Pilyii Papulu Purrukaj-ji

(Good housing to prevent sickness):

A study of housing, crowding and hygiene-related infectious diseases in the Barkly Region, Northern Territory

(Photo by Trisha Nururla Frank, 2019.)

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Culturally Responsive
Anyinginyi Health Aboriginal Corporation

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Indigenous Design Place

Acknowledgement of country

The authors acknowledge the Warumungu People on whose land this project was situated, and pay our respects to the elders past, present and emerging. We note that we live, work and learn on Aboriginal land, and sovereignty has never been ceded.

Acknowledgement of key stakeholders

The authors offer acknowledgements and thanks to all the Warumungu People and other Indigenous Australians who contributed to this project as authors, researchers, advisors, assistants and participants. We say *Kamarnta* (thank you) particularly to the Board and staff of Anyinginyi Health Aboriginal Corporation and to the residents of Tennant Creek Community Living Areas and of Barkly communities who participated in the survey and interviews. Thank you to Julalikari Council Aboriginal Corporation. We would also like to thank The University of Queensland's Global Change Institute for funding this project through a Global Change Flagship grant.

Qualifier:

This is an exploratory piece of research carried out to identify and investigate apparent relationships between health and housing in the Barkly Region. The samples of data were not sufficient in size or types to prove any direct causal relationships or establish indisputable statistical correlations of causal factors. Rather, the research was designed to determine whether plausible hypotheses could be established, and whether they deserve ongoing investigation with a larger and more comprehensive study of the phenomena involved. The authors are of the view that this aim has been achieved. Combined with other known findings from the relevant literature on these topics, there are sufficient overall findings to make a range of practice and policy recommendations for ongoing use until larger scale research can confirm further the preliminary findings herein.

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Executive Summary

> *'I worked out bush, and saw improvements from good education, good housing. I would get distressed treating kids again and again with antibiotics; they've got to affect your immune system … Before, they were living in little sheds, with eight or nine in a little shed. Caused a lot of stress for families.*
>
> *… When I started going back, and houses were built, I noticed immediately a drop in the scabies… You could see the mental change. Could see the difference in families. Kids are healthier and happier. I've seen this repeated in other communities once housing was given- the change'.*
>
> (Interview with an Aboriginal Health Worker (code K3)
>
> at Anyinginyi Health Aboriginal Corporation, June 2019).

Housing and crowding are critical to health. Sufficient, well-maintained housing infrastructure can support healthy living practices for hygiene, nutrition and safety. However, when there is insufficient public housing for a growing community and a lack of functioning health hardware, the transmission risk of hygiene-related infectious diseases increases. The outcome is that many Indigenous Australians currently living in remote areas experience considerably higher levels of preventable infections, such as boils, scabies, middle ear infections and lung infections, than their non-Indigenous and urban counterparts.

This report provides a case study of Tennant Creek and the surrounding Barkly Region in the Northern Territory, to highlight the relationship between remote housing, crowding and infectious disease. It was conducted in partnership between The University of Queensland (School of Public Health and Aboriginal Environments Research Centre) and Anyinginyi Health Aboriginal Corporation, an Aboriginal Community-Controlled Health Organisation that provides health services within the town and through a mobile clinic.

Data were drawn from three sources: over two years of infection diagnoses from the Anyinginyi clinical database, a survey of 36 households in town Community Living Areas (CLAs) and remote bush communities, and 18 interviews with clinicians and public health staff of the Anyinginyi clinic. The data were not intended to be representative, due to a limited sample size, but instead to provide a 'snapshot in time' of the health status, housing quality and crowding levels that were experienced by the targeted residents, observed by Anyinginyi staff, and recorded by the clinicians.

The project found that there are much higher levels of crowding in bush communities and in town than officially recorded, with an average of 7.3 and 10.8 people respectively, and up to maximums of 22 and 20 people respectively reported in households surveyed. Crowding increases the likelihood of health hardware malfunction and results in householders living with non-functional hot water systems, windows, kitchen facilities, washing machines and toilets, among other health hardware. This leads to difficulty performing health living practices such as washing bodies, clothes and bedding, hygienic sanitation, and safe food preparation.

New housing is required to reduce current crowding, yet no new housing has been built in at least 12 years for Aboriginal people in this region. The $78.4 million Barkly Regional Deal and the Remote Housing Strategy ($110million dedicated in the 2019-20 Federal budget) offer an opportunity, but no details had been released as of December 2019. Housing repairs are often delayed.

There are high rates of preventable, hygiene-related infectious diseases in the bush communities and CLAs. Over half of the total infectious disease diagnoses were skin infections (boils, sores, scabies and school sores), respiratory infections (upper and lower respiratory tract), and ear, nose and throat infections (middle ear/otitis media, tonsillitis, ear canal and pharyngitis/sore throat). Other notable diagnoses include trachoma, conjunctivitis, gastroenteritis, rheumatic fever, and tooth decay. Chronic kidney disease and rheumatic heart disease are the outcome of repeated infection. This burden of disease affects morbidity and mortality (life expectancy) with associated costs to the government for ongoing health care for dialysis and treatment.

Bringing together this evidence, the fundamental cause of the high rates of preventable infections is crowding, that is in turn a result of insufficient housing supply, and a lack of maintenance of existing housing by authorities. Residents correctly perceived that specific health issues are exacerbated by housing conditions and crowding, including scabies from insufficient water for bathing, intestinal worms from leaking sewage, and mental health impacts from the stress of living in crowded conditions.

This report provides new evidence that confirms ongoing issues of crowding and health impacts. Crowding rates are no longer being regularly monitored due to the cessation of targeted Aboriginal housing surveys by the Commonwealth Government. Therefore, based on the evidence collated in this report, questions are posed for policymakers in health, housing and Indigenous affairs, including:

- When will new housing be built to reduce crowding and infection levels in remote towns and communities?
- Can housing be better designed, implemented and maintained through increased local Indigenous governance and employment?
- Can health hardware, including washing machines, be ensured to be functional, accessible and available?
- Can infection diagnoses trigger environmental health improvements in clients' homes?

The research has highlighted the need for further research to strengthen the evidence and provide monitoring of improvement initiatives. In responding to these questions with a current evidence base, there is a possibility to achieve the expectation set out in the decade-old National Indigenous Reform Agreement that 'children need to live in accommodation with adequate infrastructure conducive to good hygiene … and free of overcrowding'.

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Key Definitions

Community Living Area (town camp; CLA): The Northern Territory's Community Living Areas (CLAs, formerly known as town camps; (Deloitte, 2017)) are primarily areas in and around towns and cities that were established for Aboriginal people visiting from remote areas to stay for short periods. A 'Community Living Area' (CLA) is a sublease from the Northern Territory Government's housing department that allows Territory Housing to transfer, sublet or assign the sublease to a Northern Territory Entity. This includes the right to construct, demolish, upgrade, extend, refurbish, landscape or do any other act or thing in relation to all improvements and services on the premises and in relation to the premises more generally (Deloitte, 2017). For many residents, CLAs are now their permanent home. In 2018, there were 43 CLAs in NT, including in Tennant Creek. Tennant Creek CLA houses are regularised under public housing arrangements with the Department of Housing and Community Development (NT HCD, 2018).

Health Hardware: Health hardware is the equipment and facilities (such as toilets and showers) necessary to achieve and maintain adequate personal health (Browett et al., 2012b). Such equipment predominantly pertains to water-based hygiene and enables the healthy living practices.

Healthy Living Practices: The Healthy Living Practices are nine key practices that link the environment where people live to safety and healthy living, as developed by Healthabitat (HealthHabitat, 2019, Pholeros et al., 1993a):

1) Washing people
2) Washing clothes and bedding
3) Removing wastewater safely
4) Improving nutrition, the ability to store, prepare and cook food
5) Reducing the negative impacts of crowding
6) Reducing the negative effects of animals, insects and vermin
7) Reducing the health impacts of dust
8) Controlling the temperature of the living environment
9) Reducing hazards that cause trauma (Pholeros et al., 1993a).

Hygiene-related infectious diseases: Infectious diseases are caused by pathogenic microorganisms (such as bacteria, viruses, fungi and parasites) that can be transmitted from one person to another or from animals to humans both directly and indirectly (World Health Organization [WHO], 2018). Within these, hygiene-related infectious diseases result from inadequate personal and domestic hygiene. Transmission may occur via faecal-oral route, person to person, animal to person contact, or via vectors coming into contact with food or people (Department of Health [DoH], 2010).

Indigenous Australians: Australian Indigenous Peoples include Aboriginal and/or Torres Strait Islander Peoples. The Barkly Region is traditional land to several Aboriginal Peoples.

Indigenous communities: A discrete Indigenous community is formally defined as a geographic location with physical or cadastral boundaries, inhabited predominantly (greater than 50 percent of usual residents) by Aboriginal and/or Torres Strait Islander peoples, and where housing or infrastructure is managed on a community basis (ABS, 2007). Australian Bureau of Statistics data from 2014-15 estimated the total resident population of Aboriginal and Torres Strait Islanders as three percent (approximately 686,800) of the Australian population (ABS, 2016c). Of this Indigenous population, approximately 21 percent resided in remote and very remote areas (ABS, 2016c).

Remote and very remote locations: The Australian Bureau of Statistics uses the Accessibility/ Remoteness Index of Australia (ARIA+) to classify areas and their degree of remoteness across Australia, with measures for relative access to services (Australia Bureau of Statistics [ABS], 2018a).

1. Introduction

The issue in focus: housing, crowding and health in Indigenous bush communities

Housing and crowding are critical influences of human health. Sufficient, well-maintained housing infrastructure can support healthy living practices for hygiene, nutrition and safety (HealthHabitat, 2019). However, when there is insufficient public housing for a growing community, leading to crowding, and when there is a lack of functioning health hardware such as washing machines and blocked toilets, these all increase the risk that preventable infectious diseases will spread (Ali et al., 2018).

The National Indigenous Reform Agreement (2009) stated that 'children need to live in accommodation with adequate infrastructure conducive to good hygiene … and free of overcrowding' (COAG, 2009). Despite this statement, Indigenous Australians currently living in remote areas experience considerably higher levels of preventable hygiene-related infections than their non-Indigenous and urban counterparts, largely due to crowded and poorly maintained houses (Sims Sanyahumbi et al., 2016, Bowen et al., 2014, Hoy, 2014).

In response, this report has focused on a case study of the remote Barkly Region in the Northern Territory to highlight the relationship between housing, crowding and infectious diseases and collate an evidence base to advocate for more housing and for dedicated housing repair and maintenance budgets.

Overview of the wider project

This report is a part of a larger project initiated in response to urgent challenges of health-related hygiene in Indigenous people living in remote and very remote Australia, noting the association of crowding, poorly-maintained public housing, and hygiene-related infection (Ali et al., 2018, Bailie and Wayte, 2006, McDonald et al., 2009). The project partners have sought to understand and respond to the 'system' of environmental, social and infrastructural changes that could prevent the spread of hygiene-related infections. It was motivated by earlier work by the lead author that included this quote:

> 'To stop the spread of a disease like trachoma, you need population-based housing improvements… You need to maintain a sort of a community level of health hardware in a house in order to have an impact on disease transmission' (NGO representative #1 in GCI (2017)).

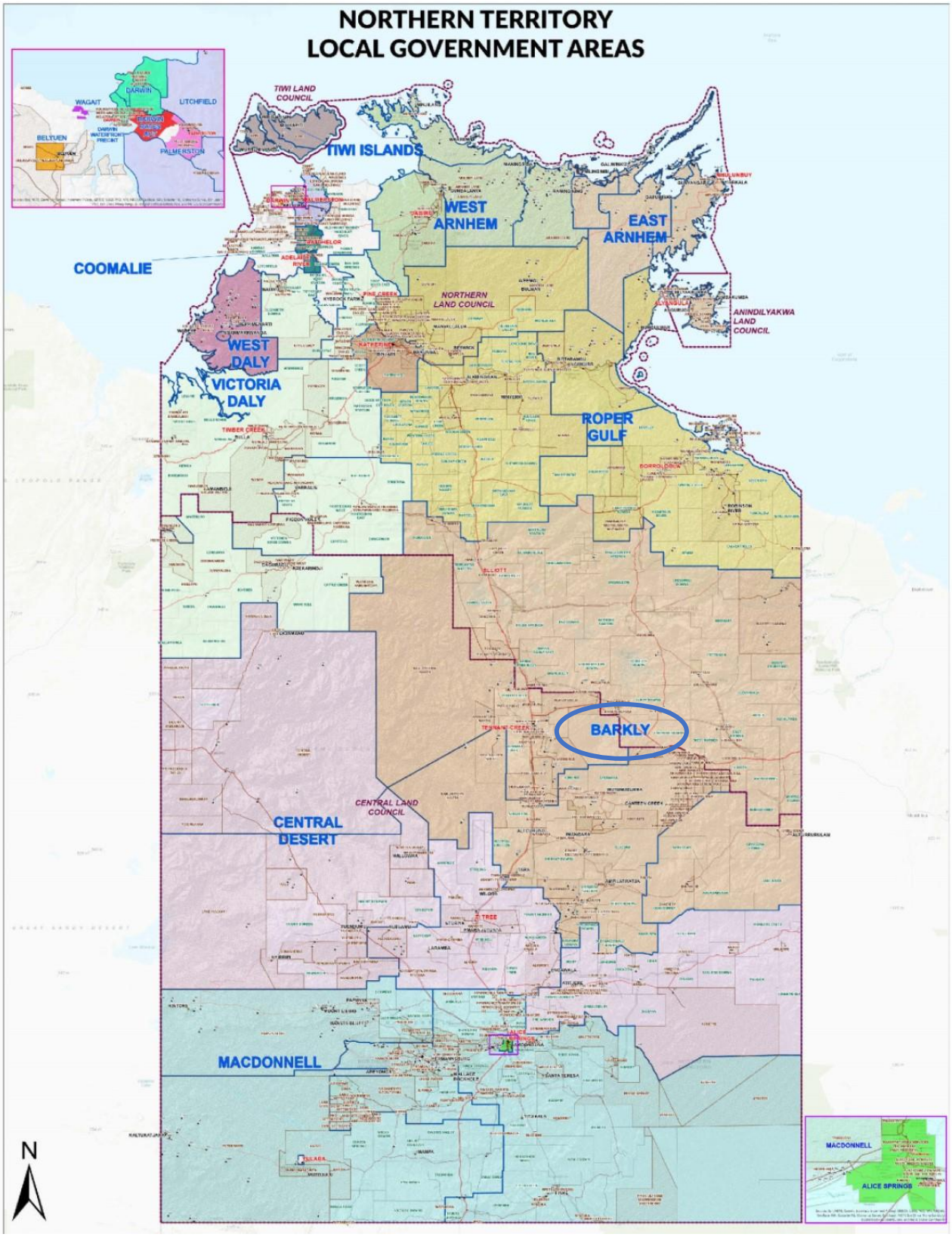
This project was funded by The University of Queensland's Global Change Institute Flagship funding. The project team includes representatives from The University of Queensland (Dr Nina Lansbury Hall, Professor Paul Memmott, Carroll Go-Sam, Dr Daphne Nash), the National Aboriginal and Torres Strait Islander Women's Alliance (NATSIWA; Professor Sandra Creamer AM, Wendy Anders), the University of Melbourne's Indigenous Eye Health Group in the Centre for Health Equality (Professor Hugh Taylor; Yash Srivastava; Fiona Lange), the Institute For Sustainable Futures at the University of Technology, Sydney (Dr Tim Foster), and the Royal Brisbane and Women's Hospital's Infectious Diseases Unit and The University of Queensland (Dr Andrew Redmond).

The case study: Anyinginyi Health Aboriginal Corporation in the Barkly Region NT

The population of Aboriginal and Torres Strait Islander Peoples is spread across Australia. The largest resident numbers live in urban areas of Queensland and New South Wales (Australia Bureau of Statistics [ABS], 2018b). However, the Northern Territory (NT) has proportionately the largest population of Aboriginal and Torres Strait Islander Peoples , comprising about 30 percent of the total population in the NT (ABS, 2018b). It is because of this higher proportionality that Indigenous communities in the NT are the focal point for this report. Furthermore, much of the NT is defined as remote or very remote (ABS, 2018a). The significance of this is that approximately 77 percent of Aboriginal and Torres Strait Islander Peoples live in areas of the NT classified as remote or very remote (ABS, 2018b).

The Barkly Region covers 283,000sqkm of semi-arid red-sand plains, low mountains, intermittent streams, and with water from artesian bores. Sixty-three percent of the Barkly population is Aboriginal, living in Tennant Creek and Elliot, as well as in dispersed and sparsely populated community and outstation bush communities (ABS, 2017b) (Memmott, 2010). Tennant Creek is the regional centre, built on Warumungu land, where people represent 11 language groups (Memmott, 2010). The Barkly Region has the smallest population of all NT regions, at 6,655 (4,531 identifying as Aboriginal), with 2,465 living in Tennant Creek (excluding CLA populations), of which 1,015 are Aboriginal Peoples (ABS, 2016a, ABS, 2017a). This region and its location relative to Darwin and Alice Springs, NT, are featured in Figure 1.

Figure 1: Map of the Barkly Region (circled) in the Northern Territory, relative to Alice Springs (from the Northern Territory Government website, nt.gov.au)



Anyingingyi Health Aboriginal Corporation is an Aboriginal Medical Service based in Tennant Creek, and servicing remote-living residents in the North East and Central Barkly areas within the central-east Northern Territory (AHAC, 2019b). In addition to clinical services in the town and mobile clinics, Anyinginyi provides allied health, public health, social and emotional health services for men, women and families (*Piliyantinji Ki/*Stronger Families*)*, and a gym with sports and recreational activities (AHAC, 2019a). Anyinginyi Health's holistic approach is based on social justice, equity, community inclusion and social acceptability broadly linked with the social determinants of health, with an integration of preventative measures through public health awareness, education, health promotion and community development to build community capacity build and to empower Aboriginal individuals, families and community accepting self-responsibility for health and wellbeing. This structure is illustrated in Figure 2. Anyinginyi is governed by Aboriginal Board members who regularly consult with members of the community, and seek to deliver services within a culturally-appropriate framework (AHAC, 2019a).

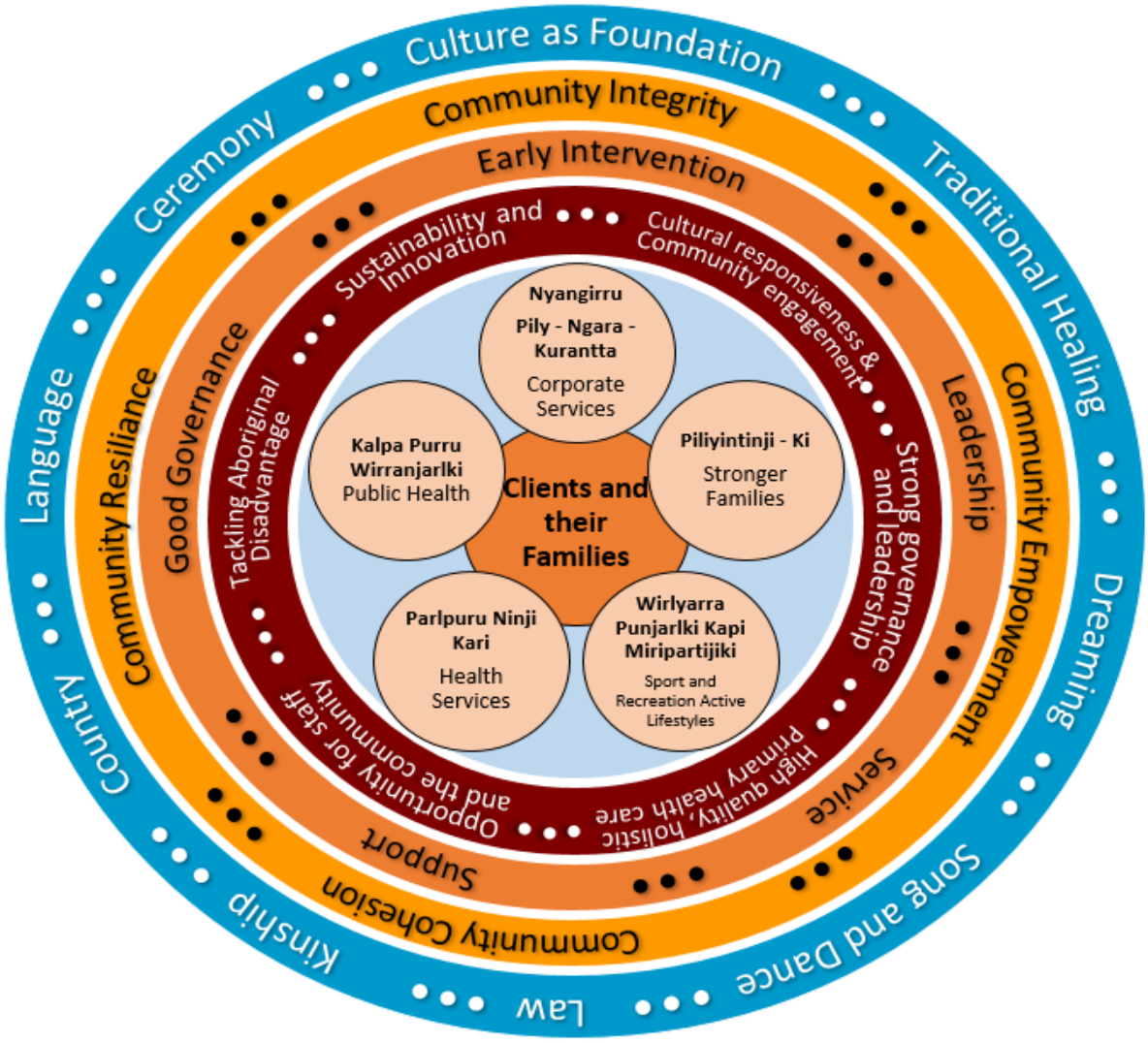


Figure 2: Structure of the Anyinginyi Health Aboriginal Corporation services

The University of Queensland, through project member Professor Paul Memmott, has a long-standing relationship with Anyinginyi Health that spans over 20 years. This relationship has enabled a case study to examine the implications of hygiene, crowding and infectious disease in the Indigenous communities in the Barkly Region. Anyinginyi's CEO has provided written support for the University of Queensland to collaborate with the Corporation on this project. Access to infectious disease diagnoses data from Anyinginyi Health was granted as an outcome of this long-standing trust. For Anyinginyi, the benefits of this project are to 'assist the vision of good health for the people of the Barkly Region. Both improved health and improved housing are held in high priority by our Board' (CEO, Anyinginyi, July 24 2018; see Appendix 1).

2. Background to housing, crowding and health in remote Indigenous Australia

Indigenous Australia

Aboriginal and Torres Strait Islander peoples have lived on their traditional lands for tens of thousands of years (Australian Indigenous HealthInfoNet, 2018b). Indigenous Australian society and economy was severely disrupted in 1788 when Australia was colonised by Europeans (AIHW, 2015, Australian Indigenous HealthInfoNet, 2018b).

As of 2018, it was estimated that there were 778,064 Indigenous Australians, equating to approximately three percent of the total Australian population (AIHW, 2015, Australian Indigenous HealthInfoNet, 2018b). Despite the pressures of colonisation there were 120 unique languages spoken in 2012, and 11 percent of Indigenous people spoke an Indigenous language at home in the 2011 census (AIHW, 2015). Identification with a tribal group, regional group, language group or clan was noted to increase with increasing remoteness, and in 2012-13 approximately three-quarters of Indigenous adults recognised a specific area as their traditional country (AIHW, 2015). In 2012-13 it was also noted that Indigenous Australians living in remote and very remote areas were more likely to live on their traditional country (AIHW, 2015). Living on country has been identified as having strong benefits for cultural and spiritual well-being for Indigenous Australians (Ganesharajah, 2009). Culture and spirituality are central to the Social and Emotional Wellbeing Framework (Australian Indigenous HealthInfoNet, 2019) that describes the holistic nature of health for Indigenous Australians.

Social Determinants of Health for Indigenous Australians

Health and wellbeing have a variety of underlying and causal factors beyond biomedical aspects, known as social determinants of health (Baum, 2015). This is reflected in the World Health Organisation's definition of health in its constitution as 'a state of complete physical, mental and social well-being and not merely the absence of disease' (World Health Organization [WHO], 1946). Social wellbeing is further described by Wilkinson and Marmot (1998) as social influences that affect physical health and longevity. These influences are present throughout an individual's lifetime, and are key determinants of health inequality regarding birth, life, work and age of an individual (Wilkinson and Marmot, 1998, Marmot, 2011). Acknowledgement of these determinants of health can direct more appropriate policy, health promotion, funding, and other responses to improve health and wellbeing (Wilkinson and Marmot, 1998).

Experiences of disadvantage across the social determinants of health are associated with health disparities between Indigenous peoples and non-Indigenous populations (McDonald et al., 2009). The relatively poor health status and living conditions are apparent in Indigenous Australians and also in other international Indigenous peoples, including New Zealand Maori, Native Americans and First Nation Canadians (McDonald et al., 2009, Alderete, 1999). Marmot (2011) details that, although the disadvantage of Indigenous Australians has international comparisons, there is a need for a comprehensive approach to understand the social determinants of Indigenous Australian disadvantage. Understanding the social determinants of health is important when considering how social dislocation, chronic diseases, economic disadvantage, education and employment levels underpin the health of Indigenous peoples (AIHW, 2015). In combination, these factors contribute to poor health in Indigenous peoples and the difference in these factors contributes to what is defined as 'the gap' in disadvantage between non-Indigenous and Indigenous Australians (AIHW, 2015).

The social determinants of health in an Indigenous Australian context are more aligned with the holistic perspective of health traditionally held by Indigenous Australians, where health is viewed as the social, spiritual, emotional and cultural wellbeing of an individual (Australian Health Minister's Advisory Council [AHMAC], 2017, Australian Indigenous HealthInfoNet, 2019). This holistic approach is seen in the structures of Aboriginal Community-Controlled Health Organisations (ACCHOs) and Aboriginal Medical Services (AMSs) that provide primary healthcare operate under an Indigenous-led constitution and on the principles of self-determination (Aboriginal Medical Services Alliance Northern Territory [AMSANT], 2019, DPMC, 2018).

The Closing the Gap 'refresh' in 2018 highlighted various social determinants of health that could offer different approaches to close the gap of Indigenous disadvantage (Holland, 2018, Turner, 2019). Indeed, the most recent Closing the Gap report (2019) noted how socio-economic gradient, remoteness, environmental factors (such as housing condition, crowding and smoking) and health literacy could translate policy into action to improve the health outcomes for Indigenous Peoples. These social determinants of health were reported to have contributed to 34.4 percent of the gap in health outcomes for Indigenous Peoples (DPMC, 2019).

Housing in Remote and Very Remote Indigenous Communities

Housing is a fundamental requirement for supporting health, including for Indigenous Peoples (Carson et al., 2007, Shaw, 2004, AIHW, 2019). The benefits of housing for health are variable but have been linked to the availability of housing, housing design and the state of physical maintenance (Bailie and Wayte, 2006, Carson et al., 2007). As of the 2016 census, 57 percent of all Indigenous households were rented and 21 percent of these were public housing (AIHW, 2019). Specific to remote and very remote areas, Indigenous Peoples were three times as likely to live in public housing when compared to Indigenous households in non-remote areas (56 and 17 percent respectively) (AIHW, 2019). These statistics highlight the reliance that Indigenous Australians have on public housing in remote and very remote areas.

Indigenous Australians rely on public housing because individual land ownership in remote and very remote Australia is difficult to obtain (AIHW, 2019). Community-titled land presents one challenge in obtaining individual land ownership (AIHW, 2019) but perhaps more important are the challenges that are rooted in colonisation (Habibis et al., 2018). Self-determination and cultural identity are inextricably linked to health in Indigenous Peoples, yet the dependence on public housing can create tensions that are particularly acute in remote and very remote areas where community-titled land and high costs of housing management and delivery drive questions of who should provide funding for necessary housing services (Fien and Charlesworth, 2012).

There are various government programs, such as the Community Housing and Infrastructure Program and the National Partnership Agreement for Remote Indigenous Housing (NPARIH), that have provided funding for the delivery of housing services. In 2016, NPARIH was replaced by the Remote Housing Strategy that proposed to fund housing in remote and very remote areas to address issues of crowding, poor housing quality and severe housing shortages (DPMC, 2017). The Strategy has been criticised by WA Labor Senator and Aboriginal Elder, Pat Dodson, as having 'no formal intergovernment communications' on the future of the Strategy, and no 'sustained effort to redesign the program' (NITV, 2018). More recently, the Closing the Gap report (DPMC, 2019) identified housing affordability and supply as a crucial area for policy into action translation. The 2019-20 Federal budget outlined $110 million for remote housing, with the Federal Government issuing a press release stating its commitment to ‘working with state and territory governments to deliver better housing for remote Indigenous communities’ (DPMC, 2019, Australian Government, 2019). Although housing needs are increasingly attracting attention, approximately 5,500 new houses are required by 2028 to reduce the health impacts of crowding in remote communities (DPMC, 2017)- significantly more than could be delivered with the pledged funding.

The Northern Territory Government established a Parliamentary Inquiry into housing in the 43 NT CLAs (Town Camps) in 2016. The Inquiry identified the failure of the Territory Government to ‘provide an efficient and effective Public Housing service to Aboriginal people living in Town Camp communities’, although the ‘complexity’ of service delivery was noted (Deloitte, 2017). In response, a Territory Government Review was commissioned to examine the CLAs in terms of governance, leasing, housing quality, essential infrastructure, service delivery, community aspirations and economic development options (Deloitte, 2017). The Review was conducted by consultancy firm, Deloitte Touche Tohmatsu, and the 2017 report recommended upgrading or replacing ‘dilapidated housing’ to the Residential Tenancy Act standards (Deloitte, 2017). This recommendation suggests that the Territory Housing Maintenance Manual (2009) might not be being followed to maintain housing to liveable standards. This Manual details the timeframe for specific housing repairs, from ‘immediate’ (make safe within 4 hours of notification, including blocked toilets and constantly-running taps), ‘urgent’ (complete within 5 days of notification), ‘routine’ (complete within 10 days of notification, such as no water coming out of bathroom taps), and ‘planned’ (repair within 25 days of notification) (Territory Housing, 2009).

Tennant Creek was one of three remote locations selected for the first rollout of Strategic Indigenous Housing and Infrastructure Program (SIHIP) packages (Furner, 2009). Over $6 million was pledged in 2007 to build 20 new houses through Julalikari Aboriginal Housing Services. However, in mid 2007, the Australian Government launched the ‘national emergency response to protect Aboriginal children in the Northern Territory’ from sexual abuse and family violence, familiarly known as the ‘NT intervention’ or the ‘Emergency Response’ (AHRC, 2007). The NT Intervention enabled the Federal Minister for Indigenous Affairs to control the activities of ‘community service entities’, such as Julalikari, including managing the funding, assets, and business structures (AHRC, 2007). No houses were built (Everingham, 2009, NT Planning Commission, 2017).

Territory Housing is now the main provider of public housing in Tennant Creek, with over 90 percent of the clientele identifying as Aboriginal- the highest in the NT. Since the shift of housing responsibility from Julalikari to Territory

Housing, 78 CLA houses were refurbished, but no new housing has been built in CLAs or in bush communities (Nash and Memmott, 2016). A 2016 review for the Australian Housing and Urban Research Institute found that the combination of Julalikari's reduced role in tenancy management and the parallel 'demise' of Tennant Creek's Council of Elders and Respected Persons have 'destabilised the effectiveness of Indigenous governance' (Nash and Memmott, 2016). In late 2018, a 10 year and $78.4 million commitment, known as the Barkly Regional Deal, was signed by Federal, Territory and Barkly Regional Council local governments. The Statement of Intent listed 'priority areas', including the possibility of 'addressing overcrowding and increasing the supply of housing' (CoA et al., 2019), but details and timelines have not been released by the government agencies.

Existing housing in Tennant Creek is limited, leading to increasingly lengthy waiting periods- from 27 months in 2005 to 98 months in 2015 (Nash and Memmott, 2016). The waiting list can be shortened for priority patients who are seeking accommodation in the town to access ongoing medical services, such as renal dialysis. However, even this prioritisation can be delayed, as illustrated by the documented experience of 75-year old Nangala, a renal patient who was sleeping in a windbreak in a relative's yard for an extended period (see Figure 3) (Frank et al., 2019).

The lack of available and affordable housing creates crowding, that in turn impacts on the functionality of housing infrastructure and on the mental health of the householders. A 2016 report noted that psychological stress from living in crowded conditions contributed to family violence, resulting in crisis accommodation, such as at the Tennant Creek Women's Refuge, being overwhelmed by demand (Nash and Memmott, 2016).

Figure 3: Personal experience of an Aboriginal resident of Tennant Creek, as recorded by her case worker at Anginyingi Health (Frank et al., 2019).

Crowding in Houses in Remote and Very Remote Indigenous Communities

Crowded houses are proportionately higher in remote and very remote areas compared to urban areas (34 and eight percent respectively) (AIHW, 2019, Habibis et al., 2018). In some houses in remote and very remote communities, crowding levels can have four people sleeping in each bedroom (DPMC, 2017, AIHW, 2019) and some reports indicate that houses may have up to 30 residents at any one time (Lowell et al., 2018). In Tennant Creek, an earlier study found an average of ten people per household in CLAs, within a range of three to 25 residents per house (Memmott et al., 2013). High levels of known and documented crowding in Tennant Creek and surrounding communities in the Barkly Region have been the focus of calls for new housing for over a decade (Furner, 2009, Memmott et al., 2013).

Crowding of houses in Indigenous communities has been associated with poor health outcomes (Ali et al., 2018, Bailie and Wayte, 2006, McDonald et al., 2009, Lowell et al., 2018, Vino et al., 2017a). Crowding can influence health in several ways, including increasing the burden on health hardware facilities, increasing stress and increased direct-transmission of infectious conditions (Andersen et al., 2018, DPMC, 2019). The elevated use and burden on health hardware has been identified as a limiting factor for individuals to engage with the healthy living practices (HLPs) (see Appendix 2)(McDonald et al., 2009, DPMC, 2017, Price Waterhouse Coopers, 2007, Bailie et al., 2010a, Bailie and Wayte, 2006, Hall et al., 2017, McDonald and Bailie, 2010).

Lowell *et al.* (2018) highlighted the implications that severe crowding can have on an Indigenous household but also the surrounding community. Also raised in Ali *et al.* (2018) and Hall *et al.* (2017), is the cultural practice of kinship sharing in Indigenous communities. These studies note that crowding not only impacts the health hardware in one household but several throughout the community as neighbours and family may ask to share working facilities such as washing machines, showers or toilets. This indicates that beyond catering for one household, the health hardware in one house may be working for several crowded houses within the community. With necessary health hardware under increased burden there is a greater probability that it will malfunction and therefore can contribute to poorer hygiene levels (Bailie and Wayte, 2006, Bailie et al., 2010b, Bailie et al., 2011, McDonald et al., 2009).

It is noted that crowding can be difficult to calculate from official population figures. Bush community populations may differ due to the inability for the Australian Bureau of Statistics (ABS) definition of 'usual resident' to reflect the high mobility of Aboriginal Australians. In towns, Aboriginal people may move between several houses throughout any given time and therefore may or may not be a 'usual resident' in any of those places. This affects the ability to document crowding (and homelessness) in CLAs as well as communities and outstations in the ABS census (Memmott et al., 2013). For example, in Tennant Creek an independent survey in 2013 found that the average number of people per household was 9.91 with a standard deviation of 4.77 and a range of three to 25, and the average number of people per bedroom per household was 3.14 with a standard deviation of 1.52 in early November (an off-peak period of visitation). This contrasts with the ABS 2016 Census that recorded Tennant Creek household size as 3.3 (ABS, 2016b). The differences in figures are likely due to the practice of the Census not to count visitors, and a possible undercount in the Census (Memmott et al., 2013, Australian Indigenous HealthInfoNet, 2018a). That same report concluded that, in Tennant Creek, Aboriginal people's accommodation needs are not being met, culturally based practices impact on levels of household crowding, and high levels of resilience exist so that high density is often not perceived as crowding from an Aboriginal cultural perspective (Memmott et al., 2013).

Hygiene-related Infectious Diseases in Remote Australian Communities

In remote communities and towns, the government-owned housing can have unmaintained or malfunctioning 'health hardware' facilities, such as bathrooms, kitchens and laundries (APO NT, 2017). These are predominantly related to water-based hygiene functions, and can cause hygiene-related ear, eye and skin infections (Pholeros et al., 1993b, Healthabitat, 2013, Browett et al., 2012a, CDC, 2015). Hygiene-related diseases from a lack of regular washing, access to soap and/or non-functioning health hardware are documented to contribute to acute diseases of diarrhoea, skin infections, strongyloidiasis and hookworm. Australia is the only developed nation listed by WHO as where trachoma persists, with prevalence mainly in remote Indigenous communities, yet trachoma is preventable through facial hygiene and environmental improvements (Lange et al., 2017a, Warren and Birrell, 2016a, Ninti One Limited, 2017).

In addition to malfunctioning health hardware, crowding has been documented as facilitating the transmission of infectious diseases (Ali et al., 2018, Bailie et al., 2011, Quinn et al., 2015, Vino et al., 2017b). Ali *et al.* (2018) provide the most recent and comprehensive review of hygiene-related diseases exploring the underlying social causes, and implications for the transmission of skin, ear, eye and respiratory diseases (see Figure 4)(Ali et al., 2018).

Indigenous children are documented as being the householders with the greatest risk of hygiene-related infectious disease in crowded houses (Clucas et al., 2008, Jacoby et al., 2011, McDonald et al., 2009, Vino et al., 2017b). It was noted in Bailie *et al.*, (2011) that crowding influences the need to wash bedding and Lowell *et al.* (2018) and McDonald *et al.,* (2009) observed that sharing beds was a factor that contributed to transmission of hygiene-related infectious disease, particularly skin infections. Whilst children sharing beds may facilitate transmission of hygiene-related infectious disease in crowded conditions, this is often considered a common cultural practice (Lowell et al., 2018) and thus may be continued despite health risks.

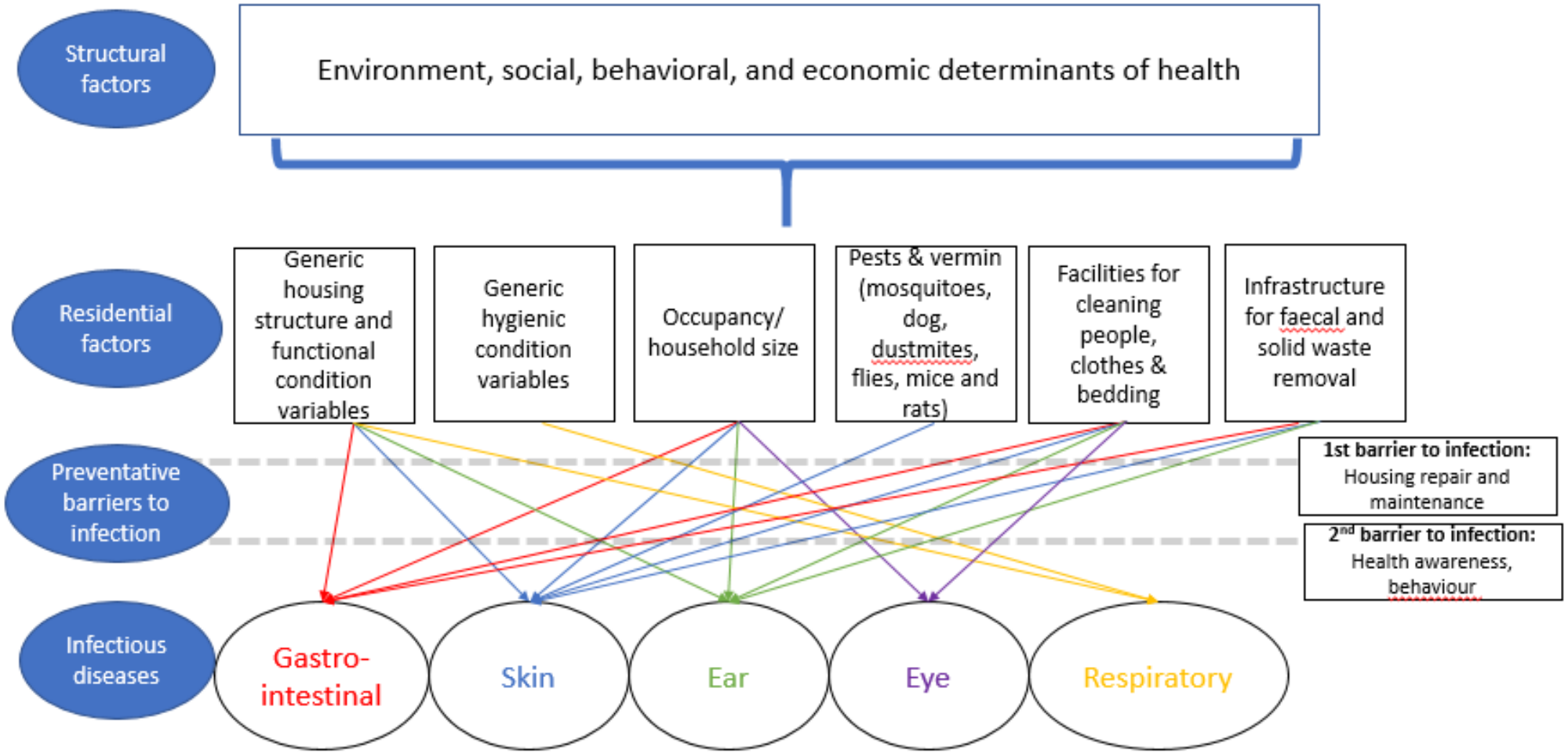


Figure 4: A visual display of the links between housing and infectious diseases (adapted from (Ali et al., 2018))

Specifically regarding skin and respiratory infections, studies have noted that these diseases are more commonly associated with crowding and hygiene-related infections (Bailie et al., 2010a, Clucas et al., 2008, Engelman et al., 2014, Jacoby et al., 2011, McDonald and Bailie, 2010, McDonald et al., 2009, Price Waterhouse Coopers, 2007, Quinn et al., 2015). Of these studies, infections with *Staphylococcus aureus* and *Streptococcus pneumoniae* were specifically linked to direct contact transmission exacerbated by levels of crowding in remote and very remote communities (Engelman et al., 2014, Jacoby et al., 2011). A recent report of *Staphylococcus aureus*-related skin infections identified that a high prevalence of skin hygiene-related infectious disease is linked with crowding (Davey and Tong, 2019).

If repeated infection occurs, these can develop into chronic diseases of limited growth (stunting and wasting), blindness, rheumatic heart disease, renal failure, and anaemia (Foster, 2017, Bailie and Wayte, 2006, DPMC, 2017). Pharyngitis is commonly caused by Group A streptococcus (GAS) bacteria. The bacterium is easily transmitted, and can lead to Acute Rheumatic Fever (ARF) (Remote Primary Health Care Manuals, 2017). Recurrent infections by GAS of traumatised skin after scabies can also lead to ARF and to post-streptococcal glomerulonephritis (PSGN) (Davey and Tong, 2019, Engelman et al., 2014, Marshall et al., 2011). This association is significant as PSGN and rheumatic fever can lead to chronic kidney disease (CKD) (Garcia-Garcia et al., 2017) and rheumatic heart disease (Kerdemelidis et al., 2010) respectively. In the Northern Territory, 32.4 percent of Indigenous adults had CKD (12,000 adults), compared with 7.9 percent of the total adult population in NT (KHA, 2016). Indigenous adults living with signs of CKD in remote (28 percent) and very remote areas (37 percent) are higher than their Indigenous counterparts in major cities (12 percent)(KHA, 2016). Earlier research on end-stage renal disease noted in 2001 that the highest incidence in NT was Tennant Creek, Aputula and Jabiru (Cass et al., 2001). Therefore, how crowding and hygiene-related infectious disease may contribute to chronic diseases warrants further investigation.

In the literature, hygiene programs were identified as potential methods to counterbalance the disease transmission consequences of living in crowded houses in remote and very remote Indigenous communities (Ali et al., 2018, Bailie et al., 2010b, Bailie et al., 2011, McDonald et al., 2009, Vino et al., 2017b). Handwashing programs have been found to reduce transmission of infectious disease (Bailie et al., 2011). McDonald *et al.* (2009) investigated the perceptions and education levels of hygiene in remote Indigenous communities and found that most Indigenous people perceived hygiene positively but were unable to identify where they could improve their hygiene. It was therefore proposed by McDonald *et al.* (2009) that hygiene education be a focus to reduce the impacts of crowding. However, hygiene programs only exhibited slight benefits as universally high levels of crowding and poor conditions of housing hindered beneficial outcomes. Lowell *et al.* (2018) concluded that effective hygiene levels were difficult to achieve with many people in the house. This sentiment was echoed in Hall et al. (GCI, 2017), where cleaning in crowded houses was thought of as a 'continuous task'. Maintenance programs were noted as the fastest and most practical way to reduce the health impacts of crowding (Price Waterhouse Coopers, 2007, Torzillo et al., 2008) but high levels of crowding also reduced the potential beneficial outcomes of these programs (Lowell et al., 2018, McDonald et al., 2009).

This potentially explains why certain housing maintenance programs have had limited success in reducing hygiene-related infections (DPMC, 2017). There have been calls for cyclical housing maintenance programs to be implemented (Ali et al., 2018, Foster and Hall, 2019a, Habibis et al., 2018) as evidence from the national Fixing Houses for Better Health program (McPeake and Pholeros, 2006) observed that 66 percent of health consequences could have been prevented by routine maintenance. It was further detailed in Pholeros and Phibbs (2012) that cyclical maintenance programs may be successful if the target community is involved in the planning and implementation of the program.

3. Methods

This project focused on a case study of an Aboriginal Community-Controlled Health Organisation, Anyinginyi Health Aboriginal Corporation, located in Tennant Creek in the Barkly Region of the Northern Territory, as detailed in the Introduction and in Figure 1.

The case study was conducted using three methods that gathered both quantitative and qualitative data:

- Analysis of diagnoses from the Anyinginyi clinical diagnoses database,
- Survey of residents in town Community Living Areas (CLAs) and remote communities, and
- Interviews with clinicians and public health staff of the Anyinginyi Health clinic.

The data were not intended to be representative, due to the small sample used in each method and the process to collect the data, including negotiating access. Instead, the data provide an indicative 'snapshot in time' of the health status, housing quality and crowding levels that have been experienced by residents, observed by Anyinginyi staff, and recorded in the clinic's database. In combination, this provides the most recent data from which Anyinginyi Health can advocate for policy changes, funding and infrastructural improvements to improve the living conditions of its clients and potentially reduce their burden of infectious diseases.

Ethical clearance was obtained from The University of Queensland Human Research Ethics Committee (approval reference 2018001773), and further approval was granted by the Anyinginyi Board of Directors (see approvals in Appendix 1). The draft results and associated discussion were shared through a return visit to Tennant Creek by one of the project members, Professor Paul Memmott. This included an oral presentation to the Anyinginyi Health Board of Directors' meeting in December 2019. The Directors and relevant staff were encouraged to interrogate the results and the structure of the report in order to ensure that it accurately reflected their region and health service, and to ensure that the data were reported in a format useful for Anyinginyi's future communication of the findings to relevant audiences.

The results from the three methods are detailed in three sub-sections below.

3.1 Clinical Database Diagnosis Analysis

The diagnosis data presented in this report were provided by the Anyinginyi Health Aboriginal Corporation's medical clinic. Data were entered into the Communicare database software by clinicians during client visits. Of these data, infectious disease diagnoses were provided by Anyinginyi Health Aboriginal Corporation for the specific use of this project. Diagnoses, age, sex and location data were collected from the clinic at Tennant Creek in the Barkly Region, Northern Territory between February 2017 and May 2019 (2.3 years).

Raw clinical data were sorted by an Infectious Diseases Physician. Infectious diseases that were not linked to hygiene were excluded due to being beyond the scope of the report. Data for the conditions of chronic kidney disease and rheumatic heart disease were included, as both are the product of repeated infection (Hoy et al., 2012). RHD is linked with Group A Streptococcal infection, and CKD with a more contested and complex relationship, but it is clear that in the NT and in the Barkly Region, repeated infection plays a role (Ramanathan et al., 2017, Dowler and Wilson, 2019). For example, one study found that the rates of decline in renal function in Indigenous Australians is three times higher than other populations, potentially with the inflammatory environment, occasioned by repeated infection, as a likely driver of progressive kidney disease (Maple-Brown et al., 2016). CKD and RHD are prevalent illnesses in the Barkly Region and have long-term impacts on quality and length of life: CKD impacts on both morbidity and mortality, and RHD on morbidity with impacts on mortality less clear. Both of these diseases are seen in Australian Aboriginal communities, in numbers as high, or higher, than in any other place in the world (Bowen et al., 2014, Sims Sanyahumbi et al., 2016, Hoy, 2014, Carapetis et al., 2016).

All data were analysed using Microsoft Excel. Infectious disease diagnoses were organised by organ system (bone and joint, cardiac, dental, ear, nose and throat, gastroenterology, hepatic, immune, neural, optical, renal, reproductive, respiratory, skin and "other"). Redundant or "like" diagnoses were grouped, and total diagnoses numbers over the time period for each organ system are graphically represented in the Results section. Additional data are included in Appendix 3.

3.2 Residential survey

A face-to-face survey was conducted in June 2019 with residents of Community Living Areas (CLAs; formerly known as town camps) within Tennant Creek town, and with residents of two remote bush communities within the Barkly Region. This survey was not intended to be representative or to provide a large sample for statistical analysis. Instead, it was conducted to gather an understanding of the size of the household (including visitor numbers), functionality of the house's health hardware, health of residents of relevance to hygiene-related infectious diseases, and householder perceptions of health and the relationships to housing condition and crowding. The survey template and associated permission requests are provided in Appendix 4.

Each survey was conducted with the self-identified 'house boss' per house. The permission to engage with the house boss was negotiated with a local Aboriginal community member engaged by the researchers and who had personal links to the CLA or community, and an ability to speak with the householders in English and sometimes in the local language or in Aboriginal English. The local assistants received a one-day training from a UQ researcher to understand the purpose of the research and the process for the conduct of the survey. When discussing the survey with the house boss, the local assistant explained that the project involved Anyinginyi Health and had received their support at the highest level. One of four University of Queensland researchers orally delivered the survey and wrote down the house boss's responses. Of these four university researchers, one was Aboriginal although she was not from a country in the Barkly Region. Each survey respondent received AUD$30 in cash for their responses, and the local assistant was paid an hourly rate for their role.

The CLAs were selected on the basis of accessibility through personal connections by the local assistants to ensure trust and openness by the participants to share their information. The bush communities were selected based on accessibility from Tennant Creek in a day trip by the researchers, availability of local assistants living in those communities, and the size of the community to ensure more than five households in total.

In Tennant Creek, six CLAs were surveyed. Two remote communities, Wogyala (also spelled Wakayala) and Mungkarta (also known as McLaren Creek), were surveyed. These locations are displayed in Figure 5. The CLAs within Tennant Creek are each comprised of an Aboriginal corporation holding a lease over Crown land, and mostly located on peripheral areas of the town (Memmott, 2010, Deloitte, 2017). Tennant Creek has seven CLAs with formal leases (with some ancillary camps), as well as some informal camps (without leases) (Memmott, 2007). The CLAs have their own elders and leaders, and in 2010 were noted as strongly retaining traditions (Memmott, 2010). The CLAs are of mixed country origins, but most have a predominance of connection to specific communities and outstations (Memmott, 2010).

Wogyala and Mungkarta are both outstations that receive Anyinginyi Health mobile service visits at least once a fortnight as a day trip from Tennant Creek (AHAC, 2019a). Wogyala is 160km northeast of Tennant Creek on Rockhampton Downs cattle station. It has approximately 30 residents, and includes the Rockhampton Downs primary school, that had 44 students in 2018 (NT Schools, 2018). The community is managed through the Manungurra Aboriginal Corporation that oversees three bush communities. The Bootu Creek mine site is nearby, and initiatives have begun for a post-mine strategy to use the infrastructure of the mine to develop a horticultural farm (NT News, 2018). Mungkarta is an outstation located 85km south of Tennant Creek. It has a population of about 80, according to the Anyinginyi Communicare database, with ten houses and a school. It is occupied all year round. Since the 1950s, the Warumungu and Alyawarre traditional owners were not allowed to live on their own country on McLaren Creek Station, but it was bought in 1985 and this purchase paved the way for a successful land claim under the Land Rights Act heard in 1988. In 1992, traditional owners received title to the 3,500sqkm McLaren Creek station, managed through the Mungkarta Aboriginal Land Trust (CLC, 1992).

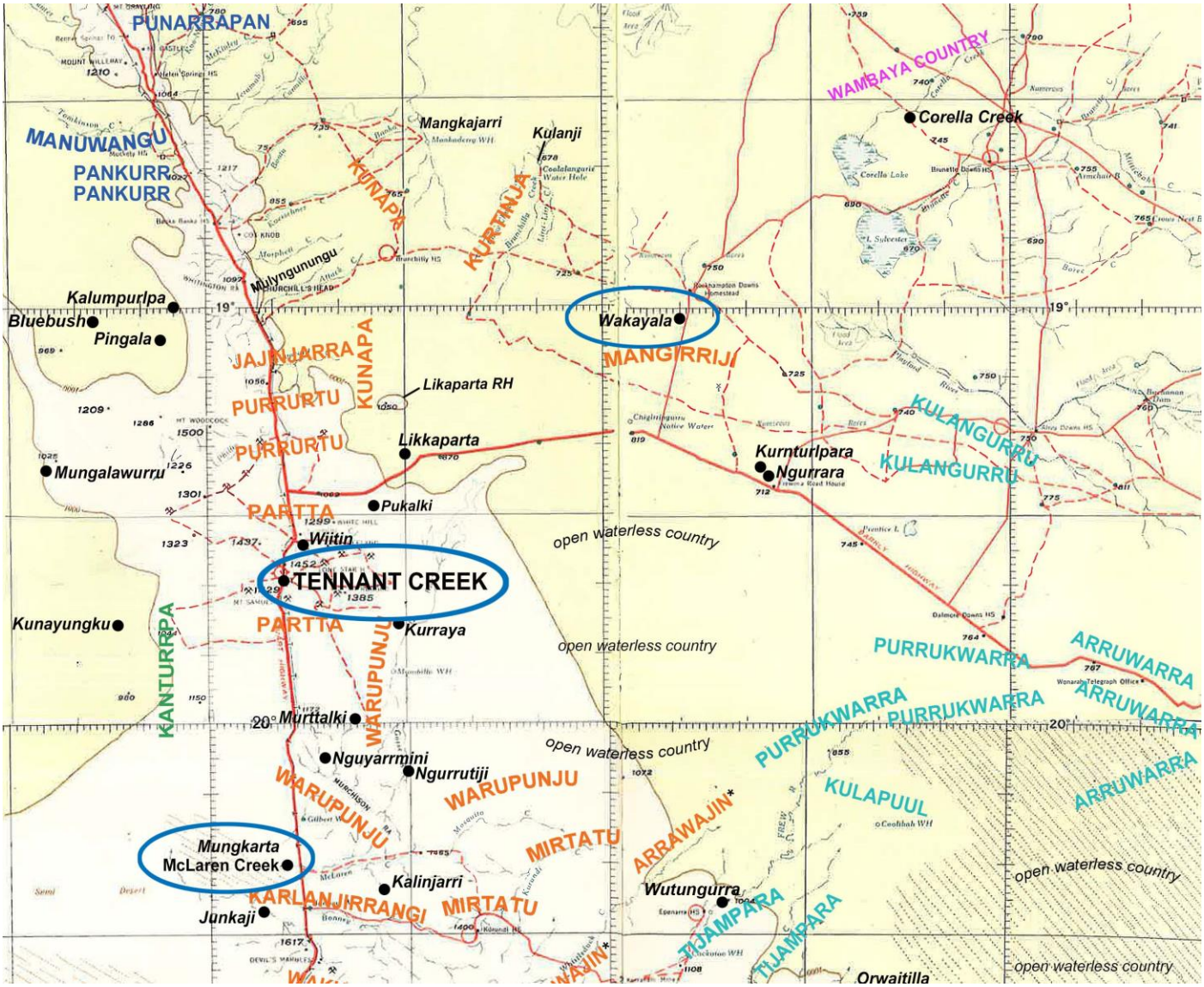


Figure 5: Map of Aboriginal countries in the Barkly Region , Northern Territory, including case study locations of Tennant Creek, Wogyala/Wakayala and Mungkarta/McLaren Creek (in blue circles) (from the Aboriginal Environments Research Centre, The University of Queensland and Barkly Elders)

The 36 resulting household surveys in CLAs and communities are detailed below in Table 1, including the name of the settlement, approximate population and number of households surveyed for this research. In Tennant Creek, 23 households in six CLAs were surveyed. In the two remote communities of Wogyala and Mungkata, a total of 13 households were surveyed. The written responses to the residential survey were transcribed digitally and analysed using Excel spreadsheets to calculate and compare responses. The findings are presented in the Results section.

Table 1: Residential surveys conducted in Community Living Areas of Tennant Creek and remote communities, Barkly Region , NT (June 2019)

Survey location (with alternative name or spelling)	Total population (approx.)*	No. households surveyed
Bush communities (outstations)		
Wogyala (Wakayala)	30	6
Mungkata (McLaren Creek)	80	7
SUB TOTAL		**13**
Community Living Areas/CLAs (in Tennant Creek)		
Tingkali (Tingkkarli)	107	7
Village Camp (Nyinkkanyura)	103	3
Mulga (Ngalpa Ngalpa)	137	8
Marla (Dump Camp)	42	2
Kargaru (including Top Camp)	109	1
Wuppa	123	2
SUB TOTAL		**23**
TOTAL		**36**

*(from Anyinginyi Communicare database 2018)

3.3 Clinical and environmental health interviews

Interviews were conducted with clinical and public health staff of the Anyinginyi Health Aboriginal Corporation in Tennant Creek in June 2019. The interviews were intended to gather the in-depth views of staff who are 'immersed' in the community through their work, and possibly also through family and social connections in the small town (Fontana and Frey, 2000). These views were sought from both clinical and environmental health worker perspectives on the hygiene-related infectious diseases, the status of housing functionality, and the existence and impacts of crowding of those Anyinginyi clients who present in both the Tennant Creek clinic and the mobile clinic visiting remote bush communities. The questions were much more detailed and technical than those asked in the residential survey due to the staff holding a professional knowledge base regarding health. These are provided in Appendix 5, including associated permissions.

A diversity of staff was sought from a range of roles, length of working time with Anyinginyi and professional backgrounds. The responses are not intended to be representative, but instead to provide a depth and diversity of perspectives from both clinical and public health staff, as well as additional staff who have close contact with clients. As displayed in Table 2, the resulting sample of 18 interview participants included nine Aboriginal staff.

The interviews were conducted by a social scientist and an infectious diseases physician, to guide both the method of open-ended interviewing and to contextualise and investigate the medical aspects of the responses. The interviews were undertaken individually for the clinical staff, and in a group discuss for the public health staff in order to maximise public health staff participation with limited availability. The responses were typed while the interview was conducted. These transcripts were uploaded into computer-assisted qualitative analytical software (QSR NVivo version 12). They were analysed to identify emerging themes, and to compare and contrast responses in a method derived from grounded theory (Hoepfl, 1997, Charmaz, 2006).

Table 2: Interviews with clinicians and public health staff of Anyinginyi Health Aboriginal Health, Tennant Creek, NT (June 2019)

Role of interviewees	Interview type	Indigenous interviewees	Non-Indigenous interviewees	Subtotal interviewees
Aboriginal Health Practitioner	Individual	3	0	3
Oral health practitioner	Individual	0	1	1
General Practitioner	Individual	0	1	1
Registered nurse	Individual	0	3	3
Field officer	Individual	1	0	1
Public Health	Group	5	4	9
TOTAL		**9**	**9**	**18**

4. Results

The following section provides the separate findings from the three sources of data collection: the clinical database, the residential survey, and the interviews with Anyinginyi staff in clinical and public health.

4.1 Clinical Database Diagnoses

Summary from diagnoses in the Anyinginyi clinical database:

Over half of the total infectious disease diagnoses were (in order from most frequent diagnoses):

1. Skin (boils, sores, scabies and school sores),
2. Respiratory (upper and lower respiratory tract), and
3. Ear, nose and throat infections (middle ear/otitis media, tonsillitis, ear canal and pharyngitis/sore throat).

Other notable diagnoses included trachoma, conjunctivitis, gastroenteritis, rheumatic fever and tooth decay.

Chronic kidney disease and rheumatic heart disease were likely the outcome of repeated infection.

Hygiene-related infectious disease diagnoses from the Anyinginyi clinical database (February 2017 – May 2019) are shown in Table 3. The organ systems that contributed over half of the total infectious disease diagnoses in this 2.3 year period were skin (1951 diagnoses), respiratory (1361 diagnoses) and ear, nose and throat (ENT, 686 diagnoses). Within other organ systems, notable diagnoses include trachoma (optical – 19; detailed in this section), conjunctivitis (optical – 321), gastroenteritis (gastroenterology – 182), rheumatic fever (cardiac – 25) and tooth decay (dental – 222). Further details are provided in Appendix 3. This section also explores conditions of chronic kidney disease and rheumatic heart disease, as both are the product of repeated infection. While access to the Communicare database has provided valuable information regarding the frequency of hygiene-related infectious disease diagnoses in the Barkly Region, limited specificity in some diagnoses means that the full scope of disease frequency is difficult to ascertain.

Table 3: Number of hygiene-related infectious disease diagnoses- grouped in organ system for categorisation (data obtained from the Anyinginyi Health Clinic)

Organ system infections	No. infection diagnoses (February 2017 – May 2019)	Average diagnoses per year
Skin	1951	848
Respiratory	1361	592
Ear, nose and throat (ENT)	686	298
Optical	363	158
Dental	338	147
Gastroenterological	253	110
Renal	219	95
Other	179	78
Bone and joint	37	16
Cardiac	30	13
Hepatic	16	7

4.1.1 Skin infections

Hygiene-related skin and skin structure infectious disease diagnoses (1951 total diagnoses) are detailed in Figure 6. Boils and similar infections (e.g. abscesses, carbuncles and furuncles) were the most common diagnoses in this category (441 diagnoses). Various miscellaneous infections (301 diagnoses: mainly skin infections not specifically identified- 118, wound infections- 49, fungal infection-41, and localised infection- 36), sores (except impetigo- 299 diagnoses), scabies (294 diagnoses, including 13 cases of crusted scabies) and impetigo (school sores- 226 diagnoses) were also frequently diagnosed.

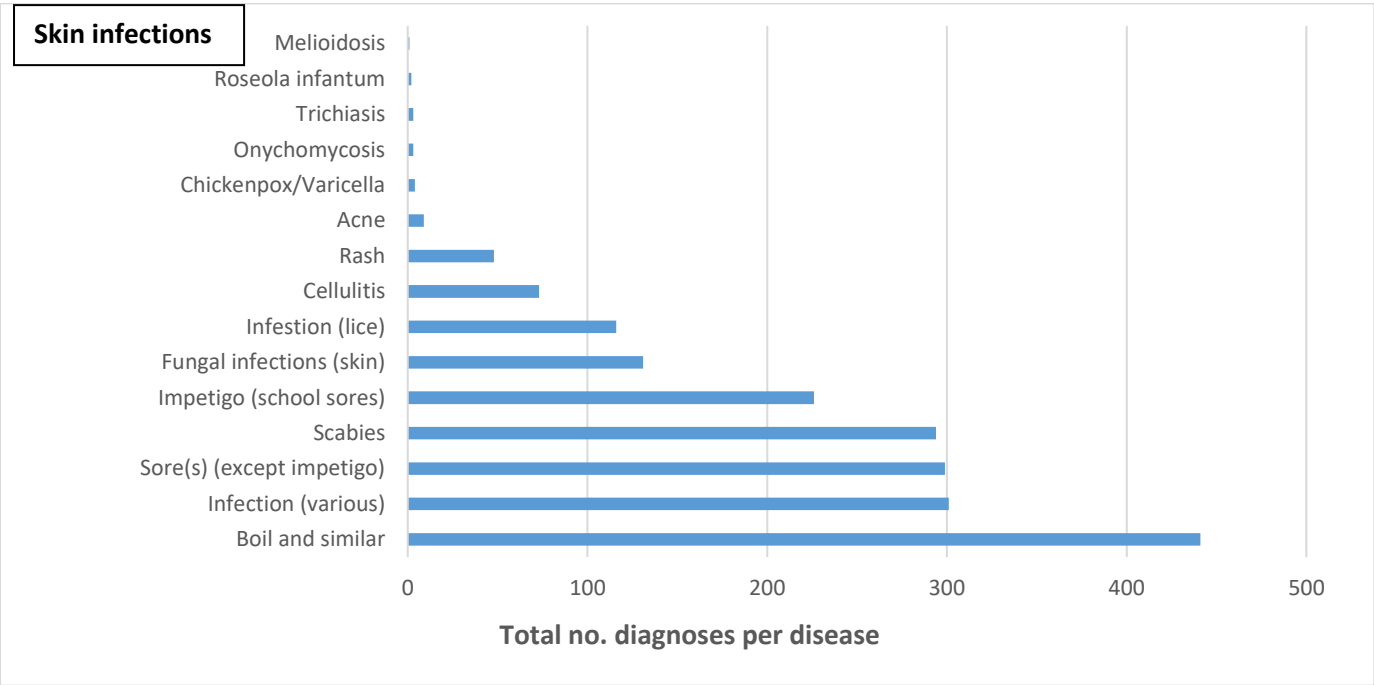


Figure 6: Number of skin hygiene-related infectious disease diagnoses (1951 total diagnoses) from February 2017 – May 2019. Infectious conditions have been consolidated for like or redundant diagnoses (data obtained from the Anyinginyi Health Clinic).

Among infectious diseases of the skin, the most frequent diagnoses have clear links to hygiene. These are furuncles (boils), scabies and impetigo. The association between crowding and scabies has been described in detail (Clucas et al., 2008, Engelman et al., 2014, Tong et al., 2015). Crowding also facilitates the spread of *Staphylococcus aureus* and *Streptococcus pyogenes* (a.k.a. Group A Streptococcus, GAS), bacteria that causes superficial skin infections, as rates of direct transmission (touch) are higher in houses that are severely crowded (Bowen et al., 2015, Clucas et al., 2008, Vino et al., 2017b). Impetigo and boils can be broadly grouped as pyoderma: skin infections that produce pus (Bowen et al., 2015). In addition, pyoderma is caused by GAS (Bowen et al., 2015, May et al., 2019). This suggests that, similar to scabies, crowding levels may increase the frequency of impetigo and boils. Additionally, impetigo (Belcher et al., 1977) and scabies (McMeniman et al., 2011, Engelman et al., 2014) have both been observed more frequently in children- suggesting that children are more likely to be at risk of the health implications of crowding.

4.1.2 Respiratory infections

Respiratory system hygiene-related infectious disease diagnoses (1361 total diagnoses) are detailed in Figure 7. In the defined period, upper respiratory tract infection diagnoses constituted the most frequent infectious disease diagnoses in this organ system category (621 of 1361 or 46 percent), as well as unspecified respiratory infections (235 diagnoses), flu-like illness (156 diagnoses) and lower respiratory tract infections (111 diagnoses). Miscellaneous infection diagnoses (235) included chest and respiratory infections however no further detail was recorded in Communicare for more specific classification. Additionally, one case of respiratory syncytial viral infection was identified in the database and was grouped in with the miscellaneous infections. The database did not include further specification regarding 'flu-like illness' diagnoses.

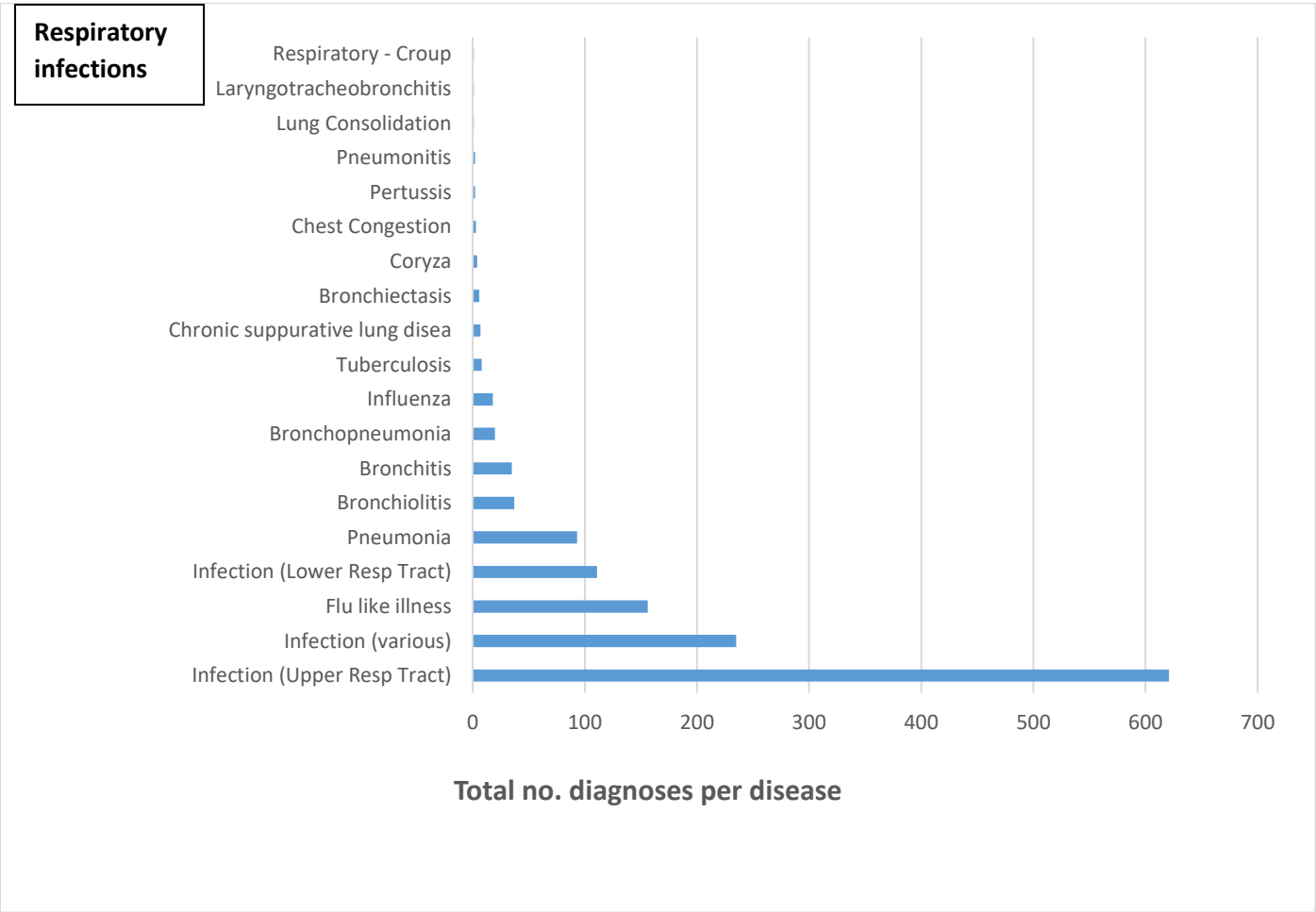


Figure 7: Number of respiratory system hygiene-related infectious disease diagnoses (1361 total diagnoses) from February 2017 – May 2019. Infectious conditions have been consolidated for like or redundant diagnoses (data obtained from the Anyinginyi Health Clinic)

4.1.3 Ear, nose and throat infections

Ear, nose and throat (ENT) infectious diseases related to hygiene are presented in Figure 8 (686 total diagnoses). Otitis media was the most frequently diagnosed in the Anyinginyi clinic (352 diagnoses consolidated for graphical representation). Numerous sub-categories of otitis media were recorded in the database, including acute (110), suppurative (71), perforated (32), and effusion (15). Tonsillitis and ear canal infections (otitis externa) and were also noted as having frequent diagnoses (115 and 111 diagnoses respectively). Pharyngitis (sore throat, including infection with Group A Streptococcus /GAS) had 55 diagnoses. GAS can be highly contagious and contribute to Acute Rheumatic Fever or kidney disease (PSGN) (Remote Primary Health Care Manuals, 2017).

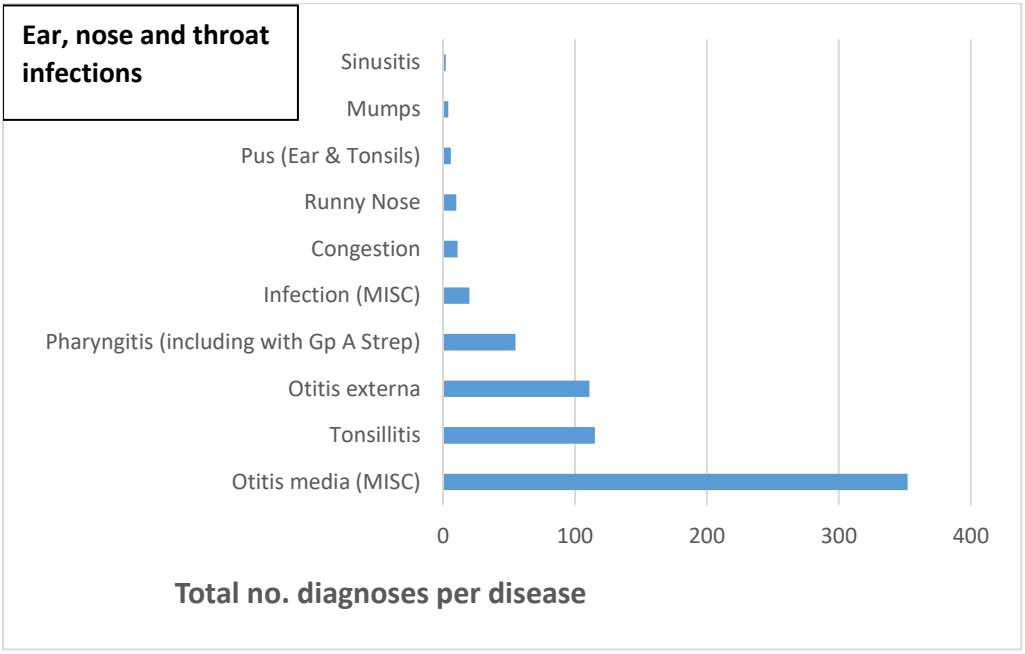


Figure 8: Number of ear, nose and throat hygiene-related infectious disease diagnoses (686 total diagnoses) from February 2017 – May 2019. Infectious conditions have been consolidated for like or redundant diagnoses (data obtained from the Anyinginyi Health Clinic)

Upper respiratory tract (URT) and otitis media (OM) infections were the highest hygiene-related infectious disease diagnoses in the respective respiratory and ENT organ system categories. Jacoby *et al.* (2011) notes the causal link between *Streptococcus pneumoniae* and upper respiratory tract infections and otitis media, and provide evidence for crowding as the common risk factor for carriage and transmission of *S. pneumoniae*. Another study highlights the burden these hygiene-related infectious diseases place on the health care system as they are the primary cause for hospitalisation in children (Clucas et al., 2008). High frequency of these disease diagnoses is problematic as *S. pneumoniae* causes several lethal diseases such as meningitis and pneumonia (Subramanian et al., 2019). Moreover, the risks of *S. pneumoniae* are greater in individuals who are immune-compromised, elderly or young (Subramanian et al., 2019). Four diagnoses of meningitis were recorded.

4.1.4 Trachoma eye infection

Although the organ systems with highest representation of hygiene-related infectious disease within this dataset are skin, respiratory and ENT, trachoma eye infection warrants consideration due to the high-profile focus of this Neglected Tropical Disease (Warren and Birrell, 2016b, Hall et al., 2017). Trachoma (19 diagnoses) was noted in the clinical database from the Barkly Region. Australia is the only developed country with endemic trachoma (Ali et al., 2018, Warren and Birrell, 2016b). This disease predominantly occurs in remote and very remote areas of the NT, Western Australia (WA) and South Australia (Kirby Institute, 2017). There are two stages, an active stage and a late stage (Warren and Birrell, 2016b). Blindness is a risk with persistent and recurrent infections in late stage trachoma (Ali et al., 2018, Warren and Birrell, 2016b). Trachoma is hygiene related and programs such as swimming pools in remote communities have been able to demonstrate reductions in the prevalence (Quinn et al., 2015, Warren and Birrell, 2016b). However, prevalence rates of trachoma in remote and very remote NT and WA have exhibited declines of 10 percent in 2009 to 4 percent in 2012 (Ali et al., 2018, Foster and Hall, 2019a, McDonald and Bailie, 2010, Warren and Birrell, 2016b, Lange et al., 2017b).

4.1.5 Chronic diseases

Only two chronic diseases (292 total diagnoses) were selected in this dataset: chronic kidney disease (CKD) and rheumatic heart disease (RHD), as described in the Methods. Various stages of CKD (Chronic Kidney Disease) were noted within the database. Notably, 66 of 246 diagnoses of CKD were of the advanced stage 4 (eGFR 15 – 29 mL/min) or stage 5 (eGFR <15 mL/min) (Kidney Health Australia, 2017). GAS infection is also a precursor for post-streptococcal glomerulonephritis (PSGN) (Marshall et al., 2011). Marshall *et al.* (2011) illustrated that in Indigenous communities in the NT, acute post-streptococcal glomerulonephritis occurs at rates that are comparable to or higher than developing countries. The association of GAS infection to PSGN indicates that crowding is a factor that can cause PSGN ultimately contributing to the progression of chronic kidney diseases (White et al., 2010).

Rheumatic Heart Disease was also identified in the analysis of the Anyinginyi database (46 diagnoses). Acute rheumatic fever (ARF) is an important public health issue (Cannon et al., 2019, Ali et al., 2018, Quinn et al., 2015) as it is can cause rheumatic heart disease (RHD) (Oliver et al., 2017). ARF is an autoimmune illness that has been identified to be associated with the social determinants of health (Cannon et al., 2019). A study from New Zealand (Oliver et al., 2017) examining rheumatic fever, illustrated that for children in crowded houses, sleeping together facilitated the transmission of GAS, further supporting the idea that crowding causes transmission of scabies and pyoderma. Indeed, Oliver *et al.* (2017) linked rheumatic fever to crowding as a result of recurrent scabies and pyoderma infections. The prevalence of rheumatic fever in remote and very remote Indigenous Australian communities has been described in literature (Bowen et al., 2015, Clucas et al., 2008, Kerdemelidis et al., 2010). RHD was diagnosed at the clinic in the Barkly Region indicating that this disease is a problem in this region.

4.2 Residential survey

Summary of responses to the CLA and bush community residential survey:

- **Crowded housing:** A high population in town to access regular medical services, no new houses built in CLAs or communities, and a long waiting list for public housing assignment has resulted in high rates of crowding: an average of 7.3 people in remote community households (ranging from three to 22) and 10.8 people per CLA (ranging from three to 20).
- **Public housing repairs delayed:** House bosses described specific and unrepaired damage to their public housing, including hot water systems, windows, kitchen facilities, washing machine and toilets. Repairs are often delayed.
- **Poor housing and crowding leads to infection:** House bosses perceived that specific health issues were exacerbated by housing conditions and crowding, including scabies from insufficient water for bathing, intestinal worms from leaking sewage, and mental health impacts from the stress of living in crowded conditions.
- **Dust and dogs:** Environmental aspects that impact on human health in Barkly bush communities include dust (causing asthma) and dogs (the high numbers living in close proximity with residents can have skin conditions and contribute to unhygienic blankets).

The residential survey covered 23 households in six Community Living Areas in Tennant Creek, and 13 households in the remote communities of Wogyala and Mungkata, resulting in 36 total surveys completed. The collated responses are presented in this section regarding environmental health conditions, the status and impact of unintended crowding in households, the quality and functionality of the public housing in which the respondents live, including the health hardware, and the status of hygiene-related infectious diseases.

4.2.1 Crowding

The residential survey sought to quantify the household size per house (at a point in time) in order to highlight crowding due to insufficient volume of housing. Housing demand in CLAs is high due to residents from other/remote communities moving to town to access regular medical services, such as renal dialysis. However, the strong desire to live on remote traditional country also resulted in crowding in housing in remote communities. The waiting list for housing in Tennant Creek was described by a CLA resident as:

> 'You have to wait 5-7 years for priority housing, and 7-10 years for Territory housing- then you pay at least $200/week rent' (Tennant Creek community living area resident G7)

Table 4 details an average of 7.3 people in remote community households (ranging from three to 22) and an average of 10.8 people per CLA (ranging from three to 20). Household populations varied at different times of the year, depending on family and other visitors coming from remote communities and other locations to stay for local events, discussing royalty payments, and cultural business. House bosses described the frequency of lots of visitors from the bush in seven of the 13 remote households, and 11 of the 23 CLA households. House bosses described the sleeping locations to accommodate regular householders and visitors. This was exemplified in a 19-person household in a CLA (H2) that had two people in bedroom 1, three in bedroom 2, four in bedroom 3, two in the lounge room, and eight in the windbreak in the yard, including a renal patient and her family who has resided in the yard for 12 months.

Beyond the challenges of living in a crowded home, some house bosses also noted their fear of breaching their leases due to too many visitors. Furthermore, residents had been informed that sleeping in the yard in windbreaks was not permitted, and some CLA house bosses reported cleaning up the outdoor sleeping area prior to a housing inspection.

Table 4: Household average size in surveyed residences

Survey item	Bush communities (x 13)	CLAs/Town camps (x 23)
Average no. people in house	7.3 (range: 3 to 22)	10.8 (range: 3 to 20)

To improve the safety and functionality of a crowded house, traditional rules can be applied. Such rules were described by a public health staff member at Anyinginyi Health, and illustrated in Figure 9 for a scenario of 27 householders and visitors. The rules include:

- an older household couple (house boss/es) taking a bedroom with a surveillance location where doors are guarded;
- single women in one room;
- single men in one room or on a verandah preferably with an uncle;
- married couples in their own room for privacy, and ideally with their own fridge and cupboard to maintain their separate food supplies;
- visitors sleeping in windbreaks in the yard; and
- inebriated people sleeping outside or elsewhere.

The majority of the house bosses surveyed noted that they maintained household rules. These included an expectation for residents and visitors to clean up, buy power cards, contribute to food costs, follow sleeping rules similar to the above, only stay for a designated period of time, respect private belongings, maintain the dry (no alcohol) status of the community or CLA, and withhold from smoking, fighting and humbug (pressuring other householders for money or other items). One house boss described her rules:

> 'Yes I've got so many rules, it'll blow your head off! Respect privacy of our own belongings; my personal space is my room; we got to do routine cleaning, mopping. We help each other' (Remote community resident B2).

The majority surveyed considered that rules were respected due to respect for the family and for the house boss, motivation to keep their children safe, and fear of the consequences of breaking the rules, such as being asked to leave with no alternative accommodation, calling in the police for fighting, and the house boss growling them (warning and criticising).

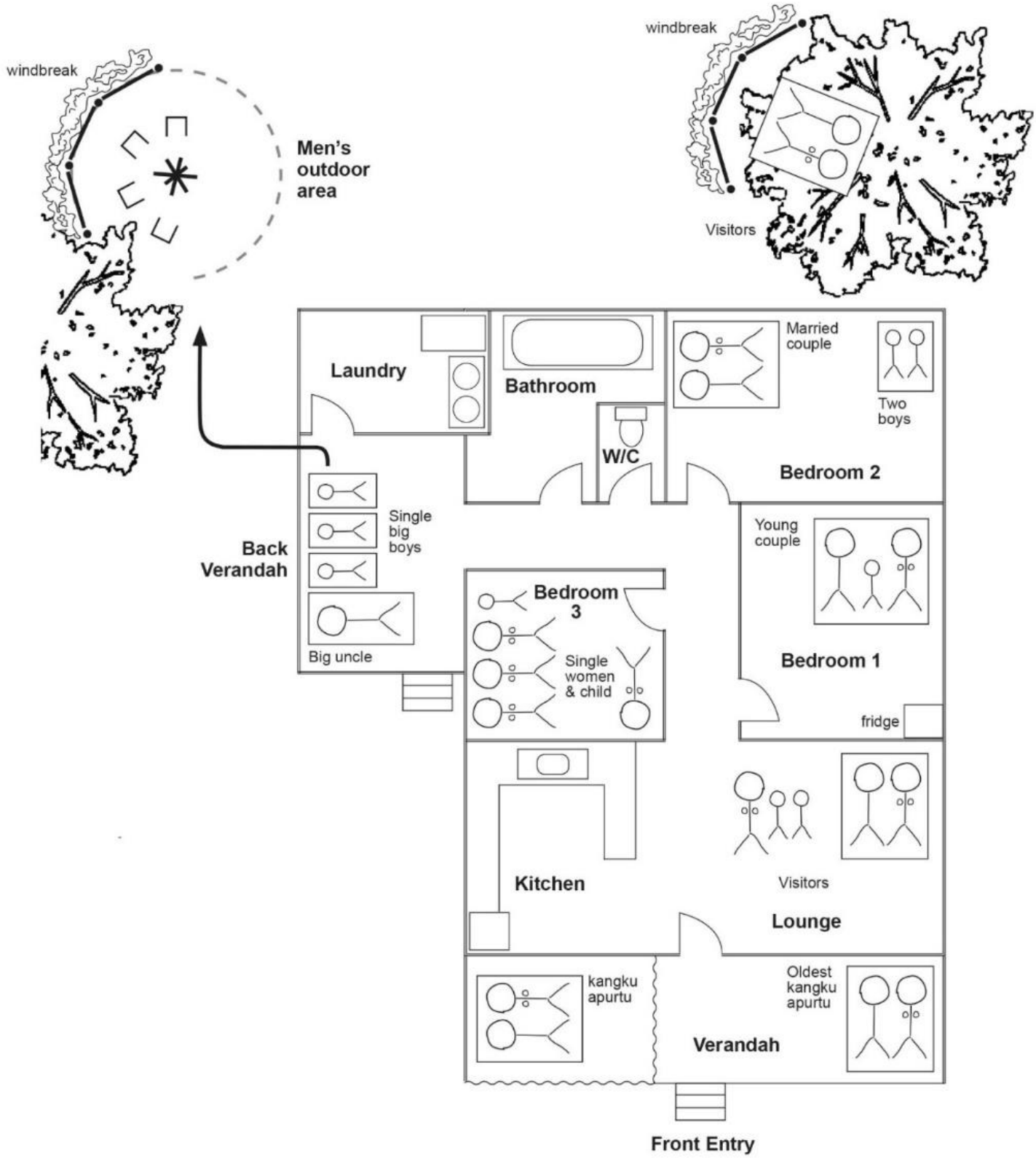


Figure 9: Traditional sleeping arrangement rules to ensure 27 people are safely located (from interview data with Sonia Ipam, Anyinginyi Health; graphics by the Aboriginal Environments Research Centre, The University of Queensland)

4.2.2 Housing quality

The survey asked house bosses about the functionality of their home in order to live safely, comfortably and healthily. This included questions about timely repair and maintenance, and about the standard of health hardware to enable healthy living practices. The questions specifically asked about the shower, toilet, kitchen sink tap, washing machine, drains fridge, hot and cold water, and yard tap. The majority of all respondents stated that all were currently working. However, when asked open-ended questions, more specific items were outlined by respondents as not present or not functioning. Many fences in the communities did not exist or were damaged and requiring repair; there was some fence damage in CLAs. The house bosses described the lack of functioning fences as a problem for keeping children safely playing in the yard, preventing dogs entering from other homes, and preventing humbug from drunken people.

Quotes from remote community members described specific housing damage to hot water systems, windows, kitchen facilities, washing machine and toilets that affected their daily lives:

> 'The hot water doesn't work. We all go to other house to have a shower and then people are waiting. It makes the kids late to school and the teacher is angry … We need a stove. Use a portable gas stove because the stove doesn't work. We need help cleaning out in the yard – there's too much rubbish' (Remote community resident A2).
>
> 'I've got boarded windows that need to be fixed. They've been like that for two weeks – the plastic glass is all broken and cold wind coming in' (Remote community resident A4).
>
> 'The washing machine has been broken for a long time. We need to get another one when we get the money. It's hard to get money as Aboriginal people - we spend ours for a feed and say "Maybe next time we'll get a washing machine". Sometimes we take washing to other family' (Remote community resident A5).
>
> 'One month back inside toilet didn't work. Had to go outside and use the outside toilet.' (Remote community resident A7).
>
> 'Drains have a big hole … [I'm] scared of a big snake entering the house… Broken windows and no screens lets in lots of flies… Bedroom doors have no handle… Broken windows cause the whole house to be cold … No insulation in the walls' (Remote community resident B5).

In the CLAs, some house bosses also detailed specific concerns regarding broken windows, lights and doors:

> 'Lights need fixing, louvres need fixing and screen door need fixing' (Tennant Creek community living area resident D4).
>
> 'We had to put cardboard up to stop that wind… On some windows the fly screens are broken. In the wet season when flies and mosquitoes come, it's a problem' (Tennant Creek community living area resident D2).

Some respondents also outlined their need for additional facilities in the house. For example, one CLA resident's partner had had a toe amputation due to diabetes, but no funding had been provided to build a ramp or footpath through the yard to access the house. In a community, one resident wanted shelving and cupboards, saying:

> 'We need cupboards for clothes. Only got milk crates and plastic bags [on the floor]. We want to clean up the rooms. Dogs and cats can go in among the clothes and poo and vomit.' (Remote community resident A1).

Respondents provided mixed descriptions of how long repairs could take, whether the tenant had to pay the housing contractor for the repair work, and whether the tenant could perform the repair. Community house bosses criticised the long delays they experienced when requesting repairs to their housing, as well as the process by which maintenance was supervised:

> 'I told [the housing agency contractors] about the toilet not flushing but they don't come out. It hasn't been working properly for about a month.' (Remote community resident B3);
>
> 'We need help planning services properly. Anyone who wants to come here needs to think about the contractors that don't know the issues and so we can get it fixed. The government is spending so much

money to pay contractors but no-one comes out and checks their work. They've never been checked. There needs to be a higher level of planning out in the communities' (Remote community resident B2).

'We need better service from housing maintenance. They need to come out and look and fix all of the houses at the same time – talk to the community people and explain all the processes about how to keep houses in order. The maintenance management are only focussed on larger communities, and that's the reason the small communities miss out' (Remote community resident A3).

CLA house bosses also described long delays or a lack of repairs:

'Sometimes it's a long line… NT Dept of Housing do inspections and we tell them and they get it down on paper. We asked for louvres to be fixed and they said they'd check in 28 days. But it's past that now but nothing done!'(Tennant Creek community living area resident D2).

'Houses inspected two time a year by Department of Housing, but no repairs or maintenance. They inspect and write down faults but don't fix. They say people will return but it doesn't happen' (Tennant Creek community living area resident D4).

4.2.3 Hygiene-related infectious diseases

Following the questions about crowding and housing functionality, residents were asked whether they thought their house could make them sick. All of the remote community respondents (13/13), and the majority of the CLA respondents (18/23) affirmed this perception. Statements describing this perception from both community and CLA respondents described specific health issues that they perceived were exacerbated or prevented by their housing conditions. One community resident described issues with scabies from insufficient water for bathing, and intestinal worms from leaking sewage:

'Scabies has come up a lot this year because of lack of water. We've been running out of water in the tanks. There's no electric pump and no back-up to solar … Because of the lack of water we are bathing less … Sewerage is a problem at this house. It's blocked. Other houses' tanks were fixed but they didn't come back and fix ours. The toilet bubbles up and the water goes black and leaks out. We try to keep the kids away. We try, but it's hard to keep them away when it's not fenced. Lots of dogs drink it and they get that worm. And people and kids step in it and [the worm] gets into your feet and leads to people getting rheumatic fever' (Remote community resident B2).

House bosses were asked about the frequency of hygiene-related infections in their household members' eyes, ears, skin and lungs (respiratory). The majority of community house bosses noted regular infections in these organs (11/13), Of interest, the two households that did not report regular infections had smaller household sizes (three and five residents respectively). A smaller majority was noted by CLA house bosses (between 12 and 21 of the 23 households), and are shown in Table 5.

Table 5: Perceptions of frequent hygiene-related infections by households in bush communities and CLAs

Survey item	Bush communities (x 13)	CLAs/Town camps (x 23)	Total households (x36)
No. households recalling regular eye infections	11/13	17/23	28/36
No. households recalling regular ear infections	11/13	21/23	32/36
No. households recalling regular skin infections	11/13	12/23	23/36
No. households recalling regular respiratory infections	11/13	16/23	27/36

Some respondents described the link they saw between the crowding in their homes (with 14 to 22 household members), and the spread of infectious diseases:

> 'Sore stomach and diarrhoea… Children infect others. If one child gets it, the other children get it' (Remote community resident B4, 22 people in household).
>
> 'Lately, sore eyes is bad – everyone had it…. One little one got it first and then it went around the whole house' (Tennant Creek community living area resident D2; 16 people in household).
>
> 'My house is a healthy house because only a few people are living here' (Tennant Creek community living area resident D1).
>
> Rheumatic fever and heart trouble… My eldest daughter had rheumatic fever at two years of age and my youngest daughter had rheumatic fever at 18 years of age.' (Tennant Creek community living area resident E2, 14 people in household).

Beyond infectious diseases, several respondents described the mental health impacts of living in crowded conditions and in town, including:

> 'There's too much drama in town with problems – family are drinking, gambling, going to clubs. It brings a lot of stress' (Remote community resident A3).

4.2.4 Environmental health

Dust, dogs and rubbish were identified as environmental health issues in both communities and CLAs. Dust was identified as a health risk for those suffering from asthma by a remote community house boss, and as affecting eye infections in the Community Living Areas in town. Respondents described the dust's origin, irritation and impacts as:

> 'Dust is a big hazard - the dust from road trains going past on the station road. There's no insulation or sealer in the house and the dust goes right in [to the roof]. The roof inside is like a desert in itself. All the time we can be breathing in dust and it gives people asthma' (Remote community resident B2).

> 'We try to block the window, but [dust] still gets in from broken louvres' (Tennant Creek community living area resident D4).

> 'When the dust comes in we get sick - sore eyes, and the dust comes in our chest, and we feel sick and get the flu.' (Tennant Creek community living area resident C1).

> 'Bung eye went around the [local] kids from flies and dust' (Tennant Creek community living area resident G6).

All households experiencing dust were implementing a range of initiatives to reduce the impact, similar to those detailed in the literature (NHC et al., 1987, O'Rourke and Nash, 2019). This included hosing or using a sprinkler in the dusty yard, raking the yard, placing boards on broken windows, staying inside with closed doors and windows, growing a lawn, building a permanent windbreak, using shade cloth on the veranda, erecting signs for trucks to drive slowly down on the main access road, and requesting a house furthest from the road at the rear of the community. House yard landscaping can often be deleted from limited government housing budgets, despite the potential for health benefits (O'Rourke and Nash, 2019, Fien and Charlesworth, 2012).

A second environmental issue experienced in both communities and CLAs were dogs and their associated health. The dogs held a mixture of outdoor-only and inside permissions, including sleeping in beds. As shown in Table 6, the dog population per household ranged from zero to 7 in communities (average 2.5) and zero to 11 in CLAs (average 3.4). All house bosses except two in remote communities reported their dogs as 'healthy'. Several respondents cited a possible risk of scabies, but this was balanced with the affection and company valued in the dogs. One house boss stated:

> 'We need the vet to come out and see our dogs with scabby skin. Too many cats and dogs. But those old ladies love their dogs!' (Remote community resident A6).

Table 6: Dog populations in surveyed residences

Survey item	Bush communities (x 13)	CLAs/Town camps (x 23)
Average no. dogs	2.5 (range: 0 to 7)	3.4 (range: 0 to 11)

Household rubbish removal was described as adequate by most residents. In remote communities, many residents had outdoor rubbish bins and a weekly rubbish collection, although many took their rubbish to a dump. In the CLAs, there were household rubbish bins and a weekly collection noted as mostly sufficient by the majority. There was varied use of the dump for additional rubbish, but all respondents noted that the fee for accessing the dump and the need for a private vehicle were both disincentives.

4.3 Clinical and environmental health interviews

Summary of the clinical and environmental health interviews:

Crowding impacts: Crowded households increase transmission of infections, cause lack of sleep, safety and control of children, and damage to health hardware.

Infections:

- **Skin infections**: There is higher frequency of skin infections than in the city, potentially caused by environmental aspects (flies during hot weather), health hardware (a lack of hot water for washing bodies, a lack of washing machine- resulting in shared, unwashed blankets and linen), household size (notably crowding), and low immunity (due to malnutrition).
- **Dog-related infections**: Fleas, scabies and untreated dog bites lead to skin infections after scratching skin irritations.
- **Lung infection**s: Frequent upper respiratory tract and chronic supperative lung infections affect the whole family in a crowded home.
- **Eye infections**: There are daily cases of viral and bacterial conjunctivitis.
- **Dental infections**: Clients present with acute dental issues rather than for preventative management. Advanced tooth decay can increase the risk of rheumatic heart disease.
- **Diarrhoea**: There are frequent presentations of diarrhoea potentially from fridges not working, untreated tank water, blocked toilets, a lack of hand washing and crowded households, and low immunity (through malnutrition) of the residents.

Chronic diseases: Group A Streptococcus infections can cause skin sores and sore throats that can later contribute to rheumatic heart disease or to kidney disease.

Interviews were conducted with 18 Anyinginyi staff members, of whom nine identified as Aboriginal people. The roles represented by the interviewees included general practitioner (2), Aboriginal Health Worker (3), registered nurse (3), driver (1), dentist (1), and public health practitioner (9). All interviews were conducted individually except for the group-based interview (discussion group) with the Public Health staff of Anyinginyi.

The activities undertaken by these 18 staff members included broad women's and men's health, specialist renal care (including dialysis and assessment of home suitability for potential transplant recipients), specialist cardiac care for patients with rheumatic heart disease, dental care, smoking cessation, mental health management, parenting skills and support, and patient transport from home to the clinic. The staff interviewed had worked at Anyinginyi for a range of durations, from nine months to 12 years, with an average of 4.5 years but most (mode) for two years.

4.3.1 Infectious diseases

Interviewees were asked whether they had seen specific infections in their role at Anyinginyi, and then asked for the frequency, the perceived causes and the suggested preventative measures. The infections are presented in this section by specific organ, in the order by which the clinical database represented frequency.

Skin infections

Clinicians noted that they were seeing three to ten cases of skin infections per week. One clinician suggested that infection frequency was higher during hot weather, and another clinician noted how this frequency was much higher than in metropolitan areas:

> 'You see none of [the types and prevalence of sicknesses] in a city practice. It does not occur in the mainstream – the difference [in prevalence] is huge' (Anyinginyi clinician K10).

A range of causes of skin infections were noted, including environmental aspects (flies during hot weather), health hardware (a lack of hot water for body washing, a lack of washing machine- resulting in shared, unwashed blankets and linen, sometimes no linen on beds, household size (notably crowding), low immunity (due to malnutrition), and conflicting opinions between carers (due to a diversity of caregivers for children, and a diversity of health beliefs).

The interviewees recommended that skin infections could be reduced through a range of responses. Similar to the causes, they recommended improving health hardware (to ensure hot water availability and functioning washing machines or an available laundromat service), more housing (to reduce unintended crowding), improved immunity (through functioning kitchen facilities to enable preparation of meals), education through health promotion (including Anyinginyi's Grow Well campaign), and encouragement to seek early medical treatment.

Animal-derived infections

Some skin infections were linked by interviewees to interaction with domestic pets- namely dogs. Dogs are often allowed in the home and share beds with their owners, leading to possible spread of fleas and scabies. The relationship between Barkly residents and dogs was described by the public health practitioners:

> 'Aboriginal people love dogs. They're nice company if you're on your own. Dogs are inside for warmth at night, and protection. There's lot of crime- so cheeky dogs are helpful' (Anyinginyi public health practitioner group discussion P1).

The interviewees raised concerns with fleas, scabies and untreated dog bites leading to skin infections after scratching skin irritations, although at least one interviewee noted that new evidence had de-linked direct scabies transmission from dogs. Interviewees also noted the risk of intestinal worms and ringworms from pets through exposure to animal faces, such as:

> 'Each camp got packs of dogs … they affect the people's health… they poo on floor inside and the yard. Kids going barefoot [step in it and] get diarrhoea, gut pain and vomiting' (Anyinginyi driver S1).

The interviewees considered that the infection risks can and have been reduced through awareness and implementation of animal health programs. A clinician mentioned that domestic dogs are up to date with vet treatment, and another described the value of health promotion regarding washing blankets, airing mattresses in the sun, and maintaining clean floors in the house. Another clinician described how malnutrition had been linked to exposure to dog-transmitted intestinal worms, and that a culturally-sensitive dog de-sexing program combined with health education regarding dog faeces management and mange had resulted in health improvements in communities. This was described by one participant as:

> 'Iron deficiency is another good story. That had to do with animals. Before, ten dogs would walk into the clinic with the person coming to see you… The communities got together and recognised the problem: animals had to be looked after. You can't kill a dog, because dogs are their Dreaming. Every Aboriginal culture has a dog Dreaming story, so you can't kill a dog because you're killing your Dreaming. The animal program is doing de-sexing- bringing the numbers down. Education was given about dogs for mange management and dog poo. Now, most of the dogs are not mange-ridden; they're healthy, not like they used to be. There's less dog poo around now' (Anyinginyi clinician K9).

Lung infection

Clinicians described frequent presentation of respiratory conditions in Anyinginyi clients- especially upper respiratory tract and chronic suppurative lung disease. They considered that these presentations were more frequent in winter, may be increased by dust, and can affect the whole family in crowded homes, described as:

> 'It can spread easily in crowded house… It's easy to catch, and people can't be separate and away from the sick person' (Anyinginyi clinician K8).

In response, clinicians recommended medical prevention through the influenza vaccine, health promotion regarding the methods of transmission, and infrastructural changes to reduce crowding and increase health-supporting aspects of the home, through new housing, and functioning window screens for both ventilation and dust suppression.

Ear infections

Ear infections were perceived by clinicians as caused by highly contagious viruses that also cause runny nose (rhinorrhoea). To prevent infections spreading, clinicians recommended medical treatment with ear drops, and behavioural approaches including blowing noses when runny and using a tissue spear to mop ear discharge. From a health promotion perspective, the public health practitioners recommended sharing information with expectant mothers regarding facial hygiene and nutrition to strengthen immunity.

Eye infections

Clinicians observed that they have daily cases of viral and bacterial conjunctivitis ('bung eye'), while they considered that trachoma cases were rarely seen and 'under control'. The perceived causes of conjunctivitis were considered to be flies during summer and a lack of hand washing and clean linen, and that the infection spread quickly through crowded homes with children. One interviewee described it as:

> 'With conjunctivitis, kids have sore eyes. It can spread like wildfire- the whole family comes to clinic for sore eyes. It was worse a few months ago [during the warmer months]' (Anyinginyi driver S1).

To prevent conjunctivitis, the respondents recommended seeking early medical treatment, practicing hand and face hygiene, and ensuring that housing was functional and could be cleaned. Mungkarta bush community had received health promotion materials from the University of Melbourne's 'Clean Faces, Healthy Eyes' campaign on trachoma eye infection, including a school wall with children's artwork regarding health eyes and clean faces. In addition, a dedicated washing area had been installed in a covered external space at the rear of the classroom.

Dental infections

To prevent dental infections, Anyinginyi runs a dental clinic. This clinic provides education on the value of daily dental hygiene (tooth brushing and flossing) and reduced sugar intake, matched with encouraging preventative visits to the dentist. However, the clients were observed to be presenting with acute dental issues rather than for preventative management. Around 25 Anyinginyi clients were reported to visit the dentist each week with gum infections and abcesses, and tooth pain. Clients with advanced tooth decay were sent to Alice Springs for an anaesthetic to remove 'rusty teeth' that could otherwise increase the risk of rheumatic heart disease. The causes were unclear- with one clinician proposing that gum diseases and periodontal disease were caused by sharing toothbrushes, while another considered that toothbrushes and dental floss were not often used. A high-sugar diet, including soft drinks, was proposed as a cause of dental infections, with one clinician noting that many clients had acidic pH levels, potentially linked to diet.

Diarrhoea

Diarrhoea (from gastrointestinal infections) was diagnosed frequently. The ranges of infections from either viral and bacterial (eg Shigella) causes proposed by interviewees included poorly-functioning health hardware, such as a fridge not working, untreated tank water, and a blocked toilet; behavioural aspects that increase transmission, such as a lack of hand washing and crowded households; and low immunity (through malnutrition) of the residents. Preventative measures proposed by interviewees included functioning health hardware (including power for the fridge, rubbish bins, and flyscreens on the windows), awareness of transmission (eg hand washing with soap), and more housing to reduce crowding that increases transmission, described as:

> '[There] can be lots of children living in one house- over ten children… with crowding, if one baby has diarrhoea, you need to clean whole house- kitchen, cups, children…' (Anyinginyi clinician K8).

Carer views on childhood immunisation

Given the high prevalence of infectious diseases, clinicians were asked whether carers were open to immunising their children. All replied affirmatively. An Aboriginal Health Worker spoke of explaining the health benefits of immunisation to encourage uptake:

> 'Some parents don't like their children to be immunised, so we explain in our language that it's important to have it … We have to explain that immunisation always protects a child from disease. After that, parents agree that bub can have it' (Anyinginyi clinician K8).

Several respondents cited the Maternity Immunisation Allowance as an incentive, and the possibility of payment reductions from the Family Tax Benefit Part A for non-immunisation, described by one clinician as:

> '[Carers] aren't necessarily understanding of the purpose [of immunisations], but rather fear of loss of Centrelink payments' (Anyinginyi clinician K3).

4.3.2 Chronic diseases

Beyond infectious diseases, the respondents were asked about chronic diseases that may arise from childhood infections. All those who responded described the many infections in which Group A Streptococcus may contribute - including skin sores, sore throats and dental infections- and how this could contribute to acute rheumatic fever, and later to RHD, or to post-streptococcal glomerulonephritis (PSGN).

Two clinicians mentioned that two to three new rheumatic heart disease (RHD) clients may be seen each week for the clinic, with many Anyinginyi clients receiving monthly penicillin injections. The perceived causes of RHD in the Barkly Region were described medically as starting with another infection, such as a respiratory infection, a sore throat, a skin infection or a gum infection. The respondents described the transmission of these initial infections as being increased due to crowding, sleeping close together in cold weather, and houses lacking adequate ventilation. In response, respondents suggested preventative options including early medical attention for skin infections, regular dental check-ups, and cleaning existing skin infections. Given that RHD is a secondary infection, one clinician recommended focusing more health promotion on the initial causes, rather than RHD, stating:

> 'RHD education is less relevant than [education] about skin sores. Health promotion requires a linked story: 'treat the skin sores'. Just keep it simple- otherwise it's too complicated' (Anyinginyi clinician K3).

For prevention, new housing and existing housing maintenance was noted by respondents as important in reducing transmission to other family members.

Renal conditions were described in detail. On kidney disease and resulting renal dialysis needs, one clinician described it as:

> 'In the Barkly Region , there is highest incidence of renal disease in world! … [patients] are on dialysis so young- at 25–27 years old; nowhere in the world are patients so young! … Renal sickness is the worst health condition in the Barkly [and] affected by poor housing. Need non-overcrowded housing, good health infrastructure, and ordinary [urban-level] household hygiene to help from an environmental perspective' (Anyinginyi clinician K1).

Treatment options for patients with severe chronic kidney disease include dialysis (with limited dialysis chairs in Tennant Creek), peritoneal dialysis, and a kidney transplant. One clinician noted that that latter two are particularly susceptible to bacterial infection, and thus functional housing is essential for kidney transplant patients – and transplants will not be performed unless the patient lives in a home with appropriate hygiene.

Mental health issues were raised unprompted during the discussions of housing and health. Many respondents described the mental stress of living in crowded conditions, such as:

> 'My message is, 'if you want to improve Aboriginal peoples' health, housing makes such a difference'. [It's] not just about sores but mental too: very stressed out people living in overcrowded houses ... They're so tough to put up with it' (Anyinginyi clinician K9).

> 'Overcrowding makes a feeling of hopelessness, feeling defeated. [Maybe you] tried to rent but been rejected by real estate, so end up with unsafe or no private rental because you're Aboriginal- [it's] racism. Getting knocked back- maybe it leads to drinking or a fight and no hope … [it] can exacerbate mental health, [so you] drink to take the worries away' (Anyinginyi public health practitioner group discussion P1).

4.3.3 Environmental health issues

Dust impacts and management

Respondents were asked about their thoughts on the existence and impact on health from dust. They described Tennant Creek as a particularly windy town, that the wind caused eye infections, and called for funding for lawns, footpaths planting and more green spaces to suppress the dust. These were described as:

> 'Tennant Creek is known for dust storms: dusty and windy days. [If you've] spent the day outside, you've got eyes streaming and sore eyes' (Anyinginyi public health practitioner group discussion P1).

> 'Some town camps have lawns. [They] keep the dust away, and you see less infections: [an older couple with an established lawn] never come to clinic, as they're not sick' (Anyinginyi driver S1).

Housing functionality and household size

All respondents were asked about their views on health impacts from unintended crowding, and from poor housing functionality- especially health hardware. Crowding was defined by respondents as 'having to have people sleep in rooms that aren't bedrooms or outside' (Anyinginyi clinician K4) and 'several families sharing a house built for one family, with many visitors, [because of] long waiting lists for all house seekers' (Anyinginyi clinician K6). One public health respondent described a three-bedroom house sleeping 45 people in Tennant Creek, although this house was not recorded in the resident survey. The respondent said:

> 'It's not about size of house, but it's about the number of people in the house… [that causes] problems with food, privacy, sleep… Ten years waiting [but] new houses are already dedicated [to a recipient]' (Anyinginyi public health practitioner group discussion P1)

Some respondents described the impacts of crowding on:

- increased transmission of infections ('it's a rotating door- you keep getting re-infection', K9),
- lack of sleep from a noisy, busy household ('kids were playing until 2am so no one sending kids to school- or they sleep in the school', P1; 'young people- start jobs but don't last in the jobs as they don't get rest or food', K9),
- safety and control of children ('visitors bring drugs- ganja, ice. It's not good for little kids- but visitors smoke when kids are around', P1), and
- health hardware ('everything wears out really quickly', P1).

Respondents described how housing with functional health hardware can support health outcomes, such as:

> 'Healthy places are where there are concerned mums washing blankets and sheets, making sure children have got clean clothes, have bath, clean house, have three meals a day … children are very clean- no sores' (Anyinginyi clinician K8)

> '[A healthy community has] very clean houses, enough housing, dry community, mobile clinic. … Children look healthy and well-groomed. … The principal of the school is in control, friendly with kids, gives breakfast and washing at school' (Anyinginyi public health practitioner group discussion P1).

Many of the health vulnerabilities were derived from the dysfunctional health hardware, such as working refrigerators, washing machines, water, and cooling options:

Refrigeration: Fridges were identified as important for keeping medicines cold and food fresh, but a number of fridges were noted as old with non-functioning thermostats, opened too often, and overstocked. Large households could result in difficulties retaining food for planned meals; for some diabetic patients, a lack of regular meals poses a risk to managing their sugar levels.

Washing machines: Residents in CLAs were noted as often having washing machines, but in variable condition. The public health practitioners noted overuse and overloading of many shared machines, resulting in machine breakdown. Laundry facilities have been installed at Anyinginyi's Stronger Families centre for clients, but a lack of transport to town can be a barrier.

In remote communities without functioning washing machines or sufficient hot water, a clinician noted the impact of unwashed clothing and bedding:

> 'Living out bush, these people are more vulnerable. They come with bad chest infections and sores because of lack of ability to wash clothes and bedding' (Anyinginyi clinician K5).

Water: The public health practitioners described a range of water-related challenges in all community and CLA homes, including taps that had calcified and ran continuously, toilets that were no longer flushing effectively, and hot water systems that break down with long delays for repairs- causing residents to boil water or postpone washing. One respondent described her own experience of a broken hot water system:

> 'I live in NT Housing and we had problem with hot water. It took NT Housing a couple of weeks to fix it. When you've got no hot water, you have to go to other people's house for shower until it's fixed. Or you use a wipe with warm water' (Anyinginyi clinician K8).

Cooling: Summertime in the Barkly Region can have many days with temperatures over 40 degrees. Several respondents considered that the housing was inadequately cooled, despite air conditioning units on many houses. The older 'swamp' air conditioners regularly required water pump replacements due to the build-up of calcium, and the newer units may wait a long time for the contractor to provide repairs.

Conclusions and suggestions for policy and future research

What has this report confirmed?

Housing in the Barkly Region

- **New housing is required to reduce current crowding**. The $78.4 million Barkly Regional Deal ((CoA et al., 2019) and the Remote Housing Strategy ($110million dedicated in the 2019-20 Federal budget) offer an opportunity, but no details had been released for the Barkly Region at the time of publication.
- **Existing housing repairs are often delayed, resulting in adverse conditions**. This results in householders living with non-functional hot water systems, windows, kitchen facilities, washing machine and toilets, among other health hardware (infrastructure).

Crowding in the Barkly Region

- **Households in bush communities and in Community Living Areas (CLAs) in town are often crowded**, with an average of 7.3 people and 10.8 people respectively, and up to 22 and 20 people reported respectively.
- **Crowded households increase transmission of infections**, and also cause lack of sleep, reduced safety and control of children, and damage to health hardware.

Hygiene-related infections in the Barkly Region

- **There are high rates of preventable, hygiene-related infectious diseases in the bush communities and CLAs**:
  - Over half of the total infectious disease diagnoses were skin infections (boils, sores, scabies and school sores), respiratory infections (upper and lower respiratory tract), and ear, nose and throat infections (middle ear/otitis media, tonsillitis, ear canal and pharyngitis/sore throat).
  - Other notable diagnoses include trachoma, conjunctivitis, gastroenteritis, rheumatic fever, and tooth decay.
  - Trachoma has been eradicated in ten developing countries, but remains endemic in some remote NT Indigenous populations (Warren and Birrell, 2016b).
  - Chronic kidney disease and rheumatic heart disease are the outcome of repeated infection.
- **Housing that is unrepaired and crowded contributes to transmission of preventable infections**:
  - **Skin infections**: These infections occur at a higher frequency than in the city. They are caused by environmental aspects (e.g. flies during hot weather; fleas, scabies and untreated dog bites leading to infections after scratching), health hardware (e.g. malfunctioning hot water system; a lack of washing machine), household size (notably crowding), and low immunity (due to poor diet/malnutrition).
  - **Lung infections**: Frequent upper respiratory tract and chronic suppurative lung infections can affect the whole household in a crowded home. Dust and wind may act as multipliers of transmission.
  - **Eye infections**: The clinic receives daily cases of viral and bacterial conjunctivitis. Trachoma has also been diagnosed.
  - **Dental infections**: Clients present with acute dental issues rather than for preventative management. Advanced tooth decay can increase the risk of rheumatic heart disease.
  - **Chronic diseases**: Group A Streptococcal infections can cause skin sores and sore throats that in turn can contribute to rheumatic heart disease and to kidney disease. Tennant Creek was noted in in 2001 as being one of the areas of highest incidence- up to 30 times the national incidence for end stage renal disease (Cass et al., 2001).

Housing and crowding can undermine health

Best practice methods of treatment for remote primary healthcare level are detailed in dedicated publications (May et al., 2019, Remote Primary Health Care Manuals, 2017, Antibiotic Expert Group, 2019). While improving access to, and quality of primary healthcare in remote Indigenous communities is possible, this would ignore the fundamental cause of these health outcomes: crowding as a result of insufficient housing supply and existing housing is not always well-maintained by the public and community housing authorities (Bailie et al., 2010a, Fien and Charlesworth, 2012, Foster and Hall, 2019a). Crowding increases the burden on health hardware increasing the probability of malfunction and thus leading to the difficulty to perform health living practices, such as washing bodies, clothes and bedding, hygienic sanitation, and safe food preparation. Residents surveyed correctly perceived that specific health issues are exacerbated by housing conditions and crowding, including scabies from insufficient water for bathing, intestinal worms from leaking sewage, and mental health impacts from the stress of living in crowded conditions.

What is significant from this project?

- **Housing impacts on health have been known for a long time, but nothing has been done:** The contribution of housing functionality and crowding on householder health have long been documented (Pholeros et al., 1993b, NHC et al., 1987). There have been repeated calls for new housing and for repair and maintenance of housing in remote areas, and a number of schemes and funding promised (Foster and Hall, 2019b). However, no new housing has been built in the Barkly Region in at least 12 years (Nash and Memmott, 2016); Personal communication with senior Anyinginyi staff member, December 2018).
- **There is increasing evidence and awareness of the link between housing and health:** There is increasing evidence of the high prevalence of hygiene-related infections related to crowding and housing functionality, and the relationship between these infections and longer-term chronic and life-threatening diseases, such as chronic kidney disease and rheumatic heart disease.
- **This research provides new evidence that strengthens the existing story:** This research has introduced data regarding perceptions of clinicians and environmental health workers, and of residents of public housing in bush communities and CLAs. These were substantiated with detailed clinical data to provide a more objective analysis than previous research (for example, see (Pholeros et al., 1993b)).
- **The case study provides a compelling argument for change:** This research presents the first known study of housing impacts on health in Tennant Creek CLAs and selected bush communities in the Barkly Region. The data details very high rates of both infectious diseases and associated chronic conditions for these Aboriginal residents. This burden of diseases affects morbidity and mortality (life expectancy), bringing associated costs to the government for ongoing health care for dialysis and treatment. Thus, while crowding and housing malfunction continue, health suffers. This provides a compelling argument for changes.
- **Cessation of government metrics of crowding and household infrastructure hides the mounting health crisis:** High household density has been documented in remote Indigenous Australia, including the Barkly Region, but continued crowding is no longer being monitored due to the cessation of targeted Aboriginal housing surveys by the Commonwealth Government (e.g. the Community Housing and Infrastructure Survey (CHINS)). The last documented CHINS assessment of NT housing condition in 2006 identified that 31 percent of the NT's Indigenous houses required major repairs or replacement (Australian Bureau of Statistics, 2007). Crisis situations such as in Tennant Creek are ignored as the Federal Government has ceased regular measurement and reporting of the state of Indigenous housing and servicing.

What were the limitations of this project?

This research cannot deliver definitive answers due to limitations on the clinical data, the involvement of non-Indigenous researchers, the small sample size of the residential survey, and the lack of additional supporting data.

- **The clinical database was not comprehensive:** The Communicare database was not comprehensive due to the options available for manual entry into the database regarding specific infection and resident location.
- **Non-Indigenous researchers may have precipitated some biased responses:** As the data were collected predominantly by non-Indigenous researchers (and the one Indigenous researcher was not from the local country), there is potential that this biased some of the responses provided by interviewees. Such interview response bias can be caused by the Indigenous respondent delivering the perceived 'correct' answer, not trusting the researcher with the data, or other aspects that were culturally-specific but unfamiliar to the researcher (Remote Primary Health Care Manuals, 2017, Wear et al., 2012)
- **Small residential survey sample:** The residential survey provided one-sample-in-time data, and therefore does not provide a longitudinal pattern regarding residential mobility within the communities and CLAs, nor between the bush and town communities.
- **Lack of additional supporting data:** No data were collected as observational data on household practices, nor to check the functionality of reported health hardware damage to substantiate the perceptions shared by residents.

These limitations necessitate cautioning that these results should only be considered as indicative of the situation, and should provide the foundation for more detailed future research to evaluate the situation more robustly.

What are the next steps?

This research has raised questions for policymakers in health, housing and Indigenous affairs that calls for political will and continuous focus towards positive change in this era of the refreshed and Indigenous-led *Closing the Gap* initiative on Indigenous disadvantage. It has also highlighted the need for further research to strengthen the evidence and provide monitoring of improvement initiatives.

Questions for policy makers on housing and health hardware

- **When will new housing be built to reduce crowding and infection levels?** Opportunities for new housing has often been raised by politicians and government departments, most recently as a possible output from the Barkly Regional Deal, but no new housing has been built in 12 years.
- **Can housing be improved through increased Indigenous governance and participation in procurement (design and construction)?** When new housing is planned, it would be enhanced by Indigenous engagement in the design, ownership, and local management and maintenance.
- **Can local Indigenous services ensure swifter and ongoing repair and maintenance?** Local Indigenous employment in the areas of maintenance and repairs can enable routine maintenance and improve housing program efficiency and effectiveness with sustainable and sufficient repair and maintenance funding. This can be achieved through such policies as permitting Aboriginal environmental health practitioners to carry out basic plumbing (WA Health, 2019).
- **Can health hardware, including washing machines, be ensured to be functional, accessible and available?** The ability to launder clothes and bedding is one of the nine Healthy Living Practices of Indigenous Australia (Pholeros et al., 1993b). Laundering can reduce the presence of bacterial infection from unwashed clothing and bedding that could lead to skin trauma. For communities with diagnosed scabies, laundry facilities are required in addition to medical anti-scabies treatment for all household members. Many CLAs and bush communities in the Barkly Region are not equipped with industrial-strength washing machines to wash blankets and bedding.

Questions for policy makers on health services

- **Can infection diagnoses trigger environmental health improvements in clients' homes?** The current practice of triggering public health engagement with households on presentation of hygiene-related infections at medical clinics can address wider health hardware and crowding improvements, as well as targeted health promotion messaging regarding the importance of washing bodies, clothes and bedding to prevent transmission of infections, and the value of early treatment for all household members.
- **Are clinical, hospital and public health staff receiving adequate cultural safety training and mentoring?** Ensuring all health staff conduct their services with cultural understandings of living conditions and constraints can improve client engagement of health services. As detailed in the Remote Primary Health Care Manual, **'**to be effective, health care must occur in a culturally safe/secure environment with practitioners who are culturally aware and competent. Learn all you can about the local culture. Always be respectful, and carefully consider the following: cultural beliefs… loss and grief… effective communication…' (Remote Primary Health Care Manuals, 2017)(p.3). A similar sentiment was stated by Read et al (p.1) who detailed the impacts on client health in medical services that was 'attributable to impaired communication between healthcare providers and clients, in turn due to fundamental differences in culture and language, compounded by high staff turnover'. Those authors noted in response that 'organisations that are culturally responsive and that support continuous learning and quality improvement can achieve better outcomes for clients' (Read et al., 2019).
- **Are clinical and hospital staff receiving regular professional development?** Clinical and hospital staff can be professionally isolated in their work, and professional development and regular and formalised collegial case discussion about unusual presentations can provide opportunities to build relevant knowledge and skills. This aligns with the Remote Primary Health Care Manual that 'covers conditions that are common or clinically significant in remote practice, have different presentations and management issues to those in 'mainstream' practice, have important public health implications, and need coordinated, standard care' (Remote Primary Health Care Manuals, 2017 p.iv).

Need for future research:

Using these findings from this exploratory research, a broader and more objective study and analysis with a larger sample size could be undertaken to document and assess housing and health hardware quality, crowding density levels and infection rates to expand the evidence base. However, in the tradition established by Healthabitat since 1987, no survey should be conducted without an associated 'fix' of repairs to health hardware (NHC et al., 1987). In providing both repairs and new evidence, this may begin to provide the change observed by an Aboriginal Health Worker visiting Barkly bush communities over decades:

> '[When] houses were built, I noticed immediately a drop in the scabies… you could see the mental change. Could see the difference in families. Kids are healthier and happier. I've seen this repeated in other communities once housing was given- the change' (Anyinginyi clinician K3).

Appendices

Appendix 1: Ethical approval and consent

Ethical clearance for this project was obtained by the University of Queensland Human Research Ethics Committee; further approval was granted by the Anyinginyi Board of Directors. Both letters of consent are provided in Figure 10 and Figure 11.

THE UNIVERSITY OF QUEENSLAND

Institutional Human Research Ethics Approval

Project Title:	Housing improvement: A comparison of infrastructure and maintenance in communities with high and low hygiene-related infections – 14/06/2019 - AMENDMENT
Chief Investigator:	Dr Nina Hall
Supervisor:	None
Co-Investigator(s):	Prof Paul Memmott, Ms Carroll Go-Sam, Prof Sandra Creamer, Ms Wendy Anders, Prof Hugh Taylor, Ms Fiona Lange, Dr Andrew Redmond, Dr Daphne Nash, Samuel Barnes
School(s):	School of Public Health
Approval Number:	2018001773
Granting Agency/Degree:	UQ Global Change Institute Flagship funding
Duration:	12 October 2020

Comments/Conditions:

- Amendment Form, 14/06/2019
- CV Samuel Barnes
- Samuel Barnes Study Report

Note: if this approval is for amendments to an already approved protocol for which a UQ Clinical Trials Protection/Insurance Form was originally submitted, then the researchers must directly notify the UQ Insurance Office of any changes to that Form and Participant Information Sheets & Consent Forms as a result of the amendments, before action.

Name of responsible Committee:
University of Queensland Human Research Ethics Committee A
This project complies with the provisions contained in the *National Statement on Ethical Conduct in Human Research* and complies with the regulations governing experimentation on humans.

Name of Ethics Committee representative:
Dr Gordon McGurk
Chairperson
University of Queensland Human Research Ethics Committee A
Registration: EC00456

Signature _____ Date 17/06/2019

Figure 10: Ethical clearance from The University of Queensland

Anyinginyi Health Aboriginal Corporation

Culturally Responsive

PO Box 403 or 1 Irvine Street
TENNANT CREEK NT 0861
ICN: 283 ABN: 97329483372
Telephone: (08) 8962 2633
Facsimile: (08) 8962 3280

Professor Paul Memmott
University of Queensland
p.memmott@uq.edu.au

Dear Professor Memmott

In addition to our letter dated 24th July 2018, for the Housing and Health Research Project, see below Motion as per Anyinginyi Health Board of Directors.

1. **Paul Memmott – Housing & Infectious Disease**
   Board welcomed Paul Memmott to the meeting.
   Paul discussed the letter sent to the Chairperson (tabled 27.06.2018). Working a new study to find the link between Housing and Infectious Disease. Project Title: Housing Improvement: The missing link for trachoma elimination? A comparison of housing infrastructure and maintenance in communities with high and low hygiene-related infections, reporting and involvement of Board and Organisation. Discussion held.

Motion 2018 - 054
That Anyinginyi Health Board of Directors endorse in principle the "Housing Improvement Project – The missing link for Trachoma Elimination"

Moved: Director Green **Seconded**: Director Foster **Result: Carried**

If you need any further information please do not hesitate to contact me.

Respectfully

Clarissa Burgen
Corporate Services Manager
Anyinginyi Health Aboriginal Corporation

2nd August 2018

"Ngarunyurr Parlpuru Munjarlki"
Prevention is the Solution

Figure 11: Permission from Anyinginyi Health Aboriginal Corporation

Appendix 2: Table: Summary of key themes identified in literature

Author	Crowding and hygiene are linked	Crowding links to hygiene-related infectious disease	Impacts of crowding can be reduced by hygiene, maintenance and greater housing supply
Database Search			
(Ali et al., 2018)	In a systems thinking approach, housing functionality links to crowding and infectious disease transmission. Notably, crowding can limit residents in practices HLPs due to hardware in need of repair.	Links skin, ear, eye and respiratory diseases to crowding. Gastrointestinal diseases not as strongly linked.	Benefits from reductions in crowding can be limited by hygiene practices.
(Bailie et al., 2010b)	Crowding was identified as a barrier to hygiene practices despite infrastructure improvements. Study notes a weak link between crowding and hygiene as some households could perform hygiene practices despite high levels of crowding.		Hygiene interventions were noted as effective at reducing incidence rates of infectious disease in children despite high levels of crowding.
(Bailie et al., 2011)	High levels of crowding and poor hygiene potentially explain why there has been limited success in housing programs to date.	High levels of crowding facilitated the transmission of infectious disease.	Hygiene practices such as handwashing is recommended to reduce the transmission of infectious disease.
(Clucas et al., 2008)		Presents evidence that links scabies (skin disease) to crowding and hygiene. The data highlights the prevalence of hygiene-related infectious disease in children. Suggests that respiratory infections may also be influenced by crowding.	
(Engelman et al., 2014)		Examining invasive *Staphylococcus aureus*, the link between this bacteria and crowding was made. Also noted the link between *S. aureus* and scabies prevalence.	
(Jacoby et al., 2011)		Risk of *Staphylococcus pneumoniae* increases with number of children living in the room. Study shows that the most common and consistent predictor of Upper Respiratory tract infection is crowding.	
(Lowell et al., 2018)	Living with extended family because of homelessness masks true estimates of crowding. In these environments, individuals noted that in crowded houses they were	Community members acknowledged that sickness is spread by too many people living in a small space sharing everything. A mother	Crowding limits the effectiveness of beneficial outcomes in newly refurbished housing.

	"obliged to literally breathe together". Sickness "hangs around the house because there are too many people to get the house clean." Neighbours were at times noted as using health hardware in house exacerbating impacts of crowding. Residents found that keeping the house clean was a continuous challenge in crowded conditions.	noted that her kids have to share everything: bedsheets, blankets and pillows.	
(McDonald et al., 2009)	Crowding increases the wear and tear of health hardware making HLPs difficult to achieve. Participants understood that coughing and increased direct contact with nasal discharge lead to respiratory infections.	Children sleeping together increased risk of skin or respiratory infections, but these outcomes were outweighed by social and emotional benefits.	Hygiene was seen as positive and healthy but the association between that positive image and the health benefits were not understood. Despite this, participants saw no disparity in their living conditions to image.
(Quinn et al., 2015)		Systematic review noted that crowding in households in remote Indigenous communities increased risk for communicable disease. Skin, eye and respiratory infections were identified as having substantial burden in remote Indigenous communities.	
(Torzillo et al., 2008)			Maintenance programs are crucial to sustaining health-supporting function of housing. When regular maintenance does not occur, the impacts of crowding are greater.
(Vino et al., 2017b)		Crowded houses have a clear implication in the transmission dynamics of infectious disease in remote communities. Crowding also can be attributed to the high burden of infectious disease in Indigenous communities.	Hygiene levels can influence the probability of transmission of infectious disease.
Grey Literature Examination			
(Department of the Prime Minister and Cabinet [DPMC], 2017)	Crowding results in the overuse and eventual breakdown in health hardware, necessary for HLPs.	Crowding and lack of access to functional hygiene facilities and poor hygiene facilitate the transmission of common illnesses. Crowding and hygiene are also noted to contribute to increased difficulty in managing chronic disease.	By 2028, at least 5,500 new houses are required to be built to reduce the health impacts crowding has on Indigenous communities.

(Price Waterhouse Coopers, 2007)	Crowding places excessive demand on health hardware necessary for hygiene.	Can contribute to the spread of infectious diseases such as rheumatic fever, respiratory diseases and skin infections.	As public housing is important in remote and very remote areas the number of houses need to be increased to reduce the health impacts of crowding. Maintenance of current houses is the fastest and most practical way to lessen the health impacts of crowding.
Academic-Provided			
(Bailie et al., 2010a)	Crowding was included as a socio-demographic variable for this study because of the potential direct impact on household infrastructure and hygiene.	Crowding contributes to increased interpersonal contact which promotes the spread of infections (such as respiratory diseases and scabies).	
(Bailie and Wayte, 2006)		Crowded housing conditions facilitates the spread of various common infectious and parasitic conditions. Recurrent and chronic infections contribute to poor growth and exacerbate chronic disease. Examples include scabies and ear infections.	
(Booth and Carroll, 2005)	When housing conditions are crowded there may be inadequate access for ablution.	Crowding can contribute to more rapid transmission of infectious diseases and high probability of poor health.	Suggested that when residing in households with more space living with fewer adults reduced the impacts of crowding.
(Hall et al., 2017)	Crowding limits the ability of people to maintain both personal and environmental hygienic conditions. Population size in the home is core to individual healthy behaviours.		
(McDonald and Bailie, 2010)	Crowding was noted as a factor that may be a barrier to achieve hygiene improvement. Due to the interrelated nature of underlying factors (crowding and housing environment) there is no single or simple intervention than can improve hygiene.	Participants identified that scabies could be passed on via close contact however did not know that ear infections could be passed on in the same way.	

Appendix 3: Additional Communicare Database Information from the Anyinginyi Health Clinic (February 2017 – May 2019)

Organ System Category	Hygiene-related Infectious Disease	Number of Diagnoses
Bone & Joint		**37**
	Arthritis (Septic)	7
	Bursitis	20
	Infection (Musculoskeletal)	2
	Osteomyelitis	8
Cardiac		**30**
	Valvular Heart Disease	1
	Endocarditis (Bacterial)	1
	Incompetence (Mitral)	1
	Murmur	2
	Rheumatic Fever	25
Dental		**338**
	Abscess (Dental)	24
	Tooth decay	222
	Disease (Periodontal)	52
	Infection (MISC)	38
	Peritonitis	2
Gastroenterology		**253**
	Colitis (MISC)	3
	Diarrhoea	25
	Enteritis (MISC)	10
	Gastroenteritis (MISC)	182
	Giardiasis	6
	Infection (*H. pylori*)	8
	Salmonellosis	1
	Shigellosis	6
	Strongyloidiasis	10
	Threadworms	2
Hepatic		**16**
	Hepatitis B	12
	Hepatitis C	3
	Jaundice (Infectious)	1
Immune		**4**
	HTLV-1	2
	Infection (Lymph Glands)	2
Optical		**363**
	Conjunctivitis	321
	Pus (Eye)	1
	Trachoma	19
	Stye	21
	Keratitis (Ulcerative)	1
Renal		**219**
	Infection (MISC)	5
	Kidney Transplant	3
	Pyelonephritis	16
	Urinary Tract Infection	193
	Albuminuria	2
Other		**179**
	Infection (MISC)	119
	Meningitis	4
	Pyrexia (Unknown Origin)	40
	Septic Shock	2
	Septicaemia	13
	Toxoplasmosis	1

Appendix 4: Residential survey template

Participant code:

Barkly Resident Survey: Housing, crowding and health

Housing improvement: A comparison of infrastructure and maintenance in communities with high and low hygiene-related infections

Resident _____

Interviewer _____

UQ researcher Daphne ☐ Carroll ☐ Nina ☐ Andy ☐ Paul ☐

Housing authority _____

CLA/community/outstation _____

For further information on this survey, please contact The University of Queensland:

Professor Paul Memmott: p.memmott@uq.edu.au / 0418441558

Dr Nina Hall: n.hall2@uq.edu.au / 0415750957

Participant Consent

Thank you for considering participation in this project. You can let the researchers know verbally that you consent to participate in an interview.

Please ensure that you are agreeable to the following:

1. I acknowledge that I have read and understand this Participant Information Sheet.

2. An opportunity has been given to me to discuss the study with the researcher.

3. I understand that while information gained during this study may be published, I will not be identified and my personal results will not be divulged. I understand that my responses will be de-identified before analysis.

4. I understand that I am free to withdraw from the project at any stage. I understand that information/data collected up to the point of my withdrawal will be included in the analysis of the study.

6. I understand that some local Aboriginal people will be employed to assist with community liaison and data collection.

Signatures

Participant to complete:

- I have read the Participant Information Sheet and Informed Consent Form [or someone has read it to me in language I understand] and I agree with it.
- I have received $30.00 for the time taken to participate in the interview.

Name: _____

Signature:_____

Email: _____

Date: / /2019

Researcher to complete:

- I have described the nature of the research to the Participant and I believe that he/she understood and agreed to it.

Name: _____

Signature: _____

Date: / /2019

Barkly Resident Survey: Housing, crowding and health

Participant Information

(Approved by The University of Queensland Human Research Ethics Committee #2018001773)

Project:

Housing improvement: A comparison of infrastructure and maintenance in communities with high and low hygiene-related infections

Researchers: Dr Nina Lansbury HALL, Carroll GO-SAM, Professor Paul MEMMOTT, Dr Daphne NASH, Dr Andrew REDMOND

Organisations: The University of Queensland

Contact: For any queries regarding the research, please contact Dr Nina Lansbury HALL, UQ School of Public Health-Environment Health Unit (n.hall2@uq.edu.au; 07 3346 4717, mobile 0415750957)

Participant Information

Introduction and aim of study

This research will work with Anyinginyi Health Aboriginal Corporation and residents of the Barkly Region , NT, to understand how to reduce infectious diseases through improved housing and housing maintenance. The findings are intended to inform community driven solutions and policy.

The project is funded by The University of Queensland (UQ)'s Global Change Institute Flagship Funding Scheme. The research team is led Dr Nina Hall, Professor Paul Memmott, Dr Daphne Nash and Ms Carroll Go-Sam at The University of Queensland and Dr Andrew Redmond at the Royal Brisbane and Women's Hospital Infectious Diseases Unit.

How will the study be carried out?

The university researchers will work under the guidance of Anyinginyi Health Aboriginal Corporation to conduct interviews about the links between housing and health.

What will I be asked to contribute?

We are seeking interviews with Anyinginyi health staff and with residents of the Barkly Region.

- For Anyinginyi staff, the interview questions will ask for insights into the link between infectious disease burden and the influence of housing.

- For Barkly residents, the interview questions will ask about the housing quality and functionality, and any link with illness and health.

What are the benefits of participating in this study?

Local Aboriginal people will be employed to assist with community liaison and data collection. These will likely be CDP recipients.

As a participant, you will be providing a valuable contribution to the knowledge, policy and action on these issues that should ideally contribute to positive changes for improved health and housing for Aboriginal peoples living in remote areas.

Are there any risks involved?

The university researchers provide assurance that any identifying data, identities and housing location will be de-identified and generalised in the results to avoid identification.

All human research undertaken will comply with the values, principles, governance and review process specified in the NH&MRC National Statement on Ethical Conduct in Human Research (2007). A copy of the National Statement can be found at https://www.nhmrc.gov.au

How will my privacy be protected?

All data collected in this study will be de-identified and any identifiable information will not be traceable to interview participants or communities, unless otherwise agreed with you. The information will be stored in a locked filing cabinet and in a password-protected folder on the researchers' computers.

The project team may publish study results and data in research publications and press releases. However, the project team will de-identify any personal information contained in the data and results so that you cannot be identified. Where possible, drafts of these publications will be shared with you before finalising and publishing.

What if I wish to withdraw?

You are free to withdraw at any time during the process. Any information/data collected up to the point of withdrawal will be included in the analysis of the study.

How will I receive the findings?

You can provide your email address on the consent form if you wish to view a draft of your interview transcript and make any changes.

Note and further contact: This study adheres to the Guidelines of the ethical review process of The University of Queensland and the *National Statement on Ethical Conduct in Human Research*.

You are welcome to contact the team at the University of Queensland with further questions:

- Dr Nina Lansbury HALL, UQ School of Public Health (n.hall2@uq.edu.au; 07 3346 4717; 0415750957) (MAIN CONTACT)
- Professor Paul MEMMOTT, UQ Institute for Social Science Research (p.memmott@uq.edu.au; 0418441558)

If you would like to speak to an officer of the University not involved in the study, you may contact the Ethics Coordinator on +617 3365 3924 or email humanethics@research.uq.edu.au.

Please detach this page and leave it with the respondent

Participant Information and Consent Form

(Approved by The University of Queensland Human Research Ethics Committee #2018001773)

Project:

Housing improvement: A comparison of infrastructure and maintenance in communities with high and low hygiene-related infections

Researchers: Dr Nina Lansbury HALL, Carroll GO-SAM, Professor Paul MEMMOTT, Dr Daphne NASH, Dr Andrew REDMOND

Organisations: The University of Queensland

Contact: For any queries regarding the research, please contact Dr Nina Lansbury HALL, UQ School of Public Health-Environment Health Unit (n.hall2@uq.edu.au; 07 3346 4717; 0415750957)

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What are the benefits of participating in this study?

As a participant, you will be providing a valuable contribution to the knowledge, policy and action on these issues that should ideally contribute to positive changes for improved health and housing for Aboriginal peoples living in remote areas.

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All human research undertaken will comply with the values, principles, governance and review process specified in the NH&MRC National Statement on Ethical Conduct in Human Research (2007). A copy of the National Statement can be found at https://www.nhmrc.gov.au/book/national-statement-ethical-conduct-human-research.

How will my privacy be protected?

All data collected in this study will be de-identified and any identifiable information will not be traceable to interview participants or communities, unless otherwise agreed with you. The information will be stored in a locked filing cabinet and in a password-protected folder on the researchers' computers.

The project team may publish study results and data in research publications and press releases. However, the project team will de-identify any personal information contained in the data and results so that you cannot be identified. Where possible, drafts of these publications will be shared with you before finalising and publishing.

What if I wish to withdraw?

You are free to withdraw at any time during the process. Any information/data collected up to the point of withdrawal will be included in the analysis of the study.

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- Professor Paul MEMMOTT, UQ Institute for Social Science Research (p.memmott@uq.edu.au; 0418441558)

If you would like to speak to an officer of the University not involved in the study, you may contact the Ethics Coordinator on +617 3365 3924 or email humanethics@research.uq.edu.au.

Participant code: _____

Start time: _____ End time: _____

1. **People in the house**
   a) Who is in charge of the people in this house? (the Boss)

   _____

   b) We are asking about people living in the house now.

   How many people live here on a regular basis/all the time? _____

   How many live here regularly / on and off, and use other houses in town? _____

   How many are short-term or overnight visitors (only a few nights)? _____

c) How often do bush visitors come and stay?

☐ Rarely (a couple of times) ☐ Once a year ☐ Lots of times

d) When bush visitors are here, how long do they usually stay?

☐ A day or two ☐ A week ☐ More than a week

e) Have you been living here for the last three months? ☐ Yes ☐ No

f) Were you here last year? ☐ Yes ☐ No

g) If you don't live here all year, where else do you live? _____

_____

2. Health in the Barkly Region

a) Who are most healthy: the people who live in town or people living in bush communities?

☐ Town ☐ Bush

Why? _____

_____

3. Infectious diseases in _____ (name of this community)

a) What sicknesses are in your house? And how often do they occur?

	Rare	Sometimes	A Lot
Eye			
Ear			
Skin			
Chest			
Other (list)			

b) Which of the sicknesses in your house are the worst? _____

_____

_____

Why? (Do they effect other people in the house?) _____

_____

4. Housing in the Barkly Region

a) In your house:

How many bedrooms? _____ How many bathrooms? _____

Where do people sleep?

☐ Bedrooms ☐ Other rooms ☐ Verandah ☐ Yard

How many / who sleeps in each space?

Bedroom 1 _____

Bedroom 2 _____

Bedroom 3 _____

Other rooms _____

Verandah _____

Yard _____

Cars _____

b) What works in your house?

	Works	Doesn't Work
Is your shower working?		
Is your toilet working?		
Is your kitchen sink tap working?		
Is your washing machine working?		
Do the drains work?		
Do you have a fridge, and does it work?		
Hot and cold water?		
Tap in the yard? (Or no tap?)		

c) Are there community rubbish bins? ☐ Yes ☐ No
Are the bins collected? ☐ Enough ☐ Not enough
Is there weekly rubbish pick up? ☐ Yes ☐ No
Do you take rubbish to the dump? ☐ Yes ☐ No

d) Is dust a problem? ☐ YES ☐ NO
If yes, how do you manage it? _____

_____

_____

e) Do you have any dogs, cats or other pets? ☐ Dog ☐ Cat ☐ Other
Are they healthy or sick? ☐ Healthy ☐ Sick
Do they live inside or outside? ☐ Inside ☐ Outside

f) Are there problems in the yard? (e.g. broken tap; pools of water; broken fences; rubbish)

_____

g) Do you have any rules for people in the house? (e.g. where certain people sleep; how long they can stay)

_____

_____

h) Do people follow the rules? ☐ YES ☐ NO

☐ YES Why? (respect; consequences if they don't)

_____

_____

☐ NO Why not? (don't know/don't care)

_____

_____

5. Health and housing

a) Can houses make people sick? ☐ YES ☐ NO
How? (prompt: faulty toilet, kitchen tap, washing machine, bathroom/shower)

_____

_____

6. Final comments

a) Do you need any support or help for living in your house? ☐ YES ☐ NO

b) Is there anything else that you would like to add?

Thank you for your time.

Appendix 5: Clinical and environmental health survey template

Participant code: [ ]

Anyinginyi Clinical and Environmental Health Survey: Housing, crowding and health

Housing improvement: A comparison of infrastructure and maintenance in communities with high and low hygiene-related infections

Name of respondent (if answering individually)

_____

Names of respondents (if answering as a group; you can list your individual names, or just the name of the group)

_____

_____

_____

_____

For further information on this survey, please contact The University of Queensland:

Professor Paul Memmott: p.memmott@uq.edu.au / 0418441558

Dr Nina Hall: n.hall2@uq.edu.au / 0415750957

Participant Consent

Thank you for considering participation in this project. You can let the researchers know verbally that you consent to participate in an interview.

Please ensure that you are agreeable to the following:

☐ I acknowledge that I have read and understand this Participant Information Sheet.

☐ An opportunity has been given to me to discuss the study with the researcher.

☐ I understand that while information gained during this study may be published, I will not be identified and my personal results will not be divulged. I understand that my responses will be de-identified before analysis.

☐ I understand that I am free to withdraw from the project at any stage. I understand that information/data collected up to the point of my withdrawal will be included in the analysis of the study.

Signatures

Participant to complete (or one person representing the group response to complete):

☐ I have read the Participant Information and Consent Form and I agree with it.

Name: _____

Signature:_____

Email: _____

Date: **/** **/**2019

Researcher to complete:

☐ I have described the nature of the research to the Participant and I believe that he/she understood and agreed to it.

Name: _____

Signature: _____

Date: **/** **/**2019

About you (for individual respondents):

1.1 What is your role in Anyinginyi Health Corporation?

_____

1.2 How long have you worked here?

_____

1.3 Do you identify as Aboriginal? If yes, which is your country or language group?

_____

About you (for group respondents):

1.4 Which parts of Anyinginyi Health Corporation do you represent (list here- eg Public Health, Stronger Families etc)

_____

_____

Part 1: Clinical questions (for GPs and other clinicians)

2. Hygiene-related infections

For the following infections, have you seen these, how often, what are your thoughts on the causes, and what should be done to prevent the causes?

	Infection	**Have you seen these? (yes/no)**	**How often per week?**	**What are your thoughts on the causes?**	**What should be done to prevent the causes?**
2.1	Skin infections – both acute (short-lived) and chronic (long-lasting,); scabies				
2.2	Lung infections – acute and chronic (tuberculosis and bronchiectasis)				
2.3	Diarrhoea				
2.4	Eye infections – including trachoma				
2.5	Ear infections (especially in children)				
2.6	Dental/gum infections				
2.7	Rheumatic heart disease				
2.8	Glomerulonephritis (eg PSGN)				
2.9	Animal-related infections (dogs/cats)				

3. Infections and immunisation

3.1 From your experience in the Barkly, do any childhood illnesses contribute to chronic disease? If yes, which and how?

_____
_____
_____

3.2 Do you know how parents might feel about vaccinations for their children in the Barkly Region ? Are mums/dads/carers worried about vaccinations, or, are they happy to have them done?

_____
_____
_____

Part 2: Environmental health questions (for Anyinginyi staff in Stronger Families, Public Health etc; GPs and nurses are also welcome to respond)

4. Perceptions of health and housing

4.1 What are the main links as you see in Anyinginyi between housing and health? Please describe.

_____
_____
_____

4.2 Do you see a link between infectious disease burden and the quality of housing? How?

_____
_____
_____

4.3 Can you name locations that have good health from housing in the Barkly? And ones that do not? What do you think creates the good conditions? And the bad conditions?

_____
_____
_____

5. Housing in the Barkly Region

5.1 What is your definition of 'crowding'? Using your definition, is there crowding in specific town camps (Community Living Areas) in Tennant Creek, communities and outstations? Is this a concern to Anyinginyi? Why?

_____
_____
_____

5.2 Have you visited any of the homes of Anyinginyi clients? How many?

_____
_____

5.3 If you have visited more than 10 houses of clients, please answer this question (if you have visited fewer than 10 houses, please move to Question 6): Do you consider that the houses in specific town camps (Community Living Areas) in Tennant Creek, communities and outstations are sufficiently maintained for:

	Yes	No
5.3.1 Residents to keep clean		
5.3.2 Adequate laundry facilities		
5.3.3 Keep food and medicine cool in a fridge		
5.3.4 Manage dogs and other pets		
5.3.5 Manage rubbish collection and disposal		
5.3.6 Keep the home cool when it is hot		
5.3.7 Manage dust		

6. Final comments

6.1 Is there anything else that you would like to add?

_____
_____
_____

6.2 Thank you for your time.

(Note: If you have completed this survey outside of the interview time, please leave it with Carolyn Renehan at Anyinginyi to deliver to the university researchers).

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