Wellbeing (the MK Study)[1]. The MK Study is a longitudinal study looking at how Aboriginal and Torres Strait Islander wellbeing is linked to culture. I particularly gained experience with community engagement, recruitment of participants and promotion of the study, and assisted with a quantitative data course for community members in Cairns in December 2018.

Through my work in the Aboriginal and Torres Strait Islander Health Program, I also gained experience with justice reinvestment, through assisting with a justice reinvestment workshop in Orange in March 2018 and attending the Public Health Association of Australia Justice Health conference in Sydney in April 2019. Additionally, I learnt about the principles and implementation of Indigenous data sovereignty practices in Australia through my involvement in the National Indigenous Data Sovereignty Summit in June 2018.

I assisted in organising and running the first Indigenous Research Forum at the ANU in November 2018 with the ANU Chancellery. This allowed me to gain an understanding of all Indigenous research occurring across the university within the last decade and engage with many researchers in this space. I undertook extra training courses to improve my skills in data analysis and qualitative research through the Australian Consortium for Social and Political Research Institute, including the Introduction to Data Analysis in Stata course in Brisbane in July 2018, and the Introduction to Qualitative Research course in Canberra in January 2019. I attended the National Indigenous Research and Knowledges Network workshop for Indigenous postgraduate scholars on the Gold Coast in November 2018. I also attended the Higher Degree by Research lab run by the National Centre for Indigenous Studies at the ANU in February 2019. These courses assisted in my learning and were valuable when undertaking my studies.

[1] https://mkstudy.com.au/

I engaged multiple times with the Melbourne Poche Centre throughout my MAE, attending training courses and conferences. The Melbourne Poche Centre supported me to complete the Professional Certificate of Indigenous Research in July 2018 and attend the University of Melbourne's Indigenous Higher Education conference in November 2018. I became a Fellow of the Melbourne Poche Centre and Kings College London Leadership Fellows Program in 2019[2], which involved two modules at the University of Melbourne and one module at Kings College in London. This program supports the development of Indigenous early career researchers and health professionals to become leaders within their health fields. It was a valuable experience. The module in London allowed me to meet with international experts and professionals that work within my interest areas, including Sir Michael Marmot at the University College of London, One Health researchers at the University of Edinburgh and the Royal Veterinary College, and Veterinarians at the International Fund for Animal Welfare and the International Companion Animal Management coalition. The learnings and reflections from these meetings will add value to my future work in the One Health space.

I presented at multiple conferences and meetings throughout the MAE including team meetings, meetings at the AMRRIC head office in Darwin in June and October 2018 and June 2019, the Melbourne Poche Centres Festival of Indigenous Health Research in November 2018, the One Health Aotearoa Symposium in Wellington New Zealand in December 2018, and at a SEARCH Centre of Research Excellence monthly research meeting in July 2019. I co-presented with Dr Bonny Cumming from AMRRIC at the Lowitja International Indigenous Health Conference in Darwin in June 2019 and at the National Aboriginal and Torres Strait Islander Environmental Health Conference in Perth in September 2019, along with a team from the TDC. I also co-presented with my colleague Bobby Maher on the importance of community engagement at the Department of Prime Minister and Cabinet in Canberra in February 2019, and at the Lowitja conference in June 2019. Finally, I presented at the Research School of Population Health's National Aborigines and Islanders Day Observance Committee (NAIDOC) Symposium at the ANU in July 2019 and was supported to attend the Otitis Media Australia (OMOZ) conference in Darwin in October 2018. I have learnt a lot from these conferences and presentations, with positive feedback gained that will add value to future work.

[2] https://poche.mdhs.unimelb.edu.au/leadership-development/leadership-fellows-program

## 1.5 Learnings and reflections

Through the MAE, I learnt about the importance of partnerships with community, research organisations and government bodies when undertaking research in the Aboriginal and Torres Strait Islander health space. Partnerships can improve the quality of research and ensure the study is culturally appropriate and program- or policy-relevant. It is also important to understand the local context and become aware of sensitivities that may surround the research topic.

Engagement is an important part of developing and maintaining partnerships in research. Engagement is most effective when you meet face to face. Therefore, for all of my studies I travelled multiple times to meet with my research partners and communities. This included multiple trips to Wadeye and Darwin to meet with TDC and AMRRIC, trips to Cairns to meet with the local ACCHS and the Tropical Public Health Unit – Cairns, and trips to Sydney to meet with the SEARCH team at the Sax Institute and their partnering ACCHS.

It is imperative to involve the community in research in the Aboriginal health space, whether that is through engaging with community members, health organisations or local government agencies, as this allows those involved to have input into controlling the message that may impact them and their community. The ability for Aboriginal people to have ownership and control over data that is about them is slowly gaining traction in Australia, with a National Indigenous Data Sovereignty network[3] formed. Going forward, it is important to consider Indigenous Data Sovereignty principles when developing studies and projects.

It is very valuable to undertake studies and work outside of your main discipline, which for me is veterinary science. Working within Aboriginal and Torres Strait Islander health as a Veterinarian opened my mind to the value of multi-disciplinary and community based research. I learnt that epidemiology is a broad discipline and can be adapted to many different areas of health. For example, while undertaking the MAE I was able to use my prior animal health knowledge with my continuing learnings about Aboriginal health and epidemiology to pull together a multi-disciplinary study within the area of One Health.

I also had experience leading a research team for all of my studies. This included developing my organisation, project management, time management, and communication skills. This also taught me a lot about the processes that need to be undertaken in order to start a study from the initial contact of people who may be interested in being involved, to forming a research team, developing a research proposal, and working through the ethics and data access

[3] https://www.maiamnayriwingara.org/

approval processes through multiple committees and organisations. Having external collaborators on the research teams was valuable as it allowed me to work with organisations and people with particular skill sets in the areas of interest and within the local communities.

My advice to future students would be to take opportunities and experience as much as you can over the two years of the MAE. The breadth of experiences and knowledge I have built has been extensive, has allowed me to widen my networks, and develop as a person and researcher. The importance of networks in the research world became clear to me through the MAE. It was through my Supervisors' networks and my own networks that my MAE studies were developed. Additionally, contacts I created during the MAE allowed me to gain feedback from my peers and undertake development opportunities.

My work in the MAE has formed ongoing partnerships, particularly in the One Health space. Following the MAE, I have been invited to present at the Vet Ed Down Under Symposium during a workshop on 'Veterinary Service Delivery to Remote Indigenous Communities – Talking Practicalities and One Health' run by AMRRIC, University of Queensland and University of Melbourne. I have also been asked to attend a Royal Society for the Prevention of Cruelty to Animals (RSPCA) 'Indigenous Community Companion Animal Health Program' in remote NSW and present at the ANU 'One Health Symposium' run by the ANU, Asian Development Bank and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). I will also put in an abstract to attend and present at the '6th World One Health Congress' held in Scotland in 2020. I hope to further my research in this space through undertaking a PhD in the area of One Health.

## References


1. Australia Government Department of Health. National Aboriginal and Torres Strait Islander Health Plan: 2013-2023: Department of Health; 2013.
2. Australian Indigenous HealthInfoNet. Overview of Aboriginal and Torres Strait Islander health status 2018. Perth: Australian Indigenous HealthInfoNet; 2019.
3. Canuto K, Aromataris E, Lockwood C, Tufanaru C, Brown A. Aboriginal and Torres Strait Islander health promotion programs for the prevention and management of chronic diseases: a scoping review protocol. Joanna Briggs Institute database of systematic reviews and implementation reports. 2017;15(1):10-4.
4. Mungabareena Aboriginal Corporation Women's Health Goulbourn North East. Using a health promotion framework with an “Aboriginal lens”. Making two worlds work. Building the capacity of the health and community sector to work effectively and respectfully with our Aboriginal community. Mungabareena Aboriginal Corporation and Women’s Health Goulbourn North East; 2008.
5. Demaio A, Drysdale M, de Courten M. Appropriate health promotion for Australian Aboriginal and Torres Strait Islander communities: crucial for closing the gap. Global Health Promotion. 2012;19(2):58-62.
6. One Health Commission. What is One Health? Apex NC: One Health Commission; 2018 [Available from: https://www.onehealthcommission.org/en/why_one_health/what_is_one_health/].
7. Johnson-Walker YJ, Kaneene JB. Epidemiology: science as a tool to inform One Health policy. Beyond One Health: From Recognition to Results first edition John Wiley & Sons, Inc. 2018:3-30.

# Chapter 2

# Evaluating a One Health approach to animal health and management in the remote community of Wadeye, Northern Territory

## 2.1 Abbreviations and acronyms

| | |
|---|---|
| ABS | Australian Bureau of Statistics |
| AMRRIC | Animal Management in Rural and Remote Indigenous Communities |
| CI | Confidence intervals |
| ICAM | International Companion Animal Management Coalition |
| MAE | Masters of Philosophy in Applied Epidemiology |
| NAIDOC | National Aborigines and Islanders Day Observance Committee |
| NT | Northern Territory |
| PR | Prevalence ratio |
| TDC | Thamarrurr Development Corporation |

## 2.2 Acknowledgements

I would like to acknowledge the pet owners in Wadeye who took part in the program, as well as the Thamarrurr Development Corporation (TDC) Rangers who continue to work to improve animal health. I would also like to acknowledge Animal Management in Rural and Remote Indigenous Communities (AMRRIC) and the important work they do in addressing a need in remote communities around Australia.

## 2.3 Abstract

**Background:** Animal health and management in remote Aboriginal communities is of public health importance. Large populations of animals in proximity to people can lead to an increased spread of disease, reduced capacity to prevent disease and increased risk of physical injury. Companion animals play an important role in Aboriginal communities as they can be of cultural significance and hold a lot of meaning for families. It can be complex to implement effective and sustainable animal health and management programs in these settings due to deficiencies of resources, funding limitations and limited accessibility. A One Health and community driven approach could improve animal health and management practices, as well as make a positive impact on human health and wellbeing in remote communities.

**Methods:** This study is a quantitative epidemiological study evaluating an animal health and management program in the remote community of Wadeye in the Northern Territory (NT). The evaluation aims to quantify animal and human health outcomes and to assess the impact of the program. The animal health data were collected over three years via a companion animal census, including initial collection (2017), pre- (2018) and post- (2019) program implementation. The census included information on dog and cat demographics and common health conditions as well as treatments delivered to animals during veterinary visits. Changes in animal health outcomes were assessed using prevalence ratios (PR) to compare the outcomes from 2018 to 2019, following implementation of the program, to assess if animal health improved over this time. Human health outcome data consisted of quarterly aggregated data on the number of presentations to the Wadeye health clinic for dog bites from 2016 to 2019. Trends in dog bite data were assessed using crude rates and time series analysis.

**Results:** Results show improvements in animal health outcomes from 2018 to 2019, with a decrease in overall population size, an aging dog population, and a decrease in the number of animals per household. Body condition score of dogs, hair score of dogs, and desexing status of cats and dogs has significantly improved over the period of the program. During the program, three veterinary visits were conducted by an AMRRIC veterinary team. 259 animals received treatment – 183 of which were surgically desexed. Additionally, there was a non-significant decreasing trend in the number of presentations to the health clinic for dog bites after implementation of the program.

**Conclusion:** Results show that animal health outcomes have significantly improved in Wadeye since program implementation. Improvements were particularly notable for body condition and hair score of dogs, and desexing status of dogs and cats. The data are also consistent with a decreasing trend of dog bites in the community, although the result was not significant. This study shows the importance and potential impact of community driven animal health and management programs in remote Aboriginal communities. This program design could be considered for other communities with similar animal health care barriers.

## 2.4 Prologue

*The One Health concept is coherent with the principles of epidemiology because risk factors for many diseases occur at the interface between humans, animals, and the environment (1, pg 31).*

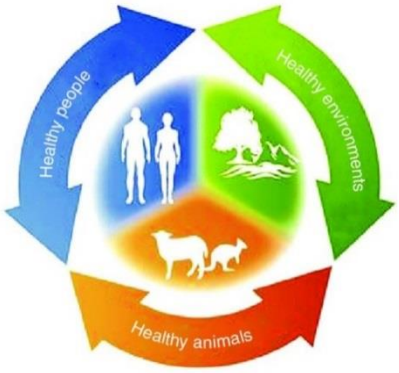



*Figure 1: The One Health triad (1)*

One Health refers to the collaborative effort and cross-disciplinary approach – working locally, nationally and globally – to improve health for people, animals and the environment (2) (see Figure 1). One Health in remote community settings would look at the interface between human, animal and environmental health rather than looking at human, animal and environmental health as separate entities.

### *2.4.1 My role*

My role in this study was as study leader. The study began following discussions with AMRRIC regarding the need for an evaluation of an animal health and management program that was due to start in Wadeye in June 2018. AMRRIC is a not-for-profit organisation that works with rural and remote Aboriginal and Torres Strait Islander communities to deliver animal health and management programs in communities that face barriers in accessing adequate animal health care (3). With my position as a Veterinarian undertaking the Masters of Philosophy in Applied Epidemiology (MAE), embedded within the Aboriginal and Torres Strait Islander Health Program, I was well placed and had the appropriate support to undertake this study.

Initially, I travelled to Wadeye with an AMRRIC veterinary team and an NT Environmental Health representative in June 2018. The goal of this trip was to engage with the Rangers who work on the animal program to assist with the census data collection and to provide assistance with the veterinary visit. I travelled back to Wadeye in June 2019 with AMRRIC and an NT Environmental Health representative to undertake the 2019 census data collection with the

Rangers (see Figure 2). The census is undertaken annually through visiting each house in the community and asking the occupants about the cats and dogs living there and their health condition. Parasite treatment is also administered to the dog population while undertaking the census. Working with the Rangers and AMRRIC on the animal program was a great opportunity to understand the local animal concerns and access barriers experienced in Wadeye, and to engage with pet owners in the community.

*Figure 2: Animal census and visiting veterinary team in Wadeye in June 2018 and 2019*

I engaged with AMRRIC and TDC multiple times throughout the study, including meetings and communications to update them on the progress of the study and seek their input and direction. I assisted AMRRIC and TDC with producing summary reports using preliminary results to contribute to their annual reporting and program planning meetings (see Appendix A). I also submitted the project for ethical review through the Human Research Ethics Committee of the NT Department of Health and Menzies School of Health Research, and the ANU Human Research Ethics Committee. Through the data analysis component of this study, I developed a data dictionary which will be provided back to AMRRIC, along with the clean dataset, for future use.

I presented about this study at multiple conferences during the MAE, including at the Melbourne Poche Centres Festival of Indigenous Health Research in Melbourne in November 2018 and the One Health Aotearoa Symposium in Wellington NZ in December 2018 (see Appendix B). I co-presented with Dr Bonny Cumming from AMRRIC at the Lowitja International Indigenous Health conference in June 2019 and at the National Aboriginal and Torres Strait Islander Environmental Health conference in Perth in September 2019, along with a team from TDC. In February 2019, I co-presented about the importance of community engagement, using this evaluation as an example, to the Australian Government Department of Prime Minister and Cabinet with my colleague and MAE graduate Bobby Maher. Bobby and I also co-presented at the Lowitja International Indigenous Health Conference in 2019. In July 2019, I presented the preliminary outcomes of this project at the Research School of Population

Health's National Aborigines and Islanders Day Observance Committee (NAIDOC) Symposium at the ANU (see Appendix C). I also had a poster accepted for the International Companion Animal Management (ICAM) Coalition conference in September 2019; however, I was unable to attend (see Appendix D).

This study has helped me form ongoing partnerships in the One Health space and I hope to maintain these after I have completed the MAE. I plan to build on this work by undertaking a PhD in the area of One Health in Aboriginal communities. I believe the ability to produce evidence in this important area would allow Aboriginal Australia to be ahead of the curve in terms of One Health. I am committed to promoting the idea of health promotion and preventative strategies, rather than a reactive approach that prioritises treatment, in communities in order to improve the health and wellbeing of animals as well as people and the environment.

### *2.4.2 Lessons learnt and reflections*

This study provided me with experience in delivering veterinary programs in a remote setting. In particular, it built my knowledge around the Ranger groups in the North of Australia and the work they do and increased my awareness of the work of AMRRIC in facilitating and assisting in the delivery of animal health and management programs. It also allowed me to build on my knowledge of common zoonotic diseases that can be found in companion animals in Australia (see Appendix E).

This study was a great example of the positive difference a community-driven program, based on community priorities, can have. I experienced how engagement with, and training of, community members to assist in the work can improve program delivery and increase the quality of data collection, including reducing the amount of missing data. Also, I found that reinforcing the reasons behind the program and the use of the data collection tool assisted in improving the quality of the data in the 2019 census. The Rangers' leading role in this program, particularly in collecting the data, was vital to the program's success and to building trust, and engaging with, the community. For most of the community English is not their first language; therefore, the Rangers helped with communicating what we were doing and why.

This study has taught me the basic principles of what can be useful when initiating community-based initiatives. The ability to build in a monitoring and evaluation component to the program from the beginning would be helpful to ensure progress is analysed and evidence of the programs achievements can be documented. Additionally, the involvement of the community

in designing and implementing programs ensures that the program activities are respectful to the community and culturally appropriate. The involvement of the community, in this case the TDC Rangers, also helps communicate the importance of the program and is more likely to see the program continue by increasing the knowledge and skills of community members in regards to animal health and management. Consulting community members before design and implementation of the program allows the priorities of the community to be integrated into the study and evaluation design. Finally, it is important to ensure that the data collection methods are useable by the community, whether through having a translated version for those who do not speak English as a first language, or alternatively work with community members to translate and ensure understanding of the program.

As things do not always go to plan, the flexibility and adaptability of the evaluation framework and research design was helpful in this study. The ability to adapt your plans if needed allows you to still complete the study with a positive outcome. I found the logic models to be useful in communicating information about the program and evaluation. These tools assisted in getting the message across to different audiences including my research partners. The logic models were a great tool for presenting at conferences. I built on my presentation and communication skills through this study as I presented this work at multiple domestic and international conferences and meetings. These presentations were to different audiences, and I tailored my presentations accordingly.

Epidemiological studies can be a useful resource when carrying out an evaluation. In this study, the ability to analyse up to four years of population level data from both animals and humans allowed us to understand the health profile of the community pre- and post- program implementation. The design of the program to include an annual census of the animal population was a strength of this program as it involved collecting data before the program was developed, at the start of the program, and 12 months later. This project gave me ample opportunity to learn how to use Stata and involved merging multiple datasets and cleaning data.

The value of One Health in addressing animal health barriers was a useful approach in this study. There are gaps in terms of research and expertise in this space, particularly in Australia. We have the potential to learn from international experts who have looked at One Health approaches to animal health care; however, when adapting to an Aboriginal context, it is important to undertake this work appropriately by ensuring the involvement of community members and maintaining Aboriginal leadership.

The ICAM coalition develops resources and guidelines to support development and use of humane and effective companion animal population management worldwide, particularly in communities with limited or no access to animal health care. There are multiple guideline documents developed by the ICAM coalition that can help with developing and evaluating a companion animal management program. In May 2019, I met with Veterinarians from the ICAM coalition and the International Fund for Animal Welfare in London to discuss their policies and guidelines, current projects, and the need for more evaluations to be undertaken and published on companion animal programs, particularly in communities with limited access to animal health care. While ICAM has many useful resources for use worldwide, the adaptation of their evaluation indicators to remote Aboriginal communities has not yet been investigated. This study may fill some of these gaps.

### *2.4.3 Public health importance*

One in five Aboriginal and Torres Strait Islander people live in remote or very remote areas (4). Generally, people living in remote areas of Australia are more likely to experience poorer access to health services and poorer health outcomes compared to those living in cities (4). This encompasses access to animal health care, including animal medicines and Veterinarians (5).

Companion animals, such as cats and dogs, are common pets in Australian families and can hold a special place in the family, including in Aboriginal and Torres Strait Islander families where the animal may also be of cultural significance. There are potential health benefits of owning pets, as animals can provide psychological benefits to people and can improve health outcomes (6). The Longitudinal Study of Indigenous Children (7) asked children to draw their families and many children drew a dog and/or cat as part of their family (see Figure 3). This is a great example of the importance of dogs and cats to Aboriginal and Torres Strait Islander children and their families.

*Figure 3: Examples of drawings from LSIC participants when asked to draw their family*

Unfortunately, in communities where there are barriers to accessing animal health care for pets, the animals may have suboptimal health. In turn, poor animal health can impact on families. These impacts can include the negative social and emotional impacts of having a sick or injured pet and the potential of acquiring zoonotic diseases. A large proportion of common zoonotic diseases in companion animal populations are easily preventable through access to animal medicines, regular treatment and increased awareness (8).

Evaluating a One Health approach has the potential to gather credible evidence and show the importance of supporting long term and effective animal health and management programs in remote Aboriginal communities. A One health approach is a holistic approach to health and connects to Aboriginal and Torres Strait Islander ways of knowing, doing and being.

This chapter looks at the evaluation of a One Health approach to animal health care in the remote Aboriginal community of Wadeye in the NT and assesses the impact of a community driven program on animal health.

## 2.5 Introduction

### *2.5.1 Animal health in remote Aboriginal communities*

Many remote communities have limited access to animal health care. Due to this barrier, the poor health of dogs and cats can be a threat to human health, particularly where animals and humans live closely together. Large populations of companion animals can lead to increased spread of disease between animals and to humans, reduced capacity to prevent disease, and increased risk of physical injury to both animals and humans (5).

The World Health Organization estimates that around 61% of all human pathogens are zoonotic (can be transmitted from animals to people) and 75% of emerging diseases affecting people in the last decade have originated from animals (9). The common forms of human disease seen in remote communities that may be related to companion animals includes skin disease, gastrointestinal disease, injury, and antimicrobial resistant bacterial infection. Dog bites are common in remote communities due to overcrowding of animals and unmanaged dog populations (5). Dog bites can cause physical injury, with secondary infection common, and have a psychological impact on those involved (5). Dogs can be carriers of zoonotic antimicrobial resistant bacteria which is a significant public health concern (10). Additionally, without access to preventative medicines, the burden of preventable diseases in the animal population can be high. A study of community members in rural and remote Aboriginal communities with limited access to animal health care recognised that external parasites (such as mites), gastrointestinal diseases (such as salmonella) and blood borne diseases (such as heartworm) are problems encountered in the dog population (11). Most of these diseases and injuries are preventable and animal health and management programs can have a beneficial role through increasing the administration of preventative medicines and preventing injuries by managing animal populations.

Animals have the potential to harbour and spread exotic diseases (diseases not yet present in Australia). It is hypothesised that the North of Australia is particularly prone to the introduction of exotic disease due to the vast coastline, remoteness of communities, and the movement of animals and people from neighbouring countries where diseases not yet present in Australia are endemic (12). The implementation and longevity of effective animal health programs, as well as ongoing surveillance of animal health, in the North of Australia is vital. Effective surveillance requires people to be trained in the range of conditions to look for when monitoring animal health.

When thinking about animal health and management in remote Aboriginal communities it is important to consider the cultural significance of animals and the integral roles they play in

this setting. Dogs and cats can be helpful for hunting, providing protection, companionship and warmth. They can also be of cultural significance through traditional cultural values and beliefs. In some communities dogs can be seen as the spiritual protector of the family and the land and integrated into the kinship system (13, 14). Given the significance of animals, particularly dogs, to communities it is important to address animal health and management concerns respectfully and appropriately.

The control of animals in remote communities can be hard to manage for many reasons including limited resources and funding, limited access to veterinary services and animal medicines, and climatic impacts affecting accessibility to the community particularly in the wet season. The low socio-economic position of some families may also limit their ability to purchase animal medicines and products, where these are available (14). One approach to animal management that has been used in Indigenous communities in the past is the practice of culling. However, two studies have suggested that this is not an effective method for maintaining a healthy and stable animal population. A study in First Nations communities in Canada revealed that the control of dog populations and diseases by culling dogs is largely unsuccessful. The authors conclude that community specific strategies involving community participation, support and engagement should be implemented for a dog health and management program to be effective (15). The study also discussed the importance of culturally appropriate dog health programs that are sensitive to local beliefs regarding the roles and importance of dogs within communities (15). Additionally, a study undertaken in Australian Aboriginal communities found that the practice of shooting free roaming dogs was largely unsuccessful at controlling the dog population, as population numbers can recover quickly. The authors recommended that population control efforts need to be continuous and sustainable to have a long term affect (14).

While we have limited published evidence within Australia, findings from studies internationally indicate that a One Health approach might be suitable. One Health is a cross-disciplinary approach that considers the relationships between human, animal and environmental health (2). A One Health approach would consider the interface between human, animal and environmental health in the community rather than addressing human, animal and environmental health independently. The World Organisation for Animal Health suggests that controlling zoonotic pathogens in animals is an effective way of protecting people (16). A One Health approach to animal health and management aligns with Aboriginal cultural and community contexts. Therefore, using and evaluating a One Health approach could be beneficial in remote Aboriginal communities.

A scoping review undertaken in 2017 found that there were 26 studies worldwide that have evaluated the impacts of dog management programs, some of which included a desexing program (17). Most of these studies were based in Africa, Asia, and North and South America, with the two studies that were based in Australia and New Zealand undertaken in relation to dogs and agricultural animals that were screened in abattoirs.

To our knowledge, this is one of the first studies to evaluate a community driven animal health and management program in a remote Aboriginal community in Australia. This study aims to evaluate an animal health and management program and explore the potential value of applying a One Health approach to animal health care in remote Aboriginal communities.

### *2.5.2 Context*

This study was based in the community of Wadeye (also known as Port Keats) within the West Daly Region, in the NT (see Figure 4). Wadeye is one of the largest remote Aboriginal communities in Australia. This community is only accessible by road through the dry season (May to October), and is accessible by air all year round.

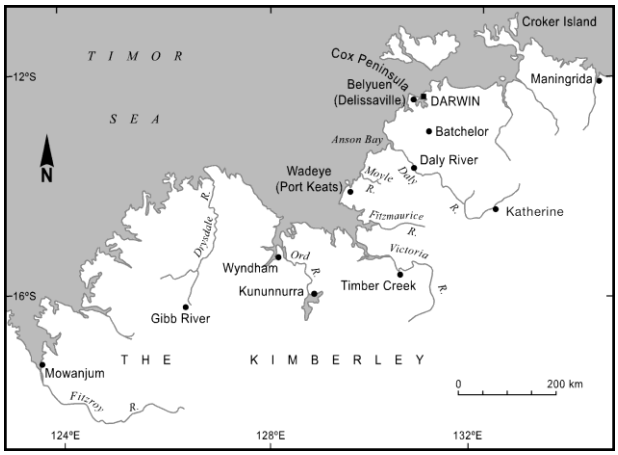



*Figure 4: Wadeye NT map (18)*

The 2016 Australian Bureau of Statistics (ABS) census approximated the following:

- The human population of Wadeye is 2280 and 77% of the population are Aboriginal;
- The human population is comprised of 49% males and 51% females;
- 64% of people speak Murrinh Patha and for 253 households it is the primary language;
- 45% of the population is unemployed;
- The median weekly household income is $906 and the median weekly per person income is $238;

- There are 321 occupied dwellings, with an average of 2.7 bedrooms (range: 1 to ≥4); and,
- In Aboriginal and/or Torres Strait Islander households, the average number of people per household was 6.1, or 2.3 per bedroom. In the NT there is 4 people on average per house, or 1.5 per bedroom, and Australia wide there is 3.2 people on average per house, or 1 per bedroom (19).

### *2.5.3 The Wadeye animal health and management program*

There is very limited access to animal health care and animal medicines in Wadeye and the closest Veterinarian is approximately six hours' drive away in the Darwin region. According to community members, previous animal health and management programs in Wadeye were delivered with limited community engagement and involvement, which may have led to some distrust of animal health programs and Veterinarians.

Due to the barriers in accessing animal health care, Wadeye was experiencing some public health concerns, including uncontrolled breeding of animals, cheeky dogs (nuisance or aggressive dogs (5)), sick and injured animals, and an increasing population of cats. Community members were often requesting support from the TDC Rangers to deal with these concerns.

Due to the community's concerns, the TDC Rangers, along with AMRRIC, co-developed and implemented a community driven animal health and management program, with support from the West Daly Regional Council. The program began in June 2018 and is ongoing. A key focus of this program was to build and maintain relationships and trust of Veterinarians in the community to enable improved uptake of veterinary services on offer.

A community-level census of the companion animal population was undertaken in 2017 to understand the state of animal health and size of the animal population. This assisted in developing a tailored program to meet community and animal needs. The animal program was funded through a Territory Grant for Local Government Authorities with in-kind contributions from TDC, AMRRIC and the West Daly Regional Council.

This program involves the TDC Rangers who, with training, are now implementing animal health activities, and assisting the visiting veterinary services. The program consists of four main components.

1. AMRRIC visiting veterinary service:

    - The visiting veterinary team (an AMRRIC coordinated veterinary service including contracted and volunteer Veterinarians and Veterinary Nurses) delivers week-long visits to Wadeye to deliver desexing programs, administer preventative medicines, and undertake other treatments and surgeries as needed.

2. Local assistance from the TDC Rangers:

    - The Rangers work with the visiting veterinary team to engage with the community and encourage owners to participate in the program, as well as transport animals from houses to the clinic.

3. Annual companion animal census:

    - An initial census was undertaken in June 2017. As part of the program, the census was repeated in June 2018, and in June 2019. The Rangers conduct the census by going door-to-door, visiting all houses in the community, to ask about the cats and dogs that live there and collect information on the animals' health.

4. Regular preventative medicine administration to the dog population:

    - In order to treat and prevent internal and external parasites, such as worms, mites and ticks, the Rangers prepare and administer Ivermectin[4] to the dog population in Wadeye every three months, between veterinary visits. Nexgard is also administered to dogs with an observed severe burden of parasites.

The main goals of the program were for the companion animal population in Wadeye to:

- Be of a more manageable number;
- Be healthier including improved body condition and hair score;
- Reduce the risk of animal to human disease transmission;
- Be less likely to roam outside of their house and yard;
- Be less likely to bite people and other animals;
- Cause less nuisance;

[4] Ivermectin and Nexgard are oral antiparasitic medicines used to prevent and treat parasites in dogs. Ivermectin targets internal and external parasites and Nexgard targets external parasites.

- Have fewer unwanted puppies and kittens; and,
- Have welfare concerns addressed promptly by qualified professional and local assistants.

The benefits of this program for the community include an improved feeling of community safety, a reduced burden of stress on residents concerned about the health and welfare of animals, and improved health and wellbeing for both animals and the community. Long term, it is hoped that this program remains consistent and is sustained in Wadeye. This would involve ongoing training and employment for local people to work on the animal program to address animal health needs in the community.

## 2.6 Methods

### *2.6.1 Ethics*

Ethics approval was provided by the Human Research Ethics Committee of the NT Department of Health and Menzies School of Health Research (**2018-3176**), and the ANU (**2018/588**). The AMRRIC Board also granted approval to undertake this study.

### *2.6.2 Study design*

This was a quantitative epidemiological study, undertaken in partnership with TDC and AMRRIC. The study analysed three years of companion animal census data to evaluate the Wadeye animal health and management program. We analysed the data to look at animal health pre-program implementation (2017) and over the period of the program (2018 to 2019). We also analysed dog bite data over four years to look at presentations of dog bite patients to the health clinic, pre-program implementation (2016 to 2018) and over the period of the program (2018 to 2019). Lastly, veterinary visit data were analysed to assess the extent and type of veterinary treatments delivered during the program period (2018 to 2019).

The research had two key aims:

1. To co-develop an adapted evaluation framework with research partners to apply to the animal health and management program in Wadeye; and,
2. To evaluate the program by assessing the change in animal and human health outcomes during the program (June 2018 to June 2019) compared to pre-implementation, and quantify the extent and type of veterinary treatments delivered.

The study hypotheses were:

- Animal health outcomes will improve over the duration of the program, i.e. one year after program implementation, compared to pre-implementation. Specifically:
    - body condition scores in dogs;
    - hair scores in dogs; and,
    - desexing prevalence in dogs and cats.
- The incidence of dog bites will decrease over the duration of the program.

### *2.6.3 Evaluation*

An evaluation investigates the impacts produced by (that can be attributed to) a program (20). The ICAM coalition has developed guidelines that state the importance of monitoring and evaluating dog management programs to quantify how activities in the program affect dogs and people, and provide evidence on what is and is not working (21).

Evaluation is important because it allows us to:

- Monitor progress towards a program's goals;
- Justify the need for further funding and support;
- Determine whether the program is producing desired outcomes;
- Find opportunities for quality improvement;
- Ensure that effective programs are maintained; and,
- Produce results that can be used to make a difference (22).

The evaluation followed the below framework set out by the Centres for Disease Control and Prevention, with a particular focus on cultural competence at all stages (see Figure 5) (23). Cultural competence was integrated through all stages of the evaluation. This included appropriate engagement with the community and local organisations through working closely with TDC. The study design and evaluation framework was discussed with contacts at TDC before undertaking research or travelling to Wadeye so that we were aware of local protocols and delivered the research respectfully and appropriately. This also allowed us to understand the priorities of the community when undertaking this research to incorporate these into the study where possible. Additionally, the importance of animals within the Aboriginal culture was at the forefront of this study, to ensure that the evaluation considered this throughout,

particularly when justifying conclusions and recommendations. The value of the community driven aspect of this program was highlighted whenever communicating about this project to support the continued empowerment of the community to lead this program.

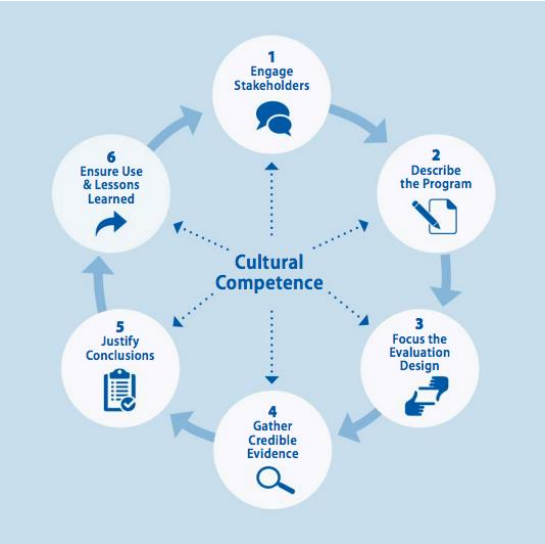



*Figure 5: The Centres for Disease Control and Prevention framework for program evaluation (22)*

This program followed the broad theory of change that the program will contribute towards a healthier animal population, which will potentially lead to a healthier human population and improved wellbeing for the community.

A logic model for the program was developed through consultation with research partners to show the pathways from the program activities to the intended outcomes and impacts. The detailed program logic model below (see Figure 6) shows the direct proposed outcomes of each activity. A compact logic model (see Figure 7) was also designed to display the program in a clear and engaging manner. These different forms of the logic model diagram were developed to assist in communicating to different audiences. For example, the first detailed logic model may be more useful for organisations, whereas the second logic model might be more useful for community members and pet owners.

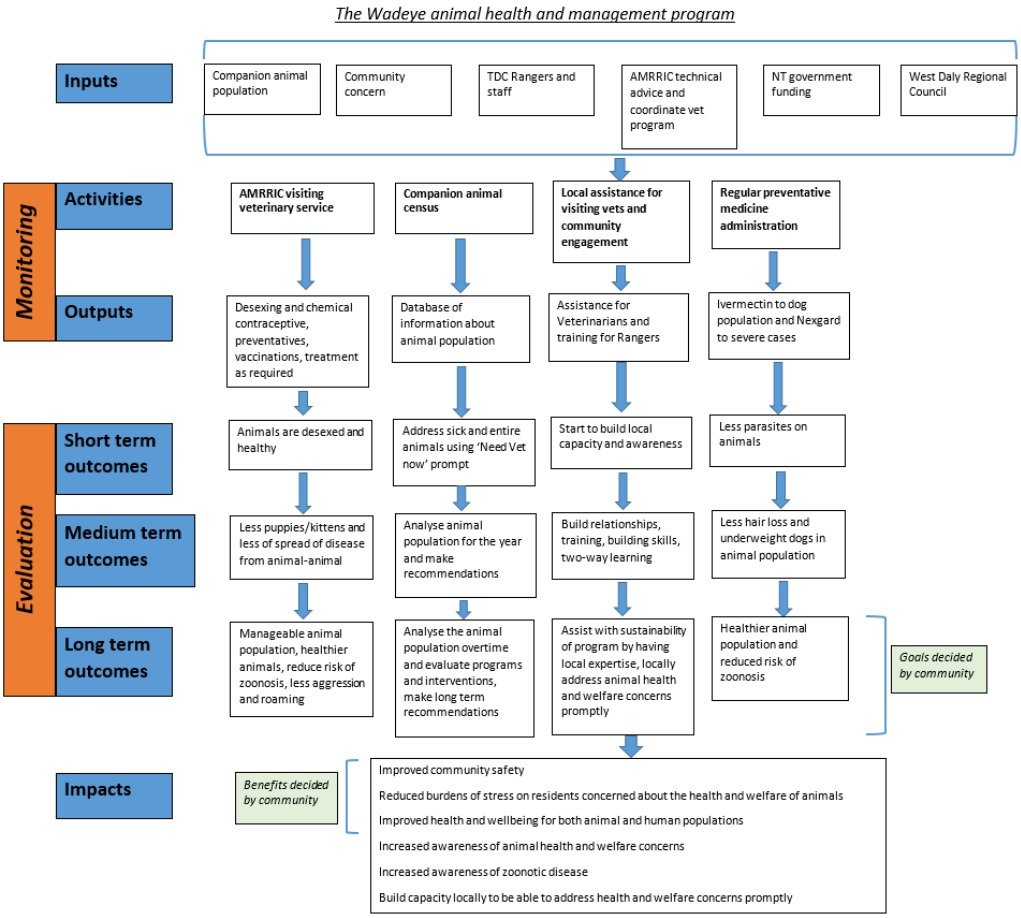



*Figure 6: Co-developed detailed logic model for the program*

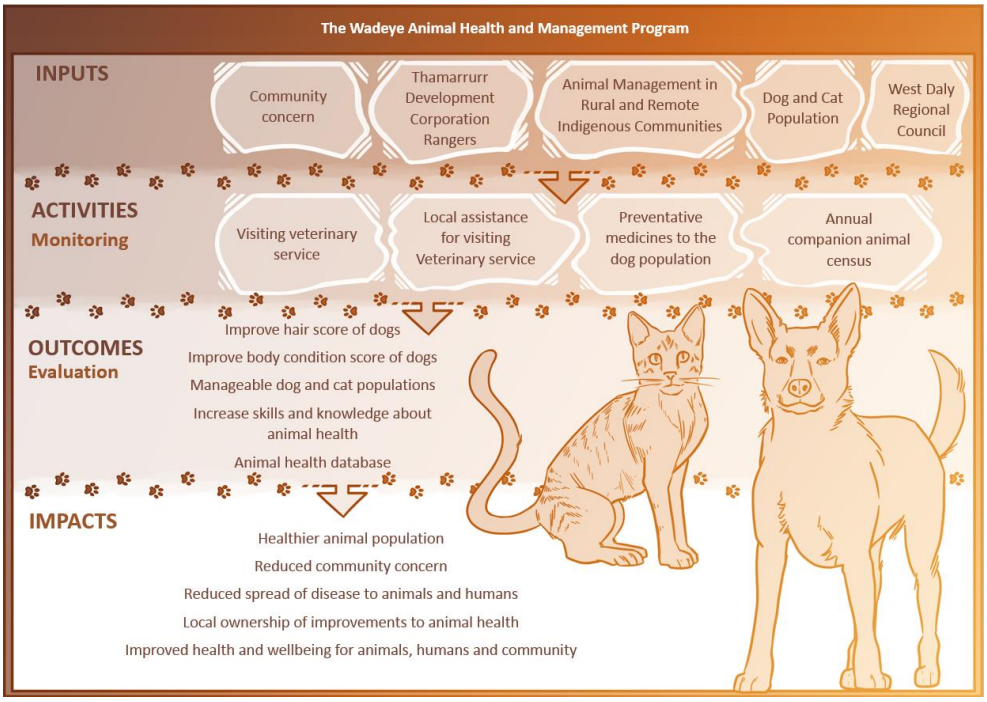



*Figure 7: Co-developed summary logic model for the program[5].*

[5] I acknowledge the support of Dr Erin Walsh, RSPH, in providing the artwork for this logic model.

The companion animal census, veterinary visit data and dog bite data were used to assess short- and medium-term outcomes of the program. The evaluation was not intended to assess the long-term impacts of the program, as this was beyond the scope of the MAE timeframe. Based on the ICAM Coalitions' suggested indicators for assessing change in companion animal populations, the following evaluation indicators and questions were developed in relation to the research questions (21) (see Table 2).

*Table 2: Research questions, evaluation outcomes, indicators and evaluation questions*

| Research Questions | Intended outcome of the program | Indicator measure of the intended outcome | Specific evaluation question |
|---|---|---|---|
| What is the state of animal health in Wadeye pre-program implementation (2017)?<br>How does the state of animal health change over the period of the program (2018 to 2019)? | Improve animal health (dogs and cats) | Body Condition score of dogs<br>Hair score of dogs | To what extent were there changes to animal health outcomes including dog body condition and hair score? |
| | Reduce or stabilise the animal population | Total population size<br>Animals per 100 people<br>Age group structure<br>Breeding females<br>Animals per household | To what extent were there changes in the companion animal population size and age distribution?<br>To what extent were there changes to desexing status in the dog and cat population? |
| How many veterinary treatments are delivered over the program (2018 to 2019)? | Improve animal health care | Preventative and curative veterinary care<br>Owner engagement | To what extent were veterinary care and animal medicines delivered?<br>To what extent were households engaged in the program? |

| | | | |
|---|---|---|---|
| What is the rate of dog bite presentations to the health clinic pre-program implementation (2016 to 2018)? How does the rate of dog bite presentations change over the program (2018 to 2019)? | Reduce risks to public health | Total number and rate of presentations to the clinic for dog bites | To what extent were there changes to the rate of presentations to the health clinic for a dog bite? |

Sustainability of the program was also considered. This included assessing whether the outcomes are likely to be sustainable, if the program is likely to continue, and what program modifications could enhance program sustainability. Recommendations to support program sustainability are provided.

### *2.6.4 Data sources*

The evaluation included analysis of three key data sources supplied by AMRRIC and TDC. The timeline of the collection of data sources was from July 2016 – June 2019 (see Figure 8).

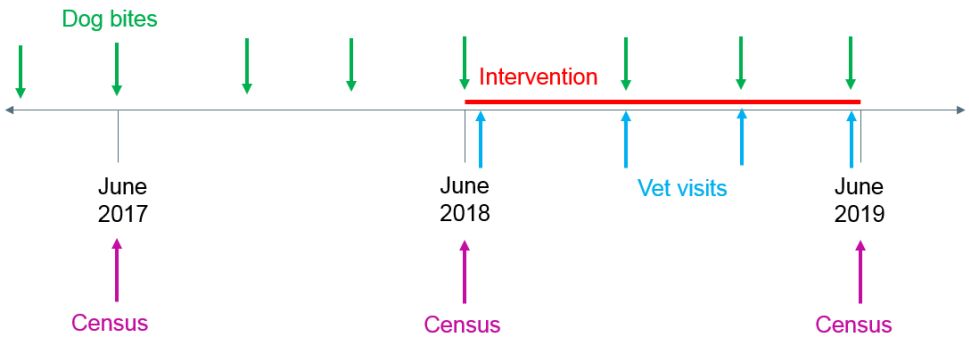



*Figure 8: Timeline of data collection*

The details of the data sources can be seen in Table 3.

*Table 3: Datasets accessed and outcomes of interest*

| Dataset | Source | Outcomes |
|---|---|---|
| Companion animal census data | A companion animal census was undertaken in June 2017, 2018 and 2019. These data were collected by the Rangers from local community households in Wadeye using the AMRRIC app, with assistance from AMRRIC and myself (see Figure 9). Each household was asked about the number of dogs and cats that reside there, and their current health status. | Outcomes included population size, age groups, number of animals per household, body condition score of dogs, hair score of dogs, and desexing status of dogs and cats. |
| Veterinary visit data | Veterinary visit data were collected during veterinary visits on the number of animals and type of treatments delivered using the AMRRIC app (see Figure 9). Three veterinary visits were delivered between June 2018 – June 2019 (occurring in June 2018, October 2018 and May 2019). | Outcomes included number of animals involved in veterinary program and treatments delivered. |
| Dog bite data | Dog bite data were collected at the health clinic in Wadeye for any patient that presented with a dog bite, and supplied to TDC quarterly. Aggregated quarterly data was then provided by TDC for July 2016 – June 2019. | Outcome included presentations to the health clinic for a dog bite. |

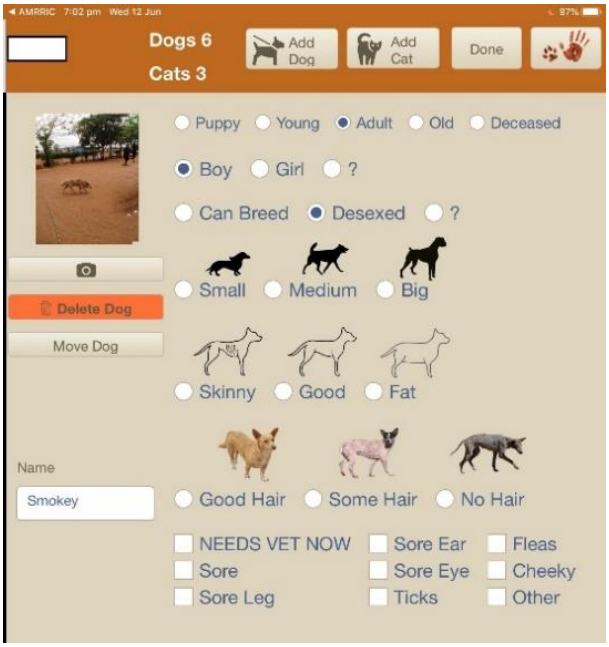



*Figure 9: AMRRIC app - data collection tool*

### *2.6.5 Variables*

Census data were supplied line listed by animal and identified by household (lot number), for each census year. The lot number was used as the unique identifier for each household. The main outcome variables included desexing status which was coded as 'can breed', 'desexed' and 'don't know'. Body condition score was coded as 'underweight', 'normal weight' and 'overweight'. Hair score was coded as 'good hair', 'some hair loss', and 'lots of hair loss'. Exposure variables included year which was coded as '2017', '2018' and '2019'. Species was coded as 'cat' and 'dog'. Variables were created to group number of animals per household, with categories including '1-5', '6-10', '11-15' and '16-24'. Age group was coded as 'kitten', 'adult cat', 'puppy', 'young dog', 'adult dog' and 'old dog'. Sex was coded as 'male', 'female' and 'don't know'.

Dog bite data were supplied as the quarterly aggregated number of presentations to the Wadeye health clinic for dog bites per year. The data were provided overall and by sex. Veterinary visit data were supplied as the aggregated number of animals that received each type of treatment at each veterinary visit. We also examined free text responses to treatments delivered.

Outcome variables were categorised into binary variables for regression analysis. For all outcomes, responses of 'don't know' were coded as 'missing' and not included in the analysis. Body condition score was coded as 'normal weight/overweight' versus 'underweight'. Hair score was coded as 'good hair' versus 'any hair loss' (some and lots of hair loss combined).

Desexing status was coded as ‘desexed’ versus ‘not desexed’. Year was coded to ‘2018’ and ‘2019’ with 2017 coded as missing, with the exception of hair score which analyses ‘2017’ and ‘2019’, with 2018 coded as missing.

### *2.6.6 Statistical analysis*

Statistical analysis was undertaken using Stata 15 and Excel.

Descriptive tables showing counts and percentages were used to summarise animal census data by year for each outcome variable. Stacked bar charts were created to visualise the distribution of each outcome by year. Number of animals per 100 people in Wadeye was calculated using ABS 2016 census population data. Average number of animals per household was calculated using the number of animals divided by the number of households involved in the census each year.

The aim of the regression analyses were to quantify differences between the pre-program implementation and post-program implementation. We were therefore interested in comparing data from 2019 (post program implementation) to data from 2018 (pre-program implementation) using PR. PR were used to compare the burden of disease in the animal population annually focusing on body condition, hair score and desexing status. Prevalence was used as the data was collected at a particular point in time to assess the current state of health in the animal population, and therefore incidence was not appropriate. Prevalence ratios are appropriate in this study as the health outcomes that were analysed (body condition, desexing status and hair score) were common. Therefore, odds ratios were not suitable. Additionally, the census used was a snapshot in time and we did not have access to longitudinal data for individual animals to be able to determine incidence (new cases). In the case of hair score, data from 2017 was used as the pre-intervention time point (instead of 2018) due to a high level of missing data on the outcome in 2018.

All regression models were adjusted for age group and sex of the animals because these potentially confounding variables might relate to both the exposure (time) and the outcome (health conditions). For example, age is directly a function of time, and the age category of the animals may have changed from 2018 to 2019. The age of the animals may also relate to the health outcomes as older animals are more likely to have more health conditions. Therefore, not adjusting for age might lead to biased associations in the results. Significance was tested using 95% confidence intervals (CI) and p values ($p=<0.05$).

Veterinary visit data were presented in descriptive summary tables broken down by the three veterinary visits and combined overall for a total over 12 months (June 2018 – June 2019). Dog bites were presented as quarterly dog bites per 1000 population, by sex and overall. ABS 2016 census population data for Wadeye was used as the denominator to calculate crude rates. Rates were presented in a table and line graph. A time series analysis was performed on total dog bites looking at July 2016 – June 2018 (pre-program implementation) compared to July 2018 – June 2019 (the program period). The best approach for this would have been an interrupted time series but we were not able to separate the data from the April – June 2018 data period, which includes both pre- and post- program implementation. In addition, we were limited by the number of time points available. As an alternative, we conducted a time series analysis using pre-program implementation (July 2016 to June 2018) and post-program implementation (July 2018 to June 2019).

## 2.7 Results

### *2.7.1 Companion animal census*

The total number of households participating in the companion animal census was 201 households in 2017 (63% of all households based on 2016 ABS census), 168 households in 2018 (52% of all households), and 172 households in 2019 (54% of all households) respectively. The below results are based on these data.

Total companion animals

The dog and cat population in Wadeye was 732 in 2017, 653 in 2018, and 633 in 2019. Across the years, dogs constituted the majority of all animals (81-84%), with cats constituting the remaining 16-19%. From 2017 to 2019 there was a decrease in the number of dogs (598-532) and cats (134-101) owned as pets. Animals per 100 people was 32.1 animals per 100 people in 2017 and 27.8 animals per 100 people in 2019. The average number of animals per household remained relatively stable, with 3.6 in 2017, 3.9 in 2018 and 3.7 in 2019 (see Table 4).

*Table 4: Total companion animals by year*

| Companion animal population in Wadeye by year | | | |
|---|---|---|---|
| | 2017 | 2018 | 2019 |
| Species: % (n) | | | |
| Cat | 18 (134) | 19 (123) | 16 (101) |
| Dog | 82 (598) | 81 (530) | 84 (532) |
| Total | 100 (732) | 100 (653) | 100 (633) |
| Animals per 100 people | | | |
| Cats per 100 people | 5.9 | 5.4 | 4.4 |
| Dogs per 100 people | 26.2 | 23.3 | 23.3 |
| Total animals per 100 people | 32.1 | 28.6 | 27.8 |
| Average animals per household | | | |
| Animals per household | 3.6 | 3.9 | 3.7 |

Dogs and cats desexing status

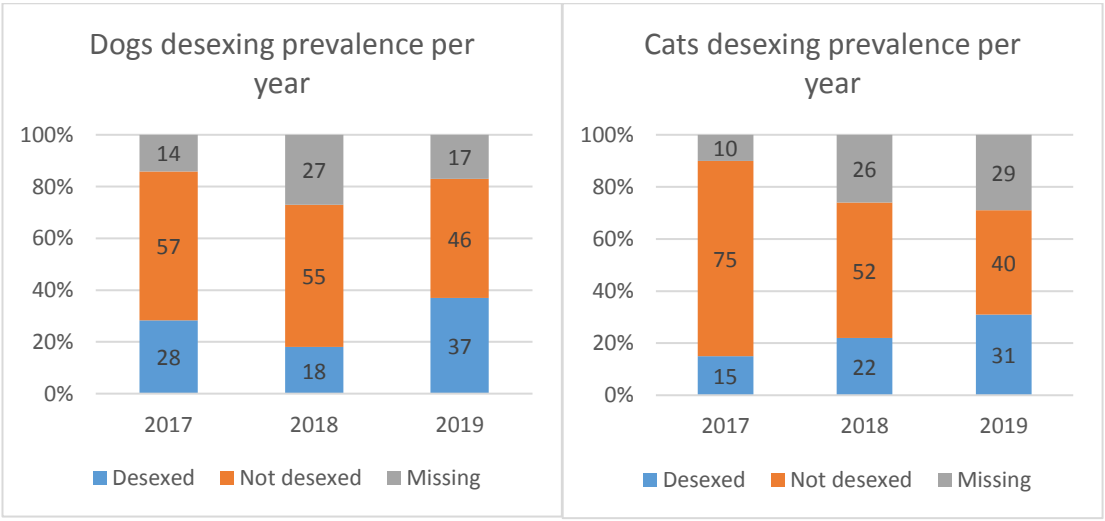



*Figure 10: Dog and cat desexing prevalence per year*

Across the years, less than half of the dog population was desexed. The percentage of desexed dogs was 28.6% in 2017, 18.5% in 2018 and 37.0% in 2019. In 2017, 14.9% of cats were desexed, in 2018 22.0%, and in 2019 30.7%. There was a higher proportion of males desexed, with 41.8% of males and 36.4% of females desexed in 2019. Desexing was most common in old dogs (56.3%) followed by adult dogs (41.9%) and adult cats (41.1%) in 2019 (see Table 5 and Figure 10).

*Table 5: Desexing status of dogs and cats by year, sex and age*

| Desexed status: % (n) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Desexed | | | Not desexed | | | Missing | | |
| | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Species | | | | | | | | | |
| Cat | 14.9 (20) | 22.0 (27) | 30.7 (31) | 75.4 (101) | 52.0 (64) | 39.6 (40) | 9.7 (13) | 26.0 (32) | 29.7 (30) |
| Dog | 28.6 (171) | 18.5 (98) | 37.0 (197) | 57.4 (343) | 54.9 (291) | 46.1 (245) | 14.1 (84) | 26.6 (141) | 16.9 (90) |
| Total | 26.1 (191) | 19.1 (125) | 36.0 (228) | 60.7 (444) | 54.4 (355) | 45.0 (285) | 13.3 (97) | 26.5 (173) | 19.0 (120) |
| Sex (dogs and cats combined) | | | | | | | | | |
| Male | 35.6 (119) | 19.8 (17) | 41.8 (135) | 57.5 (192) | 75.6 (65) | 48.3 (156) | 6.9 (23) | 4.7 (4) | 9.9 (32) |
| Female | 23.5 (66) | 16.7 (12) | 36.4 (76) | 66.2 (186) | 81. 9 (59) | 46.4 (97) | 10.3 (29) | 1.4 (1) | 17.2 (36) |
| Don't know | 4.9 (3) | 0.0 (0) | 19.0 (15) | 73.8 (45) | 9.1 (1) | 36.7 (29) | 21.3 (13) | 90.9 (10) | 44.3 (35) |
| Missing | 5.4 (3) | 19.8 (96) | 9.1 (2) | 37.5 (21) | 47.5 (230) | 13.6 (3) | 57.1 (32) | 32.6 (158) | 77.3 (17) |
| Age group (dogs) | | | | | | | | | |
| Puppy | 0.0 (0) | 0.0 (0) | 2.9 (1) | 80.5 (66) | 46.4 (32) | 91.4 (32) | 19.5 (16) | 53.6 (37) | 5.7 (2) |
| Young | 6.9 (7) | 13.5 (5) | 20.9 (14) | 85.3 (87) | 75.7 (28) | 70.2 (47) | 7.8 (8) | 10.8 (4) | 9.0 (6) |
| Adult | 40.1 (151) | 22.7 (85) | 41.9 (152) | 48.3 (182) | 57.8 (216) | 41.6 (151) | 11.7 (44) | 19.5 (73) | 16.5 (60) |
| Old | 50.0 (9) | 45.5 (5) | 56.3 (27) | 44.4 (8) | 45.5 (5) | 29.2 (14) | 5.6 (1) | 9.1 (1) | 14.6 (7) |
| Missing | 21.1 (4) | 7.7 (3) | 15.8 (3) | 0.0 (0) | 25.6 (10) | 5.3 (1) | 79.0 (15) | 66.7 (26) | 79.0 (15) |
| Age group (cats) | | | | | | | | | |
| Kitten | 0.0 (0) | 0.0 (0) | 4.0 (1) | 96.4 (27) | 52.4 (11) | 88.0 (22) | 3.6 (1) | 47.6 (10) | 8.0 (2) |
| Adult | 21.8 (19) | 28.7 (27) | 41.1 (30) | 71.3 (62) | 56.4 (53) | 23.3 (17) | 6.9 (6) | 14.9 (14) | 35.6 (26) |
| Missing | 5.6 (1) | 0.0 (0) | 0.0 (0) | 66.7 (12) | 0.0 (0) | 50.0 (1) | 27.8 (5) | 100 (8) | 50.0 (1) |

There was a 77% increase in the prevalence of desexed dogs from 2018 to 2019 (PR 1.77, 95%CI 1.45-2.16). After adjusting for age and sex, the result remained significant (PR 2.50, 95%CI 1.70-3.70). There was also a 47% increase in the prevalence of desexed cats from 2018 to 2019; however, the unadjusted association was not significant (PR 1.47, 95%CI 0.97-2.22). After adjusting for age and sex, the association was significant, with a two-fold prevalence of desexed cats in 2019 compared to 2018 (PR 2.25, 95% CI 1.14-4.47) (see Table 6).

*Table 6: PR and 95% CI of desexing in 2019 (post- program implementation) compared to 2018 (pre-program implementation), unadjusted, and adjusted for age group and sex*

| Desexing status of dogs and cats pre- and post- program implementation (desexed versus not desexed) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | PR | 95% CI | P value | | PR | 95% CI | P value |
| Dogs | Unadjusted | | | Adjusted for age group and sex | | | |
| 2018 | 1 | | | 2018 | 1 | | |
| 2019 | 1.77 | 1.45 – 2.16 | **<0.001** | 2019 | 2.50 | 1.70 – 3.70 | **<0.001** |
| Cats | Unadjusted | | | Adjusted for age group and sex | | | |
| 2018 | 1 | | | 2018 | 1 | | |
| 2019 | 1.47 | 0.97 – 2.22 | 0.066 | 2019 | 2.25 | 1.14 – 4.47 | **0.020** |

Dogs' body condition score

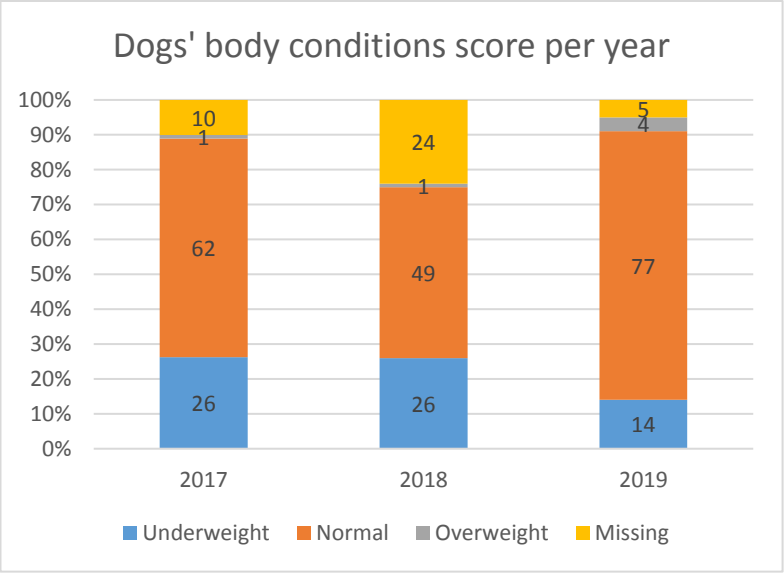



*Figure 11: Dogs' body condition score per year*

The majority of dogs were of normal weight: 62.2% in 2017, 48.7% in 2018 and 76.7% in 2019. Very few animals were overweight: 1.2% in 2017, 0.8% in 2018 and 3.8% in 2019. The prevalence of underweight was 26.3% in 2017, 25.9% in 2018, and 13.9% in 2019. The prevalence of underweight was similar for males and females in 2017 and 2018; in 2019, 18.0% of females were underweight compared to 12.2% of males.

Normal weight was more common in older age groups, with 45.7% of puppies, 71.6% of young dogs, 85.1% of adult dogs, and 66.7% of old dogs having normal body weight in 2019. Among dogs that were not desexed, 28.9% were underweight in 2017, 33.3% in 2018 and 19.6% in 2019. In comparison, 22.8%, 10.2%, and 10.2% of desexed dogs were underweight across the years (see Table 7 and Figure 11).

*Table 7: Dogs body condition score by year, sex, age and desexing status*

| Dogs body condition score: % (n) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underweight | | | Normal weight | | | Overweight | | | Missing | | |
| | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Species | | | | | | | | | | | | |
| Dog | 26.3 (157) | 25.9 (137) | 13.9 (74) | 62.2 (372) | 48.7 (258) | 76.7 (408) | 1.2 (7) | 0.8 (4) | 3.8 (20) | 10.4 (62) | 24.7 (131) | 5.6 (30) |
| Sex | | | | | | | | | | | | |
| Male | 26.8 (80) | 40.0 (28) | 12.2 (36) | 66.6 (199) | 41.4 (29) | 82.4 (243) | 1.0 (3) | 2.9 (2) | 3.1 (9) | 5.7 (17) | 15.7 (11) | 2.4 (7) |
| Female | 28.4 (63) | 44.1 (26) | 18.0 (33) | 68.5 (152) | 37.3 (22) | 75.4 (138) | 1.4 (3) | 0.0 (0) | 5.5 (10) | 1.8 (4) | 18.6 (11) | 1.1 (2) |
| Don't know | 22.5 (9) | 27.3 (3) | 14.7 (5) | 37.5 (15) | 0.0 (0) | 64.7 (22) | 2.5 (1) | 0.0 (0) | 2.9 (1) | 37.5 (15) | 72.7 (8) | 17.7 (6) |
| Missing | 13.5 (5) | 20.5 (80) | 0.0 (0) | 16.2 (6) | 53.1 (207) | 25.0 (5) | 0.0 (0) | 0.5 (2) | 0.0 (0) | 70.3 (26) | 25.9 (101) | 75.0 (15) |
| Age groups | | | | | | | | | | | | |
| Puppy | 23.2 (19) | 17.4 (12) | 31.4 (11) | 45.1 (37) | 27.5 (19) | 45.7 (16) | 0.0 (0) | 1.5 (1) | 0.0 (0) | 31.7 (26) | 53.6 (37) | 22.9 (8) |
| Young | 28.4 (29) | 29.7 (11) | 26.9 (18) | 65.7 (67) | 67.6 (25) | 71.6 (48) | 1.0 (1) | 0.0 (0) | 1.5 (1) | 4.9 (5) | 2.7 (1) | 0.0 (0) |
| Adult | 27.1 (102) | 26.2 (98) | 9.1 (33) | 67.6 (255) | 53.2 (199) | 85.1 (309) | 1.6 (6) | 0.5 (2) | 4.1 (15) | 3.7 (14) | 20.1 (75) | 1.7 (6) |
| Old | 33.3 (6) | 36.4 (4) | 25.0 (12) | 55.6 (10) | 54.6 (6) | 66.7 (32) | 0.0 (0) | 9.1 (1) | 6.3 (3) | 11.1 (2) | 0.0 (0) | 2.1 (1) |
| Missing | 5.3 (1) | 30.8 (12) | 0.0 (0) | 15.8 (3) | 23.1 (9) | 15.8 (3) | 0.0 (0) | 0.0 (0) | 5.3 (1) | 79.0 (15) | 46.2 (18) | 79.0 (15) |
| Desexed | | | | | | | | | | | | |
| Yes | 22.8 (39) | 10.2 (10) | 10.2 (20) | 71.9 (123) | 65.3 (64) | 83.3 (164) | 2.9 (5) | 3.1 (3) | 5.6 (11) | 2.3 (4) | 21.4 (21) | 1.0 (2) |
| No | 28.9 (99) | 33.3 (97) | 19.6 (48) | 63.6 (218) | 50.5 (147) | 74.3 (182) | 0.3 (1) | 0.3 (1) | 2.5 (6) | 7.3 (25) | 15.8 (46) | 3.7 (9) |
| Missing | 22.6 (19) | 21.3 (30) | 6.7 (6) | 36.9 (31) | 33.3 (47) | 68.9 (62) | 1.2 (1) | 0.0 (0) | 3.3 (3) | 39.3 (33) | 45.4 (64) | 21.1 (19) |

The prevalence of good body condition in dogs was 30% higher in 2019 compared to 2018 (PR 1.30, 95%CI 1.19-1.41). After adjusting for age group and sex, the result remained significant, with a 77% higher prevalence of good body condition score in 2019 compared to 2018 (PR 1.77, 95%CI 1.45-2.15) (see Table 8).

*Table 8: PR and 95% CI of dogs' body condition in 2019 (post- program implementation) compared to 2018 (pre-program implementation), unadjusted, and adjusted for age group and sex*

| Dogs body condition pre- and post- program implementation (normal weight/overweight versus underweight) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | PR | 95% CI | P value | | PR | 95% CI | P value |
| Unadjusted | | | | Adjusted for age group and sex | | | |
| 2018 | 1 | | | 2018 | 1 | | |
| 2019 | 1.30 | 1.19 – 1.41 | **<0.001** | 2019 | 1.77 | 1.45 – 2.15 | **<0.001** |

Dogs' hair score

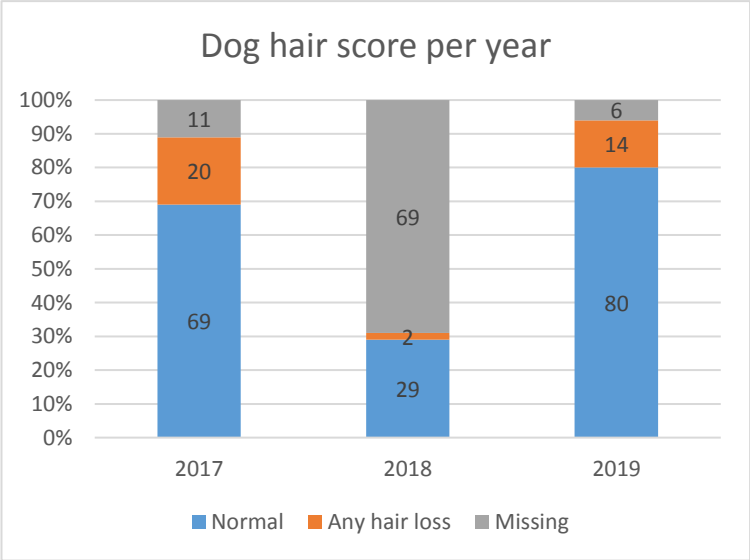



*Figure 12: Dogs hair score per year*

In 2017 and 2019, the majority of dogs had a good hair score (69.4%-80.3%), with few dogs having any hair loss (13.5%-19.2%). The prevalence of hair loss for males was 19.4% in 2017 and 11.2% in 2019. In females the prevalence of hair loss was 21.2% in 2017 and 16.4% in 2019. In 2017, 8.5% of puppies, 10.8% of young dogs, 23.1% of adult dogs and 44.4% of old dogs had hair loss. In 2019, 48.6% of puppies, 10.5% of young dogs, 10.2% of adult dogs and 20.8% of old dogs had hair loss. In 2019, 19.6% of dogs who were not desexed had hair loss, compared to 7.1% of dogs who were desexed (see Table 9 and Figure 12). 2018 results should be treated with caution due to 69.4% of data missing.

*Table 9: Dog hair score by year, sex, age and desexing status*

| Dogs hair score: % (n) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | Any hair loss (includes some and lots of hair loss) | | | Missing | | |
| | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Species | | | | | | | | | |
| Dog | 69.4 (415) | 29.1 (154) | 80.3 (427) | 19.2 (115) | 1.5 (8) | 13.5 (72) | 11.4 (68) | 69.4 (368) | 6.2 (33) |
| Sex | | | | | | | | | |
| Male | 76.3 (228) | 82.9 (58) | 86.4 (255) | 19.4 (58) | 0.0 (0) | 11.2 (33) | 4.4 (13) | 17.1 (12) | 2.4 (7) |
| Female | 74.8 (166) | 76.3 (45) | 80.3 (147) | 21.2 (47) | 3.4 (2) | 16.4 (30) | 4.1 (9) | 20.3 (12) | 3.3 (6) |
| Don't know | 40.0 (16) | 18.2 (2) | 67.7 (23) | 20.0 (8) | 9.1 (1) | 26.5 (9) | 40.0 (16) | 72.7 (8) | 5.9 (2) |
| Missing | 13.5 (5) | 12.6 (49) | 10.0 (2) | 5.4 (2) | 1.3 (5) | 0.0 (0) | 81.1 (30) | 86.2 (336) | 90.0 (18) |
| Age groups | | | | | | | | | |
| Puppy | 56.1 (46) | 23.2 (16) | 40.0 (14) | 8.5 (7) | 0.0 (0) | 48.6 (17) | 35.4 (29) | 76.8 (53) | 11.4 (4) |
| Young | 83.3 (85) | 43.2 (16) | 86.6 (58) | 10.8 (11) | 5.4 (2) | 10.5 (7) | 5.9 (6) | 51.4 (19) | 3.0 (2) |
| Adult | 72.7 (274) | 27.0 (101) | 87.1 (316) | 23.1 (87) | 0.5 (2) | 10.2 (37) | 4.2 (16) | 72.5 (271) | 2.8 (10) |
| Old | 44.4 (8) | 45.5 (5) | 75.0 (36) | 44.4 (8) | 18.2 (2) | 20.8 (10) | 11.1 (2) | 36.4 (4) | 4.2 (2) |
| Missing | 10.5 (2) | 41.0 (16) | 15.8 (3) | 10.5 (2) | 5.1 (2) | 5.3 (1) | 79.0 (15) | 53.9 (21) | 79.0 (15)s |
| Desexed | | | | | | | | | |
| Yes | 73.1 (125) | 24.5 (24) | 90.4 (178) | 24.0 (41) | 1.0 (1) | 7.1 (14) | 2.9 (5) | 74.5 (73) | 2.5 (5) |
| No | 72.9 (250) | 35.4 (103) | 76.3 (187) | 19.0 (65) | 1.4 (4) | 19.6 (48) | 8.2 (28) | 63.2 (184) | 4.1 (10) |
| Missing | 47.6 (40) | 19.2 (27) | 68.9 (62) | 10.7 (9) | 2.1 (3) | 11.1 (10) | 41.7 (35) | 78.7 (111) | 20.0 (18) |

The prevalence of good hair score was 10% higher in 2019 compared to 2017 (PR 1.10, 95%CI 1.03-1.16). After adjusting for age group and sex, the difference remained significant (PR 1.09, 95%CI 1.03-1.16) (see Table 10).

*Table 10: PR and 95% CI of dogs' hair score in 2019 (post- program implementation) compared to 2017 (pre-program implementation), unadjusted, and adjusted for age group and sex*

| Dogs hair score pre- and post- program implementation (good hair versus any hair loss) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | PR | 95% CI | P value | | PR | 95% CI | P value |
| Unadjusted | | | | Adjusted for age group and sex | | | |
| 2017 | 1 | | | 2017 | 1 | | |
| 2019 | 1.10 | 1.03 – 1.16 | **0.002** | 2019 | 1.09 | 1.03 – 1.16 | **0.003** |

Animals per household

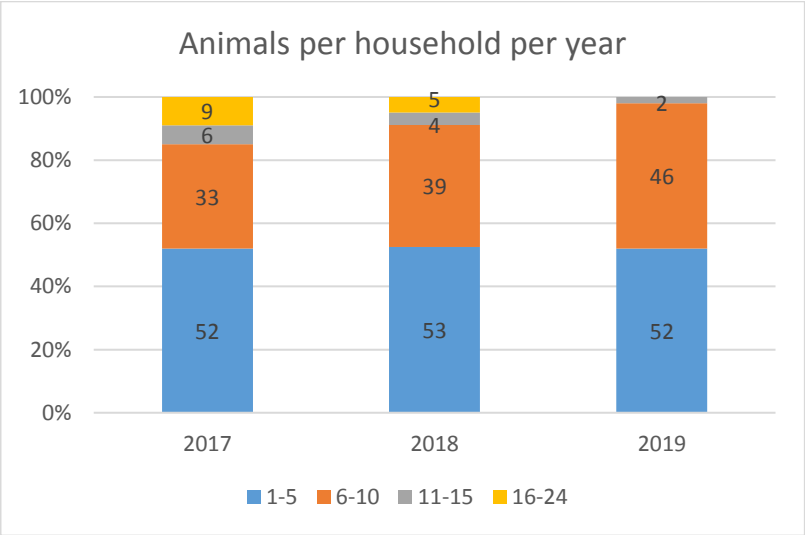



*Figure 13: Animal per household per year*

Across the years, there was few households with large numbers of animals, with 0%-1% of households having 16-24 animals and 0.5%-2% of households having 11-15 animals. The majority of households had 1-5 animals (77%-82%) or 6-10 animals (15%-23%) per household (see Table 11 and Figure 13).

*Table 11: Animals per household by year*

| Animals per household per year: % (n) | | | |
|---|---|---|---|
| | 2017 | 2018 | 2019 |
| 1-5 | 82 (185) | 77 (130) | 76 (131) |
| 6-10 | 15 (33) | 20 (34) | 23 (40) |
| 11-15 | 2 (4) | 1 (2) | 0.5 (1) |
| 16-24 | 1 (3) | 1 (2) | 0 (0) |

Dogs and cats age groups

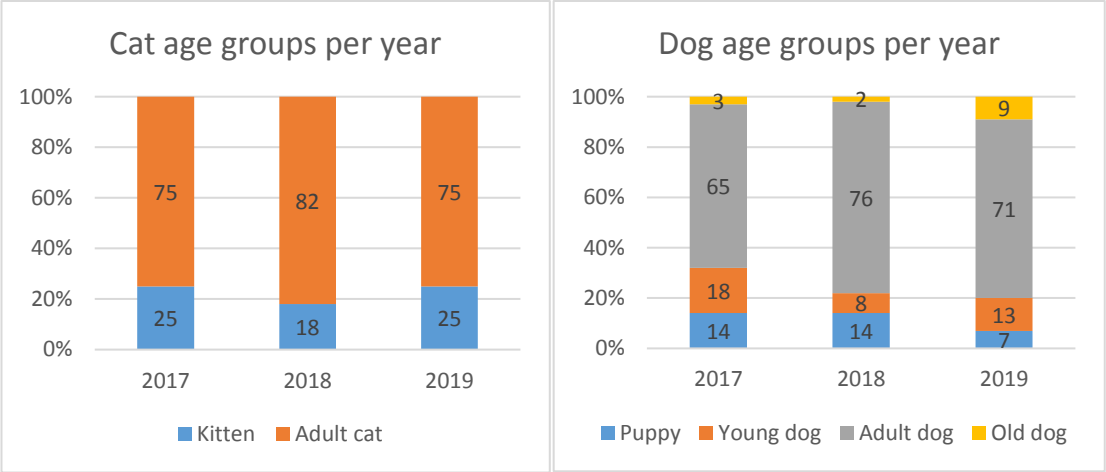



*Figure 14: Cat and dog age groups per year*

Across the years, the majority of the dogs and cats in Wadeye were adults, with 70.8% of the dogs and 73.7% of the cats in 2019 adults. The percentage of puppies was 14% in 2017 and 2018, compared to 6.8% in 2019. The percentage of kittens fluctuated from 24.1% in 2017, 18.3% in 2018 and 25.3% in 2019. The percentage of old dogs was 3.1% in 2017, 2.2% in 2018 and 9.4% in 2019 (see Table 12 and Figure 14).

*Table 12: Age group by year and species*

| Age groups per year by species: % (n) | | | |
|---|---|---|---|
| | 2017 | 2018 | 2019 |
| Age group dogs | | | |
| Puppy | 14.2 (82) | 14.1 (69) | 6.8 (35) |
| Young dog | 17.6 (102) | 7.5 (37) | 13.1 (67) |
| Adult dog | 65.1 (377) | 76.2 (374) | 70.8 (363) |
| Old dog | 3.1 (18) | 2.2 (11) | 9.4 (48) |
| Age group cats | | | |
| Kitten | 24.1 (28) | 18.3 (21) | 25.3 (25) |
| Adult cat | 75.0 (87) | 81.7 (94) | 73.7 (73) |

### *2.7.2 Veterinary visits*

From June 2018 to June 2019, three veterinary visits occurred in Wadeye. During all the veterinary visits, 259 animals received treatment, with 183 animals desexed (see Table 16). In June 2018, a total of 100 animals were seen by the visiting veterinary team, with 81 animals desexed (see Table 13). In October 2018, 42 animals were desexed (see Table 14) and in May 2019, 116 animals were seen, 60 of which were desexed (see Table 15). Over the program, eight animals were treated for canine transmissible venereal tumours.

*Table 13: June 2018 veterinary visit treatments*

| Treatment | Cat | Dog | *Total* |
|---|---|---|---|
| Chemical Contraceptive | 0 | 5 | *5* |
| Desexed: Spay and castrations | 27 | 54 | *81* |
| Euthanased | 5 | 0 | *5* |
| Other: Lump removal | 0 | 2 | *2* |
| Other: Canine transmissible venereal tumour removal | 0 | 6 | *6* |
| Other: Wound treatment | 0 | 1 | *1* |
| Total | 32 | 68 | 100 |

*Table 14: October 2018 veterinary visit treatments*

| Treatment | Cat | Dog | *Total* |
|---|---|---|---|
| Desexed: Spay | 4 | 26 | *30* |
| Desexed: Castrations | 3 | 9 | *12* |
| Other: Lump removal | 0 | 1 | *1* |
| Total | 7 | 36 | 43 |

*Table 15: May 2019 veterinary visit treatments*

| Treatment | Cat | Dog | Total |
|---|---|---|---|
| Desexed: Spay and castrations | 19 | 41 | 60 |
| Euthanased | 0 | 3 | 3 |
| Other: Ivermectin given | 0 | 29 | 29 |
| Other: Microchip | 0 | 1 | 1 |
| Other: Canine transmissible venereal tumour removal | 0 | 2 | 2 |
| Other: Vaccines* | 0 | 10 | 10 |
| Other: Lump removal | 0 | 2 | 2 |
| Other: Abdominal surgery | 1 | 0 | 1 |
| Other: Femoral head fracture | 0 | 1 | 1 |
| Other: Bloods taken | 0 | 1 | 1 |
| Other: Seen by vet | 1 | 5 | 6 |
| Total | *21* | *95* | *116* |

* Vaccines administered include nine new puppy vaccines, and one adult C5 vaccine.

*Table 16: Total veterinary visit treatments June 2018 – June 2019*

| Treatment | Cat | Dog | Total |
|---|---|---|---|
| Chemical Contraceptive | 0 | 5 | 5 |
| Surgical desexing | 53 | 130 | 183 |
| Canine transmissible venereal tumour removal | 0 | 8 | 8 |
| Euthanased | 5 | 3 | 8 |
| Other | 2 | 53 | 55 |
| Total | *60* | *199* | *259* |

### *2.7.3 Dog bites*

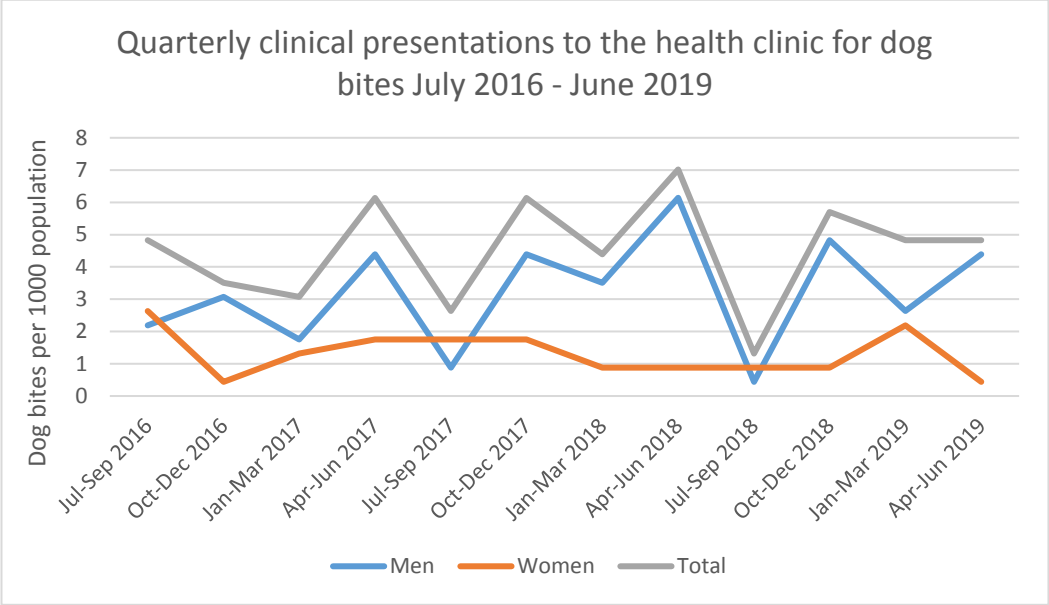



*Figure 15: Quarterly clinical presentations to the health clinic for dog bites by sex from July 2016 – June 2019*

The rate of clinical presentations to the health clinic for dog bites ranged from 1.3 to 7.0 per 1000 population between July 2016 and June 2019. The average rate pre-program implementation was 4.7 and the average rate during the program was 4.2 dog bites per 1000 population (see Table 17 and Figure 15). In general, the incidence of dog bites was higher among men presenting to the health clinic than women. Among men, the average rate pre-program implementation was 3.3 and during the program was 3.1 per 1000 population. For women, the rate per 1000 population was 1.4 pre-program implementation and 1.1 during the program.

*Table 17: Rate of clinical presentations for dog bites per 1000 population, quarterly 2016-2019, and average rate pre- and post-program implementation*

| Quarterly clinical presentations for dog bites per 1000 population | | | |
|---|---|---|---|
| | Men | Women | Total |
| Jul-Sep 2016 | 2.2 | 2.6 | 4.8 |
| Oct-Dec 2016 | 3.1 | 0.4 | 3.5 |
| Jan-Mar 2017 | 1.8 | 1.3 | 3.1 |
| Apr-Jun 2017 | 4.4 | 1.8 | 6.1 |
| Jul-Sep 2017 | 0.9 | 1.8 | 2.6 |
| Oct-Dec 2017 | 4.4 | 1.8 | 6.1 |
| Jan-Mar 2018 | 3.5 | 0.9 | 4.4 |
| Apr-Jun 2018 | 6.1 | 0.9 | 7.0 |
| Jul-Sep 2018 | 0.4 | 0.9 | 1.3 |
| Oct-Dec 2018 | 4.8 | 0.9 | 5.7 |
| Jan-Mar 2019 | 2.6 | 2.2 | 4.8 |
| Apr-Jun 2019 | 4.4 | 0.4 | 4.8 |
| Average rate pre-program implementation (Jul 2016-Jun 2018) | 3.3 | 1.4 | 4.7 |
| Average rate during program (Jul 2018-Jun 2019) | 3.1 | 1.1 | 4.2 |

From our regression analyses, we estimated the following:

**Dog bites pre-program implementation (July 2016 – June 2018):**

Trend in clinical presentations for dog bites per 1000 population = 9.33 + 0.19*Time

**Dog bites post-program implementation (July 2018 – June 2019):**

Trend in clinical presentations for dog bites per 1000 population = 11.2 + -0.2*Time

We found that the rate of dog bite presentations was increasing on average by 0.19 presentations per 1000 population each quarter before the program was implemented. During program implementation, we found that the rate of dog bites was decreasing on average by 0.20 presentations per 1000 population each quarter. The difference in the slope of the two trends was not significant.

## 2.8 Discussion

The results show that over the period of the program animal health outcomes significantly improved. There was a significantly higher prevalence of desexed dogs and cats, and a significant increase in the prevalence of good body condition and hair score for dogs in 2019 compared to 2018/2017. While not significant, the dog bite presentation data were consistent with a decrease in dog bites in the community over the period of program implementation, compared to pre-program implementation. During the program there was also a decrease in overall animal population size, an aging dog population, and fewer households with large numbers of animals.

### *2.8.1 Key findings*

Overall, the animal health outcomes of interest significantly improved. There was a two-fold increase in the prevalence of desexed dogs and cats in 2019 compared to 2018. Desexing animals can lead to a more manageable animal population. Reaching a stable population is supported by desexing to counteract the rate of reproductive success in breeding females (8). Dogs may be underweight and have hair loss due to high burdens of parasites and may also be underweight due to the effects of continual breeding, among other causes. There was a 77% increase in the prevalence of good body condition in dogs in 2019 compared to 2018. Additionally, there was a 9% increase in the prevalence of good hair score in 2019 compared to 2017.

On average, Wadeye had more animals per household compared to the Australian average (1.3 animals per household) (24). In 2019, there was an average of 3.7 animals per household in Wadeye, almost three times the national average. Additionally, Wadeye had a total of 27.8 animals per 100 people, with more dogs (23.3 dogs per 100 people) compared to the Australian average (20 dogs per 100 people). However, there was substantially fewer cats in Wadeye (4.4 cats per 100 people) compared to the Australia average (16.0 cats per 100 people) (24). The data also showed an aging dog population and less households with large numbers of animals after implementation of the program. An aging population can lead to a more stable and manageable population and less animals per household may reduce risk of communicable diseases transmitting to other animals and people (8).

The three veterinary visits that took place over the program surgically desexed 183 cats and dogs. Eight animals also received treatment for canine transmissible venereal tumours, which is a sexually transmissible tumour that is most commonly found in dog populations with a high

level of breeding. As the tumour can become a welfare issue, desexing animals is important, as this can control transmission of the tumour by ceasing breeding (21).

In general, the rates of dog bites were higher among men than women. The average quarterly rate pre-program was 4.7 dog bite presentations per 1000 population, and the average quarterly rate during the program was 4.2 dog bites per 1000 population. While not significant, the trends in dog bite presentations are consistent with a protective effect of the program against dog bites in the community.

Due to the non-randomised nature of the evaluation, these improvements cannot be solely be attributed to the program. However, the observed improvements were consistent with the hypothesised outcomes of the program, and the improvements occurred following program implementation. We therefore expect that at least some of the observed improvements can be attributed to the program itself. With the observed improvements to both animal and human health, these results show the impact that a One Health approach to animal health and management can have in a remote community setting.

Across the study period, data collection methods improved with less missing data (including fewer 'don't know' answers) in 2019 compared to 2017 and 2018. This is indicative of the importance of regularly working with and providing training for the Rangers in data collection. The continued engagement with the community about animal health from the Rangers outside of the veterinary visits assists in improving awareness of common animal health conditions and the animal program. The leadership of the Rangers and their continued work in driving this program allows them to build on their skills and knowledge of animal health care leading to a higher likelihood of program sustainability.

This program and evaluation design can be adapted and used in other communities with similar animal health care barriers. Future studies could consider a qualitative component to assess community opinions on the program, as well as perspectives of those involved in implementing the program. It would be valuable to include human health outcomes in the census so that human health outcomes can be directly examined in relation to animal health status (i.e. collecting animal and human health data from the same household). Future studies could also investigate the reasons behind observed differences between men and women presenting to the health clinic for a dog bite. In our study, we were limited by the small number of dog bite data points pre- and post-program implementation; collecting data on this outcome at additional time points would increase the power in conducting the interrupted time series analysis. Future One Health studies could also consider including wild or feral

animals (not just those that are part of the household) or could explore the impacts of domestic dogs and cats on the environment.

We hope this study will contribute to building evidence around the importance of community driven programs addressing animal health and management in remote communities. It is hoped that this program and framework may be used in other communities, with the potential addition of a human health questionnaire to understand the links between animal health and human health at the household level in this setting. It is also hoped that this research may improve the understanding of the importance of this topic and gather further support to run more programs in communities that face similar animal health care barriers. The community driven component of this program is vital to the sustainability of the program and through training the Rangers and increasing skills and knowledge around animal health and management, this program has a greater chance of continuing to improve animal health.

### *2.8.2 Strengths and limitations*

To our knowledge, this is one of the first studies to evaluate a community driven animal health and management program in a remote Aboriginal community in Australia. This study examines three years of animal health outcomes and four years of a human health outcome within a remote Aboriginal community.

The strengths of this study include the inclusion of an annual census of the animal population before the program was developed, at the start of the program and 12 months later. The collection of these data at multiple time points was integral to allowing a quantitative evaluation of the program. This allowed the evaluation to include an epidemiological study to assess health outcomes in the animal population over time. This program was co-developed with the local Ranger group in Wadeye and AMRRIC, and addresses community priorities around animal health and welfare. This program is based on building and maintaining relationships and trust with the community including the Rangers and pet owners. The community driven arrangement of the program allows the Rangers to build on their skills and knowledge about animal health and management leading to a higher likelihood of sustainability of the program. The positive outcomes of this program have the potential to inspire other communities that face animal health care barriers to adapt similar community driven programs and evaluations.

The limitations of this study include the lack of completeness of the census data, as there is a substantial amount of missing data (including responses of ‘don’t know’) over the three years.

The prevalence of missing data was lower in 2019 than previous years for most outcomes. This improvement in data quality may be attributable to the training sessions led by AMRRIC and reinforcement of how to use the data collection tool before carrying out the census. Also, the inability to link animal health and human health from the same household limits the relationships we can draw between improvements in animal and human health outcomes. Additionally, regression analysis was used to calculate prevalence ratios to assess the health outcomes over the period of the program. A limitation of this is that the significant changes seen in the population cannot be solely attributed to the program as we cannot demonstrate causality.

The analysis of dog bites had limitations in that the data that were supplied were already aggregated and one time period could not be separated into pre- and post- program implementation. There were also not enough time points to run an interrupted time series analysis on the data. The absence of a qualitative component to this study limits the ability to assess the communities' views and owner's engagement with the animal health program to assess whether it is truly addressing community needs.

While this study does have some limitations, we hope the positive outcomes may lead to increased uptake and support of community driven animal health and management programs in remote communities.

## 2.9 Recommendations

When addressing animal health and management, the ICAM coalition recommends that programs:

- Be humane and ethical;
- Be adapted to local population dynamics;
- Be sustained;
- Use an evidence-based design;
- Incorporate monitoring and evaluation;
- Understand and focus on root causes; and
- Recognise the role of human behaviour (8).

The Wadeye animal health program has addressed most of these principles, however, the role of human behaviour, such as owner engagement in the program, could be further incorporated. Additionally, other particularly important criteria in this setting include ongoing

engagement, incorporating community priorities into program design, and considering how these programs can be community-driven and sustainable.

Reinforcing the Ranger's knowledge and community awareness of common animal diseases, use of preventative medicines (such as parasite treatments) and how the animal program is improving their animal's health may help with continuation of the program. Feedback of the key findings and outcomes to the community and research partners may assist with showing the improvements to animal and human health and help communicate the importance of this program.

Although some of the missing data in this study were due to technical errors, at other times they were due to lack of capture. To address data completeness, it may be suitable to adjust the AMRRIC data collection app to not allow questions to be left blank or skipped. The training with the Rangers in 2019 did seem to address this by explaining the importance of answering every question and showing an example of the results, and there was an improvement in the data quality of most of the outcomes in 2019. Regular training to reinforce this and go over the app would be helpful, particularly given the time between app uses. Additionally, a video of one of the Rangers talking about and showing how to use the app in language (Murrinh Patha) would be helpful in communicating this.

Changing some of the questions in the survey to increase accuracy of the data could be considered. For example, currently the app allows data collectors to fill in a 'gave ivermectin' button as one of multiple options, however, most of the time this was not used. A treatment question could replace this, that includes a binary multiple choice question with 'treatment' or 'no treatment' options, so we can see which animals were given treatment and which were not, and then analyse that against the health outcomes. For those that were given treatment, the app could then have a further option of selecting which treatment was given. The ability to map animal health using QGIS or other spatial analysis software could help with targeting the areas with the most need for animal health intervention. This would assist the visiting veterinary team and allow the Rangers to further engage with the pet owners and provide preventative medicines to the animals in this area.

To see programs such as this be sustainable and continue in communities, ongoing access to resources will be needed. Building monitoring and evaluation capacity into program designs can help acquire evidence of the impact of the program which can lead to increased support and funding. Similarly using evidence to impact on the policy environment, particularly in the human health and environmental health space, may lead to government level support for One Health programs. Each state and territory is responsible for its own animal welfare legislation

(25). The NT currently does not have companion animal legislation like other jurisdictions do. This means that there is no territory-wide legislation regarding companion animal management which limits the ability of the local government to address concerns in companion animal populations. Therefore, the local government has no obligation to address animal health concerns and access to funding and resources to do so is limited.

Including human health questions into the census could allow us to collect information on animal and human health from the same household. In 2017 a critical review was undertaken focusing on the transmission of canine zoonoses to people in Aboriginal communities. This review found that there is a need for large-scale, high-quality, comparative studies of dogs and humans from the same household to assess how dogs are contributing to human disease (26). The review also found that there is a lack of research in this area, and a better understanding of the epidemiology of zoonotic diseases is needed to be able to adequately deliver health care (26).

It would be valuable to work with community members to develop human health questions to ensure it captures the community's health priorities and engages them in the process. Additionally, working with community members to translate the survey into language would help with collection as majority of people who live in Wadeye speak Murrinh Patha. Similar to the animal census, delivery of the human health surveys by the Rangers or trained community researchers from Wadeye could help with involvement of the community.

An example human health survey was created during this study as a potential addition to the animal health census (see Table 18). The survey looks to gather information on the most likely health conditions seen in humans that could relate to animals, including gastrointestinal disease (such as worms and gastrointestinal pathogens), skin disease (such as mites, fleas, ticks), and injury (such as bites and scratches). It also asks about overcrowding of households and animal factors that can increase the risk of the animals acquiring potentially zoonotic communicable diseases, such as water source, food source and roaming. The survey would have the potential to draw links between animal and human health at a household level, with the premise of improving animal and human health at the same time. Due to timing constraints and restrictions with adapting the app, there was not enough time to properly engage and get feedback from the community about the survey. It was also not possible to add the questions to the existing app so if it were delivered it would have been through a separate collection tool. Therefore, we did not undertake this survey as part of this study.

*Table 18: Potential household questionnaire*

| **Survey questions** | **Reason** |
|---|---|
| *1. Questions about your home* | |
| How many bedrooms does your house have?_____<br><br>How many people live with you?____ | To assess overcrowding |
| Do you think the house is crowded?<br>☐ yes<br>☐ no<br>☐ don't know | To gauge home owners view of crowding |
| *2. Questions about common health conditions* | |
| Has anyone in the house had skin sores in the last 12 months? (*this includes itchy/infected lumps on the skin)*<br>  <br>☐ yes<br>- If yes, how many people in your home have had this?_____<br>☐ no<br>☐ don't know | To look at burden of disease that could be linked to animal ectoparasites |
| Has anyone in the house had diarrhoea in the last 12 months? *(This includes…)*<br>☐ yes<br>- If yes, how many people in your home have had this?_____<br>☐ no<br>☐ don't know | To look at burden of disease that could be linked to animal GIT pathogens and worms |
| Has anyone in the house been bitten by a dog in the last 12 months?<br>☐ yes<br>- If yes, how many people in your home that were bitten needed to see a doctor?_____<br>☐ no | To look at burden of injury caused by dogs that required health care |

| | |
|---|---|
| ☐ don't know | |
| Has anyone in the house been bitten or scratched by a cat in the last 12 months?<br>☐ yes<br>- If yes, how many people in your home that were bitten or scratched needed to see a doctor?_____<br>☐ no<br>☐ don't know | To look at burden of injury caused by cats that required health care |
| *1. Questions about animal medicine* | |
| Did you buy medicine for your animal in the last 12 months?<br>☐ yes<br>- If yes, what was the medicine for?__<br>☐ no<br>☐ no, but I wanted to<br>- What stopped you?_____<br>☐ don't know | To look at how many people access animal medicine, what its used for, and the limitations of gaining access to animal medicines |
| *2. Questions about your animals* | |
| Are your dogs used for hunting?<br>☐ yes<br>- If yes, what animals do you hunt?__<br>☐ no<br>☐ don't know | To see if there is an increase in disease burden for those animals that have increased access to wild meat and carcasses/offal |
| How often are your animals washed?<br>☐ more than once a month<br>☐ once a month<br>☐ a few times a year<br>☐ once a year<br>☐ never<br>☐ don't know | To see if there is an increase in disease burden for those animals that are not washed often/at all |
| Usually my animals drink…<br>☐ water in a bowl<br>☐ tap water on the ground<br>☐ they find water on the ground | To see if there is an increase in disease burden for those animals that source their own water, drink stagnant ground water etc. |

| | |
|---|---|
| ☐ don't know<br>☐ other_____ | |
| Usually my animals eat…<br>☐ dog/cat food<br>☐ the same food we eat<br>☐ they find their own food<br>☐ don't know<br>☐ other_____ | To see if there is an increase in disease burden for those animals that source their own food, by hunting/scavenging etc. |
| My animals are…<br>☐ only allowed in the house and yard<br>☐ can go outside the house and yard sometimes<br>☐ can go wherever they like at all times<br>☐ don't know | To see if there is an increase in disease burden for those dogs that are free to roam compared to those that are contained |
| *3. Questions about your contact with animals* | |
| Do you have any contact with animals outside the household?<br>☐ yes<br>- If yes, what animals?___<br>☐ no<br>☐ don't know | To see if there is an increase in disease burden for those who contact animals outside the household compared to those that don't. |

Incorporating a qualitative component would assist with demonstrating the impact of the Rangers work and communicating the importance of the animal program. An example is photovoice which would involve the Rangers photographing their day to day work with animals and pet owners around Wadeye over time and then bringing these together to tell the story of their work. This could also help with showing the visual change to the animal population and communicating the impact their work is having by using the photos to show the improvements in animal health. Another qualitative component that could be considered is focus groups or interviews with community members and those that work on the program to assess if it is addressing community needs. An interview guide was created during this study for the purpose of interviewing the Rangers, however, due to limited opportunities to coordinate time for this and competing priorities, this was not undertaken. The questions developed for the interviews can be seen below (see Table 19).

*Table 19: Potential interview questions*

| *Animal health questions* |
|---|
| - What do you think about animals in Wadeye (cats/dogs/others)?<br>- Do you have any concerns about animal health in Wadeye?<br>- Have people in the community expressed concerns about animal health in Wadeye?<br><u>Desexing</u><br>- What do you think about the number of animals in Wadeye?<br>- Do you think there are too many puppies and kittens?<br>- Do you think the program helps with this? If so, how?<br><u>Hair score</u><br>- Do you see animals that look like this (picture of a dog with hair loss)?<br>  <br>- Do you think the program helps with this? If so, how?<br><u>Body condition score</u><br>- Do you see animals that look like this (picture of a skinny dog)?<br>  <br>- Do you think the program helps with this? If so, how? |
| *Dog bite questions* |
| - Are dog bites a problem in Wadeye?<br>- Do you think the program helps with this? How? |
| *Community views* |
| - Do you think people in Wadeye are worried about animals (distressed/scared/worried)?<br>- Do you think the program helps with this? If so, how? |
| *Ranger's experience* |
| - How have you been involved with the program?<br>- What are your thoughts on the program?<br>- Would you change anything about the program?<br>- Would you like to see the program continue? |

## 2.10 Conclusion

This study shows the impact a One Health approach to animal health and management in a remote community can have. All animal health outcomes significantly improved after program implementation, including desexing status of cats and dogs, body condition score of dogs and hair score of dogs. There was a decrease in the overall animal population, an aging dog population, and fewer households with large numbers of animals. Over the period of the program three veterinary visits were carried out. There was also a decreasing trend in dog bites in the community; however, this was not significant.

One Health approaches to animal health care can be appropriate in this setting as they consider the relationships between animals, humans and the environment, with improvement in animal health having the potential to improve human health and overall community wellbeing. Many programs such as this may not be supported long term and rely on obtaining support and external funding to continue. The increased skills and knowledge about animal health care within the community assists with sustainability of the program. Future programs could consider incorporating an evaluation component to be able to produce and publish evidence of the impact and assist in gaining continuing support.

The positive outcomes of this study may inspire other communities with similar animal health care barriers to implement a similar program that is community driven and addresses community needs regarding animal health and welfare. If more programs are rolled out in communities, animals will continue to become healthier and happier with their owners and other community members also seeing the benefits.

## References


1. Johnson-Walker YJ, Kaneene JB. Epidemiology: science as a tool to inform One Health policy. Beyond One Health: From Recognition to Results first edition John Wiley & Sons, Inc. 2018:3-30.
2. One Health Commission. What is One Health? Apex NC: One Health Commission; 2018 [Available from: https://www.onehealthcommission.org/en/why_one_health/what_is_one_health/].
3. Animal Management in Rural and Remote Indigenous Communities. About AMRRIC Darwin, NT2019 [Available from: https://www.amrric.org/about-us].
4. Australian Institute of Health and Welfare. Australia's welfare 2017: in brief. Canberra: Australian Institute of Health and Welfare; 2017.
5. Animal Management in Rural and Remote Indigenous Communities. Understanding the Issues Darwin NT: Animal Management in Rural and Remote Indigenous Communities; 2018 [Available from: https://www.amrric.org/our-work/understanding-issues].
6. Rabinowitz P, Conti L. Human-animal medicine: Clinical approaches to zoonoses, toxicants and other shared health risks. US: Saunders Elsevier; 2010. 412 p.
7. Thurber KA, Banks E, Banwell C. Cohort Profile: Footprints in Time, the Australian Longitudinal Study of Indigenous Children. International Journal of Epidemiology. 2014;44(3):789-800.
8. International Companion Animal Management Coalition. Humane dog population management guidance. International Companion Animal Management Coalition; 2019. p. 104.
9. World Health Organization. Neglected Zoonotic Diseases Geneva CH: World Health Organization; 2018 [Available from: http://www.who.int/neglected_diseases/diseases/zoonoses/en/].
10. Rusdi B, Laird T, Abraham R, Ash A, Robertson ID, Mukerji S, et al. Carriage of critically important antimicrobial resistant bacteria and zoonotic parasites amongst camp dogs in remote Western Australian indigenous communities. Scientific reports. 2018;8(1):8725.
11. Toribio J-A, Dixon RJ, Constable SE, Dixon RM. Approaches to dog health education programs in Australian rural and remote Indigenous communities: four case studies. Health Promotion International. 2012;28(3):322-32.
12. Australian Government Department of Agriculture and Water Resources. Northern Australia Quarantine Strategy Canberra ACT: Australian Government Department of Agriculture and Water Resources; 2017 [Available from: http://www.agriculture.gov.au/biosecurity/australia/naqs].
13. Senior K, Chenhall R, McRae-Williams E, Daniels D, Rogers K. Dogs and people in Aboriginal communities: Exploring the relationship within the context of the social determinants of health. Journal of Environmental Health. 2006;6(4):1-39.
14. Constable S, Dixon R, Dixon R. For the love of dog: the human–dog bond in rural and remote Australian indigenous communities. Anthrozoös. 2010;23(4):337-49.
15. Dhillon JM. Dog Population Management and Dog Bite Prevention in Rural and Remote Northern Saskatchewan Aboriginal Communities. Saskatoon: University of Saskatchewan; 2017.
16. World Organization for Animal Health (OIE). One Health Paris: OIE; 2019 [Available from: http://www.oie.int/en/for-the-media/onehealth/].
17. Hiby E, Atema KN, Brimley R, Hammond-Seaman A, Jones M, Rowan A, et al. Scoping review of indicators and methods of measurement used to evaluate the impact of dog population management interventions. BMC veterinary research. 2017;13(1):143.
18. University of Sydney. A Social History of Wangga Sydney, NSW: University of Sydney; 2014 [Available from: http://wangga.library.usyd.edu.au/wangga/social-history].
19. Australian Bureau of Statistics. 2016 Census QuickStats: Wadeye, Canberra ACT: Australian Bureau of Statistics; 2016 [Available from:

http://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC70275].
20. Bamberger M. Introduction to mixed methods in impact evaluation. Impact Evaluation Notes: InterAction; 2012. p. 1-38.
21. International Companion Animal Management Coalition. Are we making a difference? A guide to monitoring and evaluating dog population management interventions 2015. International Companion Animal Management Coalition; 2015. p. 132.
22. Centers for Disease Control and Prevention. Framework for program evaluation in public health. Atlanta, Georgia: Centers for Disease Control and Prevention; 1999. p. 1-58.
23. Centers for Disease Control and Prevention. Practical strategies for culturally competent evaluation. Atlanta, Georgia: Centers for Disease Control and Prevention; 2014. p. 1-35.
24. Animal Medicines Australia. Pet ownership in Australia 2016. Canberra: Newgate Research; 2016.
25. Australian Government Department of Agriculture. Australian animal welfare guidelines for dogs and cats: Australian Government Department of Agriculture; 2017 [updated 12 December 2017. Available from: http://www.agriculture.gov.au/animal/welfare/standards-guidelines/dog-cat].
26. Smout F, Schrieber L, Speare R, Skerratt L. More bark than bite: Comparative studies are needed to determine the importance of canine zoonoses in Aboriginal communities. A critical review of published research. Zoonoses and public health. 2017;64(7):495-504.

## Appendix A

Summary report of key findings.

# Wadeye Companion Animal Population Summary

## *June 2018 – June 2019*

This report was created using data collected on the AMRRIC app in June 2017, 2018 and 2019 in Wadeye, NT. Results represent preliminary analysis of raw data and are not tested for significance.

### *Total companion animals*

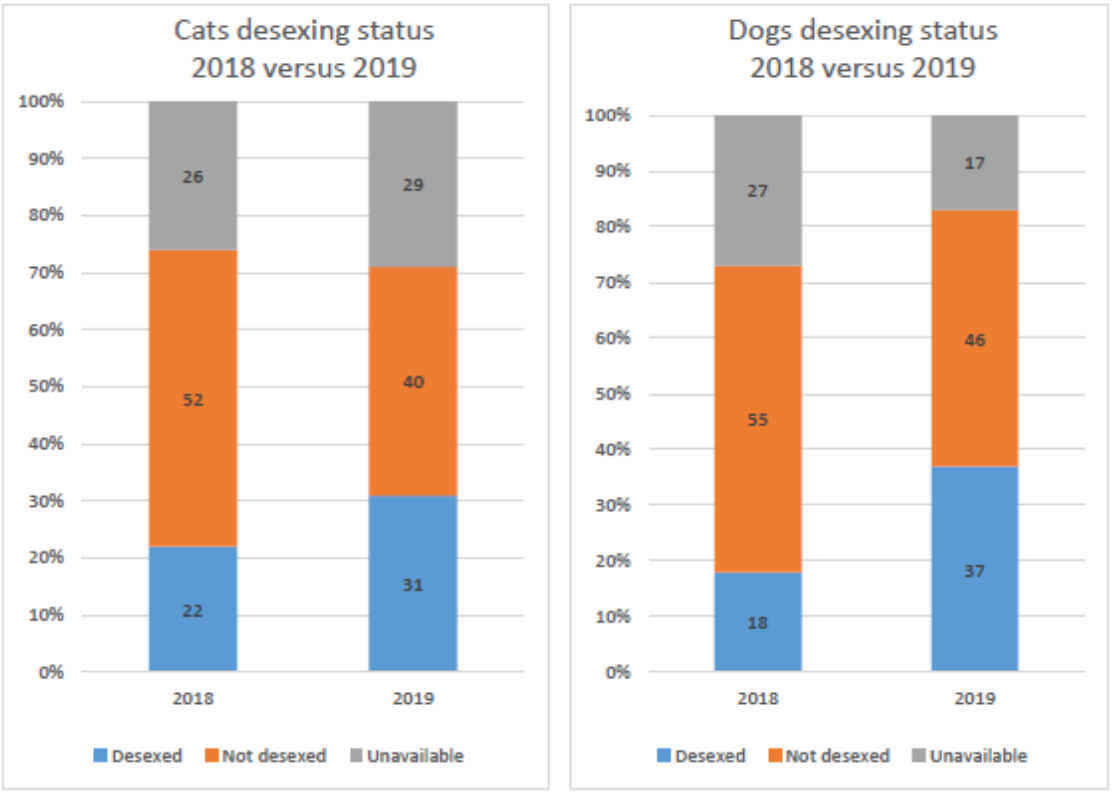
| Species | 2018 | 2019 |
|---|---|---|
| Cat | 123 | 101 |
| Dog | 530 | 532 |
| **Total** | **653** | **633** |

### *Total veterinary treatments delivered*

| Treatment | Cat | Dog | Total |
|---|---|---|---|
| Chemical Contraceptive | 0 | 5 | 5 |
| Surgical desexing | 53 | 130 | 183 |
| Euthanased | 5 | 3 | 8 |
| Other | 2 | 61 | 63 |
| **Total** | **60** | **199** | **259** |

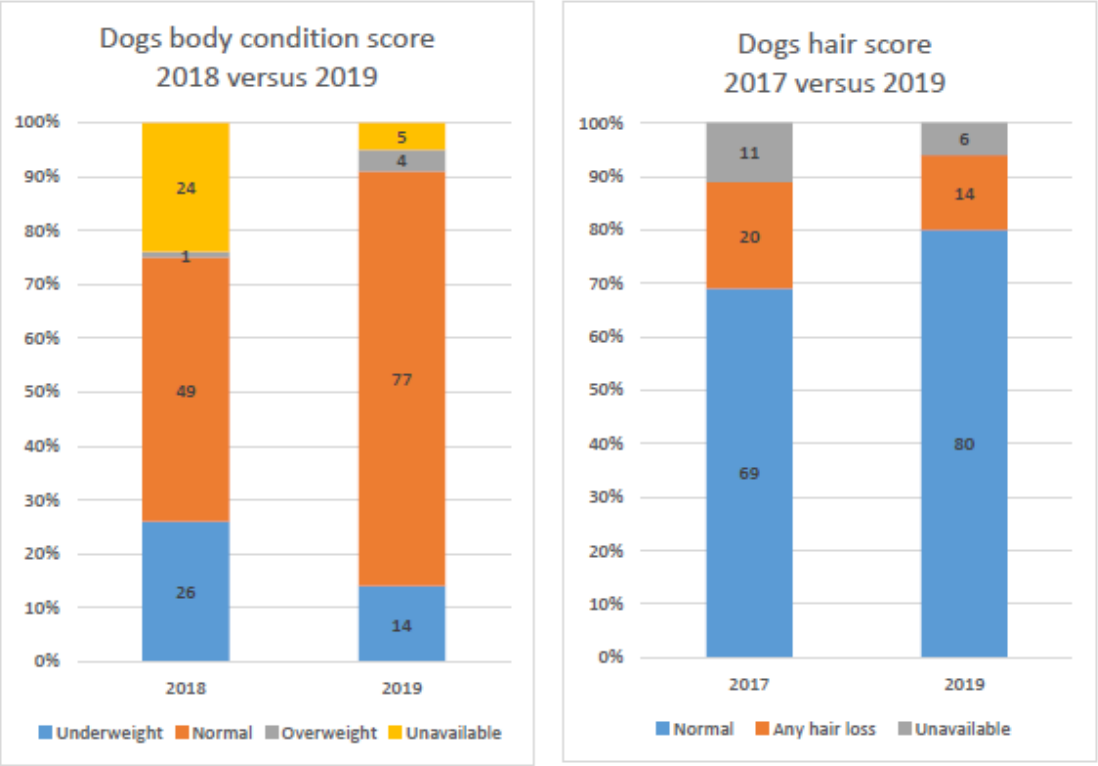
From June 2018 to June 2019 3 veterinary visits occurred in Wadeye. During these veterinary visits, 259 animals received treatment, with 183 of these animals surgically desexed.

*Dogs and cats – desexing status*




Desexing animals can lead to a more stable and manageable animal population. Through the animal health and management program, a veterinary service is visiting Wadeye regularly to provide animal treatments, including desexing. From June 2018 to June 2019 the percentage of dogs desexed changed from 18% to 37%. The percentage of cats desexed changed from 22% to 31%, however, data on desexing was unavailable for more than a quarter of cats in 2019, so these findings should be treated with caution.

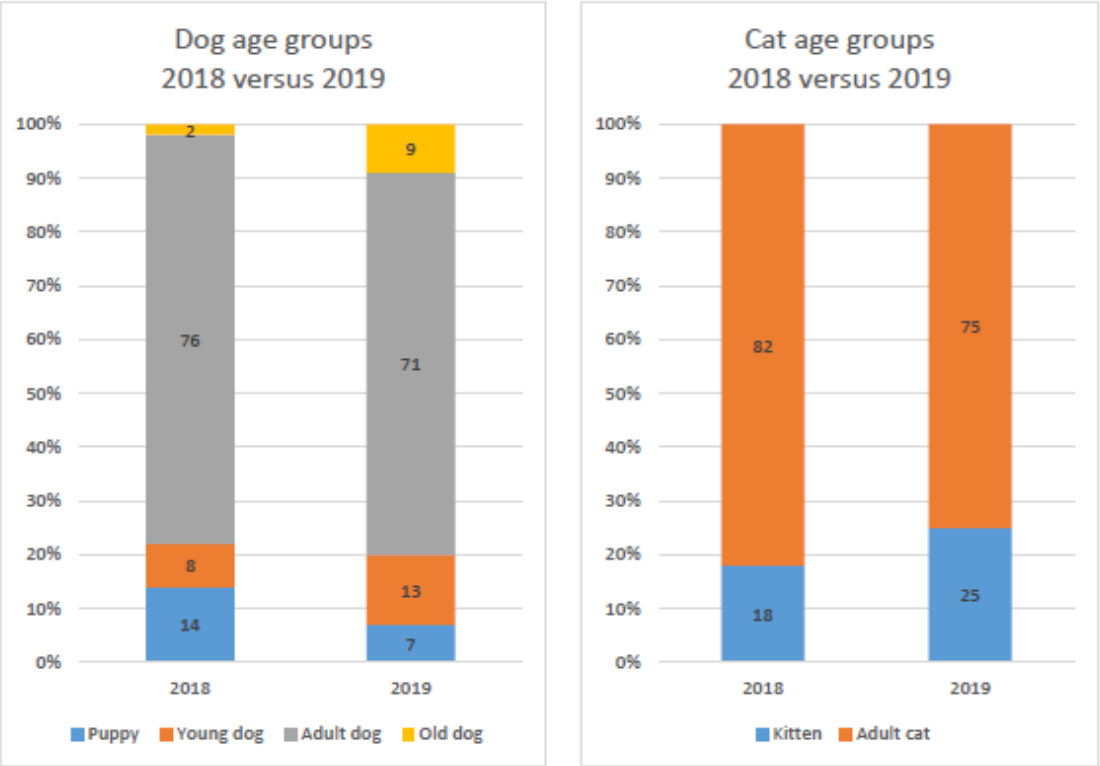
*Dogs – body condition score and hair score*




Dogs may be underweight and have hair loss due to internal and external parasites, among other causes. Through the animal health and management program, the TDC Rangers are administering parasite treatment to the dog population bimonthly. From June 2018 to June 2019 the percentage of dogs with normal body weight changed from 49% to 77%. The percentage of underweight dogs also changed from 26% to 14%.

Hair score data from June 2018 could not be used due to a large amount of missing data; therefore, June 2017 hair score data was used. From June 2017 to June 2019 the percentage of dogs with normal hair score changed from 69% to 80%. The percentage of dogs with hair loss also changed from 20% to 14%.

*Dogs and cats – age groups*




An aging population can lead to a more stable and manageable animal population. From June 2018 to June 2019 in the dog population, the percentage of puppies changed from 14% to 7%, young dogs changed from 8% to 13%, adult dogs changed from 76% to 71%, and old dogs changed from 2% to 9%. In the cat population, the percentage of kittens changed from 18% to 25% and adult cats changed from 82% to 75%.

## Appendix B

One Health Aotearoa International Symposium abstract and presentation – December 2018.

Abstract:

**One Health Approach to Animal Health and Management in a Remote Aboriginal Community**

*Type: Oral presentation*

*Theme: One Health science and policy*

Animal health and management in remote Aboriginal communities in Australia is of public health importance. This is due to a range of factors such as large populations of companion animals in proximity to humans which can lead to increased spread of disease, reduced capacity to prevent disease, and increased risk of physical injury to both animals and humans. Companion animals play an important role in Aboriginal communities and can be of cultural significance. It can be complex to implement effective and sustainable animal health and management programs in these settings, due to remoteness, and limited access to supplies and veterinary care. A 'One Health' and community driven approach to this issue could improve animal health and management practices, as well as make a positive impact on human health, in remote Aboriginal communities.

This is an evaluation of an animal health and management program in a remote Aboriginal community setting using a 'One Health' approach. The evaluation will look at animal and human health outcomes to assess the impact of the program on the community. The animal health and management data are collected through a companion animal census concentrating on the demographics of the animals and common health conditions. The human health outcome will be assessed by analysing community dog bite data over the period of the program. The evaluation will also provide recommendations for the program to assist with longevity and effectiveness into the future.

Presentation

Australian National University

# One Health approach to animal health and management in a remote Aboriginal community

*Tamara Riley, Katie Thurber, Bonny Cumming, Ray Lovett*

tamara.riley@anu.edu.au
Masters of Applied Epidemiology (MAE) Scholar
Aboriginal and Torres Strait Islander Health program
National Centre for Epidemiology and Population Health

Australian National University

## Outline

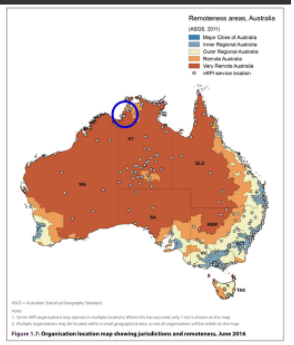
1. Study setting
2. The program
3. Evaluation methods
4. Preliminary findings
5. Next steps



Australian National University

## Context

- Remote Australia
- Approx. 3% population is Aboriginal and Torres Strait Islander
- 1 in 5 Aboriginal and Torres Strait Islander people live in remote and very remote areas
- Remote areas generally experience poorer health and access to health care






Australian National University

## Context

- One of Australia's largest remote Aboriginal communities
- Only accessible by road through dry season
- Population approx. 2300
- Dog/cat population approx. 720
- 75% houses have dogs/cats
- Limited access to animal health care


http://azoulay.arts.usyd.edu.au/mpsong2/location.html



Australian National University

## Public health concerns

- Uncontrolled breeding → large populations
- Risk of injury
- Preventable disease
- Zoonotic disease
- Introduction of exotic disease → North Australia
- Distress to community

https://www.amrric.org/



Australian National University

## Culture

- Importance of animals
  - Hunting
  - Protection
  - Companionship
  - Warmth
  - Dog dreaming
  - Family



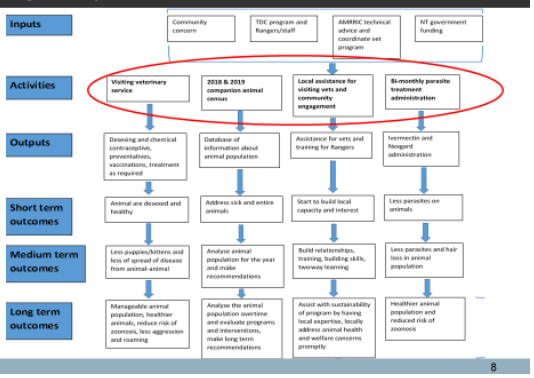
Australian National University

## Program Development

- Community concern
- TDC Rangers
- AMRRIC
  - 'One Health' approach to animal health, through:
    - Animal management
    - Preventative medicine
    - Education programs
- 2017 companion animal census



Australian National University



## 1. Visiting veterinary service

Regular vet visits to Wadeye and surrounding townships – between June 2018 and June 2019

9

## 2. Local assistance for visiting vets

Including on-the-job training for the TDC Rangers and community engagement

## 3. Bimonthly parasite treatment

To the dog population

10

## 4. Annual companion animal census

*2017*
*2018*
*2019*


11

## Intended benefits for community

- Improved community safety
- Less distress caused by animal health and welfare concerns
- Improved health and wellbeing for both animals and humans!

12

## Evaluation questions

- Does implementation of the program improve animal health?
  - Improving body condition of dogs
  - Improving hair score of dogs
  - Increasing desexing rates of dogs and cats
- Does the incidence of dog bites decrease?

13

## Study design

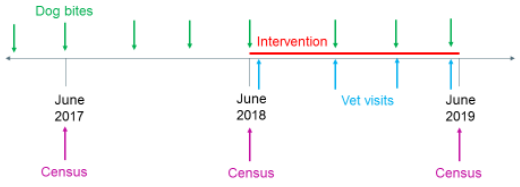
- Epidemiological study
- Evaluation
- Partners
  - AMRRIC
  - TDC

amrric
Animal Management in Rural and Remote Indigenous Communities

Thamarrurr Development Corporation

14

## Data sources




15

## Evaluation Framework


*CDC's Framework for Program Evaluation in Public Health*

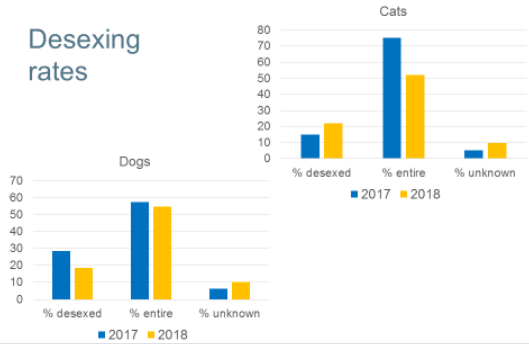
16

## Descriptive analysis of 2017 and 2018 census

- Approx. 75% houses own animals
  - Approx. 20% of houses own 5 or more
  - Approx. 5% of houses own 10 or more
  - Average 4 animals/house
  - Range 1-24 (2017) & 1-17 (2018)
  - Approx. 600 dogs and 120 cats (2018)

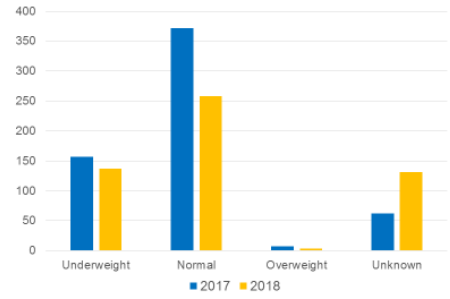
17

## Desexing rates



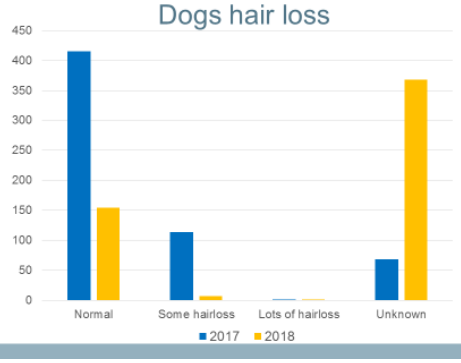

18

## Dogs body condition



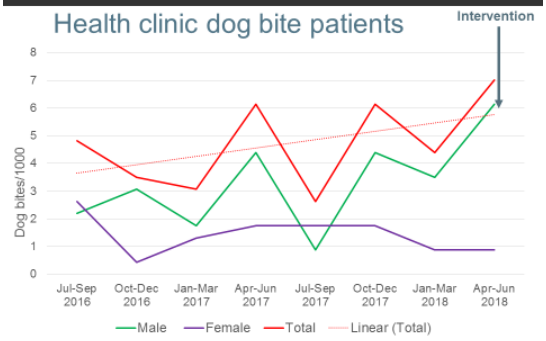

19

## Dogs hair loss




20

## Health clinic dog bite patients




21

## Next steps

- Focus group
- 2019 census
- Training for data collectors
- Look to inspire other communities to take on similar programs

22

## Thankyou!

- Wadeye community
- Research team
  - Katie Thurber, ANU
  - Ray Lovett, ANU
  - Bonny Cumming, AMRRIC
  - TDC Rangers

tamara.riley@anu.edu.au

23

## Appendix C

RSPH NAIDOC Symposium presentation – July 2019

Australian National University

**A One Health approach to animal health and management in the NT**

**Dr Tamara Riley**
MAE Scholar
Aboriginal and Torres Strait Islander Health Program
NCEPH, RSPH

Australian National University

### Outline

1. Background
2. About the animal health and management program
3. Evaluation project
4. Preliminary results
5. Next steps

2

Australian National University

*Background*

3

Australian National University

### Wadeye (Port Keats)

- One of the largest Aboriginal communities in the NT
- Population approx. 2300
- Most common language is Murrinh-patha
- Approx. 650 dogs and cats
- Limited access to animal health care and medicines
- Only accessible by road through dry season


http://azoulay.arts.usyd.edu.au/mpsong2/location.html

4


Australian National University

*'the health of people is connected to the health of animals and the broader environment.'*

**The One Health Triad**


*'at least 60% of all human pathogens are zoonotic and 75% of all emerging pathogens affecting humans in the last 10 years have originated from animals' - WHO*

8

Australian National University

*The Program*

9

Australian National University

### Wadeye animal program

Development:
- Community concern about animal health
- Rangers and WDRC collaborate AMRRIC
- 2017 companion animal census
- Community driven 12 month pilot program

Stakeholders:
- Wadeye community
- TDC Rangers
- WDRC
- AMRRIC
- Veterinary providers
- NT Environmental Health

Funding:
- WDRC
- NT Environmental Health
- In-kind contributions from TDC and AMRRIC

10

Australian National University

## 1. Visiting veterinary service


11

Australian National University

## 2. On-the-job training and community engagement




12

Australian National University

## 3. Bimonthly parasite treatment


13

Australian National University

## 4. Annual companion animal census


14

Australian National University

## Impact of the program for Wadeye

- Improved access to animal health care and animal medicines
- Less distress for community members
- Improved animal-human bond
- Improved animal health and community wellbeing

15

Australian National University

*The evaluation*

16

Australian National University

## Research project

- Evaluating the animal health and management program in Wadeye
- Study of dog and cat population
- Study partners: AMRRIC,TDC Rangers, West Daly Regional Council, ANU

Thamarrurr Development Corporation

amrric
Animal Management in Rural and Remote Indigenous Communities

17

Australian National University

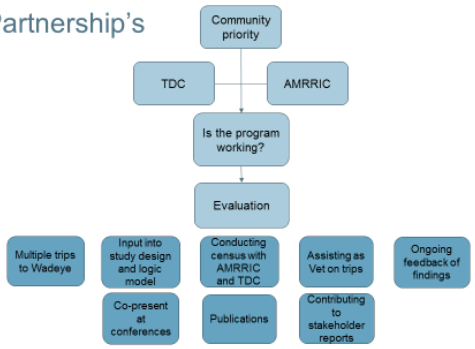
***Impact evaluation*** *… evaluation that investigates … the impacts produced by (can be attributed to) a program (Interaction 2012)*

**Why evaluate?**

- Value of the program
- Effectiveness
- Monitor progress
- Opportunities for improvement
- Sustainability

18

## Partnership's




19

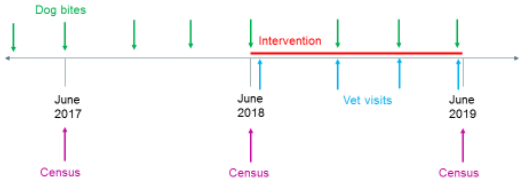
## Research questions

- Does program implementation improve animal health?
  - Body condition score of dogs
  - Hair score of dogs
  - Desexing rates of dogs and cats
- Does program implementation improve human health?
  - Does the incidence of dog bites change?

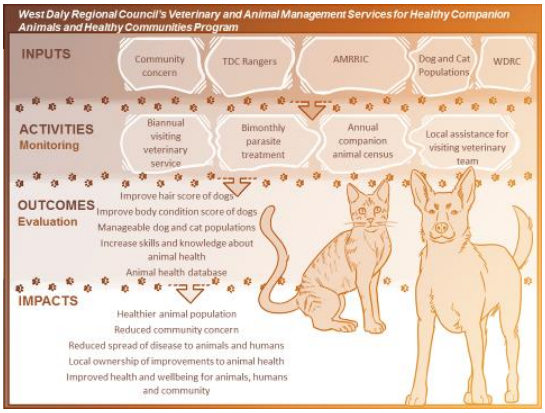

*Centre for Disease Control and Prevention (CDC) Framework for Program Evaluation in Public Health*

20

## Data sources




21




## *Preliminary results*

23

## Companion animal census results

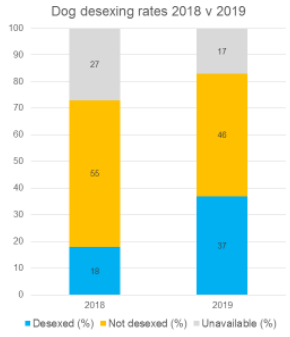
- Human population approx. 2300
- Dog/cat population
  - 2017: 598 dogs and 134 cats (732)
  - 2018: 530 dogs and 120 cats (653)
  - 2019: 532 dogs and 101 cats (633)
- 75% houses have dogs/cats
  - Average 4 animals/household

24

## Animals/household

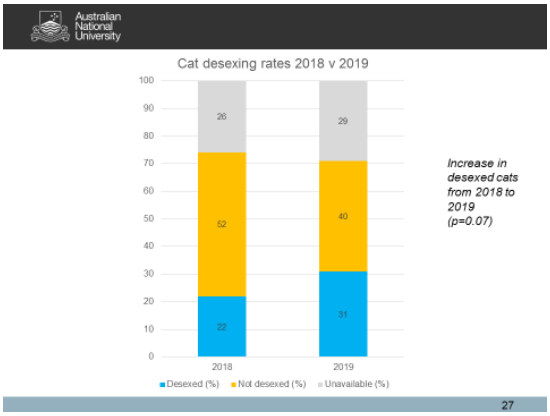
| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Animals/household** | | | |
| **1-5** | 52% | 53% | 52% |
| **6-10** | 33% | 39% | 46% |
| **11-15** | 6% | 4% | 2% |
| **>15** | 9% | 5% | 0% |

25



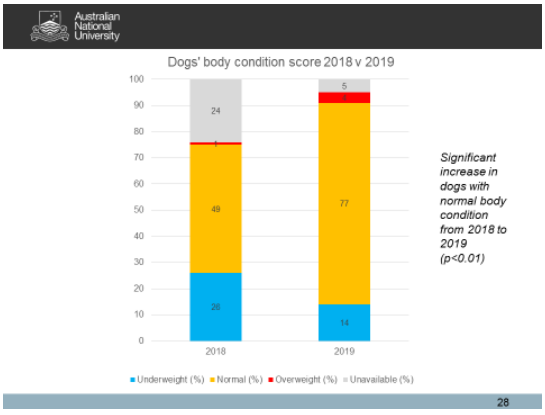

*Significant increase in desexed dogs from 2018 to 2019 ($p<0.01$)*

26



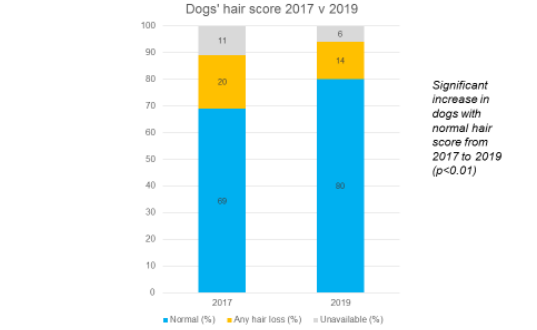

*Increase in desexed cats from 2018 to 2019 (p=0.07)*

27




*Significant increase in dogs with normal body condition from 2018 to 2019 (p<0.01)*

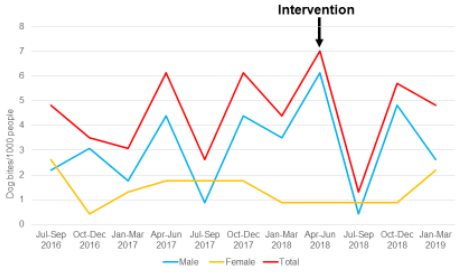
28




*Significant increase in dogs with normal hair score from 2017 to 2019 (p<0.01)*

29

## Health clinic dog bite patients




30

## Preliminary conclusions

- Census:
  - Stable animal population
  - Ageing population
  - Animal health outcomes improved
    - Increase in desexed dogs
    - Increase in dogs with good body condition score
    - Increase in dogs with good hair score (2017-2019)
    - Increase in desexed cats (not significant)

- Vet visits
  - 260 animal seen by vets
    - 185 animal surgically desexed
- Dog bites:
  - Still to do analysis

31

*What next?*

32

## Steps forward

- Finalise results
- Complete evaluation report
- Feedback to community and research partners
- Contribute to evidence base – publication
- Inspire other communities to adopt similar community driven animal health programs


www.amrric.org

33

## Thankyou for listening!

- Wadeye community
- TDC Rangers
- Bonny Cumming, AMRRIC
- Katie Thurber, ANU
- Ray Lovett, ANU

*Get in touch*

tamara.riley@anu.edu.au

34

## Appendix D

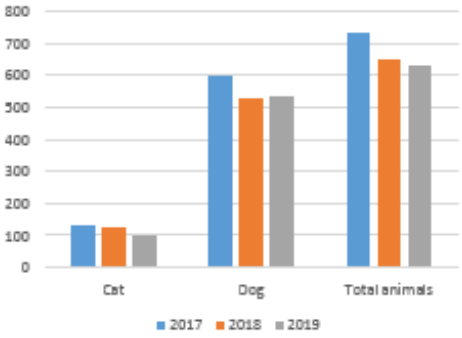
Conference poster.

# Evaluating a One Health approach to animal health and management in a remote Aboriginal community

### Background

Dogs (and increasingly cats) are a common pet in remote communities. They hold a lot of meaning for families and can be of cultural significance. However, access to animal health services can be limited due to remoteness and difficulty accessing supplies. This can impact on the health and wellbeing of the community.

Annual pet population in Wadeye 2017-2019




### Evaluation framework

The evaluation framework has been developed through consultation with stakeholders. The evaluation will follow the *Centre of Disease Control's Framework for Program Evaluation in Public Health* model.


### The study

This is an evaluation of a community driven animal health and management program in the remote community of Wadeye, NT. The study will look at animal and human health outcomes to assess the impact of the program.

### Aims

The aims of the study are to assess:

- Changes to animal health outcomes (body condition, hair score, desexing status) over the duration of the program;
- Changes to a human health outcome (dog bites) over the duration of the program.


### One Health

This study will consider a One Health approach to animal health and management in this setting. The One Health concept recognises that the health of people is connected to the health of animals and the broader environment.

## Appendix E

Summary of zoonotic diseases.

***Animal pathogens that can cause GIT disease in humans:***

| **Pathogen** | **Species** | **Information** | **Transmission & signs in humans** |
|---|---|---|---|
| Bacteria | Salmonella<br><br>*Salmonella always has a zoonotic origin* | Research has found 80% of Salmonella in dogs in Aboriginal communities were the same as those causing disease in people in that community (Brown 2006)<br><br>In Western Australia, hospitalisation for gastroenteritis was 7 times higher in Aboriginal children than Non-Aboriginal children (Gracey and Cullinane 2003). Diarrheal episodes were associated with the presence of potential zoonotic pathogens including Salmonella spp. (Gunzburg et al 1992). Nationally, rates of salmonellosis in humans (per 100,000 population) are highest in the NT | Faecal-oral<br><br>Abdominal pain, vomiting, diarrhoea, blood poisoning |
| | Campylobacter | Research is being done to see if the Campylobacter in people and dogs is the same type. | Faecal-oral<br><br>Abdominal pain, vomiting, diarrhoea |
| Protozoa | Giardia | 80% of dogs in Perth carried Giardia duodenalis (McGlade et al. 2003). Further research is looking at Aboriginal communities. | Faecal oral<br><br>Abdominal pain, vomiting, diarrhoea |
| | Cryptosporidium | Research is being done to see if the Cryptosporidium in people and dogs is the same type. | Faecal oral<br><br>Abdominal pain, vomiting, diarrhoea |

| | | | |
|---|---|---|---|
| Endoparasites | Dog Hookworm | People who grow up in community are thought to have developed antibodies to dog hookworm and therefore rarely infected. Clinical signs and illness thought to affect visitors to community rather than locals.<br><br>More of a problem for dogs! | Faecal oral<br><br>Skin rash (worm tracks in skin), abdominal pain |
| | Dog Roundworm | Only affect puppies and humans – adult dogs not affected | Faecal oral<br><br>Coughing, fever, abdominal pain, rash, headache, wheezing, difficulty sleeping, eye cysts (can make children blind) |
| | Hydatid tapeworm | Live inside dogs, dingos, and foxes. Don't affect dogs but make humans very sick – life threatening. | Faecal oral<br><br>Cysts in liver, lungs, bone, brain – if cyst burst can cause death. |

***Animal pathogens that can cause skin disease in humans:***

| **Pathogen** | **Species** | **Information** | **Transmission & signs in humans** |
|---|---|---|---|
| Fungi | Ringworm - dermatophytes | Ringworm fungus grows in the skin and destroys hair leading to hair loss. | Rings of hair loss, inflamed and itchy skin – can lead to skin sores. |
| Ectoparasites | Sarcoptes scabies (mite) | Endemic in many northern Australia communities.<br><br>Human scabies is genetically different to dog scabies however, dog scabies can still affect people's skin without going through their full life cycle. | Allergic skin reaction with vesicles, itchiness, skin sores. Looks the same as human scabies – lasts several hours or days.<br><br>Skin sores can get infected (e.g. strep). Strep sores can cause rheumatic fever in |

| | | | |
|---|---|---|---|
| | | Treated with Ivermectin<br><br>Dog scabies cause transient scabies in humans – Transient scabies can happen every time an affected human touches an infected dog or bedding. | children – can lead to heart and kidney disease. |
| | Ticks and flea borne disease | Most common is Brown tick which can carry Q fever (bacteria). Dog ticks can also bite humans and some carry pathogens<br><br>Flea bite allergy<br><br>10-35% of dogs in remote communities carried streptococcus, however, most weren't group A (S. Phelan 2010). | Skin irritation/sores – itchy, can get infected (e.g. strep). Strep sores can cause rheumatic fever in children – can lead to heart and kidney disease. |

***Dog bite injury:***

| **Information** | **Transmission & signs in humans** |
|---|---|
| ***More common than zoonotic infectious diseases.***<br><br>Dog attacks and dog bites are common in remote communities, although as with most injuries, data on risk factors, incidence and severity are limited. It is important to recognize that dogs have physical and spiritual guarding roles in many communities, helping people to feel safe. However, overcrowded and unmanaged dogs can be dangerous.<br><br>Likely to affect adults 20-50 years at higher rate than children in communities (not proven).<br><br>Not desexed and stressed dogs is an important factor. | Physical injury (can be severe). Infection is common.<br><br>Psychological trauma (can be severe and long-lasting) |

# Chapter 3

# Investigating a potential HIV outbreak in Far North Queensland

## 3.1 Abbreviations and acronyms

| | |
|---|---|
| ABS | Australia Bureau of Statistics |
| ACCHS | Aboriginal Community Controlled Health Services |
| AIDS | Acquired immunodeficiency syndrome |
| ART | Antiretroviral therapy |
| CHHHS | Cairns and Hinterland Hospital and Health Service |
| ERP | Estimated Resident Population |
| FNQ | Far North Queensland |
| GP | General practice/practitioner |
| HIV | Human Immunodeficiency Virus |
| HREC | Human Research Ethics Committee |
| IDU | Injecting drug user |
| MSM | Men who have sex with men |
| NOCs | Notifiable Conditions System |
| PCR | Polymerase Chain Reaction |
| PEP | Post-exposure prophylaxis |
| PHA | Public Health Application |
| PrEP | Pre-exposure prophylaxis |
| QAIHC | Queensland Aboriginal and Islander Health Council |
| SAHMRI | South Australia Health and Medical Research Institute |
| SHIP | Sexual Health Information Program |
| SLA | Statistical local area |
| SSA | Site specific approval |
| STIs | Sexually transmissible infections |
| UNAIDS | United Nations Programme on HIV and AIDS |

## 3.2 Acknowledgements

I would like to acknowledge the Aboriginal Community Controlled Health Services (ACCHS) in Far North Queensland (FNQ) that supported this study including Apunipima, Gurriny Yealamucka, Queensland Aboriginal and Islander Health Council (QAIHC) and Wuchoperren, as well as the Cairns Sexual Health Clinic, the Tropical Public Health Services – Cairns, and the Communicable Diseases Branch at Queensland Health. I would also like to acknowledge Associate Professor James Ward at the South Australia Health and Medical Research Institute (SAHMRI) for his support and supervision throughout the study.

Research team: Tamara Riley, A/Prof James Ward, A/Prof Ray Lovett, Dr Katie Thurber, Dr Darren Russell, Dr Annie Preston-Thomas and Dr Sonya Bennett.

## 3.3 Abstract

**Introduction**: This study is an investigation of a potential human immunodeficiency virus (HIV) outbreak affecting the Aboriginal and Torres Strait Islander population in FNQ. Local ACCHS, Cairns Sexual Health Clinic and the Tropical Public Health Services – Cairns had observed an increase in notifications of HIV in FNQ since 2014 affecting the Aboriginal and Torres Strait Islander population.

**Methods**: A descriptive analysis of the Queensland Notifiable Conditions (NOCs) database was undertaken focusing on HIV notifications from 1 January 1984 to 30 June 2019. I quantified trends in HIV notifications during this time period and assessed and compared characteristics of people diagnosed with HIV from 1984-2013 and 2014-30 June 2019 (from here on 2014-2019). The intent of these analyses was to inform an assessment of whether an outbreak had occurred and to inform the public health response. I also considered the implications of potentially labelling this an 'outbreak' for the community, service providers, and for those government organisations which enact policy and respond to outbreaks. I conducted the study in partnership with local ACCHSs, Queensland Health and SAHMRI.

**Results**: From 1984-2019, 14.1% of all HIV notifications in FNQ were in the Aboriginal and Torres Strait Islander population. The rate of HIV notifications in the Aboriginal and Torres Strait Islander population was relatively stable from 1984-2013 and started to increase in 2014. Notifications peaked in 2016, at 22.8 HIV notifications per 100,000 population per year. HIV notifications in the Aboriginal and Torres Strait Islander population in the last five years were most commonly among males (87.8% of all notifications), those aged 18-29 years

(43.9%), and men who have sex with men (MSM) (68.3%). Additionally, 36.6% of notifications in the last five years were at a late or advanced stage of disease at diagnosis and 92.7% were recorded as receiving treatment at their last clinic visit.

**Conclusion**: HIV rates in the Aboriginal and Torres Strait Islander population in FNQ have been increasing since 2014. The rate observed in 2016 was the highest recorded in this region since notifiable data has been collected, and was at least three times the rate observed in the non-Indigenous population. As notifications in the Aboriginal and Torres Strait Islander population have been above what is expected, this can be declared an outbreak. There is a need for an enhanced public health response with additional resourcing to combat the increasing rate of HIV. The promotion and dissemination of culturally appropriate sexual health resources, such as 'Young, Deadly, Free' and other locally developed resources, could be helpful to target young Aboriginal and Torres Strait Islander people who are at greatest risk of exposure.

## 3.4 Prologue

### *3.4.1 My role*

My role in this study was as the study leader. This involved engaging with health organisations in Cairns to understand the local context and gain support for this study. I developed the research proposal and undertook the ethics application and data access approval processes through Cairns and Hinterland Hospital and Health Service (CHHHS), and Queensland Health. Once data access was approved, I drafted the data analysis plan and held regular teleconferences with the research team to discuss the analysis and outcomes of the study. I also sought feedback from the research team on the chapter before submission.

I was interested in investigating this potential outbreak as I have an interest in Aboriginal and Torres Strait Islander health and sexual health. My involvement in this study came about through contacting A/Prof James Ward at SAHMRI to discuss the ideas for the study. This study involved multiple trips to Cairns with A/Prof James Ward in June 2018 and with A/Prof Ray Lovett in December 2018, to engage with the relevant organisations and gain their input into the study design. The organisations I engaged with were the Sexual Health team at the Tropical Public Health Services – Cairns, Cairns Sexual Health Clinic, and local ACCHS including Wuchoperren, Apunipima, Gurriny Yealamucka and QAIHC. I created a one page summary of the research proposal for use by the health services (see Appendix A). All organisations saw the need for this work and gave support for this study to proceed. Engaging with the local health organisations was helpful as it allowed me to better understand the local context and to discuss the suggested approaches for maintaining confidentiality of those involved.

I had regular engagement with many sectors of Queensland Health throughout the study, including the Tropical Public Health Services – Cairns, CHHHS, the Communicable Diseases Branch in Brisbane, and the FNQ Human Research Ethics Committee (HREC). The Tropical Public Health Services – Cairns was involved in the public health response and represented on the research team. The CHHHS, including Cairns Sexual Health Clinic, was involved in the public health response and represented on the research team. The Communicable Diseases Branch have been involved in supporting the public health response through guidance of management of complex cases, enhanced surveillance summaries and funding and also houses the Queensland NOCs database which was used in this study. They were also represented on the research team.

The final stage of this study will be to conduct a series of knowledge exchange sessions with local health organisations in Cairns to discuss key findings and public health implications.

### *3.4.2 Lessons learnt and reflections*

Lessons learnt from this study include the importance of ethical processes and support from the local community to undertake research in this sensitive public health space. Collaboration and engagement are integral and take time. In this study, there was 12 months of preparation time leading to the start of analysis. Given the short timeline of the MAE, this created some time pressures. However, proper engagement and adherence to ethical processes for undertaking this kind of research are important, and the support of the local community is crucial. The below flow chart shows the process I followed to get this study started (see Figure 16). Two datasets were initially thought to be useful for this study: the Queensland NOCs database based with the Communicable Diseases Branch at Queensland health and the Sexual Health Information Program database (SHIP) based at the CHHHS; however, in the end, only the NOCs database was able to be accessed.

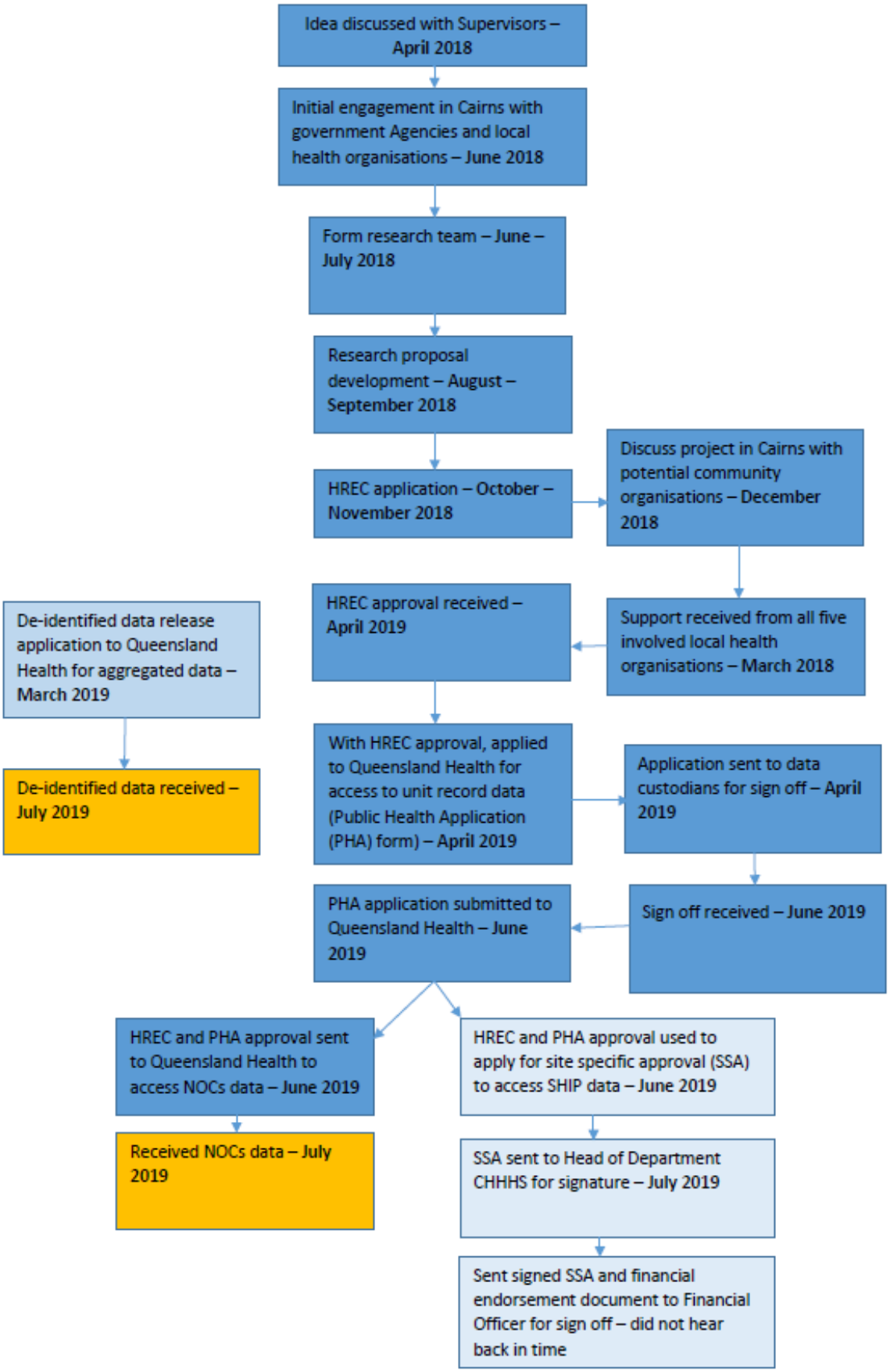



*Figure 16: Research process flow chart*

This investigation demonstrates inequity in HIV among Aboriginal and Torres Strait Islander peoples compared to the non-Indigenous population in FNQ. I learnt that despite a good policy and program environment, inequity can exist and that this can be exacerbated by advances in medicine that are well intended, scientifically rigorous, and adopted early and effectively by one population group, but unintentionally leave other populations behind. There are multiple policy documents related to sexually transmissible infections (STIs) in Australia and internationally including targets to reduce the burden of HIV, yet the Aboriginal and Torres Strait Islander population continues to be overrepresented in HIV notifications and other STIs (1). Prevention strategies include treatment as prevention and pre-exposure prophylaxis (PrEP), but not all members of the population may have equal access to these strategies, which could contribute to the observed inequity in HIV prevalence. It is therefore important to reflect and consider the reasons behind this and where there may be a breakdown between policy targets and implementing strategies to reach these targets. Whilst it is encouraging to see these policy initiatives in place, highlighting the importance of controlling HIV, it would be beneficial to work with communities from the earliest stage to understand their concerns and their desired ways forward.

For example, current prevention and treatment strategies are mainly targeted at the most common HIV transmission pathways in the non-Indigenous population, which may not be relevant for the Aboriginal and Torres Strait Islander population. In analysing and interpreting data from the Aboriginal and Torres Strait Islander population, it will be important to consider the differences in exposure factors leading to HIV. This can inform the development and adaptation of prevention strategies targeted at those most at risk within the Aboriginal and Torres Strait Islander population. Further, there are potential benefits through using culturally appropriate prevention messaging created with Aboriginal and Torres Strait Islander people and delivered in communities by local people.

Through this study, I learnt about the NOCs database in Queensland, data access approval processes, the data they collect and the limitations of this database. For example, information regarding contact tracing was not available through the NOCs database, which is an important part of an outbreak investigation. However, the non-disclosure of this information may be due to sensitivities surrounding HIV and confidentiality concerns. This data may be available through local databases such as the SHIP database, which was not able to be accessed for this study.

This outbreak investigation has taught me that not all investigations are straight forward and follow the standard 10 steps (2). For example, I could not follow up with those involved or

potential contacts and could not perform a cohort or case-control study. However, it was still important to analyse these data as this study has provided new insight into HIV notifications in FNQ, as described below. There were additional complications investigating this potential outbreak due to the sensitivities that surround this condition, particularly related to small populations, perceived confidentiality concerns and stigma and discrimination that still exist for many communities and people affected by HIV.

If this potential outbreak had occurred in a small remote community with limited access to treatment and care facilities, a rapid response with additional HIV expertise would be needed. As it is, the FNQ region is a large area with a variety of health care services and a sexual health clinic that provides outreach and specialist HIV care for the community as well as other providers across the region. This is something that is not available in many remote communities across Australia.

There is no nationally agreed definition of when an increase of HIV notifications can be declared an outbreak. The HIV Series of National Guidelines (SONG), developed in 2014, is a resource for Public Health Units when addressing a diagnosed HIV case; however, these guidelines do not currently address the investigation of an outbreak or when to declare an outbreak (3). It is understood that this work is in progress (personal communication with Dr Bennett). The process of declaring an outbreak in the Aboriginal and Torres Strait Islander health space should involve engagement with local community and health provider representatives. A response should be delivered in a way that is balanced to prevent further stigma, concern and panic for the community.

Finally, the fact that there has been uncertainty as to whether this is officially an outbreak raises concerns for those involved and at risk. The results of this study show that an increase in HIV notifications above what is expected has occurred and an enhanced public health response should be enacted.

### *3.4.3 Public health importance*

Internationally, amongst those people living with HIV, Indigenous people are overrepresented (4). Whilst HIV notifications in Australia have continued to decrease in recent years, particularly in the non-Indigenous population (5), health organisations in FNQ and the Tropical Public Health Services – Cairns in FNQ have observed an increase in notifications in the Aboriginal and Torres Strait Islander population over the last five years.

People who have a previously existing STI are at an increased risk of acquiring a co-infection with HIV (1). Given that many remote Aboriginal and/or isolated Torres Strait Island communities have some of the highest rates of STIs globally (6) this is of concern for public health in Australia. The overrepresentation of STIs in the Aboriginal and Torres Strait Islander population indicates a need to increase resources and efforts in engaging with communities and targeting prevention and treatment strategies.

Outbreaks in many settings are difficult to control, let alone in isolated and or remote communities. This outbreak occurred across a region in a relatively remote area of Australia but with good access to sexual health services, primary health care services, and a responsive policy environment. However, for many other very remote communities there remains limited capacity to scale up responses. Many remote communities face barriers including limited access to culturally appropriate treatment and care, and as such, the ability to control an outbreak could be reduced, with negative impacts on public health.

This is the first time these data have been analysed in-depth and published openly; as such, they can provide insight to inform public health and policy response in this setting. This study analysed HIV notifications over 35 years, from 1984 to 2019, to assess whether an outbreak has occurred, and to discuss the public health implications for the community. This study will contribute to the evidence base regarding HIV in the Aboriginal and Torres Strait Islander population. These findings should inform current public health response and prevention efforts. Finally, the findings from the study also highlight the importance of engaging with communities and allowing them to have input into decisions about declaring and responding to an outbreak.

## 3.5 Introduction

### *3.5.1 HIV*

HIV is a blood borne virus that can lead to acquired immunodeficiency syndrome (AIDS). HIV can be transmitted by sexual and blood contact, as well as from mother to child. There are three main stages of HIV:

1. *Acute HIV infection* – within two to four weeks of initial infection a person will start showing flu-like symptoms. At this stage, there is a very high risk of transmitting HIV to sexual or needle-sharing partners, as levels of HIV in the blood are high.
2. *Clinical latency* (also called asymptomatic/chronic HIV infection) – there are no symptoms and the virus is latent. Despite low viral load, people at this stage are able to transmit the virus. This stage lasts an average of 10 years in the absence of treatment.
3. *AIDS* – the immune system is badly compromised and people become vulnerable to opportunistic infection. Without treatment, the average survival period is around three years and is reduced to around one year for those who experience an opportunistic infection (4). One of the current sustainable development goals is to end the AIDS epidemic globally by 2030 (7).

Developments in HIV medicine have provided great benefits for humanity. Antiretroviral therapy (ART) is available publicly in Australia, which can prolong peoples' lives by suppressing the virus and preventing HIV from progressing to AIDS. It is now recommended that ART be started at the time of HIV diagnosis. As well as improving the individual's own prognosis, suppressing an individual's viral load also provides community benefits by decreasing the risk of transmission to others (4). However, it should be noted that ARTs do not cure HIV; finding a cure for HIV remains a challenge globally and for those people who do not achieve viral suppression or are not on treatment, outcomes are significantly poorer. People with HIV may have a lack of viral suppression if they are not diagnosed, they are diagnosed but not in care, they are in care but not on ART, or they are on ART but have not achieved a suppressed viral load (8).

A more recent advance in HIV medicine is the rollout and scale-up of preventative HIV drugs for high-risk groups such as MSM or those who may be exposed to HIV, such as those with HIV positive partners. PrEP is a highly effective preventative drug that can be taken daily or as required to reduce the risk of acquiring HIV. Similarly, post-exposure prophylaxis (PEP) is a course of drugs taken to prevent HIV by those who have been exposed (9).

The HIV diagnosis and care cascade has become a widely used approach to describe the benchmark stages along the care pathway from diagnosis to viral suppression. In 2014, the Joint United Nations Programme on HIV and AIDS (UNAIDS) and partners launched ambitious 90-90-90 targets for 2020. Target one is to successfully diagnose 90% of all people who are HIV positive, target two involves delivering ART to 90% of those diagnosed, and target three involves achieving viral suppression for 90% of those on treatment by 2020 (10). Viral suppression is defined as <200 HIV-1 RNA copies/mL (8). UNAIDS have also set targets of 95% of people diagnosed, in treatment and achieving viral suppression by 2030 (8). Overall, Australia is well on track to achieve 90-90-90 targets by 2020; however, national data often masks outcomes for populations such as Aboriginal and Torres Strait Islander people or people born overseas.

Achieving the 90-90-90 targets leads to reduced transmission and improved health outcomes for the community affected. However, it has been recognised that many people experience barriers when accessing health care for STIs, including shame and stigma surrounding sexual health, and concerns of confidentiality in small communities (11). This may be a barrier for those diagnosed with HIV – as well as other STIs – in accessing appropriate health care.

### *3.5.2 Epidemiology of HIV in Australia*

HIV has been a notifiable condition in Australia since 1984, reportable to Public Health Units either by laboratories or diagnosing medical officers. Surveillance of HIV among Aboriginal and Torres Strait Islander people commenced in 1992. In 2017, it was estimated that there were a total of 27,545 people in Australia living with HIV (12). Additionally, it was estimated that 574 Aboriginal and Torres Strait Islander people were living with HIV in Australia (13). Since 2012, there has been a divergence in HIV notification rates for Aboriginal and Torres Strait Islander peoples compared to non-Indigenous people nationally. Between 2012-2016 HIV notification rates among the Aboriginal and Torres Strait Islander population increased from 4.8 to 6.4 notifications per 100,000 population, representing a 33% increase (1). In contrast, HIV notification rates have been stable, and more recently decreasing, in the Australian-born non-Indigenous population: the rate changed from 3.7 notifications per 100,000 population per year in 2012 to 2.9 in 2016, representing a 22% decrease (1). In 2017, the HIV notification rate in the Aboriginal and Torres Strait Islander population was 1.6 times higher than the Australia-born non-Indigenous population (14).

Within the Aboriginal and Torres Strait Islander population nationally, approximately 60% of people living with HIV are in the MSM population (including MSM who also report injecting

drug use (IDU)), approximately 20% seen in people who inject drugs, and approximately 20% in the heterosexual population (1). This differs from the non-Indigenous population where approximately 80% of people living with HIV are in the MSM (including MSM/IDU) population.

Australia has set a national target of ending HIV transmission by 2020 through aspiring to meet the UNAIDS HIV targets (15). For the Aboriginal and Torres Strait Islander population, this goal is articulated in the latest national strategy addressing HIV and other STIs in Aboriginal and Torres Strait Islander people. The *Fifth National Aboriginal and Torres Strait Islander Blood Borne Viruses and Sexually Transmissible Infections Strategy 2018-2022* was released in 2018 to address the disproportionally high rates of blood borne viruses and STIs in the Aboriginal and Torres Strait Islander population. This strategy is one of five national strategies that focus on a national response to blood borne viruses and STIs in Australia (13). High rates of STIs have been noted as a priority for increased risk of outbreaks occurring in Aboriginal and Torres Strait Islander communities and the strategy highlights the need for heightened surveillance and increased capacity to be able to rapidly respond to outbreaks occurring in these communities (13).

### *3.5.3 HIV in Queensland*

Approximately 5,500 people within Queensland are living with HIV as of December 2017 (16). HIV has been notifiable in Queensland since 1984, which means that all new laboratory confirmed diagnoses of HIV not previously diagnosed elsewhere are reported to the Department of Health (3, 8). Between 2013 and 2016, the mean HIV notification rate in Queensland was 4.3 notifications per 100,000 population per year (16). This rate is similar to HIV notification rates Australia wide between 2013 and 2016 (ranging from 4.7 to 4.2 notifications per 100,000 population per year) (5). From 2013 – 2017, most HIV notifications in Queensland were seen in men (89%) and in the age group 20-49 years (75%).

As of 2016, 4.0% of Queensland's population are Aboriginal and/or Torres Strait Islander (17); however, 6.8% of HIV notifications from 2013 – 2017 were in the Aboriginal and Torres Strait Islander population (16). There has been a 27% decrease in HIV notification rates in the total population of Queensland from 2014-2017, from 5.2 to 3.8 HIV notifications per 100,000 population per year. Throughout that time, Aboriginal and Torres Strait Islander people have been over-represented in the notifications, representing 5% of all notifications in 2013, 10% of all notifications in 2016, and 6% of all notifications in 2017 (16). In 2017, Aboriginal and Torres Strait Islander men had the highest HIV notification rate of 9.4 per 100,000 population per year, followed by non-Indigenous men with a rate of 6.6 per 100,000 population per year.

Among both Aboriginal and Torres Strait Islander females and non-Indigenous females the HIV notification rate was 0.9 per 100,000 population per year (16).

### *3.5.4 About the study*

Since 2014, local ACCHS, Cairns Sexual Health Clinic and the Tropical Public Health Services – Cairns have noticed an increase in HIV notifications within the Aboriginal and Torres Strait Islander population. A public health alert sent out by the Tropical Public Health Services – Cairns in February 2018 noted the following (see Appendix B):

> *There has been an increase in the number of HIV diagnoses in Aboriginal and/or Torres Strait Islander people in FNQ. Most cases have been diagnosed in people resident in the Cairns region … and in men … aged less than 40 years. Sexual contact … the main route of transmission. A number of people newly diagnosed with HIV have also had syphilis co-infection (pg 1,11).*

There has been minimal research and publications undertaken on HIV in the Aboriginal and Torres Strait Islander population, including in Queensland. However, as Queensland has the highest rates of HIV notifications in the Aboriginal and Torres Strait Islander population as of 2017 (16), this study may add value by increasing awareness about HIV and the importance of prevention and treatment strategies to combat future outbreaks. This study will be the first to analyse the history of HIV in the Aboriginal and Torres Strait Islander population in FNQ since the collection of notifiable data began in 1984.

This study aimed to: 1) explore whether the recent increase in HIV notifications represents an outbreak; and, 2) quantify and compare the characteristics, diagnosis and treatment factors over time. We hope that a more detailed understanding and quantification of HIV will contribute to raising awareness of the risks of HIV among Aboriginal and Torres Strait Islander people in FNQ and inform the local public health response.

## 3.6 Methods

### *3.6.1 Ethics*

MAE scholars are covered under an ANU HREC waiver of consent for Outbreak Investigation and Surveillance Evaluation Projects (**2017/909**). Due to the sensitivity of this study, further ethics approval was sought through the FNQ HREC (**2019/QCH/47343 – 1307**). Data access approval processes were followed through Queensland Health to access and analyse NOCs data.

### *3.6.2 Study design*

This study was a quantitative descriptive analysis using the Queensland NOCs database to assess HIV notifications in the Aboriginal and Torres Strait Islander population in FNQ over 35 years.

FNQ has a population of over 280,000 people and 5.8% of the population are Aboriginal and/or Torres Strait Islander as of 2017. FNQ is made up of two main areas; Cairns and Hinterland and Torres and Cape, which has many remote and Island communities (see Figure 17).

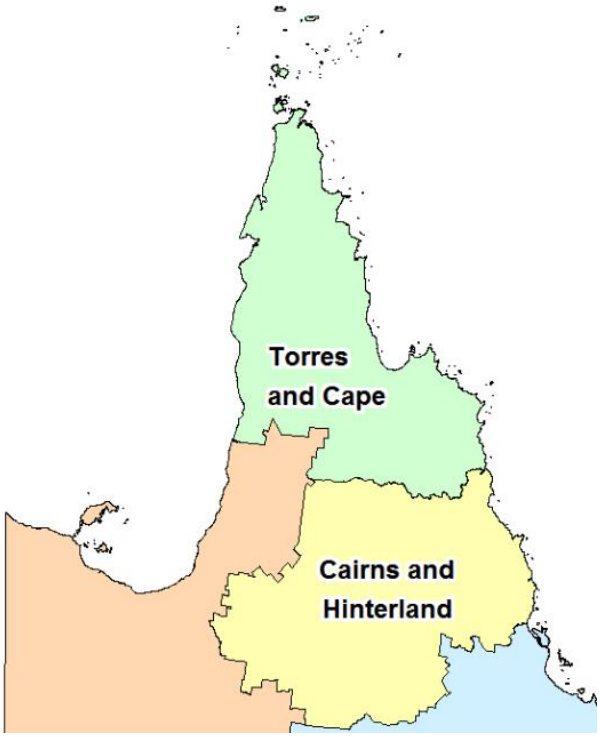



*Figure 17: FNQ region (18)*

The objectives for this study were to:

1. Assess trends in HIV notifications in the Aboriginal and Torres Strait Islander population in FNQ from 1984-2019;
2. Determine if the data in the most recent five-year period indicate an outbreak, and if so, among which risk groups;
3. Understand the profile of diagnosis and treatment factors among people living with HIV from 1984-2019; and,
4. Better understand the public health implications for the community.

The primary hypothesis was that:

1. There is an increase of HIV notifications above what is expected in the Aboriginal and Torres Strait Islander population in FNQ since 2014 indicating an outbreak.

The final stage of this study will be to conduct a series of knowledge exchange sessions with local health organisations to discuss key findings, dissemination and public health implications.

Using the NOCs data, demographic characteristics, diagnosis and treatment factors from 1984-2013 and 2014-2019 were assessed and compared. Data were analysed to quantify trends in HIV notifications over the two time periods to inform assessment of whether an outbreak of HIV had occurred in the last five years and to provide insight into the required public health response.

Inclusion criteria for the study were: 1) information available on Indigenous status; 2) resident in FNQ at the time of HIV notification; and 3) age ≥18 years. Aggregate data for the Aboriginal and Torres Strait Islander and non-Indigenous population over the study period were compared to assess trends. Further analysis was conducted within the Aboriginal and Torres Strait Islander population, to understand demographic characteristics as well as diagnosis and treatment factors (see Figure 18).

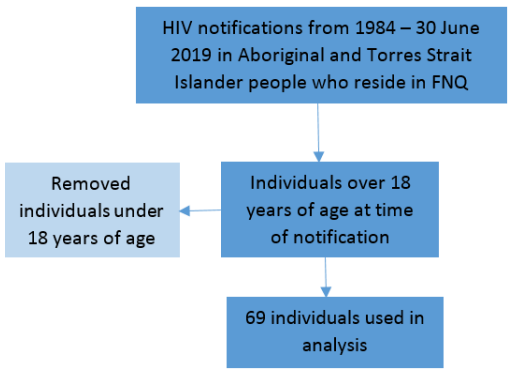



*Figure 18: Inclusion flow chart*

### *3.6.3 Outbreak investigation*

The below table highlights how the steps of an outbreak investigation were undertaken (see Table 20).

*Table 20: Outbreak investigation steps*

| Steps (2) | Steps undertaken in this outbreak |
|---|---|
| 1. Determine an outbreak is occurring | I quantified the average HIV incidence rate yearly over the period of 1984-2013. This was then compared to the incidence rate yearly over the period of 2014-2019 to assess whether there has been an increase above what is expected in the region. |
| 2. Confirm diagnosis | Diagnosis was confirmed via CD4+ count[6] and PCR[7]. CD4+ count at diagnosis was analysed in this study. |
| 3. Define and count cases | The case definition for the outbreak period was defined as: an Aboriginal and/or Torres Strait Islander person aged ≥18 years residing in FNQ and diagnosed with HIV from 1 January 2014 – 30 June 2019.<br>I counted the number of cases that fit this description over the relevant time. |
| 4. Orient data – time, place, person | I created an epidemiological curve and conducted a descriptive analysis to describe demographic, diagnosis and treatment factors of those diagnosed with HIV (see results). |
| 5. Determine who is at risk | I performed a descriptive analysis of the data and identified common characteristics of those diagnosed with HIV in the last five years in order to inform identification of |

[6] CD4+ test = T-cell count (testing how well your immune system is functioning)
[7] PCR test = Polymerase chain reaction (testing for HIV RNA)

| | |
|---|---|
| | those who are at risk at the population level (see results). |
| 6. Develop and test hypothesis | A hypothesis was developed based on engagement with local health organisations and Tropical Public Health Services – Cairns regarding the increase in HIV notifications. This was tested through analysing historical data and comparing it to the potential outbreak period, to determine whether this is an outbreak. |
| 7. Compare hypothesis with facts | The hypothesis was compared with results and discussed with the research team to confirm an outbreak. |
| 8. Plan systematic study | Data analysis processes were planned (through a Data Analysis Plan) and undertaken including gathering feedback and input from research team around presentation of data, sensitivities, and confidentiality. |
| 9. Prepare written report | This chapter was written with input from the research team. A publication will be written with input from local health organisations, Queensland Health and SAHMRI. |
| 10. Execute control and prevention practices | Local public health response is underway; however, an enhanced and tailored public health response is needed (see discussion). This study will inform the response through describing the extent of the outbreak and those most at risk. Engagement with local health organisations regarding findings and implications on community will follow. |

### *3.6.4 Data source*

Data from the NOCs database was supplied by the Communicable Diseases Branch at Queensland Health. The data provided included Aboriginal and/or Torres Strait Islander people aged ≥18 years and who reside in FNQ at the time of HIV notification from 1 January 1984-30 June 2019. Also, aggregated data on HIV in the non-Indigenous population in FNQ was supplied for the same time period, for the purpose of comparison. This time period was requested as HIV became notifiable in Queensland in 1984, and therefore, the NOCs database includes notifications from this year onwards.

The NOCS dataset included the following variables; unique identifier, Indigenous status, notification date, onset date, diagnosis date, statistical local area (SLA) code of residence, remoteness category, gender, age at onset, exposure category (exposure that likely led to transmission of disease), Queensland HIV date, Queensland AIDS date, CD4+ test date, CD4+ test result, PCR test date, PCR test result, last recorded therapy date, last recorded therapy type, diagnosing clinic, died of condition and deceased date.

### *3.6.5 Variables*

Variables were grouped and categorised to ensure confidentiality.

Date of onset was categorised into two periods; '1984-2013' and '2014-2019'. Indigenous status was categorised as 'Aboriginal', 'Torres Strait Islander', or 'both Aboriginal and Torres Strait Islander' and gender was categorised as 'male' or 'female'. Age at onset was categorised as '18-29 years', '30-39 years', '40-49 years', and '≥50 years'. Exposure category was categorised as 'MSM only', 'heterosexual only', and 'IDU (including MSM/IDU, heterosexual/IDU, and IDU only)'. Exposure categories were grouped as such to avoid small numbers in some cells.

SLA code of patient's residence at time of notification was categorised into two groups; 'Cairns', and 'Torres and Cape'. The Australian Bureau of Statistics (ABS) remoteness categories of residence were used including 'outer regional' or 'remote and very remote'.

CD4+ count at diagnosis was categorised using cut offs from Queensland Health, including '≥500 cells/μL' and '350-499 cells/μL' (indicating early stage of disease at diagnosis), '200-349 cells/μL (late HIV diagnosis)', and '<200 cells/μL (advanced HIV at diagnosis)' (16). Late HIV diagnosis suggests that HIV was acquired at least four years earlier than diagnosis (8).

Treatment status at the last recorded clinic visit was categorised as 'recorded as on treatment' or 'no treatment recorded', and type of diagnosing clinic was categorised as 'ACCHS', 'sexual

health clinic', 'hospital' and 'general practice (GP)'. Area of diagnosing clinic was categorised into 'Cairns' and 'Torres and Cape'. For those who had died of HIV, data were categorised into 'yes' or 'don't know'.

Across variables, responses of 'don't know' were categorised as 'missing'.

### *3.6.6 Statistical analysis*

Data analysis was undertaken using Excel and Stata 15.

Graphs were developed to visualise changes in notification counts and rates of HIV from 1984-2019, to assess whether an outbreak has occurred and, if so, at what point in time. Notifications from 1984-2019 were grouped into five-year age groups to avoid small numbers. Crude rates by Indigenous status were calculated per 100,000 population per year from 2002-2019 using annual estimated resident population (ERP) data supplied by Tropical Public Health Services – Cairns as the denominator. Rates were not calculated for 1984-2001 as we were not able to access consistent population data for this period. The 2017 ERP was used as the denominator to calculate crude rates for 2018 and 2019, as 2017 is the most up to date population figure we had access to. We assume that the population has remained fairly stable over these two years; if the population has increased, the rates presented in this chapter may be slightly overestimated. Crude rates were presented in a line graph. An epidemiological curve of number of notifications in the Aboriginal and Torres Strait Islander population per year was created for the potential outbreak period from 2014-2018, with 2019 data not presented as we did not have data for the whole year.

Characteristics and diagnosis and treatment factors were examined overall and by time period (1984-2013 and 2014-2019) to identify if there were any differences in these factors before versus during the potential outbreak period. This data was presented in tables using counts and percentages. These broad time periods were chosen to ensure confidentiality of those involved; it was not possible to further break down the time periods due to small numbers. Any cells containing less than three observations were reported as such to support confidentiality, with the exception of cells for missing data.

Significance testing was undertaken using Fishers Exact test (due to small numbers in some cells) to assess the difference in categories of a variable between the two time periods (1984-2013 and 2014-2019). Significance was assessed using p-values ($p<0.05$) and displayed in tables. Missing observations were not included in analysis.

## 3.7 Results

From 1984-2019 there were 489 notifications of HIV in those who reside in FNQ, with 69 (14.1%) in the Aboriginal and Torres Strait Islander population, and 420 (85.9%) in the non-Indigenous population.

In the Aboriginal and Torres Strait Islander population from 1984-2013 there were 28 notifications (40.6% of all Aboriginal and Torres Strait Islander notifications from 1984-2019) – on average <1 notification per year. From 2014-2019 there were 41 notifications (59.4% of all Aboriginal and Torres Strait Islander notifications from 1984-2019) – on average 7 notifications per year. In the non-Indigenous population from 1984-2013 there were 347 notifications (83% of all non-Indigenous notifications) – on average 12 notifications per year, and from 2014-2019 there were 73 notifications (17% of all non-Indigenous notifications) – on average 13 notifications per year (see Figure 19).

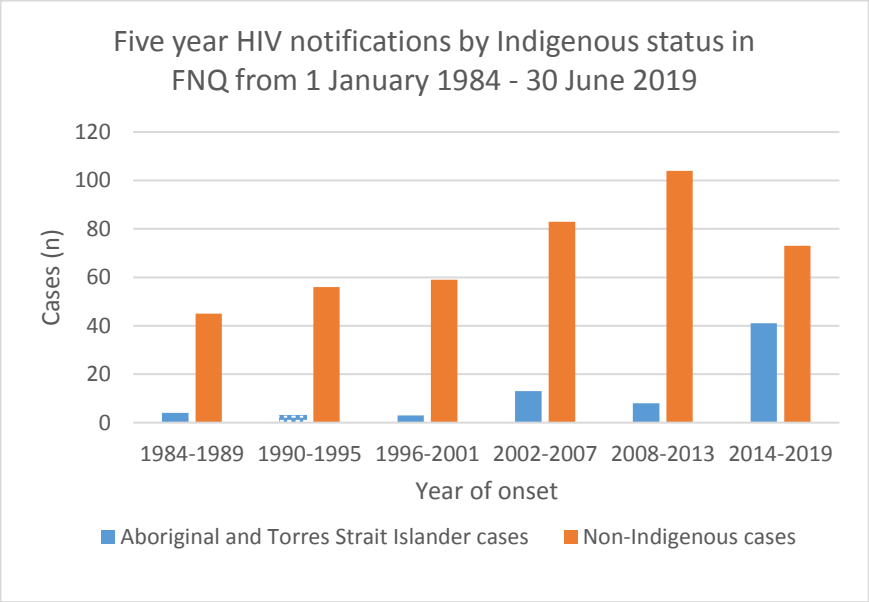



*Figure 19: HIV notifications by Indigenous status in FNQ from 1984 - 30 June 2019 (Hatched shading represents a confidentialised cell with <3 observations)*

Figure 20 shows the rates of HIV in the Aboriginal and Torres Strait Islander and non-Indigenous population from 2002-2019. The rate of HIV notifications in the non-Indigenous population was the highest in 2008 with 15.0 HIV notifications per 100,000 population per year. In the Aboriginal and Torres Strait Islander population, the rates of HIV notifications peaked in 2016 with 22.8 notifications per 100,000 population per year. This is compared to 6.9 per 100,000 population per year in the non-Indigenous population in 2016.

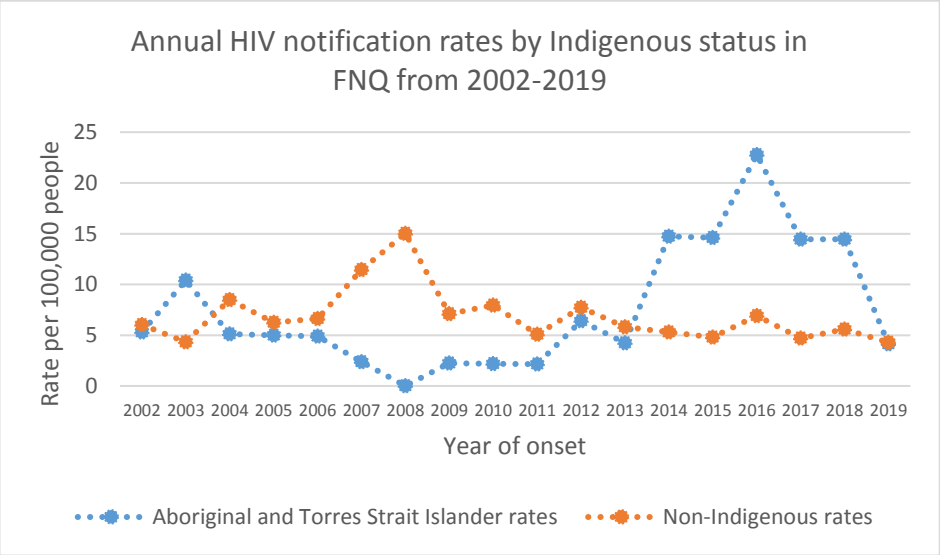



*Figure 20: HIV notification rates by Indigenous status in FNQ from 2002-2019*

From 2014 – 2019, notifications of HIV in the Aboriginal and Torres Strait Islander population rose in FNQ with the highest number of notifications seen in 2016 (see Figure 21).

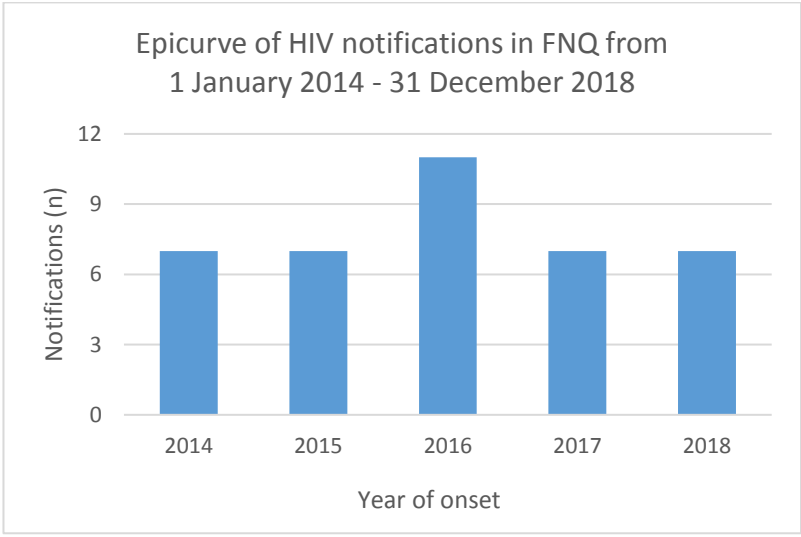



*Figure 21: Epidemiological curve of HIV notifications in the Aboriginal and Torres Strait Islander population in FNQ from 1 January 2014-31 December 2018 (2019 not presented as data not complete)*

During the entire study period, among all Aboriginal and Torres Strait Islander people with HIV, 85.5% were male. 37.7% of cases were among people aged 18-29 years, 29.0% in people aged 30-39 years and 23.2% in people aged 40-49 years. 33.3% of cases were among people who are Aboriginal, 21.7% among those who are Torres Strait Islander, and 44.9% in people who are both Aboriginal and Torres Strait Islander. At the time of notification, 82.6% of people involved were residing in outer regional areas inclusive of Cairns, and 17.4% were residing in remote/very remote areas. Additionally, 71% were residents in Cairns at the time of notification and 29% were residents of the Torres Strait and Cape York regions. The most common exposure was MSM (60.9%), followed by those who are heterosexual (20.3%) and people who inject drugs (13.0%) (see Table 21).

Males comprised the majority of notifications across both 1984-2013 (82.1%) and 2014-2019 (87.8%). In the 1984-2013 period, 28.6% of notifications were in the 18-29 year age group followed by 35.7% in the 30-39 year age group. In the most recent period, 43.9% of notifications were in the 18-29 year age group followed by 24.4% in the 30-39 year age group.

Based on fishers exact test there was a significant association between Indigenous status and the time periods (p=0.008). From 1984-2013, 67.9% of notifications were in both Aboriginal and Torres Strait Islander people, while in the most recent period 29.3% were in both Aboriginal and Torres Strait Islander people and 41.5% were in people who are Aboriginal. There was also an indication of an increase in the proportion of all notifications that were from the Torres and Cape regions from 1984-2013 to 2014-2019 (17.9% to 36.6%). Accordingly, there was an indication of a decrease in the proportion of all notifications that were from people residing in Cairns (82.1% to 63.4%).

During 1984-2013, 50.0% of notifications were in MSM, 28.6% in those who are heterosexual, and 17.9% in people who inject drugs. From 2014-2019, 68.3% of notifications were in MSM, 14.6% in those who are heterosexual, and 9.8% in people who inject drugs.

*Table 21: Characteristics of HIV in the Aboriginal and Torres Strait Islander population in FNQ from 1984-2013 and 2014-30 June 2019*

| Characteristics of HIV notifications in the Aboriginal and Torres Strait Islander population in FNQ from 1984-2013 and 2014-30 June 2019 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1984-2013 | | 2014-2019 | | Total | | Fishers exact |
| Characteristics | Notifications (n) | % | Notifications (n) | % | Notifications (n) | % | P-value |
| Total | 28 | 40.6 | 41 | 59.4 | 69 | 100.0 | |
| Gender | | | | | | | |
| Male | 23 | 82.1 | 36 | 87.8 | 59 | 85.5 | 0.729 |
| Female | 5 | 17.9 | 5 | 12.2 | 10 | 14.5 | |
| Age group (years) | | | | | | | |
| 18-29 | 8 | 28.6 | 18 | 43.9 | 26 | 37.7 | 0.604 |
| 30-39 | 10 | 35.7 | 10 | 24.4 | 20 | 29.0 | |
| 40-49 | 7 | 25.0 | 9 | 21.9 | 16 | 23.2 | |
| ≥50 | 3 | 10.7 | 4 | 9.8 | 7 | 10.1 | |
| Indigenous status | | | | | | | |
| Aboriginal | 6 | 21.4 | 17 | 41.5 | 23 | 33.3 | **0.008** |
| Torres Strait Islander | 3 | 10.7 | 12 | 29.3 | 15 | 21.7 | |
| Both Aboriginal and Torres Strait Islander | 19 | 67.9 | 12 | 29.3 | 31 | 44.9 | |
| Remoteness | | | | | | | |
| Outer regional | 24 | 85.7 | 33 | 80.5 | 57 | 82.6 | 0.749 |
| Remote/very remote | 4 | 14.3 | 8 | 19.5 | 12 | 17.4 | |
| Region | | | | | | | |
| Cairns | 23 | 82.1 | 26 | 63.4 | 49 | 71.0 | 0.111 |
| Torres and Cape | 5 | 17.9 | 15 | 36.6 | 20 | 29.0 | |
| Exposure categories | | | | | | | |
| MSM only | 14 | 50.0 | 28 | 68.3 | 42 | 60.9 | 0.196 |
| Heterosexual only | 8 | 28.6 | 6 | 14.6 | 14 | 20.3 | |
| IDU (MSM/IDU, heterosexual/IDU, IDU only) | 5 | 17.9 | 4 | 9.8 | 9 | 13.0 | |
| Missing | 1 | 3.6 | 3 | 7.3 | 4 | 5.8 | |

Over the entire study period, among Aboriginal and Torres Strait Islander notifications, 55.1% were diagnosed at an early stage of disease, 18.8% with late HIV and 21.7% with advanced HIV. The majority of people (85.5%) were reported as being on treatment when last clinic visit was recorded. The most common clinic type accessed for diagnosis was GP (31.9%), followed by hospital (24.6%), sexual health clinic (21.7%) and ACCHS (<17.4%). More people were diagnosed at clinics in Cairns (44.9%) compared to the Torres and Cape (<11.6%), and <18.8% of all people who have been diagnosed with HIV over the study period have died of the condition (see Table 22).

In 1984-2013, 42.8% of people were diagnosed at an early stage of disease with a CD4+ count of ≥350 cells/µL, and 63.4% of people in 2014-2019. 17.9% and 28.6% of people in 1984-2013 had late or advanced HIV at diagnosis, and 19.5% and 17.1% in 2014-2019. In 1984-2013, 75.0% of people were reported as being on treatment when the last clinic visit was recorded, compared to 92.7% in 2014-2019. Based on the fishers exact test there was a significant association between clinic accessed for diagnosis and the time periods (p=0.010). The most common type of clinic accessed for diagnosis in 1984-2013 was sexual health clinics (35.7%), followed by hospital (28.6%), GP (14.3%), and ACCHS (<10.7%). Comparatively, in 2014-2019 the most common clinic type accessed for diagnosis was GP (43.9%), followed by ACCHS (21.9%), hospital (21.9%) and sexual health clinics (12.2%). Based on fishers exact test there was also a significant association between area of diagnosing clinic and the time periods (p=0.021). There was a high proportion of people diagnosed at clinics in Cairns in 1984-2013 compared to 2014-2019 (78.6% to 21.9%); however, in 2014-2019 there was a large amount of missing data (65.9%) so this result should be interpreted with caution. The proportion of people that have passed away due to HIV was 35.7% of those that were diagnosed in 1984-2013 and <7.3% of those who were diagnosed in 2014-2019; however, this should also be interpreted with caution due to the large amount of missing data and the time since diagnosis.

*Table 22: Diagnosis and treatment characteristics of HIV in the Aboriginal and Torres Strait Islander population in FNQ from 1984-2013 and 2014-30 June 2019*

| Diagnosis and treatment characteristics of HIV notifications in the Aboriginal and Torres Strait Islander population in FNQ from 1984-2013 and 2014-30 June 2019 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1984-2013 | | 2014-2019 | | Total | | Fishers exact |
| Characteristics | Notifications (n) | % | Notifications (n) | % | Notifications (n) | % | P-value |
| Total | 28 | 40.6 | 41 | 59.4 | 69 | 100.0 | |
| CD4+ count at diagnosis | | | | | | | |
| ≥500 cells/µL | 9 | 32.1 | 14 | 34.2 | 23 | 33.3 | 0.326 |
| 350-499 cells/µL | 3 | 10.7 | 12 | 29.3 | 15 | 21.7 | |
| 200-349 cells/µL (late HIV diagnosis) | 5 | 17.9 | 8 | 19.5 | 13 | 18.8 | |
| <200 cells/µL (advanced HIV at diagnosis) | 8 | 28.6 | 7 | 17.1 | 15 | 21.7 | |
| Missing | 3 | 10.7 | 0 | 0.0 | 3 | 4.4 | |
| Treatment status at last recorded clinic visit | | | | | | | |
| Recorded as receiving treatment | 21 | 75.0 | 38 | 92.7 | 59 | 85.5 | 0.078 |
| No treatment recorded | 7 | 25.0 | 3 | 7.3 | 10 | 14.5 | |
| Clinic accessed for diagnosis | | | | | | | |
| ACCHS | <3 | <10.7 | 9 | 21.9 | <12 | <17.4 | **0.010** |
| Sexual health clinic | 10 | 35.7 | 5 | 12.2 | 15 | 21.7 | |
| Hospital | 8 | 28.6 | 9 | 21.9 | 17 | 24.6 | |
| GP | 4 | 14.3 | 18 | 43.9 | 22 | 31.9 | |
| Missing | <6 | <21.4 | 0 | 0.0 | <6 | <8.7 | |
| Area of diagnosing clinic | | | | | | | |
| Cairns | 22 | 78.6 | 9 | 21.9 | 31 | 44.9 | **0.021** |
| Torres and Cape | <3 | <10.7 | 5 | 12.2 | <8 | <11.6 | |
| Missing | <6 | <21.4 | 27 | 65.9 | <33 | <47.8 | |
| Died of condition | | | | | | | |
| Yes | 10 | 35.7 | <3 | <7.3 | <13 | <18.8 | NA |
| Missing | 18 | 64.3 | <41 | <100.0 | <59 | <85.5 | |

## 3.8 Discussion

An outbreak is defined as occurring when the number of people diagnosed with a disease in a community or area exceeds the number that would be expected (19). This study shows that the incidence of HIV among Aboriginal and Torres Strait Islander adults in FNQ since 2014 has well exceeded expected incidence. Therefore, this should be defined as an outbreak.

### *3.8.1 Key findings*

This study found evidence of an outbreak of HIV in the Aboriginal and Torres Strait Islander population in FNQ since 2014 with notifications above what is expected. The rate of HIV notifications in the Aboriginal and Torres Strait Islander population has increased since 2014 and peaked in 2016 with 22.8 notifications per 100,000 population per year, compared to 6.9 per 100,000 population per year in the non-Indigenous population in the same year. The majority (59.4%) of all HIV notifications in the Aboriginal and Torres Strait Islander population since 1984 have occurred in the last 5 years, with a change from on average <1 notification per year to 7 notifications per year.

Overall, from 1984-2019, 14.1% of all HIV notifications in FNQ were in the Aboriginal and Torres Strait Islander population, and 85.9% were in the non-Indigenous population. As FNQ has an Aboriginal and Torres Strait Islander population of approximately 5.8%, Aboriginal and Torres Strait Islander people in FNQ are over represented in HIV notifications.

The rate of notifications in the Aboriginal and Torres Strait Islander population in 2016 is the highest it has been in 35 years, in either the Aboriginal and Torres Strait Islander population or the non-Indigenous population in FNQ. The rate has since reduced to 4.1 per 100,000 population per year in 2019, however, this is only accounting for 6 months of the year. Comparatively, the highest rate of notifications in the non-Indigenous population over the 35-year period was 15.0 HIV notifications per 100,000 population per year in 2008.

A high proportion of all cases were in males in each time period (82.1% in 1984-2013 and 87.8% in 2014-2019) and in young people aged 18-29 years (28.6% and 43.9%) and 30-39 years (35.7% and 24.4%). Fishers' exact test found a significant association between Indigenous status and the time periods with the highest proportion of cases in 1984-2013 in both Aboriginal and Torres Strait Islander people (67.9%) and in 2014-2019 in Aboriginal people (41.5%). The distribution of notifications in the Torres and Cape district over the time periods was 17.9% in 1984-2013, compared to 36.6% in 2014-2019. This signals that more prevention

strategies could be targeted at Far North communities in the Torres Strait and Cape district, including increased resources for health organisations to address the outbreak.

The distribution of exposure categories in the recent outbreak, saw an indication of an increase in MSM exposure (50.0% to 68.3%), decrease in heterosexual exposure (28.6% to 14.6%), and a decrease in people who inject drugs (17.9% to 9.8%). Therefore, prevention strategies targeted at the MSM community in FNQ are important. Prevention strategies targeted at heterosexual people and those who inject drugs also remain important as these groups make up around a quarter of all notifications.

HIV is a lifelong illness and the year of diagnosis could be many years after initially acquiring the disease. As a proxy for disease stage at diagnosis, we looked at the CD4+ count at diagnosis to see if the patient was diagnosed during an early or late stage of disease. If a high proportion of people in the recent period had late stage diagnosis, this might mean they were living with the virus for many years prior to diagnosis. If this was the case, the observed increase in notifications might not reflect a true 'outbreak' in the recent time period. However, the CD4+ counts show that the majority of notifications in the last five years were people who had acquired the virus recently. Given all of these factors, it is reasonable to describe what has occurred here as an outbreak.

Compared to the historical period, there was a higher prevalence of people diagnosed in early stage of disease in the recent period, with 42.8% in 1984-2013 and 63.4% in 2014-2019 having a CD4+ count of ≥350 cells/μL at diagnosis. However, there is still 36.6% of people in the last five years that have had late or advanced HIV at diagnosis. Additionally, it is estimated that 20% of Aboriginal and Torres Strait Islander people living with HIV nationally are undiagnosed (13). This leaves a gap for transmission, as people who are HIV positive and not yet diagnosed, or diagnosed at a late stage of disease, are at higher risk of transmitting the virus. It is a key target of UNAIDS to reach 90% of people with HIV diagnosed, therefore this could be a target for local health organisations and the Tropical Public Health Services – Cairns going forward. Contact tracing could assist in detecting undiagnosed cases and early transmission, as well as targeting those most at risk.

Fishers' exact test found a significant association between the clinic accessed for diagnosis and the time periods. In the recent outbreak multiple clinics have been involved in diagnosing HIV. The most common clinic accessed was GPs (43.9%), followed by hospitals (21.9%), and ACCHS (21.9%). Additionally, fishers' exact test also found a statistical association between the area of the clinic and the time periods, with fewer clinics accessed in Cairns in 2014-2019 (21.9%) compared to the historic period (78.6%). It has been recognised that barriers to accessing

health care for STIs include shame and stigma surrounding sexual health and concerns of confidentiality in small communities. Therefore, it is important that these clinics are culturally safe spaces, and consider the needs of those involved in this outbreak, including how to engage with those who may be more at risk (11).

Those reported as on treatment at the last recorded clinic visit was 75.0% during the historic period and 92.7% during the outbreak period, reaching the UNAIDS target of at least 90% of those who are HIV positive are on treatment. However, as the data reflects treatment at one point in time, it is difficult to assess how many people are maintaining treatment. The maintenance of treatment is important in a HIV outbreak, as patients who maintain treatment and reach an undetectable viral load, are no longer able to transmit the virus (10). However, it was not possible to assess the population against the UNAIDS targets for diagnosis, treatment and suppressed viral load during this study as we did not have access to contact tracing data (to show how many people may have been exposed), ongoing treatment status, testing frequency and viral load results.

Less people have died from HIV in the recent time period compared to the historic period (35.7% of people in 1984-2013 compared to <7.3% in 2014-2019). This may be indicative of the advances in prevention and treatment strategies over the last few years, with the introduction of PrEP, and treatment as prevention methods enacted nationally, including in FNQ. This is a positive change to see and ensuring all those who are diagnosed with HIV have access to preventative medicines and maintenance of treatment is important in continuing to reduce the mortality associated.

A limitation associated with definitively declaring this an outbreak is the inability to analyse testing data over the entire study period which is not available without considerable efforts from both private and public health laboratory input. An increase in testing has the ability to artificially increase the number of cases seen in a specific time period which can be mistaken as an outbreak (2). Until recently, information on HIV testing in Queensland was not available; however, this information suggests that there has been an increase in HIV testing in the Aboriginal and Torres Strait Islander population in FNQ from 2010 to 2017 (20). Whilst this increase in HIV testing may contribute to a portion of the notifications involved in this outbreak, the increase in notifications is not considered to be solely due to an increase in testing. Additionally, according to the results, the outbreak began in 2014, which does not line up with the increase in HIV testing since 2010. Therefore, this is still considered an outbreak.

Defining an outbreak in the context of HIV may be difficult as there is no nationally recognised definition of when an increase in HIV notifications is considered an outbreak. This affects the

Public Health Unit's ability to classify and respond to an increase of HIV in the community, as this can impact on the ability to obtain necessary resources needed to respond to an outbreak. As HIV notifications have increased above what is expected in the Aboriginal and Torres Strait Islander population of FNQ, a local response has been mounted; however, an enhanced response is needed. When classifying the situation as an outbreak, the implications of this label must be considered. The risk of stigmatising a community and causing panic among community members should be managed appropriately; however, language that can contribute to action and resourcing is required to create equity.

### *3.8.2 Current public health response to HIV in FNQ*

At a regional level, the local health organisations and Tropical Public Health Services – Cairns have mounted a public health response to address the outbreak. The response initially involved extra temporary staff including Aboriginal and Torres Strait Islander health workers working with those involved in the outbreak to improve access to care and maintenance of treatment, as well as engage about the risk of further transmission. An HIV Response Plan was developed in response to the outbreak and included consultation throughout North Queensland. As part of this, the temporary response staff have been made permanent and some health organisations also received funding for more ongoing clinical staff, particularly to support people with more complex needs, and for public health nurses to perform contact tracing and other response activities. The contact tracing may identify other people with HIV, people who may benefit from additional information and access to prevention strategies, and will help with targeting messaging about the outbreak.

Recommendations on who should be tested and targeted for testing have also been refined. There are recommendations to increase testing for STIs through the response plan, including embedding testing into annual health checks and considering other testing options. Funding has been provided for a residential retreat for Aboriginal and Torres Strait Islander people who are HIV positive in Queensland to combat isolation and improve access to health care. Work is also being undertaken to understand how best to communicate relevant messages with the community who are at risk.

### *3.8.3 Syphilis outbreak in North Australia*

The increase in HIV notifications has occurred in the context of a major syphilis outbreak occurring in FNQ since 2011, affecting many Aboriginal and Torres Strait Islander people. This

outbreak has been thought to be linked to this HIV outbreak, with co-infection of syphilis a major risk for those with HIV in the region.

There are known links between STIs and HIV, with STIs known to increase the risk of HIV three to five-fold (21). STIs can also increase shedding of HIV which further increases the risk of transmission (6, 21). Syphilis was thought to be close to elimination in Australia in the early 2000s; however, syphilis began to increase in January 2011 among young Aboriginal and Torres Strait Islander people in North Queensland and spread throughout North Australia. An official outbreak was declared in North Queensland in September 2011 and in 2014 outbreaks of syphilis were also declared in the Northern Territory and Western Australia (22). From 2011 to 2015, 790 people were diagnosed with syphilis associated with this outbreak, with the majority residing in remote and rural communities. The outbreak is now affecting thousands of people in North Australia, many of whom are Aboriginal and Torres Strait Islander.

In 2015, a multijurisdictional syphilis outbreak group was formed as part of the Communicable Diseases Network Australia to address the syphilis outbreak (22). Through this response, the disease control interventions that are now in place include:

- Opportunistic and community screening, particularly of the young (aged less than 35 years) sexually active population;
- Immediate treatment of those with symptoms, tested positive or sexual contacts;
- Antenatal screening;
- Public health alerts;
- Education and campaign programs; and,
- Active follow up of individuals (22).

Additionally, North Queensland have developed the *North Queensland Aboriginal and Torres Strait Islander STI action plan 2016 – 2021* as a direct response to the syphilis outbreak. The main goals of the action plan are to eliminate congenital syphilis, control the syphilis outbreak and to reduce prevalence of STIs in the Aboriginal and Torres Strait Islander population in North Queensland (23).

This response has the potential to impact on HIV in the region through the increased screening for STIs, and increased awareness about STIs generally. The control of syphilis and other STIs in North Queensland may reduce the risk of acquiring HIV and assist in controlling this outbreak (23).

### *3.8.4 Public health implications*

As HIV is a lifelong illness that cannot be cured but can be managed, ongoing care and sustainable resources are required to control this outbreak. Improving awareness of preventative strategies, increasing accessibility to culturally safe health services, and addressing the stigma and shame that surround STIs, could be helpful in addressing this outbreak (13). Culturally appropriate resources focused at young Aboriginal and Torres Strait Islander people could assist in overcoming this barrier, such as the 'Young, deadly, free' campaign (see Figure 22).

'Young, deadly, free' is a resource that aims to provide information about sexual health to young Aboriginal and Torres Strait Islander people and increase uptake of testing and treatment of STIs (24). It was developed with Aboriginal and Torres Strait Islander people, is culturally appropriate and targets the at risk groups within communities. It also involves training young Aboriginal and Torres Strait Islander people in remote and very remote areas of Australia to deliver education sessions within their communities to increase awareness and uptake of routine testing. Contact tracing of newly identified cases and routine surveillance – including testing for HIV – has the potential to identify transmission clusters and associated risk factors that may otherwise go unnoticed (25). The ability to find and diagnose these cases when newly acquired would help in reducing further transmission and ceasing outbreaks early.


*Figure 22: Young, Deadly, Free website*

Reflecting the patterns observed in the non-Indigenous population, the majority of national preventative strategies currently target the MSM community (1). This may be an ineffective HIV prevention strategy for Aboriginal and Torres Strait Islander people, given that nationally approximately 50% of cases are not amongst MSM. However, this outbreak did show an increased prevalence of HIV in Aboriginal and Torres Strait Islander MSM in FNQ. To reflect the transmission risks within the Aboriginal and Torres Strait Islander population nationally, preventive strategies must balance efforts among the affected population groups; MSM, people who inject drugs and the heterosexual populations. Very few HIV campaigns are

initiated for heterosexual people and people who inject drugs in Australia. This is in part because of the low number of prevalence of HIV relative to the MSM population overall, but within the Aboriginal and Torres Strait Islander population this should not be the case.

Recent advances in HIV prevention, such as PrEP, have seen Aboriginal and Torres Strait Islander peoples largely left behind because strategies have not accounted for underlying determinants and social nor structural factors at play that enhance HIV risk in Aboriginal and Torres Strait Islander communities (26). This has resulted in a lower uptake and coverage of PrEP among high risk Aboriginal and Torres Strait Islander MSM than for the non-Indigenous population.

### *3.8.5 Strengths and limitations*

To our knowledge, this is the first study to quantify the notification rates for, or characteristics of, HIV in the Aboriginal and Torres Strait Islander population in FNQ since HIV became notifiable 35 years ago.

Strengths of this study included engaging with and receiving support from local health organisations in FNQ. Also, the engagement and involvement of Queensland Health on the research team assisted in gaining an understanding of the local context and response activities. The processes in place to access and analyse the data is strong which protects individuals and communities who may be involved.

Limitations of this study included that it was not possible to look at syphilis or other STI data in relation to HIV which led to an inability to show how many people involved in the HIV outbreak had a syphilis co-infection which may be related to the simultaneous syphilis outbreak. Not having access to testing data, or data on contact tracing and mobility those involved limited the ability to assess the nature of this outbreak. HIV is coded anonymously across Australia which can be problematic from a public health surveillance point of view; however, there are barriers to this as maintaining confidentiality is vital. Not having access to data on treatment clinics, ongoing treatment status or testing data was also a limitation. These variables are important in outbreak investigations as they can impact on transmission and control of an outbreak. Combining multiple databases, such as the SHIP database with NOCs, through data linkage studies may fill some of these gaps. Sequencing data to analyse the possible link between cases may also help address this limitation in future studies. Calculating rates annually for 35 years' (1984-2019) proved difficult as population measurement practices have changed multiple times over this period and consistent population estimates were

problematic. Finally, the small numbers may have impacted on the ability to detect significant differences during analysis.

## 3.9 Recommendations

The development of a nationally agreed upon definition for an outbreak of HIV could assist state and territory authorities with their capacity to declare an outbreak and respond appropriately. However, local perception of an outbreak should also be responded to quickly to limit further transmission.

The *Fifth National Aboriginal and Torres Strait Islander Blood Borne Viruses and Sexually Transmissible Infections Strategy 2018-2022* includes 10 guiding principles to support the national response to HIV:

1. Centrality of people with HIV and meaningful involvement of priority populations;
2. Human rights;
3. Access and equity;
4. Health promotion;
5. Prevention;
6. Quality health services;
7. Harm reduction;
8. Shared responsibility;
9. Commitment to evidence-based policy and programs; and,
10. Partnership (13).

These principles can be adapted to the response in FNQ. Based on this study, recommendations include enhancing the public health response including care teams with additional resources traveling to communities, as well as comprehensive contact tracing to test those who have been exposed and thus control the outbreak. However, comprehensive contact tracing should be undertaken using a culturally appropriate approach, building relationships and trust, and may need to be tailored for specific individuals and communities.

Increasing awareness of culturally appropriate sexual health resources such as those seen through the campaign, 'Young, Deadly, Free' and finding ways to improve engagement with the affected communities and individuals is important. This could include appointing more

Aboriginal and Torres Strait Islander staff to act as liaisons with medical staff, the affected community, and those at risk, to help reduce transmission. Multiple studies have recommended peer education as a way to engage with young Aboriginal and Torres Strait Islander people who are at higher risk of acquiring STIs (24, 27).

Increasing routine HIV testing in the population, particularly at risk groups, and analysing testing data in relation to case data is important. An increase in notifications should be quickly resourced and responded to. Improving access and awareness of preventative medicines (such as PrEP), and the importance of early diagnosis and maintenance of treatment, including culturally respectful health services, can contribute to stabilising the outbreak. Ensuring prevention and treatment medicines are affordable and easily accessible for all people is vital.

## 3.10 Conclusion

This study found that there has been an outbreak of HIV in the Aboriginal and Torres Strait Islander population in FNQ occurring since 2014, with rates in 2016 the highest recorded in this region and at least three times that of the non-Indigenous population. Additionally, 59.4% of all notifications affecting Aboriginal and Torres Strait Islander people over the last 35 years have occurred since 2014. There is a need for an enhanced public health response with additional resourcing to combat this outbreak.

The enhanced response should consider multiple care teams with additional HIV resources traveling to communities throughout Cairns, Torres and Cape to engage with the community about prevention and control of STIs. Additionally, comprehensive contact tracing could be undertaken to reach those that may have been exposed and control the outbreak; however, sensitivities surrounding this should be considered and confidentiality of patients should be ensured. It is important that this outbreak is dealt with promptly to avoid a similar situation to the syphilis outbreak that is still ongoing. The promotion and dissemination of culturally appropriate sexual health resources, such as ‘Young, deadly, free’, could be helpful to target young Aboriginal and Torres Strait Islander people who are at greatest risk.

## References


1. Ward JS, Hawke K, Guy RJ. Priorities for preventing a concentrated HIV epidemic among Aboriginal and Torres Strait Islander Australians. The Medical Journal of Australia. 2018;209(1):5-7.
2. Gregg MB. Field epidemiology. Third ed. USA: Oxford University Press 2008.
3. Communicable Diseases Network Australia. Human Immunodeficiency virus (HIV): CDNA National Guidelines for Public Health Units. First ed: Department of Health; 2014. p. 34.
4. U.S. Department of Health & Human Services. What Are HIV and AIDS? 2017 [Available from: https://www.hiv.gov/hiv-basics/overview/about-hiv-and-aids/what-are-hiv-and-aids].
5. Kirby Institute. HIV, viral hepatitis and sexually transmissible infections in Australia: Annual surveillance report 2018. UNSW Sydney: Kirby Institute; 2018. p. 218.
6. Ward J, Bryant J, Wand H, Pitts M, Smith A, Thiele DD, et al. Sexual health and relationships in young Aboriginal and Torres Strait Islander people: Results from the first national study assessing knowledge, risk practices and health service use in relation to sexually transmitted infections and blood borne viruses. Alice Springe, NT: Baker IDI Heart & Diabetes Institute; 2014.
7. United Nations. Sustainable Development Goals - Good Health and Wellbeing 2019 [Available from: https://www.un.org/sustainabledevelopment/health/].
8. Kirby Institute. Annual Surveillance Report on HIV, Viral Hepatitis and STIs in Australia. UNSW Sydney: Kirby Institute; 2017. p. 208.
9. Australian Federation of AIDS Organisation. HIV Prevention Sydney NSW: Australian Federation of AIDS Organisation; 2018 [Available from: https://www.afao.org.au/about-hiv/hiv-prevention/prep/].
10. Joint United Nations Programme on HIV/AIDS. 90-90-90: an ambitious treatment target to help end the AIDS epidemic. Geneva: UNAIDS. 2014.
11. Public Health Alert. Re: Increased cases of HIV in Aboriginal and/or Torres Strait Islander people in Far North Queensland [press release]. Cairns, Queensland: Queensland Health, February 2018.
12. Australian Federation of AIDS Organisations. HIV Statistics. Sydney NSW: Australian Federation of AIDS Organisations; 2018 [Available from: https://www.afao.org.au/about-hiv/hiv-statistics/].
13. Australian Government Department of Health. Fifth National Aboriginal and Torres Strait Islander Blood Borne Viruses and Sexually Transmissible Infections Strategy 2018-2022. Canberra ACT: Australian Government Department of Health; 2018. p. 1-68.
14. Kirby Institute. HIV in Australia. Annual surveillance short report 2018. UNSW Sydney: Kirby Institute; 2018. p. 82.
15. Ward J, McManus H, McGregor S, Hawke K, Giele C, Su J-Y, et al. HIV incidence in Indigenous and non-Indigenous populations in Australia: a population-level observational study. The Lancet HIV. 2018;5(9):e506-e14.
16. State of Queensland (Queensland Health). HIV in Queensland 2017. In: Department of Health, editor. Brisbane QLD: Queensland Health; 2018. p. 1-13.
17. Australian Bureau of Statistics. Aboriginal and Torres Strait Islander Population, 2016 Canberra: Australian Bureau of Statistics,; 2017 [Available from: https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Aboriginal%20and%20Torres%20Strait%20islander%20Population%20Article~12].
18. State of Queensland (Queensland Health). Hospital and health services maps 2019 [updated 23 September 2019. Available from: https://www.health.qld.gov.au/maps].
19. World Health Organization. Disease Outbreaks 2019 [Available from: http://www.searo.who.int/topics/disease_outbreaks/en/].
20. Preston-Thomas A. HIV Health Needs Assessment for Aboriginal and Torres Strait Islander people in North Queensland August 2019. Cairns, Queensland: Tropical Public Health Services - Cairns; 2019. p. 1-54.

21. Wright MR, Giele CM, Dance PR, Thompson SC. Fulfilling prophecy? Sexually transmitted infections and HIV in Indigenous people in Western Australia. Medical Journal of Australia. 2005;183(3):124-8.
22. Bright A, Dups J. Infectious and congenital syphilis notifications associated with an ongoing outbreak in northern Australia. Commun Dis Intell. 2016;40(1):E7-E10.
23. State of Queensland (Queensland Health). North Queensland Aboriginal and Torres Strait Islander sexually transmissible infections action plan 2016−2021. In: Branch AaTSIH, editor. Brisbane, Qld: State of Queensland (Queensland Health),; 2016. p. 40.
24. D'Costa B, Lobo R, Thomas J, Ward JS. Evaluation of the Young Deadly Free Peer Education Training Program: Early Results, Methodological Challenges, and Learnings for Future Evaluations. Frontiers in Public Health. 2019;7.
25. National Centre for HIV/AIDS VH, STD, and TB Prevention, Division of HIV/AIDS Prevention,. Detecting and responding to HIV transmission clusters: A guide for health departments June 2018. Centers for Disease Control and Prevention; 2018. p. 1-132.
26. Hope A, Haire B. “No-one’s driving this bus”–qualitative analysis of PrEP health promotion for Aboriginal and Torres Strait Islander gay and bisexual men. Australian and New Zealand Journal of Public Health. 2019;43(1):18-23.
27. MacPhail C, McKay K. Social determinants in the sexual health of adolescent Aboriginal Australians: a systematic review. Health & social care in the community. 2018;26(2):131-46.

## Appendix A

One page summary.

# HIV in Far North Queensland

Contact: Tamara Riley (tamara.riley@anu.edu.au)

Masters of Applied Epidemiology (MAE) Scholar
Aboriginal and Torres Strait Islander Health program
Australian National University

ANU Supervisors: Katie Thurber & Ray Lovett

The research team includes members from Cairns and Hinterland Hospital and Health Service, Queensland Health, Communicable Diseases Branch, Queensland Health, South Australia Health and Medical Research Institute, and the Australian National University.

The research aim is to investigate the increases in HIV cases among the Aboriginal and Torres Strait Islander population in Far North Queensland.

The key objectives are to:

- Perform a descriptive analysis and characterise the cases;
- Describe the diagnosis and treatment cascade; and,
- Hold knowledge exchange sessions with local health organisations to discuss findings.

Context: Since 2014 there has been an increase of Human Immunodeficiency Virus (HIV) cases within the Aboriginal and Torres Strait Islander population in Far North Queensland, with approximately 41 new cases identified. Usually in this region, there is 1-2 cases diagnosed within the Aboriginal and Torres Strait Islander population annually. This study will characterise and describe the increase in cases and investigate whether an outbreak has occurred. Concurrently we will describe the diagnosis and treatment cascade to understand health care access and treatment uptake. Knowledge exchange sessions will also be held with local health organisations to discuss findings, dissemination and public health implications.

This study will provide a means to be able to document the increase in cases and discuss implications for the community and for local health services. This study may also contribute to the evidence base regarding HIV in the Aboriginal and Torres Strait Islander population.

Method: This will be a quantitative study involving a case-series analysis, and knowledge exchange sessions with local health organisations. The study will involve using de-identified data obtained through Queensland Health.

The study will involve the following:

- Gather information from Queensland Health and local databases such as those held at Cairns Sexual Health Service;
- Describe the increase in cases including epidemiological factors;
- Characterise the cases by time, place, person, and clinical and lab characteristics of cases at diagnosis;
- Describe the diagnosis and treatment cascade;
- Identify and assess control measures to prevent further transmission; and,
- Write report and recommendations for public health action, incorporating knowledge from local health services.

## Appendix B

Queensland Health

# Public Health Alert

Queensland Government

February 2018

Attn: All clinicians

Re: Increased cases of HIV in Aboriginal and/or Torres Strait Islander people in Far North Queensland.

There has been an increase in the number of HIV diagnoses in Aboriginal and/or Torres Strait Islander people in Far North Queensland (FNQ). Most cases have been diagnosed in people resident in the Cairns region; some also travel to, or reside in regional or remote communities. The majority of cases have been in men, many of whom have male and female partners, but do not identify as gay or bisexual. Sexual contact appears to be the main route of transmission. 63% of new cases diagnosed in Aboriginal and/or Torres Strait Islander people in FNQ since 2014 have been in people aged less than 40 years. Contact tracing has been undertaken for all cases, but it is highly likely that others may have been exposed, and these people may be unaware of their risk.

A number of people newly diagnosed with HIV have also had syphilis co-infection. Syphilis is known to increase the risk of HIV transmission. There are syphilis outbreaks affecting young Aboriginal and Torres Strait Islander people across northern Australia and also affecting gay men and men who have sex with men (MSM) in the Cairns and Hinterland HHS area.

Many people experience barriers when accessing services for sexual health care, including experiences of shame and stigma and concerns re confidentiality. Ensuring your service is welcoming and non-judgemental can increase attendance and facilitate better health outcomes.

At risk groups: Most of the HIV cases diagnosed in Aboriginal and/or Torres Strait Islander people in FNQ have been in men aged 20 - 40 years who have male sex partners. All gay men and men who have male sexual partners are also at risk.

Offer opportunistic HIV, syphilis and other STI testing to all people in at risk groups when they attend health services.

**Key points:**

- Continue to offer syphilis and HIV testing to all Aboriginal and Torres Strait Islander people aged 15-39 years as part of a comprehensive STI screen.
- Ensure all clients who test positive for chlamydia or gonorrhoea are also tested for syphilis and HIV.
- Test all gay men and MSM as per the STIGMA guidelines (http://stipu.nsw.gov.au/wpcontent/uploads/STIGMA_Testing_Guidelines_Final_v5.pdf)
- Consider ways to make your service accessible for all clients.
- Prompt treatment and contact tracing are critical to STI control.
- Provide information to clients about risk reduction and regular testing if they change partners.

**Further information and assistance with contact tracing:**

- Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM) resources: http://www.ashm.org.au/HIV/
- Your local Sexual Health service, Men's and Women's Health service or contact tracing officer
- In Cairns and Hinterland: Cairns Sexual Health Service HIV Response CNC Lucy Thallon and Cairns Contact Tracing Officer Debbie Penney on (07) 4226 4769.

Dr Annie Preston-Thomas Public Health Medical Officer- Sexual Health Team, Tropical Public Health Service, Cairns

| Office | Postal | Phone | Fax |
|---|---|---|---|
| Tropical Public Health Services (Cairns)<br>William McCormack Place II<br>Level 7, 5B<br>Sheridan Street<br>CAIRNS QLD<br>4870 | PO Box 1103<br>CAIRNS QLD 4870 | (07) 4226 5555 | (07) 4031 1440 |

# Chapter 4

# Markers of chronic disease risk in a cohort of Aboriginal children and adolescents in urban New South Wales: findings from the Study of Environment on Aboriginal Resilience and Child Health

## 4.1 Abbreviations and acronyms

| | |
|---|---|
| ACCHS | Aboriginal Community Controlled Health Services |
| BMI | Body mass index |
| CI | Confidence interval |
| CVD | Cardiovascular disease |
| HbA1c | Haemoglobin A1c |
| HDL | High density lipoprotein cholesterol |
| LDL | Low density lipoprotein cholesterol |
| NSW | New South Wales |
| PR | Prevalence ratio |
| SEARCH | Study of Environment on Aboriginal Resilience and Child Health |

## 4.2 Acknowledgements

I would like to acknowledge the Study of Environment on Aboriginal Resilience and Child Health (SEARCH) project team at the Sax Institute and partnering Aboriginal Community Controlled Health Services (ACCHS) that have assisted with this study, as well as the SEARCH participants and their families. I would also like to acknowledge Professor Emily Banks and Dr Jason Agostino for their input and valuable feedback.

## 4.3 Abstract

**Background**: There are high rates of chronic disease present within the Aboriginal and Torres Strait Islander population. However, there is limited evidence regarding the distribution of chronic disease risk markers in children and adolescents. This study aims to provide insight into the chronic disease risk profiles of children and adolescents using data from a cohort study of Aboriginal youth in New South Wales (NSW).

**Methods**: SEARCH is conducted with four ACCHS in NSW. Data were collected by Aboriginal Research Officers employed by the local ACCHS. This study investigated the distribution of adult chronic disease risk markers including blood lipids (total cholesterol, low density lipoprotein (LDL) cholesterol and high density lipoprotein (HDL) cholesterol), haemoglobin A1c (HbA1c), and Body Mass Index (BMI) among Aboriginal children and adolescents aged 5-19 years participating in SEARCH. The relationship of cholesterol and HbA1c markers to demographic factors and BMI was also analysed using prevalence ratios (PR).

**Results**: The prevalence of chronic disease risk markers, according to established adult cut-offs, was low in the cohort. No individuals had high total cholesterol (0.0%), and only a small percentage of individuals had high LDL (2.9%) or HbA1c (2.4%). The majority of the cohort had normal HDL (85.0%). 45.7% of the cohort had a BMI in the normal weight range, 23.2% were overweight, and 31.2% were obese. The prevalence of borderline total cholesterol was 27% higher in those who were obese compared to those with a normal weight (PR 1.27, 95%CI 1.06-1.52). The prevalence of low HDL was two-fold among those who were obese compared to those with a normal weight (PR 2.12, 95%CI 1.26-3.57). Finally, the prevalence of low HDL was 81% higher in those aged 15-<19 years compared to the 5-<10 year age group (PR 1.81, 95%CI 1.00-3.26). We did not observe significant differences in LDL or HbA1c by age group, BMI, or sex.

**Conclusion**: Most youth in the SEARCH cohort were healthy with a low prevalence of chronic disease risk markers in the cohort. However, there were some signs that children in the cohort may be at risk of developing chronic disease later in life. A small percentage of the cohort did have high 'bad' cholesterol and HbA1c levels. We found some evidence of increasing prevalence of chronic disease risk with increasing age and BMI. There are opportunities to intervene and promote health factors that may decrease the risk of chronic disease in this age group.

## 4.4 Prologue

### *4.4.1 My role*

My role in this study was as the study leader. Chronic disease research is a priority for SEARCH and in Phase 2 new biomarkers were collected from the participants including chronic disease risk markers. I worked with Professor Emily Banks, Chief Investigator of SEARCH, to develop the research proposal. I developed a one page summary of the research proposal and engaged with the ACCHS to gain their input on the study (see Appendix A). I also developed a one page summary report of key findings to feedback to the ACCHS (see Appendix B). I made multiple trips to Sydney to meet with the SEARCH project team at the Sax Institute and accompany the team to the ACCHS to meet their staff. I travelled to Sydney in May 2018 to initially discuss the proposal for the study, and again in February 2019, to engage with the Tharawal Aboriginal Medical Service. I formed networks with the SEARCH project team who were helpful in assisting me with undertaking the data access process, undertaking training to access the secure network which houses the database, and engaging with the ACCHS. I also regularly attended the monthly SEARCH Centre for Research Excellence[8] meetings and presented on my recent training and conference experiences during the CRE meeting in July 2019 (see Appendix C). The SEARCH project team, the Tharawal Aboriginal Medical Service in Western Sydney, and the Riverina Medical and Dental Corporation in Wagga Wagga have representatives on the research team.

### *4.4.2 Lessons learnt and reflection*

This study gave me experience in developing a paper for publication and allowed me to learn more about Aboriginal and Torres Strait Islander chronic disease risk.

I undertook training and learnt how to use the Secure Unified Research Environment (SURE) to access the SEARCH database and undertake the analysis. This took some getting used to as importing documents and data into and out of SURE was tricky and, as my Supervisors did not have access to SURE, it made it difficult at times to work through queries about the analysis and seek feedback. I also built on my skills and experience in performing a data analysis using Stata.

This study reiterated the importance of the involvement of the community, in this case the partnering ACCHS, when undertaking research and publishing in the Aboriginal health space.

[8] https://www.saxinstitute.org.au/centre-for-research-excellence-in-urban-aboriginal-child-health/

The ability for the ACCHS to control the messaging that comes from the data they collect is integral and their continued input must always be sought.

### *4.4.3 Public health importance*

Chronic disease is the one of the biggest contributors to the burden of disease in the Aboriginal and Torres Strait islander population, with cardiovascular disease (CVD) and diabetes among the most common (1). Understanding who is at low risk, as well as who is at high risk, is important to understand disease burden in the population.

This study analysed the distribution of adult chronic disease risk markers in a cohort of Aboriginal youth in NSW and the relationship between these biomarkers and BMI. Understanding the distribution of these biomarkers can help with understanding the chronic disease risk profile of the cohort.

Currently, there is not a lot known about the development of chronic disease risk across the life course of Aboriginal peoples. This study will contribute to filling this evidence gap by profiling the distribution of risk markers in a cohort of Aboriginal children and adolescents. Preventive medicine and health promotion in children and adolescents could help prevent the development of chronic disease in adulthood; therefore, it is important to understand the early patterning of chronic disease risk in this population.

This chapter contains a data analysis of SEARCH data to assess the distribution of chronic disease risk markers in Aboriginal children and adolescents in NSW.

## 4.5 Introduction

There have been dramatic declines in CVD mortality in the Aboriginal and Torres Strait Islander population in recent decades (2). However, there is extensive evidence that there is still a high risk of chronic disease in this population. In 2011, an estimated 64% of the total Aboriginal and Torres Strait Islander burden of disease was chronic diseases (1). Some of the most prevalent chronic conditions and risk factors include overweight and obesity, renal disease, diabetes, and CVD (3). These conditions also affect young people, with CVD and diabetes among the top 10 health conditions affecting Aboriginal and Torres Strait Islander people aged 10-24 years in 2012-13 (4).

CVD is the second largest contributor to the burden of disease in Aboriginal and Torres Strait Islander people (1). In 2012-13, 8 per 100 Aboriginal and Torres Strait Islander people aged 10-24 years self-reported having a heart or circulatory condition, with 2.7 per 100,000 Aboriginal and Torres Strait Islander people aged 15-19 years passing away due to CVD (4). However, CVD in young people may be congenital and, therefore, may not be related to cholesterol levels. A high BMI during childhood has been correlated with hypertension in adolescence. A study undertaken using the SEARCH cohort found that 15.6% of the cohort had hypertension and 12.3% had pre-hypertension, with one of the strongest predictors of hypertension being a high BMI (5). The research also revealed that hypertension in childhood reliably predicts hypertension in adulthood increasing the risk of circulatory conditions (5). Similarly, a study undertaken in 2017 using the Aboriginal Birth Cohort found that a high BMI in childhood and adolescence (at 11 and 18 years of age) was associated with hypertension (6).

Type 1 diabetes commonly occurs during childhood and adolescents. Type 2 is more common in adulthood; however, it can still affect young people (4). In 2012-13, 0.5 per 100 Aboriginal and Torres Strait Islander people aged 10-24 years self-reported as having diabetes (4). Aboriginal and Torres Strait Islander adolescents with type 2 diabetes can show higher rates of chronic disease risk markers, including hypertension, elevated cholesterol, and obesity (7). Aboriginal and Torres Strait Islander people have been found to have an earlier onset of metabolic diseases, with the incidence of these diseases continuing to increase in adolescents, including a rise in type 2 diabetes (7).

A high BMI has found to be associated with an increased risk of chronic disease in adults (8). A high BMI in childhood can predict a high BMI in adulthood as overweight children are more likely to become overweight and have a high BMI as adults (9). A cohort study of Aboriginal and Torres Strait Islander children found that overweight and obesity was common and increased rapidly in early childhood, with the prevalence of obesity significantly higher in

Aboriginal and Torres Strait Islander children aged 5-9 years of age, compared to non-Indigenous children of the same age (10). In 2012-13, 30% of Aboriginal and Torres Strait Islander children aged 2-14 years were found to be overweight or obese, with similar percentages in males and females, and the prevalence increasing with age (11). Additionally, approximately 8% of children aged 2-14 years were underweight (11).

While it is clear that chronic diseases affect Aboriginal and Torres Strait Islander children and adolescents, their distribution is unknown as there is limited evidence quantifying chronic disease risk in this population (8). There is also limited evidence describing the relationship between chronic disease risk markers, demographic factors and BMI. We require further evidence on the chronic disease risk profile of Aboriginal and Torres Strait Islander children and adolescents, including the relationship between chronic disease risk markers and BMI, age and sex, in order to assess those at early risk, improve early detection of chronic disease, and assist in preventing chronic conditions. Analysing the distribution of blood lipids and HbA1c in Aboriginal and Torres Strait Islander children and adolescents will assist in assessing the risk of chronic diseases, such as CVD and diabetes, in this population. We recognise that the markers used in this study are chronic disease risk markers for adults; however, we will be using them throughout this study in relation to children and adolescents. There are limited validated risk factor thresholds established for Aboriginal children and adults. This requires additional study and is beyond the scope of this paper.

## 4.6 Methods

This is a cross-sectional analysis of data from a cohort study and involves quantifying the distribution of chronic disease risk markers among children and adolescents aged 5-19 years involved in the SEARCH.

### *4.6.1 Ethics approval*

Ethics approval was provided by The Australian National University's Human Research Ethics Committee (**2013/162**), and the Aboriginal Health and Medical Research Council (**892/12**).

### *4.6.2 SEARCH*

SEARCH is a longitudinal study of 1672 urban Aboriginal children and adolescents and 642 carers in NSW. Baseline data (Phase 1) were collected in 2008 – 2012 from children,

adolescents and their carers, through four ACCHS within NSW. Data are collected by Aboriginal Research Officers who are employed by the local ACCHS. The Research Officers conducted face-to-face interviews with the child and their carer, and conduct a clinical assessment including weight, height, waist circumference, and blood pressure measurements.

In Phase 2, families were followed up starting in 2014 and the data collection is still ongoing. Phase 2 included surveys and clinical assessment with an additional chronic disease component in which biomarkers – including a blood lipid panel and HbA1c testing – were taken for analysis. The current analysis is based on data from Phase 2.

### *4.6.3 Study aims and hypothesis*

The main aims of this study were to 1) investigate the distribution of blood lipids and HbA1c among children and adolescents in the SEARCH Phase 2 cohort, and 2) investigate the relationship between blood lipids and HbA1c with BMI, age and sex. The objective was to determine those at low risk and high risk of developing chronic disease and contribute to improving early detection and prevention by informing screening principles in Aboriginal children and adolescents.

We hypothesised that markers of chronic disease risk would be present among Aboriginal and Torres Strait Islander children and adolescents, and that these would be associated with high BMI and increasing age. To our knowledge, this is the first Australian study to quantify the distribution of chronic disease risk markers in Aboriginal children and adolescents in relation to BMI, age and sex.

### *4.6.4 Study sample*

The inclusion criteria for this study were children and adolescents participating in Phase 2 of SEARCH as of March 2019. This study was restricted to children aged 5-19 years of age, and to children who do not have an implausible BMI Z-score recorded. Of these children and adolescents, those who had total cholesterol, HDL, LDL and HbA1c recorded were also included in further analysis based on these outcomes (see Figure 23).

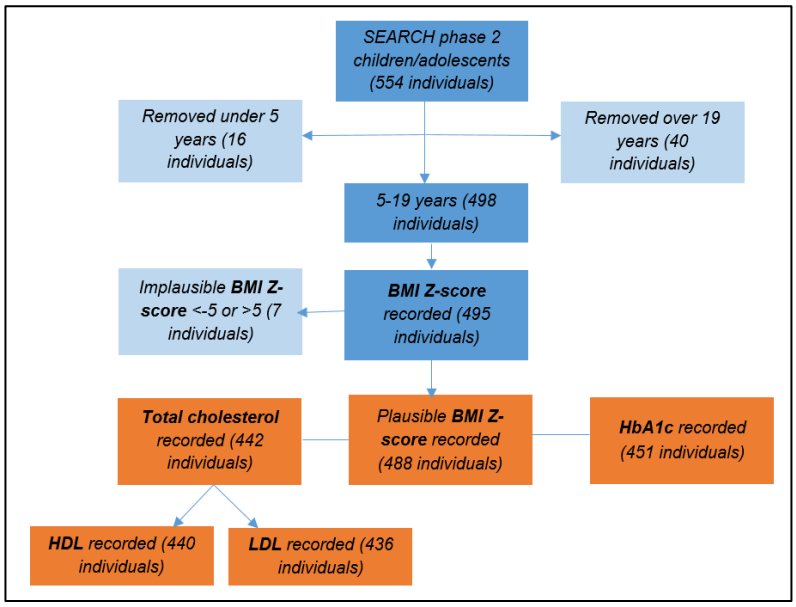



*Figure 23: Flow chart of study sample*

### *4.6.5 Study variables*

The primary outcome variables, cholesterol and HbA1c, were used as blood lipids can be a marker for CVD and HbA1C can be a marker for diabetes (3).

Blood lipid levels (cholesterol) can provide information on one aspect of CVD risk. Cholesterol results should be interpreted with caution when analysing them in isolation as these need to be considered in the context of absolute CVD risk (12). The cholesterol measures included in this study are total cholesterol, HDL cholesterol and LDL cholesterol. The *National Guide to a preventative health assessment for Aboriginal and Torres Strait Islander people* was used to specify the cut-offs (13). For total cholesterol <4.0 mmol/L is normal, 4.0 – 7.5 mmol/L is borderline, and >7.5 mmol/L is high. For LDL cholesterol <2.0 mmol/L is normal, 2.0 – 3.5 mmol/L is borderline, and >3.5 mmol/L is high (13). For HDL cholesterol <1.0 mmol/L is low and >/= 1.0 mmol/L is normal, with higher HDL being a protective factor for CVD (13). The cut offs used in this study are the adult cut offs as there are no validated cut offs for children (13).

HbA1c tests are used to diagnose diabetes by analysing the levels of glucose in the blood (4). Since 2012, HbA1c has been accepted as the primary method for diagnosing diabetes (13). The *National Guide to a preventative health assessment for Aboriginal and Torres Strait Islander people* was also used to specify relevant HbA1c cut-offs. HbA1c of <5.5% (<42mmol/mol) is normal, 5.5 – 6.4% (42-47 mmol/mol) is borderline (prediabetic and requires further investigation), and ≥ 6.5% (≥48 mmol/mol) is diagnostically high for diabetes (13). The cut offs

used in this study are the adult cut offs as there are no validated cut offs for children (13). Borderline and high HbA1c were grouped together to avoid small numbers.

BMI was a secondary outcome. BMI and BMI Z-scores are calculated by the SEARCH project team for each individual. BMI is a proxy measure of total body fat that considers weight and height. BMI can be standardised in relation to age and sex by calculating BMI Z-scores. This allows comparison of BMI across different age groups and sexes. The World Health Organization (WHO) cut-offs were used to categorise BMI in this study. This study was restricted to children aged 5 to 19 years so that all participants were subject to the same BMI Z-score cut offs (14). The WHO guidelines define underweight as a BMI Z-score of <-2, normal weight as -2 – 1, overweight as 1-2, and obesity as >2 in those aged 5-19 years (14). Underweight and normal weight were grouped together to avoid small numbers. Where outcomes are presented as a continuous variable in graphs, small cells are excluded.

The exposure variables were age and sex. Age was calculated by the SEARCH project team based on date of birth and date at survey. Age was cut into three categories: 5-<10 years, 10-<15 years, and 15-<19 years. Sex was a binary variable coded as male and female.

### *4.6.6 Statistical analysis*

All statistical analyses were performed using Stata 16.

The first step of the analysis was to quantify the distribution of blood lipids (total cholesterol, HDL cholesterol and LDL cholesterol), HbA1c, and BMI in the cohort overall. Histograms were created to display the distribution of each outcome in the cohort. We then examined the mean value and associated 95% confidence interval (CI) for each measure overall and in relation to the exposure variables (age, sex and BMI). All cells <5 were confidentialised.

Regression analyses were undertaken to calculate PR and quantify the association between the outcome and age, sex, and BMI. First, univariate analyses were undertaken, adjusted for one variable at a time. Next, adjusted analyses were undertaken. The univariate models were repeated with additional adjustment for age and sex, where appropriate. BMI was not adjusted for when quantifying the association between age or sex and the outcomes, as BMI is potentially along the causal pathway between age or sex and the outcome of interest (see Figure 24).


*Figure 24: Hypothesised pathway between age and sex, BMI, and the outcomes of interest*

For each model, the outcome variable was a binary variable and significance was assessed using p values ($p<0.05$) and 95% CI.

## 4.7 Results

This study included 488 children and adolescents: 192 aged 5-<10 years (39.3%), 211 aged 10-<15 years (43.2%), and 85 aged 15-<19 years (17.4%). Of this cohort, 234 were male (47.9%) and 254 were female (52.1%).

BMI

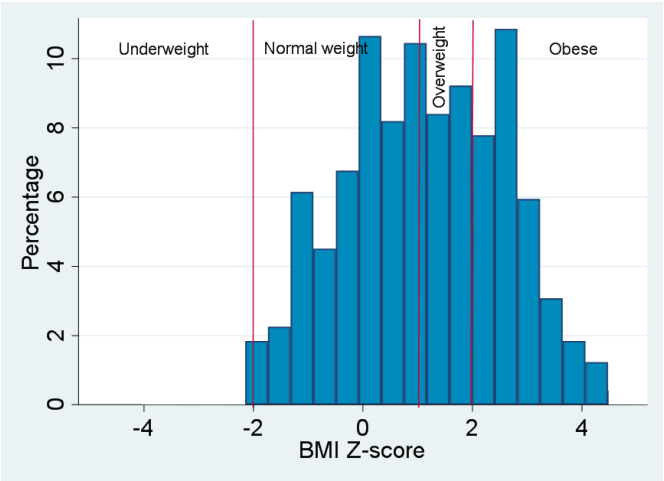



*Figure 25: BMI Z-score histogram (small cells not shown)*

Of the 488 children and adolescents who had a BMI recorded, 45.7% were of normal weight, 23.2% were overweight, and 31.2% were obese (see Figure 25). The mean BMI Z-score was 1.13 (95%CI 0.99-1.26). The mean BMI was higher among those aged 10-<15 (1.25, 95%CI 1.05-1.45) and 15-<19 years (1.61, 95%CI 1.31-1.91), compared to those who were 5-<10 years (0.78, 95%CI 0.58-0.98). The prevalence of obesity was 40.0% in those aged 15-<19 years, 35.5% in those aged 10-<15 years, and 22.4% in those aged 5-<10 years. The distribution of BMI was similar in males and females (see Table 23).

*Table 23: BMI distribution overall and by age group, sex*

| BMI | | | | | |
|---|---|---|---|---|---|
| | Mean (95% CI) | Normal weight % (n) | Overweight % (n) | Obese % (n) | Total |
| Total | 1.13 (0.99-1.26) | 45.7 (223) | 23.2 (113) | 31.2 (152) | 488 |
| Age group | | | | | |
| 5-<10 | 0.78 (0.58-0.98) | 58.9 (113) | 18.8 (36) | 22.4 (43) | 192 |
| 10-<15 | 1.25 (1.05-1.45) | 40.3 (85) | 24.2 (51) | 35.5 (75) | 211 |
| 15-<19 | 1.61 (1.31-1.91) | 29.4 (25) | 30.6 (26) | 40.0 (34) | 85 |
| Sex | | | | | |
| Male | 1.07 (0.87-1.27) | 46.6 (109) | 21.4 (50) | 32.1 (75) | 234 |
| Female | 1.18 (1.01-1.35) | 44.9 (114) | 24.8 (63) | 30.3 (77) | 254 |

Total cholesterol

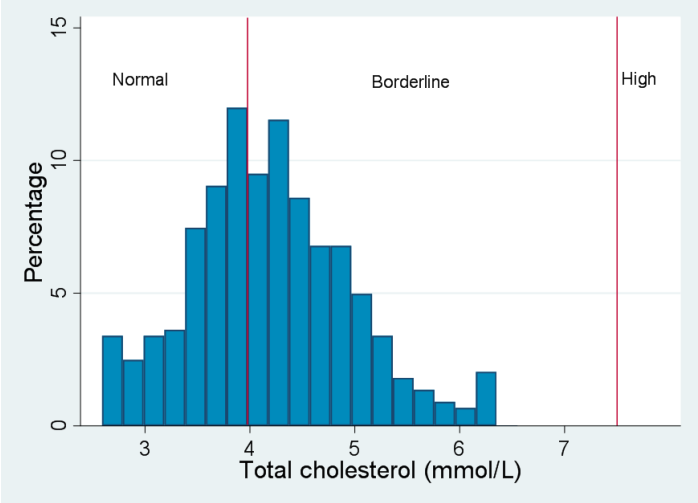



*Figure 26: Total cholesterol histogram (small cells not shown)*

Of the 442 children and adolescents who had total cholesterol recorded, 43.2% had normal, 56.8% had borderline and no individuals had high total cholesterol (see Figure 26). The mean total cholesterol was 4.19 mmol/L (95%CI 4.12-4.27) and was relatively similar across age groups. The prevalence of borderline total cholesterol was 54.9% among those aged 5-<10 years, 56.7% among those aged 10-<15 years, and 60.9% among those aged 15-<19 years (see Table 24). There was no significant difference in the prevalence of borderline (versus normal)

total cholesterol in the older age groups compared to those aged 5-<10 years (10-<15 years PR 1.03, 95%CI 0.86-1.24; 15-<19 years PR 1.11, 95%CI 0.89-1.38) (see Table 25).

There was a similar distribution among males and females, with 43% of each having normal and 56% of each having borderline total cholesterol. There was no significant difference in the prevalence of borderline (versus normal) total cholesterol among females compared to males (PR 1.00, 95%CI 0.85-1.18).

The prevalence of borderline total cholesterol was higher in those with a higher BMI. 52.0% of those with normal weight, 53.1% of those who were overweight and 66.2% of those who were obese had borderline total cholesterol. There was a 28% increase in the prevalence of having borderline (versus normal) total cholesterol in those who were obese compared to those with a normal weight (PR 1.27, 95%CI 1.06-1.52). After adjusting for age and sex, the result remained significant (PR 1.27, 95%CI 1.06-1.52).

*Table 24: Total cholesterol distribution overall and by age group, sex, and BMI*

| **Total cholesterol** | | | | | |
|---|---|---|---|---|---|
| | Mean (95% CI) mmol/L | Normal % (n) | Borderline % (n) | High % (n) | Total |
| Total | 4.19 (4.12-4.27) | 43.2 (191) | 56.8 (251) | 0.0 (0) | 442 |
| Age group | | | | | |
| 5-<10 | 4.18 (4.06-4.29) | 45.1 (78) | 54.9 (95) | 0.0 (0) | 173 |
| 10-<15 | 4.18 (4.07-4.29) | 43.3 (81) | 56.7 (106) | 0.0 (0) | 187 |
| 15-<19 | 4.26 (4.09-4.43) | 39.0 (32) | 60.9 (50) | 0.0 (0) | 82 |
| Sex | | | | | |
| Male | 4.18 (4.07-4.28) | 43.3 (94) | 56.7 (123) | 0.0 (0) | 217 |
| Female | 4.21 (4.11-4.31) | 43.1 (97) | 56.9 (128) | 0.0 (0) | 225 |
| BMI | | | | | |
| Normal | 4.12 (4.02-4.23) | 47.9 (94) | 52.0 (102) | 0.0 (0) | 196 |
| Overweight | 4.19 (4.03-4.34) | 46.9 (46) | 53.1 (52) | 0.0 (0) | 98 |
| Obese | 4.31 (4.17-4.45) | 33.8 (47) | 66.2 (92) | 0.0 (0) | 139 |

*Table 25: PR and 95% CI of borderline/high total cholesterol, by age group, sex, and BMI*

| Total cholesterol (borderline/high versus normal) | | | | | | |
|---|---|---|---|---|---|---|
| | Unadjusted | | | Adjusted for age and sex | | |
| | PR | 95% CI | P value | PR | 95% CI | P value |
| Age group | | | | | | |
| 5-<10 | 1 | - | - | 1 | - | - |
| 10-<15 | 1.03 | 0.86-1.24 | 0.736 | 1.03 | 0.86-1.24 | 0.734 |
| 15-<19 | 1.11 | 0.89-1.38 | 0.350 | 1.11 | 0.89-1.39 | 0.345 |
| Sex | | | | | | |
| Male | 1 | - | - | 1 | - | - |
| Female | 1.00 | 0.85-1.18 | 0.965 | 0.99 | 0.84-1.17 | 0.932 |
| BMI | | | | | | |
| Normal weight | 1 | - | - | 1 | - | - |
| Overweight | 1.02 | 0.81-1.28 | 0.868 | 1.00 | 0.79-1.27 | 0.978 |
| Obese | 1.27 | 1.06-1.52 | **0.009** | 1.27 | 1.06-1.52 | **0.011** |

<u>HDL cholesterol ('good cholesterol')</u>

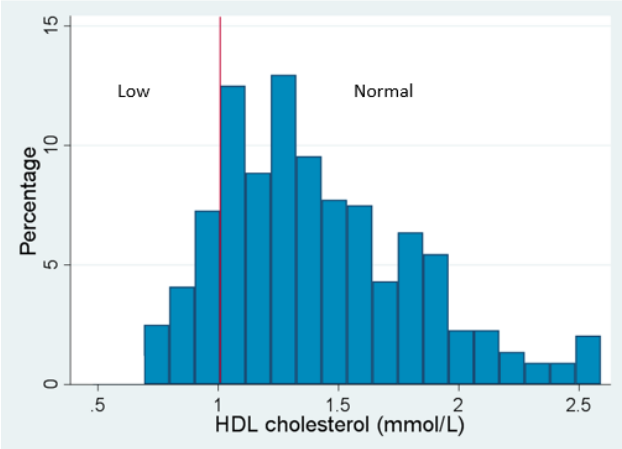



*Figure 27: HDL histogram (small cells not shown)*

Of the 440 children and adolescents who had HDL recorded, 15.0% had low, and 85.0% had normal HDL cholesterol (see Figure 27). The mean HDL was 1.41 mmol/L (95%CI 1.37-1.44). The prevalence of low HDL 11.6% among those aged 5-<10 years, 15.5% among those aged 10-<15 years, and 21.0% among those aged 15-<19years (see Table 26). There was an 81% increase in the prevalence of having low (versus normal) HDL cholesterol in those aged 15-<19 years compared to the 5-<10 year age group (PR 1.81, 95%CI 1.00-3.26). After adjusting for age and sex the result was not significant (PR 1.72, 95%CI 0.96-3.11). There was not a significant

difference between the 10-<15 and the 5-<10 year age group (PR 1.33. 95%CI 0.78-2.27) (see Table 27).

The prevalence of normal HDL was 81.7% among females and 88.4% among males. Comparatively, 18.3% of females and 11.6% of males had low HDL. There was no significant difference in the prevalence of low (versus normal) HDL among females compared to males (PR 1.58, 95%CI 0.99-2.51).

89.7% of those with normal weight had a normal HDL, compared to 87.8% of those who were overweight and 78.3% of those who were obese. 10.3% of those with normal weight had low HDL, compared to 12.2% of those who were overweight and 21.7% of those who were obese. The prevalence of having low (versus normal) HDL was two-fold in those who were obese compared to those with a normal weight (PR 2.10, 95%CI 1.24-3.54). After adjusting for age and sex the result remained significant (PR 1.95, 95%CI 1.15-3.32).

*Table 26: HDL cholesterol distribution overall and by age group, sex, and BMI*

| **HDL cholesterol** | | | | |
|---|---|---|---|---|
| | Mean (95% CI) mmol/L | Low % (n) | Normal % (n) | Total |
| Total | 1.41 (1.37-1.44) | 15.0 (66) | 85.0 (374) | 440 |
| Age group | | | | |
| 5-<10 | 1.48 (1.41-1.54) | 11.6 (20) | 88.4 (152) | 172 |
| 10-<15 | 1.40 (1.34-1.46) | 15.5 (29) | 84.5 (158) | 187 |
| 15-<19 | 1.27 (1.21-1.34) | 21.0 (17) | 79.0 (64) | 81 |
| Sex | | | | |
| Male | 1.46 (1.40-1.51) | 11.6 (25) | 88.4 (191) | 216 |
| Female | 1.36 (1.30-1.41) | 18.3 (41) | 81.7 (183) | 224 |
| BMI | | | | |
| Normal | 1.50 (1.44-1.56) | 10.3 (20) | 89.7 (175) | 195 |
| Overweight | 1.43 (1.34-1.51) | 12.2 (12) | 87.8 (86) | 98 |
| Obese | 1.28 (1.22-1.34) | 21.7 (30) | 78.3 (108) | 138 |

*Table 27: PR and 95% CI of low HDL cholesterol, by age group, sex, and BMI*

| HDL cholesterol (low versus normal) | | | | | | |
|---|---|---|---|---|---|---|
| | Unadjusted | | | Adjusted for age and sex | | |
| | PR | 95% CI | P value | PR | 95% CI | P value |
| Age group | | | | | | |
| 5-<10 | 1 | - | - | 1 | - | - |
| 10-<15 | 1.33 | 0.78-2.27 | 0.288 | 1.34 | 0.79-2.27 | 0.277 |
| 15-<19 | 1.81 | 1.00-3.26 | **0.050** | 1.72 | 0.96-3.11 | 0.070 |
| Sex | | | | | | |
| Male | 1 | - | - | 1 | - | - |
| Female | 1.58 | 0.99-2.51 | 0.051 | 1.54 | 0.97-2.44 | 0.067 |
| BMI | | | | | | |
| Normal weight | 1 | - | - | 1 | - | - |
| Overweight | 1.19 | 0.61-2.34 | 0.606 | 1.08 | 0.55-2.14 | 0.819 |
| Obese | 2.12 | 1.26-3.57 | **0.005** | 1.97 | 1.16-3.35 | **0.012** |

LDL cholesterol ('bad cholesterol')

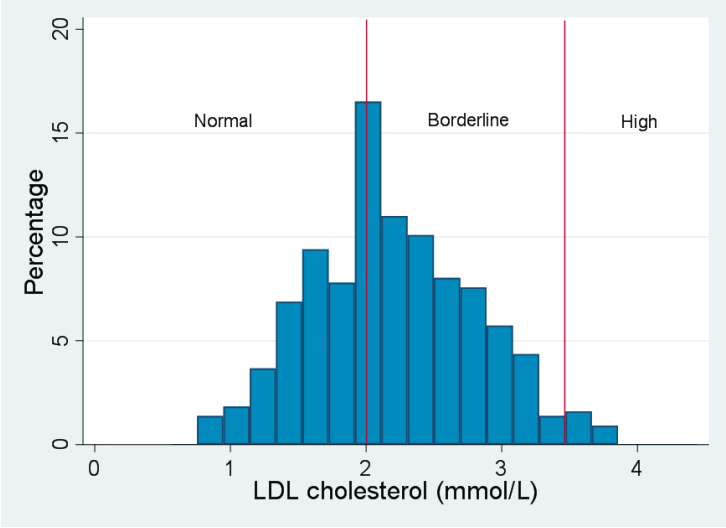



*Figure 28: LDL histogram (small cells not shown)*

Of the 436 children and adolescents who had LDL recorded, 37.2% had normal, 59.9% had borderline, and 2.9% had high levels of LDL cholesterol (see Figure 28). The mean LDL was 2.21 mmol/L (95%CI 2.15-2.27). The prevalence of borderline LDL was 57.7% among those aged 5-<10 years, 60.5% among those aged 10-<15 years and 62.9% among those aged 15-<19 years (see Table 28). Additionally, the prevalence of high LDL was <2.9% among those aged 5-<10 years, 3.2% among those aged 10-<15 years and <7.4% among those aged 15-<19 years. There

was no significant difference in the prevalence of borderline/high (versus normal) LDL in the older age groups compared to those aged 5-<10 years (10-<15 years PR 1.08, 95%CI 0.92-1.28; 15-<19 years PR 1.18, 95%CI 0.97-1.42) (see Table 29).

The prevalence of normal, borderline and high LDL was similar for females and males. There was no significant difference in the prevalence of borderline/high (versus normal) LDL among females compared to males (PR 1.06, 95%CI 0.91-1.22).

41.2% of those with normal weight had a normal LDL, compared to 36.1% of those who were overweight and 32.6% of those who were obese. 56.8% of those with normal weight had borderline LDL, compared to 61.9% of those who were overweight and 62.3% of those who were obese. There was no significant difference in the prevalence of borderline/high (versus normal) LDL in those who were overweight or obese compared to normal weight (overweight PR 1.09, 95%CI 0.89-1.31; obese PR 1.15, 95%CI 0.97-1.35).

*Table 28: LDL cholesterol distribution overall and by age group, sex, and BMI*

| **LDL cholesterol** | | | | | |
|---|---|---|---|---|---|
| | Mean (95% CI) mmol/L | Normal % (n) | Borderline % (n) | High % (n) | Total |
| Total | 2.21 (2.15-2.27) | 37.2 (162) | 59.9 (261) | 2.9 (13) | 436 |
| Age group | | | | | |
| 5-<10 | 2.19 (2.10-2.28) | 41.2 (70) | 57.7 (98) | <2.9 (<5) | <173 |
| 10-<15 | 2.17 (2.07-2.26) | 36.2 (67) | 60.5 (112) | 3.2 (6) | 185 |
| 15-<19 | 2.35 (2.19-2.51) | 30.9 (25) | 62.9 (51) | <7.4 (<6) | <82 |
| Sex | | | | | |
| Male | 2.15 (2.06-2.24) | 38.9 (84) | 57.4 (124) | 3.7 (8) | 216 |
| Female | 2.27 (2.19-2.35) | 35.5 (78) | 62.3 (137) | 2.3 (5) | 220 |
| BMI | | | | | |
| Normal | 2.13 (2.05-2.22) | 41.2 (79) | 56.8 (109) | <2.6 (<5) | <193 |
| Overweight | 2.21 (2.07-2.34) | 36.1 (35) | 61.9 (60) | <5.2 (<5) | <100 |
| Obese | 2.32 (2.19-2.44) | 32.6 (45) | 62.3 (86) | 5.1 (7) | 138 |

*Table 29: PR and 95% CI of borderline/high LDL cholesterol, by age group, sex, and BMI*

| LDL cholesterol (borderline/high versus normal) | | | | | | |
|---|---|---|---|---|---|---|
| | Unadjusted | | | Adjusted for age and sex | | |
| | PR | 95% CI | P value | PR | 95% CI | P value |
| Age group | | | | | | |
| 5-<10 | 1 | - | - | 1 | - | - |
| 10-<15 | 1.08 | 0.92-1.28 | 0.340 | 1.08 | 0.91-1.27 | 0.367 |
| 15-<19 | 1.18 | 0.97-1.42 | 0.100 | 1.17 | 0.96-1.41 | 0.118 |
| Sex | | | | | | |
| Male | 1 | - | - | 1 | - | - |
| Female | 1.06 | 0.91-1.22 | 0.459 | 1.04 | 0.89-1.20 | 0.614 |
| BMI | | | | | | |
| Normal weight | 1 | - | - | 1 | - | - |
| Overweight | 1.09 | 0.89-1.31 | 0.396 | 1.05 | 0.86-1.27 | 0.639 |
| Obese | 1.15 | 0.97-1.35 | 0.109 | 1.13 | 0.95-1.33 | 0.162 |

HbA1c

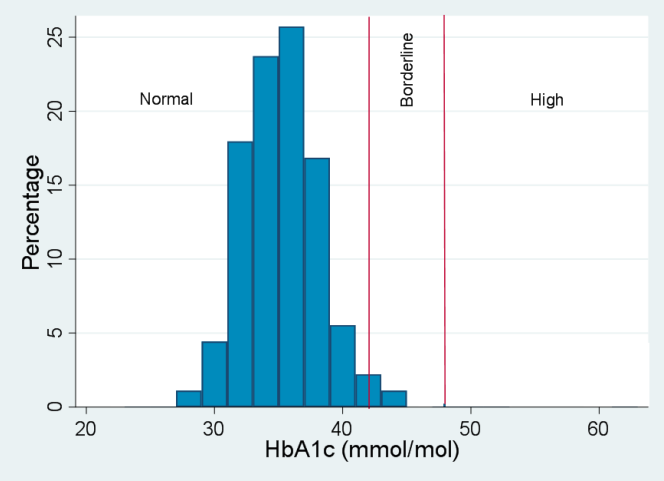



*Figure 29: HbA1c histogram (small cells not shown)*

Of the 451 children and adolescents who had HbA1c recorded, 97.6% had normal and 2.4% had borderline or high HbA1c (see Figure 29). The mean HbA1c was 34.85 mmol/mol (95%CI 34.53-35.17). The prevalence remained similar in all age groups with approximately 97% having normal HbA1c (see Table 30). There was no significant difference in the prevalence of borderline/high (versus normal) HbA1c in the older age groups compared to those aged 5-<10 years (10-<15 years PR 1.20, 95%CI 0.33-4.39; 15-<19 years PR 1.15, 95%CI 0.22-6.16) (see Table 31).

Prevalence remained similar for males and females with 97% normal, and approximately 2% having borderline or high HbA1c. There was no significant difference in the prevalence of borderline/high (versus normal) HbA1c among females compared to males (PR 0.85, 95%CI 0.26-2.75).

The prevalence of borderline or high HbA1c was <2.4% in those who were normal weight, <4.7% in those who were overweight and 4.4% in those who were obese. There was no significant difference in the prevalence of borderline/high (versus normal) HbA1c in those who were overweight or obese compared to normal weight (overweight PR 0.66, 95%CI 0.07-6.30; obese PR 2.96, 95%CI 0.75-11.65).

*Table 30: HbA1c distribution overall and by age group, sex, and BMI*

| **HbA1C** | | | | |
|---|---|---|---|---|
| | Mean (95% CI) mmol/mol | Normal % (n) | Borderline/high % (n) | Total |
| Total | 34.85 (34.53-35.17) | 97.6 (440) | 2.4 (11) | 451 |
| Age group | | | | |
| 5-<10 | 34.73 (34.29-35.18) | 97.8 (178) | <2.7 (<5) | <183 |
| 10-<15 | 35.21 (34.67-35.75) | 97.4 (185) | 2.6 (5) | 190 |
| 15-<19 | 34.25 (33.49-35.02) | 97.5 (77) | <6.1 (<5) | <82 |
| Sex | | | | |
| Male | 34.81 (34.40-35.22) | 97.4 (222) | 2.6 (6) | 228 |
| Female | 34.89 (34.40-35.38) | 97.8 (218) | 2.2 (5) | 223 |
| BMI | | | | |
| Normal | 34.35 (33.87-34.82) | 98.5 (200) | <2.4 (<5) | <205 |
| Overweight | 34.48 (33.93-35.03) | 99.0 (101) | <4.7 (<5) | <106 |
| Obese | 35.82 (35.21-36.42) | 95.6 (131) | 4.4 (6) | 137 |

*Table 31: PR and 95% CI of borderline/high HbA1c, by age group, sex, and BMI*

| HbA1c (borderline/high versus normal) | | | | | | |
|---|---|---|---|---|---|---|
| | Unadjusted | | | Adjusted for age and sex | | |
| | PR | 95% CI | P value | PR | 95% CI | P value |
| Age group | | | | | | |
| 5-<10 | 1 | - | - | 1 | - | - |
| 10-<15 | 1.20 | 0.33-4.39 | 0.786 | 1.19 | 0.32-4.36 | 0.795 |
| 15-<19 | 1.15 | 0.22-6.16 | 0.869 | 1.16 | 0.22-6.25 | 0.860 |
| Sex | | | | | | |
| Male | 1 | - | - | 1 | - | - |
| Female | 0.85 | 0.26-2.75 | 0.789 | 0.86 | 0.26-2.78 | 0.795 |
| BMI | | | | | | |
| Normal weight | 1 | - | - | 1 | - | - |
| Overweight | 0.66 | 0.07-6.30 | 0.721 | 0.63 | 0.07-6.07 | 0.689 |
| Obese | 2.96 | 0.75-11.65 | 0.120 | 2.81 | 0.70-11.31 | 0.147 |

## 4.8 Discussion

We found that almost all children and adolescents in the cohort had normal cholesterol and HbA1c levels. The cohort had no individuals with high total cholesterol (0.0%), few individuals with high LDL ('bad') cholesterol (2.9%), and the majority of individuals had normal HDL ('good') cholesterol (85.0%). The majority of the cohort had a normal HbA1c (97.6%) and only a few individuals had a borderline or high HbA1c (2.4%). This shows a low prevalence of chronic disease risk markers in this cohort.

Individuals with obesity had higher levels of total cholesterol and lower levels of HDL, compared to individuals with normal weight; both of which can increase the risk of CVD (13). There was a 27% increase in the prevalence of having borderline total cholesterol in those who were obese compared to those with normal. There was an 81% increase in the prevalence of low HDL cholesterol in those aged 15-<19 years compared to the 5-<10 year age group; however, after adjusting for age and sex the result was not significant. There was also a 97% increase in the prevalence of low HDL in those who were obese compared to those with a normal weight.

Overall, these measures suggest a healthy cardiovascular risk profile for the cohort, given that it was common for participants to have high levels of 'good' cholesterol and low levels of 'bad' cholesterol. The risk of diabetes associated with HbA1c was also found to be low in this cohort.

While the prevalence of some chronic disease risk markers increased with age, the results were only significant for low HDL cholesterol. There was also no significant difference in the prevalence of chronic disease risk markers between males and females.

The cohort showed an increase in BMI distribution throughout childhood and adolescence, with the mean BMI higher among those aged 10-<15 and 15-<19 years, compared to those who were 5-<10 years. Close to half the cohort had a BMI of normal weight (45.7%), with 23.2% overweight and 31.2% obese. Other studies have also found that BMI increases with age and that overweight children are more likely to become overweight adults, leading to an increased risk of chronic disease in adulthood (9).

This is one of the first and largest studies to analyse the distribution of chronic disease risk markers in Aboriginal children and adolescents. Limitations of this study included the use of adult cut offs to assess chronic disease risk, as cut offs for children and adolescents were not available (13). We included underweight participants in the normal weight group due to small numbers; this might bias our results because those with underweight might have a different risk profile to those with normal weight. However, there were fewer than five underweight participants; therefore, this is unlikely to impact our results. This sample was not representative and includes children and adolescents that are attending primary care and, therefore, may be healthier than those who are not. Additionally, the chronic disease risk markers were not measured from a fasting sample. We had limited power to detect differences in outcomes, due to the small sample size and some outcomes being uncommon in the cohort.

It has been recommended to undertake an absolute CVD risk assessment when assessing people for CVD risk. Absolute CVD risk assessment includes multiple factors such as smoking status, blood pressure, blood lipid levels, diabetes status, age and sex to quantify the absolute risk of CVD (12). However, we did not have the data required to undertake an absolute CVD risk assessment. Given that we have analysed these individual risk measures in isolation rather than in the context of an individual's absolute CVD risk, results should be interpreted with caution (12). An absolute CVD risk algorithm for children and adolescents has not been validated to date (13).

Future studies could explore how social and environmental factors relate to the risk of chronic disease, to identify protective factors associated with healthy trajectories. Carers' health could also be analysed in relation to the children and adolescents in order to understand the relationships between the health of carers and youth. It may also be helpful to analyse participants' self-reported health conditions and health status in the surveys in relation to the

chronic disease risk markers, to assess how many of the cohort are aware of their chronic disease risk or have already been diagnosed with a chronic disease. As the SEARCH study continues, it would be valuable to repeat this research and assess the levels of total cholesterol, HDL, LDL and HbA1c in an aging cohort in order to identify the critical ages at which risk markers emerge and impact on chronic disease risk.

## 4.9 Conclusion

The majority of the cohort had normal cholesterol and HbA1c levels. However, there were some signs that those in the cohort may be at risk of developing chronic disease later in life. Close to half of the cohort were in the normal weight category, with the prevalence of overweight and obesity increasing with age. The prevalence of borderline total cholesterol and low HDL was significantly higher in those who were obese compared to those with normal weight. The prevalence of low HDL was significantly higher among older adolescents (15-<19 years) compared to children (5-<10 years). This suggests that those who are obese and in an older age group may be at a higher risk of acquiring chronic disease than those with normal weight or in younger age groups. Markers of chronic disease risk may begin to arise in childhood and adolescence, with the prevalence of distribution increasing with age and BMI.

Future studies on environmental factors that may impact on chronic disease risk markers and BMI could help understand our findings. Repeating this study as the cohort ages may also allow us to identify the critical ages at which chronic disease risk markers may emerge. We hope the results contribute to improving prevention of chronic disease in the Aboriginal and Torres Strait Islander population by identifying low and high risk groups. There are opportunities to intervene and promote health factors that may decrease risk of chronic disease markers in childhood and adolescence.

## References


1. Australian Institute of Health and Welfare. Australian Burden of Disease Study: Impact and causes of illness and death in Aboriginal and Torres Strait Islander people 2011. Canberra: AIHW; 2016.
2. Australian Institute of Health and Welfare. The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples 2015. Cat. no. IHW 147. Canberra: AIHW; 2015.
3. Ashman A, Collins C, Weatherall L, Brown L, Rollo M, Clausen D, et al. A cohort of Indigenous Australian women and their children through pregnancy and beyond: the Gomeroi Gaaynggal study. Journal of Developmental Origins of Health and Disease. 2016;7(4):357-68.
4. Australian Institute of Health and Welfare. Aboriginal and Torres Strait Islander adolescent and youth health and wellbeing. In: Welfare AIoHa, editor. Canberra ACT: Australian Institute of Health and Welfare; 2018. p. 1-248.
5. Larkins N, Teixeira-Pinto A, Banks E, Gunasekera H, Cass A, Kearnes J, et al. Blood pressure among Australian Aboriginal children. Journal of Hypertension. 2017;35(9):1801-7.
6. Gialamas A, Kinnell A, Mittinty MN, Davison B, Singh G, Lynch J. Association of anthropometric measures and cardiovascular risk factors in children and adolescents: Findings from the Aboriginal Birth Cohort study. PloS one. 2018;13(6):e0199280.
7. Titmuss A, Davis EA, Brown A, Maple-Brown LJ. Emerging diabetes and metabolic conditions among Aboriginal and Torres Strait Islander young people. Medical Journal of Australia. 2019;210(3):111-3. e1.
8. Davison B, Goodall J, Whalan S, Montgomery-Quin K, Howarth T, Singh G. Nutritional dual burden in Indigenous young adults: The geographical differential. Australian Journal of Rural Health. 2019;27(1):14-21.
9. Dyer SM, Gomersall JS, Smithers LG, Davy C, Coleman DT, Street JM. Prevalence and characteristics of overweight and obesity in indigenous Australian children: a systematic review. Critical Reviews in Food Science and Nutrition. 2017;57(7):1365-76.
10. Thurber KA, Dobbins T, Neeman T, Banwell C, Banks E. Body mass index trajectories of Indigenous Australian children and relation to screen time, diet, and demographic factors. Obesity. 2017;25(4):747-56.
11. Australian Bureau of Statistics. Overweight and Obesity. Canberra, ACT: Australian Bureau of Statistics; 2013 [updated 16 December 2015. Available from: http://www.abs.gov.au/ausstats/abs@.nsf/0/A07BD8674C37D838CA257C2F001459FA?opendocument].
12. Banks E, Crouch SR, Korda RJ, Stavreski B, Page K, Thurber KA, et al. Absolute risk of cardiovascular disease events, and blood pressure-and lipid-lowering therapy in Australia. Medical Journal of Australia. 2016;204(8):320-.
13. National Aboriginal Community Controlled Health Organisation and The Royal Australian College of General Practitioners. National guide to a preventive health assessment for Aboriginal and Torres Strait Islander people: Evidence base. 3rd ed. East Melbourne, Vic: RACGP; 2018.
14. World Health Organization. BMI-for-age (5-19 years): World Health Organization; 2007 [updated 2019; cited 2019 29 August ]. Available from: https://www.who.int/growthref/who2007_bmi_for_age/en/].

## Appendix A

One page summary of research proposal.

## Chronic disease risk among children in SEARCH

Contact: Tamara Riley, tamara.riley@anu.edu.au, (02) 6125 5499

I am a Wiradjuri woman from Western NSW. I am currently undertaking a Masters of Applied Epidemiology at the ANU, based within the Aboriginal and Torres Strait Islander Health Program within the National Centre for Epidemiology and Population Health.

ANU Supervisors: Dr Katie Thurber & Associate Professor Ray Lovett

Summary: The aim of this project is to better understand chronic disease risk in Aboriginal children and adolescents and improve early detection of chronic disease. This project will investigate the distribution of blood lipids (marker for heart disease) and HbA1c (marker for diabetes) among Aboriginal youth in SEARCH.

The key objectives are to investigate:

1. the distribution of blood lipids and HbA1c, overall and in relation to age group and sex; and
2. the relationship between Body Mass Index (BMI), blood lipids and HbA1c.

Context: We know there is a high risk of chronic disease among Aboriginal adults. Common chronic conditions seen in Aboriginal and Torres Strait Islander people include renal disease, diabetes, overweight and obesity, and cardiovascular disease. We think that chronic disease risk appears in early life, but we don't know much about Aboriginal children's level of risk of chronic disease.

We want to better understand the chronic disease risk profile of Aboriginal children and adolescents in order to make it easier to predict children's risk of later disease. We want to look at the relationship between blood lipids, HbA1c, and BMI in children to learn more about the risk of chronic disease and how we can improve prevention of chronic disease later in life.

Impact for AMSs and community: We hope that these findings will be useful for AMSs, including making it easier for AMSs to screen children for chronic disease risk. Our main goal is to work together with AMSs to develop or improve programs to prevent chronic disease in Aboriginal youth.

It is important to us that AMSs are involved in this study. This will help us make sure findings are relevant and useful for AMSs.

AMSs will be invited to give input on the study. AMSs will also be invited to work with the research team to interpret the results within the local context. The research team would like to present early findings back to the AMSs for discussion, and to work with the AMSs to share findings with the community.

## Appendix B

One page summary of key findings.

## Markers of chronic disease risk in an urban cohort of Aboriginal children and adolescents in New South Wales, Australia: findings from the SEARCH study

Please find attached a draft paper entitled "*Markers of chronic disease risk in an urban cohort of Aboriginal children and adolescents in New South Wales, Australia: findings from the SEARCH study*".

About the study:

Previous studies have shown that chronic disease is common in Aboriginal and Torres Strait Islander people. We know that signs of chronic disease risk can show up early. However, we don't know much about chronic disease indicators in children and adolescents. For example, blood lipids (cholesterol) can tell us about cardiovascular disease risk. HbA1c can tell us about diabetes risk. We used data from SEARCH to look at these risk indicators in children and adolescents aged 5-19 years. We wanted to see the levels of risk in the cohort. We also wanted to see how the levels of risk varied by age, gender, and weight status (Body Mass Index, or BMI). This might tell us about which groups of children are at least risk, or at highest risk, of developing disease later on.

Main findings:

When we looked at the data in relation to standard risk cut-offs, we found that most children in the SEARCH cohort were healthy. However, there were some signs that children in the SEARCH cohort may be at risk of developing chronic disease down the track.

- The majority of children and adolescents had normal cholesterol and HbA1c.
- **Almost half of the children were in the normal weight category** (45%). About one quarter (23%) of children were in the overweight category, and one in three children (31%) were in the obese category. Very few children were underweight (0.6%).
- **Few children had signs of risky cholesterol levels**.
- The majority of children (56%) had borderline (above normal but not 'high') total cholesterol, and no individuals had a high total cholesterol.
- The majority of children had borderline (above normal but not 'high') LDL cholesterol (59%), and a small percentage had high LDL cholesterol (2.9%).
- The majority of children had high HDL cholesterol (85%); this is good, because high HDL cholesterol can be a protective factor against chronic disease.
- **Few children had signs of diabetes risk.** The majority of children had normal HbA1c (97%), and a very few children had diagnostically high HbA1c (0.9%).
- **Risk markers for chronic disease were more common for older children** (15-19 years) compared to younger children (5-10 years). It was more common for older children to have high BMI, high levels of 'bad' cholesterol, and low levels of 'good' cholesterol.
- **Risk markers for chronic disease were more common for children who were overweight or obese.** High 'bad' cholesterol and high HbA1c were more common among children who were overweight or obese, compared to children who had a weight in the normal range.

What this might mean for your service:

- Findings might help us determine which groups to screen for disease, and which groups might need extra support to stay healthy.
- This study may help with early detection and prevention of chronic disease in adulthood by addressing the health risks early in life. We want to learn how we can keep all children and adolescents healthy.

Please feel free to contact me if you have any feedback or would like further information (tamara.riley@anu.edu.au).

## Appendix C

SEARCH CRE presentation – July 2019. I was asked to present on my MAE journey including recent training and conference opportunities.


# Chapter 5

# Teaching

## 5.1 Prologue

In the second year of the Masters of Philosophy in Applied Epidemiology (MAE), we are required to undertake a Teaching session with the first year cohort, as well as a lessons from the field session with our own cohort. This chapter describes how I met those two MAE requirements.

### *5.1.1 Learnings and reflections*

Before I did the MAE, I did not have much experience with teaching or with the notion of lessons from the field. I now see their importance as ways in which we as Epidemiologists can increase our skills and professional development.

For the teaching session, it was helpful to work through the lesson plan process and see how helpful a lesson plan can be to a session – not only for time management and organisation – but to plan activities and interactive sessions, and make the lesson engaging. I also enjoyed teaching about One Health, as One Health is my primary interest and I would like to see it taught more.

In putting together the lesson plan for the teaching session, I found it useful to reflect on Bloom's pyramid of intellectual behaviour important in learning (see Figure 30) (1). This is a helpful resource when thinking through how to adapt your lesson plan to allow students to remember the information, understand it, apply it, and ultimately have a level of understanding that allows them to create their own ideas about the concept. To achieve this level of learning behaviour, using engaging and interactive material can allow students to get the most out of the session.


*Figure 30: Blooms taxonomy* (1)

Gagne's nine steps was also a useful resource when planning the sessions. The nine steps include:

1. Gain attention – consider a story, problem or case study and why it is important;
2. Provide learning objectives – be clear on what they will be learning and asked to do;
3. Stimulate recall of prior knowledge – building on previous knowledge and skills;
4. Present material – clear and spaced out (do not overload);
5. Provide guidance on learning – how to learn the skill;
6. Allow student to demonstrate their learning – consider an activity or interactive session;
7. Provide feedback – consider quiz or verbal feedback;
8. Assess performance – has the lesson been learned; and,
9. Enhance retention and transfer – consider additional practice and how students can take this knowledge and adapt it to other situations (2).

The lessons from the field session is held with our own cohort. Each scholar is required to present a lesson from the field to the rest of the cohort. For my lesson from the field, I chose logic models. Other lessons from the field given by members of my group included investigating a tuberculosis outbreak, Aboriginal and Torres Strait Islander research and ethics, and influenza surveillance in New South Wales. The difference in topics was great and as my placement was not in a Public Health Unit, learning about tuberculosis outbreaks and influenza surveillance was new for me. Being able to reinforce what I know about Aboriginal and Torres Strait Islander ethics was also helpful, and I believe, an important conversation to have with non-Indigenous members of my cohort.

This chapter presents the lesson plans and teaching presentations I used during the first year MAE teaching session and lessons from the field, and discusses the informal and formal feedback from each session.

## 5.2 First year MAE teaching session – One Health

For the first year MAE teaching session, my group delivered a session on One Health and its use within field epidemiology, particularly outbreak investigations. We used three case studies about zoonotic pathogens, with international and domestic examples, to explain the One Health concept. The three case studies were Nipah virus, Q fever and Anthrax. The below lesson plan was developed for the session (see Table 32 and Table 33).

*Table 32: Teaching plan - purpose and objectives*

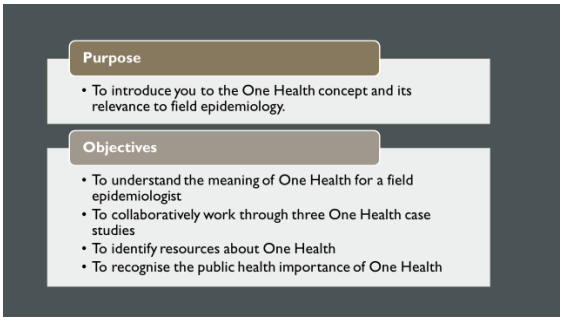
| **First years' teaching session: One Health** | **Delivery method** | **Facilitators** |
|---|---|---|
| **Purpose**<br>▪ To introduce students to the One Health concept and its relevance to field epidemiology. | PowerPoint presentation<br><br>Q&A<br><br>Group Discussion | ▪ Hendrik<br>▪ Tamara<br>▪ Celeste<br>▪ Callum |
| **Objectives**<br>1. To understand the meaning of One Health as it pertains to field epidemiology;<br>2. To collaboratively work through three One Health case studies (domestic and international);<br>3. To identify additional resources about One Health; and<br>4. To recognise the public health importance of a One Health approach to field investigations | | |

*Table 33: Teaching Plan - schedule*

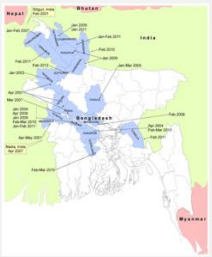
| **Title & time** | **Topic summary** | **Slides** | **Presenter** |
|---|---|---|---|
| Introduction<br>(1 min) | ▪ Introduce team members including placement | 1 slide | Callum |
| Session purpose & objectives<br>(3 min) | ▪ Summarise the purpose and objectives of teaching session | 1 slide | Callum |
| Case One<br>(5 min) | ▪ Introduce case study 1: "***Palm fever": A Nipah virus outbreak in Bangladesh***<br>▪ Introduce questions and have students discuss/submit answers | 2– 3 slides | Celeste |
| Case one<br>(4 min) | ▪ Collaboratively work through answers<br>▪ Summarise disease and relevance of One Health approach to investigation | 2 slides | Celeste |
| Case Two<br>(5 min) | ▪ Introduce case study 2: ***"Farm fever": A Q fever outbreak in rural Queensland*** | 2– 3 slides | Tamara |

| Title & time | Topic summary | Slides | Presenter |
|---|---|---|---|
| | ▪ Introduce questions and have student's discus/submit answers | | |
| Case Two<br>(4 min) | ▪ Collaboratively work through answers<br>▪ Summarise disease and relevance of One Health approach to investigation | 2 slides | Tamara |
| Case Three<br>(5 min) | ▪ Introduce case study 3: ***"An African misadventure": an Anthrax outbreak in an African ecosystem***<br>▪ Introduce questions and have students discuss/submit answers | 2– 3 slides | Hendrik |
| Case three<br>(4 min) | ▪ Collaboratively work through answers<br>▪ Summarise disease and relevance of One Health approach to investigation | 2 slides | Hendrik |
| Introduction to One Health concept<br>(4 min) | ▪ Define the One Health concept<br>▪ Provide an example of public health importance<br>▪ Discuss a field epidemiologists' role in a One Health field investigation | 1–2 slides | Callum |
| One Health resources<br>(1 min) | ▪ Summarise additional resources available to learn more about the One Health concept | 1 slide | Callum |
| Session wrap<br>(2 min) | ▪ Summarise objectives<br>▪ Complete evaluation questionnaire | 1 slide | Callum |

The below presentation was used to work through the lesson on One Health and its relevance to field epidemiology.

## CASE STUDY 1 PALM FEVER IN BANGLADESH



- Rural Bangladesh
- 2001
- Fever, headaches, respiratory symptoms
- CFR of 69%
- Pathogen identified
- But source a mystery

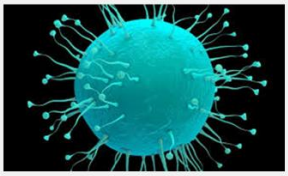
- First identified in 1998 in Malaysia in pig farmers and abattoir workers – no human to human transmission
- Different picture in Bangladesh
- Risk factors: rural areas, drinking raw palm sap
- Nosocomial transmission = human to human

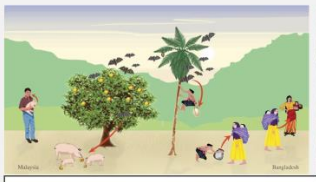
## DIFFERENTIAL DIAGNOSES?

- Is there another host?
- Transmission pathways?
- How is the environment playing a role?

## NIPAH VIRUS

- Zoonotic
- Human symptoms – fever, headaches, sort throat, ILS – less commonly atypical pneumonitis, encephalitis
- Usual host – flying fox
- Animal to human transmission – close direct contact with infected animals or their excretions





## THE EVOLUTION OF NIPAH

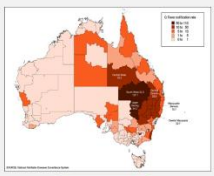
*How has the One Health Paradigm helped to successfully identify the source and to control Nipah outbreaks in this setting?*

## CASE STUDY 2 FARM FEVER

- South West Queensland farming community
- Multiple people with severe flu like symptoms
  - 6 farm workers – 2 hospitalised
  - Vet nurse in the town also sick

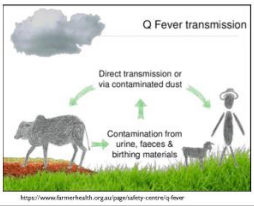
- All associated with sheep and goat farm
  - Farm workers assisting with birthing
  - Vet and vet nurse attending to abortions

Differential diagnoses?



## Q FEVER

- Zoonotic bacteria – *Coxiella burnetii*
- Severe flu-like symptoms in humans
- Often asymptomatic in animals
- Can cause abortion in sheep and goats
- Farmers, abattoir workers, and veterinarians most at risk
- In Australia, not notifiable in animals, notifiable in humans



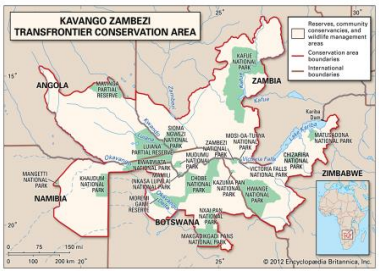

PPE SAFETY

## Q FEVER PREVENTION

- Personal protective equipment (PPE)
- Hygienic on-farm practices
- Skin test and/or vaccination for people who work or live in high risk areas

## CASE STUDY 3 AN AFRICAN (MIS)ADVENTURE

## Study setting - KAZA, southern Africa

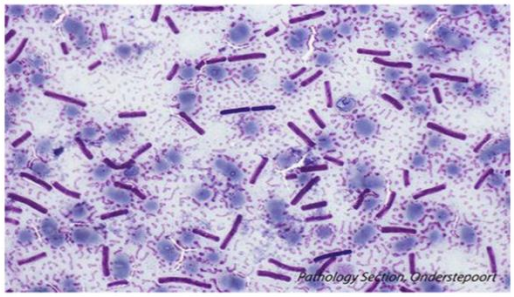


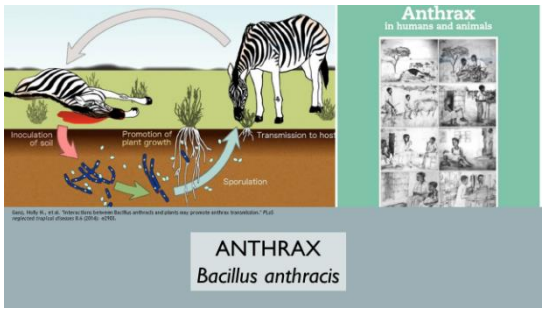

## CASE FINDINGS:

- **13 cases:** 1 death, 4 villages (n=120) past 3 weeks;
- CFR 7%; Fatal case displayed fever, coughing, respiratory distress, septicaemic shock, coma
- **Cluster 1:** 3 cases, all children from one family, GI signs
- **Cluster 2:** 7 cases, skin blisters and oedema upper limbs
- **Cluster 3:** 3 cases, 1 death, all park rangers

## WILDLIFE FATALITIES:

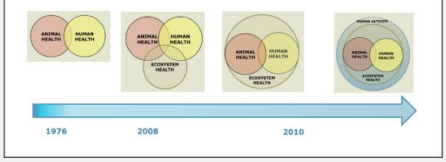
- 33 HIPPOPOTAMI
- 16 AFRICAN BUFFALO
- 5 AFRICAN ELEPHANT
- VARIOUS HERBIVORE SPECIES
- TOURIST REPORTS OF SUSPECTED ILLNESS IN AFRICAN LIONS

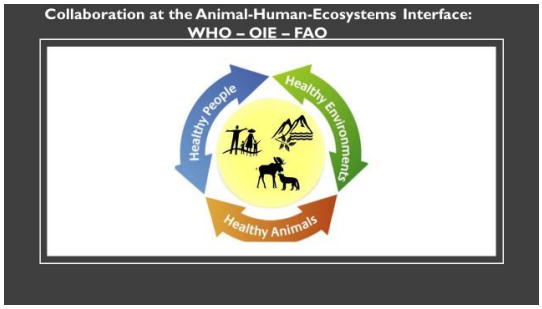


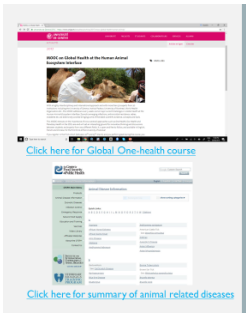



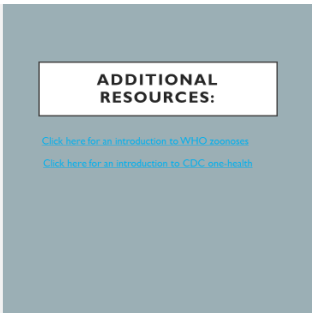

## ANTHRAX
*Bacillus anthracis*

## THE ONE HEALTH PARADIGM






### *5.2.1 Teaching evaluation*

An evaluation was undertaken with the first year MAE students (n=16) to assess how they found the lessons and what they got out of the session. For the One Health session, the below feedback was given (see Table 34). Overall, we received positive feedback from the students with constructive suggestions for how the session could be improved. The majority of students found it mostly or very useful, very engaging, found the pace of the session was ideal, and understood the objectives and purpose of a One Health teaching session within epidemiology.

*Table 34: Teaching evaluation question and responses*

| Evaluation question | Response |
|---|---|
| Was the presentation style engaging (multiple choice)? | • 81.2% (n=13) found it 'very engaging'<br>• 19.8% (n=3) found it 'mostly engaging' |
| How did you find the pace of the session (multiple choice)? | • 87.5% (n=14) found it 'just right'<br>• 12.5% (n=2) found it a 'bit fast' |
| How useful was the content (multiple choice)? | • 43.8% (n=7) found it 'very useful'<br>• 56.2% (n=9) found it 'mostly useful' |
| Were the objectives and purpose of the session clear to you (multiple choice)? | • 43.8% (n=7) found it was 'very clear'<br>• 37.5% (n=6) found it was 'mostly clear'<br>• 6.2% (n=1) found it a 'little bit clear',<br>• 12.5% (n=2) were 'neutral' |
| What was good (free text question)? | • Interesting topics and case studies. Well explained and presented.<br>• Interesting case studies.<br>• Good intro to important topic.<br>• The use of case studies will help me remember the information.<br>• Great slides.<br>• Objectives listed at beginning of presentation.<br>• Was good to have a more unusual case study (Anthrax), quite familiar with Nipah and Q fever, however overall One Health is very interesting. Also liked the format of case studies.<br>• Great, varied range of case studies.<br>• Very interesting case studies.<br>• Succinct, good pictures to visualise graphs. |
| What could be improved (free text question)? | • Maybe signpost a little more and present One Health approach first.<br>• Slide with written explanation of what the One Health paradigm is rather than pictures and diagrams.<br>• Could have had more case studies.<br>• It was interesting, but short. Examples were good but a bit more focus on the actual One Health topic. |

## 5.3 Lessons from the field – Logic models

I chose to discuss logic models during my lessons from the field as I was aware the others in my group had not come across logic models in their projects and I thought it would be a helpful lesson for future work.

The below lesson plan and pre-work was developed for the group and sent to participants before the lesson (with exception of the answers). This included general background of what logic models are and when they can be used, with particular focus on evaluations. It also included pre-readings and activities to help participants answer the questions prior to the lesson. During the lesson we discussed participant's prior knowledge of logic models; it was revealed that no participant had been exposed to them through their MAE projects, which made this lesson useful. Participants then gave feedback on the readings and activities and we went through the questions as a group. According to participants, the use of the example logic models that I developed during my MAE were particularly helpful as it gave them an example of how to put the knowledge into action. The below lesson plan and activities were developed for the session.

### Logic models

**Learning objectives:**

For each of the participants, to -

1. Understand what logic models are and when they are useful
2. Understand the main components of a logic model
3. Understand how a logic model fits into an evaluation framework

---

**Activity 1: Pre-readings and activities**

***Pre-readings and activities:***

- Watch this 10 minute video on 'logic models in public health' - https://www.youtube.com/watch?v=IHEp0gJRTwI
- Read the CDC's 'Program Evaluation Framework checklist for Step 2: Describe the program' - https://www.cdc.gov/eval/steps/step2/Step-2-Checklist-Final.pdf

- Read the NSW Health guide to 'Developing and Using Program Logic' - https://www.health.nsw.gov.au/research/Publications/developing-program-logic.pdf

***Additional resource:***

- Better evaluation website - https://www.betterevaluation.org/en/rainbow_framework/define/develop_programme_theory

***Background information***

Logic models can be used for a range of reasons including program planning, monitoring, implementation, and evaluation. In a program evaluation there is a number of steps to follow, one of which is to understand and describe the program you are evaluating. Using the CDC's program evaluation framework below as an example, we can see that they recommend 6 main steps in undertaking an evaluation (see Figure 31). Step 2 of the framework is to 'describe the program', which commonly involves designing a logic model (3).


*Figure 31: CDC's program evaluation framework (3)*

Engagement with stakeholders is an important step in understanding the program and intended outcomes and should be undertaken before designing a logic model. If creating a logic model for an organisation, the logic model should align with the organisation's vision, mission and goals.

Logic models can focus on specific programs as well as how organisations run at different levels (i.e. the organisation as a whole, a department within the organisation). Logic models are a visual representation of how a program works and how the components of the program relate to and impact on each other. A typical logic model includes:

- inputs,
- key activities,
- outputs,

- short, medium and long term outcomes, and,
- impacts.

A logic model is a living document and can continue to change and grow with the program. There are many different ways to design a logic model and the design you choose may depend on what makes sense for the program – the *betterevaluation* website describes many different approaches. If creating a logic model about an established program, it can be useful to start at inputs and activities to show how they lead to the expected outcomes. Alternatively, if you are designing a logic model on a new or developing program, it can be helpful to think about what you want the outcomes and impacts to be, and then think about what inputs and activities can lead to these outcomes (backcasting) (4). The NSW Health program logic guide describes backcasting in detail.

---

**Activity 2: Questions and discussion**

***Please complete the below questions using the pre-readings and the video.***

*Questions:*

1. What is a logic model?

   *Answers can include:*

   - A visual representation of the sequence of events that brings about change
   - Program logic
   - Illustration of relationships among program elements and measurements of success
   - Term for displaying how your program is supposed to work
   - Shows relationships between activities and outcomes
   - Graphic depiction that presents shared relationships among resources, activities, outputs and outcomes/impacts
   - Shows the change you expect to see after implementation of the activities

2. What is a logic model useful for?

   *Answers can include:*

   - Describe a program or agency

- Communicate with people
- Align activities to outcomes
- Improve staff understanding and buy in
- Focus activities on what's important guide use of data to review results and make improvement

3. When is a good time to create a logic model?

   *Answers can include:*

   - New project or program
   - Existing work that lacks a logic model
   - Satisfy requirement of a funder
   - Show or select meaningful performance measures
   - When undertaking an evaluation

4. What considerations should you think of when creating logic models for different audiences (i.e. for a community v for an organisation)?

   *Answers can include:*

   - Simplicity v specificity
   - High level v detail
   - Jargon

5. What are the key components of a logic model, and what do they entail?

   *Answers can include:*

   - Inputs – resources, guidelines, resources needed to implement the activities
   - Activities – what work are you going to do with the resources/inputs
   - Outputs – end product of service created by your activities, tangible products, deliverables
   - Outcomes (short, medium and long term) – better quality, better cost effectiveness, how can you improve, change in skills, behaviours, policy, ultimately why are you doing it? Changes that occur in people or conditions because of activities and outputs

- Measures – indicators on how you are going to measure outcomes
- +/- Impact (society/community impact, very long term) – the most distal/long term outcomes
- +/- moderators – factors outside of our control of the program but may hinder achieving the outcomes

6. <u>The two logic models below are examples from an MAE project, showing two different model designs describing the same animal health and management program (see Figure 32 and Figure 33). What are the major differences in the designs and in what context may each model be useful?</u>

   *Answers can include:*

   - First logic model – more detailed, includes measures, less engaging, more for use with organisation running the program
   - Second logic model – less detailed, more high level, overarching, simplified, more for use with community involved in the program – how does this help my animal?

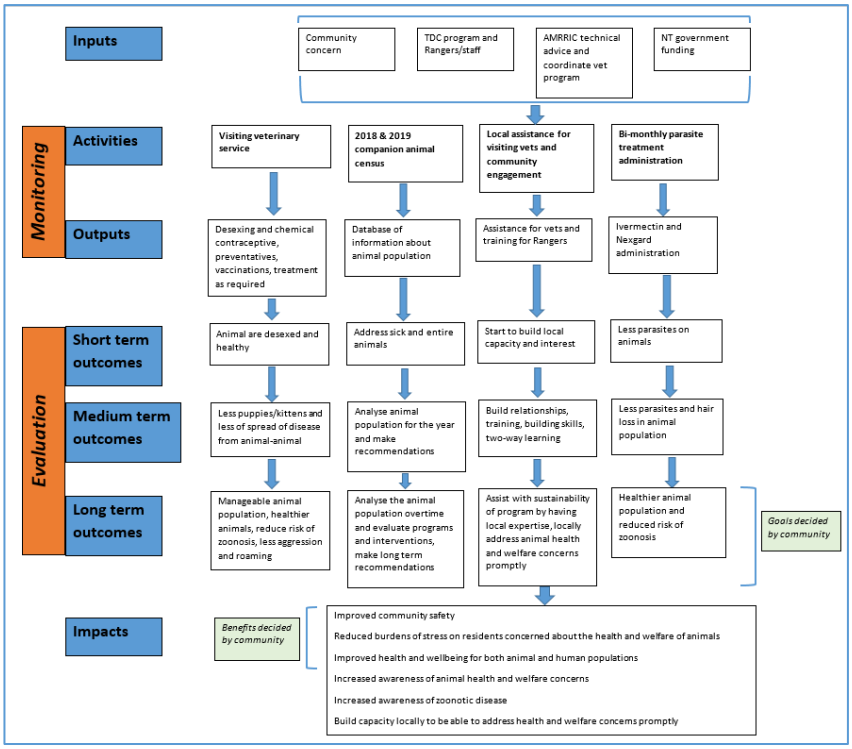



*Figure 32: Logic model example 1*

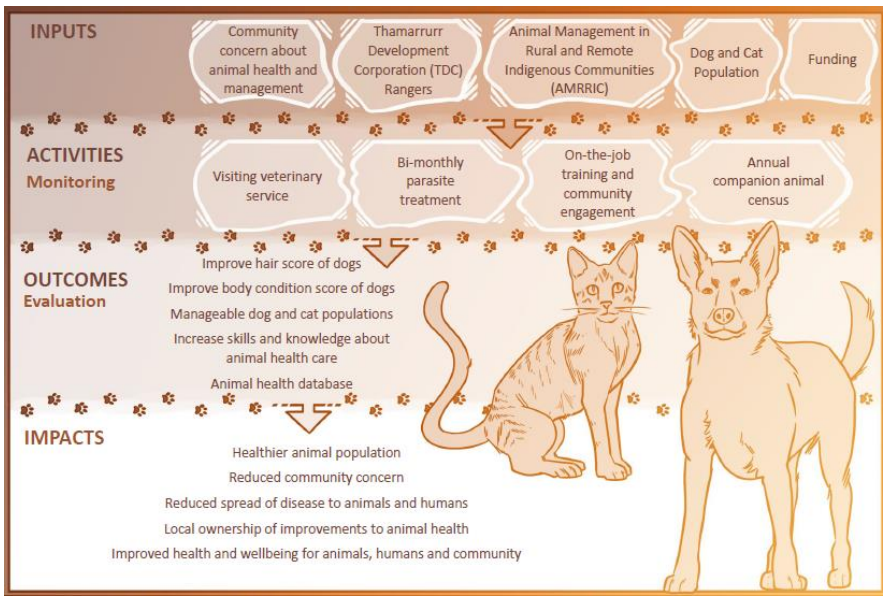



*Figure 33: Logic model example 2*

7. List some examples of how logic models may be/are used in your workplace?

    - Individual answers

8. Other thoughts?

## References

1. Center for teaching Vanderbilt University. Bloom's Taxonomy 2019 [Available from: https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/].
2. Clark D. Robert Gagne's Nine Steps of Instruction 2014 [updated 11 December 2014. Available from: http://nwlink.com/~donclark/hrd/learning/id/nine_step_id.html].
3. Centers for Disease Control and Prevention. Framework for program evaluation in public health. Atlanta, Georgia: Centers for Disease Control and Prevention; 1999. p. 1-58.
4. Centre for Epidemiology and Evidence. Developing and Using Program Logic: A guide. In: Evidence and Evaluation Guidance Series Population and Public Health Division editor. Sydney NSW: Ministry of Health; 2017.