

Modifiable Risk Factors for Chronic Disease in Indigenous Australians: A Pragmatic Mixed Methods Study

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Abstract

Background: There is major disparity in health outcomes for Indigenous Australians with negligible improvements in the past decade. This thesis explored factors that may contribute to this inequity.

Methods: The research presented in this thesis included a variety of methods ranging from primary interviews to secondary data analyses. The first study presented perceptions of Indigenous people on what they considered important regarding their medication management and usage, and lifestyle factors. Participants revealed an acceptance of chronic illness prevalence, and many identified a need for more sleep. Scant literature about the sleep of Indigenous Australians compelled the need for further research. Large national data sets were used to explore the potential role of sleep in understanding health disparities between non-Indigenous and Indigenous Australians. Statistical analyses using ANOVA and various regression models were utilised. Obesity was used as a marker for chronic illness. Sleep duration was subjectively reported.

Results: Analyses of data for Indigenous children indicated unhealthy weight was associated with shorter sleep duration and that sleep duration mediated the relationship between Indigeneity and BMI. These were the first studies to describe such a relationship for Indigenous Australian children, providing impetus for further research. Subsequent research in this thesis explored the relationship between sleep duration and increased BMI in Indigenous Australian adults. Results revealed sleep duration was not a notable predictor of BMI; however, Indigeneity was independently associated with increased BMI and sleep duration partially mediated this relationship. Socioeconomics, lifestyle and sleep duration did not account for differences in BMI between Indigenous and non-Indigenous Australians.

Conclusion: Optimisation of sleep may positively impact the health of Indigenous Australians. Sleep and BMI are modifiable risk factors. Further research is needed into the role of sleep and the drivers of BMI for Indigenous Australians in the context of their daily lives.

List of Abbreviations

χ^2	Chi squared test
>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
%	percentage
AATSIHS	Australian Aboriginal and Torres Strait Islander Health Survey
ABS	Australian Bureau of Statistics
ACCHO	Aboriginal Community Controlled Health Organisations
AHS	Australian Health Survey
AHW	Aboriginal Health Worker
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
AIHW	Australian Institute of Health and Welfare
ANCOVA	analysis of covariance
ANOVA	analysis of variance
ASGS	Australian statistical geography standard
BMI	Body Mass Index
CI	Confidence interval
COAG	Council of Australian Governments
COPD	Chronic obstructive pulmonary disease
CURF	Confidentialised Unit Record File
DHHS	Department Health and Human Services
DSS	Department of Social Services
GP	General Practitioner
HACC	Home and Community Care
LORI	Level of Relative Isolation
LSAC	Longitudinal Study of Australian Children
LSIC	Longitudinal Study of Indigenous Children
NATSIHMS	National Aboriginal and Torres Strait Islander Health Measures Survey
NATSIHS	National Aboriginal and Torres Strait Islander Health Survey
NHMRC	National Health and Medical Research Council
NNPAS	National Nutrition and Physical Activity Survey
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
OSA	obstructive sleep apnoea
OTC	Over the Counter
RADL	Remote Access Data Laboratory
RAO	Research Administration Officers
SA	Statistical Area
SC	Study Child
SD	Standard deviation
SEIFA	Socioeconomic Indexes for Areas
SES	Socio-economic status
VACCHO	Victorian Aboriginal Community Controlled Health Organisation

WC	Waist circumference
WHO	World Health Organization
WHS	Wathaurong Health Service

List of Tables and Figures

Table 1: Dissemination of knowledge: publications and conferences

Table 2: Six differences between Aboriginal and 'Western' Worldview (Reproduced from Mead,2002)

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Figure 1: Methodology

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Figure 3: Structure of the Australian Health Survey

Figure 4: Structure of the Australian Aboriginal and Torres Strait Islander Health Survey

Statement of Authorship

This thesis consists of work by the author that has been published or accepted for publication as described in the text. Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis accepted for the award of any other degree or diploma. No other person's work has been used without due acknowledgment in the main text of the thesis. This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

Melissa Deacon-Crouch 6 October 2021

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I acknowledge the Traditional Owners of Country throughout Australia on which this research has been conducted. I pay my respects to Elders, past, present and emerging and to the ongoing living cultures of Aboriginal peoples.

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My thanks and appreciation to all the Indigenous people involved in this research: particularly the study participants, and the Aboriginal Health Workers.

I acknowledge the wisdom, friendship and mentorship of Stephanie Armstrong: Aunty for Weenthunga Health Network; a wise and strong woman who has taught me much.

Heartfelt gratitude to my supervision team – each of you were there with your particular strength and wisdom when I needed it. Without you I would never have completed. THANKYOU.

Dedication

To my father, you can rest now. It is done!

Dissemination of research

Publications

I am the primary author on all included publications except for the first paper inserted in Chapter

1. As primary author I have made substantial contributions towards the research including project conception and design, ethics applications, analysis and interpretation of data and drafting, revision and submission of manuscripts. As second author of the paper referred to in Chapter 1, I contributed to the data analysis and writing of the manuscript.

The research procedures reported in paper 2 was approved by La Trobe University Human Ethics Committee Application number 12-057 on September 3, 2012.

Papers 3, 4, 5 and 6 were secondary analyses of national Australian surveys data collected by the Australian Government Department of Social Services and the Australian Bureau of Statistics. Each agency fulfilled its obligations regarding human research ethics approvals, and I was granted access to their de-identified databases through their authorised approval processes. There was no requirement for separate La Trobe University Human Research Ethics authorisation.

My supervisors contributed to the studies designs, data analyses, intellectual input and editing of all manuscripts.

Table 1: Dissemination of knowledge: publications and conferences

Paper	Title	My contribution	Status
1	Ellis, I., Deacon-Crouch, M. , Bhana, A., Longley, K., Voon, N., & Skinner, T. (2013). Reporting of non-prescribed medication usage in remote Australia: health seeking habits in Port Hedland. <i>Australian Journal of Rural Health</i> , 21(6), 350-351.	20%	published
2	Deacon-Crouch, M. , Skinner, I., Connelly, M., & Tucci, J. (2016). Chronic disease, medications and lifestyle: perceptions from a regional Victorian Aboriginal community. <i>Pharmacy Practice</i> , 14(3), 798.	80%	published
3	Deacon-Crouch, M. , Skinner, I., Tucci, J., & Skinner, T. (2018). Association between short sleep duration and body mass index in Australian indigenous children. <i>Journal of Paediatrics and Child Health</i> , 54(1), 49-54.	80%	published
4	Deacon-Crouch, M. , Begg, S., Tucci, J., Skinner, I., & Skinner, T. (2019). The mediating role of sleep in the relationship between Indigenous status and body mass	80%	published

	index in Australian school-aged children. <i>Journal of Paediatrics and Child Health</i> , 55(8), 915-920.		
5	Deacon-Crouch, M. , Begg, S., & Skinner, T. (2020). Is sleep duration associated with overweight/obesity in Indigenous Australian adults? <i>BMC public health</i> , 20(1), 1-13.	80%	published
6	Deacon-Crouch, M. , Skinner, I., Tucci, J., Begg, S., & Skinner, T. (2020). Indigeneity and its association with Body Mass Index (BMI) in Australian adults: Does sleep duration affect the relationship? Submitted to <i>PLOS One</i> February 2021. Revisions submitted on June 15, 2021 and September 17, 2021.	80%	Under revision
Conference Presentations			
13th National Rural Health Conference, May 2015. (Darwin, Australia) Chronic disease, medications, lifestyle and smoking: perceptions from a regional Victorian Aboriginal Community. Melissa Deacon-Crouch ¹ , Isabelle Skinner ² and Joseph Tucci ³ ¹ Department of Rural Nursing and Midwifery, La Trobe Rural Health School, La Trobe University Bendigo Victoria 3550. ² Charles Darwin University, Darwin Northern Territory 0909. ³ Department of Pharmacy & Applied Sciences, La Trobe Institute of Molecular Sciences, La Trobe University Bendigo Victoria 3550			
Australasian Pharmaceutical Science Association (APSA) – Australasian Society of Clinical and experimental Pharmacologists and Toxicologists (ASCEPT) Joint Scientific Meeting 2017. (Brisbane Australia) Perceptions of credible drug information sources for Aboriginal people attending a regional Aboriginal Health Service Melissa Deacon-Crouch¹, Isabelle Skinner² and Joseph Tucci¹ ¹ Pharmacy & Applied Sciences, LIMS, La Trobe University Vic Australia ² Psychological and Clinical Sciences, Charles Darwin University NT Australia. Chronic disease, medications & lifestyle: perceptions from a regional Victorian Indigenous Community. Melissa Deacon-Crouch¹, Isabelle Skinner² and Joseph Tucci¹ ¹ Pharmacy & Applied Sciences, LIMS, La Trobe University Vic Australia ² Psychological and Clinical Sciences, Charles Darwin University NT Australia. The association between short sleep duration and BMI in Australian Indigenous children Melissa Deacon-Crouch¹, Isabelle Skinner², Joseph Tucci¹ and Timothy Skinner² ¹ Pharmacy & Applied Sciences, LIMS, La Trobe University, Vic, Australia. ² Psychological and Clinical Sciences, Charles Darwin University NT Australia.			

Chapter 1: Introduction

Structure of the thesis

Chapter 1 is the introduction to the thesis and provides an overview of the research problem, the background to the study and its significance. The key concepts are defined, and the research question and the research aims are articulated.

Literature

The original literature review was a scoping review that is incorporated into the background of Chapter 1 and the published paper presented in Chapter 3. Owing to the nature of the research question and as this is a dynamic field of enquiry, the literature was constantly updated over the course of the candidature. The current literature reviews are presented in Chapter 1 (Introduction), Chapter 2 (Methodology) and in the introduction and published papers presented in Chapters 3, 4, 5, 6, 7 and 8.

Methods

This thesis is a presentation of a series of 5 studies. The overarching methodology is presented in Chapter 2 and includes the researcher's motivation for the study and a discussion of the researcher's "adaptation from a Western worldview to understanding the Indigenist research paradigm approach" which enabled the research. The methods for the five studies that make up the thesis are presented in each of the published papers and manuscript under revision. The specific aims for each study are provided and a detailed description of the data collection, statistical and other data analysis methods are provided in the published works. Where the word allowance was insufficient for a full description of the methods, this has been provided in the introductions to Chapters 4, 5, 6, 7 and 8.

Results

Each of the five studies are dealt with individually. The results of which are presented in the published works. Presented in Chapter 9, Table 3 consolidates the results, addressing the aims and objectives of this research.

Discussion

The discussion presents the current literature relevant to the research question and how the findings from this research are related to the health of Australian Indigenous peoples and the

broader national influences. The relevant discussions are presented in each of the published papers.

Conclusion and recommendations

Each chapter of this thesis presents a conclusion that builds a narrative of the significance of the findings to the research question and the aims. The final chapter, Chapter 9, provides the conclusion and discusses the limitations of the research, the significance and the contribution to knowledge and provides recommendations for further research. The researcher also provides a concluding statement that summarises the importance of the research in addressing the research question.

Introduction

This thesis will address some of the potentially modifiable causes of the gap in Indigenous life expectancy and health. It is a series of studies that take a broad approach initially, narrowing to a detailed analysis of contributing factors. Data has been collected in line with the National Health and Medical Research Council (NHMRC) ethical guidelines for Indigenous research and the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) guidelines. The following definitions have been provided for clarity.

Definitions

Australian Standard Geographical Classification (ASGC): a hierarchical system for the classification of statistical units by geographic areas used in the Australian health Survey. ASGC classifications: major cities of Australia, inner regional Australia, outer regional Australia, remote and very remote Australia.

Body Mass Index (BMI): index of weight-for-height, commonly used to classify overweight and obesity. Defined as weight in kilograms divided by the square height in meters (kg/m^2). Defined by the WHO, BMI greater than or equal to 25 is overweight; BMI of greater than or equal to 30 is obese (<https://www.who.int/westernpacific/health-topics/obesity>).

Chronic condition: a disease that persists longer than three months. Often long-term without prospect of cure.

Indigenous is a term not used as a specific descriptor, but rather to signify a concept that has been endorsed by the United Nations as follows:

“Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies ... consider themselves distinct from other sectors of the societies now prevailing in those territories ... They form at present non-dominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal systems” (Ellis, Davey, & Holliday, 2013 p.357).

In this thesis, Indigenous Australians are defined as peoples of **Aboriginal and/or Torres Strait Islander** descent who are accepted as such by the community in which they live (Australian Bureau of Statistics, 2014b). Indigenous Australians represent many diverse Australian Aboriginal and/or Torres Strait Islander peoples and cultures, hence the reference to peoples rather than people, which may imply homogeneity. The terms **Indigenous, Aboriginal peoples, Aboriginal and Torres Strait Islander peoples, First Nation peoples** are used interchangeably in this thesis to refer to the **First Peoples of Australia** (Narragunnawali Reconciliation in Education, (n.d)).

Indigeneity: in this thesis Indigeneity is used as a descriptor for people who identify as Indigenous. The three components of Indigeneity are: descent, self-identification and community acceptance. The use of this term is debated across various legal and academic contexts (Bello-Bravo, 2019).

Indigenous status: an accepted Australian Bureau of Statistics data collection variable used to measure whether a person identifies as being of Aboriginal or Torres Strait Islander origin.

Level of Relative Isolation (LORI) describes geographical characteristics of families in the LSIC Study. The LORI variable provides an indicator of the level of geographical remoteness using five categories of isolation: None (e.g. metropolitan area), to areas of Low, Moderate, High and Extreme remoteness and inaccessibility.

SEIFA: an index developed by the Australian Bureau of Statistics to rank areas (not individuals) in Australia according to relative socio-economic advantage and disadvantage. SEIFA is commonly used for exploring relationships between socioeconomic disadvantage and various health and educational outcomes.

Sleep duration: the hours and minutes of sleep calculated from the subjectively reported time of going to bed with the intention to sleep and the time of waking up.

Social determinants of health: “the non-medical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems” (WHO, accessed 27/08/2021, https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1).

Yarning: a conversational process that involves the sharing of stories, the collection of information and the development of knowledge. It is a culturally appropriate way for Indigenous people to build relationships and exchange information both socially and formally.

Background

Indigenous Australians suffer disproportionate disability, morbidity and mortality compared with the non-Indigenous Australian population and this disparity has endured over many decades (Anderson et al., 2006; Gatwiri, Rotumah, & Rix, 2021). Furthermore, the disparities experienced by the Australian Indigenous population have been estimated to be greater than the disparities experienced by Indigenous populations in other Western countries such as New Zealand, Canada and the United States of America (Hill, Barker, & Vos, 2007). In response to the alarming inequality, the Council of Australian Governments (COAG) approved the National Indigenous Reform Agreement that is known as *Closing the Gap*, in 2008 (Council of Australian Governments, 2009). One of the six main targets set by the reform was to close the gap in life expectancy between Indigenous and non-Indigenous people within a generation (25 years). Thirteen years later, according to the latest *Closing the Gap* report, “the target to close the life expectancy gap by 2031 is not on track” (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020, p.78).

Indigenous age-standardised mortality rates declined by about 10% from 2006-2018. However, the decline in the mortality rate was the same for non-Indigenous people so there was no overall gain in equity (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020). Life expectancy at birth is a frequently used health status indicator (OECD, 2021) that is also used as a measure of social equity and to assess the relative disadvantage of populations (Rosenstock, Mukandi, Zwi, & Hill, 2013). Overall life expectancy for the Indigenous Australian population is currently about 8.6 years less than for their non-Indigenous counterparts. Indigenous males born from 2015-2017 can expect to live for 71.6 years compared with 80.2 years and Indigenous females born between 2015-2017 can expect to live 75.6 years compared to 83.4 years (Australian Institute of Health and Welfare, 2021b). However, life expectancy can be vastly different for smaller local area communities such as experienced by Indigenous people living in remote Australia. For instance, in 2008-2010, the average age of death for an Indigenous person in the Mount Isa area of North-Western Queensland, was 53 years (Western Queensland Primary Health Network, 2016). This statistic illustrates that the disparity is greatest in remote and very remote areas of Australia (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020). Moreover, life expectancy does not describe the wider issues of physical, social and mental wellbeing during life – it merely measures the final outcome; expected age at death (Gracey & King, 2009).

In Australia, Indigenous people are more likely to die younger and at greater rates than non-Indigenous people. In the 2014-2018 period, the all-causes age-standardised mortality rate for Indigenous Australians was 1.6 times higher than for non-Indigenous Australians (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020). In the same period, the main causes of death for Indigenous people across Australia, irrespective of status and vicinity of residence, were neoplasms including cancer (23%), cardiovascular diseases (23%), external causes such as injury and suicide (15%), respiratory diseases (9%), and endocrine, metabolic and nutritional disorders exemplified by diabetes (9%) (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020).

Although non-Indigenous Australians experience similar causes of death as Indigenous Australians, chronic diseases have been identified as contributing 70% to the disparity in mortality rates between non-Indigenous and Indigenous Australians (Australian Institute of Health and Welfare, 2016). It is also important to consider that significant morbidity, such as depression, disability and arthritis, may not directly cause death, but may have intensely negative effects on quality of life (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020). Such complications are often overlooked by reports of mortality statistics. To make matters worse, multi-morbidity has been found to be 2.6 times more prevalent for Indigenous Australians across all age groups, than for their non-Indigenous counterparts (Randall, Lujic, Havard, Eades, & Jorm, 2018). This disparity is the cause of much of the difference in mortality rates, with a greater prevalence of mental health issues for young Indigenous people and physical diseases for Indigenous people over 60 years (Broe & Radford, 2018). Living with multimorbidity is a huge challenge for Indigenous Australians, further exacerbated by institutional racism in healthcare and problematic access to culturally appropriate care that must be addressed by policy makers and healthcare systems to affect improvement in health and wellbeing for Indigenous people. (Randall et al., 2018).

Social determinants of health

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1948, p. 1). This definition aligns well with the viewpoint of Indigenous people for whom individual health is interrelated with physical, social, emotional, cultural, spiritual and ecological wellbeing (Australian Institute of Health and Welfare, 2018b). Non-biomedical, social determinants of health experienced by Indigenous Australians have been reported to cause 34% of the gap in health between Indigenous and non-Indigenous Australians (Commonwealth of Australia Department of the

Prime Minister and Cabinet, 2020).

Social determinants are of utmost importance in the determination of health and wellbeing. According to the WHO, social determinants of health are the complex non-biomedical, social conditions and systems into which people are born and live including socioeconomic position, education, conditions of employment, addictions, food and resource accessibility, social support, social exclusion, and social and cultural norms; as well as other forms of structural, political and systemically imposed policies (World Health Organization, 2003). The reasons for health disparities for Indigenous Australians are complex and multifactorial but dominated by the enduring trauma experienced as a result of colonisation and separation from Country (Australian Institute of Health and Welfare, 2018a). The social determinants of health experienced by Indigenous Australians result in different risks, exposures and access to services across their lifespan compared with non-Indigenous Australians (Commonwealth of Australia Department of the Prime Minister and Cabinet, 2020). Such social determinants are often longstanding structural and institutional factors that are outside individual control, hence inequities are difficult to address and require enormous effort at all strata of society and government (WHO Commission on Social Determinants of Health. World Health Organization, 2008).

Possible modifiable risk factors

Nineteen percent of the health gap between Indigenous and non-Indigenous Australians has been attributed to risk factors such as smoking, binge drinking, obesity, poor nutrition and inactivity (Australian Institute of Health and Welfare, 2018a). The combination of social determinants and such risk factors have been estimated to contribute about 11% of the gap in health outcomes. The remaining 47% of the gap in health equity remains unexplained (Australian Institute of Health and Welfare, 2018a). While many of the risk factors for chronic illness and mortality associated with the gap in health equity in Australia are potentially modifiable, this thesis will investigate two in particular: compliance and adherence with medical treatment plans, and sleep duration.

Compliance and adherence

It has been generally accepted that adherence to and compliance with medical plans and medication therapy is often challenging and poor in Indigenous Australian communities (Bryce, 2002; de Dassel, Ralph, & Cass, 2017). However, the literature mostly presents the perspective of the non-Indigenous researcher and healthcare professional and lacks the perspective of Indigenous people. A recent review of adherence in Indigenous Australians living with chronic

illnesses revealed that most healthcare practitioners regard Indigenous Australians as having insufficient adherence to medications resulting in adverse effects (de Dassel et al., 2017). However, adherence and compliance, terms that are often used interchangeably in the literature, are concepts that have been found to be based on theoretical assumptions of agreement between the patient and their healthcare professionals that are rarely met, and hence doomed to fail (Skinner & Ellis, 2009). Indigenous people managing chronic illness, are faced with many challenges that can impede adherence, such as communication and language barriers (Isabelle Ellis et al., 2013), sociocultural priorities that preclude adherence, travelling away from home, medication swapping or sharing, cost, and inadequate storage conditions (de Dassel et al., 2017). Western healthcare systems have been imposed on Indigenous people in recent times whereas for millennia, Indigenous people took a whole system approach to problems and solutions working as a community (Skinner & Ellis, 2009). Hence a community development model for the management of chronic illnesses proposed for remote area Indigenous people, may be key for all Indigenous people (Skinner & Ellis, 2009). The model offers a strengths-based approach that involves healthcare providers (experts) supporting Indigenous people to identify their own priorities and solutions and assisting the procurement of the necessary resources.

Sleep duration

It is widely reported that Indigenous peoples and other ethnic minorities across the globe, experience health outcome inequities; however it is also important to note that these groups have also been found to experience concomitant sleep disparities compared with the dominant population (Jean-Louis & Grandner, 2016).

Sleep is a vital part of human circadian rhythm and it is essential for health (Adams et al., 2017). Sleep has been defined as “a state of immobility with greatly reduced responsiveness, which can be distinguished from coma or anaesthesia by its rapid reversibility” (Siegel, 2005). However, sleep is far from an inert state, rather it is actively and intrinsically involved with physical, endocrine, metabolic and neurologic physiological regulation and homeostasis (Siegel, 2005). Sleep is regulated by two cooperative mechanisms: sleep-wake homeostasis and circadian rhythm (Kitamura et al., 2016). Sub-optimal sleep has detrimental effects on human neurophysiology that includes memory loss, mood disturbances and dementia, and affects chronic health conditions such as compromised immunity, obesity and cardiometabolic disease (Adams et al., 2017). Sleep is a complex state that is usually described in terms of quality and quantity both of which have been associated with varying health outcomes (Bin, 2016).

Sleep quality depends on sleep continuity (Ohayon et al., 2017). Short sleep latency, and awakenings after sleep with reduced periods of wakefulness if awakened, are all factors associated with sleep continuity and quality. Sleep quality can also be affected by health conditions such as sleep apnoea (Guglielmi, Magnavita, & Garbarino, 2018), the ageing process (Landry, Best, & Liu-Ambrose, 2015) and other neurological disorders such as depression, bipolar disorders and anxiety (Hertenstein et al., 2018), as well as many medicinal and illicit drugs (Qureshi & Lee-Chiong, 2004). Bin (2016) proposed that sleep quality is at least as important, if not more so, than sleep quantity, as a risk factor for future health. In this thesis it is the quantity or duration aspect of sleep that has been explored.

Sleep duration has been identified as a predictor of all-cause mortality (Bin, Marshall, & Glozier, 2013). A U-shaped association between sleep duration and mortality rate was first described more than four decades ago (Patel, Malhotra, Gottlieb, White, & Hu, 2006). The optimal sleep duration range has been described as 7-9 hours (Hirshkowitz, Whiton, Albert, Alessi, Bruni, DonCarlos, Hazen, Herman, Adams Hillard, et al., 2015) with habitual shorter or longer sleep associated with adverse effects on metabolism and immunity, as well as psychological and neurological problems with memory, learning and mental health (Cappuccio, D'Elia, Strazzullo, & Miller, 2010).

Research question

The overarching question explored in my PhD project was “What is the cause of the gap in Indigenous life and health expectancies compared with the non-Indigenous Australian population?”

To narrow my focus, I had the following aims:

Aims

1. to investigate the perceptions of a group of Victorian Aboriginal people taking medications for diagnosed chronic illnesses regarding their lifestyle, disease management and medication usage in order to identify novel factors that may contribute to the disparity in life and health expectancies for Indigenous people (addressed in Chapter 3)
2. to investigate whether sleep contributes to health outcomes in Aboriginal and Torres Strait Islander children and adults, specifically, whether there was any association between sleep duration and BMI. (Chapters 5 & 7)

3. to examine the effect of sleep duration on the relationship between Indigenous status and BMI for Australian school aged children and adults. (Chapters 6 & 8)
4. to identify the factors that impact the relationship between Indigenous status and BMI. (Chapters 6 & 8)

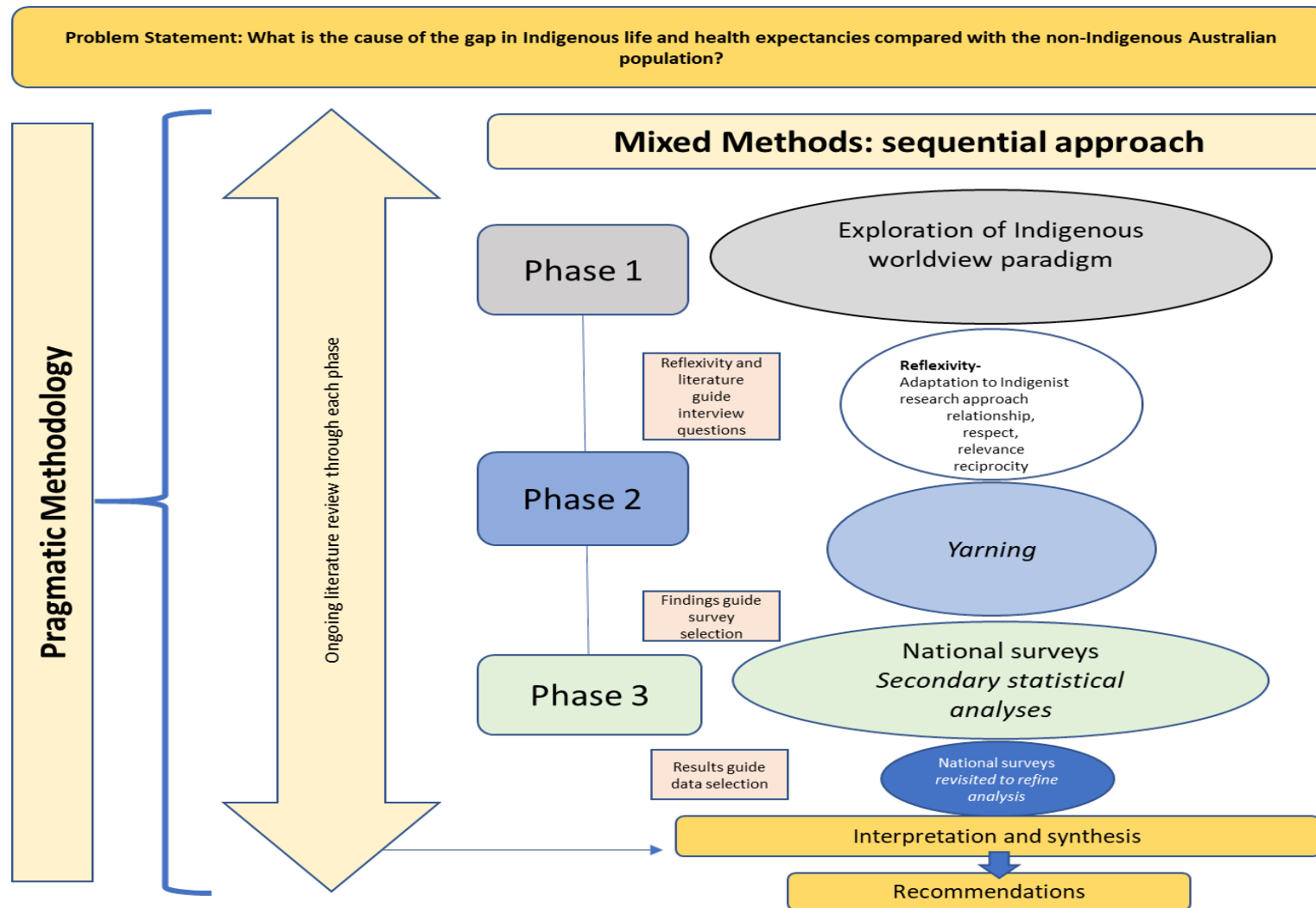
Chapter 2: Methodology

The research approaches

As a non-Indigenous middle-aged woman of Anglo-Saxon heritage, my main motivation to undertake this thesis stemmed from my first experience engaging with Aboriginal people when I spent time in the Nauiyu Community (Daly River), Northern Territory, educating the Home and Community Care (HACC) workers. Prior to my visit to the community, I was naïve to the living conditions of many remote Aboriginal communities. Reflecting on the experience emphatically impressed my white privilege and *otherness*.

The approach to the research presented in this thesis was pragmatic using mixed methods naturally evolved from mixed paradigms utilising research methods appropriate to each. A pragmatic approach focuses attention on the methodological matters rather than on the more philosophical paradigmatic concerns (Morgan, 2007). Mixed paradigm, mixed methods research acknowledges that different worldviews provide different philosophical foundations for the research methods (Creswell & Tashakkori, 2007). A *paradigm* is a set of broadscale, interrelated assumptions about the nature of reality; an accepted conceptual framework describing the worldview of a group (Wilson, 2001). Therefore, a *research paradigm* is “a set of beliefs about the world and about gaining knowledge that go together to guide your actions as to how you’re going to go about doing your research” (Wilson, 2001 p.175). The methodologies for the research presented in this thesis were informed by the Indigenous worldview paradigm and utilised aspects of the qualitative naturalistic paradigm and the positivist quantitative paradigm. Following Kovach (2010), the multi-paradigm approach allowed the use of complementary methods arising from differing epistemologies, ontologies and axiologies to ensure the relationship, alignment and relevance of the resultant knowledge to the Aboriginal worldview.

Figure 1: Methodology



Given that the research question was directly related to the experiences of Indigenous Australian people, it was crucial that as a non-Indigenous woman, I develop an understanding of the Indigenous world view to gain an appreciation of how Indigenous people consider the nature of their reality. Much has been written about the importance of the process of reflexivity for non-Indigenous researchers in the Indigenous space (Nilson, 2017; E. Rix, Barclay, & Wilson, 2014), but although my personal growth and understanding of my own worldview with its associated cultural norms, biases and ambivalences has been exponential, I had only just started my reflective and reflexive journey at the beginning of the research period. Researcher reflexivity is a concept of thoughtful and critical self-awareness that assists the researcher to understand their own role and impact in the research process in order to facilitate understanding of the 'other' (Hiller & Vears, 2016).

My personal journey in the Indigenous research space has been ongoing over the past decade and although naïve at the outset, I commenced the research process following the central principles of the Indigenous Research Paradigm (National Health and Medical Research Council, 2003b). These principles include: the **5Rs** (relationship, respect, responsibility, reciprocity and relevance); as well as survival and protection; and spirit and integrity. These core values all stem directly from the Indigenous worldview; a worldview distinct from the post-colonial dominant worldview that drives the healthcare system in Australia today. Therefore, in my mind, without gaining an understanding of Indigenous worldviews, and how they differ from the endemic, systemic Western worldview, it is not possible to address Indigenous health inequities.

Phase One: Understanding Indigenous worldviews

Worldviews have been defined as ingrained mental frameworks that provide ways of understanding the world; influencing belief systems, assumptions, problem solving and decision making (Hart, 2010). Anthropologists termed the Indigenous Australians' worldview the *Dream Time or The Dreaming*; a framework used by Indigenous people to understand the world and their place in that world. *The Dreaming* explains creation and provides the tenets for living and all associated activities (Aboriginal Policy Reference Group & the Muswellbrook Shire Council, 2007).

In post-colonial Australia, Indigenous Australian worldviews have been subverted by the dominant Western worldviews. Stanner, an Australian anthropologist, highlighted the difference between the two worldviews by describing the Western understanding of reality as largely deductive and reductionist, and the Aboriginal Dream time interpretation as underpinned by an

intuitive and implicit philosophy (Stanner, 1979). According to Stanner, to understand Indigenous Australians' perspectives, one must understand the unity and interrelationship of all elements of body, spirit, person, people, and environment.

"The truth of it seems to be that man, society and nature, and past, present and future, are at one together within a unitary system of such a kind that its ontology cannot illumine minds too much under the influence of humanism, rationalism and science" (Stanner, 1953 p.27 from Stanner, 1979))."

Pre-colonialism, the Indigenous Australian ethos, mode and principles reflected "continuity, constancy, balance, symmetry, regularity, system..." (Stanner, 1979, p39) whereby the people lived at one with nature; with societal values of reciprocity and fair dealing as the moral code; and where individualism was not the focus but that humanity exists as part of a larger system striving to preserve balance. Furthermore, Stanner (1953) described Indigenous Australians' outlook as one of *assent*; seeming "to see 'life' as a one-possibility thing" (p35); contrasting with the Western outlook largely driven by hope, strive for betterment, change and alternative options (Stanner, 1979).

Mead highlighted six diametrically opposed differences between Aboriginal and Western worldviews (Mead, 2002). These differences are so profound I have reproduced them here.

Table 2: Six differences between Aboriginal and 'Western' Worldview (Reproduced from Mead, 2002)

Aboriginal Worldview	Western Worldview
1. Spiritually orientated society. System based on belief and mysticism	1. Scientific, sceptical. Requiring proof as a basis of belief. Suspicious of mysticism.
2. Society operates in a state of relatedness. Everything and everyone is related. There is real belief that people objects and the environment are all connected. Law, kinship and mythology reinforce this connectedness.	2. Compartmentalised society, becoming more so. Identity comes from jobs and material possessions.
3. Aboriginal people are be-ers, happy to fit in with and exist with the environment and what's happening now	3. Do-ers, progress is important. Life seen in terms of 'getting on'. Utilising the environment
4. Time is non-linear, cyclical in nature. Time is measured in cyclical events. The seasons are central to this cyclical concept	4. Time is usually linearly structured and future orientated. The framework of months, years, days etc reinforces the linear structure.

5. Authority is based on age, cultural knowledge, and relationship with people. Small-scale authority system.	5. Large scale authority systems. Authority given through roles and bureaucracy. A relationship is established by the role.
6. Feeling comfortable is measured by the quality of your relationships with people.	6. Feeling comfortable is related to how successful you feel you have been in achieving your goals.

With such profound differences in the way Aboriginal and Western people interact with and interpret the world, it is little wonder that research and healthcare conducted from a Western perspective is vastly inadequate to serve the health and wellbeing needs of Indigenous people because it is impossible to interpret Indigenous Australians' beliefs, culture, ways of being and their creative epoch through the lens of the Western framework (Sherwood & Edwards, 2006).

Despite a plethora of research about Indigenous people, the lack of success in addressing the health inequities experienced by Indigenous people to date, supposes that there must be other key knowledge that is not attainable by Western research processes. To uncover such previously inaccessible knowledge, that can be used to benefit Indigenous communities, it is important to use an appropriate approach such as provided through the lens of the Indigenous Research paradigm (Terare & Rawsthorne, 2020). Led by L. Smith (1999), Indigenist research knowledge has been developing over the last 22 years to enable context-specific collective self-development and empowerment amongst Indigenous communities. Indigenist research decolonises the research process whereby Indigenous people conduct research that is relevant to, and of interest to, their communities, (E. Rix et al., 2014). With the development of an Indigenous research paradigm, much has been written about what researchers 'should do' while working with Indigenous people, but there was little information about the practicalities of the research and 'how to do it' (K. Adams & Faulkhead, 2012). Fortunately, Russ (2008) outlined practical ways of improving health research practices for Victorian Aboriginal (Koori) communities:

- Research should be beneficial to community, practical and positive.
- Research processes must build research capacity within community.
- The research must strengthen the community – act as a voice for the community to foster understanding and future opportunities.
- The research should be owned and controlled by the community organisation.
- Research must be done in partnership with Indigenous people and led by the Indigenous partners to maintain community control.
- The community must be informed about the purpose of the research.

- Research must be experience-based, socially oriented and individualised.
- The research must maintain confidentiality, privacy and respect of the participants and community.
- Research outcomes must be relayed to the community and implemented.

As a non-Indigenous researcher entering the Indigenous health research arena, I endeavoured to adhere to the core values of the Indigenous paradigm (National Health and Medical Research Council, 2003b) by closely following the recommendations in *Values and Ethics: Guidelines for Ethical Conduct in Aboriginal and Torres Strait Islander Health Research* (National Health and Medical Research Council, 2003b) and the commendations of Russ (2008) and previous Indigenous and non-Indigenous researchers working in the Indigenous space (Adams & Faulkhead, 2012; Brands & Gooda, 2006; De Crespigny, Emden, Kowanko, & Murray, 2004; Maar et al., 2011; Nilson, 2017; Pyett, Waples-Crowe, & Van Der Sterren, 2009; Rix et al., 2014; Terare & Rawsthorne, 2020).

Phase Two: Naturalistic qualitative approach to research in Indigenous community

Gaining theoretical insight into the Indigenous paradigm or worldview was the first step towards developing respectful, reciprocal, and meaningful relationships with Aboriginal people.

Engagement with an Aboriginal Community Controlled Health Service (ACCHS) was the next crucial step in honouring the self-determination of Aboriginal peoples and to identify relevant areas of research for the communities involved (Pyett et al., 2009). Using the 5Rs as a reference point, as well as other researcher advice (Adams & Faulkhead, 2012; Pyett et al., 2009), my supervision team and I applied to partner in a research project with the Victorian peak body for Aboriginal health, the Victorian Aboriginal Community Controlled Health Organisation (VACCHO). I was already known to some members of VACCHO due to my previous teaching role where I provided health assessment training and education for Aboriginal Health Workers (AHW), at which time I had gained valuable insight into Aboriginal Worldview through the students. This laid the foundation for further development of mutual *respect* and *relationship* as well as providing a precedent for *reciprocity* (Pyett et al., 2009). The research application was reviewed by the VACCHO Senior Research Officer, the Public Health Medical Officer, the Good Medicines, Better Health Project Officer and the La Trobe University Human Ethics Committee. At a subsequent meeting with the Senior Researcher, the terms of engagement were discussed to establish roles and *responsibilities* and Wathaurong Health Service (WHS) was identified by VACCHO as the most appropriate community organisation to partner with.

The next phase was to engage with WHS, the Aboriginal Community Controlled Health Service (ACCHS), to develop a level, balanced partnership so that the research was relevant, meaningful and reciprocal for both Aboriginal Health Service and University partners (Adams & Faulkhead, 2012). The benefit of this approach is that non-Aboriginal and Aboriginal researchers both contribute to the study design, execution and governance (Holmes, Stewart, Garrow, Anderson, & Thorpe, 2002). Contact was made between VACCHO and the WHS practice manager who agreed to meet with us because our research proposal was relevant and well aligned with work that the local community was completing. To establish a research partnership my supervision team and I travelled to WHS for all team meetings to avoid a time impost on the ACCHS staff members who already had very busy schedules. The research team consisted of the WHS Practice Manager, two AHWs as well as my supervisor and I. Roles in the research partnership were delineated by the WHS Practice Manager in consultation with the AHWs and I. It was determined that because I was non-Indigenous and an outsider to the community, that the most appropriate people to interview Indigenous participants were the AHWs. My role would be to provide the WHS approved information brochures to be available in the clinic waiting room so that people could take them home and consult with others before volunteering to participate. I also provided the equipment to record the interviews. The WHS partners determined that to ensure reciprocity, in return for information, the participants would be presented with a voucher to a large retail organisation to spend as they pleased, however at the request of WHS, purchase of alcohol and tobacco was not authorized. The research team agreed that the most appropriate and credible method of data collection was to use Yarning. Yarning includes the sharing of stories and has been identified as a culturally appropriate way for Indigenous people to connect and exchange information socially or more formally such as in an interview setting (Bessarab & Ng'andu, 2010; Lin, Green, & Bessarab, 2016). Through Yarning, rich qualitative data can be collected and thematically analysed to reveal the complexities and richness of the participant's experiences and perceptions.

As a tool to better understand my own contribution to the research, I also used a qualitative naturalistic approach (Guba & Lincoln, 1982) and employed a conversational method (Kovach, 2010), to document my experiences of engagement and relationship building with the AHS through contemporaneous note taking, journaling and reflection. A naturalistic descriptive approach was adopted as an appropriate way to explore my research journey with Aboriginal peoples because it is based on the ontological premise that reality is a subjective experience, understood and interpreted differently by different people (Murt, Krouse, Baumberger-Henry, & Drayton-Brooks, 2019); and because it was a paradigm that accommodated the organic and

inductive development of my research rather than me having to manipulate conditions to fit with other *a priori* methods (Armstrong, 2012).

"I realised that to participate in research in Indigenous communities, I was going to have to form relationships and build trust by ensuring those relationships were equal and reciprocal."

(Entry, September 2011)

My journal reflects on my experiences engaging with the Aboriginal research partners as my role in the partnership did not include engagement with the Aboriginal study participants. Although I remained peripheral to the interview process and data collection, it was important that I developed a sense of self-awareness in order to identify any stereotypical or idiosyncratic concepts I may have formed that would impede my understanding of Aboriginal peoples and their perceptions, attitudes and responses (Nilson, 2017; Rix et al., 2014). In order to explore my worldviews, position of privilege and associated feelings of guilt (Rix, Wilson, Sheehan, & Tujague, 2019), an important part of the process was to engage in the reflexive practice of ongoing critical self-reflection (Lincoln, Lynham, & Guba, 2011), through journaling and by engaging in a two-way learning relationship with my Aboriginal mentor, where "Indigenous Relational Standpoint and the White normative standpoint can co-exist" (Coff & Lampert, 2019, p. 4). Reflexivity challenges the researcher to explore the epistemological foundations of the research question and the methodology, as well as their own part in the creation of the knowledge, in order to assess the reliability the knowledge developed (Rix et al., 2014).

Conversational methods are accepted methods from both Indigenous research and qualitative research paradigmatic perspectives, hence I kept contemporaneous notes as a method to document and aid my understanding of the relationships between my evolving understanding of Indigenous worldviews and engagement with community and the Indigenous research paradigm (Kovach, 2010). Given that I am not of Indigenous descent and I do not share the deep cultural roots of the Aboriginal worldview, I adopted the Conversational method as an appropriate way of exploring and understanding the Indigenous research paradigm, as it employs story telling as a means of gathering information to reveal the relationship between the method and its efficacy and congruence with the Indigenous worldview (Kovach, 2010). The narrative of my experiences, feelings and observations were recorded via a series of notes and a reflective journal and uploaded to the software QSR International's NVivo Release 1.4 (QSR International Pty Ltd, 2020) to identify the emergent main themes. Part of the learning process was to debrief regularly about my experiences, feelings and knowledge with a trusted *Aunty*, a wise *Murri* woman who

has mentored me over the past decade. In this way, as a mentee, using the conversational method and a reflective process, an idiographic understanding of the Indigenous worldview evolved which I applied to the research process (Guba & Lincoln, 1982). The main themes that emerged from my narrative were identified as: *relationships; adaptation from a Western worldview to Indigenist research paradigm approach; and experiences and learnings.*

Theme One: Relationships

Relationship is of paramount importance to Aboriginal people – relationships between people; Spirit; The Dreaming; elements; nature (animate and non-animate); the living; the ancestors; and country – everything is linked. As a principle, relationship closely relates to the other principles inherent in the Indigenous Research paradigm and the Indigenous ways of knowing; in particular the other four of the five ‘Rs’ identified earlier - respect, responsibility, reciprocity and relevance (National Health and Medical Research Council, 2003b). The relationship formed with the WHS was based on a formalised project agreement (Pyett et al., 2009), however prior to that there was a period of respectful and reciprocal relationship building with Aboriginal people that helped me to become known by the community; as a teacher for VACCHO and the Northern Territory, Nauiyu Community and as a member of the Board of Management for the First Nations led Weenthunga Health Network. Insights gained through these experiences helped me to understand how my research could be meaningful and relevant with positive outcomes for the community. One of the most important lessons I learned was that of patience and time – nothing worthwhile can be rushed. Positive relationships built on mutual trust take time to build (Isaacs et al., 2011; Pyett et al., 2009). Once I had been introduced to the WHS Practice Manager and the AHWs by the peak body, VACCHO, it was then possible to develop a relationship with each individual so that we could each understand the other’s attitudes and worldviews to determine the appropriate roles and responsibilities of our working partnership.

“We formed relationships and shared much about our lives. As women and mothers, sisters, aunties, and healthcare providers, we had much in common.”

(Entry October 2012)

Theme Two: Adaptation from a Western worldview to an Indigenist Research paradigm approach.

As discussed earlier, there is a vast difference between the Western worldview and the Aboriginal worldview and many of my experiences and challenges related to adapting my

Western outlook approach to working in partnership with people with an Indigenous worldview. The thematic analysis of my journaling and notes revealed that in the process of learning about, and adapting to research informed by an Indigenist perspective, some of the most important lessons I learned was to develop flexibility in my expectations of timelines, priorities and situational control. The prolonged timelines involved in the development of all aspects of the research process initially prompted frustration on my part.

"It was very difficult to contact the two AHW researchers who were extremely busy carrying out their core responsibilities caring for their community members, attending to community outreach; caring for members of the community who had experienced family or police problems or who needed transport home or about. Very often they were away in Melbourne or elsewhere attending in-service education. Also, because AHWs are so connected with many members of the community, they were often absent from the clinic due to sorry business."

(Entry, May 2013)

Previous researchers have discussed time as a barrier to working with Indigenous research partners (Turner & Sanders, 2007), however in my quest for insight I came to appreciate that Indigenous world views and ways of knowing, present a different understanding of time compared with my own empirical Western linear approach. Indigenous worldview perceives time as multidimensional and contextual rather than as the discrete functional linear units perceived by the Western worldview (Janca & Bullen, 2003). From an Indigenous worldview, time is perceived in relation to socially sanctioned importance of events, where community and family are prioritised over the individual (Janca & Bullen, 2003). Therefore, previously scheduled events or meetings may subsequently be ranked lower in priority compared with the requirement to respond to the needs of family and the community. Indigenous researchers have acknowledged that such different perspectives regarding time and schedules may evoke frustration and concern for the research team members (K. Adams & Faulkhead, 2012). Indigenous researchers also explain that irrespective of other commitments, many Indigenous organisations like ACCHOs, are focused on the core business of service delivery to the community, so that they may be unable to dedicate the time to research that is perceived as necessary by their non-Indigenous academic partners (K. Adams & Faulkhead, 2012). Through reading, consultation, reflection and mentorship, I came to realise that the often cancelled meetings, the changes in the Indigenous research personnel and the lack of timely progress was not a reflection of disinterest and lack of responsibility, but rather an indication of the importance of their uniquely Indigenous social and cultural obligations and priorities that existed and took precedence over Western conventional notions of times and schedules. I learned to be flexible and responsive to their changing timelines and needs and realised that over time, I had

developed the understanding “it is not important *when* things happen, it is important *that* they happen” (Janca & Bullen, 2003 p. S41) .

Theme Three: Experiences and learnings

Reciprocity is a dominant aspect of Indigenous worldview that reflects a relational value-system that impresses the importance of honouring relationships with others by giving as having received (Hart, 2010). Adams and Faulkhead (2012) explain that *reciprocity* can take varied forms and that training can be such an activity. From my own cultural and spiritual background, the value of reciprocity is well known to me whereby the building of friendship and relationship is organic and involves giving unconditionally. I have built relationships through teaching and giving service to Indigenous organisations over the last decade. As the academic representative of the research team, I also offered interviewing and data collection training for the Indigenous research team. This training was conducted as an in-service activity at the WHS, however not wanting to demean the AHWs knowledge by imposing Western ideas of interviewing technique when they had agreed to employ Yarning, an Indigenist method.

“We do this every-day”.

(Entry, 2012)

In response to one comment from the AHWs, I adjusted my approach to briefing the AHWs about the data collection and use of open ended questions to facilitate their Yarning.

Reflecting on my learnings about Aboriginal worldviews, and through two-way learning with the AHWs (Coff & Lampert, 2019), we realised that similar to the lessons about perceptions of time (Janca & Bullen, 2003 p. S41), the lessons from this situation were that despite changes in method and analysis, the most important things were that the research questions were relevant to the Aboriginal people involved; data had been collected by Aboriginal people; and that Aboriginal people had been able to voice their perceptions about their healthcare; and that the data could be analysed and subsequently disseminated as planned. The research map changed but we arrived at an appropriate destination for the whole research team, including the AHWs.

Phase Three: Positivist population approach to research in Indigenous communities

Phase three adopted a positivist empirical methodology for reasons explained in Chapter 3. According to Richardson-Tench, et.al, (2018 p. 8) , “the positivist paradigm provides and objective reality against which researchers can compare their claims and ascertain truth”. The

survey data that were selected for secondary analysis were guided by the outcomes and results of phases one and two. The selected data derived from Australian national surveys, where Indigenous people were involved at all stages of the survey design, development and data collection. The outcomes from phases one and two of my research of most interest to me, and where knowledge was scant, was that sleep was an area of concern for Indigenous people. A range of surveys were explored to ascertain the presence of sleep items for Indigenous peoples. Empirical sleep data were available in the LSIC, NATSINPAS and NPASS surveys, hence their selection. From a population health perspective, the surveys were important because they are considered to be nationally representative. A variety of descriptive and inferential statistical methods were utilised to analyse the data as described in later chapters.

Chapter 3: Chronic disease, medications and lifestyle: perceptions from a regional Aboriginal community

Introduction

It has been established that a large proportion of Indigenous Australians live with chronic health conditions, and many take one or more medications. Until recently however, the literature has abounded with reports about Indigenous people as *non-compliant* with their medicines (Humphery, Weeramanthri, & Fritz, 2001). Much of the literature has proliferated from a deficit rather than strength-based approach, with little or no consideration of *cultural responsiveness*. In the main, the reports have focussed on the opinions and assumptions of non-Indigenous healthcare providers rather than the perceptions of the Aboriginal peoples themselves (Hamrosi, Taylor, & Aslani, 2006; Swain & Barclay, 2013). A consequence of this is the risk that non-Indigenous accounts of Indigenous lives and experience can lead to misrepresentation and stereotyping which transforms Aboriginal peoples' reality.

This chapter presents a study that was developed to address the issues discussed in Chapter one, particularly regarding the experiences of Indigenous people with non-Indigenous researchers and Chapter two, regarding the differences in worldviews between Indigenous and non-Indigenous people. In the context of chronic disease management, the study presented the perceptions of a group of Wathaurong people who attended an Aboriginal Medical Service in the Greater Geelong area, Victoria in 2012-2013.

The aim of the study was to investigate the perceptions of a group of Aboriginal people with diagnosed medical conditions regarding their medication knowledge, management and usage and lifestyle factors.

Original Research

Chronic disease, medications and lifestyle: perceptions from a regional Victorian Aboriginal community

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ABSTRACT

Background: Poor medication management may contribute to the increased morbidity and mortality of Aboriginal people in Australia. Yet while there is extensive literature about the perceptions of healthcare providers on this issue, there is limited information on the perceptions of Aboriginal people themselves.

Objectives: To investigate the perceptions of a group of Aboriginal people attending a Victorian regional Aboriginal Health Service (AHS) with diagnosed medical conditions requiring medications, of their lifestyle, disease management and medication usage.

Methods: Data was collected through one to one in depth interviews using a semi-structured 'yarning' process. Twenty patients were invited to participate in the study and were interviewed by Aboriginal Health Workers in a culturally appropriate manner. The interviews were recorded and transcribed verbatim. The data were analysed using descriptive statistics.

Results: Our results show that the majority of participants perceived that changes in lifestyle factors such as diet, exercise, and smoking cessation would help improve their health. Most patients reported having been counselled on their medicines, and while the majority reported adherence and acknowledgement of the efficacy of their medicines, there was a lack of clarity regarding long term maintenance on regimens. Finally, while the majority reported taking over the counter products, some did not see the need to inform their doctor about this, or chose not to.

Conclusion: Chronic illness was perceived as common in families and community. Patients relied mostly on their health care professionals as sources for their drug information. Patients may have benefited from further counselling in the area of complementary and other over the counter medicines, as well as on the necessity of maintenance of regimes for chronic disease management. Finally, lifestyle changes such as dietary improvements and smoking cessation were identified as areas that may assist in improving health outcomes.

Keywords: Oceanic Ancestry Group; Health Services, Indigenous; Health Knowledge, Attitudes, Practice; Chronic Disease; Medication Adherence; Life Style; Patient Education as Topic; Australia

INTRODUCTION

It has been well established that the health of Aboriginal Australians is poor and that there is a disparity in health standards and life expectancy among Aboriginal populations compared to non-Aboriginal groups.¹⁻⁵ The transition to western diets and lifestyles and ensuing chronic disease has been previously identified as a major contributor to the increased morbidity and mortality of Australian Aboriginals.⁶⁻⁸ Many Aboriginal people are diagnosed each year with chronic diseases such as hypertension, diabetes, obesity, cardiac disease, chronic obstructive pulmonary disease, kidney disease and depression.⁹ Risk factors such as obesity, malnutrition, tobacco smoking and alcohol consumption that contribute to the development of these chronic illnesses are multifactorial and often related to socio-economic disadvantage and poor access to service provision.⁹

Adequate solutions for the inequity in Indigenous health and wellbeing standards require rigorous national political effort.^{4,8} The 'Closing the Gap' strategy aims to reduce Indigenous disadvantage and achieve Indigenous health equality within 25 years.¹⁰ Much of the existing research available to inform healthcare policy and procedure has been conducted from a non-Indigenous "scientific" perspective without consultation with Indigenous people. In recent times there has been extensive information available to educate researchers about culturally appropriate methods for undertaking meaningful research partnerships with Indigenous people and the risk of misrepresenting and stereotyping Indigenous experiences if appropriate methods are not employed.¹¹⁻¹⁹ One serious and possibly underestimated ramification of non-Indigenous accounts of Indigenous information is the potential for the transformation of Aboriginal reality; an example of which is the creation of a "non-complier" stereotype commonly applied to people who struggle to adhere to prescribed medication regimens.²⁰

Most of the available information on management of medication by Aboriginal people discusses medication compliance²¹⁻²³, poor medication management and underutilisation of health care resources²⁴, from the healthcare provider viewpoint. There is scarce information regarding the perceptions of Aboriginal people and their management of chronic illnesses and medications.²⁵ More research and information from the Australian Aboriginal perspective is required to facilitate better health outcomes for this population. This research

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Table 1. Interview questions

1.	How long have you been taking medicines for your sickness? How old were you when you started taking medicines for your sickness?
2.	Do you know what each of your medicines is for? Can you tell us about them?
3.	When you started taking the medicine, who told you about them?
4.	What sort of information did they tell you?
5.	Did you also get information from someone else?
6.	Do you think the medicine is helping you?
7.	Do you think the medicine is causing you problems?
8.	What do you do if you think the medicine is causing you problems?
9.	Who do you tell about the problems?
10.	What would make you stop taking the medicines?
11.	Do you know how long you will have to take the medicines?
12.	Other than taking the medicines, what else do you need to do to look after yourself?
13.	Do you smoke? Have you been ordered anything to help you give up smoking?
14.	How hard is it for you to make lifestyle changes? Can you tell us about this?
15.	Do many people in your family and community need to take medicines? Can you tell us about this?
16.	How old are people when they start needing medicines?
17.	Where can you get information about medicines?
18.	Do you take more medicines than those the doctor orders? PROMPT: from the supermarket/health food shop/bush medicine/other people
19.	Did you know that you should tell the doctor about those other medicines?
20.	Do you think the medicines will help cure your sickness?

aims to investigate the perceptions of a group of Victorian Aboriginal people taking medications for diagnosed chronic illnesses regarding their lifestyle, disease management and medication usage.

METHODS

Through consultation and collaboration with the Victorian Aboriginal Community Controlled Health Organisation (VACCHO), our research team formed a co-researcher partnership with the Practice Manager and the Aboriginal Health Workers (AHWs) practicing at an Aboriginal Health Service (AHS) situated in a large regional centre. The AHS Chief Executive Officer, Practice Manager and AHWs verified the benefit of the research for their community, an important consideration in such collaborations.¹⁷ Academic members of the research team travelled to the Aboriginal Health Service on a number of occasions prior to the interviews being conducted, and in conjunction with the AHS Chief Executive Officer, Practice Manager and AHWs determined the content and style of interview that was most culturally appropriate. It was determined that AHWs would conduct culturally appropriate, one to one indepth interviews using a semi-structured 'yarning' process. 'Yarning' is an accepted Indigenous research method that encourages rich data collection by encouraging participants to tell their story in a conversational manner.^{11,12,25} Members of the research team who were experienced in interview methods provided training to augment the AHWs' skills in interviewing. Regular telephone contact was made between the academics and AHW team members for mentorship and discussion.

A purposive sample of 20 Aboriginal people over the age of 18 years who took medications as part of their chronic disease care were invited to participate by an AHW when they attended their AHS appointment. Potential participants were verbally informed about the study by the AHWs at the time of their health consultation and given written information to peruse in their own time. Participants were offered a gift voucher in appreciation for their

time and contribution to the research. The researchers obtained written support for the study from the Chief Executive Officer of the AHS and approval from the La Trobe University Human Ethics Committee (No. 12-057).

The interviews took place from October 2012 to July 2013. Table 1 lists examples of questions that were used as prompts. The de-identified interviews were recorded by dictaphone with the consent of the participants and transcribed verbatim. Transcripts were validated by members of the research group including the AHW research partners. Although the intention was to use a 'yarning' methodology, due to unforeseen staffing issues at the AHS, including the departure of experienced AHW and their replacement with less experienced staff, the interviews were conducted in a manner that did not generate rich, descriptive qualitative data. Instead, the data was analysed by a member of the academic team for descriptive statistical analysis.

RESULTS

Participants were taking medications to treat a variety of chronic illnesses, and many were treated for more than one disease. No personal identifying data was collected. The average age of commencement of medications for the management of chronic illness was 32 years (Range: 17 - 64 yrs). The average length of time that participants had been taking the medications was 11.4 years (Range: 0.5 - 35 yrs). Over half the participants had cardiac diseases and over a third reported mental health disorders (Table 2). Cardiac disease was equally distributed in men and women while mental

Table 2. Chronic illnesses identified by participants when discussing their prescribed medication usage.	
Chronic illness	(%)
Cancer	5
Cardiac	55
COPD	20
Diabetes	10
Mental health	35
Gastro-intestinal	20
Inflammation	15
Others	20

health disorders were more prevalent in females (42%) compared with males (25%).

Medication knowledge: The majority of participants reported that they knew why they were taking all their medicines; however when questioned specifically, less people than originally reported knew why they were taking some or all of their medicines (n=18 vs. n=14). It is not known if this was related to the length of time since commencement of their medicines.

Medication Education: On commencement of a new medication, the majority of participants responded that their treating medical practitioner from the AHS was the primary source of education. The most common recollections were: how to take the medication and how often (16 participants); potential side effects of their medications (10 participants); medication action (4 participants); and dose (2 participants). Half of the participants specified that one or more of these components of their medication education was missed by their health professional or that they did not recall having been informed about them. No participants mentioned having been educated about storage issues.

Following initial education about their medications, 13 participants gained further information from other sources. Five participants consulted pharmacists, and nurses were consulted by four participants, medical practitioners by three participants, Aboriginal Health Workers by two participants and information leaflets from the drug company by two participants. Some participants also sought advice from relatives and the internet. Almost half of the participants reported that they relied on the secondary source of education to clarify their understanding of their medications:

"Aboriginal Health Workers have helped me in a lot of ways by getting the Doctors and Nurses to express things to me in a plain English way."

Participants were also asked about their perceptions of reliable general sources of information about medications. Pharmacists and medical practitioners were broadly recognised as the main sources of information about medications:

"Probably the best place to get your information is from a Pharmacist because they are going to be pretty much spot on with any information that they pass on."

"Often the Pharmacist knows more than the GP. The Pharmacist seems to have it more on their fingertips because they're trained in a different way. The GP, well the ones that I go to anyway, are very good and look it all up on the computer which makes it easy these days it wasn't so easy for them before."

In general, nurses and AHWs were not recognised as sources of information about medicines. In this study, more participants nominated that they would be more likely to consult the internet about medications than a nurse or AHW.

Role of medications in the treatment for chronic illness: 15 participants perceived that their medications played a role in the control and management of their illness rather than a cure; four hoped that the medications would help cure their illness; one believed that their medications would help cure their illness. **Efficacy:** 14 participants perceived that their medications were helping most, or all of the time. The remaining six participants were unsure regarding the efficacy of the medications, perceiving their medications were helpful some of the time or not helpful at all. **Side effects:** 15 participants, irrespective of whether they had actually experienced side effects, stated that they would ideally seek medical advice before ceasing their medication, if they experienced any. The majority of participants (n=15) stated that they would inform their AHS general practitioner, followed by nurses, AHWs and pharmacists. Most participants would also discuss their side effects with family members. Experience of side-effects: eight participants stated that they had experienced side effects from their medications. Actual responses to side effects varied. Two affected participants took no action and chose to endure the side-effects. The remaining affected participants reported that they had stopped taking the medication prior to seeking medical advice with the majority seeking their own alternative means to treat their problems.

Medication regimen: Most participants perceived that they would be taking their medications for life, or at least for a long, indefinite period. Participants were asked to report any perceived reason they may cease their medications either permanently or temporarily. Eight participants stated that they would not cease their medications unless directed by their doctor and for three participants this included continuing with medications that they perceived were making them feel worse. The 12 remaining participants stated that they would cease their medications if they felt sicker due to side-effects or if they perceived that the medications were no longer needed or were not helping. Seventeen patients reported that they adhered to their prescribed medication regimen. Three patients reported that their prescribed regime altered on a regular basis. Two reasons were given for this: forgetfulness or because they consciously stopped taking their medications when they wanted to drink alcohol:

"I forget a bit. And like I say, if I even lose two or three days out of a week I feel that my body feels it. I get very sick."

"The side effects are quite demanding if I have alcohol. It means that I might not take it [medication] for two days.....so I can drink if I have a special occasion."

Medicines other than those prescribed by medical practitioners: six participants stated that they did not take any other medicine or supplement (over-the-counter (OTC) or other) aside from the medications prescribed by their medical practitioner:

"Do I take more medicines? No way known. You have got to be very careful on what you take. Yeah, you have got to understand it and if you don't know, ask about it."

"I am only on the prescribed, what the doctor has already given me to take..... So if they want me to take any other different medications they would.....have wrote out a prescription for me wouldn't they?"

Nine participants stated that they regularly took a variety of OTC products including non-steroidal anti-inflammatory drugs and other analgesics; vitamins, minerals, omega 3 fatty acid supplements & herbal/spice/calming remedies. The other five participants said that they regularly took unspecified medications other than those prescribed.

Awareness of the importance of reporting all other medications to doctor: 15 participants reported that they knew that they should tell the doctor about any other medications or supplements that they were taking and complied:

"I would be wary because I don't know what clashes with the medication or not..... if I did [take OTC or complementary medicine], but I don't think that I would, because I would have to consult my doctor first."

Three stated that despite knowing they should tell the doctor about other medicines, they chose not to – some perceiving that if the other medicines were "natural", there was no need to report:

"I don't think it would actually have any adverse effect with what was prescribed because it is all natural products there is nothing been added to it. There is only a process like making tea out of it."

Two participants indicated that they were not aware of the importance of telling the doctor about other medicines.

Lifestyle influences. Aside from taking medications, participants were asked to describe their views about how to improve their wellbeing. Perceived important behaviours were: (i) eating a healthy diet, drinking more water, eating less and losing weight (identified by 15 participants); (ii) combinations of increasing daily exercise, adopting a healthy lifestyle, sleeping and resting more (identified by 15 participants); (iii) improving mental health (five); (iv) giving up smoking (two); (v) drinking less alcohol (one). The majority of participants (n=16) reported that even though they realised their lifestyles needed to change in order to enhance their wellbeing, it was very difficult to make the required changes. The main perceived barriers were due to competing demands (family, community and employment) and the self-perception of being too "set in their ways" to change.

Smoking: 13 participants had a history of smoking: nine current smokers and four ex-smokers. All participants with a history of smoking were asked to identify reasons they would consider smoking cessation. Both genders nominated reasons such

as health issues and prohibitive expense. Females were also inclined to consider smoking cessation due to pregnancy and feelings of duty to children.

Six of the current smokers and three of the ex-smokers had been prescribed medications to help them cease smoking at some time. These included prescription medicines taken internally, as well as transdermal nicotine replacement patches. Seven of the participants who had taken these prescribed medications reported that they had ceased them mainly due to unbearable side-effects and because the medications were not working as hoped.

Perceptions about family and community: 18 participants perceived that most people in their family and community took regular medications for chronic illnesses:

".....everybody in my family takes medication."

Familial and community obesity and cardiac disease were identified by half of the participants as highly prevalent; followed by diabetes mellitus (identified by nine participants); mental health disorders (eight participants); cancer (four participants) and respiratory diseases (two participants).

Age at which people require medications for disease management: fourteen participants thought that most people would need to start taking regular medications by 40 years of age. Of this group, four perceived that the most likely time to commence medications is around late twenties while seven perceived that it would not be uncommon for children and babies to require medications to manage illnesses. Only one perceived that medications would not start until old age.

DISCUSSION

The range of chronic illnesses experienced by the participants in this study reflects the distribution of chronic illnesses in the Aboriginal and Torres Strait Islander community at large.⁹ The majority of participants in this study thought that most people would develop a chronic illness and require regular medications by the age of 40 years and some thought that it would not be unusual for children and babies to require medications. These perceptions are concerning as they generally reflect the incidence of chronic illnesses in Aboriginal people across Australia.²⁶

It has been reported that 80% of indigenous adults had confidence in their local doctors.²⁶ In this study, the local Aboriginal Health Service doctors provided the initial education for most of the participants on the commencement of medications, however half of the participants relied on a secondary source of information to clarify their understanding. This is possibly because only half stated that they recalled counselling for potential side effects, with only two recalling counselling about dose, from their doctor. The most common secondary sources of information were pharmacists, followed by nurses, other medical practitioners and AHWs. As the participants were attending an Aboriginal Health Service, it was interesting that Aboriginal Health

Workers did not rank higher as a source of information about specific prescribed medicines given their multi-faceted roles in the Aboriginal community and at the AHS.²² When asked to nominate credible sources of general information about medicines, participants nominated medical practitioners and pharmacists as the best sources followed by Aboriginal Health Workers and the internet before nurses. Although nurses were nominated as important secondary sources of education about prescribed medications, very few participants said that they would inform a nurse when experiencing problems with their medications. Additional enquiry is necessary to understand whether this is due to perceptions about Nurses' credibility or whether it is related to their accessibility in the community. More research is required to assess the eHealth literacy skills of Aboriginal health consumers in order to further inform their need for education and support their self-management of chronic illnesses.^{27,28}

There have been reports in the literature and anecdotally within healthcare services that inappropriately label Aboriginal people as non-compliant or poor self-managers of their medications for chronic diseases.²⁹ The majority of the participants reported here that they tried to adhere to their prescribed medication regimen even when experiencing side effects, because they believed it was in their best interests. A small number reported that they did not adhere at all times, due to forgetfulness or if they planned to drink alcohol knowing it was contraindicated.

Almost half of participants stated that they regularly took a variety of OTC products in addition to their prescribed medications. Yet while the majority of participants stated that they would report the use of any non-prescribed medication, supplement or complementary medicine to their prescribing doctor, a quarter of those questioned suggested that they would not. There was a perception among a small number of participants that there was no need to report the use of "natural" products such as herbs and supplements. Therefore, it would seem reasonable to suggest that education focussing on the potential adverse reactions and drug interactions associated with OTC products and complementary medicines would be warranted.

An area that has been highlighted recently is that of cultural barriers to delivery of health care for Aboriginal people, with Aboriginal patients valuing the interpersonal relationships between themselves and health practitioners.³⁰ While this was not investigated in our study, the participants here appeared to be comfortable with their Health Care Professionals.

However, this study does highlight the importance of ongoing patient counselling and education about medicines, no matter how long people have been taking their medications and how well supported they feel by their AHS.³¹ Addressing this issue may assist in improving the benefit derived from medicines by Aboriginal and Torres Strait Islander patients and their subsequent self-management of chronic illness. Particularly as chronic illness was

perceived as prevalent in families and community in this study. To this end, our studies suggest that it is important to stress to these patients that continued adherence to the medication regime is required in order for longer term health benefits to be seen. This is particularly so in conditions such diabetes and cardiovascular disorders, and in light of the comments by some of the people here that they would cease their medicines if they perceived that they were no longer needed or if they thought they were not helping. Such education would also need to stress the importance of reporting side effects from medicines, so that alternatives may be prescribed, rather than patients ceasing to take them because of adverse reactions.

Considering ways to help maintain or improve health aside from taking their medications, most participants stated that they wanted to adopt a healthier lifestyle but found competing demands of family and community responsibility and employment as barriers. Here the authors suggest that the input of allied health professionals such as dieticians, may be beneficial and effective.³² Apart from more general advice from AHWs, GPs, nurses and pharmacists, dieticians could more precisely advise on food intake and instigate manageable programs. For those participants who wanted to cease smoking, medication aides were largely unsuccessful due to side effects and unmet expectations. Further enquiry is required to explore whether these perceptions also reflect those of Aboriginal people who live in more rural and remote regions where healthcare resources differ vastly from those in the urbanised setting. Irrespective, healthcare providers in all settings could identify personalised, culturally appropriate strategies to help Aboriginal people adopt healthier lifestyles in their particular communities and circumstances. In the setting for our study, for instance, a concerted smoking cessation program could be initiated. This should involve input from the GP and pharmacists in particular, and include an assessment of the individual patient's lifestyle in order to guide therapy, as well as extensive counselling (with back up counselling) so that patients are aware of potential issues and side effects of the smoking cessation programs. It has been shown that community pharmacist led interventions can significantly impact abstinence rates in smokers³³, and the relatively familiar setting of the AHS may assist in such a program. Personalised medication for smoking cessation has been shown to be an effective and sensible approach to minimising adverse effects and maintaining abstinence.³⁴⁻³⁶ This involves the pharmacogenetic analysis of enzymes responsible for the metabolism of drugs involved in smoking cessation. Such an approach may significantly improve the prospects of people such as those we interviewed here in their efforts to quit smoking.

A coordinated healthcare network approach is also required to ensure regular evaluation of medicine use. Such regular evaluation may help with ongoing education about drug side effects, interactions and contraindications, as well as important issues around the storage of medicines. These are

particularly relevant for people who manage chronic illnesses while negotiating challenging and changing life circumstances.

To this end, pharmacist led education of AHWs has been proposed as a way of providing drug information to Aboriginal patients in rural and remote communities.³⁷ More recently, there have been calls for pharmacists to play an integral role within AHS, particularly in the delivery of Home Medication Reviews.³⁷ Being more closely involved with the AHS would enable pharmacists to attain appropriate education in the cultural sensitivities required to reduce barriers to delivery of such an important service in medication management^{38,39} and may provide a catalyst that would potentially be of benefit to such a co-ordinated approach.

Finally, an important over-riding issue which stems from this research is that while the non-Aboriginal health staff at the AHS had been trained in cultural awareness, it may be more helpful for Aboriginal people to be cared for by Aboriginal medical practitioners, nurses and pharmacists, as well as AHWs.⁴⁰ In Australia there is an urgent need for the education of Aboriginal students in order to increase the numbers of graduating Aboriginal doctors, pharmacists and allied health professionals.^{41,42} Aboriginal patients may benefit from this, in that it may help in their management of lifestyle, medications, and chronic disease.

This study has a number of limitations. Firstly, the results are derived from the perceptions of a relatively small number of Aboriginal people attending one Aboriginal Health Service and as such, may not be representative of Aboriginal communities at large. Secondly, the recollection of participants about their medication use and health care was not able to be triangulated with other health service records. Thirdly, given that the interviewer was a healthcare provider employed by

the Aboriginal Health Service, rather than a "neutral" party, there is the possibility that participants may not have been so forthcoming in their responses and discussion during the interviews. Finally, as was mentioned earlier, this study did not yield rich data stemming from a proposed 'yarning' process, and so it was necessary to analyse the results employing descriptive statistics instead. While these are important limitations, this study contributes issues and perspectives to consider regarding chronic disease management for Aboriginal people.

CONCLUSIONS

In conclusion, the findings may help facilitate better health outcomes for Aboriginal people by informing healthcare providers about issues that are important to Aboriginal people in their medication usage and management of chronic illnesses. Particularly, further education about over the counter and complementary therapies, the need for more effective counselling on all aspects of medications, the need for continued adherence to medications in order to gain maximum benefit from these, the implementation of programs involving dietetics in order to facilitate healthy lifestyle and diet management, and the instigation of dedicated and personalised smoking cessation programs within AHS.

CONFLICT OF INTEREST

The authors are unaware of any conflicts of interest.

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Conclusion

This study highlighted the inappropriate use of the term “non-complier” when describing Aboriginal peoples. The *compliance* issues about Aboriginal peoples participating in mainstream medical services that had been reported in the literature up to that time, were not observed. Given the positive feedback by the participants regarding their health care provided by the AHS, the study supported the provision of culturally responsive health care. The study also emphasised the need for healthcare providers to respond to issues that are important to Aboriginal peoples in their medication usage and self- management of chronic illnesses to encourage patient empowerment and self-management for the appropriate use of medicines by their Aboriginal patients.

Notably, the study also revealed an almost fatalistic acceptance of the prevalence of chronic illness in the Aboriginal community and families. Most participants identified concerns with familial and community obesity and cardiometabolic illnesses. Interestingly, three-quarters of the participants identified that they felt that they should improve their lifestyle that included recognition of the need for more sleep, but many felt they lacked the motivation and time to make the required adjustments. The identification of obesity and sleep duration as issues of concern piqued my interest in exploring whether sleep duration had a relationship with chronic illness for Indigenous people. Subsequent literature reviews revealed that there was scant information available about the sleep of Indigenous Australians, convincing me of the need for further research into this area.

The next step

Following the completion of data collection in this study, over the next three years, my supervision team and I worked to establish relationships with other Aboriginal communities to further the research in other rural and remote locations: Groote Eylandt (2014), Mt Isa Gidgee (2015); Onslow (2016). Unfortunately, as each relationship was built with the communities and plans were made, barriers presented that prevented the initiation and progression the research: community threats by flooding and associated natural disasters at Groote Eylandt; staff and leadership restructures at Mt Isa and sadly; *Sorry Business* and customary community practices associated with the death of a Thalanji community Elder at Onslow. It is worthwhile briefly

discussing the planned research with the Thalanji community at Onslow, Western Australia, as this project was on the brink of commencement when it was deferred indefinitely.

The research team was initially invited to meet with senior Thalanji community members in 2015 and then again in February 2016. The meetings were held in response to identified needs and questions of community members regarding their sleep quality. The discussions revealed that the Indigenous community believed that there was a high likelihood of sleep disorders within the community as many people had problems achieving regular high quality restorative sleep. The Elders believed that many people would want to be involved as there was a prevalent perception of snoring and sleep apnoea symptoms within the community. Following the meetings, the Thalanji community confirmed their support for a project entitled the Onslow Sleep study for which I was registered as a PhD student investigator. Mindful that the disparity in health between Indigenous Australians and the rest of the Australian community remained unabated, the Onslow sleep study was designed to explore whether sleep was a factor that contributed to the disparity, and if so, to develop strategies to ameliorate any such contribution.

Poor quality and reduced duration of sleep had been shown to mediate the relationship between low SES and minority ethnic groups in the USA, but prior to 2016, no study had explored the role of sleep and its contribution to health disparities in Australia. This was to have been the first study to explore whether Indigenous Australians experience poorer quality and quantity of sleep than non-Indigenous Australians, and the potential role of sleep in understanding health disparities in Australia. Regrettably, the Onslow sleep Study did not progress as planned and due to the constraints of the PhD candidature timeline, it was decided that the best progression plan would be to abandon plans of future primary research and focus on secondary data analysis of large national data sets containing appropriate further data that could be used to explore the potential role of sleep-in understanding health disparities between non-Indigenous and Indigenous Australians.

Chapter 4: Obesity as a marker of chronic illness and its association with sleep

Obesity and Chronic illness

As reported in Chapter 1, chronic illnesses are major contributors to the gap in health equity between Indigenous and non-Indigenous Australians. Obesity has been strongly linked with increased morbidity and numerous chronic illnesses (Guh et al., 2009; Kopelman, 2000). However, obesity has also been classified as a chronic disease in its own right, caused by long term, excessive adiposity (Jastreboff, Kotz, Kahan, Kelly, & Heymsfield, 2019). Such excess adiposity contributes to structural changes to body organs and the musculoskeletal system that result in wide ranging functional pathologies, including cardiometabolic conditions such as insulin resistance, hyperlipidaemia, chronic inflammation and hypertension (Jastreboff et al., 2019).

Since 1975, worldwide obesity rates have almost tripled and obesity has been classified as an epidemic of utmost importance to world public health (World Obesity, 2021). Obesity is defined according to a body mass index (BMI) of ≥ 30 by the World Health Organisation (WHO) (Fig. 1) (World Health Organization, 1998). BMI is an index of weight (Piers, Rowley, Soares, & O'Dea) in kilograms (kg) divided by height in metres squared (m^2) expressed as kg/m^2 .

Figure 2: BMI chart with obesity classifications (World Health Organization, 1998).

WHO CLASSIFICATION OF WEIGHT STATUS	
WEIGHT STATUS	BODY MASS INDEX (BMI), kg/m^2
Underweight	<18.5
Normal range	$18.5 - 24.9$
Overweight	$25.0 - 29.9$
Obese	≥ 30
Obese class I	$30.0 - 34.9$
Obese class II	$35.0 - 39.9$
Obese class III	≥ 40

Although the WHO adopted the index in 1995 and has used it as a measure of obesity ever since, the index was not originally designed for such use (Jones, 2018). Validated for Caucasian men, the index does not account for fat distribution or body fat percentage and was not meant for use for women or non-Caucasians (Nuttall, 2015). Waist circumference (WC) is a better indicator of

visceral fat, an accepted risk factor for cardiometabolic diseases (Ross et al., 2020). Detection of clinically significant obesity requires both BMI and WC measurements (Jones, 2018), however despite the inherent problems, BMI remains the prevalent and accepted marker of obesity for most populations to date (Zierle-Ghosh A & Jan A, 2021).

The foetal origins of chronic illness

The *Barker* hypothesis proposes that adult chronic diseases have their origins *in utero* because of foetal nutritional deficits secondary to maternal malnutrition (Barker, 1995). The theory proposes that developmental plasticity enables a foetus to adapt to environmental signals *in utero* by forfeiting lesser organ growth in favour of brain development at critical times (Barker, 2012). Such adaptation increases the survival of the foetus but may have deleterious effects later in life with increased risk of adult-onset chronic disease when there is a mismatch between the foetal environment and that of the adult (Jirtle & Skinner, 2007). Programmed changes in utero may be the origins of a diseases in future adulthood, however it is also known that epigenetic alterations in expression of a single genotype can produce a variety of adult phenotypes (Jirtle & Skinner, 2007). Therefore, although the foetal origin of disease is an accepted model, environmental conditions also play a role in the development of adult disease (Hoffman, Reynolds, & Hardy, 2017). Sleep has been reported as a potential, modifiable environmental factor that can lead to epigenetic alterations in gene expression and disease development (Cedernaes et al., 2018).

Sleep related to the physiology of obesity

Sleep has been frequently implicated as potential risk factor for obesity, with meta-analyses demonstrating U-shaped relationships between sleep duration and obesity (Cappuccio et al., 2008; C. A. Magee, Reddy, Robinson, & McGregor, 2016; Wu, Zhai, & Zhang, 2014). Sleep has specific impacts on human physiology (K Spiegel, Leproult, & Van Cauter, 1999). Studies of shift workers indicated that alterations of circadian rhythm negatively impacted their energy balance and increased their risk of weight gain due to hedonic feeding as well as causing disturbances of the composition of the gut microbiome (J. L. Broussard & Van Cauter, 2016). Furthermore, significant differences in the gut microflora and consequent altered bacterial metabolism of carbohydrates have been reported between obese compared to lean youth (Goffredo et al., 2016). It follows that the specific changes that may contribute to body fat partitioning and *de*

novo lipogenesis (Goffredo et al., 2016), may potentially arise with insufficient sleep and circadian misalignment (J. L. Broussard & Van Cauter, 2016).

Meta-analysis has determined that partial deprivation of sleep resulted in increased calorie intake without a concomitant energy expenditure, which may cause long term weight gain (Al Khatib, Harding, Darzi, & Pot, 2017). However, increased weight gain may also be a result of metabolic dysfunction due to activation of the stress response triggered by short sleep, that causes increased cortisol levels and pro-inflammatory processes (Knutson, Spiegel, Penev, & Van Cauter, 2007). High cortisol levels can stimulate appetite and cause dysregulation of ghrelin and leptin hormones leading to the accumulation of visceral fat (J. P. Chaput, Després, Bouchard, & Tremblay, 2011). In turn, visceral fat interferes with carbohydrate metabolism by decreasing insulin sensitivity and glucose tolerance, causing and perpetuating a greater accumulation of visceral fat, leading to an increased risk of diabetes and obesity (K. Spiegel, Knutson, Leproult, Tasali, & Van Cauter, 2005).

Notably, less than one week of sleep restriction in healthy young adults has been demonstrated to have had a substantial negative impact on their metabolic and hormonal activity (K Spiegel et al., 1999). A more recent experimental study showed that biopsies from healthy young adults after just four days of short sleep (less than 5 hours/night) revealed insulin resistance in their adipocytes (Josiane L Broussard, Ehrmann, Van Cauter, Tasali, & Brady, 2012). The associations between short sleep duration, obesity and insulin resistance implicates sleep as an important regulator of energy metabolism in peripheral tissues (Quist, Sjödin, Chaput, & Hjorth, 2016; Wu et al., 2014). Short sleep has been identified as both a neuro-biological and physiological stressor that leads to excessive allostatic load, resulting in disease (McEwen, 2006).

At the other end of the sleep duration continuum, long sleep has been associated with significant morbidity as well as death (Patel et al., 2006). A recent systematic review and meta-analysis confirmed that long sleep (>9 hours) was associated with a modest but significant risk of obesity and larger relative risk magnitudes for various cardiometabolic diseases and death (Jike, Itani, Watanabe, Buysse, & Kaneita, 2018). However, compared with the relationship between short sleep and disease, it is more difficult to pinpoint possible mechanisms to explain the association between long sleep and disease and to identify mediators and confounders of the relationship (Patel et al., 2006). To date there has been little focus on the mechanisms between long sleep and obesity, and long sleep and disease, however there are likely to be

multiple pathways, mediators and moderators involved (Tan, Chapman, Cedernaes, & Benedict, 2018).

Further to the significant associations of habitual short and long sleep duration with obesity, it is important to recall that sleep duration has also been identified as a predictor of all-cause mortality (Bin et al., 2013). The U-shaped association between sleep duration and mortality rate that was described over four decades ago has since been revisited. Two recent systematic-reviews and meta-analyses (Cappuccio et al., 2010; Gallicchio & Kalesan, 2009) reconfirmed a persistent U-shaped curve depicting the relationship between sleep duration and all-cause mortality. The meta-analyses clearly showed that both routine short sleepers (<7 hours) and routine long sleepers (>9 hours) were at increased risk of death from all causes compared with people who slept for the recommended 7-9 hours (Cappuccio et al., 2010; Gallicchio & Kalesan, 2009). This corresponds with the U-shaped curve reported for the relationship between sleep duration and BMI for adults (Marshall, Glozier, & Grunstein, 2008). The similarity between the distribution curves for sleep associated with mortality and with obesity adds credence to the exploration of obesity as a proxy for current and potential chronic health outcomes in this thesis.

Considering the information presented above, it is important to investigate whether poor sleep is contributing to the gap in health outcomes for Indigenous people compared with non-Indigenous adults and children. Although the body of evidence regarding sleep and its association with obesity is rapidly expanding, there remains very little information available in this area regarding Indigenous Australians (Blunden, Fatima, & Yiallourou, 2021; S. R. Yiallourou et al., 2019).

As obesity and other associated chronic illnesses develop over a long period of time, it is important to consider a lifespan approach to the analysis of the data. Obese children may exhibit breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects (World Health Organization, 2000). Importantly, childhood obesity has been strongly associated with adult obesity (Brisbois, Farmer, & McCargar, 2012; Llewellyn, Simmonds, Owen, & Woolacott, 2016; Singh, Mulder, Twisk, Van Mechelen, & Chinapaw, 2008) and by extension, the increased risk of adulthood morbidities. Therefore, I decided to commence my analyses by examining whether there was a relationship between sleep duration and BMI for Indigenous Australian children.

The following four chapters will present the results of analyses of secondary data related to Indigenous Children (Chapter 5 & 6) and Indigenous adults (Chapters 7 & 8). These studies, to the best of our knowledge, are the first to specifically address the relationship between sleep duration and obesity in Indigenous Australians. For the analyses, I drew upon the well-established link between obesity and chronic illnesses and used obesity as a marker for the actual or potential development of chronic illness.

Chapter 5 describes the first of such studies using data from the Longitudinal Study of Indigenous Children (LSIC).

Chapter 5: Association between short sleep duration and body mass index in Australian Indigenous children

The Longitudinal Study of Indigenous Children

The Longitudinal Study of Indigenous Children (LSIC) is the only national longitudinal child cohort study of Indigenous child development (Biddle et al., 2019). LSIC is an annual survey of Indigenous children and their primary carers. LSIC aims to facilitate understanding of, and policy response to, the wide-ranging and contextual experiences of Indigenous children, their families and communities. The LSIC was created to address a gap in knowledge about how early childhood experiences of Indigenous Australian children affect their later life and wellbeing (Kneebone, Christelow, Neuendorf, & Skelton, 2012). Study data provides resources for policy makers, service providers, all levels of government and communities as well as for academic researchers (Department of Social Services, 2020). The original sample size of over 1680 represented 5-10% of the Australian Indigenous children from wide-ranging socioeconomic and cultural contexts (Katherine A Thurber, Banks, & Banwell, 2015). LSIC data are readily accessible by arrangement with the Australian Government Department of Social Services (see <https://dataverse.ada.edu.au/dataverse/lisic> for data and access requirements). My licence to use LSIC data was approved on April 4, 2016 (Appendix 10).

LSIC is a cohort study that uses non-random purposive sampling to ensure a broad, but approximately equal, representation of Indigenous people from urban, regional and remote regions (Dodson, Hunter, & McKay, 2012). Dodson et. al. (2012), discuss the strengths and weaknesses of the LSIC and warn that it is a non-representative sample and so findings cannot be generalised to all Indigenous children in Australia. Nonetheless, lack of generalisability is a feature of many cohort studies and the LSIC was not intended to provide population level generalised information but rather, it was designed for comparisons within the dataset and for longitudinal analyses (Katherine A Thurber et al., 2015). As such, the LSIC remains a very good source of information about the development of Indigenous children across diverse settings that is accepted by government policy makers and researchers alike (Dodson et al., 2012).

The LSIC survey design, like that of the Longitudinal Study of Australian Children (LSAC), used an accelerated cross-sequential design with two cohorts commencing in 2008: Baby (B) cohort (0.5-2 years) and Kindergarten (K) cohort (3.5-5 years). LSIC has an enviable retention rate attributed to the high level of community involvement and support as well as the personalised face to face

data collection by Indigenous Research Administration Officers (Dodson et al., 2012). To date there have been 13 waves of data collection completed. The content for each wave of data collection is approved by the *Footprints in Time* Steering Committee (Dodson et al., 2012). The main Human Research Ethics Committee (HREC) for the study is the Australian Government Department of Health and Ageing Departmental Ethics Committee. Following National Health and Medical Research Council (NHMRC) and Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) guidelines, regional ethics approval was gained through state and territory HRECs or their equivalents (Department of Social Services, 2020). At the time of my studies, I used the most current available data collected in Wave 7, 2014. By wave 7, all the participating children attended primary school and ranged in age from 6 to <12 years of age. The following study aimed to investigate whether sleep contributed to health outcomes in Aboriginal children, specifically, whether there was any association between sleep duration and BMI.



ORIGINAL ARTICLE

Association between short sleep duration and body mass index in Australian Indigenous childrenMelissa Deacon-Crouch¹,^{ORCID} Isabelle Skinner,² Joseph Tucci³ and Timothy Skinner⁴

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Aim: Associations between short sleep duration and obesity and the relationship between obesity and chronic illness are well documented. Obese children are likely to become obese adults. To date, there is a paucity of information regarding sleep duration and quality for Indigenous Australian people. It may be that poor-quality, short sleep is contributing to the gap in health outcomes for Indigenous people compared with non-Indigenous adults and children. This study sought to investigate the possibility that poor sleep quality may be contributing to health outcomes for Indigenous children by exploring associations between sleep duration and body mass index (BMI).

Methods: Participants included 1253 children aged 7–12 years in Wave 7 of the national Longitudinal Study of Indigenous Children survey. Interviewers asked primary carers about children's sleep times. BMI was derived from measurements of children made by researchers.

Results: Regardless of age, relative socio-economic disadvantage and level of remoteness, unhealthy weight was associated with less sleep duration than healthy weight for Indigenous children.

Conclusion: The relationship between short sleep duration and BMI in Indigenous children has important implications for their future health outcomes. Both overweight conditions and short sleep are established modifiable risk factors for metabolic dysfunction and other chronic illnesses prominent in the Indigenous population. It is important to consider strategies to optimise both for Indigenous children in an attempt to help 'close the gap' in health outcomes and life expectancy between Indigenous and non-Indigenous people.

Key words: Australian; BMI; children; Indigenous; obesity; sleep.

What is already known on this topic

- 1 Sleep quality, particularly short sleep, is associated with poor health outcomes in children and adults.
- 2 Short sleep is associated with obesity in children and adults.
- 3 Obesity is an identified risk factor for the development of chronic illness.

What this paper adds

- 1 Short sleep is associated with unhealthy body mass index (BMI) in Indigenous children, and the effect size is similar to that of the Longitudinal Study of Australian Children.
- 2 The sleep duration of Indigenous children decreases as the number of adults in the household increases, and there is a need to explore the complex issues contributing to this finding.
- 3 There is a need for further research to explore the association between sleep, obesity and poor health outcomes in the high-risk Indigenous population.

Sleep quality is associated with a number of poor health outcomes, particularly obesity,^{1–4} diabetes,^{3–6} cardiovascular disease^{6–8} and mortality.⁹ Short sleep duration appears to activate the stress response, increasing evening cortisol levels and pro-inflammatory processes and, thus, a number of pathophysiological reactions, resulting in cardio-metabolic diseases.⁶ Short sleep

duration interferes with carbohydrate metabolism, decreases insulin sensitivity and results in decreased glucose tolerance and increased risk of diabetes.⁴ Short sleep is associated with increased food intake due to down-regulation of leptin and up-regulation of ghrelin.⁴ High cortisol levels also result in appetite stimulation and accumulation of visceral fat in humans.¹⁰ Hence, the links between short sleep duration, obesity and cardio-metabolic disease are well established.¹¹

These effects are seen early in childhood² with meta-analyses showing increasing odds ratios (OR) of 1.89¹–2.15¹² for short sleep duration and obesity in children. Other reviews have confirmed a clear linear pattern between short sleep duration and body mass index (BMI) for young children.^{2,13} Data from the Australian Health and Fitness Survey from 1985 indicate a similar

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inverse relationship for sleep duration and BMI for boys,¹⁴ but no significant relationships was found for girls. However, more recent data shows a significant relationship between short sleep and obesity in Australian children regardless of gender (OR 1.97).¹⁵ Childhood obesity is now a substantial contributor to excessive population health-care costs in Australia.¹⁶

The link between socio-economic status (SES) and health has been well documented.^{17,18} It is also apparent that differences in sleep quality and duration exist between different socio-economic groups.^{17,19} An Australian study showed that children with the lowest SES experienced the shortest sleep duration and the highest BMI.²⁰ Differences in sleep duration may help explain the gap in health outcomes by social groupings.

While Aboriginal and Torres Strait Islander peoples experience higher levels of socio-economic disadvantage compared with non-Indigenous people across Australia,²¹ there is very limited data about sleep quality in Indigenous Australians. To our knowledge, there have been only two studies to date that examined sleep duration and quality for Indigenous children.^{22,23} These small-scale studies examined academic performance and behaviour in primary school children living in urban²² and remote²³ settings. Blunden and Chervin²² found there were significant relationships between poor sleep quality and behavioural problems for Indigenous children. These findings raise concerns regarding learning and mental health issues for these children. Cooper, Kohler and Blunden²³ used actigraphy to quantify sleep duration and discovered that Indigenous children, living in a remote setting, experienced shorter sleep than the published norms for non-Indigenous children.

In short, there is very little known about sleep duration and quality for Indigenous people in Australia, and it is important to investigate whether poor-quality, short sleep is contributing to the gap in health outcomes for Indigenous people compared with non-Indigenous adults and children. Our research aimed to investigate whether sleep was contributing to health outcomes in Aboriginal children, specifically, whether there was any association between sleep duration and BMI. For this purpose, we analysed data from the Longitudinal Study of Indigenous Children (LSIC) survey.

Methods

Design and setting

A deed of licence was obtained to access the Australian LSIC data. Data analysed were from Wave 7 of the LSIC. The details of the complete study design, ethics approval and sampling methods are described elsewhere.^{24–26}

In summary, a multi-stage clustered survey design was used over 11 national sites. LSIC is not considered nationally representative as it lacks representation from one Australian State and one Territory. Community engagement was integral to the study design and response to the survey. Based on communities' interest in participating, the sites were purposively chosen to represent the socio-economic and community environments where Aboriginal and Torres Strait Islander children lived, as well as to ensure approximately equal inclusion of people from urban, regional and remote areas. In terms of design and implementation, cultural sensitivity is a noted strength of the LSIC.²⁵ At each site, purposive sampling was conducted. Eligible families were approached by LSIC Research

Administration Officers (RAOs) to ascertain interest in the study. Children were recruited using a snowballing approach, employing informal word of mouth, local knowledge and study promotion. Voluntary, informed consent was obtained.²⁵

Upon commencement of the LSIC (Wave 1; 2008), the Aboriginal and Torres Strait Islander children were divided into two cohorts: the K cohort (the Child cohort, born between December 2003 and November 2004) and the B cohort (the Baby cohort, born between December 2006 and November 2007). The study was designed to sample approximately 150 children at each site (5–10% of the Aboriginal and Torres Strait Islander children of appropriate ages). In some sites, due to availability of appropriately aged children, there were fewer or greater numbers of participants. In total, 1670 Indigenous children and their families were sampled, and between 64 and 239 children and their families were surveyed in each area. Although the LSIC sample is not nationally representative, it is accepted as an appropriate reflection of the distribution of Aboriginal and Torres Strait Islander children in Australia.²⁷ By Wave 7, conducted in 2014, all children were aged between 6 and 12 years of age; 1253 interviews were conducted.

Procedures

At all Waves, interviews were conducted by the Australian Government, Department of Social Services (DSS)-employed Aboriginal and Torres Strait Islander RAOs with multiple informants. All data from Wave 7 were collected by face-to-face interview with either the SC or their primary carer.

Measures

Generally, LSIC employs instruments that have been validated in similar cultural contexts; however, screening instruments measuring social and emotional well-being require verification within Indigenous populations.²⁸

Sleep duration: Short sleep was defined as less than 9 h for school-age children and 7 h for adults.²⁹ The Study Child's (SC) hours of sleep were derived from information provided by the primary carer about their child's usual bed time and wake time during the week ('What time does (SC) usually go to bed on week nights?' and 'What time does (SC) usually wake up (get up) on weekdays?'). Parental recall is a commonly used measure when actigraphs are not used; however, it may be a limitation of the study. **BMI:** was used as a measure of physical health for children in this analysis. With parental permission and SC willingness, height and weight measurements were completed by the interviewer. Measurement data were cleaned using methods described elsewhere.²⁶ Two BMI measures were derived from the data: BMI categories (underweight, healthy weight, overweight, obese) and BMI for age Z score. **Well-being:** was measured using parental ratings of their SC general health (Global Health Ratings: either excellent, very good, good, fair or poor); and the SC was asked, 'How often do you feel happy?' Responses ranged from Always to Never (Feelings of Happiness).

Level of Relative Isolation (LORI) is a measure of remoteness that uses the Australian Standard Geographical Classification Remoteness structure 2006 edition. LORI has five categories: none (urban), low moderate, high and extreme. Data for the last two categories were combined due to low numbers. LORI takes

Table 1 Mean hours of sleep duration during the week for children by gender, household occupants, relative disadvantage and remoteness

	Male			Female		
	<i>n</i>	Mean hours sleep/week night	SD	<i>n</i>	Mean hours sleep/week night	SD
Age of child (years)						
6	31	10.52	1.02	31	10.31	1.17
7	207	10.40	0.86	230	10.51	0.79
8	66	10.23	0.97	74	10.56	0.88
9	35	10.32	0.77	38	10.31	0.79
10	162	10.211	0.94	171	10.28	0.75
11	40	9.99	1.11	37	10.06	1.02
12	1	9.25	NA	1	9.75	NA
Child lives with						
Adults only	82	10.23	0.84	68	10.35	0.76
Adults and children <16 years	460	10.30	0.94	514	10.40	0.85
Index of relative disadvantage (SEIFA)						
Deciles 1–3	378	10.27	0.98	404	10.34	0.87
Deciles 4–6	125	10.34	0.82	114	10.41	0.85
Deciles 7–10	68	10.40	0.66	85	10.61	0.86
Relative level of remoteness (LORI)						
None	170	10.36	0.88	171	10.60	0.79
Low	292	10.35	0.92	309	10.38	0.84
Moderate	88	10.24	0.99	85	10.39	0.95
High/extreme	42	9.85	0.91	59	9.91	0.84
Attended school each day last week						
Yes	383	10.30	0.87	416	10.41	0.86
No	158	10.28	1.06	165	10.36	0.81
Parent 1 highest educational qualification						
Year 8 or below	20	9.79	1.06	20	10.21	0.92
Year 9 or 10	132	10.20	1.19	160	10.43	0.82
Year 11 or 12	149	10.33	0.85	155	10.33	0.91
TAFE/TRADE qualification	165	10.27	0.83	164	10.46	0.76
University UG or PG degree	50	10.60	0.51	50	10.30	0.77
Unknown	46	NA	NA	45	NA	NA

LORI, Level of Relative Isolation; NA, not available; SEIFA, Socio-Economic Indexes For Areas.

into account Indigenous languages and other culturally specific geographical characteristics. Socio-Economic Indexes For Areas (SEIFA) Index: The data describe the deciles from the Index of Relative Socioeconomic Disadvantage (based on the 2006 Australian census).

Statistical analyses

The LSIC database was cleaned by DSS LSIC data managers. Comparisons between groups were undertaken using Analysis of Variance. Where there were multiple groups (age, remoteness, deprivation), planned comparisons were used to test for linear effects. All other between-group comparisons were performed *post-hoc* using Bonferroni correction. Bivariate associations between data were tested using Pearson's correlation coefficient. When controlling for confounding variables, associations were tested using linear multiple regression analysis, with controls variables entered first. Categorical, non-ordinal data were dummy-coded where appropriate. All analyses were performed using IBM SPSS, version 24.0 (IBM Corp., Armonk, NY, USA).

Results

All study children were between 6 and 12 years of age. Table 1 shows the mean hours of sleep duration for males and females on weeknights. Children tended to sleep less hours as they got older. Sleep duration dropped for boys from a mean 10.52 h per night to 9.25 h at age 12. For females, sleep duration dropped from a mean at aged 6 years of 10.31–9.75 h by age 12, although this linear trend was only significant for girls (planned linear contrast $F = 4.148$, $df = 6$; $P = 0.022$).

Sleep duration for both males and females appeared longer when they lived with a combination of adults and children under 16 years of age (Table 1). However, this association was only significant for the number of adults living in the household, not the number of children ($r = -0.062$, $P = 0.016$ (one tailed)).

Regardless of gender, sleep duration also decreased as relative socio-economic disadvantage (SEIFA) increased ($F = 2.647$, $df = 9$, $P = 0.005$), and the LORI and remoteness from population centres (LORI) increases (Table 1) ($F = 11.97$, $df = 3$, $P < 0.001$). Males living in the areas of greatest socio-economic disadvantage slept an average of 10.27 h compared with 10.40 h for those in

Table 2 Health outcomes and sleep duration for male and female Indigenous children

Health outcomes		Male			Female		
		<i>n</i>	Mean hours sleep/week night	SD	<i>n</i>	Mean hours sleep/week night	SD
Body mass index	Underweight	23	10.22	0.74	27	10.29	1.05
	Healthy weight	325	10.41	0.93	345	10.48	0.84
	Overweight	83	10.15	0.88	113	10.26	0.76
	obese	111	10.07	0.95	97	10.29	0.84
Global health ratings	Excellent	248	10.28	0.89	273	10.48	0.78
	Very good	231	10.33	0.89	245	10.36	0.90
	Good	97	10.27	1.07	96	10.24	0.95
	Fair	14	10.34	0.96	9	10.69	0.85
Feelings of happiness	Poor	1	10.50		0		
	Yes: Always	83	10.22	0.86	101	10.16	0.84
	Yes: Most of the time	103	10.16	0.96	109	10.38	0.79
	Sometimes: Fair bit	42	10.20	0.96	28	10.13	0.81
	Sometimes: Little bit	13	10.35	0.71	6	10.00	0.63
	No: Not much	4	10.25	0.65	4	9.75	0.54
		0	NA	NA	0	NA	NA

NA, not available; SD, standard deviation.

the least disadvantaged areas. Similarly, for females, those in the most disadvantaged areas slept for 10.34 h compared with 10.61 h for those in the least disadvantaged areas.

Children living in very remote areas experienced less hours of sleep than urban dwellers. Males in very remote areas slept, on average, 9.85 h compared with 10.36 h for those in urban areas. Females living in very remote areas slept, on average, 9.91 h compared with 10.60 h for those living in urban areas. As age distributions of participants varied by remoteness and disadvantage, these analyses were repeated, controlling for age. For both SEIFA and LORI, these relationships were no longer significant.

Study children's estimated sleep duration was correlated with their age-standardised BMI ($r = -0.124$, $P < 0.001$). For both males and females, shorter sleep duration was associated with BMIs outside the healthy range: underweight, overweight and obese (Table 2). ANOVA indicates that there was a significant difference in sleep duration between the four BMI categories, underweight, healthy weight, overweight and obese ($F = 7.4$, $df = 3$, $P < 0.001$). This relationship was seen for both genders (Males $F = 4.83$, $df = 3$, $P = 0.003$; Females: $F = 2.81$, $df = 3$, $P = 0.039$). Obese males slept a mean of 21 min less per night than males in the healthy weight range. Obese females slept for a mean of 12 min less per night than girls in the healthy weight range, with *post-hoc* tests revealing that sleep duration for children with healthy weight was significantly longer compared with overweight ($P = 0.006$) and obese children ($P < 0.001$), but there were no significant difference for underweight children.

Children's BMI was not significantly associated with economic disadvantage; however, it was weakly correlated with remoteness ($r = -0.09$, $P = 0.001$). When age, SEIFA and LORI effects were controlled for, short sleep duration remained associated with unhealthy weight ($r = 0.09$, $P < 0.001$).

Feelings of happiness were weakly associated with children's ages ($r = -0.068$, $P = 0.026$). As children got older, their feelings of happiness decreased. Sleep duration did not display a significant correlation with global health rating and children's feelings of happiness.

Discussion

The main finding from this study was that, regardless of age, relative socio-economic disadvantage and level of remoteness, for Indigenous children, unhealthy weight was associated with shorter sleep duration than for those of healthy weight, even though most children's sleep duration was within the recommended guidelines.²⁹ The study effect size is similar to that of the Longitudinal Study of Australian Children (LSAC).³⁰ Relatively small differences in sleep duration between healthy and unhealthy weight children appeared to affect BMI, but this prompts consideration of other confounders not included in the analysis. Although a cause and effect relationship has not been described, this result has important implications for children's future health status as both obesity and short sleep have been identified as risk factors for metabolic dysfunction and cardiovascular disease.^{31,32}

The parent-reported LSIC data indicates that Indigenous children slept for shorter periods as they got older, corroborating data trends from the LSAC where prospective population-based sleep data were obtained³³ and normative sleep data for Australian children and adolescents reported.³⁴

Children also slept less as the number of adults increased in the household. Reasons for this may include household overcrowding,^{35–37} the tendency for children to go to bed when adults did or the tendency for children to be put to bed when they fell asleep rather than at a set time.³⁸ In this study, the same effect was not observed with increasing numbers of children residing in the household.

In short, the results of this study suggest the importance of considering sleep quality across the life-span, from childhood through adulthood, to decrease the risks for poor health outcomes particularly associated with obesity. Although other studies have reported that short sleep is associated with low SES,^{17,19,20} this was not the case for the children in this study. When age effects were controlled for, sleep duration was not significantly affected by SEIFA or LORI. This result contrasts with the evidence presented earlier and

prompts future consideration of other possible impacts not evaluated here, such as parental education and SC feelings of security. It also raises the possibility that the socio-economic measures employed, may not be culturally appropriate in Indigenous populations. Important and complex cultural issues such as parenting styles and indigenous concepts of time, dreaming and spiritual beliefs related to sleep must also be factored into future research.³⁵

In addition, given the complex aetiology of obesity, other home environment factors should be investigated, such as family food availability, eating practices and influences on child physical and sedentary activity^{39,40} and parental BMI.⁴⁰ The association between obesity and sleep disorders also warrants further investigation to determine the impact of sleep disorders, such as obstructive sleep apnoea (OSA), on the relationship between obesity and short sleep duration.⁴¹ This is particularly relevant in light of the association between obesity and OSA and recent evidence indicating a bidirectional relationship where abdominal adiposity is both a cause and a result of short sleep duration in childhood.⁴²

Strategies that address short sleep and poor sleep quality used by individual communities and schools also need evaluating to determine the efficacy and replicability of such strategies across different Indigenous communities. Anecdotal strategies have included: (i) sleep time in class, similar to that employed by early childhood educators; (ii) implementation of later school commencement times, previously reported as advantageous for adolescents⁴³; and (iii) the establishment of safe sleep houses where children from noisy households can sleep safely under the supervision of a female community Elder.

Conclusion

The relationship between short sleep duration and BMI in Indigenous children has important implications for their future health outcomes. Both overweight conditions and short sleep are established risk factors for metabolic dysfunction and other chronic illnesses prominent in the Indigenous population.⁴⁴ Unlike many social determinants of health,⁴⁵ both sleep and BMI are modifiable risk factors for children, so it is important to consider strategies to optimise both in an attempt to help 'close the gap' in health outcomes and life expectancy between Indigenous and non-Indigenous people.

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Conclusion

This study showed that although most of the primary-school aged Indigenous children slept for the recommended time (Hirshkowitz, Whiton, Albert, Alessi, Bruni, DonCarlos, Hazen, Herman, Katz, et al., 2015), sleep duration was negatively correlated with age standardised BMI whereby unhealthy weight was associated with shorter sleep duration than for those of healthy weight. This finding is important for although the LSIC data is not representative of all Indigenous children, and this report represents a cross-sectional view in a longitudinal study, recent government reports confirm that Indigenous children have higher rates of obesity and diabetes than their non-Indigenous counterparts (Australian Institute of Health and Welfare, 2020). Sleep is a potentially modifiable risk factor that if optimised, may have a positive impact on the health and wellbeing of Indigenous children.

Chapter 6: The mediating role of sleep in the relationship between Indigenous status and body mass index in Australian school-aged children

Introduction

The study presented in chapter 5, reported that sleep duration predicted BMI for Indigenous children similar to the findings reported for other groups of children (Cappuccio et al., 2008; Chen, Beydoun, & Wang, 2008; Felső, Lohner, Hollódy, Erhardt, & Molnár, 2017). However, the extent to which differences in sleep duration might contribute to differences in BMI between Indigenous and non-Indigenous children had not been addressed.

It is important to explore this issue as obesity has been identified in preceding chapters as an accepted risk factor for the development of a variety of chronic illnesses. It is also useful to refer to the concept of a developmental cascade that considers the cumulative effect of multifactorial interactions and transactions (eg. biological and cultural) occurring in a developing system over time that change the course of development (Masten & Cicchetti, 2010). Potential interventions could be designed to interrupt negative or promote positive cascades that occur across the lifespan. A cascade model of paediatric obesity has recently been proposed that implicates poor sleep as one of the contributors to the snowballing development of obesity (J. D. Smith et al., 2018). Understanding the influences predicted by such a model is important in the development of potential interventions which may contribute to improved public health. Hence, if sleep duration is found to mediate the relationship between Indigeneity and BMI in children, recommendations can be made that may begin to help address the health disparities for Indigenous people.

There are very few studies that have examined a mediator role for sleep associated with BMI in children. One recent study has reported that sleep duration mediated the relationship between children's health behaviour patterns and their BMI. The premise was that poor sleep leads to cyclic overeating, lack of exercise, circadian rhythm disruption, hormonal and metabolic changes resulting in weight gain (Kaar, Schmiede, Vadiveloo, Simon, & Tovar, 2018). Mediation analysis showed that regardless of the presence or absence of health-related behaviours, each hour of sleep was significantly associated with a lower BMI of 2.93 units in children. Another mediation analysis study related to chronic illness development, showed that sleep duration was a small but significant mediator (2.4%) of the dose-response relationship between child mistreatment and the development of CVD in adulthood (Ho et al., 2020).

A mediator is a variable that affects the association between an independent variable and the dependent outcome variable (Bennett, 2000). For sleep duration to meet the criteria for a full mediator role in the relationship between Indigeneity and BMI, the following conditions must be met - Indigeneity must be independently associated with BMI; sleep duration must also be independently associated with BMI; and when sleep duration is accounted for, the direct relationship between Indigeneity and BMI must become non-significant.

The following study aimed to examine the effect of sleep duration on the relationship between Indigeneity and BMI for Australian school aged children. To achieve this, I analysed data from the National Australian Health Survey (2011-2013) that comprised of the Australian Health Survey (AHS) (2011-2012) and the complementary Australian Aboriginal and Torres Strait Islander Health Survey (AATSIHS) (2012-2013).

[The National Australian Health Survey](#)

The National Australian Health Survey is a comprehensive health survey conducted every three years in Australia, by the Australian Bureau of Statistics under the Australian Census and Statistics Act 1905. The survey is conducted throughout Australia, and was designed to collect information about health status, risk factors, health behaviours, socioeconomic circumstances, nutrition and physical activity. In the period 2011-2013, the survey included a nationally representative sample of 35,000 people from the general population (Australian health survey (AHS)) (figure 2) and a specific survey of 13,250 Aboriginal and Torres Strait Islander people (Aboriginal and Torres Strait Islander Health Survey (AATSIHS) (figure 3).

The AHS was administered to the general Australian population and comprised of three components: the National Health Survey; the National Nutrition and Physical Activity Survey (NNPAS); and the National Health Measures Survey (NHMS). The survey was conducted in Australia in 2011-2013.

Figure 3: Structure of the Australian Health Survey

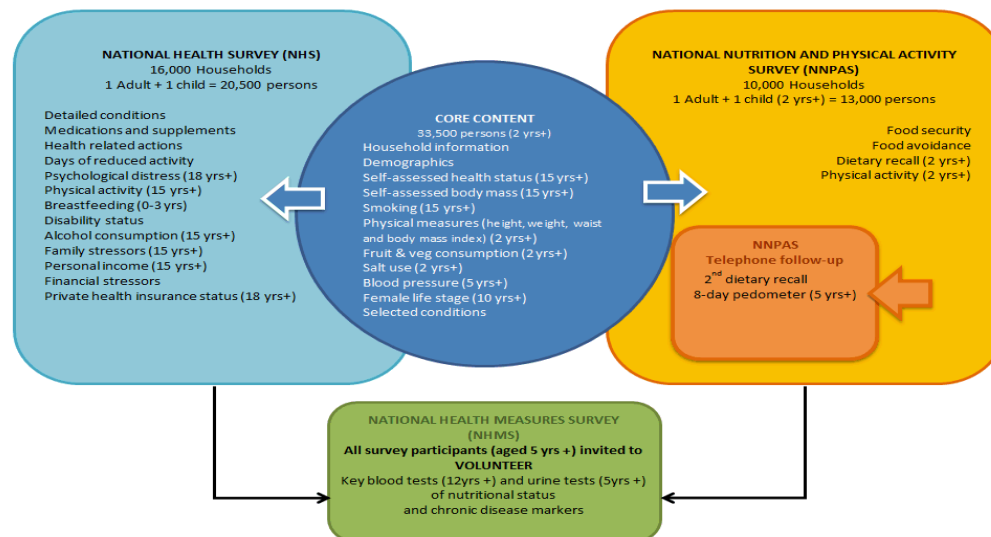


Figure 3 source:

<https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/D79750D8923E9049CA257AA30014B6A1?opendocument>

The matching AATSIHS conducted in 2012 – 2013, was similarly structured with three corresponding components: the National Aboriginal and Torres Strait Islander Health Survey (NATSIHS); the National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS); and the National Aboriginal and Torres Strait Islander Health Measures Survey (NATSIHMS). The survey was designed to be comparable with that for the general population so that the survey results could be used to assess the efficacy of policies aimed at Closing the Gap in health outcomes. The survey involved Aboriginal and Torres strait Islander people living in non-remote and remote areas.

Figure 4: Structure of the Australian Aboriginal and Torres Strait Islander Health Survey

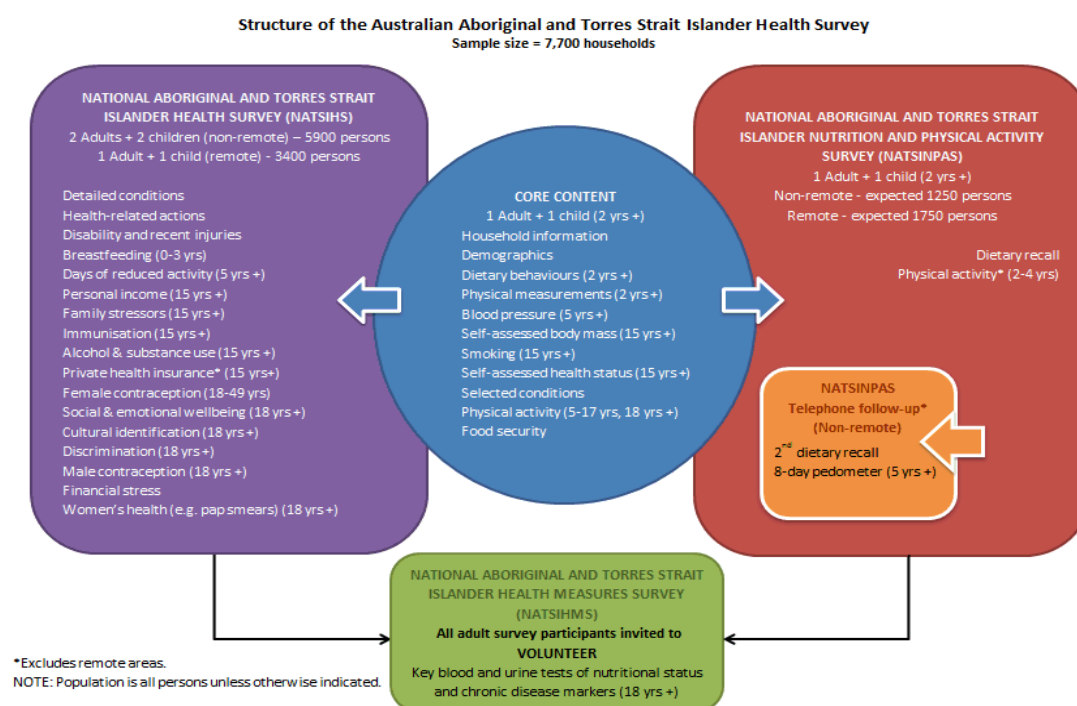


Figure 4 source: <https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4727.0.55.001main+features952012-13>

The AHS (2011-2012) and the AATSIHS (2012-2013) data were accessible for analysis by arrangement with the Australian Bureau of Statistics (ABS). There are strict regulations regarding access to detailed microdata files and the purpose for which the files can be used. The data is freely available from the ABS however, access to microdata is managed to protect privacy and confidentiality.

Users need to apply and be approved by the ABS before accessing microdata. For data and access requirements, please see

<https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Microdata+Entry+Page>. My application to use the Australian Health Survey National Health Survey (2011-2012) and the Australian Aboriginal and Torres Strait Islander Health Survey (2012-2013) was approved on January 19, 2017 (Appendix 11).

All data are protected by the secrecy provisions in the Australian Government Census and Statistical Act 1905. The detailed data required for the analyses were available as microdata in the form of expanded confidentialised unit record files (CURF). The microdata was only available for use within the secure online remote ABS DataLab environment. No unit record information was permitted to leave the ABS DataLab. All output that was intended to be reported outside

the ABS DataLab was checked by the ABS statisticians before release to ensure it met confidentiality standards and could not be used to re-identify an individual or organisation.

The 2011-12 NHS and NNPAS covered over 95% of the people residing in Australia. The surveys were conducted by in-person interviews with a usual adult resident of private homes in urban and rural areas of Australia. The 2012-13 NATSIHS and NATSINPAS covered about 38% of the in-scope population at the national level. Potential bias due to a reasonably high under-coverage rate was addressed by data weighting, benchmarking and estimation, rendering the survey data accepted as nationally representative. Greater information regarding the scope and coverage of the survey can be found at

<https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4727.0.55.001Explanatory%20Notes12012-13?OpenDocuments>.

For both NNPAS and NATSINPAS in all selected households, the general characteristics of the household were obtained from the first responsible adult contacted. From this information, participants for the survey were randomly selected by a computer assisted instrument. One adult (≥ 18 years) and up to one child (2-17 years) was selected in both non-remote and remote areas.

The NNPAS households were selected based on stratified multistage sampling. Area-based selection ensures that all sections of the population living in private dwellings within the geographic scope of the survey were represented by the sample (Australian Bureau of Statistics, 2013b). Each state and territory was divided into geographically homogenous strata. Strata were formed by dividing Australia into regions formed within state/territory boundaries, which corresponded to the Statistical Division or Statistical Subdivision levels of the Australian Standard Geographical Classification (ASGC) (cat. no.1216.0). Each stratum contained several Census Collection Districts (CDs). A CD on average contains around 250 dwellings (Australian Bureau of Statistics, 2013b).

The NATSINPAS households were also selected using stratified multistage sampling, however the procedure was different to that for NNPAS due to the remoteness and size of some communities where Aboriginal and Torres Strait Islander people live (Australian Bureau of Statistics, 2013a). Statistical Area Level 1 (SA1) were first stratified by state, remoteness area and the number of Aboriginal and Torres Strait Islander dwellings in the SA1 based on 2006 or 2011 Census data. A sample of SA1s were selected from each stratum with probability proportional to the number of Aboriginal and/or Torres Strait Islander households in the SA1. This meant that SA1s with a higher number of Aboriginal and/or Torres Strait Islander households had a greater chance of selection. A random selection of dwellings within selected SA1s were then screened to assess

their usual residents' Indigenous status. Where a dwelling contained one or more Indigenous usual residents, a random selection process was undertaken to select the survey participant (Australian Bureau of Statistics, 2013a).

Some of the AATSIHS households may have been included in both the AHS and the AATSIHS however, where possible, the sampling methodology attempted to reduce the likelihood of this occurring, although respondents moving between the survey periods and being selected in their new residence was a possibility. However, Very Remote areas of Australia were excluded from the NHS and NNPAS samples to avoid overlap occurring in this geographic region. Discrete Aboriginal and Torres Strait Islander communities were also excluded from the NHS and NNPAS to avoid overlap in the community sample (Australian Bureau of Statistics, 2013a). Hence, I proceeded with the assumption that the number of Indigenous people included in the NNPAS would be proportionally extremely small and would not significantly influence the results.



ORIGINAL ARTICLE

The mediating role of sleep in the relationship between Indigenous status and body mass index in Australian school-aged children

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Aim: Associations between sleep duration and obesity and between obesity and chronic illness are established. Current rates of obesity for all Australian people are rising. Recent reports indicate that high body mass index (BMI) is a leading contributor to overall burden of disease for Indigenous Australians. Understanding the factors that contribute to higher rates of obesity in Indigenous people is critical to developing effective interventions for reducing morbidity and premature mortality in this population. To explore the effect of sleep duration on the relationship between Indigenous status and BMI in Australian children.

Methods: 716 non-Indigenous and 186 Indigenous children aged 5–12 years in the Australian Health Survey 2011–2013. Primary carers were interviewed regarding children's sleep times; BMI was derived from measurement.

Results: Analysis of covariance revealed that regardless of a number of demographic and socio-economic status markers, sleep duration and Indigenous status were independent predictors of BMI. However when both predictors were considered together, only sleep duration remained predictive of BMI.

Conclusions: Sleep duration plays an important mediating role in the relationship between Indigenous status and BMI in this Australian sample. Modification of sleep duration for Indigenous children may lead to longer-term positive health outcomes.

Key words: Australian; body mass index; children; Indigenous; obesity; sleep.

What is already known on this topic

- 1 Short sleep, is associated with obesity and poor health outcomes in children and adults.
- 2 Short sleep is associated with unhealthy body mass index (BMI) in Indigenous children.
- 3 Obesity is an identified risk factor for the development of chronic illness.

What this paper adds

- 1 Sleep duration appears to play a mediating role in the relationship between Indigenous status and BMI for Indigenous Australian school-aged children.
- 2 If sleep duration can be modified regardless of the many disadvantages experienced by Indigenous children, it may have a positive impact on their health.
- 3 Further research is required to examine the long-term BMI and health outcomes for Indigenous children when sleep is used as a therapeutic intervention.

The far greater morbidity and considerably earlier mortality in Aboriginal and Torres Strait Islander Australians compared with non-Indigenous Australians is well documented.¹ The most recent information regarding the burden of disease in Australia reveals that Indigenous people are twice as likely to live with chronic poor health and 2.7 times more likely to die prematurely than non-Indigenous Australians.²

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The recent Australian Burden of Disease Study (2016) reported high body mass index (BMI) second only to tobacco use, and equal to alcohol use, as a leading contributor to the overall burden of disease for Indigenous Australians. High BMI was linked with a range of chronic illnesses, contributing 62% of the burden for endocrine disorders, 37% for renal diseases, 34% for cardiovascular diseases and 5% for cancer. Chronic disease accounted for 70% of the difference in disease burden between Indigenous and non-Indigenous Australians.²

Current reports indicate that obesity rates in both Indigenous and non-Indigenous Australians are increasing.^{3,4} If this trend continues, obesity is likely to become an even greater contributor to the overall burden of disease in the future. Understanding the factors that contribute to higher rates of obesity in Indigenous

people is critical to developing effective interventions for reducing morbidity and premature mortality in this population.

Recent meta-analyses and reviews show that short and, to a lesser extent, long sleep duration is predictive of obesity.^{5,6} Low social economic status (SES) is also predictive of both obesity^{7,8} and sleep duration.^{9,10} Regarding this point, an early review suggested that any deleterious effect of low SES on health might be partly mediated by sleep duration and quality.¹¹ Subsequently, Moore *et al.* showed a statistically significant effect of income on physical health being mediated by sleep quality rather than quantity, and when controlling for sleep quality, socio-economic differences in health outcomes were rendered non-significant.¹² Together, these data suggest that sleep may mediate the relationship between SES and health outcomes. A recent study of Australian Indigenous children has shown that sleep duration predicts BMI, an association also observed in non-Indigenous children.¹³ However, it is unknown to what extent differences in sleep duration account for variances in BMI between Indigenous and non-Indigenous children. The present study sought to shed light on this by exploring the effect of sleep duration on the relationship between Indigenous status and BMI in Australian children.

Methods

Design and setting

Cross-sectional data from the Australian Bureau of Statistics (ABS) National Nutrition and Physical Activity Survey (NNPAS)¹⁴ and the National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS)¹⁵ were accessed and analysed through the ABS Remote Access Data Laboratory (RADL). All data are de-identified and protected by the Australian Government Census and Statistical Act 1905. Authorisation to access data from the Confidentialised Unit Record Files from the NNPAS and the NATSINPAS was gained from the ABS in January 2017. Both surveys were components of the Australian Health Survey (AHS) 2011–2013.

The AHS 2011–2013 consists of three components: the National Health Survey (NHS); the NNPAS; and the National Health Measures Survey (NHMS). Participants were allocated to either the NHS or the NNPAS with an invitation to participate in the NHMS.

The NNPAS was conducted in 9500 private dwellings selected in all geographical regions other than very remote areas of Australia, between May 2011 and June 2012. Sampling design ensured that within each state or territory, each person had an equal chance of selection and that reliable estimates could be produced for each. Data were collected for one adult and up to one child aged 2–17 years in each selected household.

In 2012–2013, the AHS added the National Aboriginal and Torres Strait Islander Health Survey (NATSIHS), an additional representative sample of 12 300 Aboriginal and Torres Strait Islander people living in remote and non-remote areas. The NATSIHS structure was the same as the AHS outlined above, including the corresponding NATSINPAS component. The NATSINPAS was conducted in 2900 households, with data collected for one adult and up to one child aged 2–17 years in each selected household in the same fashion as the NNPAS with 4100 participants. Survey

questions in the NATSINPAS were based on the NNPAS, hence the data are comparable. The ABS released data for non-remote NATSINPAS participants only. Complete details about the AHS and NATSIHS structure and design, ethics approval and sampling methods and data collection are described elsewhere.^{16,17}

Procedures

Trained ABS interviewers conducted face-to-face interviews with the selected adult member of all households. A parent or guardian answered for all children aged less than 15 years and where possible, the child was present.

Measures

Sleep duration was calculated as time in hours and minutes between going to bed and time waking up. 'Time went to bed' was defined as time the light was turned off with the intention of going to sleep, as it is difficult to ascertain the time when sleep actually commenced. 'Time woke up' was defined as 'the last time waking up'. A typical night's sleep was considered to reflect the approximate pattern and/or number of hours that occurred on that same night of the week over time.

BMI: the interviewer completed height and weight measurements. BMI categories were derived from Centre of Disease Control (2000) age standardised growth charts for children aged 2–18 as recommended for use in Australia.¹⁸

Index of Relative Socio-economic Disadvantage – 2011 (Socio-economic Indexes for Areas (SEIFA)): summarises low income, low educational attainment, high unemployment and jobs in relatively unskilled occupations. The index relates to the area in which the survey respondent lived rather than the individual respondent's socio-economic status.

Equivalised income of household (deciles): standardised estimates of income using the modified Organisation for Economic Cooperation and Development equivalence scale (1994) reflect the households' relative well-being allowing for differences in household types, compositions and requirements relative to income.

Australian Statistical Geography Standard (2011) was used to generate two broad geographical categories: non-remote (including major cities and inner regional Australia) and remote.

Statistical analyses

Variables of interest common to both the NNPAS and the NATSINPAS databases were identified. Data were cleaned by excluding implausible values, missing data and outliers. A final merged dataset of NNPAS and NATSINPAS was restricted to primary school-aged children under 13 years of age who had, or whose parents had, identified the previous night's sleep duration as 'typical'. Categorical, non-ordinal data was 'dummy coded' where appropriate. *t*-tests and χ^2 tests were used to assess differences between the Indigenous and non-Indigenous children groups for each of the variables listed in Table 1. Differences in BMI between Indigenous and non-Indigenous groups were tested using analysis of covariance (ANCOVA), including the covariates listed in Table 1. To assess whether sleep was a mediator in the relationship between Indigeneity and BMI, multiple linear

regression analysis was performed with and without sleep included as a covariate while controlling for each of the other variables. The unstandardised β coefficients have been reported. All analyses were completed through the ABS RADL using IBM SPSS, version 11.5 (SPSS Inc., Chicago, IL, USA).

Results

Table 1 summarises the demographic, household and BMI characteristics of the 716 non-Indigenous and 186 Indigenous children included in this analysis. The mean sleep duration appeared similar in both groups. The age and gender distributions for the Indigenous and non-Indigenous cohorts were similar; however, Indigenous children had a significantly higher average BMI. Greater proportions of Indigenous children resided in socio-economically disadvantaged areas and had lower household incomes compared with

the non-Indigenous cohort. The number of adults in the household was significantly different for children in the two cohorts, with Indigenous children more likely to reside in households with a single adult than the non-Indigenous children. A significantly greater proportion of Indigenous children were obese (12.9%) compared with non-Indigenous children (7.8%) (Table 2).

An ANCOVA was conducted to determine whether Indigenous status influenced sleep duration. Due to differences in sample characteristics between Indigenous and non-Indigenous individuals, covariates included age, equivalised income of household, SEIFA, number of adults in household, number of children aged 0–17 in household, gross weekly cash income of household and gender. This analysis indicated that Indigenous children experienced less sleep on average compared with non-Indigenous children, $F(1, 900) = 6.05$, $P = 0.014$. Age was also found to significantly influence sleep duration, $F(1, 900) = 178$, $P < 0.001$,

Table 1 Demographic information for Indigenous and non-Indigenous children (<13 years) who reported sleep duration as 'typical'

	Non-Indigenous (n = 716)		Indigenous (n = 186)		t-test value	df	P value
	Mean	SD	Mean	SD			
Age, years	8.83	2.56	8.51	2.72	1.50	900	0.134
BMI	18.2	3.49	18.8	4.34	35.1	900	<0.001
Sleep duration, min	620	57.7	613	62.8	1.45	900	0.147
Category	Sub-category		n (%)	n (%)	χ^2 value	df	P value
Gender	Males		357 (49.9)	99 (53.2)	0.67	1	0.413
	Females		359 (50.1)	87 (46.8)			
Index of Relative Socio-economic Disadvantage – 2011 (SEIFA)	Decile 1 (lowest)		60 (8.4)	49 (26.3)	110	9	<0.001
	Decile 2		65 (9.1)	36 (19.4)			
	Decile 3		62 (8.7)	25 (13.4)			
	Decile 4		70 (9.8)	30 (16.1)			
	Decile 5		73 (10.2)	15 (8.1)			
	Decile 6		71 (9.9)	8 (4.3)			
	Decile 7		74 (10.3)	7 (3.8)			
	Decile 8		77 (10.8)	9 (4.8)			
	Decile 9		77 (10.8)	5 (2.7)			
	Decile 10 (highest)		87 (12.2)	2 (1.1)			
Number of adults in household	One		136 (19.0)	73 (39.2)	44.8	3	<0.001
	Two		520 (72.6)	88 (47.3)			
	Three		43 (6.0)	16 (8.6)			
	Four or more		17 (2.4)	9 (4.8)			
Number of children in household (0–17 years)	One		163 (22.8)	42 (22.6)	7.43	3	0.059
	Two		332 (46.4)	69 (37.1)			
	Three		151 (21.1)	48 (25.8)			
	Four or more		70 (9.8)	27 (14.5)			
Equivalised income of household (deciles)	First lowest		84 (11.7)	57 (30.6)	118	9	<0.001
	Second		33 (4.60)	31 (16.7)			
	Third		67 (9.4)	31 (16.7)			
	Fourth		77 (10.8)	24 (12.9)			
	Fifth		107 (14.9)	15 (8.1)			
	Sixth		82 (11.5)	10 (5.4)			
	Seventh		86 (12.0)	6 (3.2)			
	Eighth		77 (10.8)	6 (3.2)			
	Ninth		55 (7.7)	4 (2.2)			
	Tenth highest		48 (6.7)	2 (1.1)			

BMI, body mass index; SD, standard deviation; SEIFA, Socio-economic Indexes for Areas.

Table 2 Body mass index (BMI) categories: Percentage distribution of Indigenous and non-Indigenous children (<13 years)

Category	Sub-category	Non-Indigenous (n = 714)	Indigenous (n = 186)	χ^2 value	df	P
		n (%)	n (%)			
BMI categories for children	Underweight class 2 BMI 16–<17	5 (0.70)	2 (1.1)	1.48	1	>0.05
	Underweight class 1 BMI 17–<18.5	29 (4.1)	11 (5.9)			
	Normal range child: 18.5–<25.0	489 (68.5)	108 (58.1)	7.18	1	0.007
	Overweight BMI 25–<30	134 (18.8)	41 (22.0)	1.01	1	>0.05
	Obese class 1 BMI 30–<35	56 (7.8)	24 (12.9)	4.67	1	0.031

as did the number of children aged 0–17 in the household, $F(1, 900) = 4.22$, $P = 0.014$.

Multiple linear regression analysis revealed that even after controlling for gender, age, number of adults and children living in the household, SEIFA and equivalised household income, being Indigenous was significantly associated with increased BMI, $R^2 = 0.203$, $\beta = 0.656$, $P = 0.026$. When sleep duration was added to the analysis, sleep was also significantly predictive of increased BMI, $R^2 = 0.214$, $\beta = -0.007$, $P < 0.001$, although Indigenous status became non-significant in this model, $\beta = 0.570$, $P = 0.053$.

Discussion

This analysis suggests that Indigenous children have a higher BMI and sleep less than non-Indigenous children, controlling for a number of demographic and socio-economic status markers. However, the relationship between Indigeneity and BMI is no longer significant when sleep duration is considered. That is, in this cross-sectional sample of Australian children, sleep duration plays an important mediating role in the apparent relationship between Indigenous status and BMI.

After accounting for possible confounding influences in the obesity-short sleep relationship (including gender, age, number of adults and number of children living in the household, SEIFA and equivalised household income), it appears that even small differences in sleep duration between Indigenous and non-Indigenous children can affect BMI. The size of this effect is similar to that observed in the Longitudinal Study of Australian Children (LSAC), where small differences in sleep times affected paediatric physical health related quality of life.¹⁹

The link between short sleep duration and obesity is multifactorial. Short sleep hinders carbohydrate metabolism, increases insulin resistance and decreases glucose tolerance.²⁰ Short sleep also stimulates appetite, increases food intake and visceral fat via increased cortisol levels²¹ and the down-regulation of leptin and upregulation of ghrelin.²⁰ A recently proposed cascade model of paediatric obesity identified that despite a small effect size, short sleep duration is a key factor in the development of obesity in school-aged children.²² The cascade model explains the cumulative consequences and downstream effects of the complex multifactorial risk and protective factors for childhood obesity by asserting that while no single risk or protective factor has a large effect, early and cumulative influence snowballs to a greater effect over time.²²

Childhood is a critical period when inequities in health determinants such as social and economic factors begin their impact.²³

In developed countries, low socio-economic status is associated with childhood obesity that is likely to persist throughout the life-span.^{24,25} Cross-sectional results from the first wave of the LSAC showed that Indigenous status and low socio-economic status were two of the main predictors of obesity in Australian pre-schoolers.²⁶ In the light of the current analysis, it would be interesting to include sleep duration in the LSAC analysis to see if the mediating role of sleep in the relationship between Indigenous status and BMI is corroborated.

To date, two paediatric studies have reported that increased sleep duration significantly improved BMI measures,^{27,28} while an adult study showed short-duration sleepers who increased their sleep experienced a smaller increase in BMI and adiposity than counterparts who maintained short sleep habits.²⁹ Additionally, a prospective birth cohort study showed that short sleep in childhood increased risk of adult obesity.³⁰ In light of such studies, our results may be clinically significant despite the small effect size. Working with Indigenous communities to help improve the duration of Indigenous children's sleep may impart protective factors with possible significant, cascading long term benefits²² and thereby help reduce the poorer morbidity and mortality experienced by Indigenous Australians. If sleep duration can be modified regardless of socio-economic disadvantage, it may have a positive impact on Indigenous people's health. Anecdotal information suggests that some Aboriginal and Torres Strait Islander communities have identified the need to address short or inadequate sleep experienced by children by implementing strategies such as timetabled sleep time in class, later school starting times and quiet, safe-sleep houses supervised by a respected female elder.¹³ The impact of such strategies on the health and wellbeing of Aboriginal and Torres Strait Islander children requires evaluation.

The results of this study must be viewed in the light of a number of limitations. First, due to the cross-sectional analysis, while significant relationships were found, we cannot argue causality. In addition, this study did not include data for Indigenous children who resided in remote or very remote geographical areas due to privacy restrictions.³¹ There was disproportionate sampling between the two surveys from which the data was pooled. The number of Indigenous children who participated in the randomly selected NNPA survey is unknown because Indigenous status data was not available. However, we assumed that the number of Indigenous children in the NNPA would be very small and would not significantly influence the results. Another common and generally accepted limitation is the sleep time measure. First, the measure relies on parental recall in the absence of actigraphy

and second, sleep duration is calculated from the time the lights were first turned off with the intention of going to sleep until the last time a respondent woke up. Total sleep time may not accurately depict actual hours slept in situations where a long time was taken to fall asleep and/or the participant woke during the night. This would lead to a possible overestimation of sleep duration. However, it is unlikely that such biases affected the Indigenous and the non-Indigenous groups in this analysis differently. Lastly, while socio-economic and other measures used in the survey may not be culturally appropriate for Indigenous people,³² the results are consistent with the wider literature regarding SES disadvantage and health.

Conclusions

In this study of primary school-aged children, sleep duration and Indigenous status were independent predictors of BMI. However when both predictors were considered together, only sleep duration remained predictive of BMI. Sleep appears to mediate the relationship between Indigenous status and BMI. Given what is already known about the relationship between short sleep and higher BMI, our analysis suggests that Australian Indigenous children have a higher BMI than Australian non-Indigenous children because, at least in part, they sleep less than non-Indigenous children. If sleep duration can be modified regardless of the many disadvantages experienced by Indigenous children, it may have a positive impact on their health. Further research is required to examine the long-term BMI and health outcomes for Indigenous children when sleep is a therapeutic intervention. In the meantime, it is important that health practitioners and others do not discount short sleep duration as a possible contributor to childhood obesity and that strategies to optimise sleep quality for Indigenous children are considered in the overall strategy to 'close the gap' in health outcomes and life expectancy between Indigenous and non-Indigenous Australians.

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Conclusion

In this sample of school aged Indigenous children, sleep duration was found to have a partial mediating role in the relationship between Indigenous status and BMI.

A recent systematic review of the literature revealed a paucity of information about Australian Indigenous children's sleep with a mere 13 studies conducted from 2004-2020 (Blunden et al., 2021). At the time of publication, the studies presented in chapters 5 & 6 were the only studies that focused on the relationship between sleep and BMI in Indigenous children and provided a good starting point for further research. Since then a longitudinal study examining sleep phenotypes in Indigenous children and the associations between sleep duration and BMI gain has been published (Fatima, Al Mamun, Bucks, & Skinner, 2020). This study extends the findings of our cross-sectional studies by emphasising that while it has a significant role, sleep duration is only one aspect of healthy sleep and that the timing of sleep, particularly early bedtime, may be even more important to avoid future weight gain for Indigenous children.

In summary, issues around sleep and BMI for Indigenous children are multifactorial and complex. Improved sleep duration and timing for Indigenous children may begin to address some of the disparities in health by imparting a long-term beneficial influence on any *in-utero* pre-programming for future disease and by dampening the cascade effect of childhood behaviours on future adulthood health and wellbeing.

The following chapter moves to the exploration of sleep duration experienced by Indigenous Australian adults. For the adult analyses, again I used the nationally representative Australian Health Survey (2011-2012) and Australian Aboriginal and Torres Strait Islander Health Survey (2012-2013) data. Although adolescent participant data was available, I restricted my analysis to adults of at least 18 years of age because adolescents are recognised as having complex sleep patterns unique to their developmental stage that may be difficult to account for and that may confound the results (Short, Gradisar, Lack, Wright, & Dohnt, 2013).

Chapter 7: Is sleep duration associated with overweight/obesity in Indigenous Australian adults?

Introduction

The previous chapters have identified a significant relationship between sleep duration and BMI for Indigenous Australian children consistent with reports for other groups of children. However, the link between sleep duration and BMI for adults is not as clear cut. Information is available that reported an association between short sleep and obesity for Australian adults (Magee, Iverson, & Caputi, 2010), however there was no information about whether the association was also relevant for the Indigenous Australian adult subpopulation.

The following study aimed to examine whether the relationship between sleep duration and BMI in the general Australian population reported by Magee et, al. (2010), also holds true for Indigenous Australian adults. Findings are described in the following published study entitled, *Is sleep duration associated with overweight/obesity in Indigenous Australian adults?*

RESEARCH ARTICLE

Open Access



Is sleep duration associated with overweight/obesity in Indigenous Australian adults?

Melissa Deacon-Crouch^{1*}, Stephen Begg² and Timothy Skinner³

Abstract

Background: Associations between high BMI and sleep duration and chronic illness are recognised. Short sleep is an accepted predictor of high BMI for children, including Indigenous Australian children. Short sleep has also been associated with high BMI in Australian adults, although not specifically in Indigenous Australian adults. This study aims to determine whether the relationship between sleep duration and BMI observed in non-Indigenous adults holds for Indigenous adults.

Methods: Data collected from 5204 non-Indigenous and 646 Indigenous participants aged over 18 years in a nationally representative Australian Health Survey 2011–2013 were analysed. Sleep duration was self-reported as the time between going to bed and time waking up; BMI was derived from measurement and categorised into normal weight (BMI = 18.5–24.9) and overweight/obese (BMI ≥ 25). Logistic regression was performed for the non-Indigenous and Indigenous groups separately to examine the association between sleep duration and BMI in each group.

Results: Proportionally more Indigenous people were classified as overweight/obese than non-Indigenous ($\chi^2 = 21.81, p < 0.001$). Short sleep was reported by similar proportions in both groups (Indigenous 15% vs non-Indigenous 17%) whereas long sleep of > 9 h was reported by proportionally more Indigenous than non-Indigenous people (41% vs 26%). Without accounting for possible confounders, the association between sleep duration and BMI for the Indigenous group was not significant but a possible dose-response relationship was evident, with the odds of overweight/obesity being greatest for those who typically slept < 7 h (OR = 1.77, 95% CI 0.38–3.94) and < 6 h (OR = 1.55, 95% CI = 0.58–4.14). The same model for the non-Indigenous group was significant, with the odds of overweight/obesity being greatest for those who typically slept < 6 h (OR = 1.67, 95% CI 1.25–2.25). The risk of overweight/obesity diminished for both groups with sleep > 7 h. Accounting for a range of socioeconomic and personal confounders attenuated the strength of these relationships marginally.

Conclusion: Adding to reports relating sleep duration and BMI for Australian adults, this study provides evidence for an inverse relationship in non-Indigenous adults and suggests a similar trend for Indigenous adults. This trend was non-significant but is consistent with previous results for Indigenous children.

Keywords: Sleep, Indigenous, Obesity, Body mass index, Australian, Adult

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Background

High Body Mass Index (BMI) is an accepted risk factor for the development of chronic illnesses including metabolic syndrome and cardiovascular diseases [1, 2]. BMI is calculated as a person's mass in kilograms divided by their height in metres squared and is categorised by the World Health Organization (WHO) into normal weight ($18.5 \leq \text{BMI} < 25$), overweight ($25 \leq \text{BMI} < 30$) and obese ($\text{BMI} \geq 30$). In the last two decades, Australia has experienced dramatic increases in obesity, while overweight rates have remained relatively constant [3]. From 1995 to 2018 the proportion of obese Australian adults rose from 19 to 31% [4]. Currently, 67% of Australian adults aged 18 years and over are overweight or obese [3]. Indigenous Australians are particularly vulnerable to increased body mass, with nearly three-quarters of adults assessed as overweight or obese (27 and 44%, respectively) [5].

The burden of disease attributable to overweight and obesity in Australia in 2015 was 8.4%, up from 7.0% in 2011, imparting a significant and increasing economic burden [6]. In 2013/2014, the total health expenditure was 38% greater for Indigenous compared with non-Indigenous Australian people [7] reflecting greater health needs of Indigenous people and the higher cost of health services in the regional and rural areas where many Indigenous people live [8].

A number of socioeconomic factors and health behaviours have been identified as contributing to obesity in Australian Indigenous people [9]. However, sleep is one health factor that has not been adequately explored but warrants consideration, given the increasing evidence for an association between sleep duration and BMI in many other populations [10] and because Indigenous people in high income countries like Australia are known to experience poorer sleep than their non-Indigenous counterparts [11–13].

Cardio-metabolic diseases that arise from obesity have been associated with increased cortisol levels and pro-inflammatory processes activation due to the stress response resulting from short sleep duration [14]. High cortisol levels can also stimulate appetite and increase food intake by upregulation of ghrelin and down regulation of leptin, leading to the accumulation of visceral fat [15]. Increased visceral fat leads to insulin resistance and possible obesity due to adverse effects on carbohydrate metabolism [16]. Short sleep duration of less than 7 h has been linked with mortality from all causes and from obesity and cardio-metabolic diseases [17]. A recent review examined the relationship between sleep and cardiometabolic disease risk for global Indigenous populations [13]. The review confirmed a paucity of specific information but concluded that Indigenous populations generally experience suboptimal sleep duration and sleep

quality compared with their non-Indigenous counterparts and that poor sleep is likely to negatively impact cardiometabolic health. Regarding Australian Indigenous people, the review reported that Indigenous Australians are 1.8 times more likely to experience obstructive sleep apnoea (OSA) than their non-Indigenous counterpart as a likely result, at least in part, to their higher rates of obesity. The authors also confirmed that, to date, there have been no studies investigating the relationship between sleep and cardio-metabolic risk factors such as obesity, exclusively in Australian Indigenous adults.

Short sleep duration is an accepted predictor of obesity for children, including Indigenous Australian children [18–21]. For adults, the link between sleep duration and BMI seems to depend on age: quasi-linear for young adults; U-shaped in middle age; and less definitive in older age [22]. For Australian adults, short sleep of less than 7 h was associated with obesity in middle aged adults (45–65 years) [23]. However, with age stratification, a U shaped relationship was found for adults aged 55–64 years and no significant relationship for adults over 65 years of age [24]. Similar variation in cross sectional study sleep duration patterns in adults has been previously reported [25]. Information about sleep in Indigenous Australians is lacking [13] and it is not known if sleep duration is associated with obesity in this population.

Methods

This paper aims to determine whether the relationship between sleep duration and BMI observed in non-Indigenous adults holds for Indigenous adults in a recent, nationally representative sample of the Australian population. It was predicted that short sleep duration would be associated with a higher risk of overweight/obesity in both populations.

Design and setting

Cross sectional data from the National Nutrition and Physical Activity Survey (NNPAS) [26] and the National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS) [27] were accessed, analysed and checked through the online Australian Bureau of Statistics (ABS) DataLab. All data are de-identified and protected by the Australian Government Census and Statistical Act 1905. Authorisation to access the Confidentialised Unit Record Files (CURF) from the NNPAS and the NATSINPAS was gained from the ABS in January 2017. Both surveys were components of the Australian Health Survey (AHS) 2011–2013.

More details about the AHS are available in our previous report regarding sleep, BMI and Indigenous children [21]. In brief, the National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) was added to the

AHS in 2012–2013. The NATSIHS included a representative sample of around 12,300 Aboriginal and Torres Strait Islander people. The structure and data collection were the same as the AHS including the corresponding NATSINPAS that was conducted in 2900 households, with data collected for one adult and up to one child aged 2–17 years in each selected household. Survey questions in the NATSINPAS were based on those from the NNPAS so the two datasets are comparable and are considered to be nationally representative. The ABS released data for non-remote NATSINPAS participants only. Complete details about the AHS and NATSIHS structure and design, ethics approval and sampling methods and data collection are described elsewhere [28, 29].

Procedures

Trained ABS interviewers conducted face-to-face interviews with the selected adult member of all households.

Measures

Sleep duration

reported as the time between going to bed and time waking up (hours and minutes). ‘Time went to bed’ was defined as time the light was turned off with the intention of going to sleep, as it can be difficult to ascertain the time when sleep commences. ‘Time woke up’ was defined as ‘the last time waking up’. A typical night’s sleep was a self-reported measure by respondents. Sleep duration was stratified into 5 categories: < 6 h, 6 h (≥ 6 to < 7 h), 7 h (≥ 7 to < 8 h), 8 h (≥ 8 to < 9 h) and ≥ 9 h [30].

BMI

Height and weight were objectively measured by the interviewers. Calculated BMI was categorised using World Health Organisation (WHO) guidelines: normal (18.5–24.9), overweight (25–29.99) and obese (greater than or equal to 30) [31]. The overweight and obese groups were combined in this analysis such that BMI was dichotomised into overweight/obese (high BMI) versus normal weight (normal BMI).

Index of relative socio-economic disadvantage – 2011 (SEIFA)

is a general socio-economic index that summarises a range of information about the economic and social conditions of people and households within an area. The index includes measures of relative disadvantage including low income, low educational attainment, high unemployment and jobs in relatively unskilled occupations. The index relates to the area in which the survey respondent lived and is not necessarily indicative of their individual socio-economic status.

Equivalised income of household (deciles)

Standardised estimates of income using the modified OECD equivalence scale (1994) reflect the households’ relative well-being allowing for differences in household types, compositions and requirements relative to income.

Australian statistical geography standard (ASGS) (2011)

was used by the ABS to generate two broad geographical categories; non-remote (including major cities and inner regional Australia) and remote. However, the ABS only released the non-remote data for the Indigenous sample so we excluded the remote participants for the non-Indigenous sample to ensure comparability.

Fruit and vegetable consumption

was used as a measure of dietary behaviour which was categorised by the ABS as either having met the Australian Dietary Guidelines [32] or not.

Physical activity

was categorised by the ABS as having met 150 min of physical activity per week as recommended by the *Australian Physical Activity and Sedentary Behaviour Guidelines for Adults* [33] or not.

Statistical analyses

The variables of interest that were common to both the NNPAS and the NATSINPAS databases were identified (Table 1). Data were cleaned by excluding implausible values, missing data and outliers. A final merged dataset of NNPAS and NATSINPAS was restricted to adults aged 18 years and older who had identified the previous night’s sleep duration as ‘typical’. Typical night’s sleep reports were considered to reflect the approximate pattern and/or number of hours of sleep that occurred on the same night of the week over time. Demographic, categorical data for the two groups were compared using χ^2 tests. Logistic regression analyses were performed for the non-Indigenous and Indigenous groups separately to examine the association between sleep duration and BMI in both groups. Two models were tested for each group. Model 1: the non-adjusted model examined the relationship between sleep duration and BMI. Model 2: the adjusted model examined the relationship between sleep duration and BMI controlling for the covariates described in Table 1. Sleep duration of 7 h was used as the reference category because it has been reported as having the lowest mortality risk [30]. To reduce the risk of Type 1 error due to multiple testing, the OR were tested against a p value of 0.025 (two-tailed). All analyses were completed through the ABS *DataLab* using STATA 13 [34].

Table 1 Demographic information for Indigenous and Non-Indigenous adults who reported sleep duration as 'typical'

Category	Sub-Category	non-Indigenous N = 5204 N (%)	Indigenous N = 646 N (%)	χ^2	df	p
Gender	Males	2504 (48.12)	270 (41.80)	1	9.21	< .005
	Female	2700 (51.88)	376 (58.20)			
Index of Relative Socio-economic Disadvantage – 2011 (SEIFA)	Quintile 1(lowest)	996 (19.14)	327 (50.62)	4	395.29	< .001
	Quintile 2	1106 (21.25)	160 (24.77)			
	Quintile 3	1022 (19.64)	74 (11.46)			
	Quintile 4	1040 (19.98)	64 (9.91)			
	Quintile 5(highest)	1040 (19.98)	21 (3.25)			
Labour Force Status	Employed	3263 (62.70)	283 (43.81)	2	138.73	< .001
	Unemployed	120 (2.31)	57 (8.82)			
	Not in the labour force	1821 (34.99)	306 (47.37)			
Equivalised income of household: quintiles	Quintile 1 (lowest income)	1088 (20.91)	278 (43.03)	4	222.98	< .001
	Quintile 2	1002 (19.25)	162 (25.08)			
	Quintile 3	918 (17.64)	89 (13.78)			
	Quintile 4	1096 (21.06)	73 (11.30)			
	Quintile 5 (highest income)	1100 (21.14)	44 (6.81)			
Household type	person living alone	1442 (27.71)	145 (22.45)	5	186.04	< .001
	Couple only	1537 (29.53)	116 (17.96)			
	Couple family with children	1447 (27.81)	169 (26.16)			
	One parent family with children	421 (8.09)	120 (18.58)			
	Unrelated persons aged ≥15 yrs	124 (2.38)	10 (1.55)			
	All other households	233 (4.48)	86 (13.31)			
Number of adults in household	One	1703 (32.72)	234 (36.22)	3	5.24	> .05
	Two	2854 (54.84)	324 (50.15)			
	Three	466 (8.95)	65 (10.06)			
	Four or more	181 (3.48)	23 (3.56)			

Table 1 Demographic information for Indigenous and Non-Indigenous adults who reported sleep duration as 'typical' (Continued)

Category	Sub-Category	non-Indigenous N = 5204 N (%)	Indigenous N = 646 N (%)	χ^2	df	p
Number of children in household (0 – 17 years)	None	3642 (69.98)	331 (51.24)	4	143.5	< .001
	One	619 (11.89)	103 (15.94)			
	Two	631 (12.13)	109 (16.87)			
	Three	226 (4.34)	59 (9.13)			
	Four or more	86 (1.65)	44 (6.81)			
Sleep duration categories	< 6 h	285 (5.48)	35 (5.42)	4	67.59	< .001
	6 - < 7 h	594 (11.48)	65 (10.06)			
	7 - < 8 h	1337 (25.69)	111 (17.18)			
	8- < 9 h	1638 (31.48)	172 (26.63)			
	≥ 9 h	1350 (25.94)	263 (40.71)			
Body Mass Index (BMI)Categories	Normal range BMI 18 to < 25	1843 (35.42)	169 (26.16)	1	21.81	< .001
	Overweight/Obese BMI ≥ 25	3361 (64.58)	477 (73.84)			
Vegetable & fruit consumption	Met recommended guidelines	286 (5.50)	32 (4.95)	1	0.33	> .05
	Did not meet recommended guidelines	4918 (94.50)	614 (95.05)			
Physical activity last week at least 150 min	Met recommended guidelines	2654 (51.00)	287 (44.43)	1	9.93	< .005
	Did not meet recommended guidelines	2550 (49.00)	359 (55.57)			
Smoking status	current - daily	845 (16.24)	271 (41.95)	3	257.45	< .001
	current - weekly or less	92 (1.77)	13 (2.01)			
	Ex-smoker	1773 (34.07)	185 (28.64)			
	Never smoked	2494 (47.92)	177 (27.40)			

Results

There were 646 people in the Indigenous group and 5204 people in the non-Indigenous group.

The Indigenous group was significantly younger than the non-Indigenous group: $t(5848) = 9.78$, $p < .001$ (42 ± 15.5 vs 49 ± 16.2 years of age, respectively).

Table 1 describes the characteristics of the non-Indigenous and Indigenous groups including gender, socioeconomic factors, typical daily sleep duration, physical activity, dietary factors, smoking status and BMI.

Results show that short sleep (< 7 h/night) was experienced by similar proportions of participants in both groups (17% non-Indigenous, 15.5% of Indigenous participants). A greater proportion of Indigenous participants reported long sleep compared with non-Indigenous people (> 9 h/night: 40.7% vs 25.9%, $\chi^2(4) = 67.59$, $p < 0.001$ respectively). Compared with the non-Indigenous group, the Indigenous group had a greater proportion of female participants; were more likely to live in households with 3 or more children under 17

years of age; and were over represented in the most deprived quintile (50.6%, quintile 1) and underrepresented in the least deprived quintile (3.3%, quintile 1). Significantly more Indigenous people were current smokers than non-Indigenous participants (42% vs 16.2%, $\chi^2(3) = 257.45$, $p < 0.001$) and significantly fewer met the recommended Australian physical activity guidelines each week compared with non-Indigenous participants (55.6% vs 49%, $\chi^2(1) = 9.93$, $p < 0.005$). A significantly greater proportion of Indigenous people were classified as overweight/obese than non-Indigenous people (73.8% vs 64.6%, $\chi^2(1) = 21.81$, $p < 0.001$).

Unadjusted and adjusted odds ratios for the Indigenous and non-Indigenous groups are shown in Table 2. In the unadjusted models, sleep duration alone accounted for very little of the overall variance in the odds of overweight/obesity in either group (non-Indigenous pseudo $R^2 = 0.005$, $p < 0.001$ and Indigenous pseudo $R^2 = 0.012$, $p = 0.07$, respectively). The unadjusted model for the Indigenous group was not significant but nevertheless a possible dose-response relationship was evident, with the odds of obesity being greatest for Indigenous people who typically slept less than 7 h (OR = 1.77, 95% CI 0.79–3.94) and < 6 h (OR = 1.55, 95% CI = 0.58–4.14). The unadjusted model for the non-Indigenous group was significant, with the odds of overweight/obesity being greatest for those who typically slept less than 6 h (OR = 1.67, 95% CI 1.25–2.25). Longer than normal sleep times seem to be associated with lower odds of overweight/obesity for both Indigenous and non-Indigenous people; however, the risk reduction was only statistically significant for non-Indigenous people who typically slept for more than 9 h (OR = 0.81, 95% CI 0.69–0.95).

The inclusion of covariates marginally increased the overall explanatory power of the models (non-Indigenous pseudo $R^2 = 0.06$, $p < 0.001$ and Indigenous pseudo $R^2 = 0.15$, $p < 0.001$, respectively). For the Indigenous group, the same trends observed in the unadjusted model were evident in the adjusted model, but again the results were not statistically significant. For the non-Indigenous group, the odds of overweight/obesity were statistically significant for those who slept less than 6 h (OR = 1.52, 95% CI = 1.12–2.06). Like the unadjusted model, the adjusted model suggested that longer than 7 h sleep lowered the odds of overweight/obesity for the Indigenous and non-Indigenous groups alike (see Fig. 1). For both groups, there seemed to be an inverse relationship between sleep duration and the odds of overweight/obesity.

For Indigenous participants, the two covariates in the adjusted model that were most strongly associated with overweight/obese were household type and smoking status. Compared with living alone, there was significantly greater odds of being overweight/obese if the person lived as part of a couple without children (OR = 4.64,

95% CI = 1.44–14.98); with a partner and children (OR = 8.16, 95% CI = 1.59–41.86); as a single parent family (OR = 3.48, 95% CI = 1.16–10.47); and in any other type of household other than with unrelated people (OR = 5.46, 95% CI = 1.14–26.17). Indigenous people who were ex-smokers (OR = 3.16, 95% CI = 1.84–5.43) or who had never smoked (OR = 1.75, 95% CI = 1.07–2.86) were at significantly greater odds of being overweight/obese compared with daily smokers.

Socioeconomic status of home locality and household income were not significantly associated overweight/obesity, although the odds seemed lowest for those who lived in the higher socioeconomic localities.

For non-Indigenous participants, the odds of overweight/obesity were significantly lower in females than males (OR = 0.56, 95% CI = 0.49–0.63). Similarly, people not participating in the labour force had a significantly lower odds of overweight/obesity compared with those in employment (OR = 0.80, 95% CI = 0.67–0.95). The odds of overweight/obesity was greatest for those living in the lowest socioeconomic localities, with a significantly lower odds for those living in the mid to higher socioeconomic status localities (quintile 3 (midrange): OR = 0.71, 95% CI = 0.59–0.87; quintile 4: OR = 0.66, 95% CI = 0.54–0.81; quintile 5 (highest): OR = 0.60, 95% CI = 0.49–0.74). However, the opposite is observed for actual household income where participants living in the household with the highest incomes had the greatest odds of being overweight/obese (quintile 4: OR = 1.31, 95% CI = 1.05–1.64 and quintile 5 (highest): OR = 1.34, 95% CI = 1.07–1.69). The risk of overweight/obesity was significantly greater for non-Indigenous people who did not meet the weekly physical activity guidelines (OR = 1.2, 95% CI = 1.06–1.35) and for ex-smokers (OR = 1.44, 95% CI = 1.20–1.73).

Increased age was significantly associated with overweight/obese in both groups (Indigenous OR = 1.05, 95% CI 1.03–1.07); non-Indigenous OR = 1.03, 95% CI = 1.03–1.04). Fruit and vegetable intake did not significantly impact on the risk of overweight/obesity for either group, however Indigenous participants had twice the risk of overweight/obesity associated with inadequate dietary intake of fruit and vegetables (OR = 2.00, 95% CI = 0.85–4.76) compared with Indigenous people who met the dietary guidelines. Indigenous participants who did not meet the recommended 150 min of physical activity per week were also at higher risk of overweight/obesity compared with those who did meet the guidelines, although again the results were not significant for this group (OR = 1.37, 95% CI = 0.92–2.05).

Discussion

Through its association with chronic cardiometabolic diseases, excess BMI has been established as a leading

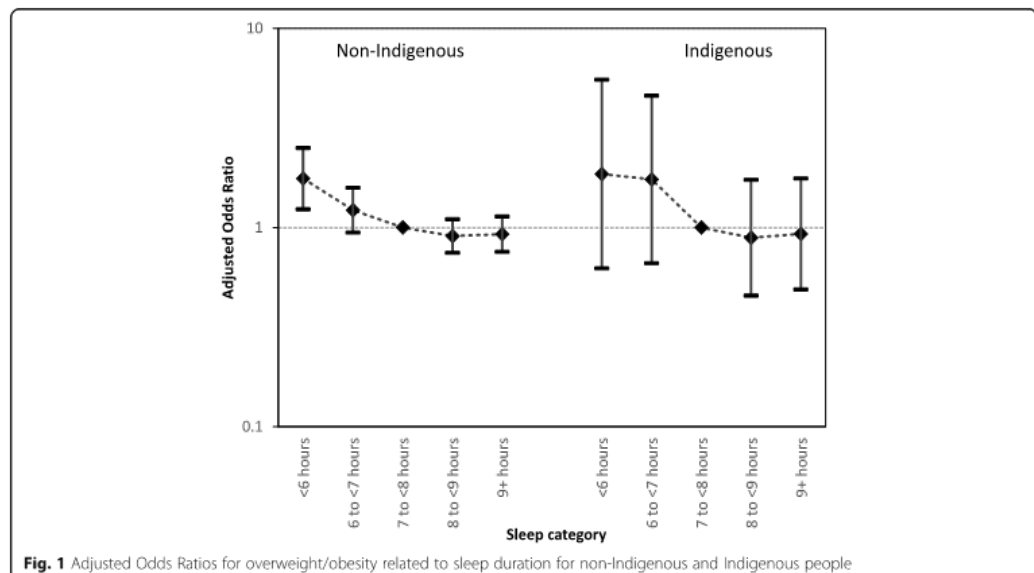
Table 2 Unadjusted and adjusted odds ratios for Indigenous and non-Indigenous groups

	Indigenous N = 646		non-Indigenous N = 5204	
	OR	95% CI	OR	95% CI
Model 1	**p = 0.075		**p < 0.001	
Sleep duration (hrs)				
< 6	1.55	(0.58–4.14)	1.67*	(1.25–2.25)
< 7	1.77	(0.79–3.94)	1.22	(0.99–1.50)
< 8	Ref		Ref	
< 9	0.88	(0.51–1.53)	0.9	(0.77–1.04)
9+	0.74	(0.44–1.22)	0.81*	(0.69–0.95)
Model 2	**p < 0.001		**p < 0.001	
Sleep duration (hrs)				
< 6	1.51	(0.53–4.30)	1.52*	(1.12–2.06)
< 7	1.66	(0.67–4.07)	1.15	(0.93–1.43)
< 8	ref		Ref	
< 9	0.71	(0.38–1.31)	0.92	(0.78–1.07)
9+	0.77	(0.43–1.37)	0.88	(0.74–1.03)
Age	1.04*	(1.03–1.06)	1.03*	(1.02–1.03)
Female	0.64	(0.41–1.01)	0.56*	(0.49–0.63)
Employment Status				
Employed	Ref		Ref	
Unemployed	0.81	(0.38–1.73)	0.96	(0.64–1.42)
Not in Labour force	0.99	(0.58–1.71)	0.8*	(0.67–0.95)
Socioeconomic status of locality				
Quintile 1 (lowest)	Ref		Ref	
Quintile 2	0.89	(0.55–1.44)	0.92	(0.76–1.11)
Quintile 3	1.84	(0.91–3.71)	0.71*	(0.59–0.87)
Quintile 4	0.56	(0.29–1.10)	0.66*	(0.54–0.81)
Quintile 5 (highest)	0.86	(0.24–3.12)	0.6*	(0.49–0.74)
Household type				
Person living alone	Ref		Ref	
Couple only	4.64*	(1.44–14.98)	1.47	(0.89–2.42)
Couple family with children	8.16*	(1.59–41.86)	1.62	(0.81–3.22)
One parent family with children	3.48*	(1.16–10.47)	1.27	(0.84–1.93)
Unrelated persons aged 15+ only	0.96	(0.15–6.27)	1.14	(0.60–2.15)
All other households	5.46*	(1.14–26.17)	1.65	(0.81–3.36)
Equivalised income of household				
Quintile 1 (lowest)	Ref		Ref	
Quintile 2	1.48	(0.85–2.56)	1.2	(0.99–1.46)
Quintile 3	1.3	(0.62–2.71)	1.1	(0.88–1.36)
Quintile 4	1.05	(0.48–2.29)	1.31*	(1.05–1.64)
Quintile 5 (highest)	1.75	(0.56–5.15)	1.34*	(1.07–1.69)
Number of adults in household				
One	Ref		Ref	
Two	0.49	(0.19–1.24)	0.71	(0.44–1.14)

Table 2 Unadjusted and adjusted odds ratios for Indigenous and non-Indigenous groups (Continued)

	Indigenous N = 646		non-Indigenous N = 5204	
	OR	95% CI	OR	95% CI
Three	0.5	(0.15–1.62)	0.65	(0.35–1.17)
Four or more	1.05	(0.21–5.16)	0.59	(0.31–1.16)
Number of children 0–17 yrs. in household				
None	Ref		Ref	
One	0.59	(0.24–1.47)	1	(0.73–1.39)
Two	0.48	(0.18–1.27)	0.96	(0.68–1.35)
Three	0.69	(0.24–2.00)	1.28	(0.84–1.94)
Four or more	0.46	(0.15–1.40)	0.92	(0.54–1.58)
Fruit and vegetable intake				
Met recommended dietary guidelines	Ref		Ref	
Did not meet recommended dietary guidelines	2.00	(0.85–4.76)	1.05	(0.81–1.36)
Physical activity				
Met recommended guidelines	Ref		Ref	
Did not meet recommended guidelines	1.37	(0.92–2.05)	1.2*	(1.06–1.35)
Smoking Status				
Current daily	Ref		Ref	
Current weekly or but not daily	1.96	(0.54–7.20)	0.9	(0.57–1.41)
Ex-smoker	3.16*	(1.84–5.43)	1.44*	(1.20–1.73)
Never smoked	1.75*	(1.07–2.86)	1.08	(0.91–1.28)

* indicates significant result **indicates the overall p value for the model



contributor to the disease burden in Australia [3]. This is particularly so for Indigenous people who are at higher risk of obesity based on BMI measurements [9] as demonstrated by this study, where significantly more Indigenous people were classified as overweight/obese than non-Indigenous people. For the past two decades, reports have also established an association between BMI and sleep duration, indicating that sleep durations ≤ 7 h and ≥ 9 h, are not ideal for health and may influence BMI [35, 36].

Previous Australian studies have shown that for adults aged 45–65 years, short sleep (< 7 h) was associated with obesity in both males and females while long sleep (≥ 9 h) was associated with obesity in males only [30]. Further stratification showed that both short and long sleep were associated with obesity (U-shaped curve) for those aged 55–65 years [23]; however, there was no association between sleep duration and obesity for those over 65 years [24].

Due to the comparatively small number of Indigenous adults in our study, we did not stratify participants by age. Contrasting with previous reports, our results indicate that Indigenous adults are more likely to experience long sleep duration compared with non-Indigenous adults [12, 36]. Furthermore, rather than a previously described U-shaped curve [23], we found evidence of an inverse relationship between sleep duration and BMI, with longer sleep duration appearing to reduce the odds of developing overweight/obesity for both Indigenous and non-Indigenous participants.

In our analysis, similar to previous meta-analysis guidelines, we considered short sleep duration to be < 7 h, optimal sleep duration to be 7–9 h with 7–8 h used as the normal reference range and long sleep to be ≥ 9 h [17]. Exploring the relationship between sleep duration and BMI in the unadjusted model, without consideration of other possible confounders, both Indigenous and non-Indigenous people who slept less than 7 h per night (i.e. short sleepers) were more likely to be overweight/obese compared with their counterparts who slept a normal 7–8 h (i.e. the reference sleeping category) on a typical night. Even though both the Indigenous and non-Indigenous groups reflected similar trends in this respect, only the results for the non-Indigenous group were statistically significant. The absence of significant association in the Indigenous group is most likely a power issue, with the Indigenous group being approximately eight times smaller than the non-Indigenous group.

In the adjusted model, the combination of covariates accounted for a greater proportion of the variance in BMI for Indigenous people compared with the non-Indigenous people. Like the unadjusted model, the relationship between sleep duration and BMI in the adjusted

model showed that both Indigenous and non-Indigenous people who slept less than 7 h per night were more likely to be overweight/obese compared with those who slept a normal 7–8 h on a typical night. Preliminary reports from a 6 year longitudinal study indicated that short sleepers gained more abdominal fat than people who slept for 7 or more hours [15]. This is important because fat deposition patterns tend to favour the abdomen in the Australian Indigenous population, regardless of overall weight [37]. Hence, BMI-based measurements are likely to underestimate this risk in Indigenous Australians and the prevalence of actual overweight and obesity may be much greater than reported.

Consistent with the findings of a meta-analysis [10], our study showed that more than 9 h of sleep did not pose a greater likelihood of overweight/obesity than sleeping 7–8 h. The reasons for weight gain with longer sleep are thought to be different from that of short sleep duration [38]. Furthermore, it is difficult to quantify the effect of long sleep on BMI because often adults are already overweight/obese when recruited to studies [39] and their long sleep may be attributable to other comorbidities such as depression, cancer and the effects of medications [40]. In light of this, and given that in this study, a larger proportion of Indigenous people compared with non-Indigenous people reported long sleep duration, it is important to note that other Australian reports have shown that Indigenous adults consistently self-report mental health concerns at higher rates than other members of the Australian community [41].

There is a paucity of information about the relationship between mental health and sleep for Australian Indigenous people. Unfortunately, such an analysis was not possible in this study as mental health data was not included in the survey we accessed. Notably however, one American study of middle-aged women with ongoing depressive symptoms found the women to be almost three times more likely to have long sleep of 9 or more hours per night, compared with those who did not experience depression [40]. Another study of adults aged over 57 years from the Netherlands also showed that people who experienced long sleep (≥ 9 h per night) were significantly more likely to have a depressive disorder than people who slept 7 to < 8 h per night [42]. Exploration of such associations in the Australian Indigenous community are for future research.

Considering other covariates associated with obesity, increasing age was significant for both Indigenous and non-Indigenous people. This may reflect that as people age, they are more likely to suffer chronic comorbidities and be less physically active [20, 22]. Gender differences have been previously reported whereby Indigenous Australian women have been found to be significantly more likely to be obese compared with Indigenous males

[9]. However, in this study, gender differences were apparent only in the non-Indigenous group where males were significantly more likely to be overweight/obese than females. Greater activity levels in Australian females compared with males may explain this finding [36]. Overall, participation in recommended levels of physical activity was lower for both Indigenous and non-Indigenous participants in this study than reported for another Australian study [36]. However, there seemed to be an increased risk, albeit non-significant, of overweight/obesity for Indigenous participants who did not meet the guidelines compared with those who did, which may be due to short sleep leading to increased daytime fatigue and lower levels of physical activity [43], long sleep leading to less time for physical activity or, if the long sleep is related to other comorbidities, long sleepers having less capability for physical activities [44].

Family life generally seemed to be associated with overweight/obese for both groups, however our results were only significant for the Indigenous group. Indigenous people living with a partner or children under 18 were significantly more likely to be overweight or obese compared to people living alone. Similarly, in the non-Indigenous group, those living in families with children under 18 were at greatest risk of being overweight or obese. A recent Australian study showed that compared with singles, couples were significantly less likely to be within a normal weight range [45], while another associated lower levels of physical activity in the time of transition to parenthood as a main contributor to increased obesity of parents [46].

Our findings of the greater risk of overweight/obesity in Australian males and for those who are not living alone are consistent with other studies of males living in Tehran and the Gulf States, which showed that overweight and obesity were significantly more prevalent in those who were married [47] or living with a partner and other family members compared with those who lived alone [48]. Socioeconomic status of the household locality did not significantly increase the odds of overweight/obesity for Indigenous people, however the trend appeared to be that people who resided in higher socioeconomic areas were less likely to be overweight/obese than those who lived in the most deprived areas. The significantly lower SEIFA ranking and household income may reflect a greater number of Indigenous women in the sample caring for greater numbers of children.

Results for the non-Indigenous people reflected this trend and were statistically significant. Non-Indigenous people living in the 3 highest quintile areas were significantly less likely to be overweight/obese compared with those living in the lowest quintile areas. These findings are consistent with recent reports that show the proportion of Australian adults

aged at least 18 years who were overweight or obese increased with relative disadvantage [9].

The results for nutritional intake were not statistically significant but suggested Indigenous participants with inadequate dietary intake of fruit and vegetables had double the odds of overweight/obesity associated compared with those who met the dietary guidelines when other covariates were accounted for. This finding is consistent with a recent meta-analysis including of Australian studies, that reported an inverse relationship between fruit and vegetable consumption and risk of increased adiposity [49].

Finally, compared with current smokers, all other Indigenous participants were at increased odds of overweight/obesity, with the odds being greatest amongst ex-smokers. Weight gain following smoking cessation is well documented, and there are concerns that the benefits of tobacco cessation maybe diminished by the onset of overweight/obesity and the associated comorbidities [50].

Limitations

Several limitations must be considered in relation to the findings presented here. First, the study presents prevalence data and the use of cross-sectional data precludes the determination of causality and possible direction of causation. However, it is probable that the association between short sleep duration and greater than normal BMI is bidirectional. As already mentioned, overweight/obesity may result from prolonged short sleep duration or it may be that overweight/obesity causes short sleep due to concomitant comorbidities and pain. Obstructive sleep apnoea (OSA) is one such comorbidity that has been associated with overweight/obesity [51] and sleep disturbance [52]. OSA could not be considered in this study because it was not part of the survey dataset we accessed but a recent review concluded that it is more prevalent and more severe in global Indigenous populations than non-Indigenous populations [12]. Two reports have since added to the Australian Indigenous context. A retrospective analysis of diagnostic sleep test data from the Northern Territory found that severe sleep apnoea was associated with male gender, increasing age, higher body weight, and Indigenous status [53]. Similar data from Central Australia and far north Queensland reported that compared with non-Indigenous people, Indigenous people diagnosed with OSA were more likely to be female, live in remote communities and be obese [54]. This is an area for further research given the prevalence of obesity in Indigenous communities and the associated risk of OSA with adverse health outcomes and increased all-cause mortality [53].

Second, self-reported sleep data, although widely used, is likely to systematically overestimate sleep duration. It

is very difficult, for example, for a person to know when sleep actually occurs without objective measurement. If sleep time is calculated from the time the person intended to go to sleep and it took longer than anticipated to fall asleep, this would lead to an overestimation of sleep duration. However, it is unlikely that such biases affected the Indigenous and the non-Indigenous groups in this analysis differentially. Although actigraphy and polysomnography are considered better objective measurements of sleep duration [25], there was no opportunity to such measures in this study.

Third, BMI was used in this study because it is the most commonly used measure of overweight / obesity [55]. However, World Health Organisation recommended BMI ranges may be inappropriate for Indigenous Australians [56] and may, in fact, underestimate overweight / obesity in this population. Waist measurements of ≥ 94 cm for men or ≥ 80 cm for women are recognised as better measures of body fat and are indicative of increased risk of developing chronic disease such as heart disease and Type 2 diabetes (WHO, 2000). High BMI may be indicative of a much greater risk and link with metabolic syndrome and chronic illness for Indigenous Australians than previously thought. It is reassuring, therefore, that in this sample at least, there was a strong correlation between the two measures ($r = 0.9$, $n = 16,262$, $p < 0.01$).

Conclusion

The results of this study differ from the previously reported 45 up Australian study [23] in that in there appeared to be an inverse relationship between sleep duration and BMI for non-Indigenous Australians and an inverse trend between sleep duration and BMI for Indigenous Australians, rather than the previously reported U-shaped relationship [24]. In this study, BMI appears to be partially explained by current sleep duration in non-Indigenous adults, but this pattern is less well defined in Indigenous adults. Sleep duration did not appear to be strongly associated with BMI for either non-Indigenous or Indigenous participants. The adjusted model indicates that other factors are more strongly associated with overweight/obesity than sleep. Further research is needed to determine whether the null findings with sleep duration and BMI among the Indigenous sample can be explained by the interaction between social and personal determinants of health and Indigenous status, and whether sleep duration plays a mediating or moderating role in the predisposition of Indigenous Australians towards overweight/obesity.

Interestingly, a recent study of Australian Indigenous children found that sleep duration is inversely associated with overweight /obesity [57], while a cascade model of paediatric obesity identified that despite a small effect

size, short sleep duration is a key factor in the development of obesity in school-aged children [58]. Cascade models have the basic tenet that no single risk or protective factor has a large effect but its early and cumulative influence snowballs to a greater effect over time. Such models may be useful to explain the cumulative consequences and downstream effects of the complex multifactorial risk and protective factors associated with adult obesity. Using such a model, it may be that the influence of sleep on future adult BMI is most potent in childhood.

Another piece of the puzzle that needs to be considered is that a previous longitudinal study of non-Indigenous adults found a positive effect by optimising sleep duration over a six-year period. People with a baseline short sleep duration (≤ 6 h per day) who increased their sleep to 7–8 h over the 6-year period experienced significantly lower adiposity gain than those who maintained their short sleep habit but no significant difference in adiposity gain compared with the control group who maintained their baseline 7–8-h sleep duration [15].

In view of the cascade model of paediatric obesity and the positive effects of sleep optimisation found in non-Indigenous people, further work is needed, ideally in a prospective longitudinal study, where sleep can be measured over childhood and adulthood to gain a clearer picture of the role of sleep duration in the health and wellbeing of Australian Indigenous people.

Abbreviations

ABS: Australian Bureau of Statistics; AHS: Australian Health Survey; ASGS: Australian Statistical Geography Standard; BMI: Body Mass Index; CURF: Confidentialised Unit Record File; NATSINPAS: National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey; NNPAS: National Nutrition and Physical Activity Survey; SEIFA: Index of Relative Socio-economic Disadvantage; WHO: World Health Organisation

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Authors' contributions

MDC, SB & TS conceived and designed the study. MDC acquired and analysed the datasets. SB, TS & MDC interpreted the data. MDC was the major contributor in writing the manuscript. SB & TS revised the paper. MDC & SB revised manuscript in response to reviewers. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated analysed during the current study are available on successful application from the Australian Bureau of Statistics DataLab, NNPAS: <https://www.abs.gov.au/AUSSTATS/abs@nsf/Lookup/4324.0.55.002>Main+Features12011-12> NATSINPAS: <https://www.abs.gov.au/ausstats/abs@nsf/Lookup/4715.0.30.002/main+features12012-13>

Ethics approval and consent to participate

The survey data used in the analysis for this manuscript was secondary data from the Australian Health Survey (AHS) 2011–2013. The survey data was

originally collected by the Australian Bureau of Statistics under the **legislated Australian Government Census and Statistics Act 1905**. The ABS is authorised to conduct the household interview components of the survey under the *Census and Statistics Act 1905 with no requirement for ethics approval*. The protocols for the optional voluntary biomedical **sample collection** was approved by the Australian Government Department of Health and Ageing Departmental Ethics Committee. Please note that no biomedical data was used in this analysis. The Chief Statistician at the Australian Bureau of Statistics manages the AHS data informed by two laws: the Census and Statistics Act 1905 and the Privacy Act 1988. Data is stored by the ABS in Confidentialised Unit Record Files (CURF). Access to the data is restricted to authorised users only. Authorisation to access data from the AHS CURF related to the National Nutritional and Physical Activity Survey (NNPAS) and the National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey NATSINPAS was gained from the ABS on January 19, 2017. All data analysis was completed online in a secure ABS DataLab platform. All analytical output used in this manuscript was checked and cleared by the ABS before release.

Consent for publication

Not applicable.

Competing interests

None.

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Conclusion

The results of this study differ from those previously reported by Magee et.al. 2010, in that my study identified an inverse relationship between sleep duration and BMI for non-Indigenous Australians rather than the previously reported U-shaped relationship. Sleep duration seemed to partially explain BMI in non-Indigenous adults, but the association was not as clear for Indigenous adults. Instead, an inverse trend was identified between sleep duration and BMI for Indigenous Australians. To my knowledge, this was the first study to specifically report about the relationship between sleep duration and BMI in Australian Indigenous adults.

In this study, sleep duration was not a strong predictor of BMI for either non-Indigenous or Indigenous participants. For Indigenous adults, other factors such as family life and age were more strongly associated with overweight/obesity than sleep duration. However, given the prevalence of increased BMI in Indigenous Australians, it was also important to consider that although sleep duration may not be a strong predictor of their BMI, was it possible that it still had a role to play in the relationship between Indigeneity and BMI.

The next chapter presents further analyses to identify factors that impact the relationship between Indigenous status and BMI.

Chapter 8: Indigeneity and its association with Body Mass Index (BMI) in Australian adults: Does sleep duration affect the relationship?

Introduction

There is a genuine lack of information about the sleep behaviours of Indigenous Australians (Macniven et al., 2016; Yiallourou, Maguire, & Carrington, 2020; Yiallourou et al., 2019), previously mentioned in Chapter 4. This is despite the vast health disparities experienced by Indigenous Australians and notwithstanding the established relationships between sleep and allostatic load (McEwen, 2006) and all-cause mortality (Cappuccio et al., 2008; Gallicchio & Kalesan, 2009). Interestingly, much of the literature about Indigenous morbidity and mortality focuses on disparities in socioeconomic factors that are estimated to account for between 30-50% of the disparity between Indigenous and non-Indigenous Australians (Booth & Carroll, 2008). However, other complex factors must be at play to explain the remaining disparity. Shepherd et. al. (2012), premised that the associations of traditional SES factors reported in the literature may not hold true for Indigenous people because: (i) the experience of colonisation, discrimination and exclusion may counteract any health benefit of attaining higher SES; (ii) marginalization can have developmental effects and impede healthful behaviour at every level of SES; and (iii) other social, cultural and spiritual factors may have a greater impact on the health of Indigenous people than SES. Subsequent study of the literature revealed a varied and less predictable social gradient for Indigenous health in Australia compared with widely accepted associations for the general population that possibly reflected the uniqueness of the Indigenous context (Shepherd, Li, & Zubrick, 2012). Regrettably, there is little data available about the impact of factors that influence health outcomes in the context of Indigenous Australia (Durey & Thompson, 2012; Shepherd et al., 2012).

Sleep has been ascribed a mediator role in the relationship between a number of socioeconomic, physical and psychological factors and various health outcomes for numerous population groups (Hall et al., 1998; Sickel, Moore, Adler, Williams, & Jackson, 1999; Tomfohr, Pung, & Dimsdale, 2016; Van Cauter & Spiegel, 1999). One Australian study demonstrated that short sleep duration mediated the relationship between long work hours and high BMI (Magee, Caputi, & Iverson, 2011). Another study reported that sleep mediated the relationship between food insecurity and obesity across different racial groups (Narcisse et al., 2018). A study of children identified that sleep duration mediated the relationship between health behaviours

related to inactivity and fruit and vegetable intake and obesity (Kaar et al., 2018). However, a recent scoping review that explored the impact of sleep on the relationship between socioeconomic status and health revealed that few studies have considered BMI as a health outcome (Papadopoulos, Sosso, Khoury, & Surani, 2020), hence a paucity of information about the possible mediating effects of sleep related to obesity.

Having identified that sleep duration was found to partially mediate the relationship between Indigenous status and BMI in children in our earlier study, the following study explores the possibility that despite not being strongly associated with BMI in Indigenous adults, sleep duration may have a role to play in the relationship between Indigenous status and BMI for adults.

Full title: Association between Indigenous status and Body Mass Index (BMI) in Australian adults: Does sleep duration affect the relationship?

Short title: Indigenous status and BMI in Australia – effect of sleep duration.

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Abstract

Background: Overweight/obesity is a well-defined risk factor for a variety of chronic cardiovascular and metabolic diseases. Sleep duration has been associated with overweight/obesity and other cardio metabolic and neurocognitive problems. Notably, overweight/obesity and many of the associated comorbidities are prevalent in Indigenous Australians. Generally, sleep duration has been associated with BMI for Australian adults but information about Australian Indigenous adults' sleep is scant. A recent report established that sleep is a weak predictor of obesity for Indigenous Australian adults.

Aim: to determine whether sleep remains a predictor of obesity when physical activity, diet and smoking status are accounted for; and to determine whether sleep duration plays a mediating role in the relationship between Indigenous status and BMI.

Methods: Statistical analyses of 5,886 Australian adults: 5236 non-Indigenous and 650 Indigenous people aged over 18 years who participated in the Australian Health Survey 2011-2013. Demographic and lifestyle characteristics were described by χ^2 and t-tests. ANOVA was used to determine the variables that significantly predicted BMI and sleep duration. Stepwise regression analyses were performed to determine the strongest significant predictors of BMI. Sleep duration was self-reported; BMI was calculated from measurement.

Results: The study revealed two main findings: (i) short sleep duration was an independent predictor of obesity (adjusted- $R^2 = 0.056$, $p < 0.0001$); and (ii) controlling for sleep duration and other possible confounders, Indigenous status was a significant predictor of BMI overweight/obesity. Sleep duration played a weak, partial mediator role in this relationship. Increased BMI was associated with lower socioeconomic status and level of disadvantage of household locality for non-remote Indigenous and non-Indigenous people.

Conclusion: Indigenous status strongly predicted increased BMI. The effect was not mediated by the socioeconomic indicators but was partially mediated by sleep duration.

Introduction

Overweight/obesity is a well-established risk factor for the development of chronic illnesses including cardio-metabolic diseases and cancer (Grundy, 2004) (Lauby-Secretan et al., 2016), with considerable contribution to the total burden of disease (Australian Institute of Health and Welfare, 2017) and hence, the economic costs to the community (Australian Institute of Health and Welfare, 2018a). Prior to Western colonisation, Indigenous Australians led traditional lifestyles that promoted lean body weight (O'Dea, 1991). However the incidence of overweight/obesity in Indigenous Australians is now widespread, with 71% of adults assessed as overweight (27%) or obese (44%)(Australian Institute of Health and Welfare, 2018b). The high prevalence of obesity and associated chronic illnesses experienced by Indigenous Australians is a complex and multifactorial phenomenon (Deacon-Crouch, Skinner, Tucci, & Skinner, 2018) related to colonisation with multiple socioeconomic and behavioural dimensions (Katherine Ann Thurber et al., 2018) including political marginalisation and ingrained institutional, structural and interpersonal racial prejudice (Gracey & King, 2009). To address this pervasive situation, Australian Indigenous peoples released the Uluru Statement from the Heart (Referendum Council, 2017) seeking constitutional reforms to empower self-determination by giving Indigenous peoples a voice to impact laws and policies that affect them. To date, despite widespread Australian public support for self-determination of Indigenous Australians, constitutional change has not occurred (Baum et al., 2020).

Sleep duration has been shown to be an important health factor associated with obesity and other metabolic, immunologic, and cardiovascular diseases as well as psychiatric and other neurocognitive dysfunctions in non-Indigenous Australians (Grandner, 2017). Previous studies with children have shown that short sleep duration is an accepted predictor of obesity for children (L. Magee & Hale, 2012; Nielsen, Danielsen, & Sørensen, 2011; Patel & Hu, 2008), including Indigenous Australian children (M. Deacon-Crouch, Begg, Tucci, Skinner, & Skinner, 2019). Sleep duration has been shown to have a mediating role in the relationship between

Indigenous status and body mass index (BMI) for Indigenous Australian school-aged children (Deacon-Crouch et al., 2018).

Associations between sleep duration and BMI in the general Australian adult population (including Indigenous people) have been reported (C. A. Magee, Caputi, & Iverson, 2010; C. A. Magee, Iverson, & Caputi, 2009), however to date, information about sleep duration specific to Indigenous Australians remains scant (S. R. Yiallourou et al., 2019). Lack of sleep has previously been identified as an issue of concern by one group of Australian Indigenous people (Melissa Deacon-Crouch, Skinner, Connelly, & Tucci, 2016) and our recent study of Australian adults showed that less than 7 hours sleep duration predicted obesity for both Indigenous and non-Indigenous adults (Melissa Deacon-Crouch, Begg, & Skinner, 2020). However, it remains unknown if differences in sleep duration account for any of the variation in BMI between Indigenous and non-Indigenous Australian adults.

Sleep duration has been associated with both chronic illness and overweight/obesity in other populations (Chattu et al., 2019) yet there is little known as to whether sleep duration is associated with these conditions for Indigenous Australian adults. If sleep duration is found to influence the risk of obesity and by extension, risk of chronic illness for Indigenous people, interventions to help optimise sleep duration may improve health outcomes.

Lifestyle factors such as diet, physical activity and smoking that are associated with sleep and BMI were also considered in this study (Grandner et al., 2015). Diet and sleep appear to have a bi-directional relationship: sleep has been reported to affect eating behaviours (J.-P. Chaput, 2014) and metabolic processes (Janochova, Haluzik, & Buzga, 2019) while diet, particularly fruit and vegetable intake, has been shown to influence sleep efficiency and duration (Jansen, She, Rukstalis, & Alexander, 2021). A recent meta-analysis revealed that physical activity significantly improved both subjective perceptions and objective measures of sleep in healthy individuals (Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015). Conversely, lack of physical activity has been

associated with abdominal obesity and increased risks of cardiometabolic diseases (McCarthy, Gibney, Flynn, & Livingstone, 2002) and physical activity has been endorsed in Australia to help reduce obesity and the risks for other cardiometabolic diseases (Australian Institute of Health and Welfare, 2017). Smoking status has also been found to influence both BMI (Rasmussen, Tynelius, & Kark, 2003; Tuovinen et al., 2016) and sleep (Patterson, Grandner, Lozano, Satti, & Ma, 2018; Phillips & Danner, 1995).

Having previously established that sleep is a weak predictor of obesity for Indigenous Australian adults, the aim of this study is to determine (i) whether sleep remains a predictor of obesity when selected lifestyle variables are accounted for; and (ii) whether sleep duration plays a mediating role in the relationship between Indigenous status and BMI.

Methods

This study used the same dataset and followed on from our previous report (Melissa Deacon-Crouch et al., 2020). In short, the dataset from participants in the Australian Health Survey (AHS) and the complementary Australian Aboriginal and Torres Strait Islander Health Survey (AATSIHS) was provided by the Australian Bureau of Statistics (ABS). All data were de-identified and protected by the secrecy provisions in the Australian Government *Census and Statistical Act 1905*, rendering it impossible to identify individual respondents from published findings. In consultation with Aboriginal and Torres Strait Islander authorities (National Aboriginal and Torres Strait Islander Health Equality Council; National Aboriginal Community Controlled Health Organisation; National Advisory Group on Aboriginal and Torres Strait Islander Health Information and Data; Office for Aboriginal and Torres Strait Islander Health) and other stakeholders, the ABS was granted ethical approval by the Australian Government Department of Health and Ageing's Departmental Ethics Committee for the AATSIHS survey to be administered to the Aboriginal and Torres Strait Islander participants in October 2011 and for the AHS to be administered to the general Australian public (which may include Indigenous

people) in March 2011 (Australian Bureau of Statistics, 2011a, 2012). Complete details about the AHS and AATSIHS structure and design, ethics approval and sampling methods and data collection are described elsewhere (Australian Bureau of Statistics, 2013a, 2013b). The AHS and AATSIHS comprised a number of corresponding components including the National Nutrition and Physical Activity Survey (NNPAS) 2011–2013 (Australian Bureau of Statistics, 2014a) and the matching National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS) (Australian Bureau of Statistics, 2016). The 5886 participants in this study included 5236 non-Indigenous adults who participated in the NNPAS and 650 Indigenous adults who participated in the NATSINPAS in the period 2012–2013. The participant age range was 18-75 years. Following ABS protocols, authorisation to access data from the Confidentialised Unit Record Files (CURF) from the NNPAS and the NATSINPAS was gained from the ABS in January 2017. Survey questions in the NATSINPAS were based on those from the NNPAS and so were directly comparable. All data were accessed, analysed, and cleared for research use through an online Australian Bureau of Statistics (ABS) DataLab virtual desktop portal. The secondary analysis of ABS data did not require separate University Human Research Ethics approval (La Trobe University Research and Graduate Studies Committee & University Human Ethics Committee, 2015). In this study the term Indigenous refers to all persons who identified themselves as being of Aboriginal, Torres Strait Islander, or both Aboriginal and Torres Strait Islander origin. Non-Indigenous refers to all other participants. Area of residence of participants was classified according to the Australian Statistical Geographic Standard (ASGS) which identifies locations based on the relative access to services for people living in these areas. Locations are defined as Major Cities (ASGS 1), Inner Regional (ASGS 2), Outer Regional (ASGS 3), Remote (ASGS 4) or Very Remote (ASGS 5)(Australian Bureau of Statistics, 2011b). In this study the term non-remote refers to the urban and regional areas of Australia (ASGS1, ASGS2, ASGS3) that have been assessed as having relatively good access to services. Remote (ASGS4) and very remote (ASGS 5) areas of Australia have little or very limited access to services. The ABS released data for non-remote NATSINPAS participants only, hence analysis of data in this study pertains only to

those Indigenous and non-Indigenous peoples who resided in non-remote locations (ASGS 1, 2 & 3).

Measures

As a follow on from the previous study, the same measures were employed (Melissa Deacon-Crouch et al., 2020) with the addition of lifestyle variables related to diet, physical activity and smoking status. In short, **sleep duration** was subjectively reported and declared as a typical night's sleep. Those who reported an atypical night's sleep were excluded from the analysis. A typical night's sleep was considered to reflect the approximate pattern and/or number of hours that occurred on that same night of the week over time. Sleep duration was stratified into 3 categories: Short sleep (<7 h), optimal sleep (7-9 h) and long sleep (>9 h) (Cappuccio et al., 2010); **BMI**: derived from height and weight objectively measured by the interviewers. **Index of Relative Socioeconomic Disadvantage 2011 (SEIFA) quintiles**: This index relates to the area in which the survey respondent lived and may not be indicative of their individual socioeconomic status. **Equivalised income of household (quintiles)**: Standardised estimates of income using the modified OECD equivalence scale (1994) reflect the households' relative well-being allowing for differences in household types, composition, and requirements relative to income.

Diet: Participants were asked about their usual daily consumption of vegetables and fruits from all sources, to determine whether they had met the National Health and Medical Research Council dietary guidelines (2003)(National Health and Medical Research Council, 2003a). **Physical activity**: Participants were asked about all their physical activity for the previous week to determine whether they had met the recommended 150 minutes of physical activity per week associated with good health, as recommended by the National Physical Activity Guidelines for Australian adults(Australian Government Department of Health, 2003). **Smoking status**: Participants were asked about their current and previous smoking status. If the participant

responded that they had ever smoked, they were asked to nominate the product they smoked, the regularity, and the quantity.

Statistical analyses

Statistical analyses described the study participants in 2 ways: (i) as a whole group and, (ii) divided into two subgroups according to Indigenous and non-Indigenous status. The variables of interest that were common to both the NNPAS and the NATSINPAS databases were identified. Data were cleaned by excluding implausible values, missing data, and outliers. The final merged dataset of NNPAS and NATSINPAS was restricted to adults aged 18 years and older who had identified the previous night's sleep duration as 'typical'. Assumptions for testing were confirmed, tests were two-tailed and the alpha value of 0.05 was used. Demographic and lifestyle characteristics of the sample were described using χ^2 for categorical data and t-tests for scale data. In preliminary analyses, ANOVA with post-hoc Bonferroni corrections were used to determine the variables that significantly predict BMI and sleep duration in the whole sample. Forward stepwise regression analyses using the identified significant predictors of BMI were performed to determine the strongest predictors of BMI in the whole sample as well as in the subgroups. All analyses were completed through the ABS DataLab using IBM SPSS Statistics 24 (IBM Corp, 2016).

RESULTS

Demographics/sample description

The analysis involved a total of 5,886 Australian adults: 5236 non-Indigenous and 650 Indigenous people. Table 1 describes various demographic, socioeconomic, diet, lifestyle, sleep, and BMI characteristics of the whole sample as well as the Indigenous and non-Indigenous groups.

Overall, more females than males participated in the survey and the average age was 46 years.

Forty-four (44) % of participants resided in the two most disadvantaged localities and 43%

experienced the lowest household income. Almost two-thirds of participants reported that they slept for the recommended period (mean of 492 mins or approximately 8 h) on a typical night whereas the remaining participants reported either short sleep or long sleep. Almost two-thirds of participants were classed as overweight or obese, with a mean BMI of 29. Regarding diet and lifestyle factors, 95% of participants reported not meeting the recommended dietary intake of fruit and vegetables, 50% met the recommended amount of weekly physical activity and almost 20% of participants were daily smokers.

Table 1: Demographic data describing whole sample and Indigenous and non-Indigenous groups

		Whole sample N= 5886	non-Indigenous N=5236	Indigenous N= 650		
Category	Sub-Category	N (%)	N (%)	N (%)	χ^2 ^a	p
Sex	Males	2797 (47.52)	2,526 (48.24)	271 (41.69)	9.95	0.002
	Female	3089 (52.48)	2,710 (51.76)	379 (58.31)		
Index of Relative Socio-economic Disadvantage – 2011 (SEIFA)	Quintile 1 (lowest)	1341 (22.78)	1,011 (19.31)	330 (50.77)	395.01	0.000
	Quintile 2	1269 (21.56)	1,109 (21.18)	160 (24.62)		
	Quintile 3	1104 (18.76)	1,029 (19.65)	75 (11.54)		
	Quintile 4	1109 (18.84)	1,045 (19.96)	64 (9.85)		
	Quintile 5 (highest)	1063 (18.06)	1,042 (19.90)	21 (3.23)		
Labour Force Status	Employed	3576 (60.75)	3,291 (62.85)	285 (43.85)	142.92	0.000
	Unemployed	178 (3.02)	120 (2.29)	58 (8.92)		
	Not in the labour force	2132 (36.22)	1,825 (34.85)	307 (47.23)		
Equivalised income of household: quintiles	Quintile 1 (lowest income)	1372 (23.31)	1,092 (20.86)	280 (43.08)	224.9	0.000

	Quintile 2	1170 (19.88)	1,008 (19.25)	162 (24.92)		
	Quintile 3	1017 (17.28)	927 (17.7)	90 (13.85)		
	Quintile 4	1177 (20.00)	1,103 (21.07)	74 (11.38)		
	Quintile 5 (highest income)	1150 (19.54)	1,106 (21.12)	44 (6.77)		
Household type	person living alone	1593 (27.06)	1,448 (27.65)	145 (22.31)	187.13	0.000
	couple only	1661 (28.22)	1,544 (29.49)	117 (18.0)		
	couple family with children	1627 (27.64)	1,457 (27.83)	170 (26.15)		
	One parent family with children	545 (9.26)	424 (8.1)	121 (18.62)		
	Unrelated persons aged ≥15 yrs.	136 (2.31)	126 (2.41)	10 (1.54)		
	All other households	324 (5.50)	2,37 (4.53)	87 (13.38)		
Number of adults in household	One	1946 (33.06)	1,711 (32.68)	235 (36.15)	5.27	0.153
	Two	3200 (54.37)	2,874 (54.89)	326 (50.15)		
	Three	534 (9.07)	469 (8.96)	65 (10.0)		
	Four or more	206 (3.50)	182 (3.48)	24 (3.69)		

Number of children in household (0–17years)	None	3992 (67.82)	3,660 (69.9)	332 (51.08)	147.7	0.000
	One	730 (12.40)	626 (11.96)	104 (16.0)		
	Two	743 (12.62)	634 (12.11)	109 (16.77)		
	Three	290 (4.93)	230 (4.39)	60 (9.23)		
	Four or more	131 (2.23)	86 (1.64)	45 (6.92)		
Sleep duration categories	< 7hrs (short sleep)	986 (16.75)	885 (16.9)	101 (15.54)	69.84	0.000
	7-9 hrs	3817 (64.85)	3,465 (66.18)	352 (54.15)		
	> 9 hours (long sleep)	1083 (18.40)	886 (16.92)	197 (30.31)		
Body Mass Index (BMI) Categories	Normal range BMI 18 to <25	2023 (34.37)	1,853 (35.39)	170 (26.15)	21.87	0.000
	Overweight/Obese BMI ≥ 25	3863 (65.63)	3,383 (64.61)	480 (73.85)		
Vegetable & fruit consumption	Met recommended guidelines	319 (5.42)	287 (5.48)	32 (4.92)	0.35	0.553
	Did not meet recommended guidelines	5567 (94.58)	4,949 (94.52)	618 (95.08)		
physical activity last week at least 150 minutes	Met recommended guidelines	2941 (49.97)	2,654 (50.69)	287 (44.15)	9.96	0.007

	Did not meet recommended guidelines	2908 (49.41)	2,549 (48.68)	359 (55.23)		
	Not known	37 (0.63)	33 (0.63)	4 (0.62)		
Smoking status	current daily	1127 (19.15)	855 (16.33)	272 (41.85)	255.46	0.000
	current weekly	76 (1.29)	66 (1.26)	10 (1.54)		
	current less than weekly	30 (0.51)	27 (0.005)	3 (0.005)		
	Ex-smoker	1971 (33.49)	1,783 (34.05)	188 (28.92)		
	Never smoked	2682 (45.57)	2,505 (47.84)	177 (27.23)		
Continuous variables		Mean (SD)	Mean (SD)	Mean (SD)	t-test value ^b	P value
BMI		28.76 (6.24)	27.56 (5.5)	29.96 (6.97)	10.16	< .0001
Age (years)		45.82 (15.8)	49.1 (16.15)	42.55 (15.45)	9.79	< .0001
Sleep duration (minutes)		492.345 (90.05)	479.87 (82.67)	504.82 (97.43)	7.11	< .0001

a χ^2 tested differences between non-Indigenous and Indigenous groups

b t-tests compared means between non-Indigenous and Indigenous samples

Participants were divided into two sub-groups for further analysis – Indigenous and non-Indigenous. The Indigenous group was significantly younger than the non-Indigenous group (42.6 (15.5) vs 49.1 (16.2) years of age) and was comprised of a significantly greater proportion of female participants. The Indigenous cohort was also significantly more likely to live in areas of greater socioeconomic disadvantage (40.5% vs 75.4% in Quintile 1 and 2); experience lower household income (40.1% vs 68.0% in Quintile 1 and 2); as well as higher unemployment (8.9% vs 2.3%) and higher rates of non-participation in the paid workforce (47.2% vs 34.8%) than the non-Indigenous cohort. Non-participation in the paid workforce included those who were engaged in unpaid household duties; retirees; students; and those experiencing long term infirmity (Australian Bureau of Statistics, 2018).

The proportion of household participants living as part of a couple with children was similar for both Indigenous and non-Indigenous people, however, greater proportions of Indigenous people lived in single parent families with children (18.6% vs 8.1%) and either extended family or non-related, group-share, households than non-Indigenous people (13.4% vs 4.5%). Indigenous households were more likely than non-Indigenous households to have three or more children.

The proportions of Indigenous and non-Indigenous participants who met the recommended fruit and vegetable consumption guidelines each week were similar; however, a significantly greater proportion of Indigenous compared with non-Indigenous people did not meet the recommended 150 min of weekly physical activity (55.2% vs 48.7%), were current daily smokers (41.8% vs 16.3%) and were less likely to have never smoked (27.2% vs 47.8%).

The mean sleep duration for the Indigenous group was 504.82 (97.43) minutes (range 7.72 – 10.03 hours), significantly longer than the mean sleep duration of the non-Indigenous group (479.88 (82.67) minutes (range 6 .60 - 9.34 hours)). Further examination revealed that similar

proportions of participants in both groups experienced short sleep duration each night (non-Indigenous 16.9%, Indigenous 15.4%), while a significantly higher proportion of Indigenous people reported long sleep duration each night (30.3 % vs 16.9 %). Compared to the non-Indigenous group, the Indigenous group also had a significantly higher mean BMI (30(7) vs 27.6(5.5)).

Predictors of Sleep and BMI

Table 2 shows the predictors of sleep for the whole sample. Model 1 (adjusted- $R^2 = 0.046$, $p < 0.0001$) included lifestyle factors (diet, physical activity, smoking status) and sociodemographic factors (age, sex, employment status, household type, income, and SEIFA) but excluded Indigenous status. Model 2 was the same as Model 1 but with the inclusion of Indigenous status as a covariate. Both models showed similar trends: four variables significantly predicted shorter sleep duration - increased BMI, advancing age, lower household incomes, and having four or more children in the household. Longer sleep duration was significantly predicted by female sex, unemployment, and non-engagement in the workforce, and less than recommended weekly physical activity. The addition of Indigenous status in Model 2 slightly weakened the relationship between sleep duration and most covariates; the exceptions were BMI, number of children in household and lack of minimum recommended weekly physical activity, where the relationship slightly increased. Overall, accounting for Indigenous status slightly strengthened the inverse relationship between sleep duration and BMI. Model 2 also showed that Indigenous status was a significant predictor of longer sleep duration ($\beta = 18.54$, $p < 0.0001$).

Table 2: Predictors of sleep duration

WHOLE SAMPLE	Model 1: Predictors of Sleep duration in whole sample not accounting for Indigenous status				Model 2: Predictors of Sleep duration in whole sample accounting for Indigenous status			
Dependent Variable = SLEEP	F (26, 5859) = 11.81 p<0.0001 Adjusted R-squared = 0.046				F (27, 5858) = 12.32 p<0.0001 Adjusted R-squared = 0.049			
	Coeff.	p	[95% Conf. Interval]		Coeff.	p	[95% Conf. Interval]	
Indigenous status	NA				18.54	0.00	11.19	25.89
Age	-0.74	0.00	-0.91	-0.57	-0.68	0.00	-0.86	-0.51
BMI	-0.81	0.00	-1.19	-0.43	-0.93	0.00	-1.31	-0.55
Sex								
Female	12.82	0.00	8.37	17.27	12.59	0.00	8.14	17.03
Male	Reference				Reference			
Employment Status								
Employed	Reference				Reference			
Unemployed	22.82	0.00	9.85	35.79	20.29	0.00	7.31	33.27
Not in Labour force	22.43	0.00	16.54	28.32	21.36	0.00	15.46	27.25
Socioeconomic status of locality	-0.27	0.75	-1.93	1.39	0.35	0.68	-1.32	2.03
Household type								
Person living alone	Reference				Reference			
Couple only	-1.12	0.89	-17.65	15.41	-0.48	0.95	-16.99	16.02
Couple family with children	-10.17	0.38	-33.08	12.75	-8.36	0.47	-31.24	14.52

One parent family with children	-7.11	0.33	-21.38	7.15	-6.87	0.34	-21.11	7.36
Unrelated persons aged 15+ only	-10.97	0.33	-33.04	11.11	-9.62	0.39	-31.66	12.42
All other households	1.23	0.92	-22.15	24.60	0.40	0.97	-22.93	23.73
Equivalised income of household	-4.85	0.00	-6.82	-2.87	-4.56	0.00	-6.54	-2.59
Number of adults in household								
One	Reference				Reference			
Two	10.73	0.18	-4.83	26.28	9.87	0.21	-5.66	25.39
Three	11.11	0.27	-8.63	30.85	9.84	0.33	-9.86	29.55
Four or more	21.74	0.06	-0.45	43.93	20.98	0.06	-1.17	43.13
Number of children 0-17 yrs in household								
None	Reference				Reference			
One	3.06	0.59	-8.21	14.33	1.94	0.74	-9.32	13.20
Two	-8.22	0.18	-20.13	3.68	-9.67	0.11	-21.56	2.22
Three	-12.33	0.09	-26.58	1.92	-14.27	0.05	-28.51	-0.02
Four or more	-20.82	0.02	-38.70	-2.93	-24.33	0.01	-42.24	-6.43
Fruit and vegetable intake								
Met recommended dietary guidelines	Reference				Reference			
Did not meet recommended dietary guidelines	-1.09	0.82	-10.51	8.32	-0.94	0.85	-10.34	8.46
Physical activity								
Met recommended guidelines	Reference				Reference			
Did not meet recommended guidelines	6.29	0.01	1.90	10.69	6.35	0.01	1.96	10.73
Not known	-8.63	0.53	-35.60	18.35	-7.80	0.57	-34.72	19.12

Smoking Status									
Current daily (Reference)	Reference					Reference			
Current weekly	2.26	0.82	-17.04	21.56	4.37	0.66	-14.92	23.65	
Current less than weekly	11.72	0.45	-18.41	41.85	13.45	0.38	-16.63	43.52	
Ex-smoker	3.68	0.26	-2.68	10.03	5.30	0.10	-1.07	11.68	
Never smoked	4.48	0.15	-1.55	10.51	6.64	0.03	0.56	12.71	

Table 3 examines the predictors of BMI for the whole sample with and without the addition of sleep duration as a covariate. Model 3 (adjusted- $R^2 = 0.048$, $p < 0.0001$) did not account for sleep duration and indicated that significant predictors of BMI were: age, non-engagement with the workforce, socioeconomic disadvantage of the household locality, household income, miscellaneous household types (other than nuclear families and unrelated housemates), lack of minimum recommended weekly physical activity, and ex- or non-smoker status. When sleep duration was accounted for in Model 4 (adjusted- $R^2 = 0.056$, $p < 0.0001$), short sleep was the strongest predictor of increased BMI where a decrease in sleep duration of 1 hr less than the recommended 7 hr predicted a rise in BMI by 1 unit. Long sleep, on the other hand, was not a significant predictor of BMI. Age remained a significant predictor of BMI in Model 4, as was households of three children, lack of physical activity and ex-smoker status. Socioeconomic disadvantage of the household locality remained a significant predictor, however household income was no longer a significant predictor of BMI, nor was non-engagement with the workforce. When sleep was accounted for, compared with males, females were at significantly less risk of being overweight. Further sub-analysis showed that the predictors of BMI remained the same for the non-Indigenous group as for the whole sample, however age was the only significant predictor of BMI in the Indigenous group, where BMI increased with increased age.

Table 3: Predictors of BMI

WHOLE SAMPLE	MODEL 3: Predictors of BMI <u>not accounting for</u> sleep duration F(26, 9366) = 19.3 p<0.0001 Adjusted R-squared = 0.048				MODEL 4: predictors of BMI <u>accounting for</u> sleep duration F(26, 5859) = 14.48 p<0.0001 Adjusted R-squared = 0.056			
Dependent Variable = BMI								
	Coeff.	p	[95% Conf. Interval]		Coeff.	p	[95% Conf. Interval]	
Sleep category								
short sleep duration < 7 hours								
recommended sleep duration (7-9 hours)								
long sleep duration >9 hours								
Age	0.05	0.00	0.04	0.06	0.05	0.01	0.04	0.06
Sex								
Female	-0.06	0.62	-0.31	0.18	-0.45	0.01	-0.73	-0.13
Male	reference				reference			
Employment Status								
Employed	reference				reference			
Unemployed	0.30	0.39	-0.38	0.98	0.67	0.13	-0.21	1.54
Not in Labour force	-0.40	0.02	-0.73	-0.08	-0.11	0.58	-0.51	0.28
Socioeconomic status of locality	-0.45	0.00	-0.55	-0.36	-0.48	0.00	-0.59	-0.37
Household type								
Person living alone	reference				reference			
Couple only	0.73	0.08	-0.10	1.57	0.51	0.37	-0.60	1.62
Couple family with children	1.08	0.06	-0.03	2.19	0.72	0.36	-0.82	2.26

One parent family with children	0.55	0.14	-0.18	1.27	0.31	0.52	-0.64	1.27
Unrelated persons aged 15+ only	0.07	0.91	-1.07	1.21	-0.37	0.63	-1.85	1.11
All other households	1.36	0.02	0.23	2.48	1.69	0.04	0.12	3.26
Equivalised income of household	0.13	0.02	0.02	0.24	0.11	0.09	-0.02	0.25
Number of adults in household								
One	reference				reference			
Two	-0.64	0.10	-1.40	0.12	-0.34	0.53	-1.38	0.71
Three	-0.89	0.06	-1.83	0.05	-0.50	0.46	-1.83	0.82
Four or more	-0.57	0.27	-1.58	0.44	-0.26	0.73	-1.75	1.23
Number of children 0-17 yrs in household								
None	reference				reference			
One	0.25	0.40	-0.34	0.83	0.20	0.60	-0.55	0.96
Two	-0.12	0.69	-0.72	0.48	0.20	0.63	-0.60	1.00
Three	0.47	0.20	-0.24	1.19	1.26	0.01	0.31	2.22
Four or more	0.25	0.55	-0.55	1.05	0.67	0.27	-0.53	1.87
Fruit and vegetable intake								
Met recommended dietary guidelines	reference				reference			
Did not meet recommended dietary guidelines	0.18	0.52	-0.36	0.71	0.21	0.51	-0.42	0.85
Physical activity								
Met recommended guidelines	-1.76	0.00	-2.20	-1.33	reference			
Did not meet recommended guidelines	-0.59	0.01	-1.02	-0.17	1.10	0.00	0.80	1.39
Not known	-2.12	0.01	-3.73	-0.52	0.04	0.97	-1.77	1.85
Smoking Status								
Current daily (reference)	reference				reference			

Current weekly	0.37	0.49	-0.67	1.41	0.33	0.62	-0.97	1.62
Current less than weekly	1.07	0.19	-0.55	2.68	0.29	0.78	-1.73	2.31
Ex-smoker	1.53	0.00	1.18	1.87	1.25	0.00	0.83	1.68
Never smoked	0.57	0.00	0.25	0.90	0.31	0.14	-0.10	0.71

Table 4 examines predictors of BMI controlling for Indigenous status. Model 5 (adjusted- $R^2 = 0.062$, $p < 0.0001$), did not account for sleep duration. Model 6 (adjusted- $R^2 = 0.073$, $p < 0.0001$) was the same as Model 5 but included sleep duration as a covariate. Model 5 indicated that Indigenous status was a significant predictor of BMI, with the Indigenous group being 2.61 BMI units higher than the non-Indigenous group. In Model 6 when sleep duration was controlled for in the analysis, Indigenous status remained a significant predictor of BMI. Interestingly, the inclusion of sleep duration improved the model fit (adjusted- $R^2 = 0.073$, $p < 0.0001$) but the relationship between Indigenous status and BMI remained significant with a slight decrease in the magnitude of the effect ($\beta = 2.61$ vs $\beta = 2.48$). A positive Sobel test ($p < 0.002$) indicated that sleep mediated the relationship between Indigenous status and BMI.

Table 4: Predictors of BMI accounting for Indigenous status

WHOLE SAMPLE	MODEL 5: Predictors of BMI not accounting for sleep duration				MODEL 6: predictors of BMI accounting for sleep duration			
Dependent Variable = BMI	F(27, 9365) = 24.16 p<0.0001 Adjusted R-squared = 0.062				F(28, 5857) = 17.53 p<0.0001 Adjusted R-squared = 0.073			
	Coeff.	p	[95% Conf. Interval]		Coeff.	p	[95% Conf. Interval]	
Sleep category								
short sleep duration < 7 hours								
recommended sleep duration (7-9 hours)								
long sleep duration >9 hours								
Indigenous status	2.61	0.00	2.18	3.04	2.48	0.00	2.00	2.97
non-Indigenous	reference				reference			
Age	0.06	0.00	0.05	0.07	0.06	0.00	0.05	0.07
Sex				-				
Female	-0.09	0.47	-0.34	0.15	-0.45	0.00	-0.75	-0.15
Male	reference				reference			
Employment Status								
Employed	reference			-	reference			
Unemployed	0.01	0.98	-0.67	0.68	0.33	0.46	-0.54	1.20
Not in Labour force	-0.50	0.00	-0.82	-0.17	-0.24	0.23	-0.64	0.15
Socioeconomic status of locality	-0.36	0.00	-0.45	-0.26	-0.39	0.00	-0.50	-0.28
Household type								
Person living alone	reference				reference			

Couple only	0.69	0.10	-0.13	1.52	0.59	0.30	-0.51	1.69
Couple family with children	1.07	0.06	-0.04	2.17	0.95	0.22	-0.58	2.47
One parent family with children	0.48	0.19	-0.24	1.20	0.34	0.48	-0.61	1.29
Unrelated persons aged 15+ only	0.06	0.92	-1.07	1.19	-0.19	0.80	-1.66	1.28
All other households	1.14	0.05	0.02	2.25	1.55	0.05	-0.01	3.10
Equivalised income of household	0.17	0.00	0.06	0.28	0.15	0.03	0.02	0.28
Number of adults in household								
One	reference				reference			
Two	-0.62	0.11	-1.38	0.14	-0.44	0.40	-1.48	0.59
Three	-0.87	0.07	-1.80	0.05	-0.66	0.33	-1.97	0.66
Four or more	-0.47	0.36	-1.47	0.53	-0.35	0.64	-1.83	1.13
Number of children 0-17 yrs in household								
None	reference				reference			
One	0.19	0.51	-0.39	0.77	0.05	0.90	-0.70	0.80
Two	-0.19	0.53	-0.79	0.40	0.00	0.99	-0.80	0.79
Three	0.33	0.36	-0.38	1.04	0.98	0.04	0.03	1.93
Four or more	-0.02	0.97	-0.81	0.78	0.18	0.76	-1.01	1.38
Fruit and vegetable intake								
Met recommended dietary guidelines	reference				reference			
Did not meet recommended dietary guidelines	0.18	0.52	-0.36	0.71	0.23	0.47	-0.40	0.86
Physical activity								
Met recommended guidelines	0.18	0.51	-0.36	0.72	reference			
Did not meet recommended guidelines	1.33	0.00	0.81	1.86	1.09	0.00	0.80	1.38

Not known	-0.07	0.94	-1.70	1.57	0.15	0.87	-1.65	1.94
Smoking Status								
Current daily (reference)	reference				reference			
Current weekly	0.53	0.31	-0.50	1.57	0.61	0.36	-0.68	1.89
Current less than weekly	1.27	0.12	-0.33	2.88	0.52	0.61	-1.49	2.53
Ex-smoker	1.68	0.00	1.34	2.03	1.45	0.00	1.02	1.87
Never smoked	0.81	0.00	0.49	1.14	0.59	0.00	0.19	1.00

In Model 5, non-engagement with the labour force significantly predicted BMI; however, when sleep duration was accounted for in Model 6, employment status was no longer predictive of BMI. In Model 5, sex was not a significant predictor of BMI, but when sleep was accounted for in Model 6, female sex predicted a significantly lower BMI than male sex. Model 6 also showed that short sleep duration but not long sleep, was significantly associated with increased BMI ($\beta = 0.97, p < 0.0001$). Both models indicated that advancing age; socioeconomic disadvantage of household locality; household income; failure to meet the recommended weekly minimum 150 min of physical activity; and ex- or non-smoker status all independently predicted BMI.

DISCUSSION

Previous reports of the sleeping habits of Australian adults have generally agreed that both short and long sleep duration (<7 h or >9 h) are suboptimal and unhealthy (Bartlett, Iwasaki, Gottlieb, Hall, & Mannell, 2007; Macniven et al., 2016; C. A. Magee et al., 2009). A recent meta-analysis reported a significant association between obesity and shorter than optimal sleep duration though long sleep did not appear to significantly influence BMI (Wu et al., 2014).

Overweight/obesity has a well-established relationship with chronic illness and poor health outcomes related to cardiovascular, metabolic, and renal diseases (Grundy, 2004), as well as numerous cancers (Lauby-Secretan et al., 2016), musculoskeletal disorders, and other diseases (GBD Obesity Collaborators, 2017). The possible influence of sleep duration on the established relationship between overweight/obesity and chronic illness is an important consideration for Indigenous Australians given the prevalence of overweight/ obesity (Australian Institute of Health and Welfare, 2018b) and the disparately high incidence of chronic illnesses experienced by this population (Keast & Dragon, 2015).

The current study showed that the mean sleep duration for Indigenous Australians was significantly longer than that for non-Indigenous people. This finding echoes that of a previous

studies of African Americans(Hale & Do, 2007), however extremes of sleep duration have been reported for various groups (Kingsbury, Buxton, & Emmons, 2013). The current study also found that proportionally more Indigenous people experienced longer sleep than non-Indigenous people.

Consistent with previous reports (Wu et al., 2014), and as we have previously described (Melissa Deacon-Crouch et al., 2020), increased BMI was independently associated with short sleep duration of less than 7 hours, but not with long sleep of greater than 9 hours. Notably, after accounting for possible confounding influences, Indigenous status was a significant predictor of BMI. Without considering the effects of sleep duration, Indigenous people were likely to be more than 2.5 BMI units higher than non-Indigenous people. This finding concurs with a recent review that showed obesity rates were significantly higher in Indigenous compared with non-Indigenous people in Australia, Canada, New Zealand, Norway, and the USA(Ian Anderson et al., 2016). When sleep duration was accounted for, the relationship between Indigenous status and BMI remained significant, with a slight attenuation of the strength of the relationship. A positive Sobel test confirmed the partial mediating role of sleep in the relationship between Indigenous status and BMI. However, the very small drop in β coefficient indicated that the mediator effect was weak but statistically significant. Therefore, it seems that socioeconomics, lifestyle, and sleep do not account for the differences in BMI seen between Indigenous and non-Indigenous participants.

A recent Australian Institute of Health and Welfare (AIHW) report (Australian Institute of Health and Welfare, 2018a) identified the three main areas of concern related to the health disparities experienced by Indigenous Australians as (i) social determinants; (ii) health risk factors; and (iii) access to appropriate health services. Social determinants were determined to account for approximately 34% of the health inequity. While access to health services is not addressed by the present study, Indigenous participants in this study exhibit the characteristics of concern(Australian Institute of Health and Welfare, 2018a) and echo the findings of another recent

Australian study (Katherine Ann Thurber et al., 2018), including lower levels of employment and income and higher rates of smoking with lower rates of physical activity present for this sample.

Relevant to the AIHW report findings, the Indigenous participants in this study tended to sleep longer, experience lower socioeconomic status and greater rates of obesity than non-Indigenous people. In addition, while short sleep duration was an independent predictor of increased BMI, it was also significantly associated with low household income and having 4 or more children in the household. Long sleep duration was significantly predicted by female sex, unemployment, and non-engagement in the workforce. However, the relationship between these social determinants and BMI were only significant in the non-Indigenous participants. Age was the only significant predictor of BMI, within the Indigenous sample. This suggests that there are different drivers of BMI in Indigenous participants, and points to structural differences within these contexts. That is, Australia's policies for Indigenous adults differ from non-Indigenous adults in systemic ways that affect all parts of Indigenous life. Indigenous Australians experience significant socioeconomic inequality and interpersonal, institutional, and systemic racism (Durey & Thompson, 2012). This is important because Australia exhibits one of world's highest levels of societal financial inequality and greatest social gradients (Wilkinson & Pickett, 2017), while concomitantly exhibiting elevated incidence of stress related conditions, more prevalent in people in the lower SES range (Cohen, Doyle, & Baum, 2006; Tomiyama, 2019). Indigenous Australians are over-represented in the lower SES groups of Australian society (Australian Institute of Health and Welfare, 2018b) and experience social insecurity, social immobility and psychological stress due to feeling disrespected, unvalued and subordinated (Cohen et al., 2006; Durey & Thompson, 2012; Paradies, 2016). This inequality renders Indigenous Australians strongly predisposed to stress related conditions (Australian Institute of Health and Welfare, 2017). Stress increases physiological inflammation, and is strongly implicated as a contributor to the development of obesity and many of the associated cardio-metabolic co-morbidities experience by Indigenous Australians (Tomiyama, 2019).

Limitations and Strengths

The results of this study must be viewed in the light of several limitations. First, the use of cross-sectional data precludes the determination of causality. While statistically significant relationships were found, we cannot conclude cause and effect. In addition, statistically significant results do not always translate to clinical significance (Ranganathan, Pramesh, & Buyse, 2015). Second, self-reported data is a potential limitation due to the possibility of response bias (Rosenman, Tennekoon, & Hill, 2011). Self-reported responses may offer under, or over, estimations of participants' experiences due to poor inaccurate recall, misunderstanding or desire for social approval. Self-reports of fruit and vegetable intake are often prone to social approval bias (Miller, Abdel-Maksoud, Crane, Marcus, & Byers, 2008). Similarly, self-reported measures of physical activity may also be subject to bias. A recent study reporting international compliance with physical activity guidelines showed marked differences between subjectively self-reported and objectively measured physical activity (Steene-Johannessen et al., 2016). In addition, self-reported sleep duration, although widely used may not be a reliable measure because although participants may know when they went to rest with the intention of going to sleep, they can only estimate the actual time that sleep occurred. Although not available for this study, non-invasive actigraphy is a widely used, validated tool, that offers a more objective measurement of sleep duration, despite the tendency to over-estimate sleep duration when stillness is reported as sleep (Martin & Hakim, 2011). Additionally, it is important to recall that self-reported sleep duration is only one aspect of the sleep picture. There are other factors related to both sleep duration and sleep quality such as sleep disturbances, comorbidities, pain, sleep apnoea, medication use, alcohol consumption, and mental health that were not examined (R. J. Adams et al., 2017).

The omission of data regarding the intake of alcohol and other substances that impact the quality and duration of sleep is another limitation of this study. It would have been useful to have included alcohol as well as prescription and non-prescription medications, and substances

such as recreational or illicit drugs that act as sedatives, stimulants and psychotropics. However, such data was not available and was outside the scope of this study. It is worth noting that recent reports show that Indigenous Australians are more likely to abstain from alcohol than non-Indigenous Australians and are only slightly more likely to exceed the National Health and Medical Research Centre (NHMRC) lifetime risk guidelines for drinking than non-Indigenous people (Australian Institute of Health and Welfare, 2021a).

Another consideration is that although the data was collected in a robust manner through the Australian Bureau of Statistics, the small ratio of Indigenous to non-Indigenous participants in this sample limits how representative the results are in the Australian structural context. Additionally, the lack of significant predictors within the Indigenous sample could be a function of lower sample size and reduced variability in the social determinants.

It is also important to note that Australian Indigenous people have different fat distributions than non-Indigenous people with a greater propensity for abdominal adiposity and leaner limbs (Kondalsamy-Chennakesavan et al., 2008; Piers et al., 2003). Some authors suggest that BMI measures for Indigenous people may underestimate central abdominal obesity and hence, underestimate their risk for metabolic syndrome and chronic illness. Waist circumference and waist to hip ratio are commonly used as determinants of healthy weight because they are more precise measures of central obesity than BMI and better indicators of potential risk for the development of chronic metabolic and cardiovascular diseases (Li & McDermott, 2010). In this analysis, BMI was used because it is more commonly reported in the literature and because it was highly correlated with waist measurement ($r = 0.9$, $p < 0.01$ (2-tailed)).

The ABS NATSINPAS data were collected by Indigenous Research Officers in collaboration with Indigenous organisations and stakeholders in accordance with the ethical guidelines released by

the NHMRC for research with Indigenous peoples (National Health and Medical Research Council, 2003b). However, these guidelines also advise that Indigenous peoples' voices are critical to all stages of the research process and the capacity building of Indigenous researchers. Notably, it is a limitation of this paper that the data analysis and report writing lacked participation by Indigenous peoples (Came, Gifford, & Wilson, 2019).

Despite the limitations of the study, the strength of this study is that it reports one of the largest data samples of Indigenous and non-Indigenous people regarding sleep, BMI, and other socioeconomic and lifestyle factors, to date.

Conclusion

This study found that increased BMI was independently associated with short sleep duration of less than 7 hours, but not with long sleep of greater than 9 hours. The study also showed that the mean sleep duration for Indigenous Australians was longer than that for non-Indigenous people and that Indigenous status was independently associated with increased BMI.

Previously we reported that sleep duration played a mediator role in the relationship between Indigenous status and BMI for Australian Indigenous children (M. Deacon-Crouch et al., 2019). This study has replicated that finding for Indigenous Australian adults, whereby sleep played a weak, partial mediator role between Indigenous status and obesity. The study also indicated that socioeconomic, lifestyle, and sleep do not account for the differences in BMI seen between Indigenous and non-Indigenous participants. Future research in this area must focus on the drivers of BMI for Indigenous people in the context of their daily lives, and not as a standardised subgroup of the greater population. However, most importantly, to find meaningful ways to *Close the Gap* (Australian Government Department of Health, 2009) in health inequities for Indigenous Australians, researchers, governments, and policy makers must heed the *Uluru Statement from the Heart* (First Nations National Constitutional Convention, 2017) so that Indigenous voices are heard and Australian laws and policies reflect the landmark declaration of Aboriginal and Torres

Strait Islander self-determination as the key to addressing existing disempowerment and the ongoing impact of colonisation.

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Conclusion

My study of Indigenous and non-Indigenous Australian adults found that increased BMI was independently associated with short sleep duration of less than 7 hours, but not with long sleep of greater than 9 hours. This result for long sleep contrasts with that of a recent systematic review, meta-analysis and meta-regression where long sleep duration of greater than 9 hours was reported to be associated with a significant increase in risk for mortality and for diabetes, cardiovascular disease, stroke, coronary heart disease, and obesity (Jike et al., 2018).

My study also showed that this sample of Indigenous Australian adults tended to sleep longer than their non-Indigenous counterparts. However, notwithstanding the lack of association between long sleep and BMI, Indigenous status was independently associated with increased BMI. Additionally, similar to our previous report for Indigenous school aged children, sleep duration was found to play a partial mediator role between Indigeneity and obesity for Indigenous Australian adults.

Further elucidation of the mediator role of sleep in the relationship between Indigeneity and BMI is a subject for future research, however my study indicated that isolated social determinants of health did not have a significant impact for Indigenous people when compared with non-Indigenous people. However, it is important to note that the Indigenous Australian participants' living context may be very different to that of the non-Indigenous participants (Shepherd et al., 2012). Hence there are likely to be other drivers of Indigenous health and wellbeing that are entrenched in the daily experience of Indigenous people and the systemic difficulties they face in a post-colonial 'white' Australian culture and the inherently racist dominant, Westernised biomedical model (Durey & Thompson, 2012).

Chapter 9: Conclusion

Introduction

This thesis has identified that Indigenous Australians have disparity in health outcomes compared to non-Indigenous Australians with concomitant higher prevalence of obesity. The overarching aim of this study was to investigate possible causes of the gap in life expectancy and health outcomes for Indigenous Australians. Table 3 presents a summary of findings from the analyses and conclusions.

This study used a pragmatic, mixed methods, mixed paradigm methodology (Indigenous worldview informed the Naturalistic Qualitative enquiry & Positivist statistical analyses). These methods enabled investigation of the concepts from a broad to a narrower focus. All primary data were collected by Indigenous researchers and collaborators in line with National Health and Medical Research Council (NHMRC) and Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) guidelines and the Indigenous Worldview paradigm that informed this study.

Table 3: Summary of findings based on the research aims.

To investigate the perceptions of a group of Victorian Aboriginal people taking medications for diagnosed chronic illnesses regarding their lifestyle, disease management and medication usage in order to identify factors that may contribute to the disparity in life and health expectancies for Indigenous people. This aim was addressed in chapter 3.	The paper published and presented in Chapter 3 highlighted the importance of ongoing patient counselling and education about medicines. There was a perception by the majority of participants in this study that most people would develop a chronic illness and require regular medications by the age of 40 years. It was also perceived that children and babies could also require medications. These perceptions are concerning as they generally reflect the incidence of chronic illnesses in Indigenous people across Australia. Participants stated that they regularly took a variety of OTC products in addition to their prescribed medications. Whilst this study did not examine the actual diarised medication use, there was no evidence that Indigenous people were unaware of the requirements of their medical plans. In fact, the majority of participants stated that they would report the use of any non-prescribed medication, supplement or complementary medicine to their prescribing doctor.
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	Indigenous patients in this study conducted with an Aboriginal Community Controlled Health Service, valued the interpersonal relationships between themselves and health practitioners and they highlighted novel issues of obesity, overweight and lack of sleep as potential contributing factors impacting their wellbeing.
To investigate whether sleep contributes to health outcomes in Indigenous children and adults, specifically, whether there was any association between sleep duration and BMI. This was addressed in chapter 5 & 7.	In contrast with previous reports, the paper published and presented in Chapter 5 relating to children showed that irrespective of age, relative socio-economic disadvantage and level of remoteness, for Indigenous children, unhealthy weight was associated with shorter sleep duration than for those of healthy weight, even though most children's sleep duration was within the recommended guidelines. The paper published and presented in Chapter 7 relating to adults, found a statistically significant inverse relationship between sleep duration and BMI for non-Indigenous Australians and an inverse trend between sleep duration and BMI for Indigenous Australians, rather than the previously reported U-shaped relationship. In this study, BMI appears to be partially explained by current sleep duration in non-Indigenous adults, but this pattern is less well defined in Indigenous adults. In this sample, there was a strong correlation between waist measurement and BMI ($r = 0.9$, $n = 16,262$ $p < 0.01$).
To examine the effect of sleep duration on the relationship between Indigeneity and BMI for Australian school aged children and adults. This was addressed in chapters 6 & 8.	The paper published and presented in Chapter 6 regarding a nationally representative sample of school aged Indigenous children, showed that sleep duration and Indigenous status were independent predictors of BMI. However, when both predictors were considered together, only sleep duration remained predictive of BMI. Sleep duration was found to have a partial mediating role in the relationship between Indigenous status and BMI. Given what is already known about the relationship between short sleep and higher BMI, this analysis suggested that Australian Indigenous children have a higher

	BMI than non-Indigenous children because they sleep less than non-Indigenous children. The paper presented in Chapter 8 regarding adults reported that increased BMI was independently associated with short sleep duration of less than 7 hours, but not with long sleep of greater than 9 hours. The study also showed that the mean sleep duration for Indigenous Australian adults was longer than that for their non-Indigenous counterparts and that Indigenous status was independently associated with increased BMI. The study of adults replicated the previous findings for Indigenous Australian children, in that sleep played a weak, partial mediator role between Indigeneity and obesity. The study also indicated that socioeconomics, lifestyle, and sleep do not account for the differences in BMI seen between Indigenous and non-Indigenous participants.
To identify the factors that impact the relationship between Indigenous status and BMI. This was also addressed in chapters 6 & 8.	The paper published and presented in Chapter 6 regarding children, explored the cascade model of paediatric obesity which identified that despite a small effect size, short sleep duration is a key factor in the development of obesity in school-aged children. The cascade model explains the cumulative consequences and downstream effects of the complex multifactorial risk and protective factors for childhood obesity by asserting that while no single risk or protective factor has a large effect, early and cumulative influence snowballs to a greater effect over time. Childhood is a critical period when inequities in health determinants such as social and economic factors begin their impact. The paper presented in Chapter 8 regarding adults, reported that short sleep duration was an independent predictor of increased BMI, and it was also significantly associated with low household income and having four or more children in the household. Long sleep duration was significantly predicted by female gender, unemployment, and non-engagement in the workforce. However, the relationship between these social

	determinants and BMI were only significant in the non-Indigenous participants. Age was the only significant predictor of BMI, within the Indigenous sample. This suggests that there are different drivers of BMI in Indigenous participants, and points to structural differences within these contexts. That is, Australia's policies for Indigenous adults differ from non-Indigenous adults in systemic ways that affect all aspects of Indigenous life. Indigenous Australians experience significant socioeconomic inequality and interpersonal, institutional, and systemic racism. This is important because Australia exhibits one of world's highest levels of societal financial inequality and greatest social gradients, while concomitantly exhibiting elevated incidence of stress related conditions, more prevalent in people in the lower SES range. Indigenous Australians are over-represented in the lower SES groups of Australian society and experience social insecurity, social immobility and psychological stress due to feeling disrespected, unvalued and subordinated.
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Limitations

Invariably, all research projects have limitations associated with their methods and findings.

Therefore, it is appropriate to discuss the limitations of this study before discussing the thesis' significance and contribution to knowledge, final recommendations and conclusion.

The results from the first study about chronic disease, medications and lifestyle, derived from the perceptions of a small number of Indigenous people attending one Aboriginal Health Service in a large regional area and may not be representative of other Aboriginal communities living in different contexts. Indigenous people are not one homogeneous group. Therefore, determinants of health and attitudes may differ amongst different Indigenous communities (Shepherd et al., 2012). Furthermore, the study's proposed 'yarning' process did not yield the expected rich qualitative data. The small sample size meant that statistical analysis was limited to descriptive statistics. Another potential limitation was related to the dual role of the interviewer /researcher who was also a healthcare provider employed by the Aboriginal Health Service. Aside from the possible power differential between healthcare professional/ patient and researcher /participant, the researcher was also a member of the community rather than an external,

“neutral” person. It is therefore possible that participants may have felt constrained in their responses and discussion during the interviews, despite the fact that the Indigenous Worldview paradigm supported the approach that was taken. Additionally, the recollection of participants about their medication use and health care was unable to be triangulated with their health and medical records.

Limitations associated with the secondary data analyses

The three studies reported in Chapters 6,7 and 8 all used data from the AHS (2011-2012) and the AATSIHS (2012-2013). Due to confidentiality issues, the survey data for participants living in remote and very remote communities was not released for analysis. Hence the results presented may not be representative of Indigenous people living in remote and very remote community contexts. The data reported in chapters 5,6,7 and 8 were the results of cross sectional analyses. This precludes the determination of causality and possible direction of causation.

Limitations of BMI as a measure

WHO (2000) recommended BMI ranges were used as a measure of weight status because it is the most commonly used measure of overweight /obesity. However, the BMI ranges may not be appropriate for Indigenous Australians who have been found to have different fat composition and distribution compared with non-Indigenous Australians, particularly those of European heritage. BMI may underestimate overweight /obesity for Indigenous Australians.

Limitations of sleep duration as a measure

(i) A common and generally accepted limitation is subjectively reported sleep duration as a sleep time measure. The measure relies on parental or self-recall in the absence of an objective measure such as actigraphy. In this case, sleep duration is calculated from the time the lights were first turned off with the intention of going to sleep until the last time a respondent woke up. Total sleep time may not accurately depict actual hours slept in situations where a long time was taken to fall asleep and/or the participant woke during the night. This would lead to a possible overestimation of sleep duration. However, it is unlikely that such biases affected the Indigenous and the non-Indigenous groups in these analyses differently.

(ii) Sleep is governed by a large number of neurophysiological processes in the brain and sleep quantity is only one dimension of sleep. There are numerous other factors that may impact the amount and quality of sleep an individual experiences that were not considered in this body of work. Such factors include, sleep efficiency, sleep latency, sleep disturbances and sleep timing.

Other important factors that may impact the amount and quality of sleep include comorbidities such as pain, obstructive sleep apnoea (OSA) and mental health issues as well as physical activity and the use of medications, alcohol and illicit drugs (Guglielmi et al., 2018; Ohayon et al., 2017). Particularly, alcohol and almost all classes of drugs (prescribed and illicit) have varying degrees of effect on sleep through interaction with neurotransmitters, hormones and other chemicals involved in the sleep process (Qureshi & Lee-Chiong, 2004).

Limitations of using cross sectional data

The use of cross-sectional data precludes the determination of causality and possible direction of causation. This is particularly relevant given that the association between sleep duration and obesity could be bi-directional; for example, overweight/obesity may result from prolonged short sleep duration, or it may be that overweight/obesity causes short sleep.

Limitations of the selected social determinants of health

This body of work focuses on a selection of social determinants of health where data were available. Other social determinants of health have also been shown to influence BMI that were not considered in this report. Such factors relate to early experiences of early family life, mother's BMI and mother's smoking habits, as well as living conditions including access to nutritious food, proximity to fast food outlets and availability of transport (Australian Institute of Health and Welfare, 2021c).

Contribution to knowledge and the significance of the research

This body of work has contributed to the understanding of sleep and its relationship with BMI, particularly in the Australian Indigenous population, where there has been scant research in this area.

- Indigenous children slept for the recommended duration however the average sleep duration was less than for non-Indigenous children and this had a significant impact on BMI.
- The cascade model of paediatric obesity seemed to apply to Indigenous children, whereby despite a small effect size, short sleep duration was a significant factor in the development of obesity in school-aged Indigenous children.
- Sleep duration was predictive of BMI for non-Indigenous adults, replicating the previously reported U-shaped distribution.
- The acknowledged U-shaped distribution curve for sleep duration and BMI did not apply for the adult Indigenous Australians in this sample.

- Both short sleep duration and Indigenous status were independent predictors of BMI in this sample of Australia children and adults.

Publications generated in this body of work, supported and contributed to the understanding of the relationship of sleep with BMI and the role of sleep in the relationship between Indigeneity and BMI. This body of work produced four published peer-reviewed publications, one peer-reviewed manuscript under revision and four conference presentations. This work was the first to specifically explore the relationship between sleep duration and BMI in the Australian Indigenous population, evidenced by subsequent citations. Each publication has been cited in reputable, peer reviewed journals by other international research groups. For example, the paper presented in chapter 7, *Is sleep duration associated with overweight/obesity in Indigenous Australian adults?* has been cited in the Annual Review of Nutrition, with an impact factor of 10.897.

Recommendations for public health and future research

1. Compared with non-Indigenous European Australians, Indigenous Australians have been shown to have a different body fat distribution characterised by greater abdominal fat with a concomitant lower BMI. Applying the standard normal range of 18-25 for Europeans as recommended by the WHO heightens the risk of undetected and untreated metabolic syndrome and chronic illness for Indigenous Australians. Hence the WHO (1997) have suggested that a BMI of 17-22 may be more appropriate for Indigenous Australians, rather than the standard recommended normal range of 18-25. Future research regarding obesity and chronic illness for Indigenous Australians should consider using the adjusted BMI scale along with waist measurements and waist: hip measurements to gain a more accurate picture of body fat distribution for Indigenous people in order to inform timely interventions to minimise the risk of chronic diseases such as heart disease and Type 2 diabetes.
2. Objective measures of sleep duration such as actigraphy may improve the precision of the measurement of sleep duration which is particularly important for children as parental reporting is problematic when sleep time increments are small.
3. While much is known about the link between short sleep and obesity, there has been little focus on the relationships between long sleep and obesity, and long sleep and disease. Future research in this area is needed to determine the pathways, mediators and moderators involved.

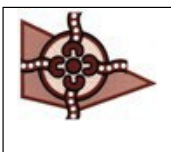
4. Future research is also required to understand how sleep may lead to epigenetic alterations in gene expression and disease development in order to minimise a potentially modifiable risk factor for chronic illnesses.
5. Sleep duration is only one part of the sleep picture and may not reflect the quality of sleep experienced. Other parameters that are known to significantly affect sleep and sleep quality such as sleep efficiency, sleep latency, sleep disturbances, sleep timing, pain, obstructive sleep apnoea, mental health issues, physical activity, and use of medications, alcohol and illicit drugs, should also be considered to elucidate the underlying mechanisms between sleep and obesity. Additionally, psychological factors such as stress and worry must also be considered in future research since it has been postulated that a lack of autonomy and self-determination is the base cause of sleep disparities experienced by Indigenous groups (Hale & Hale, 2010). Therefore, any future sleep research intended to inform recommendations for interventions to reduce undesirable health outcomes must consider not only sleep duration but also sleep quality and the important factors described above.
6. This study identified that SES is not a major contributor to BMI for Indigenous people, however future research requires greater examination of the effect size of SES on health for Indigenous Australians. The Indigenous Worldview paradigm informs us that the Indigenous view of health is very different to that of non-Indigenous people, which in Australia, is influenced by other macrosocial factors such as dispossession, exclusion and entrenched racism. Therefore, future research in this area must focus on the drivers of BMI for Indigenous people in the context of their daily lives, and not as a standardised subgroup of the greater Australian population.
7. Although most Indigenous people in Australia live in urban contexts, Indigenous people are more likely to live in rural and remote areas than non-Indigenous Australians. Consequently, within the Indigenous population, a gradient of access to health services and public health resources is likely to exist. Further research is needed to better understand whether there is a gradient effect, and if so, the magnitude of the effect among Indigenous communities to inform public health policy makers.

Concluding statement

The relationship between BMI and sleep that was previously understood for adults and children is different to that found in this research for Australian Indigenous adults and children. Future research in this area must focus on the drivers of BMI for Indigenous people in the context of their daily lives, and not as a standardised subgroup of the greater Australian population. However, most importantly, to find meaningful ways to Close the Gap (Australian Government Department of Health, 2009) in health inequities for Indigenous Australians, researchers, governments, and policy makers must heed the Uluru Statement from the Heart (First Nations National Constitutional Convention, 2017) so that Indigenous voices are heard and Australian laws and policies reflect the landmark declaration of Aboriginal and Torres Strait Islander self-determination.

Appendices

Appendix 1: Application for research support, participation or partnership with VACCHO and/or VACCHO members



APPLICATION: Request for VACCHO to support or participate in research

Date Received:

Date and outcome of recommendation:

Applicant notified:

Application for research support, participation or partnership with VACCHO and/or VACCHO members

This application form has been developed to facilitate engagement between the Victorian Aboriginal Community Controlled Health Organisation (VACCHO) and researchers who are wishing to work with VACCHO and/or VACCHO members. It is intended to provide guidance with the aims of ensuring that research is directed by the identified priorities and health needs of the Aboriginal community of Victoria, that there is appropriate engagement between researchers and the Aboriginal community allowing participation with informed consent, and that the process of conducting a research project is of benefit to all of those involved.

Please use this form if you wish to undertake research which will require the participation of VACCHO and VACCHO members. For more detailed guidance about engaging and conducting research with Aboriginal communities and their representative organisations, please see *“Values and Ethics - Guidelines for Ethical Conduct in Aboriginal and Torres Strait Islander Health Research”* (NHMRC, 2003), the companion guide for the Aboriginal community *“Keeping research on track: a guide for Aboriginal and Torres Strait Islander peoples about health research ethics”* (NHMRC, 2006), both available from <http://www.nhmrc.gov.au>, plus the “Advice to researchers” section on the VACCHO webpage at http://www.vaccho.org.au/resources/resources_advice.asp.

VACCHO appreciates involvement as early as possible in the process of developing of a research proposal. While this form is primarily aimed at review of requests for VACCHO to consider participation in research projects which have been substantially or fully developed, this form is able to be used at all stages of development, providing guidance alongside other documents for initial project planning. VACCHO has an internal Research Review Team as well as a larger Research Advisory Committee with external members to advise VACCHO on research issues. When reviewing requests for VACCHO and/or VACCHO members to partner or participate in research, we will consider in particular:

- 11 Does the research proposal address either the priorities identified by VACCHO members as representatives of the Victorian Aboriginal community or evidence-based Aboriginal health needs determined by current literature review?
- 12 Is the research question clearly stated?
- 13 Has advice been sought to guide development of the research proposal from VACCHO, VACCHO members or other Aboriginal community members or Aboriginal organisations?
- 14 Have appropriate and feasible methodologies been chosen to answer the research question?
 - Is the target group stated?
 - Has consideration been given to culturally appropriate methods and timelines for the project, including allocating time at the start of the project to engage with the Aboriginal community or other participants?

- 15 Have co-investigators (potential or confirmed) been identified?
 - 16 Has appropriate ethics approval been requested or granted?
 - 17 If requests are made for letters of support from VACCHO or VACCHO members for funding or ethics approval, have copies of the applications been provided?
 - 18 Have the resource implications for VACCHO or VACCHO members been addressed in the proposal, including provisions in the budget for personnel or infrastructure requirements?
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VACCHO - 5-7 Smith St, Fitzroy VIC 3065 - PO Box 132, Collingwood VIC 3066 - 03 9419 3350
VACCHO Research Application Form Approved December 2010 (version 1) – for review
November 2011 Thanks to the Victorian Metropolitan Alliance, whose form this was based on

**APPLICATION: Request for VACCHO to support or participate in research**

Date Received:

Date and outcome of recommendation:

Applicant notified:

- 19 Will participants from the Aboriginal community or health organisations gain additional skills or formal qualifications through the research project?
- 20 Have or will intellectual property rights been stated in a formal contract?
- 21 Has consideration been given to ownership of data and processes and permissions required for access for purposes other than the specified research project?
- 22 Who will have input and responsibility for dissemination of results back to participants and for presentation and publication?

Please send your completed electronic form to:

Dr Karen Adams, Senior Researcher, Public Health and Research Unit, karena@vaccho.com.au**Dr Nadia Lusic**, Public Health Medical Officer, nadial@vaccho.com.au**1. Applicant details and summary of research proposal**

Name of Chief Investigator (Applicant):	Professor Isabelle Ellis
Postal address:	PO Box 199, Bendigo 3552
Telephone:	0354447874
Fax Number:	0354447977
Email:	isabelle.ellis@utas.edu.au
Co-investigators (if any):	Ms Melissa Deacon-Crouch Associate Professor Joseph Tucci Ms Kym Walker

Proposed Research Project Title: Perceptions of Aboriginal people in Northern Victoria regarding use of medicines

Ethics approval

Received

Outcome pending

Application pending ☒

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Rationale and Expected Outcomes *Please outline the rationale behind your proposed research, including relevance to identified Aboriginal community priorities or known Aboriginal health priorities, the gaps in current knowledge or practice that your research will address, and how this may be useful to improve the health of Aboriginal people or contribute to the quality and safety of primary health care services.*

There is an increased recognition that Indigenous health in Australia is poor with many Aboriginal people diagnosed with and medicated for chronic illnesses such as diabetes, hypertension, heart disease, and depression. Additionally, informal anecdotal discussions with Aboriginal Health Workers support the notion that there is a need for research that contributes to better health outcomes for this population. Our research project will explore the perceptions of Victorian Aboriginal people in relation to their use of medicines in their self-management of chronic disease. Much of the research literature to date has focused on the perceptions of healthcare providers rather than on the perceptions of the Aboriginal people themselves. We are aiming to develop a partnership with Aboriginal Health Workers (AHW) by inviting them to be co-researchers. The AHW will help to recruit and interview interested Aboriginal participants in a culturally appropriate and competent manner. Participants will be asked questions about their medications and how they incorporate taking the medicines into their lifestyles. Participants will also be asked about the role of medications in their self-management of chronic illnesses as well as their perceptions regarding how they were taught about taking the medicines and what to do if there are adverse side effects. We are seeking data that will inform healthcare providers about the reasons why Aboriginal people may not cope well with their medicines and why they may vary the way they take their medications or stop taking them altogether. The intended outcome of this project is to highlight the inappropriate use of the term “non-complier” when describing Aboriginal people and to inform healthcare providers of the role they can play to improve the appropriate use of medicines by their Aboriginal patients and support patient empowerment and self-management.

4. Relevance to VACCHO or VACCHO members or community

Please outline the relevance of the proposed project to the work of VACCHO and/or VACCHO members. What are the expected benefits to the Aboriginal community members or organisation(s) who participate in the research?

This project will support the policy work of VACCHO in the areas of chronic disease management including mental health; nutrition & physical activity; and Aboriginal Health Promotion & Chronic Care Partnership programs.

Through the project we hope to gain a better understanding of medication taking as a dimension of chronic disease self-management. We will also identify the barriers to effective medication use for people with chronic conditions. Finally, we will identify strategies to assist community pharmacists to help their patients with the appropriate use of medicines.

5. Involvement of VACCHO and/or VACCHO members and/or other Aboriginal community members or organisations in planning

Please outline the ways in which you have sought advice from VACCHO or VACCHO members, other members of the Aboriginal community, or other Aboriginal organisations in Victoria or interstate in the planning of this research proposal.

Ms Kym Walker of La Trobe University is a co-investigator in this research. Kym is the Aboriginal Student Services Co-ordinator at the Bendigo Campus. Through her role, Kym has extensive links with the Aboriginal community in rural Victoria. She has consulted health workers from a range of community controlled organisations about the research question, including Bendigo Aboriginal Cooperative.

Professor Isabelle Ellis has extensive experience working with Aboriginal organisations in WA and the NT. Isabelle has recently attended the HWA consultation on the role of Aboriginal Primary Health Care Workers

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in Melbourne where she had the opportunity to discuss the research questions with participants from community controlled health organisations, including policy makers and practitioners. As a follow up to those initial discussions Isabelle met with Carol Williams of VACCHO and contacted Corina Peisich, canvassing their views as to the relevance of this research question to VACCHO as an organisation. They were supportive and felt there was a need. Ms Melissa Deacon-Crouch has recently been involved in the teaching of Aboriginal Health Workers for VACCHO. During this time, informal discussions with the AHWs highlighted the need for this study.

6. Cultural safety

How will you ensure that the research is carried out in a manner that is culturally appropriate?

All non-Aboriginal members of the research team are engaged in cultural competence training. Each recognises that cultural competence is a journey and actively seek out opportunities for learning and engagement. An Aboriginal co-researcher is a member of the research team and 3 Victorian AHWs have been invited to gain skills in interview techniques, research techniques and data interpretation as paid research assistants in the project.

7. Research Design and Methods

Please outline the research methodology, including a justification of your research design, sample size and type of analyses relevant to your research question, as well as a description of the roles to be played by researchers and participants.

The research will use the qualitative method of interpretive phenomenological analysis. It will involve in-depth interviews with people who take medicines as part of their chronic disease care. Thematic analysis will be used to identify core categories from the transcripts of those interviews using a line-by-line approach to data analysis. Themes will be cross checked between members of the research group including the AHW research assistants. A model will be created that illustrates the interaction between the themes and the identified role that community pharmacists and other health workers can play to improve the appropriate use of medicines by their patients and support patient empowerment and self-management.

A purposive sample of approximately 20 Aboriginal people over the age of 18 years who take medications as part of their chronic disease care will be sought. These people will be invited to participate through the local Aboriginal Health Organisation they receive health care from. This sample size will give meaningful insight into the lived experience of people who have chronic illness and who take medication.

The participants will be interviewed in-depth for approximately 1 hour by the AHW research assistant using a guided interview schedule. This will ensure that the research questions are fully explored.

8. Proposed Timeline

Please provide an outline of when major components of the project will be completed.

Date	Deliverable/Component
31/10/2012	Completion of data collection and analysis

9. Ethics review

Has ethics approval been sought from a Human Research Ethics Committee (HREC) established under the National Health and Medical Research Council guidelines?

Yes: No: Pending: ☒ Not Applicable:

If yes, please provide details of the institution from which approval has been sought, and attach written confirmation. If confirmation is pending, please forward once you have received it.

If you have selected 'No' or 'Not Applicable' please provide an explanation below. Note that research Criteria

10. Co-investigators

Please list co-investigators (if any) to be involved in this research project

Name	Institution / contact
Ms. Melissa Deacon-Crouch	Dept Nursing & Midwifery, La Trobe Rural Health School, Bendigo 3552 Tel: 03 5444 7874
Associate Professor Joseph Tucci	Dept. Pharmacy & Applied Sciences La Trobe University, Bendigo 3552 Tel: 03 5444 7897
Ms. Kym Walker	Aboriginal Liaison Coordinator, La Trobe University, Bendigo 3552 Tel: 03 5444 7812

11. Support from VACCHO

Please list support required from VACCHO, including required time and roles of VACCHO staff, access to infrastructure, access to VACCHO data including liaison with VACCHO members to invite participation in the research project.

If applications for research grants and ethics committee approval are to be submitted and you require a letter of support or an agreement to be a partner from VACHCO and/or VACCHO members, you will at that stage need to provide a copy of the relevant application forms.

We are seeking a letter of support for this project to accompany our ethics application to the La Trobe University Human Research Ethics Committee. We would also like access to the VACCHO QUM team to understand the role that Aboriginal Health Organisations have in supporting medication use. Finally we would request liaison through VACCHO to disseminate information about the study to their member organisations in Mildura, Warrnambool, Gippsland and VAHS.

12. Budget

Please insert or attach a detailed budget for the project and identify available or proposed sources of funding. If you are requesting access to resources of VACCHO or VACCHO members (personnel, administration/infrastructure), please list these and whether funding is allocated in the budget for this.

Funding of \$18,603.52 has been approved for this project by the **Nurses' Board Victoria Legacy League(NBVLL)**

	Cost per annum	Total cost
Personnel	Research Assistant \$ 29.18 per hour X 7 hours per week X 40 weeks = \$8170.40 (Plus 28.51% oncosts (\$2329.39)	\$ 10,499.79
Travel	3,923.03	3,923.03
Stationery, duplicating, printing, postage etc	300.00	300.00
Administrative costs of Institution	3,680.70	3,680.70
Miscellaneous	200.00	200.00
TOTAL	18, 603.52	\$18, 603.52

13. Intellectual property and dissemination of research findings

Please state how intellectual property rights of participants or partners in the research project will be stated and protected, how the results of the study will be disseminated to VACCHO, VACCHO members and other research participants, and who will be involved in the interpretation, publication and presentation of results.

All information will be de-identified. Any quotes will be representative of a generalised view or general in nature. No Aboriginal cultural information will be sought however information about lifestyles of individual participants will be sought. A plain language summary report will be provided to all Aboriginal organisations involved in or supporting this research. We acknowledge that the participants have full intellectual property rights for their contribution to this research and the intellectual contribution of participants will be appropriately acknowledged in all publications. A draft of these acknowledgements will be submitted to VACCHO prior to publication. On completion of the research, the results will be disseminated to the community by the research team including the Aboriginal co-researchers through a meeting with key leaders in the local Aboriginal Health Organisation from where the participants have come from. Aboriginal co-researchers will be invited to present the findings at the National Rural Health Alliance Conference.

Chief investigators signature:

Date:

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Appendix 2: Evidence of support from Victorian Aboriginal Community Controlled Health Organisation

From: Melissa Deacon-Crouch

To: Kaye Collins

Cc: Joseph Tucci

Subject: Faculty Ethics Application : How do medications assist in the management of chronic diseases in Victorian Aboriginal communities

Date: Tuesday, 29 May 2012 11:18:00 AM

Hello Kaye,

Further to our conversation this morning I am writing to clarify that we do have support from both VACCHO and the Wathaurong Aboriginal Health Service in Geelong.

As I explained, I am a PhD student working with Assoc. Prof Joe Tucci (La Trobe) and Prof. Isabelle Ellis (UTAS) on the NVBLL funded grant for which I have recently submitted the Faculty Ethics application.

I have checked the affirmative for both sections:

- evidence of permission to use places off-campus (Question 10) and
- evidence of external approvals (Questions 11(a) and (b)).

I have included the email trail between myself, Professor Isabelle Ellis and Karen Adams VACCHO's Senior Researcher. I have been assured by VACCHO that this constitutes evidence of support for our proposed research. Karen Adams contacted the Wathaurong Aboriginal Health Service on our behalf. We have been advised it is not wise to be demanding at this early stage in the relationship building process, so we have not pushed the point of a formalised letter of support.

However, last week I spoke with Ms Connolly the Practice Manager at Wathaurong Aboriginal Health Service in Geelong. Ms Connolly is very keen to meet with us to discuss the project. She is also very enthusiastic about the Aboriginal Health Workers' roles as interviewers and intends for the interviews to be included in the regular health check for consented participants. This would occur either at the health service or possibly in their client's home. If the Faculty Ethics committee requires a more formal document of support, we will be in a position to request such at our meeting with Ms Connolly on June 15.

With Thanks,

Melissa

Melissa Deacon-Crouch

Senior Lecturer in Nursing

La Trobe Rural Health School

BN Course Coordinator

Faculty of Health Science

La Trobe University, Bendigo 3550

T: 03 54447874| F: 03 54447977| M:0418584408 W: www.latrobe.edu.au

La Trobe University - ranked top in Victoria for student satisfaction

(Sweeney Uni Student Report, 2009)

CRICOS Provider 00115M



Please kindly consider your environment before printing this e-mail

From: Karen Adams [KarenA@vaccho.com.au]

Sent: Tuesday, 28 February 2012 10:03 AM **To:** Melissa Deacon-Crouch **Cc:** Joseph Tucci; Isabelle Ellis (Isabelle.Ellis@utas.edu.au) **Subject:** RE: Research partnership application

Hello Melissa, thanks for emailing yes I

Yes spoken to Mo Connolly the practice manager and she said she would be happy to talk and it fits in well with the work they are doing. Her email is Mo.connolly@wathaurong.org.au their phone number is on our member list on the website, tel her that you've spoken to myself and Corina, thanks Karen

From: Melissa Deacon-Crouch [<mailto:M.Deacon-Crouch@latrobe.edu.au>] **Sent:** Friday, 24 February 2012 2:18 PM **To:** Karen Adams **Cc:** Joseph Tucci; Isabelle Ellis (Isabelle.Ellis@utas.edu.au) **Subject:** RE: Research partnership application

Hello Karen,
Just catching up with you since our meeting last Monday.
Thanks for offering to contact your colleague in Geelong regarding our research partnership application.
I was wondering how you got on.
Is there anything you require from us at this stage?

Thanks

Melissa Deacon-Crouch

Senior Lecturer

La Trobe Rural Health School

BN Course Coordinator

La Trobe University

PO Box 199

Bendigo 3552

(03) 5444 7874

From: Karen Adams [<mailto:KarenA@vaccho.com.au>] **Sent:** Thursday, 9 February 2012 1:08 PM **To:** Melissa Deacon-Crouch **Subject:** RE: Research partnership application

Hello, yes 5-7 Smith st just come up to reception and ask for me, kind regards Karen

From: Melissa Deacon-Crouch [M.Deacon-Crouch@latrobe.edu.au] **Sent:** Thursday, 9 February 2012 11:59 AM **To:** Karen Adams **Subject:** RE: Research partnership application

Thank you Karen, looking forward to it.

Where shall we find you?

Are you at the Smith Street Office?

Melissa Deacon-Crouch

Senior Lecturer

La Trobe Rural Health School

BN Course Coordinator

La Trobe University

PO Box 199

Bendigo 3552

(03) 5444 7874

From: Karen Adams [<mailto:KarenA@vaccho.com.au>] **Sent:** Thursday, 9 February 2012 11:54 AM **To:** Melissa Deacon-Crouch **Cc:** Joseph Tucci **Subject:** RE: Research partnership application

Hello we can do monday the 20th at 10am? thanks Karen

From: Melissa Deacon-Crouch [M.Deacon-Crouch@latrobe.edu.au] **Sent:** Wednesday, 8 February 2012 5:56 PM **To:** Karen Adams **Cc:** Joseph Tucci; Isabelle Ellis

Subject: FW: Research partnership application

Dear Karen,

Following the email from Isabelle Ellis (below), Dr Joe Tucci and I would like to make a time to visit you to discuss our proposed research partnership and how to develop the research project.

Would you be available for a meeting in the week February 20-24?

Joe and I can travel to Melbourne to meet with you.

Please let me know your availability.

With Thanks,

Melissa Deacon-Crouch

Senior Lecturer

La Trobe Rural Health School

BN Course Coordinator

La Trobe University

PO Box 199

Bendigo 3552

(03) 5444 7874

From: Isabelle Ellis [<mailto:Isabelle.Ellis@utas.edu.au>] **Sent:** Wednesday, 18 January 2012 3:47 PM **To:** Karen Adams **Cc:** Jill Gallagher; Corina Pesich; Stephen Carbone; Melissa Deacon-Crouch; Joseph Tucci; Kym Walker

Subject: RE: Research partnership application

Hi Karen,

That is terrific news. We are very happy to consider your suggestions and would like to come and meet with you to really be clear about how to best further develop this project.

Thanks

Isabelle

Isabelle Ellis Professor of Nursing: Rural and Regional Practice Development

University of Tasmania/ Department of Health and Human Services, Tasmania

PO Box 3513 BURNIE TAS 7320

Ph: 036430 4585 Mob: 0488128855 Fax: 036431 5670

www.rcs.utas.edu.au/



MEMORANDUM

RESEARCH SERVICES

To: Assoc Prof Joseph Tucci, School of Pharmacy and Applied Science, FTSE Ms Melissa Deacon, School of Pharmacy and Applied Science, FTSE

From: Secretary, La Trobe University Human Ethics Committee

Subject: Review of Human Ethics Committee Application No. 12-057

Title: How do medications assist in the management of chronic diseases in Victorian Aboriginal communities

Date: 3 September 2012

Thank you for your recent correspondence in relation to the research project referred to above. The project has been assessed as complying with the *National Statement on Ethical Conduct in Human Research*. I am pleased to advise that your project has been granted ethics approval and you may commence the study.

The project has been approved from the date of this letter until 31 July 2013.

Please note that your application has been reviewed by a sub-committee of the University Human Ethics Committee (UHEC) to facilitate a decision about the study before the next Committee meeting. This decision will require ratification by the full UHEC at its next meeting and the UHEC reserves the right to alter conditions of approval or withdraw approval. You will be notified if the approval status of your project changes. The UHEC is a fully constituted Ethics Committee in accordance with the National Statement on Ethical Conduct in Research Involving Humans- March 2007 under Section 5.1.29.

The following standard conditions apply to your project:

- **Limit of Approval.** Approval is limited strictly to the research proposal as submitted in your application while taking into account any additional conditions advised by the UHEC.
- **Variation to Project.** Any subsequent variations or modifications you wish to make to your project must be formally notified to the UHEC for approval in advance of these modifications being introduced into the project. This can be done using the appropriate form: *Ethics - Application for Modification to Project* which is available on the ResearchServices website at http://www.latrobe.edu.au/research-services/ethics/HEC_human.htm. If the UHEC considers that the proposed changes are significant, you may be required to submit a new application form for approval of the revised project.
- **Adverse Events.** If any unforeseen or adverse events occur, including adverse effects on participants, during the course of the project which may affect the ethical acceptability of the project, the Chief Investigator must immediately notify the UHEC Secretary on telephone (03) 9479 1443. Any complaints about the project received by the researchers must also be referred immediately to the UHEC Secretary.
- **Withdrawal of Project.** If you decide to discontinue your research before its planned completion,

you must advise the UHEC and clarify the circumstances.

- **Annual Progress Reports.** If your project continues for more than 12 months, you are required to submit an *Ethics - Progress/Final Report Form* annually, **on or just prior to 12 February**. The form is available on the Research Services website (see above address). Failure to submit a Progress Report will mean approval for this project will lapse. An audit may be conducted by the UHEC at any time.
- **Final Report.** A Final Report (see above address) is required within six months of the completion of the project or by **31 January 2014**.

If you have any queries on the information above or require further clarification please contact me through Research Services on telephone (03) 9479-1443, or e-mail at:
humanethics@latrobe.edu.au.

On behalf of the University Human Ethics Committee, best wishes with your research!

Ms Barbara Doherty
Administrative Officer (Research Ethics) University
Human Ethics Committee
Research Compliance Unit / Research Services La
Trobe University Bundoora, Victoria 3086 P: (03)
9479 – 1443 / F: (03) 9479 - 1464
http://www.latrobe.edu.au/research-services/ethics/HEC_human.htm

Appendix 4: Letter of support Wathaurong- La Trobe University Research partnership



Title: "Perceptions of Aboriginal people in Victoria regarding use of medications"

Wathaurong Aboriginal Cooperative – Health Service with La Trobe University, Faculty of Science, Technology and Engineering – Bendigo Campus, have agreed to work in partnership with a research project.

The research "Perceptions of Aboriginal people in Victoria regarding use of medications" will be established as collaboration. The ethics approval will be sought by La Trobe University, the interview questions and research method will be a partnership with La Trobe University, La Trobe will work with the health team to formulate interview questions and teach the health workers affective interview skills.

Approximately 25 community members will be interviewed with full consent. All participants will be paid for their time and information by a Coles Myer gift card worth \$50.00.

Wathaurong Aboriginal Co-operative will be acknowledged in the final research document that has potential to be submitted as a conference presentation or published journal article. Wathaurong will have the opportunity to give full approval of the final document before publishing.

Tracey Currie

Chief Executive Officer

Wathaurong Aboriginal Cooperative

WATHAURONG ABORIGINAL CO-OPERATIVE LTD.

ABN 26 564 626 453

LOT 62, MORGAN STREET, NORTH GEELONG 3215 * P.O. BOX 402, NORTH GEELONG 3215

PH: (03) 5277 0044

FAX: (03) 5278 4123

EMAIL: admin@wathaurong.org.au



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Participant Information Statement

How do medications assist in the management of chronic diseases in Victorian Aboriginal communities

1. I understand what this project is about

I have read [or had read to me] the Plain English Research Statement which explains what this research project is about and I understand it.

I have had a chance to ask questions about the project, and I am comfortable with any answers that I have been given. I know that I can ask more questions whenever I like.

2. I have volunteered to participate

I agree to participate in the research. I know that I do not have to participate in it. I made up my own mind to participate – nobody is making me do it or talking me into it. I know that I don't have to answer any questions I don't like and the Aboriginal Health Worker researcher will turn off the audio tape if I ask them to.

3. What will happen if I want to stop participating?

I know that I can pull out at any time without getting into trouble with the University researchers or the Aboriginal Health Worker or the Victorian Aboriginal Community Controlled Health Organisation. If I pull out, the researchers will be allowed to use any information that I have given them before I pulled out and they will be able to write down that I have stopped participating. They will not be able to make me keep participating if I don't want to.

4. How the research will happen

I agree that the Aboriginal Health Worker researcher can interview me for the research and audiotape what I say. The interview will last for 45 to 60 minutes. The University research team will listen to the taped voice and write down what I have said without being able to identify me. I understand that I will not be asked about Aboriginal cultural or sacred information however the Aboriginal Health Worker will ask me questions about my personal lifestyle.

6. Getting paid for participating in the research

I will receive a gift voucher for \$50 for participating in this research project. This gift is to recognise my time and effort that is required to contribute my valuable knowledge to the research.

7. Risks and benefits of the research

I understand that the research may not benefit me personally but depending on what the researchers find, it may benefit my community in the future by informing healthcare providers

how they can improve the use of medicines by Aboriginal patients. The research may also help Aboriginal people in their own management of chronic illnesses.

I know that there is a risk that by taking part in this research that I may become upset when talking with the Aboriginal Health Worker about sickness and medicines. Culturally appropriate counselling will be provided to me by the Aboriginal Health Worker if this occurs. If I do not want to continue discussions or be counselled by any particular Aboriginal Health Worker Researcher, there are other Aboriginal Health Workers, General Practitioners and Aboriginal Elders employed at the Wathaurong Health Service with whom I can discuss my concerns and who will provide culturally appropriate counselling and aide.

8. Who will be the authors of the research?

I understand that the University researchers want to write about the research in an article in a health journal and present the report at conferences such as the National Rural Health Alliance Conference

I understand that the researchers will write the reports and journal articles themselves. I won't write the reports with them. I understand that even though the information I contribute will be anonymous, my intellectual contribution will be appropriately acknowledged in all publications in a way advised by the Victorian Aboriginal Community Controlled Health Organisation.

9. Will people find out personal things about me from the research?

I understand that my name will NOT be mentioned in any publications that come out of this research, and that people won't know who I am from reading the articles. My information will be added to the information from the other people who participate and will remain anonymous. Consent forms that contain identifying information will be stored in a locked filing cabinet at La Trobe University, Bendigo. The interview data, which includes the notes and audiotapes of the focus groups will also be kept in a locked filing cabinet at La Trobe University, Bendigo. However, the interview data will be stored at a separate location to that where the consent forms will be stored. All forms and data will be kept for seven (7) years. After that, they will be destroyed.

11. Who will have access to the research results?

I understand that anyone can read the article that comes out of this research, and that even people on the other side of the world might see it, maybe on the internet. That's OK with me.

I agree that the University and Aboriginal Health Worker researchers can present information from the research at conferences even if I'm not there. I understand that the researchers can do this without asking me first.

I understand the researchers will give the Victorian Aboriginal Community Controlled Health Organisation and my local Aboriginal Health Organisation a copy of any articles they write from the research.

12. Intellectual property

I understand that the researchers will hold copyright in any books, articles, databases or conference papers produced as a result of this research.

This means that:

- The researchers will be able to reproduce the information that is in these books, articles, databases or conference papers in other places or for other purposes (eg on the internet) without asking for anyone else's permission.
- The researchers will grant the Victorian Aboriginal Community Controlled Health Organisation an irrevocable perpetual license to use this copyright material for any purpose whatsoever.

13. Complaints

I know that, if I am worried about the research project, I can talk to the Aboriginal Health Worker and I can ring up Melissa Deacon-Crouch on telephone number (03)5444 7874 and talk to her about it.

I know that if I have any concerns or complaints about the way I am treated during the study, or if I have a question that the researchers have not answered satisfactorily, I can also write to:

The Secretary,
Human Ethics Committee,
Research Services
La Trobe University
Victoria 3086
AUSTRALIA
Tel: +61 3 9479 1976
Email: rgs@latrobe.edu.au

Consent Form

I have read this Participant Information Statement along with the plain language statement and I agree with it.

Name of Research Participant

.....

Signed by the research participant

.....

Date/...../2012

OR

I read this Informed Consent Form aloud to

..... and I

[name of research participant]

believe that he/she understood it and agrees with it.

Name of

Witness.....

Signed by a

witness

Date/...../2012

On behalf of the research team

Researcher's name:

.....

Signature:

.....

Date/...../2012



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www.latrobe.edu.au/scitecheng

Perceptions of Aboriginal people in Victoria regarding use of medications

Plain English Statement

1. Who is involved in the project?

This research project is being conducted by us - Joseph Tucci, Melissa Deacon-Crouch and Isabelle Ellis. We are pharmacists and nurses who work for La Trobe University and the University of Tasmania, respectively.

The research is supported by **the Victorian Aboriginal Community Controlled Health Organisation (VACCHO)**. We can show you the letters of support if you want to see them. We have received some grant money from **The Nurses Board of Victoria Legacy League** to do this research.

This project will be carried out according to the *National Statement on Ethical Conduct in Research Involving Humans* (June 1999) produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies. The project has been approved by the La Trobe University Human Research Ethics Committee and by the **VACCHO** Public Health Research Unit.

2. What will the researchers do?

We are trying to find out what Aboriginal people with diagnosed medical conditions in Victoria think and feel about taking their medications and how they manage their illness.

We are very interested to find out about whether people find it difficult to take their medications in the way prescribed by the health worker.

Using the information we gather we hope to develop community educational materials relating to medications for Aboriginal people.

Aboriginal Health Workers from your local Aboriginal Community Controlled Health Organisation will tell you about our project. You will be given the opportunity to ask any questions you like and to tell them if you have any concerns.

If you agree to participate in this study, you will be interviewed one on one by an Aboriginal Health Worker (AHW). The AHW will ask you questions about what you think and feel about medications for diagnosed medical illnesses. We are interested to know your thoughts about what helps and what stops you taking the medication exactly as the health worker has instructed. During the interview, the AHW will audio-record your answers so we can study it later. Your name will not be recorded so your comments will remain anonymous. The interview should last 40 – 60 minutes. The research will happen sometime between July and October 2012.

3. Participation

Participation in any research project is voluntary. If you do not wish to take part you are free to refuse without prejudice. If you decide to take part and later change your mind, you are free to withdraw from

participating in the study. However, it will not be possible to withdraw your data once you have participated as your individual comments will not be identifiable. Before you make your decision about participating, the AHW or another member of the research team will be available to answer any questions you have about the research project. You can ask for any information you want. Sign the Consent Form only after you have had a chance to ask your questions and have received satisfactory answers. You will be paid \$50 for your participation.

4. What will the researchers do with the information they collect?

All information will be de-identified. Any quotes will be representative of a generalised view or general in nature. No Aboriginal cultural information will be sought however the AHW will ask you questions about your general lifestyle. Any information obtained in connection with this project and that can identify you will remain confidential. Except for the consent form, we won't use any names to identify people who participate in this research. We will identify people by numbers only. Consent forms that contain identifying information will be stored in a locked filing cabinet at La Trobe University, Bendigo. The interview data, which includes the notes and audiotapes of the focus groups will also be kept in a locked filing cabinet at La Trobe University, Bendigo. However, the interview data will be stored at a separate location to that where the consent forms will be stored. All forms and data will be kept for seven (7) years. After that, they will be destroyed.

We will use the information to write articles in scientific journals and to advise doctors, pharmacists, nurses and AHWs regarding the appropriate use of medications by Aboriginal people. As a participant, you have full intellectual property rights for your contribution to this research which will be appropriately acknowledged in all publications.

5. Possible benefits

We cannot guarantee or promise that you personally will receive any benefits from this project. However, we hope the information we gather will benefit your community in the future by enabling us to inform healthcare providers of the role they can play to improve the appropriate use of medicines by their Aboriginal patients and to empower Aboriginal people in the self management of chronic illnesses.

6. Possible Risks:

There are minor risks associated with participating in this project. It is possible that you may become distressed or embarrassed during the interview with the AHW. If you become distressed, you may suspend or end your participation at any time. We will arrange a culturally appropriate counsellor for you to talk to if you wish to.

7. Further Information or Any Problems

If you have any questions regarding this project, please ask your AHW in the first instance. If you require more information, please contact Melissa Deacon-Crouch on telephone number (03)5444 7874. If you have any concerns or complaints about the way you are treated during the study, or if you have a question that the researchers have not answered satisfactorily, please write to: The Secretary, Human Research Ethics Committee, Student Administration Building, La Trobe University, PO Box 199, Bendigo Victoria 3552



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La Trobe University

Withdrawal of Consent for use of Data

Project Title: How do medications assist in the management of chronic diseases in Victorian Aboriginal communities?

I, ..., wish to WITHDRAW my consent to:

(Name)

Tick appropriate box

(i) be interviewed as a participant in the study

☐

(ii) the use of data arising from my participation.

☐

Data arising from my participation must NOT be used in this research project as described in the Information and Consent Form. I understand that data arising from my participation will be destroyed provided this request is received within two weeks of the completion of my participation in this project. I understand that this notification will be retained together with my consent form as evidence of the withdrawal of my consent to use the data I have provided specifically for this research project.

However, I understand that after a 2 week period following my interview it may not be possible to withdraw my consent to use the information I have provided. This is because the information I provide will be not be able to be linked back to me once it has been analysed with all the other participants' information.

Participant's name (printed):

.....

Signature:

Date:...../...../.....

.....
Melbourne (Bundoora) | Bendigo | Albury-Wodonga | Melbourne (City) | Shepparton | Mildura | Beechworth

ABN 64 804 735 113
CRICOS Provider 00115M



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Confidentiality Agreement

Research Project: How do medications assist in the management of chronic diseases in Victorian Aboriginal communities?

I _____, agree to be a co- researcher in the research project.

In accepting this role I agree to meet the requirements of confidentiality and data storage as required by the La Trobe University Human Research Ethics Committee who have approved this project.

Aboriginal Health Worker name (printed) _____

Aboriginal Health Worker signature _____

Date ____/____/____

Witness

Name (printed): _____

Position: _____

Signature: _____

Date: ____/____/____

Perceptions of Aboriginal people in Victoria regarding use of medications

Interview Questions

1. How long have you been taking medicines for your sickness? How old were you when you started taking medicines for your sickness?
2. Do you know what each of your medicines is for? Can you tell us about them?
3. When you started taking the medicine, who told you about them?
4. What did they tell you?
PROMPT: how often?
 When?
 Problems you can expect?
 What to do about the problems?
 How your medicines from the doctor, OTC and from the bush might act together?
5. Did you get information from someone else?
PROMPT: Pharmacist (Chemist)/Nurse/QUM worker/ AHW/relative
6. Do you think the medicine is helping you?
7. Do you think the medicine is causing you problems?
8. What do you do if you think the medicine is causing you problems?
9. Who do you tell about the problems?
10. What would make you stop taking the medicines?
11. Do you know how long you will have to take the medicines?
12. Other than taking the medicines, what else do you need to do to look after yourself?
PROMPT: Do you smoke?
 Have you been ordered anything to help you give up smoking?
13. How hard is it for you to make lifestyle changes? Can you tell us about this?
14. Do many people in your family and community need to take medicines? Can you tell us about this?
15. How old are people when they start needing medicines?
16. Where can you get information about medicines?
17. Do you take more medicines than those the doctor orders?
PROMPT: from the supermarket/health food shop/bush medicine
18. Did you know that you should tell the doctor about those other medicines?
19. Do you think the medicines will help cure your sickness?



Australian Government
Department of Social Services

Individual Deed of Licence for Australian Researchers

Name of Researcher Melissa Deacon-Crouch

For LSIC Applicants only This section can be deleted if you are not applying for the LSIC dataset - Please refer to chapter 6 of the manual for information on how to address your standpoint Please provide a statement of your standpoint noting that this is NOT your project description. This section is compulsory for LSIC applicants.

I am a non-Indigenous Australian woman of Anglo-Saxon descent born in the Wimmera district and raised in a middleclass family in Mildura, Victoria. My father was a humanitarian and animal welfare advocate and the local pharmacist. Many of my relatives were nurses and other healthcare professionals. I completed my schooling at the local catholic primary and secondary schools during the 1970s. During my childhood many of my friends were first generation Australians of Italian, Croatian, Greek and Chinese descent and I developed an interest in exploring culture, society, cuisines and spirituality. I hold tertiary qualifications in Biological Science, Education, Nursing and Midwifery.

My employment commenced as a research assistant at the University of Melbourne, Department of Medicine, followed by work as a researcher and clinical Registered Nurse and Midwife. Most of my clinical life was spent as an RN at the Royal Melbourne Hospital and a Midwife at the Mildura Base Hospital. Working in these institutions that are well known to provide services to people of many nations and cultural backgrounds provided me with a rich multicultural experience. I began reflecting on my own standpoint, values and prejudices following attendance at the short course "Race, Culture, Indigeneity and the Politics of disadvantage" in 2011. This course was the beginning of my new understanding and personal paradigm shift.

I currently reside in Bendigo with my Australian, Anglo-Celtic husband and 3 school aged children. I am employed as a Senior Lecturer in Nursing at La Trobe University. I am also enrolled in a PhD exploring various aspects of chronic illness associated with Indigenous people. My journey with Indigenous people commenced about 7 years ago when I spent weeks in the NT with members of the Nauiyu community at Daly River, working with and providing education for the Nauiyu Indigenous HAGG providers. My experiences in this community provided the impetus to further explore ways I could contribute to improving the health and wellbeing of Indigenous people. On return to Victoria I spent time teaching Indigenous students in the Cert IV AHW with VACCHO; liaising with researchers at VACCHO to explore research issues that are important and relevant to Indigenous people; developing a research partnership with the CEO, practice manager and AHWs at the Wathaurong Aboriginal Co-operative Health Service (North Geelong) in order to explore the perceptions of Aboriginal people with chronic illnesses regarding their lifestyle and medication self-management. We have also formed research relationships with the past practice manager of Gunditjmara Aboriginal Health Service (Warrnambool) and the CEO of Dhauwurd Wurrung Elderly and Community Health Services (Portland).

I am currently a member of the La Trobe Rural Health School: ACCESS Group. The group's primary aim is to help under represented students, particularly Indigenous students, to gain access to La Trobe Rural Health School and provide them with a culturally safe physical and social environment. I also work closely with the Indigenous Liaison Officer at the Bendigo campus to provide academic support and mentorship for Indigenous nursing students. Additionally, along with the members of the La Trobe University Gamagoen Yarrbat Indigenous Education Strategy Group, I am part of a team developing a 2nd year nursing subject: Indigenous health and wellbeing.

I am a Board Member of the Weenthunga Health Network and the Local Area Network Coordinator for Central Victoria. Led by Indigenous people, Weenthunga is a network of Indigenous and non-Indigenous healthcare providers, working together to improve the health and wellbeing of Victorian Indigenous people and their communities. As the local network coordinator, I work closely with Indigenous women and other Indigenous health workers to organise retreats, workshops and social gatherings for Indigenous women and school aged girls to build relationships, trust and mutual understandings and to encourage them to aspire to a career in healthcare. My journey to date has provided me with insight regarding the necessity to engage in reflexivity as a non-Indigenous researcher working with Indigenous people. By reflecting and spending time with two strong Indigenous women mentors, I strive to further my cultural competence. Referring to the LSIC protocols I confirm that I understand that Indigenous communities are diverse, with different languages, cultures, histories and perspectives. I also understand that there is a diversity of people within communities that must be reflected in the analysis, interpretation and reporting of the data.

I am a member of a diverse team of researchers working in the Northern Territory and Western Australia. My role is as a PhD student under the supervision of Professor Timothy Skinner from CDU who holds an Individual Deed of Licence for Australian Researchers for the LSIC data.

- Our group includes an Indigenous Australian woman; a non-Indigenous Australian woman (who is a long-term resident of remote, Indigenous communities through her work as remote area nurse, midwife, health service manager and business woman); a non-Indigenous Australian woman PhD student (Me); four, non-Aboriginal Australian-born white men; one British-born, white male; one British-born, white female; and a woman born in America who was a long term resident in England before. recently moving to Australia.
- From a professional perspective, our group includes, a medic, three nurses (of which two are also midwives and one, a business woman), an architect, a respiratory physiologist, a clinical psychologist, a health psychologist, a sports scientist, and educators.
- From a methodology perspective, our group contains a complex mix of researchers .from a diverse range of paradigms. Thus, our group includes biomedical-orientated researchers who focus on the physiology and biomedical basis of disease, through to qualitative researchers who focus on the lived experience, phenomenological and the shared community world view, and individuals who work from a public policy and governance perspective.

The team does not have a single perspective but rather negotiates and reformulates its standpoint as it works to understand the questions it is asking, and the diverse answers it receives.

Why are we focusing on this analysis?

We are seeking to undertake the specific analysis here as a result of our previous discussions with the Thalanji community to develop a research approach and methodology with them. These discussions re-affirmed that the Indigenous community believe that they do have a problem with getting regular high quality restorative sleep, and possibly with sleep disorders. Discussions have also re-affirmed that this is a complex issue to explore requiring subjective and objective sleep assessments, examination of problems with sleep disorders and formulation of appropriate systems to provide care to anyone with an existing or newly identified disorder. Concomitantly the impact of housing and the physical environment on sleep will be considered. Therefore, whilst we work with the community to establish a methodology that recognises the shared understanding of Indigenous perspectives on sleep and health, and western scientific

methods of knowledge acquisition and research, it was decided that we should explore any current data sets that are available, that might provide insight into the question.

Thus, we are seeking to undertake analysis on the relationship between subjective reported sleep and markers of social, educational and psychological well-being in the LSIC study cohort and to see if Aboriginal Australians have to deal with sleep problems more than non-Indigenous people.

LSIC Data Integrity Statement

LSIC data applicants need to read this statement and show a willingness to adhere to it by signing below.

"In relation to using the LSIC data and reporting findings publicly I agree to uphold the following where relevant and practical. I will:

- show respect for: land, laws, elders, culture, community, families and support Indigenous people's visions for their futures when interpreting data outputs and reporting on them.
- declare my standpoint when reporting my work including my theoretical/ methodological approach, institutional context and personal frame of reference such as my cultural background, work background, depth of experience liaising with Aboriginal and Torres Strait Islander people.
- represent Aboriginal and Torres Strait Islander people in a manner that honours the diversity of perspectives and experiences and avoids inappropriate or outdated perspectives and terminology
- fully acknowledge Aboriginal and Torres Strait Islander contributions to the research including reviews and commentary and provide co-authorship where relevant.
- provide DSS with the results of the analysis so that the Department can honour its commitment to give Aboriginal and Torres Strait Islander peoples and communities (particularly those involved in the study) feedback on how the data are being used and a summary of the findings. This will also allow them to make my findings available so they can contribute in the policy planning, management and delivery of services".

☒ I have read the above and understand that these protocols are for the use of LSIC data as explained in the Manual.

☒ I have downloaded a copy of the NHMRC's Values and Ethics - Guidelines for Ethical Conduct in Aboriginal and Torres Strait Islander Health Research and appreciate the importance of the values and ethics of Reciprocity, Respect, Equality, Responsibility, Survival and Protection, Spirit and Integrity even in secondary data analysis and reporting (see <http://www.nhmrc.gov.au/publications/synopses/e52syn.htm>)

(Please tick boxes above then sign below)

Signed:

Date: 06/04/16 (dd/mm/yy)

Name: Melissa Deacon-Crouch

Parties

The Commonwealth of Australia as represented by the Department of Social Services (DSS)

AND

(Licensee)

Family Name * Required field	Deacon-Crouch
First Name * Required field	Melissa
Title (Prof, Dr, Ms, Mr) * Required field	Ms
Name of Organisation * Required field	La Trobe University
Position (if student, specify current level e.g. Masters, PhD) * Required field	PhD student
If a student, Name of Supervisor*	Professor Timothy Skinner (CDU) Dr Joseph Tuohi
Contact Details of Supervisor	Email: Timothy.Skinner@cdu.edu.au Business Telephone: +61 8 8946 6408
Postal Address (business) * Required field	Dept. Rural Nursing and Midwifery, La Trobe Rural Health School, La Trobe University PO Box 199 Bendigo Victoria 3552
Address (where data will be used) * Required field	Dept. Rural Nursing and Midwifery, La Trobe Rural Health School, La Trobe University Edwards Road, Bendigo Victoria 3550
Telephone (business) * Required field	03 5444 7874
Email (business) * Required field	m.deacon-crouch@latrobe.edu.au
Indicate how will data be accessed	☐ CD ROM ☒ Secure Server ☐ Secure Room
Have you ever used HILDA, LSAC, LSIC or BNLA before?	☐ Yes

	☒ No
--	---

Note: If a student - *Supervisors must have independent access to the dataset for which the student is applying.

FOR USE OF THE FOLLOWING DATASET(S)

- | | |
|---|---|
| ☐ HILDA General Release | ☐ HILDA Unconfidentialised |
| ☐ LSAC General Release | ☐ LSAC Unconfidentialised |
| ☒ LSIC General Release | |
| ☐ BNLA General Release | |

You will be sent the latest version and release of the nominated datasets.

Please note: Users of the unconfidentialised datasets need to abide by additional security requirements as stated in this Deed and the Manual. Before DSS will give approval to use the unconfidentialised datasets, applicants must demonstrate that they can meet the security requirements and justify the research need for data at this detailed level.

Background

- A. The Licensee wishes to use a DSS dataset/s for a specific research project that is to be conducted by the Licensee and is of interest to DSS in meeting its strategic priorities.
- B. The Commonwealth of Australia through DSS offers to provide the Dataset to the Licensee on the terms set out in this Deed and the Licensee accepts the terms.

Operative provisions

1 Definitions and Interpretation

In consideration of the mutual promises contained in this document, the parties to this Deed agree as follows:

Definitions

- 1.1 In the Deed the following definitions apply:

Approved Research means the research project(s) which DSS has approved the use of the Datasets specified in clause 6.1 of this Deed.

Authorised User means a person who has been given permission by DSS to have access to and use the Datasets for the Approved Research. For more information see the Manual.

BNLA means the Building a New Life in Australia Survey, also known as the Longitudinal Study of Humanitarian Migrants.

Business Day means any day on which all banks are open for business generally in Canberra, Australian Capital Territory.

Commercial purposes means the use of DSS longitudinal data for a fee, rate, charge or other consideration, or directly or indirectly in connection with any business, or other undertaking intended for profit.

Confidential Information means, in relation to DSS, information that:

- (a) is by its nature confidential
- (b) is designated in writing by DSS as confidential;
- (c) is personal information under the *Privacy Act 1988*, protected information under section 23(1) of the *Social Security Act 1991*, or protected information under Division 2 of Part 6 of *A New Tax System (Family Assistance) (Administration) Act 1999*;
- (d) the Licensee knows or ought to know is confidential and includes:
 - i. the Datasets, if in a form which discloses any of the information referred to in paragraphs (a)–(d) above;
 - ii. other information comprised in or relating to any Intellectual Property of DSS or third parties (where that information is provided by the third party on behalf of DSS) if in a form which discloses any of the information referred to in paragraphs (a)–(d) above; or
 - iii. information relating to the internal management and structure of DSS, but does not include information which:
 - 1. is or becomes public knowledge other than by breach of this Deed, other confidentiality obligations or the *Privacy Act 1988*, the *Social Security Act 1991*, or *A New Tax System (Family Assistance) (Administration) Act 1999*; or
 - 2. the Licensee can establish by written evidence has been independently developed or acquired by the Licensee without breach of any obligation of confidence.

Datasets means any or all of the DSS;

- General and Unconfidentialised Release household and person level Unit Record Data from the Household, Income and Labour Dynamics in Australia (HILDA) survey;
- General and Unconfidentialised Release household and person level Unit Record Data from the Longitudinal Study of Australian Children (LSAC), which may include administrative linked dataset/s;
- General Release household and person level Unit Record Data from the Longitudinal Study of Indigenous Children (LSIC);
- General Release household and person level Unit Record Data from the Building a New Life in Australia (BNLA) survey; and
- Any variations or updates of Releases that may be released from time to time;

Document includes:

- (a) any paper or other material on which there is writing;
- (b) any paper or other material on which there are marks, figures, symbols or perforations having a meaning to persons qualified to interpret them; and
- (c) any article, material or media from which sounds, images or writings are capable of being reproduced with or without the aid of any other article or device.

DSS means the Commonwealth as represented by the Australian Government Department of Social Services.

FLoSse means the DSS Longitudinal Surveys Electronic Research repository into which users must directly deposit bibliographic details of research created using the datasets <http://flosse.dss.gov.au>.

General Release means a release of data from which personal information such as names, addresses (including postcodes) and date of birth have been removed and other information has been modified by various methods such as top coding and the application of classification codes at a more general level.

HILDA means the Household, Income and Labour Dynamics in Australia survey, also known as Living in Australia.

Intellectual Property means copyright (and all associated rights, including moral rights), and all rights in relation to inventions, registered and unregistered trade marks (including service marks), registered and unregistered designs, and circuit layouts, and any other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields.

Licensee means the signatory of this Deed.

LSAC means the Longitudinal Study of Australian Children, also known as Growing Up in Australia.

LSIC means the Longitudinal Study of Indigenous Children, also known as Footprints in Time.

Manual means the Manual for Access and Use of DSS Longitudinal Datasets, prepared and updated by DSS and published on the [NCLD](#) website.

Organisation means the entity listed in the parties section of this Deed.

Permitted Geographic Area means any of the areas falling within the geographical area classifications that are described in the Australian Statistical Geography Standard (ASGS), 2011, released and used by the Australian Bureau of Statistics (ABS) for the collection and dissemination of geographically classified statistics. Descriptions of these geographical area classifications are available on the [ABS website](#).

Personal Information means information or an opinion (including information or an opinion forming part of a database), whether true or not, and whether recorded in a material form or not, about an individual whose identity is apparent, or can reasonably be ascertained, from the information or opinion.

Release means a dataset that differs from another dataset from the same survey in that it contains additional information based on new responses from survey respondents. For the purposes of this Deed, a Release does not include a new version of the data in which changes have been made based on the existing information from respondents.

Research Material means any final research findings based on the analysis of the Dataset created by the Licensee.

Survey Contract Manager means in the case of HILDA, the Melbourne Institute of Applied Economic and Social Research (MIAESR) at the University of Melbourne, Australia and in the case of LSAC, the Australian Institute of Family Studies. DSS manages the functions of the Survey Contract Manager for LSIC and BNLA.

Unauthorised Person means a person who is not authorised in writing by DSS to use the Dataset.

Unconfidentialised Release means a release of data from which the names and addresses have been removed but includes other potentially confidential information such as postcodes, date of birth and data at a more detailed level than the General Release datasets.

Unit Record Data means records about individual respondents from the Datasets, also known as unaggregated data.

Interpretation

- 1.2 In this Deed, unless the context otherwise requires:
 - 1.2.1 a reference to any law or legislation or legislative provision includes any statutory modification, amendment or re-enactment, and any subordinate legislation or regulations issued under that legislation or legislative provision;
 - 1.2.2 a reference to any agreement or Document is to that agreement or Document as amended, novated, supplemented or replaced from time to time;
 - 1.2.3 words in the singular include the plural and words in the plural include the singular;
 - 1.2.4 all references to clauses are reference to clauses in this Deed;
 - 1.2.5 where any word or phrase has been given a defined meaning, any part of speech or other grammatical form about that word or phrase has a corresponding meaning;
 - 1.2.6 if an example is given of any thing (including a right, obligation or concept), the example does not limit the scope of that thing; and
 - 1.2.7 each party provision of this Deed will be interpreted without disadvantage to the party who (or whose representative) drafted that provision, that is, the *contra proferentum* rule does not apply to this Deed.

2 Term of the Deed

- 2.1 This Deed takes effect on and from the Commencement Date and will continue in effect until terminated by either party in accordance with the Deed.

3 Licence

- 3.1 DSS grants to the Licensee a non-exclusive, non-transferable licence to use, copy, adapt and modify the Datasets on the terms set out in this Deed for the purposes of undertaking Approved Research for the term of this Deed.

4 Roles, Responsibilities and Access Management

- 4.1 The Licensee agrees to comply with all procedures and requirements specified in this Deed and the Manual as at the Commencement Date which forms part of the documentation for the administration of this Deed.
- 4.2 The Licensee agrees to regularly check for updates to the Manual.

- 4.3 The Licensee must comply with the provisions set out in the latest version of the Manual. If the Licensee is unable or unwilling to comply with the provisions therein, the Licensee must immediately notify DSS and relinquish all DSS datasets in the Licensee's possession by returning them to DSS.
- 4.4 In the event of any inconsistency between the latest version of the Manual and this Deed, the Licensee must comply with the requirements which produce the highest level of protection of the Confidential Information.

5 Administration Fee

- 5.1 The Licensee must pay the administration fee of \$77 to the Survey Contract Manager prior to the Dataset being provided.
- 5.2 The Survey Contract Manager will provide a tax invoice or payment link as soon as is reasonably practicable.

6 Restrictions on use of the Dataset

- 6.1 The Dataset must only be used for the purposes of undertaking the following research project until the expected date of completion:

What are the research aims/ questions or hypotheses for which you will be using the data?

1. Do Indigenous Australian children have more sleep problems, more sleep disturbances and shorter sleep than Non-Indigenous Australian children?
2. Do sleep problems, duration and quality show the same relationships with measures of physical, social, emotional and psychological health in Indigenous Australian children as seen in studies with non-Indigenous Australian children?
3. Are there differences in the prevalence and impact of sleep problems, duration and quality between urban, regional and remote communities?

What is your analytical plan or the key variables you will be examining?

Key variables

Parent 1 Questionnaire

- Child's sleeping patterns
- Health conditions
- Hospitalisation
- Child social emotional development and well-being
- Child temperament
- Socio demographics

Child Questionnaire

- Height and weight
- Progressive achievement tests
- Social and emotional well-being

Teacher Questionnaire

- School attendance
- Language and literacy
- Social, emotional and physical development

Analytical Plan

Question 1 – we will compare data on sleep patterns between the LSIC and LSAC data sets, controlling for social demographic characteristics. Thus, we will attempt to derive a comparable marker of sleep quality, duration, or sleep problems that are comparable across data sets. Having derived comparable measures, we will then merge a restricted set of items, sleep and socio-demographic items and undertake the comparative analysis.

Question 2. – we will follow the analysis plans used by research groups who have reported this analysis on the LSAC group, and attempt to replicate this as closely as possible with comparable data from the LSIC data sets. Thereafter, following appropriate statistical modelling, we will compare effect sizes between the LSAC and LSIC cohorts.

Question 3 – we will compare the data on sleep patterns between participants living in different degrees of remoteness. This will be done using only the LSIC data set.

What outputs do you intend will result from this research (e.g. journal article, thesis, book chapter, report, conference presentation etc)? (If you intend to produce more than one article, please include all that you know about at the time of application.)

We anticipate at least three research journal articles, one relating to each question. We will also present the outcomes of the analysis to the Thalanji community we are working with, further to inform and advance the research that we are co-developing with them.

If this project is being sponsored or commissioned by an agency other than the organisation listed in this application, please provide the full name of the sponsoring organisation (for administrative purposes only). If a grant, please provide grant number/s.

NA

Please list who will be on this project with you. Please note if these persons intend to use the data then they must also apply independently

Name: Mr Geoff Barker, PM&D Architects P/L	Project Role: Expertise in the impact of housing on health in remote and Indigenous communities.
Name: Associate Professor Romola Bucks, University of Western Australia	Project Role: Expertise in neuropsychological and cognitive consequences of disrupted and shortened sleep, and expertise on neuropsychological sequelae of aging and dementia.
Name: Professor Alan Cass, Director, Menzies Institute for Health Research	Project Role: Lead clinician for examination of the relationship between sleep quality and morbidity and mortality.
Name: Melissa Deacon-Crouch, Senior Lecturer, La Trobe University	Project Role: PhD student
Name: Professor Peter Eastwood, NH&MRC Senior Research Fellow, University of Western Australia	Project Role: Expert in sleep and respiratory physiology, sleep disorders and physiological consequences of disrupted and short sleep.
Name: Professor Marilynne Kirshbaum, Head of Nursing, Charles Darwin University	Project Role: Expertise on impact of sleep and fatigue on health, quality of life and daily functioning, and qualitative research methodologies
Name: Dr Jim Lee, Lecturer in Sports and Exercise Science, Charles Darwin University	Project Role: Expertise in physical literacy, physical activity and the use of micro sensors to monitor activity
Name: Professor Isabelle Skinner, Associate Dean Research, Charles Darwin University	Project Role: Expertise in remote health care provision (remote areas nurse and remote area midwife), remote community life, liaison with Aboriginal communities and research methodology
Name: Prof Timothy Skinner, Head of School of Psychological and Clinical Sciences, Charles Darwin University	Project Role: Project leader, with expertise in health psychology and the relationship between psychological well-being and physical health, along with expertise in adolescent paediatric psychology
Name: Professor Ruth Wallace, Director, the Northern Institute	Project Role: Expertise in Indigenous leadership, co-creation of research methodology with Indigenous community, building resilience through community engagement and collaborative knowledge, policy and governance.

Who will own the Intellectual Property of the research material for which the data will be used?

Charles Darwin University

Is this project being undertaken for commercial purposes?

Yes ☐ No ☒

Expected Date of Completion of Research 30 / 4 / 19 (dd/mm/yy) * Required field up to a maximum of 3 years from the date of application

- 6.2 If the Licensee requires the data beyond the three years he or she may apply to DSS in writing prior to the termination date requesting permission to retain the data for an additional specified length of time.
- 6.3 The Licensee must obtain approval from DSS before using the Dataset for any research project other than specified in this clause. To obtain approval for any additional research, the Licensee should email longitudinalsurveys@dss.gov.au.
- 6.4 This Deed is granted based on the Licensee's association with the Organisation listed under Parties of this Deed. If the Licensee ceases association with that Organisation, the Licensee must inform DSS and must obtain prior written approval from DSS before using the Dataset while undertaking research for or with another organisation.
- 6.5 The Licensee may modify the Dataset in order to undertake data analysis (e.g. create new derived data items, aggregate and manipulate the data).
- 6.6 The Licensee may copy/reproduce the Dataset for the permitted purpose, but may not copy/reproduce the Dataset for any other reason (e.g. give copies of the Dataset to Unauthorised Persons).
- 6.7 The Licensee must not:
- 6.7.1 use the Unconfidentialised dataset for the purpose of reporting on or showing data in relation to a geographic area other than a Permitted Geographic Area; or
 - 6.7.2 perform any matching, sharing, merging or linkage of any of the HILDA dataset with any non-HILDA datasets or any of the LSAC datasets with any non-LSAC datasets or any of the LSIC datasets with any non-LSIC datasets or any of the BNLA datasets with any non-BNLA datasets without the prior written consent of DSS; or
 - 6.7.3 attempt to identify any Individuals in the Dataset; or
 - 6.7.4 publish, in any form, any part of the Dataset; or
 - 6.7.5 in relation to the LSAC datasets, use the ACARA MySchool Institution level data to calculate or publish material which ranks schools.

7 DSS responsibility for the Dataset

- 7.1 The Dataset is provided to the Licensee on an 'as is' basis and DSS is not responsible for its accuracy, quality or fitness for purpose.

8 Provision of the Dataset

- 8.1 Subject to clause 5.1 DSS will use its best endeavours to arrange the provision of the Dataset to the Licensee as soon as possible after the Commencement Date.
- 8.2 DSS must notify the Licensee immediately in writing of any delay in the arrangement of the provision of the Dataset in accordance with clause 8.1 and in this event the parties will agree on a revised delivery date and appropriate changes to other timing obligations included in this Deed.

9 Security

- 9.1 The Licensee must comply at all times with the following security requirements in relation to the Datasets with a classification of unclassified – (DLM) for General Release and unclassified – (official use only) for Unconfidentialised datasets:

Only allow the Unit Record Data from the Datasets to be viewed by Authorised Users. Store all complete or partial dataset/s, in accordance with the baseline security controls detailed within the Australian Government Protective Security Policy Framework (PSPF) and the Australian Government Information Security Manual (ISM) applicable to Australian government information which requires some level of protection.

Further information relating to the PSPF and the ISM can be found on the following websites:

- Protective Security Policy Framework: <http://www.protectivesecurity.gov.au>
- Information Security Manual: <http://www.asd.gov.au/infosec/ism/>

The PSPF and ISM may be updated from time to time. The Licensee must regularly check for updates to these documents and comply with the provisions set out in the latest version.

- 9.2 The following ISM standards are the minimum requirements for users of DSS longitudinal Datasets. These include but are not limited to:
- a. Agencies must register all ICT equipment and media with a unique identifier in an appropriate register

(control 0336 of ISM (control last updated Sep 2011))
 - b. To destroy media, agencies must either:
 - Break up the media
 - Heat the media until it has either burnt to ash or melted
 - Degauss the media
(control 0364 and see 0366 of ISM (control last updated Nov 2010))
 - c. Agencies using passphrases as the sole method of authentication must enforce the following passphrase policy:
 - a minimum length of 13 alphabetic characters with no complexity requirement; or
 - a minimum length of 10 characters, consisting of at least three of the following character sets:
 - lowercase alphabetic characters (a-z)
 - uppercase alphabetic characters (A-Z)
 - numeric characters (0-9)
 - special characters.
(control 0421 of ISM (control last updated April 2015))

- d. Securing ICT equipment and media during operational and non-operational hours. ICT equipment and media needs to be stored in accordance with the *Australian Government Physical Security Management Protocol*.

The physical security requirements of the Australian Government Physical Security Management Protocol can be achieved by:

- ensuring ICT equipment and media always resides in an appropriate security zone
- storing ICT equipment and media during non-operational hours in an appropriate security container or room
- using ICT equipment with a removable hard drive which is stored during non-operational hours in an appropriate security container or room as well as sanitising the ICT equipment's Random Access Memory (RAM)
- using ICT equipment without a hard drive as well as sanitising the ICT equipment's RAM
- using an encryption product to reduce the physical storage requirements of the hard drive in ICT equipment to an unclassified level as well as sanitising the ICT equipment's RAM

Agencies must ensure that ICT equipment and media with sensitive or classified information is secured in accordance with the requirements for storing sensitive or classified information in the *Australian Government Physical Security Management Protocol*.

(control 0161 of ISM (control last updated Sep 2011))

10 Administrative Requirements

- 10.1 The Licensee agrees to comply at all times with the following Administrative minimum requirements.
- a. only allow the Unit Record Data from the Datasets to be viewed by Authorised Users;
 - b. access to the password protected drive is only by Authorised Users and the password must only be known to Authorised Users of the Datasets;
 - c. where the Authorised User has access to the **General Release** dataset via CD ROM or DVD it is to be kept and used only on the Organisation's premises;
 - d. where the Authorised User does not have access to the **Unconfidentialised** dataset via a password protected server, Authorised Users may download the Dataset onto a password protected stand alone computer on the Organisation's premises;
 - e. there must be an effective means of limiting entry during both operational and non-operational hours to rooms or buildings in which the **General Release** datasets are used or stored. If possible and where practical, the room must be locked when an Authorised User is not there;
 - f. there must be an effective means of limiting entry during both operational and non-operational hours to the dedicated lockable room/s in which the **Unconfidentialised** datasets are used or stored. The room must be locked when an Authorised User is not there;
 - g. the keys or combinations to lockable containers in which Datasets are kept must be kept secure and not be given to any Unauthorised Person;
 - h. a record must be kept of all people who have been issued with keys and/or combinations to containers in which the Datasets are used or stored;

- i. any unit record output from the Datasets must not be left unsecured for more than 10 minutes, and must be stored in a locked commercial grade container and disposed of using a crosscut shredder when no longer required;
- j. when using the Datasets, users must lock their screen when they are away from their workstation;
- k. the Business Owner or their nominated representative may with at least three Business Days' notice and during normal business hours make a physical inspection of the premises in which the Datasets are stored or used to ensure the security and administrative measures are in place, subject to the Business Owner complying with the security measures of the Organisation.

11 User support

- 11.1 DSS will provide Authorised Users, through the Survey Contract Manager, with technical assistance to the Licensee in use of the Dataset in accordance with this Deed.

12 Non-disclosure

- 12.1 In consideration of DSS disclosing certain Confidential Information to the Licensee, the Licensee acknowledges and agrees with DSS:
 - 12.1.1 that all Confidential Information is confidential, is the property of DSS, and is of value to DSS, and that any Confidential Information disclosed to the Licensee is only disclosed pursuant to the terms of this Deed;
 - 12.1.2 to keep Confidential Information confidential at all times;
 - 12.1.3 that it must not, other than with the prior written approval of DSS (which may be granted or withheld in DSS's absolute discretion);
 - (a) use;
 - (b) disclose;
 - (c) divulge;
 - (d) make a digital or any other copy of;
 - (e) transmit electronically (including via email); or
 - (f) deal with,
 any Confidential Information, nor allow any act, matter or thing to be done or occur whereby any Confidential Information may be ascertained or used by, or disclosed or communicated to, any other person, except in accordance with the terms of this Deed; and
 - 12.1.4 that it must observe and be bound by the provisions of this Deed.
- 12.2 The Licensee must:
 - 12.2.1 take all reasonable steps and do all reasonable things necessary, and do all things that may be reasonably required by DSS to keep the Confidential Information, including all Documents, and all other things recording, containing, settling out or referring to any Confidential Information, under effective control of the Licensee and protected from any unauthorised use or access;

- 12.2.2 immediately notify DSS if the Licensee becomes aware of any unauthorised access to, or use or disclosure of, any Confidential Information;
- 12.2.3 ensure that Confidential Information is not given to a person who is not an Authorised User;
- 12.2.4 if required at any time by DSS to do so, deliver up to DSS, or at the option of DSS destroy, without limitation, all Documents containing any Unit record Data in the possession, custody or control of the Licensee; and
- 12.2.5 if required by DSS:
 - (a) permit DSS or any nominees of DSS, upon at least three Business Days' notice and during normal business hours and subject to the security measures of the Licensee's Organisation, reasonable access to those premises where the Datasets are stored or being used, and records of the Licensee, (including without limitation, access to any of the Licensee's computer hard drives and computer disks containing Confidential Information belonging to DSS) to ensure or check compliance with this Deed; and/or
 - (b) provide to DSS a statutory declaration signed by the Licensee stating that they have complied with clause 12.2.4.
- 12.3 The Licensee may retain a copy of the Confidential Information if, and only to the extent to which and for the purpose for which, the Licensee is required by law to do so but subject to compliance with clause 12.1.
- 12.4 This clause 12 will survive the expiration or termination of this Deed.

13 Disclosure as required by law

- 13.1 The Licensee may disclose any Confidential Information which the Licensee is required by law to disclose, but only if the extent and the manner of the disclosure is strictly limited to what is required by law.
- 13.2 The Licensee undertakes to provide DSS with sufficient notice to enable DSS to seek a protective order or other relief from disclosure and to provide all assistance and co-operation which DSS reasonably considers necessary for that purpose.

14 Intellectual Property

- 14.1 The Licensee acknowledges and agrees that the Commonwealth owns all Intellectual Property rights in the Dataset.
- 14.2 Except where specified under a separate agreement, the Commonwealth will not own the Intellectual Property rights in any Research Material created using the Dataset to the extent the Research Material does not include the Unit Record Data.
- 14.3 The Licensee must enter into FLoSee, bibliographic details of any final Research Material produced by the Licensee using the Datasets within 30 days of completion.
- 14.4 The Licensee is exempt from the requirements in clause 14.3 if the Research Material is for internal administration of Australian Government agencies or for confidential business purposes for the Australian Government.
- 14.5 Where the Licensee has ownership of the Intellectual Property, the Licensee grants a perpetual licence to the Commonwealth to use, reproduce, adapt and modify the Research Material for any of the Commonwealth's Internal Purposes.

- 14.6 For the purposes of this clause 14, the Commonwealth's Internal Purposes means:
- 14.6.1 use of the Research Material by DSS to understand the extent to which the Datasets are being used; and
 - 14.6.2 ready access by the Commonwealth to information and research to support internal policy development and evaluation.
- 14.7 Where the Licensee is not the owner of the Intellectual Property of the Research Material, the Licensee warrants that he or she will procure a sub-licence from a third party for the Research Material on the same terms as the Licensee grants to DSS under clause 14.5.
- 14.8 If the Commonwealth wishes to make any part of the Research Material publicly available, the Commonwealth will first obtain the written consent of the owner of the Intellectual Property.
- 14.9 This clause 14 will survive the expiration or termination of this Deed.

15 Acknowledgement and Disclaimer

- 15.1 The Licensee agrees to acknowledge DSS and the Survey Contract Manager for the use of the Dataset and assistance provided in using the Dataset in any reports and publications that use the Dataset.
- 15.2 The Licensee agrees that any of the material produced by the Licensee and made publicly available will include the acknowledgment in the latest version of the Manual or any variation of the acknowledgment which has been approved in writing by DSS in any reports and publications.

16 Privacy

- 16.1 The Licensee agrees with respect to all Confidential Information made available or provided by DSS or any other person at any time which comprises Personal Information as defined in the *Privacy Act 1988 (the Act)*:
- 16.1.1 to comply as if they were an agency bound by the Act with those provisions of the Act concerning the security, use and disclosure of information;
 - 16.1.2 to co-operate with any reasonable demands or enquiries made by the Privacy Commissioner;
 - 16.1.3 to ensure that any person who has an access level which would enable that person to obtain access to any information in respect of which DSS has obligations under the Act is made aware of, and undertakes in writing, to observe the provisions referred to in clause 16.1.1 above;
 - 16.1.4 to take all reasonable measures to ensure that such information is protected against loss and against unauthorised access, use, modification, disclosure or other misuse and that only Approved Individuals have access to it;
 - 16.1.5 not to transfer such information outside Australia, or allow parties outside Australia to have access to it, without the prior written approval of DSS;
 - 16.1.6 to immediately notify DSS when the Licensee becomes aware of a breach of security by any Individual; and
 - 16.1.7 to notify DSS of, and co-operate with DSS in the resolution of, any complaint alleging an interference with privacy.

16.2 The Licensee's obligations in this clause 16 are in addition to, and do not restrict, any obligations it may have under:

16.2.1 the Act; or

16.2.2 any privacy codes or privacy principles contained in, authorised by or registered under any law including any such privacy codes or principles that would apply to the Licensee but for the application of the other provisions of this clause 16.

16.3 This clause 16 will survive the expiration or termination of this Deed.

17 Conflict of interest

17.1 The Licensee warrants that no conflict of interest exists or is likely to arise while in receipt of Confidential Information.

17.2 The Licensee warrants that it will not permit any situation to arise or engage in any activity that may result in a conflict of interest with the Licensee's receipt of Confidential Information.

18 Legal requirements

18.1 Each party acknowledges and agrees to comply with the law in force in the Australian Capital Territory (Australia), including but not limited to:

18.1.1 *Social Security Act 1991*;

18.1.2 *Privacy Act 1988*; and

18.1.3 *Criminal Code Act 1995*.

18.2 The Licensee acknowledges that unauthorised disclosure of information held by the Commonwealth is subject to the sanction of criminal law under sections 70 and 79 of the *Crimes Act 1914* and section 91.1 of the *Criminal Code Act 1995*.

19 Indemnity

19.1 The Licensee agrees to indemnify DSS from and against any:

19.1.1 cost or liability incurred by DSS;

19.1.2 loss of or damage to property of DSS; or

19.1.3 loss or expense incurred by DSS in dealing with any claim against it including reasonable legal costs and expenses on a solicitor/own client basis;

arising from:

19.1.4 any negligent act or omission by the Licensee in connection with the use of the Dataset;

19.1.5 any breach by the Licensee of its obligations or warranties under this Deed;

19.1.6 any use or disclosure by the Licensee of Confidential or Personal Information held or controlled in connection with this Deed; or

19.1.7 the use by DSS of the Research Material as intended under this Deed but only to the extent that the Research Material has not been misquoted or taken out of context.

- 19.2 The Licensee's liability to indemnify DSS under clause 19.1 will be reduced proportionately to the extent that any negligent act or omission of DSS contributed to the relevant liability, loss or damage, or loss or expense.
- 19.3 The right of DSS to be indemnified under this clause 19 is in addition to, and not exclusive of, any other right, power or remedy provided by law, but DSS is not entitled to be compensated in excess of the amount of the relevant liability, loss or damage, or loss or expense.
- 19.4 This clause 19 will survive the expiration or termination of this Deed.

20 Applicable law

- 20.1 This Deed will be governed by and construed in accordance with the laws of the Australian Capital Territory (Australia) and the Licensee agrees to submit to the non-exclusive jurisdiction of the courts of the Australian Capital Territory in respect of all matters arising under, or in relation to, this Deed.

21 No exclusion

- 21.1 This Deed does not exclude the operation of any principle of law or equity intended to protect and preserve the confidentiality of the Confidential Information.
- 21.2 The rights and remedies provided under this Deed are cumulative and not exclusive of any rights or remedies provided by law.

22 Dispute resolution

- 22.1 DSS and the Licensee will attempt in good faith to resolve through negotiation any disputes, claim or controversy arising out of or relating to this agreement.

23 Termination of Deed

- 23.1 This Deed may be terminated by either party providing at least 14 days prior notice in writing.
- 23.2 DSS may terminate this Deed by notice in writing, with effect from the date in the notice, if the Licensee fails to remedy a breach of the Deed within 30 days of being given notice by DSS requiring the breach to be remedied.
- 23.3 On expiration or termination of this Deed in accordance with clause 23.1 or clause 23.2, the Licensee must immediately relinquish all DSS datasets in the Licensee's possession by returning them to DSS or take such other steps as agreed with DSS.

24 Notices

Giving notices

- 24.1 A notice, consent, information, application or request that must or may be given or made to a party under this Deed is only given or made if it is in writing and:
- 24.1.1 delivered or posted to that party at its address set out below;
 - 24.1.2 emailed to that party at its email address set out below; or
 - 24.1.3 faxed to that party at its fax number set out below.
- 24.2 If a party gives the other party 5 business days' notice of a change of its email or postal address, a notice, consent, information, application or request is only given or made by that other party if it is delivered, posted or emailed to the latest address.

DSS

Name: Department of Social Services
Business Owner Longitudinal Surveys
National Centre for Longitudinal Data
Policy Evidence Branch TOP DE4

Postal Address: PO Box 9820
Canberra ACT 2610

Email: longitudinalsurveys@dss.gov.au

Fax: 02 6206 9545

Licensee

Name:
Melissa Deacon-Crouch

Position:
PhD student

Address:
Dept. Rural Nursing and Midwifery,
La Trobe Rural Health School,
La Trobe University
PO Box 199
Bendigo Victoria 3552

Email:
m.deacon-crouch@latrobe.edu.au

Fax Number:

I understand that I must provide DSS with any changes to the above information.

Signature of the Licensee

Time notice is given

24.3 A notice, consent, information, application or request is to be treated as given or made at the following time:

- 24.3.1 if it is delivered, when it is left at the relevant address;
- 24.3.2 if it is sent by post, 5 Business Days after it is posted; or
- 24.3.3 if it is sent by email or fax, upon actual receipt by the addressee.

If a notice, consent, information, application or request is delivered after the normal business hours of the party to whom it is sent, it is to be treated as having been given or made at the beginning of the next Business Day.

25 Miscellaneous

Assignment

- 25.1 Except as expressly permitted by this Deed, the Licensee must not assign any of their rights under this Deed without the prior written consent of DSS. That consent may be given or withheld at DSS's absolute discretion.

Costs

- 25.2 Each party will bear its own costs in relation to this Deed, including the exercise of rights and performance of obligations specified in the Deed.

Entire agreement

- 25.3 This document contains everything the parties have agreed on in relation to the matters it deals with. No party can rely on an earlier document, or anything said or done by another party, or by a director, officer, agent or employee of that party, before this Deed was executed, save as permitted by law.

No agency or partnership

- 25.4 No party is an agent, representative, partner of any other party by virtue of this Deed.

No authority to act

- 25.5 No party has any power or authority to act for or to assume any obligation or responsibility on behalf of another party, to bind another party to any agreement, negotiate or enter into any binding relationship for or on behalf of another party or pledge the credit of another party except as specifically provided in this Deed or by express agreement between the parties.

Severability

- 25.6 If a clause or part of a clause of this Deed can be read in a way that makes it illegal, unenforceable or invalid, but can also be read in a way that makes it legal, enforceable and valid, it must be read in the latter way. If any clause or part of a clause is illegal, unenforceable or invalid, that clause or part is to be treated as removed from this Deed, but the rest of this Deed is not affected.

Time for action

- 25.7 If the day on or by which something is required to be done or may be done is not a Business Day, that thing must be done on or by the next Business Day.

Variation

- 25.8 No variation of this Deed will be of any force or effect unless it is in writing and signed by the parties to this Deed.

Waiver

- 25.9 The fact that a party fails to do, or delays in doing, something the party is entitled to do under this Deed, does not amount to a waiver of any obligation of, or breach of obligation by, another party. A waiver by a party is only effective if it is in writing. A written waiver by a party is only effective in relation to the particular obligation or breach in respect of which it is given. It is not to be taken as an implied waiver of any other obligation or breach or as an implied waiver of that obligation or breach in relation to any other occasion.

Execution

Executed as a DEED on Date: 13/11/16

Signed, sealed and delivered for and on behalf of THE COMMONWEALTH OF AUSTRALIA as represented by the Department of Social Services by

Name of authorised officer (print)

Signature of authorised officer

Delegate, Longitudinal Surveys

Name of HILDA authorised officer (print)

Signature of HILDA authorised officer

Name of LSAC authorised officer (print)

Signature of LSAC authorised officer

Anastasia Sartbayeva

Name of LSIC authorised officer (print)

Signature of LSIC authorised officer

Name of BLNA authorised officer (print)

Signature of BLNA authorised officer

In the presence of

Joanne Harrison

Departmental Officer

Department of Social Services

Name of witness (print)

Signature of witness

Signed, sealed and delivered by

Name of Licensee (researcher)

Meissa Deacon-Crouch

Signature of Licensee (Researcher)

In the presence of:

Kathleen Tan

Name of witness

Signature of witness

Appendix 11: Approval to access to Australian Bureau of Statistics Confidentialised Unit Record Files

From: [Mark Miller](#)

To: [Melissa Deacon-Crouch](#)

Cc: [Tricia Van Der-Kuyp](#)

Subject: Approval to access to ABS CURF/s Deacon-Crouch

Date: Thursday, 19 January 2017 12:40:59 PM

Dear Ms Deacon-Crouch,

Thank you for your application to access the following CURF/s:

Australian Health Survey National Health Survey 2011-12 - Expanded on RADL

Australian Health Survey Core Content - Risk Factors and Selected Health Conditions 2011-12 - Expanded on RADL

Australian Health Survey Nutrition and Physical Activity 2011-12 Second Edition - Expanded on RADL

Australian Aboriginal and Torres Strait Islander Health Survey Nutrition and Physical Activity 2012-13 Second Edition - Expanded on RADL

Your Application has been approved and you are now authorised to access the CURF/s (above).

For CURF/s which you are authorised to access via the RADL

To obtain your **password** please phone 02 6252 7714 between the hours of 10am - 4pm Canberra Time.

Please note: you have been allocated additional User Ids for access to:

Australian Aboriginal and Torres Strait Islander Health Survey Core Content Risk Factors and Selected Health Conditions 2012-13 - Expanded on RADL - State

Australian Aboriginal and Torres Strait Islander Health Survey Detailed Conditions and Other Health Data 2012-13 - Expanded on RADL - State

Australian Aboriginal and Torres Strait Islander Health Survey Core Content Risk Factors and Selected Health Conditions 2012-13 - Expanded on RADL - State by Remoteness

Australian Aboriginal and Torres Strait Islander Health Survey Detailed Conditions and Other Health Data 2012-13 - Expanded on RADL - State by Remoteness

As an authorised user, it is essential that you read the [User Manual: ABS Remote Access Data Laboratory](#) (RADL) before accessing RADL and [User Manual: Responsible Access to ABS CURFs](#). .

Under the CURF Terms & Conditions of use, your User ID and password must be kept secure and must not be disclosed to any other person.

Please allow at least 24 hours upon receipt of this letter before logging onto the Remote Access Data Laboratory at www.abs.gov.au/radl.

Approval to access ABS CURF/s - DATALAB

Australian Health Survey National Health Survey 2011-12 - ABSDL

Australian Health Survey Nutrition and Physical Activity 2011-12 Second Edition - ABSDL

Australian Health Survey Core Content - Risk Factors and Selected Health Conditions 2011-12 - ABSDL

Your application has been approved and you are now authorised to access this microdata file.

The DataLab team has been notified, and you will need to organise a time to go into an ABS office if required.

Basic CURF access

Thank you for your application to access the following CURF/s:

**Australian Aboriginal and Torres Strait Islander Health Survey Nutrition and Physical Activity
2012-13 - Basic on CD-ROM**

Australian Health Survey Nutrition and Physical Activity 2011-12 Third Edition - Basic on CDROM

Your Application has been approved and you are now authorised to access the CURF/s.

CURF/s which you are authorised to access via CD-ROM will be provided by your **Contact Officer
Tricia Van Der-Kuyp at La Trobe University.**

If you have any questions please contact us via microdata.access@abs.gov.au.

Kind regards,

Mark

Please send all correspondence to microdata.access@abs.gov.au

Microdata Access Strategies

Communications and Dissemination Branch | Governance, People and Culture Division | **Australian
Bureau of Statistics**

(T) +61 2 6252 7714

(E) microdata.access@abs.gov.au (W) [Microdata Entry Page](#)

Appendix 12: Summary of Licences

	Journal	Permission to reproduce in thesis
Paper 2	Deacon-Crouch, M, Skinner, I, Connelly M, Tucci J. Chronic disease, medications and lifestyle: perceptions from a regional Victorian Aboriginal community. Pharmacy Practice 2016 Jul-Sep (2016); 14(3): 798. doi: 10.18549/PharmPract.2016.03.798 www.pharmacypractice.org(eISSN: 1886-3655ISSN: 1885-642X)	Pharmacy Practice permits and encourages authors to post and archive the final PDFs of their respective articles submitted to the journal on personal websites or institutional repositories after publication, while providing bibliographic details that credit its publication in this journal. Creative Commons This is an open access article distributed under the terms of the Creative Commons CC BY license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. You are not required to obtain permission to reuse this article. CC0 applies for supplementary material related to this article and attribution is not required.
Paper 3	Association between short sleep duration and body mass index in Australian Indigenous children Journal of Paediatrics and Child Health	 Right to use in dissertation LSIC BM
Paper 4	The mediating role of sleep in the relationship between Indigenous status and body mass index in Australian school-aged children Journal of Paediatrics and Child Health	 Right to use in disseration LSIC mec
Paper 5	Deacon-Crouch, M., Begg, S. & Skinner, T. Is sleep duration associated with overweight/obesity in Indigenous Australian adults? BMC Public Health (2020) 20, 1229.	Creative Commons This is an open access article distributed under the terms of the Creative Commons CC BY license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. You are not required to obtain permission to reuse this article. CC0 applies for supplementary material related to this article and attribution is not required.
Paper 6	Indigeneity and its association with Body Mass Index (BMI) in Australian adults: Does sleep duration affect the relationship? Under Revision with PLOSOne	PLOS applies the Creative Commons Attribution (CC BY) license to articles and other works we publish. If you submit your paper for publication by PLOS, you agree to have the CC BY license applied to your work. Under this Open Access license, you as the author agree that anyone can reuse your article in whole or part for any purpose, for free, even for commercial purposes. Anyone may copy, distribute, or reuse the content as long as the author and original source are properly cited. This facilitates freedom in re-use and also ensures that PLOS content can be mined without barriers for the needs of research.

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