Pedestrian deaths and serious injuries

in the Northern Territory

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Key findings

- Visibility is a major factor in the severity of pedestrian crashes in the NT. Compared to daylight, the odds of a fatal crash occurring at dawn/dusk are 10.90 times higher and 10.99 times higher on roads listed as dark without streetlights.

- Speed limits are important for crash outcomes. The odds of a pedestrian crash resulting in a fatality on NT roads increases by 3.3% for every 1km/h increase in designated road speed.

- Pedestrian crashes were 65 times more likely to end in fatality and three times more likely to end in severe injury when alcohol was involved (either pedestrian and/or driver). Keeping people away from roads (as a driver and a pedestrian) while they are intoxicated is a priority for reducing pedestrian injury and deaths.

- There are opportunities to improve NT reporting and capture of alcohol and drug involvement in road crashes, particularly blood alcohol content in non-fatal pedestrian crashes.

- In the NT, pedestrian crashes predominantly affect middle-aged, Aboriginal and/or Torres Strait Islander men.

- High risk periods typically include evenings (6-10pm) and pre-dawn (2-6am) on weekends. There are spikes in risk during holiday periods such as April, June, July and December.

- Weather, traffic and road conditions appear to not be a major factor in NT pedestrian crashes. Most typically involved light traffic, clear weather and were on straight, flat, sealed roads.

- Interventions to prevent and reduce the severity of outcomes of pedestrian crashes will need to be multi-pronged to address the associated risk factors. Lighting, speed limits, horizontal features of the road, alcohol involvement and drug involvement will need to be targeted together.

Contents

Purpose of this study

During collisions, pedestrians are the most likely to be injured or die compared to any other road user (1). Road crashes involving pedestrians are a significant concern in the Northern Territory (NT), accounting for 23.1% of road fatalities in the NT compared to 13.7% nationally (2,3). This has long been recognised as an issue, as noted by an NT Coroner two decades ago:

> *"The third matter of concern was the prevalence of the deaths of this type. That is to say, there is a long history of pedestrians under the influence of alcohol being involved in motor vehicle accidents." Greg Cavanagh, NT Coroner, 2005 (4)*

Road crashes involving pedestrians have also received public interest, with a number of high-profile cases and calls from Aboriginal leaders to address this issue (5–7).

This study aimed to develop an understanding of key factors and issues associated with pedestrian road trauma in the NT. Furthermore, we aimed to gain insights from professionals and community members on feasible and appropriate prevention measures. We conducted three sub-studies: a quantitative analysis of police crash records and hospital admissions; a qualitative analysis of interviews and focus groups with relevant professionals; and a qualitative analysis of interviews and focus groups with people from remote and urban communities, including those at risk of involvement in pedestrian road crashes and their family members.

In addition, a summary of the NT coronial investigations of pedestrian deaths is provided in Appendix A, which provides further insight into causal and contextual factors involved in pedestrian road crashes. Appendix B highlights three stories of pedestrian crashes that exemplify common features of these incidents.

Methodology

This is a mixed method project, where we used both quantitative (sub-study 1) and qualitative data (sub-study 2 and 3). These data were triangulated to inform a more in-depth understanding of why crashes happen and how they might be prevented in the NT. This report will draw from each of the relevant data sources to provide comprehensive insights into key issues. Our aim is to provide details relevant to policy and practice in plain English. Detailed methodology and many of the additional tables and figures are provided in embargoed appendices.

For sub-study 1 we did a retrospective observational analysis of two datasets comprised of routinely collected administrative data. These included police-recorded crashes involving pedestrians and records of hospital admissions related to pedestrian crashes. We assessed a ten-year period from 2013 – 2023 to identify any changes over time in the rate of pedestrian crashes. For sub-study 2 and 3 we interviewed people about their professional and lived experience of pedestrian crashes or exposure to pedestrian crash risk factors. All interviews were audio recorded and transcribed. To begin, transcripts were coded inductively via a group thematic analysis process initiated through a two-day online workshop with the respective team of researchers (CW, SC, RR, RC, FW). Once an initial codebook was generated, these codes were categorised under the five Safe Systems Approach pillars to identify factors related to road users (drivers and pedestrians), roads, speed and post-crash care.

As part of sub-study 3, some participants told us their pedestrian crash story. In Appendix B we highlight three of these stories as case studies which exemplify common factors identified across the other qualitative and quantitative data. To protect confidentiality, identifiable information was removed. Ethical approval was obtained from the Northern Territory Department of Health and Menzies School of Health Research Human Research Ethics Committee (2024-4825).

Table 1: Data sources

Sub-study 1	**Data source**	**Data custodian**	**Timeframes**	**Number of records**
Quantitative administrative data	Vehicle Accident Database (VADB)	Department of Infrastructure, Planning, and Logistics (DIPL)	1 January 2013 – 30 June 2023	709
	Hospital admissions	NT Health	1 January 2013 – 30 June 2023	1153
Sub-study 2	**Participant characteristics**		**Number of participants**	**% of total**
Qualitative Key Informants	Professional experience in roads, policing, emergency response		11	41%
	Professional experience in health, housing, alcohol and drug support, social support (i.e. work with at-risk clients)		16	59%
	Government agency		11	41%
	Aboriginal Community Controlled Organisation		15	55%
	Non-government organisation		1	4%
	Men		17	63%
	Women		10	37%
	Aboriginal and/or Torres Strait Islander		15	56%
	Non-Indigenous		12	44%
	Darwin		21	78%
	Katherine		3	11%
	Alice Springs		3	11%
	Total		100%	27
Sub-study 3	**Participant characteristics**		**Number of participants**	**% of total**
	Men		12	55%
	Women		10	45%
	Aboriginal and/or Torres Strait Islander		20	91%
	Non-Indigenous		2	9%
	At risk of pedestrian death (sleeping rough and/or unstable housing) themselves		15	68%
	Family member or loved one at risk of pedestrian death		7	32%
	Darwin		3	14%
	Katherine		4	18%
	Tennant Creek		1	4%
	Alice Springs		2	9%
	Remote – West Arnhem		3	14%
	Remote – Big Rivers		3	14%
	Remote – Central		2	9%
	Remote – East Arnhem		2	9%
	Interstate		2	9%
	Total		22	100%
	Total number of records			1862
	Total number of interviews			49

Study participants and data sources

Sub-study 1: Epidemiological analyses

Administrative data were requested, and provided by the data custodians.

Sub-study 2: Key informant interviews

Key informants were selected purposively, on the basis of their ability to contribute unique knowledge or insights into the interview topic. A list of potential interviewees or representative organisations was developed in consultation with the Northern Territory Motor Accident Compensation Commission. Contact details were provided by the Motor Accident Compensation Commission or located through the research teams professional networks. Key informants could be included if they had professional knowledge or insights relevant to pedestrian crashes and/or the population at risk, were aged 18 or older, and had lived in the NT for at least a year at time of interview. Interviews took approximately 60mins and were conducted by phone, Zoom/Teams, or in person at a place convenient to the participant.

Sub-study 3: Community member interviews

Participants in this study component were included if they were aged 16 or older and were currently living in the NT. We purposively sampled individuals who could provide in-depth insights into risk factors for pedestrian crashes, based in information obtained in the epidemiological analyses and key informant interviews. For instance, we identified local community members who had experience of long-grassing/sleeping rough, who had family members who had been involved in pedestrian crashes, who had experienced problems with alcohol and who lived in urban or remote Aboriginal communities. Many participants met multiple criteria. The majority of people interviewed were Aboriginal and/or Torres Strait Islander. Interviews took approximately 30-60 minutes and were conducted in person at a place convenient to the participant.

Results

We will first discuss the trends in pedestrian crashes over the study period. We will then explore the timing and location of crashes, and characteristics of people most at risk. Finally, we will examine factors that contributed to the crash.

This report will integrate findings from statistical analyses of quantitative data alongside insights derived from qualitative data, such as interviews. Where relevant, de-identified participant quotes will be included to highlight and contextualise key findings.

What is the magnitude/burden of road motor accidents in the NT?

There were 709 pedestrian crashes recorded by police from January 2013 to June 2023, involving 727 pedestrians and 723 drivers.[1] Four in five pedestrian crashes were recorded as resulting in an injury (81%; n=570) with half (52%; n=367) recorded as resulting in a hospital admission, predominantly for the pedestrian. Only a small number of drivers were recorded as admitted (n=10) or treated but not admitted (n=7). One in ten crashes resulted in fatalities (11%; n=82 crashes), totalling 84 pedestrian deaths (Figure 1).

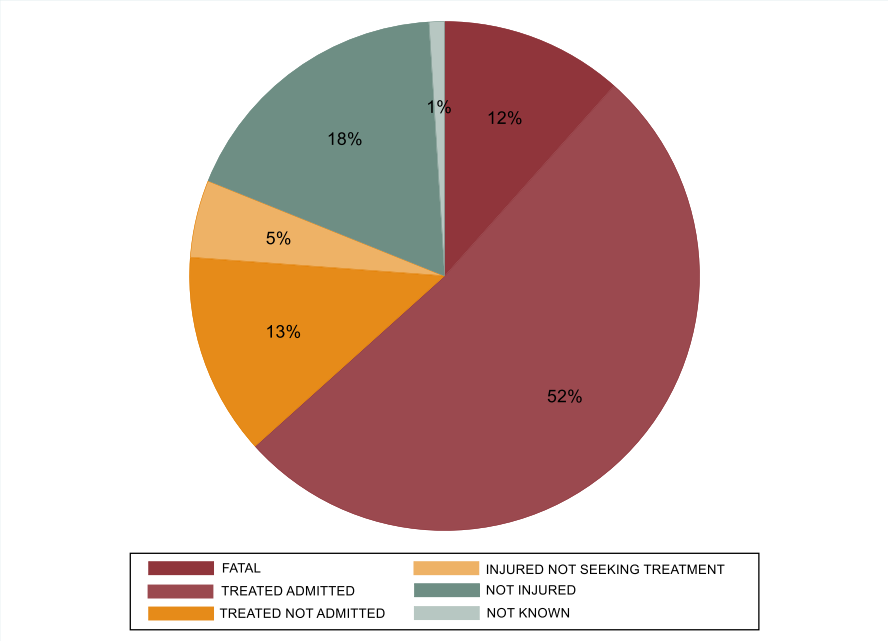

Figure 1: Pedestrian crash injury outcomes, recorded by police

[1] While the majority of pedestrian crashes involved one vehicle (98%) and one pedestrian (97%), in some cases a vehicle hit multiple pedestrians, in other cases a vehicle hit a pedestrian and was subsequently hit by another car (i.e. rear ended), so the number of pedestrians and drivers does not exactly reflect the number of crashes.

A greater number of pedestrian crashes were identified when using hospital data (compared to police data presented above). **Over the same time period, 1154 pedestrians were admitted to NT hospitals as a result of a traffic accident.**

Discrepancies between police and hospital data are not uncommon. In Victoria, the police-recorded serious injuries (pedestrian recorded as transported to hospital) underestimated the number of actual hospital admissions for pedestrian injuries (only 44.1% of hospital admissions were recorded as such in police records) (8). In contrast, other research from the NT (which probabilistically linked police recorded crash data and hospital admission data) found that only 48% of traffic injuries (for all road users) identified by police as serious were in fact admitted to hospital (9). The inconsistency likely reflects the different legislative reporting requirements and core business of the agencies. For example, the NT Traffic Act require blood samples to be collected and tested for alcohol and drugs "if a person enters a hospital or health centre for examination or treatment of injuries which **may** have been received in a crash" (Traffic Act 1987 (NT), s.29AAK). It is possible this may contribute to an overcount of injuries from traffic crashes in healthcare setting to ensure compliance with legislation regarding BAC tests. It's also possible that there are pedestrians who are injured in crashes who do not report to police.

Are rates of pedestrian crashes in the NT changing over time?

We analysed trends in the quarterly population rates of pedestrian crashes, with detailed analyses of different trends for all (fatal and non-fatal) pedestrian crashes (Figure 2); pedestrian crashes resulting in severe injury (death or hospital admission as recorded by police) (Figure 3); pedestrian crashes resulting in death only, as recorded by NT police (Figure 4); and hospital admissions for pedestrian crashes (as recorded by the hospitals) (Figure 5).

Over a ten-year period, police records showed a very minor but statistically significant decrease in the rates of *all* pedestrian crashes and rates of *pedestrian crashes resulting in severe injury*, for both Aboriginal and Torres Strait Islander and non-Indigenous pedestrians in the NT. The size of the change however, was very small (<2% reduction for Aboriginal and Torres Strait Islander pedestrian crashes and <3% for non-Indigenous). Hospital admission data did not however find any significant change during the time-period. This is consistent with national pedestrian deaths, which have remained largely unchanged (average trend change per annum of -1%) over the last decade (2). It is worth noting that prior to the time-period we analysed (2005/06 – 2009/10), a national study found that nationally there were decreases in Aboriginal and Torres Strait Islander pedestrian deaths (estimated decrease of 13.2% per year) and non-Indigenous pedestrian deaths 6% per year (10).

It is important to note that the analyses only capture data up to June 2023.

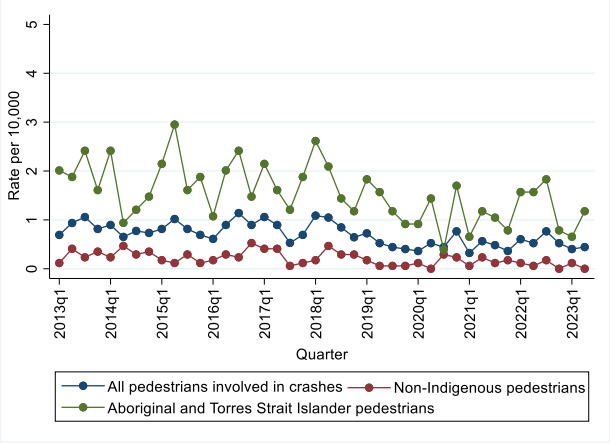

Figure 3: Pedestrians involved in crashes, as recorded by NT police

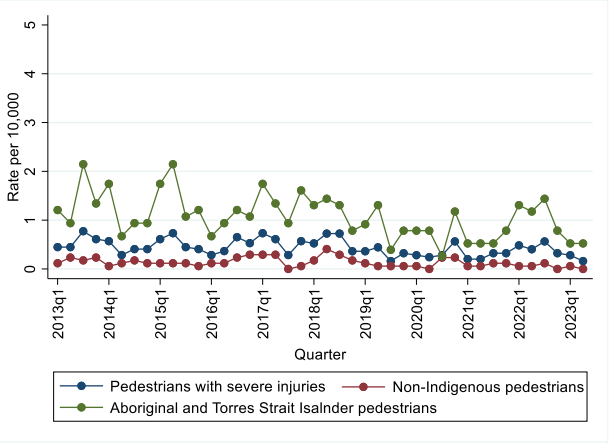

Figure 2: Pedestrians with severe injuries as the result of a crash, as recorded by NT police

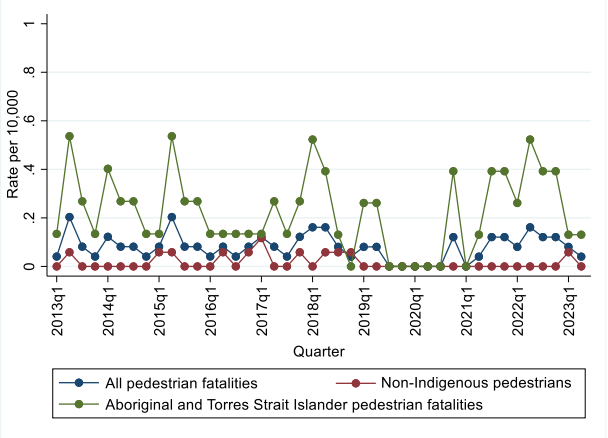

Figure 4: Pedestrian fatalities, as recorded by NT police

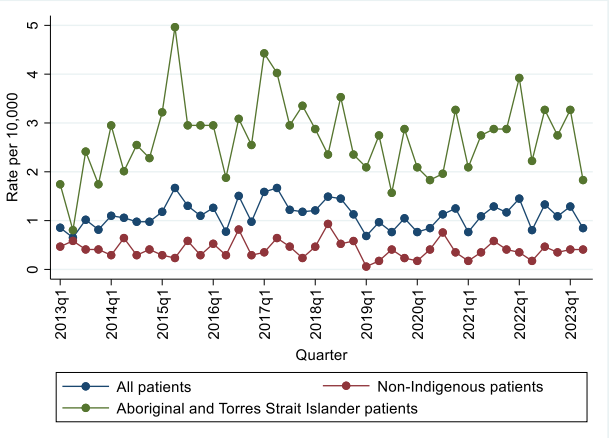

Figure 5: Patients admitted to NT hospitals for injuries related to pedestrian crashes

When do pedestrian crashes happen?

Most pedestrian crashes occurred in the evening between 6 pm and 10 pm, regardless of whether it was a weekday or weekend (Figure 7). Fatal pedestrian crashes, however, followed a different pattern (Figure 6). While weekday fatal pedestrian crashes were also most common in the evening (6pm to 10pm: 54%), weekend fatal crashes happened more often in the early hours of the morning (2 am to 6 am: 46%). Pedestrian crashes during this early morning period (2am to 6am) were three times more likely to occur on weekends (18%) than weekdays (5%), and this difference was even greater for fatal pedestrian crashes (46% on weekends compared to 9% on weekdays).

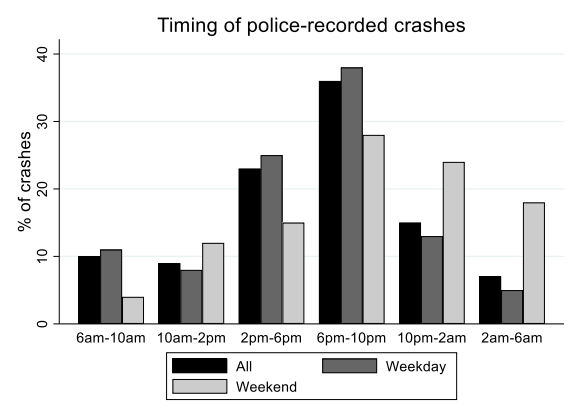

Figure 5: Police-recorded time of pedestrian crashes by day of week

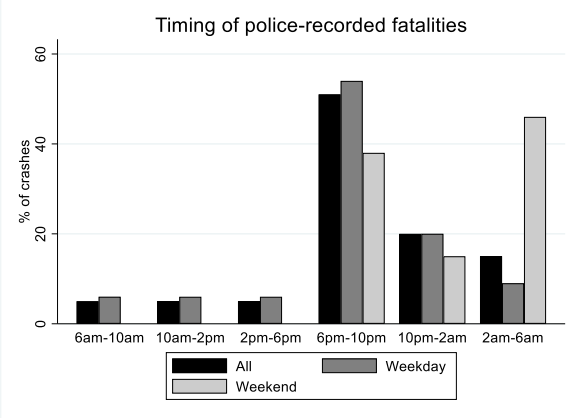

Figure 4: Police-recorded time of pedestrian fatalities by day of week

Analysis of monthly trends of all (fatal and non-fatal) pedestrian crashes found the number of crashes per month was reasonably evenly distributed throughout the year, with a slightly higher proportion occurring in March and April (10% in each; range 7-10%). Monthly trends in fatal pedestrian crashes showed more variation, ranging from 3% to 13% depending on the month. The highest proportion of fatal crashes occurred during major holiday periods, such as Easter in April (13%), the dry season in June (13%) and July (12%), and Christmas in December (12%).

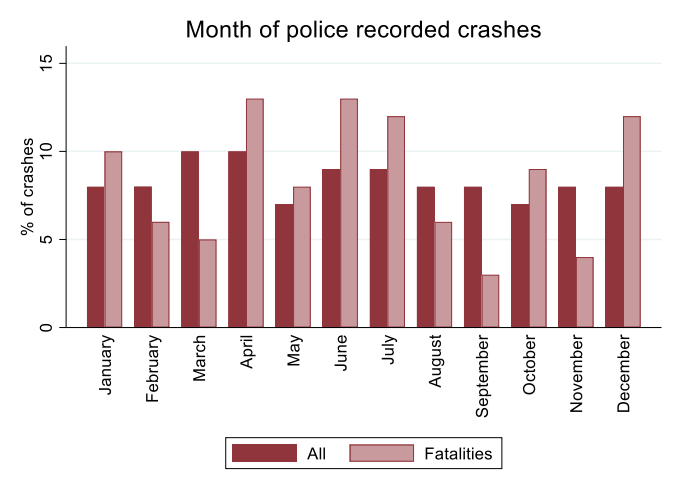

Figure 6: Police-recorded month of pedestrian fatalities

Where do pedestrian crashes happen?

Most pedestrian crashes occurred in the major towns with higher populations and more road traffic: Darwin (47%), Alice Springs (21%) and Palmerston (12%). We also present the rates (number of crashes per 10,000 residents) in each Local Government Areas; this helps us to understand where there are more crashes than would be expected proportionally for the population size. Alice Springs (51.6 crashes per 10,000) had the highest rates of pedestrian crashes.

When separating fatal and non-fatal pedestrian crashes, the largest proportion of fatal pedestrian crashes occurred in Darwin (30%; 2.9 per 10,000), Alice Springs (15%; 4.2 per 10,000) and Palmerston (13%; 2.7 per 10,000). Coomalie had the highest rate of fatal pedestrian crashes (14.3 per 10,000), due to there being two fatal crashes in a very small population. Table 1 outlines the location of pedestrian crashes based on Local Government Areas including both proportion of total and rates per 10,000 people. Rates of all (fatal and non-fatal) pedestrian crashes and fatal pedestrian crashes by LGA are presented visually in Figures 7 and 8.

Table 2: LGA of pedestrian crashes as recorded by NT Police, Jan 2013- June 2023[2]

Local Government Area	Pop	All (fatal and non-fatal) pedestrian crashes	%	Rate per 10,000	Fatal pedestrian crashes	%	Rate per 10,000
Alice Springs	28859	149	21%	51.6	12	15%	4.2
Barkly	7212	25	4%	34.7	4	5%	5.5
Central Desert	4105	5	<1%	12.2	1	1%	2.4
Coomalie	2024	7	1%	34.6	3	4%	14.8
Darwin	85166	334	47%	39.2	25	30%	2.9
East Arnhem	10108	4	<1%	4.0	0	0%	0.0
Katherine	10834	40	6%	36.9	4	5%	3.7
Litchfield	23083	24	3%	10.4	9	11%	3.9
MacDonnell	6627	6	<1%	9.1	3	4%	4.5
Nhulunbuy	3642	5	1%	13.7	0	0%	0.0
Palmerston	40467	88	12%	21.7	11	13%	2.7
Roper Gulf	7475	10	1%	13.4	5	6%	6.7
Tiwi Islands	2743	1	<1%	3.6	0	0%	0.0
Victoria Daly	3262	7	1%	21.5	4	5%	12.3
West Arnhem	7258	2	<1%	2.8	1	1%	1.4
West Daly	3434	2	<1%	5.8	0	0%	0.0

When discussing where pedestrian crashes happened and why this might be, key stakeholder participants noted that larger urban centres typically had increased traffic and more people walking on roads due to higher population and visitor numbers. It is also worth noting that low-severity pedestrian crashes in more remote areas may be less likely to be reported to police, meaning that figures may underestimate total crashes in remote areas.

[2] We have collapsed Darwin Waterfront Precinct and Unincorporated NT (East Arm) into Darwin. Unincorporated NT (Yulara) has been collapsed into MacDonnell and Wagait and Belyuen have been collapsed into Coomalie.

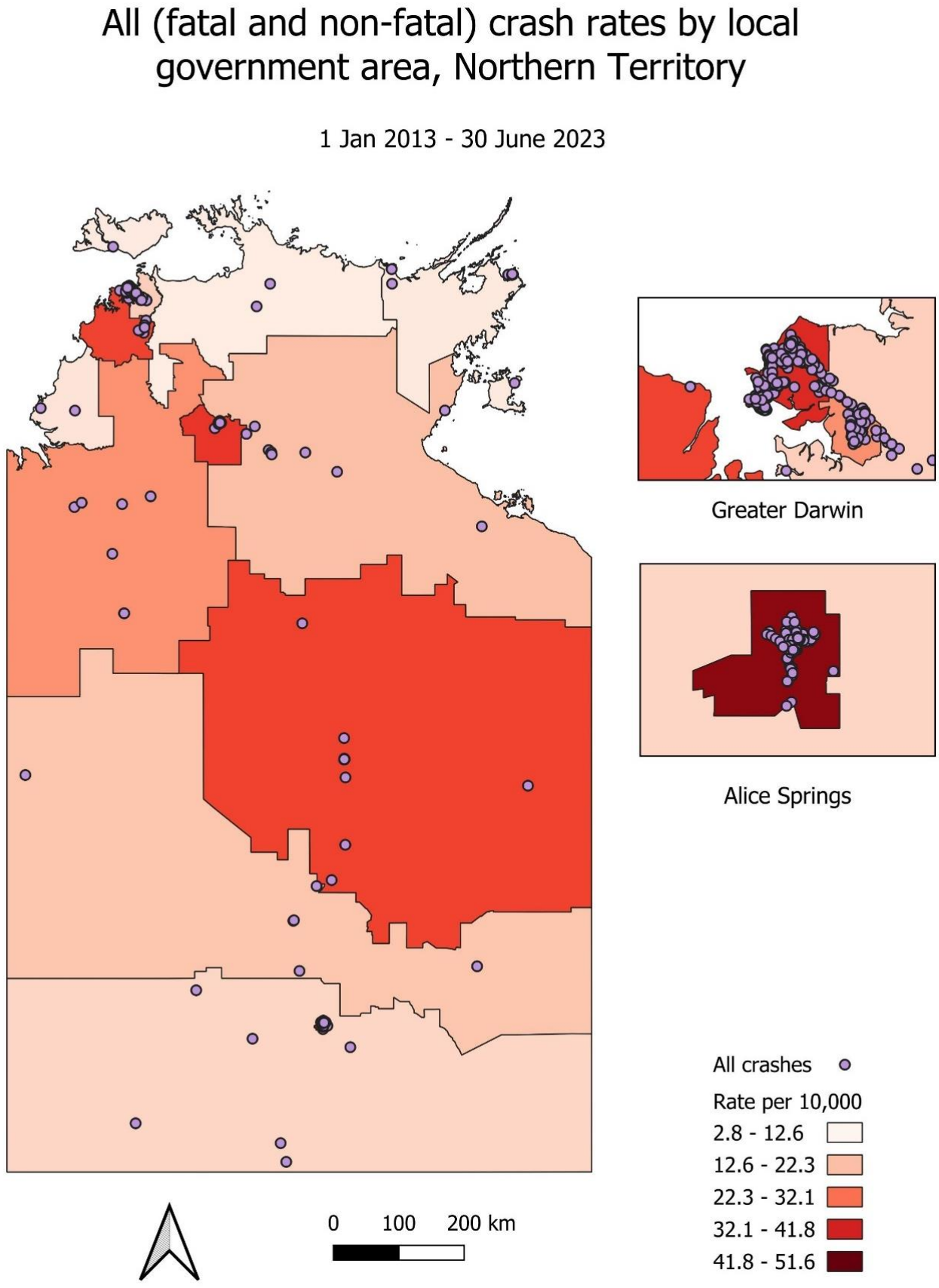

Figure 7: Visual map of rates of all pedestrian crashes by LGA

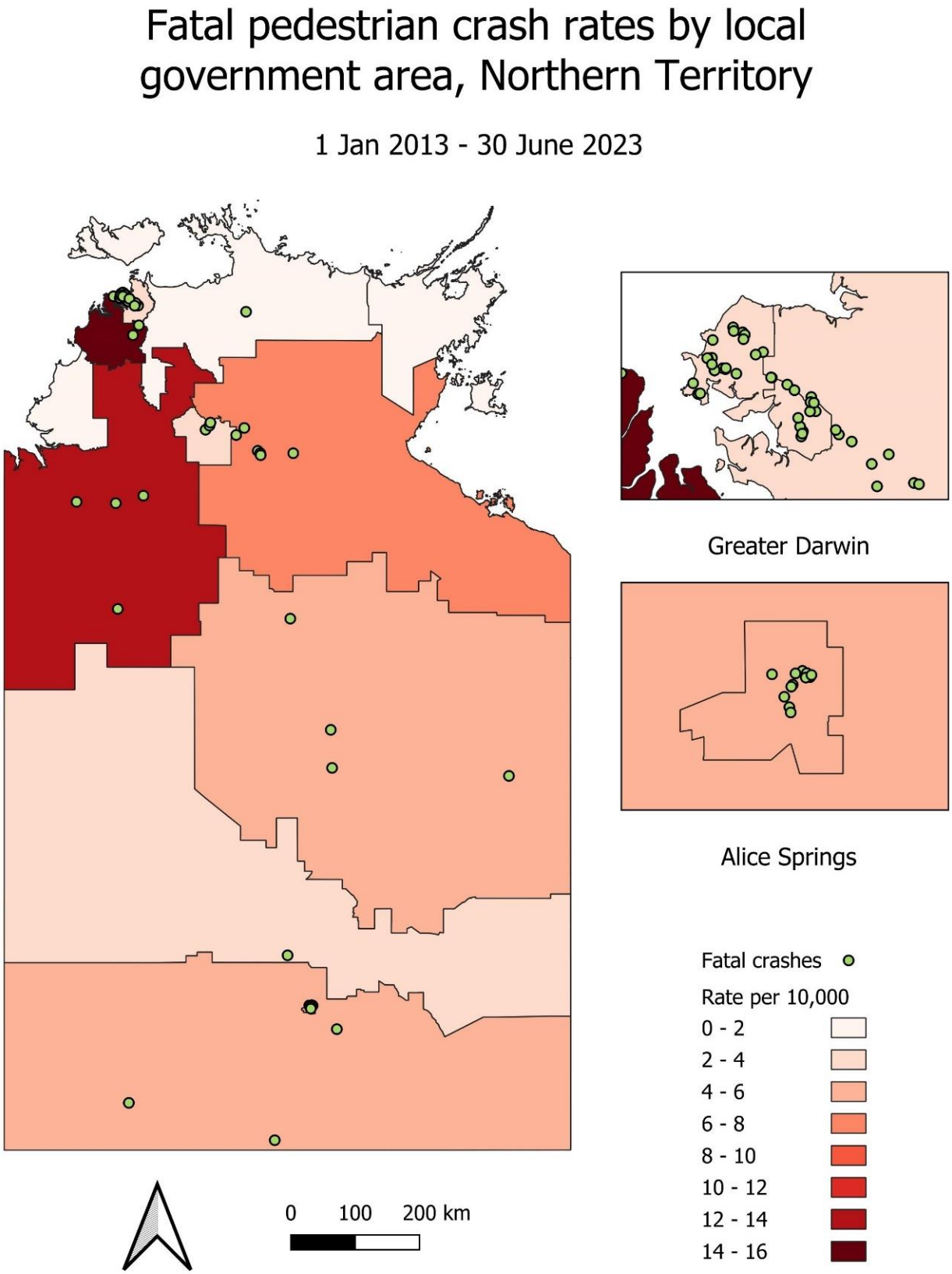

Figure 8: Map of pedestrian fatalities by LGA

The Ordinary Least Squares method was used to analyse spatial patterns of crash incidents, identifying hot spots within the study area. A grid of 50m cells was created, with every cell within 250m of each other being considered part of a neighbourhood. Neighbourhoods with more than one crash were considered hotspots with 99% confidence.

In the following maps, each green dot represents a pedestrian crash that was recorded by police as resulting in severe injury or death. Each purple dot represents a pedestrian crash that was recorded by police as not resulting in severe injury or death. Some hotspots contain relatively large numbers of crashes resulting in serious injury or death in a small area. These hotspots may be useful for identifying zones where prevention efforts could be prioritised.

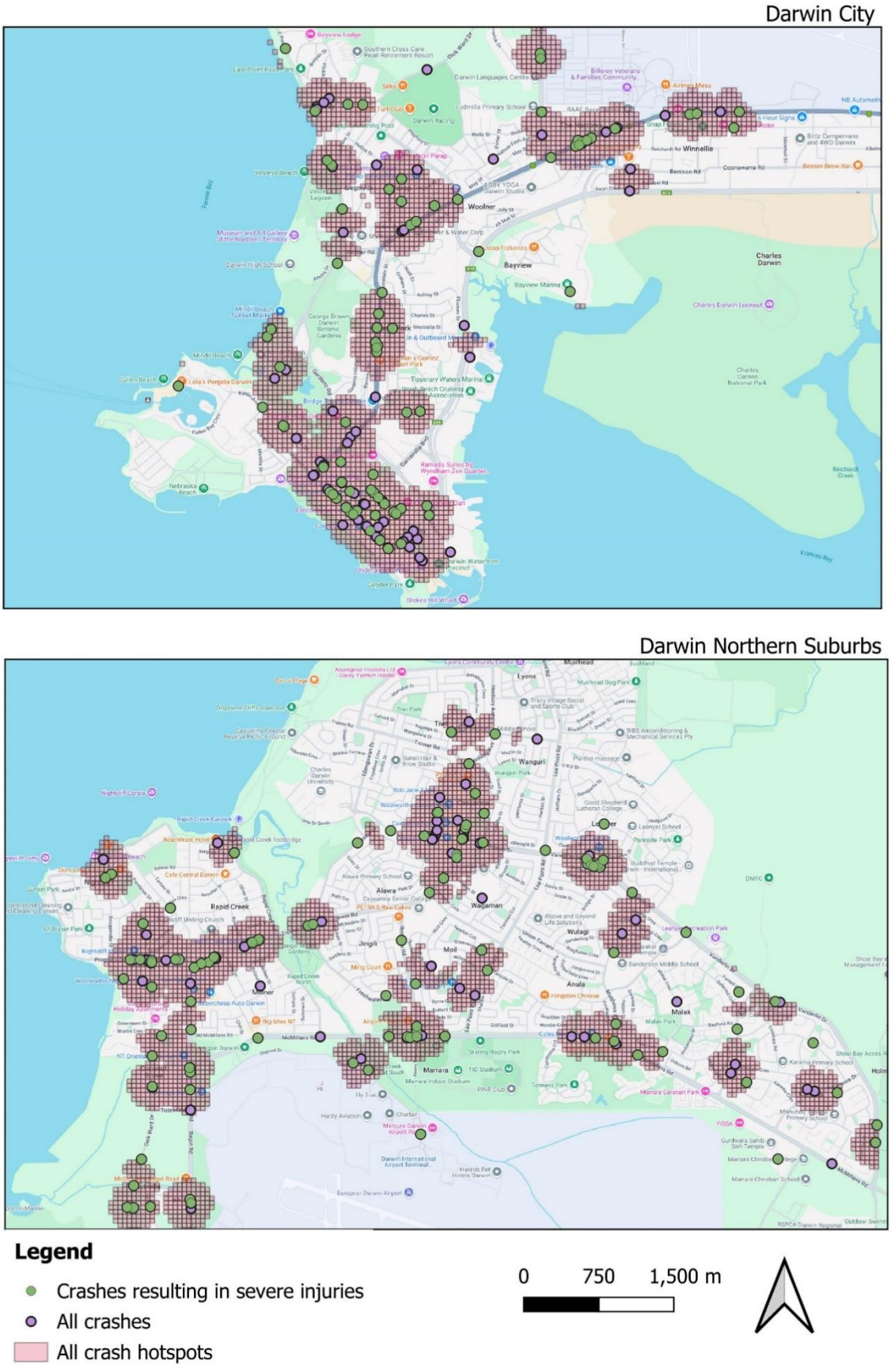

Figure 9: Map of pedestrian hotspots Darwin

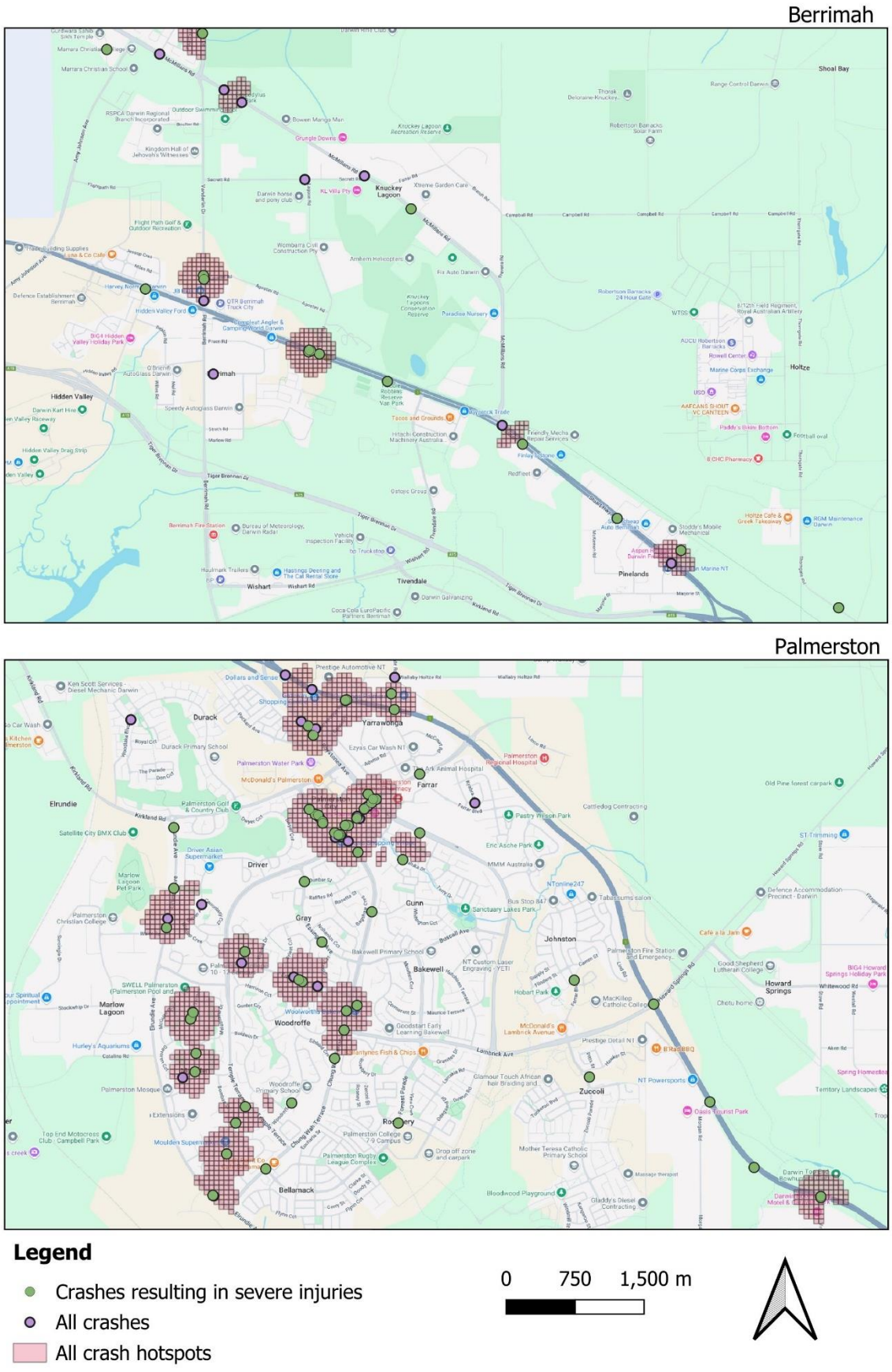

Figure 10: Map of pedestrian hotspots Palmerston

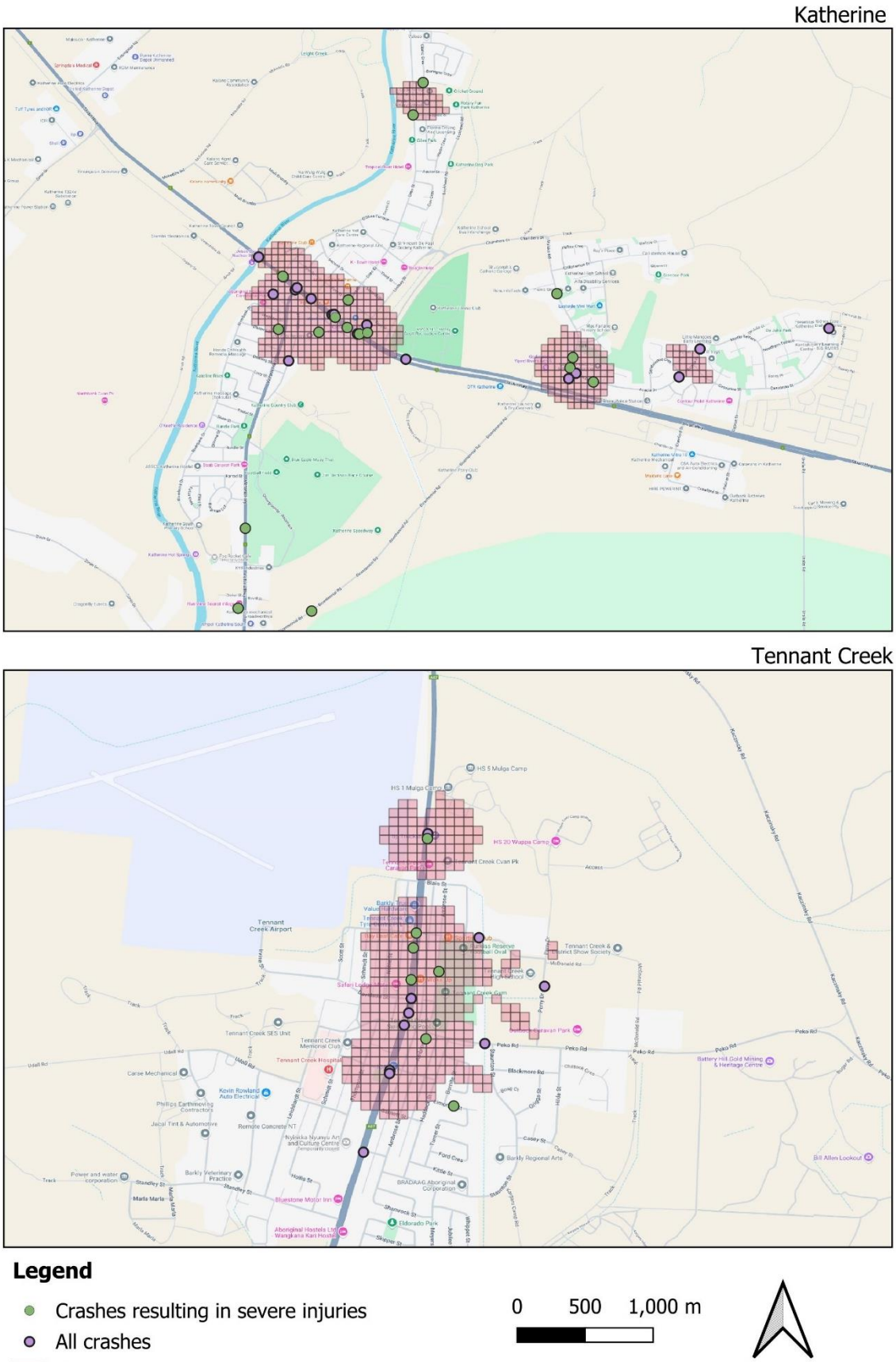

Figure 11: Map of pedestrian hotspots Katherine and Tennant

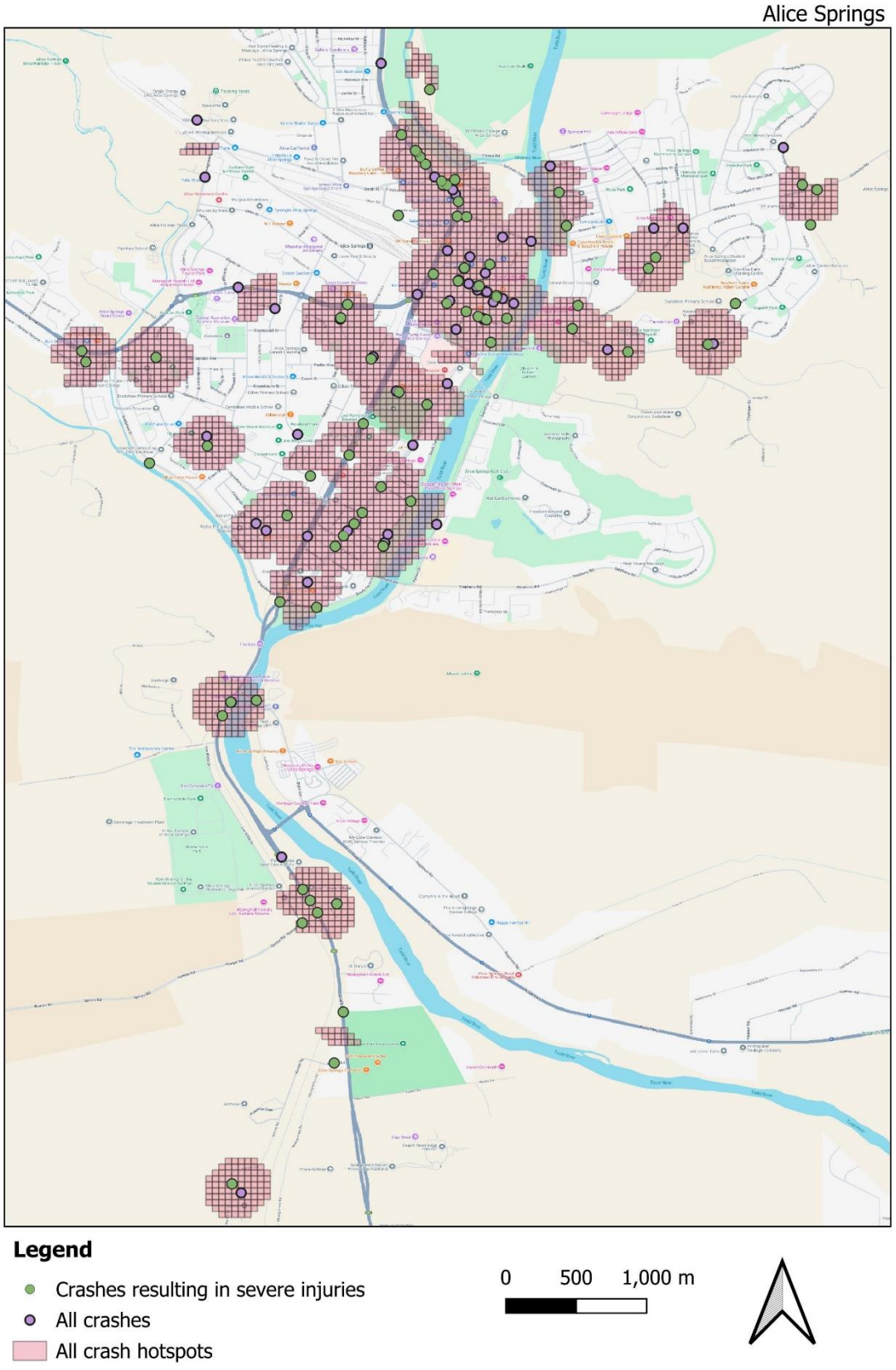

Figure 12: Map of pedestrian hotspots Alice Springs

Who is at risk of pedestrian crashes?

Data from both police and hospital records consistently show that in the NT, pedestrians involved in crashes are predominantly middle-aged Aboriginal and/or Torres Strait Islander men. Below, we will discuss a range of risk factors for being involved *as a pedestrian* in a crash, including gender, Aboriginal and/or Torres Strait Islander status, age, socioeconomic disadvantage, physical health and mental wellbeing.

Gender

Regression analyses found male pedestrians were 1.43 times more likely (CI 95%, 1.22-1.66) to be involved in pedestrian crashes than female pedestrians and 1.38 times more likely (CI 95%, 1.23-1.56) to be hospitalised as a result of a pedestrian crash. This is consistent with findings from other Australian jurisdictions (8) and from studies overseas in similar high-income countries like the United States of America (USA) (11) and Canada (12). Internationally, these gender differences are hypothesised to stem from different patterns of risk-taking behaviour – for example, men are more likely to walk alone late at night and more likely to walk in poorly lit areas. Women may be less likely to engage in these behaviours due to personal safety concerns, hence lowering their exposure to risk (11). In addition, women may be able to access additional places of safety (i.e. women's shelters) which removes them from exposure to roads at high-risk periods.

Aboriginal and Torres Strait Islander peoples

We found that, annually, Aboriginal and Torres Strait Islander peoples were between 4.5 and 18 times more likely to be killed in pedestrian crashes than non-Indigenous people. Indeed, for four recent consecutive years within the study period (2019 - 2022) there were no deaths of non-Indigenous pedestrians at all, while there were 33 deaths of Aboriginal and Torres Strait Islander pedestrians in the same time period. Across all age bands, rates of deaths and hospital admissions (standardised by age, gender and ethnicity)[3] were statistically significantly higher for Aboriginal and Torres Strait Islander pedestrians compared to non-Indigenous pedestrians. The over-representation of Aboriginal and Torres Strait Islander peoples is consistent with national trends which show the fatal injury rate for Aboriginal and Torres Strait Islander pedestrians is 5.2 times higher than non-Indigenous pedestrians, while the rate of serious injuries was almost double (10). National figures further find greater disparities with increased remoteness, with the rate of serious injuries increasing to four times higher for Aboriginal and Torres Strait Islander pedestrians compared to non-Indigenous pedestrians in Remote and Very Remote areas (10). Racial disparities are also seen in the USA, with Black Americans and Native Americans both disproportionately involved in pedestrian crashes (13). Native Americans and Alaskan Natives have the highest pedestrian fatality rates, with those living in rural areas experiencing double the fatality rate compared to those in urban areas (14). Studies attribute these differences to transport disadvantage

[3] Standardising the data means that we accounted for population differences by age, gender, and ethnicity. For example, even though there were more non-Indigenous pedestrians aged 65 and over involved in crashes than Aboriginal and Torres Strait Islander pedestrians, because the population of Aboriginal and Torres Strait Islander peoples aged over 65 is much smaller than the non-Indigenous population aged over 65 the relative risk remains higher.

(lack of consistent and appropriate public transport provision), alongside greater exposure to multi-lane roads with higher speed limits and lower pedestrian improvements.

Middle age

The risk of pedestrian crash was greatest among those aged 35 to 54 years. During the study period Aboriginal and Torres Strait Islander pedestrians aged between 35-44 years were 35 times more likely to be involved in a crash and 14 times more likely to be fatally injured than their non-Indigenous peers in the same age group. People aged between 45-54 years were 19 times more likely to be involved in a crash and 37 times more likely to be fatally injured. We saw the same pattern in hospitalisations: Aboriginal and Torres Strait Islander pedestrians aged between 35-44 were 19 times more likely to be hospitalised for crash-related injuries and 45-54 year-olds were 12 times more likely. This is congruent with national data, which demonstrates rates of fatal injuries for Aboriginal and Torres Strait Islander pedestrians peak in middle age, compared to non-Indigenous people who have higher rates in young adult (18-24) years (10).

Socioeconomic disadvantage

In high-income countries, pedestrian deaths are more common among people with lower incomes, as they are more likely to rely on walking as their main form of transport due to lower access to both vehicles and fuel (15). Similarly, our qualitative data highlights social disadvantage including transport disadvantage and unstable housing as key risk factors for pedestrian crashes.

Key informants identified that many people living within Aboriginal communities, both in urban and remote areas, faced challenges in accessing transport which forced them to rely on walking for their daily activities like accessing services, groceries, healthcare and school, or to access public transport. Within Darwin, Palmerston and Alice Springs, this often involves walking along or crossing high speed roads. One key informant pointed to a study of transport disadvantage from Alice Springs Town Camps which found that 54% of community members reported difficulties accessing services, while less than half had a driver's license (42%) or registered vehicle (37%) (16). The same report found that key drivers of transport disadvantage were compounding effects of limited transport options and high transport costs for low-income households, and recommended improved public transport routes, more free transport services, reviewing and modifying community transport options and providing travel subsidies for priority groups (16). Transport disadvantage was also identified as a key issue in Darwin/Palmerston for residents of, or visitors to, urban Aboriginal communities. Key informants in Katherine reported that the current system of transport to and from communities ameliorated (to some extent) the risks during the daytime, with the night patrol providing some coverage through the evening.

Informants across sectors predominantly agreed that a large proportion of pedestrians who had been involved in crashes in the NT were experiencing unstable housing – specifically people who were from remote Aboriginal communities, living in population centres "temporarily" without stable housing ('long grassing' in Darwin, 'sleeping rough' in Central Australia).

> And I find it at a majority of the time it's probably rough sleepers that are getting hit on the road getting bumped, they call it in the in the streets, they call it getting bumped.
>
> **Key Stakeholder 2, non-Indigenous, frontline social service**

We are unable to test this hypothesis concretely with quantitative data as neither the police crash data nor hospital admission data record current housing status. Our best insights on this come from police crash records recording "pedestrian community", a variable describing where pedestrians involved in crashes said they were from. In line with the general population distribution, most pedestrians involved in crashes were recorded as from Darwin (22%) or Alice Springs (18%). The remainder were fairly consistently from areas distributed across the NT. These places tended to be the surrounding region of the town where the crash happened (albeit in some cases hundreds of kilometres away). That is, pedestrians involved in crashes in Darwin tend to be from Darwin or from an Aboriginal community in the Top End. Similarly, pedestrians involved in crashes in Alice Springs who are not from Alice Springs tend to be from Aboriginal communities in Central Australia.

Transience

Reporting practices in police and hospital data are inadequate to capture the complexities of the concept of where people are 'from'. Many Aboriginal and Torres Strait Islander peoples in the NT have grown up and lived between multiple communities and towns where they may have family links. Additionally, people often move from areas with poor access to infrastructure and health care to areas with better access. When asked where they are from, people may refer to a place where they have spent the most time, where they spent childhood, or where they have most recently resided (or an area that will be understood by the person asking). These data are difficult to record precisely as some people may still identify as 'from' other communities and regions, despite living in other population centres for an extended period of time. This is demonstrated in a quote from a focus group with three Aboriginal women who were in unstable housing (long grassing and/or in shelters) in Darwin.

Interviewer: Been a long time since you went back home to [remote Central Australia]?

Participant 5: 10 years.

Community Voices: woman aged 40-50s, rough sleeper, Central Australian remote community, interviewed in Darwin

While quantitative data is limited, qualitative data from this study elucidated more. Our deepest insights came from front-line service workers who knew clients who had been hit in pedestrian crashes, community members who had family who had been injured or killed in pedestrian crashes, and people in unstable housing who themselves had experienced or witnessed near misses or crashes.

While there were some similar experiences among people deemed 'at-risk' (i.e. transport disadvantage leading to higher use of walking, increased likelihood of sleeping in public areas including near roads at the time of accident), there is significant diversity among the population of Aboriginal and Torres Strait Islander people who are in unstable housing. Informants and community members in our studies identified there are lots of different reasons why people might be living in the long grass/sleeping rough, which aligns with other studies about this population from the NT (17). Sometimes unstable housing is temporary, while for others, it is more akin to long-term homelessness. Sometimes people are 'stuck' in town with insufficient funds to return to their home. Sometimes people have made a clear decision to be in an urban area and are unable to access stable accommodation (18).

> Transient people - from my point of view - it's not that easy to distinguish the two groups [people who have moved to town compared to people who are 'stuck' in town] because there's some overlap and there's families where some members live in town and some live out bush, so obviously there are people from out bush who come to town [to visit], but I don't think this is a completely distinct group from the people who live in town…Because you know, if you're doing any sort of [medical] tests or anything that might need to follow up, you need to know how to contact them and so I see a lot of people who've relocated from remote communities and they are quite clear that they don't want to go back. But…don't have anywhere [to live] because the wait list for public housing is so long and it's so difficult to get a private rental. So there are a lot of people who have moved to town and you know, they're not sort of accidentally in town. They want to stay in town.
>
> **Key Informant 21, non-Indigenous, frontline worker, health service**

Physical health

While quantitative data do not record these characteristics, qualitative data connected physical health to risk of pedestrian crashes. This also intersects with the age bracket of those identified as being most at risk as physical health generally declines with age, with many chronic conditions developing around middle age. Older people are also at greater risk of pedestrian crashes because of the effect of age on sensory, cognitive, and motor abilities (19).

Key informants identified that many people they saw to be at risk of pedestrian crashes had complex physical health needs, compounded by unstable housing (particularly those sleeping rough). People with unstable housing can often face particularly harsh living conditions in the NT, which can lead to additional health issues. Transport disadvantage also compounds poor physical health, as people with complex health needs including disabilities and co-morbid chronic health conditions can struggle to access the healthcare they need to be well. Key informants in qualitative interviews identified that many of their clients (a key risk group for pedestrian crashes) had experienced a lifetime of disadvantage and adverse life experiences, which contributed to poorer health in general.

> You see a lot of those people on a regular basis and a lot of them have lived very rough lives. You can tell by their age, like when you hear their age and you look at their appearance. You know, it's a bit confronting. It's shocking because they look really old and really battered and a lot of them have been through domestic violence and they regularly use alcohol and drugs and yeah it's sad to see that they live that way…some of those things that are so traumatic in their lives that they've experienced can easily lead to putting themselves at risk. Like, you know, putting themselves in front of traffic, yeah. Not wanting to live, I guess you know, that's one way of putting it because life is so hard for them.
>
> **Key Informant 13, Aboriginal, frontline worker, social service**

Key informants in frontline roles discussed that transport options to and from hospitals and clinics were not always consistent and some were not available to people without fixed addresses. Some frontline workers identified a need for more responsive wraparound care that coordinated services and hospitals in ways that better addressed the complex health, housing and transport needs of the client groups most at risk.

Mental wellbeing

Key informants in frontline roles and community members noted that poor mental wellbeing could contribute to pedestrian crashes. They shared examples of individuals involved in crashes or near misses whose mental state affected their behaviour around roads.

Mental wellbeing and trauma were also linked to experience of, or exposure to, violence. As described by the Key Stakeholder 13 (above), the violent milieu of the most at-risk group's lives was linked to their risk of pedestrian crashes both chronically and acutely. The former was raised in relation to the impact of violence on cognitive function and physical ability (i.e. brain injuries). The latter was raised in regard to people escaping violence as a precursor to pedestrian crashes. For instance, we heard repeatedly from both community members and key informants about people walking or running out onto roads during physical or verbal arguments with partners or family. People who worked closely with clients long grassing or sleeping rough described this as important context for the visible behaviour on and surrounding roads. Some key stakeholders considered these behaviours to extend to active self-harming behaviours, as noted by Key Stakeholder 13 above, but this was acknowledged as difficult to definitively ascertain post-crash.

> Whether they expect people to stop, I don't know. There's just disregard to the surrounds, whether that's because of the impact of alcohol or the circumstances. Sometimes there's fights and they're running. You know, the person is fleeing the scene and will be hit by a motor vehicle.
>
> **Key Informant 24, non-Indigenous, operational**

At this juncture we will highlight that many participants suggested the provision of road safety education to people from remote communities who are visiting larger towns. We know people involved in pedestrian crashes are from a large range of remote communities and may have lower English literacy. Given the number of Aboriginal languages across the NT, provision of written or audio resources in Aboriginal languages is likely to be very time and resource intensive. The same participants who highlighted education also highlighted that people who are at risk of pedestrian crashes are often intoxicated or in a heightened emotional state at the time of the crash. They also often live high-pressure lives and are unlikely to have the capacity to meaningful engage with these type of education resources, and so road safety education is unlikely to be salient.

Who are the drivers?

Data from both police records and qualitative interviews were analysed to investigate risk factors for being involved *as a driver* in pedestrian crashes, including gender, age, Aboriginal status, age and licence status. Records collect more limited information about drivers, and aside from drink driving - which is addressed below - demographics or risk factors of drivers were less commonly discussed by participants in qualitative sub-studies. In general, people felt more comfortable discussing pedestrian-related factors, which likely reflects different visibility of pedestrians compared to drivers. Post-crash response was raised across a number of interviews.

Gender, age, Aboriginal status

Similar to other road crash statistics, males (67%) were over-represented as drivers involved in pedestrian crashes. The majority of drivers involved in pedestrian crashes were non-Indigenous (70%), with 12% of drivers identifying as Aboriginal and/or Torres Strait Islander. Indigenous status was missing in 18% of driver records. The median age of drivers was 37 [inter quartile range: 27-51], with the youngest aged 12 and the oldest aged 85.

Licence status

The majority (79%) had current standard (full/non-conditional) drivers' licences (Table 3) and most (86%) were not injured in the pedestrian crash (Figure 13).

Table 3: License status of drivers

Drivers license status	Number	%
Standard	570	79%
Provisional	23	3%
Learners	17	2%
Cancelled/Disqualified	12	2%
Expired	7	1%
Unlicensed	17	2%
Not known	77	8%
Total	723	100%

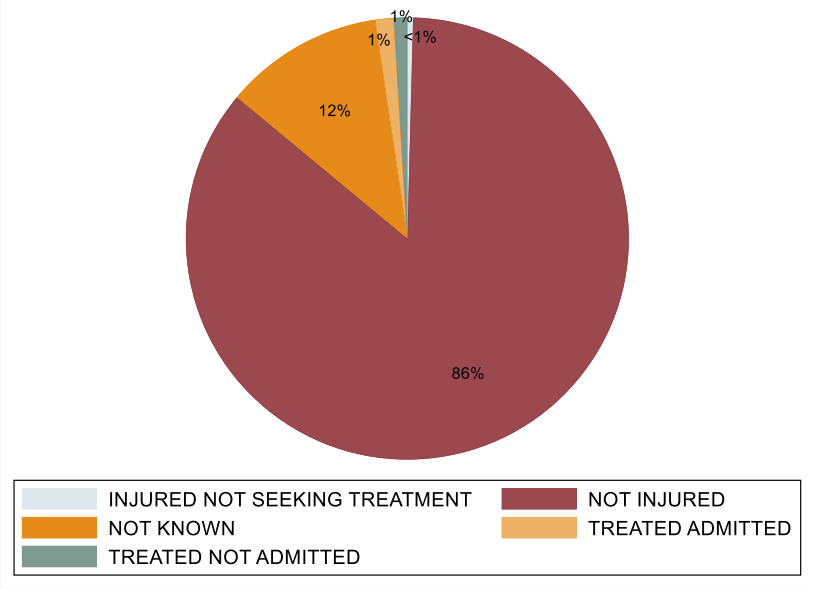

Figure 13: Injuries of drivers in pedestrian crashes

Driver responses to pedestrian crashes

Almost one-fifth of pedestrian crashes (19%) were classified as 'hit and runs', meaning that the driver left the scene of crash, an offence under NT law. There have been a number of high profile hit and run pedestrian crashes in recent years and in all these cases the pedestrians involved have been Aboriginal. Media interest in the high rates of road crashes involving Aboriginal and Torres Strait Islander pedestrians often includes implicit and explicit speculation that racism (overt or structural) plays a role in this phenomenon (5–7). Indigenous status of driver was unknown in 50% of hit and run cases but of the remaining, 37% were non-Indigenous and 13% Aboriginal and Torres Strait Islander. Some key informants discussed a potential of greater apathy towards Aboriginal victims, particularly if they were perceived to be sleeping rough (i.e.an assumption that the person may not be reported missing or that the driver may be able to evade detection on isolated roads).

Aboriginal key informants noted that Aboriginal drivers involved in crashes may also be motivated to leave the scene, due to worries about payback systems that may pose a threat to their wellbeing if the person's injury or death was attributed to them.

> *Participant 22:* There's payback too, you know? Yeah, there's a big fear of that. Yeah, that's why most probably they take off. So it's rare that you see someone stay on the scene, especially if it's Indigenous mob. Some of them will just take off because of the fear that the payback will happen even if that person walked out in front of them, yeah. Yeah, it wasn't them actually doing thinking there might be that fear of that or they'll still blame me because, you know.
>
> *Participant 23:* That's a big factor.
>
> **Key Stakeholder 22 and 23, Aboriginal, operational**

Due to the lack of data available on drivers' motivations for leaving the scene of an accident, these hypotheses were not able to be explored further.

Participant 1: Car got nothing to do [with it] but the person doing, what the other people are paying back. Just payback. That one, that's the partner. So we don't get accidents, we don't know reason, just because we've got a payback. We didn't, we didn't turn up for the family of us or family for them [partner], we didn't go back for funeral or something, that's the partner [giving payback]. So that's why lots of people got hurt by car, that happened now. That's happened.

Interviewer: So you think - for the driver - they don't have any control over it?

Participant 1: The driver…he just wasn't watching the road and concentrate for himself when he go travel somewhere. Person gonna come over here, from the bush…Other people, they're killing him for payback.

Interviewer: Do you think sometimes the driver are distracted? Or someone gets off the bus and they're not looking?

Participant 1: They right, [the] drivers. But the person walking –

Participant 2: - he force himself to cross the road –

Participant 1: - he cross the road and that man [driver] need to hurry, hurry get something else.

Participant 1: When he's driving he's thinking about job, what he's doing. We don't - we don't like to blame driver. Only the things we blame is other people where they do it our way [payback].

Community Voices 1 and 2: male 30-40s, rough sleepers, West Arnhem remote community, interviewed in Darwin

Why do crashes happen?

More than two thirds (70%) of *all* pedestrian crashes occurred on roads with speed limits between 40-60 km/h, while *fatal* crashes predominantly occurred on roads with a speed limit of 70 km/h or over (64%). Traffic density was typically light, and the weather was clear in both fatal and non-fatal crashes. The majority of pedestrian crashes occurred on straight, flat, sealed roads that are dry. Approximately 56% of *all* crashes occurred in dark conditions, compared to 83% of *fatal* crashes. Half of these occurred in darkness where there were no streetlights. Together, these findings suggest that speed limit and darkness may be crucial factors for crash severity while weather and road conditions are otherwise less important.

We ran more detailed statistical analyses (multivariate logistic regressions) to identify the factors that are statistically significantly associated with both pedestrian crashes resulting in fatal or severe injuries (injury requiring hospital attendance). To do this, we first ran a stepwise logistic regression. This means we tested whether each factor was statistically likely to affect fatal crashes and severe injury collisions on its own, separate to other factors. This is called a bivariate analysis. If a factor was found likely to affect the outcomes, we included it in the final model. This is the multivariate component. In some cases, factors that were significant by themselves did not end up being significant when included with other factors, which helps us understand when a factor might be a

'confounder' for the actual influential factor. For example, on its own, the rurality of a pedestrian crash, was significant. However, in the multivariate model, rurality is no longer statically significant. It is likely that rurality was acting as a proxy for other factors like road speed and lighting, which are likely to be poorer in rural locations.

Factors that were statistically significant for being associated with increased risk of *fatal* pedestrian crashes were **lighting, road speed limit, horizontal features of the road, alcohol involvement** and **drug involvement.** Factors that were statistically significant for pedestrian crashes involving *severe injury* outcomes were **lighting, road speed limit, horizontal features of the road,** and **alcohol involvement**. Together, these highlight important characteristics for prevention and intervention that could reduce the severity of outcomes of crashes if addressed.

Visibility

The odds of a *fatal* pedestrian crash occurring at **dawn/dusk were 10.90 times higher than daylight** (p=0.013, CI 95% 1.66, 71.37). They are also **10.99 times higher in the darkness without streetlights** (p=0.000, CI 95% 2.95, 40.94) compared to daylight. However, there was no statistically significant difference in odds of fatal crash happening between daylight and darkness *with* streetlights.

In contrast, the odds of a pedestrian crash resulting in *severe injury* occurring in the **darkness with streetlights are 1.58 times higher than daylight** (p=0.024, CI 95% 1.06, 2.36). They are also **2.68 times higher in the darkness without streetlights** (p=0.003, CI 95% 1.41, 5.11) compared to daylight. However, there was no statistically significant difference in the odds of a fatal crash happening between daylight and dawn/dusk.

Together, these sets of finding support that darkness without streetlights is a clear risk factor for pedestrian crashes resulting in injury or death. It also illustrates streetlights can indeed ameliorate some risks posed by darkness, as the risks of these serious outcomes are reduced when streetlights are present. This makes practical sense, as the main risk of darkness is reduced ability for the driver to see the pedestrian and take evasive action to avoid a crash.

> Pedestrians routinely underestimate their level of conspicuity, and drivers overestimate how far they can see as they're travelling.
>
> **Key Stakeholder 3, non-Indigenous, frontline emergency response**

As previously identified, Aboriginal and Torres Strait Islander peoples are more likely to be involved in pedestrian crashes. Aboriginal community members and informants from front-line service organisations identified that darker skin colours and a preference for dark clothes may contribute to poor visibility.

> Yeah, a lot of our mob and the clients that we service, they are obviously quite dark in skin, so if you're driving at 11/12 at night, 1/2 in the morning and these mob are walking and crossing the roads, probably not going to see them until the last minute.
>
> **Key Stakeholder 4, Aboriginal, frontline social service**

> Most of our people wear dark, dark colours, you know. Very little wear lighter colours.
>
> **Key Stakeholder 11, Aboriginal, frontline social service**

Some informants discussed previous short-term initiatives to provide people in unstable housing with reflective clothing, however this reportedly had mixed uptake and success. In one case, a participant described the distribution of black t-shirts (which had been focus group tested as the most appealing to the demographic) with reflective material through sporting clubs. However, they explained that the reflective material wore out after several washes, leaving people with a black t-shirt, which did not enhance visibility.

The need to improve streetlights, beginning in locations of higher risk for pedestrian movement was reiterated across different stakeholder groups. People frequently pointed to common locations (which coincide with the maps above) where accidents had happened or were 'waiting to happen' due to a combination of multi-lane roads, high speed limits, poor lighting, and frequent road crossings by pedestrians (i.e. in areas of high transport disadvantage where communities were across from shops or bus stops).

Some community members identified other simple changes that may additionally improve visibility. For instance, some noted that while their town had accessible crossings, town councils had planted trees and greenery that obstructed drivers' ability to see pedestrians in the median strip of crossings, especially children. Ensuring that median strips near pedestrian crossings prioritise visibility was suggested as a simple way to ensure that people could use the safety infrastructure available and minimise risk of crashes.

Speed

We examined speed and speed limits as two separate concepts. Even when drivers comply with speed limits, the actual speed a vehicle travels at is a major contributing factor to the outcomes of road crashes. The *speed limit* in any given area therefore acts as a risk factor. We found that the odds of a fatal pedestrian crash on NT roads increases by 3.3% for every 1km/h increase in designated road speed. The odds of a pedestrian crash resulting in a severe injury (fatality or hospital admission) increased by 2.4% every 1km/h. Most pedestrian crashes (98%) and fatalities (94%) in the NT were recorded as not 'speeding' related (i.e. the driver was deemed to be complying with the limit). Previous meta-analyses of global studies on the estimated impact speed (i.e. speed of the car, not speed limit of the road which we looked at above) increases by 1 km/h, the odds of a pedestrian fatality increases on average by 11% (20).

Key informants knew that speed was an important factor, but several discussed crash specific modelling that demonstrated that very low speed was required to remove fatality risk.

> When police talked us through the accident, the driver was going at 100 and something kilometres an hour. The man was on the road and they said even if he was going 40, if they were going 40 kilometres an hour, it still would have been the same result. So that's probably the one that sticks in my mind.
>
> **Key Stakeholder 17, non-Indigenous, operational**

Our findings do however suggest that higher speed limits on roads are a significant contributor to pedestrian crashes in the NT, in particular those resulting in serious injury (requiring hospital admission) and death. Any reduction in speed limits reduce the odds that a crash will be fatal. This does not mean no crashes will happen on roads with reduced speeds, but that the odds of someone experiencing serious injury or death when crashes do occur is reduced. These findings may be used in conjunction with hotspot maps to identify areas where significant gains could be made by reducing speed limits.

Alcohol and other drugs

At the time of a crash, police assess whether alcohol or drugs are deemed to have been involved. We found the odds of a crash resulting in a fatality were 65 times greater if alcohol was involved and 3 times greater for severe injuries. Drug involvement increased the odds of fatality by 13 times. Alcohol and other drug use – but particularly alcohol – of both pedestrians and drivers featured consistently and prominently in all qualitative interviews with informants and community members.

> What we're seeing, is that the driver is influenced by the alcohol or drugs in the vehicle crashes. There is high, very high number of alcohol and drug involved. So, it's like that, a drunk finding a drunk. So drunk pedestrian hit by a drunk driver.
>
> **Key Stakeholder 1, non-Indigenous, operational**

There are challenges in quantifying the involvement of alcohol using available records. The above odds have been calculated based on whether the crash was recorded by police as alcohol-related, with no differentiation in the records between use by the driver, pedestrian, or both. An alternative variable is the recording of blood alcohol content (BAC) (Table 4) which show more than half of pedestrians involved in fatal accidents were intoxicated at the time of the crash. One-quarter of drivers (25%) had zero BAC but more than two thirds (70%) were unknown.

Table 4: Blood Alcohol Content

BAC	Zero	Very low (<0.05)	Low range (0.05-0.079)	Medium (0.08 - 0.149)	High range (>0.15)	Unknown	Total
All drivers	184 (25%)	4 (0.5%)	6 (0.8%)	12 (1.6%)	8 (1.1%)	509 (70%)	723
All pedestrians	591 (81%)	5 (1%)	1 (<1%)	6 (1%)	63 (9%)	61 (8%)	727
Pedestrian fatalities	29 (35%)	3 (4%)	0	5 (6%)	43 (51%)	4 (5%)	84
Pedestrian survived	561 (87%)	2 (<1%)	1 (<1%)	1 (<1%)	20 (3%)	57 (9%)	643

The Vehicle Accident Database was incomplete regarding the accurate capture of BAC. This data is provided by the police to the Vehicle Accident Database which is managed by the Department of Logistics and Infrastructure.

Presently in the NT, police may require an alcohol (breath) and drug (salvia) sample from a driver (or person who police have reasonable causes to suspect was a driver), followed by an evidential sample. If the road users are injured and attend a hospital or health centre bloods must be taken. However, medical staff are not required to take blood if they believe on reasonable grounds the BAC is already known, or doing so would be detrimental to medical condition, or if they believe the injuries were not received in a motor vehicle crash, or the crash happened more than 12 hours before entering hospital or 4 hours since entering hospital. Despite the requirement to take bloods, there is no requirement to test bloods. The majority are not tested and police only collect bloods from a hospital to support a prosecution or when they think it will likely result in a death (and hence require coronial investigation). When hospitals do not take bloods, police will occasionally seize hospital admission bloods under search warrant for the same purposes. Forensic testing of bloods can take some time to complete, particularly if being sent in from remote locations. It may be that either no BAC was recorded or that the BAC was not updated in the Vehicle Accident Database. We also note that alcohol recording in major datasets is a recognised problem in other jurisdictions, for example, although BAC was recorded by the Victorian State Trauma Registry, no test results were available for 41.3% of cases (21). The NT Major Crash Investigation Unit was in recent years reviewed by the Victoria Police Major Collision Investigation Unit, which recommended that the NT Police Force initiate a legislative review seeking provisions to allow a police officer to demand a blood sample from any driver involved or suspected to be involved in a fatal or serious injury collision. Opportunities to improve NT reporting and capture of alcohol and drug involvement in the Vehicle Accident Database would be valuable.

Driver alcohol and drug use

High rates of drink driving in the NT were frequently raised by key informants and community members as a risk factor for pedestrian crashes. Attitudes to drink driving in the NT were commonly raised, with participants highlighting high acceptability of drink driving as a key challenge. People also raised low enforcement by police and/or challenges in enforcement as contributing to higher rates of drink driving.

> There is a very lax attitude to drink driving and drug driving, drug driving especially…You know, there are a lot of people out there quite willing to drive after doing drugs and alcohol and probably the NT as a whole, I would suggest, is 20-30 years behind other jurisdictions in terms of attitudes to drink driving. You know, I've said before, in some of these bigger cities, you wouldn't dare mention on Monday that you drank drive to go home because it's a social faux pas there. Here it's not. Maybe in inner Darwin, maybe it's becoming a little bit more socially unacceptable, but it's completely considered acceptable in the rural, remote areas of the Territory.
>
> **Key Stakeholder 3, non-Indigenous, operational**

One community member we interviewed had themselves been the driver in a fatal crash. Despite identifying that they had been using substances at the time of the crash, they still saw the crash as ultimately being 'unlucky' i.e. they felt that even though they had been drink-driving, the crash would not have happened if not for the presence of the pedestrian. The normalisation of drink driving and low risk perception highlights one avenue for prevention focus which could have significant public health gains due to the contribution of alcohol to all road crashes. Evidence supports that campaigns should be paired with increased enforcement of BAC limits.

Pedestrian alcohol use

Pedestrian intoxication was discussed more frequently than driver intoxication in qualitative interviews. The differential focus is likely influenced by increased visibility of alcohol use and alcohol intoxication among people with unstable housing who sometimes drink in public areas. Furthermore, our key stakeholder interviews focused predominately on people working in roles or services closer to people at risk of being a pedestrian in a crash. We also note that while many participants discussed alcohol, they also discussed witnessing other behaviours that could be due to intoxication, but that could also be due to other physical and mental health conditions (i.e. low blood sugar in diabetics, psychosis, physical disabilities, brain injuries or other factors affecting cognitive impairment or motor control).

> But it's not a crossing you know, and some of them just stumbled. I remember about a week ago. There was a bloke standing right in the middle of the road, peak hour traffic. He was lucky to get across, you know. Someone could of hit him. He sort of walked across the road and he ended up right on the line there, in the middle there, he was off his face…And drunk and whatever and cars just zooming pass him.
>
> **Key Informant 12, Aboriginal, frontline social service**

Alcohol outlets

Key informants identified the location of alcohol outlets, particularly takeaway alcohol outlets, along high-speed roads as contributing to the risky environment that crashes occurred in. Other community members noted that people moving around via public transport to access alcohol and drinking locations near alcohol outlets or away from locations monitored by police and security contributed to patterns of movement that put people at risk.

> With homelessness, they're always moving from place to place. Most of our mob up here they like everybody gets paid on different days so and they all got family from Palmerston to the city, so they catch the bus. Then they got to get intoxicated and then they cross the road. Someone's got to go and buy more grog. So they got to go back across the road again, you know. So you just take like. Winnellie pub there most of them mob there, our people that drink. They're drinking on the other side of the highway. You know, they're not drinking on the same side. They're drinking on the opposite side where they can't be seen. So they got to cross that road all the time.
>
> **Key Informant 11, Aboriginal, frontline social service**

> [We are] beachside at Nightcliff or here at Mindil Beach…Go hide myself there and drink get drunk, get bus, camp, then come back here.
>
> **Community Voices 2, male 30-40s, rough sleeper, West Arnhem remote community, interviewed in Darwin**

Given that outlets were seen to play a critical role in facilitating the level of intoxication that placed people at risk, both professionals and community members highlighted the need for greater accountability for businesses who contribute to high levels of intoxication. When discussing locations they knew to be sites of pedestrian crashes, key informants and community members frequently referred to alcohol outlets and the immediate vicinity.

> *Participant 14:* Sometimes we're dealing with drunk intoxicated people that are drinking on the network. So that's again most of that's happening around 2:00pm and maybe 9:00 at night. So the further they can push these things back, the less -
>
> Interviewer: So the opening times of alcohol outlets?
>
> Participant 14: Alcohol outlets. Pushing them back so that's not impacting on... You don't have those incidents happening in those peak hours.
>
> **Key Informant 12, Aboriginal, frontline transport service**

To illustrate the intersection between alcohol outlets, both takeaway and on premise, Figure 14 maps alcohol-related crash hotspots with takeaway outlets. The purple grids identify hotspots where multiple pedestrian crashes have occurred. Blue dots identify locations of on-premise alcohol outlets (i.e. venues such as pubs, clubs, bars). Yellow dots signify takeaway outlets (i.e. bottle shops). Purple dots signify combined on-premise and takeaway licences (i.e. a pub with a licence to sell takeaway alcohol). Not all hotspots exclusively overlap with the immediate location of the outlet. For instance, crashes happen all along Bagot Road in Darwin, where people walk to and from Bagot Community. However, there are also clusters of outlets in the immediate surrounds of these locations (i.e. outlets in Nightcliff/Coconut Grove, the closest shops to Bagot Community). There are also locations with clear overlap in clusters of outlets and pedestrian crash hotspots. Qualitative data suggests that some outlets are 'worse' than others in terms of overserving patrons and other non-compliance with licence conditions, creating risks to patrons. This will be discussed more below.

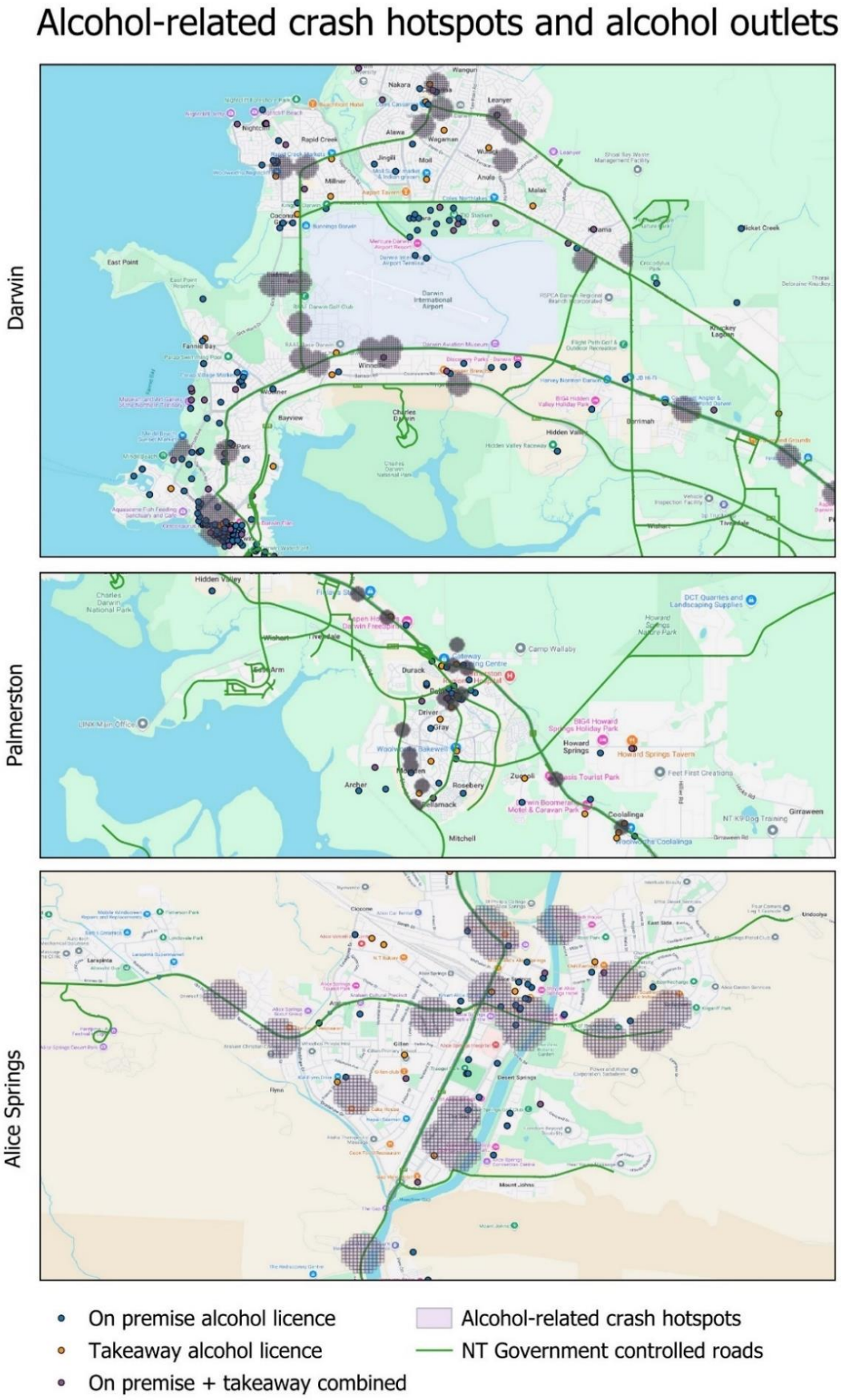

Figure 14: Alcohol-related crash hotspot and alcohol outlets

Risk environments

Frontline workers clearly identified risky environments created by lack of safe spaces for people without stable housing to consume alcohol, as a key factor in pedestrian crashes.

People working with populations at risk identified that the policing of public alcohol use and intoxication leads people to move to more hidden spaces, often just outside of urban areas, to evade detection. Key informants described risks related to walking along high-speed roadways to access these locations. In addition, these locations are often poorly lit with minimal access to amenities. Pedestrians may then subsequently return along the same high-speed roadway with the added risk factor of intoxication. These intersecting risk factors (transport disadvantage, social exclusion, and alcohol) compounds their risk of being involved in pedestrian crashes.

> I actually think it's about poverty and inequality mostly, and you know, like the thing is that - I also think alcohol is a big factor - but you know, the truth is that if you're a white person with an alcohol problem, you might be drinking at home, whereas if you don't have a home or your home's too overcrowded, you might be out in more public places, so I guess, overcrowding and poverty.
>
> **Key Informant 21, non-Indigenous, frontline health service**

Key informants working in frontline community and health organisations and community members frequently highlighted practices of overserving by alcohol outlets as contributing to the high levels of intoxication of pedestrians. For instance, some key stakeholder reported that some outlets served takeaway alcohol repeatedly to the same people or groups situated near outlets from 10am until late afternoon, by which time many customers were heavily intoxicated. Retailers then called night patrol or police to move people away from outlets, leading them to disperse to more risky environments.

As mentioned above, there was support for measures to regulate alcohol outlet trading hours to reduce the total hours of availability that contribute to harm. We know from local and international studies that reducing trading hours can reduce alcohol consumptions and alcohol-related harms, like assaults (22–26). These studies have not focused on the relationship between trading hours and pedestrian crashes, however, because intoxication is a significant contributor, it is possible that reducing consumption would have a positive effect. Prevention measures such as this are best supported by harm reduction, which focuses on keeping people safe while they are using alcohol or drugs (discussed below). Both work together to reduce risk of harm.

Harm reduction options

For people with unstable housing, there are few safe places to be intoxicated. Frontline workers described that Sobering Up Shelter beds frequently fill before dusk, meaning that the majority of people in unstable housing do not have a safe place they can be transported to. Where appropriate options were not available, intoxicated people often remain in unsafe locations (i.e. near roads), are taken to already stretched Emergency Departments, or are at risk of interacting with police. Frontline workers described how compromised they felt when they were not able to find secure accommodation for people who were highly intoxicated and at risk of harm.

Interviewer: So if someone is too intoxicated to go to SUS [Sobering Up Shelter]?

Participant 14: Hospital.

Participant 13: Hospital. They don't want them at the hospital either.

Participant 14: That's causing chaos at the hospital. They need a triage system for our, for the drunk clientele, intoxicated, separate from the hospital. Yeah, I feel terrible when I take people in there.

Key Stakeholders 13 + 14, Aboriginal, frontline social service

Community members also talked about challenges of finding safe places to sleep, encountering monitoring and intervention from security and police, and limited access to amenities.

Urban planning around Aboriginal communities

So far, this section has focused on risk environments for people who are lack stable housing. However, key informants also discussed the risk environments which surround some Aboriginal communities. Specifically, the ongoing implications of historical urban planning (or lack thereof) which has led to a number of Aboriginal communities being located along high-speed roadways.

But one thing I also struggle with is the planning part of a road layout. So we've got an Aboriginal community that lives on Stuart Hwy, about 10 minutes from here. I've personally been to three pedestrian fatals there - so one was a suicide, and two were accidents. But all three of them had to cross 6 lanes of traffic and walk 100 metres down the road to get to the bus stop. So you know, if we're not designing like a clear path, footpath crossing and making it more accessible - like you know there's a community there, it's been there longer than anything else in the area. Why is the bus stop 100 metres down the road? And for me to sit in my air-conditioned office and drive my car everywhere, it's only 100 metres. But when you gotta walk there every day, you're gonna find shortcuts. And the shortcut are in 100km/h zone, in 6 lanes of traffic.

Key Stakeholder 25, non-Indigenous, frontline emergency response

There is a roadway that was would never be constructed currently – with, you know, residences right on the road. There was, you know, clearly a lack of planning and foresight by government probably 20, 30, 40, 50 years ago in relation to some of these roadways. That extends to, you know, to Bagot road for example. Going to Bagot community from Casuarina on the bus, you get off that and then you got across 6 lanes of six lanes of traffic. Well, it's difficult for them now because of dealing with the results of probably poor planning from a long time ago.

Key Stakeholder 1, non-Indigenous, operational

Prevention opportunities include improving safety features of roads surrounding Aboriginal communities, noting residents of these communities typically have higher rates of public and active transport use. This might include, for instance, lower speed limits, design and placement of bus stops and ensuring there are pedestrian crossings at the places where people most frequently cross to access shops and transport. Key informants talked about the challenges they had observed in obtaining basic infrastructure upgrades within and surrounding Aboriginal communities and town camps. Although some participants discussed advocacy from local residents and services regarding transport disadvantage and road safety (i.e. speed bumps, bollards) (16), implementation was reported to be slow due to limited coordination among the various agencies responsible for these infrastructure upgrades. Clearer delineation of responsibilities and stronger interagency collaboration are needed to progress these safety improvements.

Figure 15 (below) highlights the occurrences of pedestrian crashes with bus stops in Great Darwin. Each X represents the location of a bus stop. Green dots signify locations where pedestrian crashes resulting in serious injury have occurred. Purple dots signify locations of all other pedestrian crashes. These kinds of maps can be used as a starting point for investigating where pedestrian crashes are occurring, and how these relates to availability and location of bus stops. This can be layered with knowledge of where communities with high rates of walking and public transport are located, who may be transiting to and from bus stops.

Supporting infrastructure upgrades within communities and town camps may have additional benefits for road safety outcomes and support improvements across a range of other health and social outcomes which coalesce around transport.

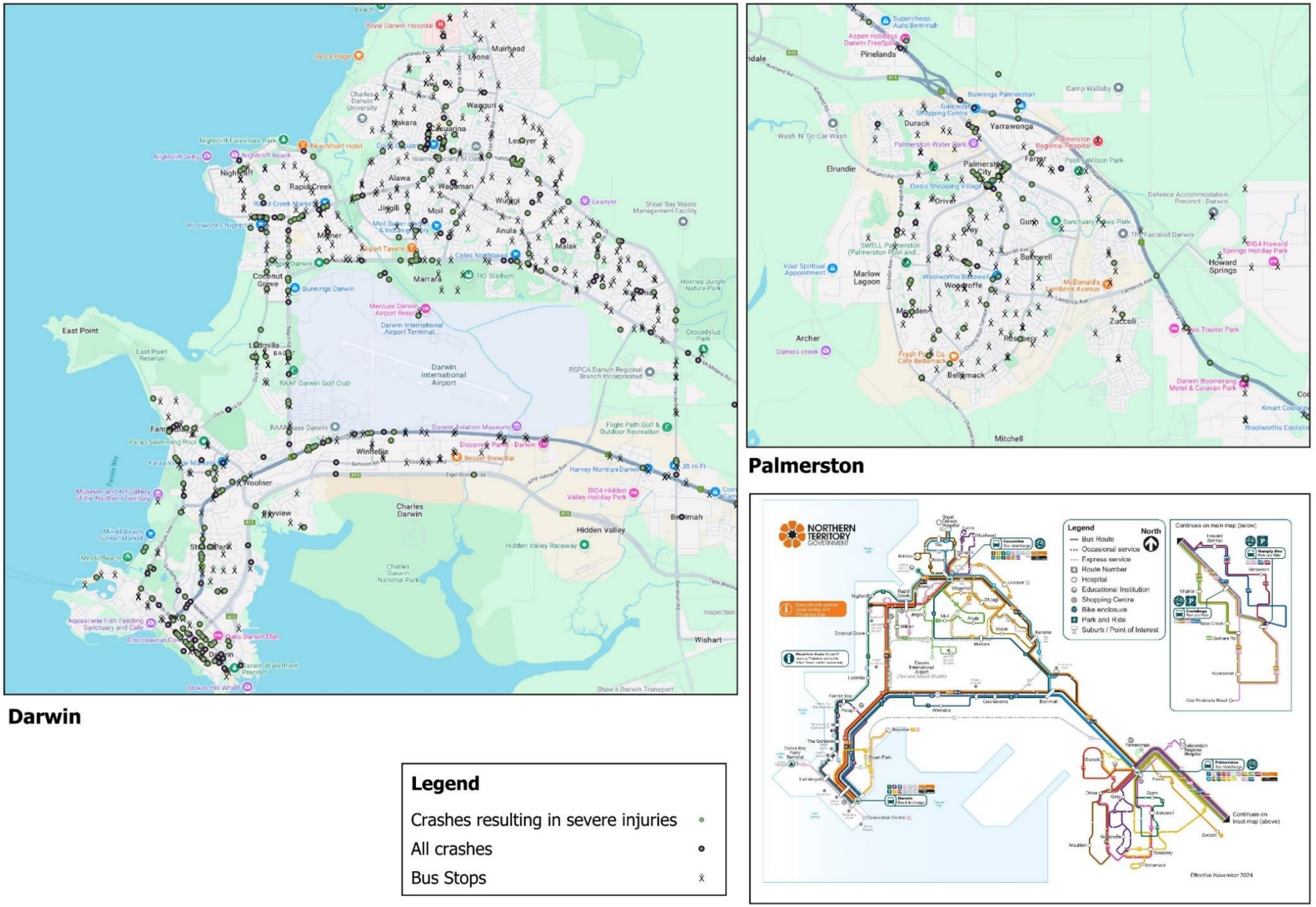

Figure 15: Map of pedestrian crashes and bus stops in Greater Darwin

Recommendations: What can be done?

In the simplest terms – people who use walking as primary transport and who occupy and reside in public spaces are at greatest risk of pedestrian crashes. We see this across Australia and the world. In the NT, the people who are predominately near or on roads are often the most marginalised in the community, who may experience transport disadvantage, unstable housing, and sometimes have high healthcare needs.

Pedestrian injuries and deaths often occur in a perfect storm of factors involving road conditions (darkness/poor lighting and other challenges to visibility, high speed limits), factors related to the driver (alcohol or drug use, post-crash behaviour) and factors related to the pedestrian (presence on or near roads, physical and mental health, alcohol and drug use). **Reducing or removing one factor within the storm may prevent a crash or reduce the severity of outcome if it does occur.** For instance, increasing visibility on a road or reducing speed limits increases the ability of the driver to react to the presence of a pedestrian on the road, which can help to avoid a crash even when a pedestrian is present on the road.

This approach to prevention invokes the Safe Systems Approach to road safety, which sees road safety as a shared responsibility, recognises that humans are fragile, people are fallible and that we therefore need a safe and forgiving road system. Pedestrians are the most vulnerable of all road users for obvious reasons. In the NT, our report illustrates the complexity of the lives and context of people identified as most at risk of pedestrian crashes, the solutions to which require significant investment in addressing social determinants of health. This is in no way to say that pedestrian crashes are intractable in the NT and our findings point to a range of prevention measures which can work together to reduce the incidences and severity of pedestrian crash outcomes in the NT. We recommend the following actions will be most likely to have the greatest impact, some at low or no cost.

SPEED
1. Reduce speed limits in areas of high pedestrian traffic Targeted reduction of speeds in high pedestrian traffic areas is likely to reduce the volume of crashes which result in death or serious injury. There are specific areas highlighted via hotspot maps on pg. 15 – 18, but in general this includes roads with permanent structures that are likely to attract pedestrian traffic (i.e. grocery stores, takeaway food outlets, alcohol outlets, etc.). High priority should be given to permanent structures which provide goods and service for lower socioeconomic groups as they are the most likely to use walking as their primary transport. Locations of temporary accommodation and government housing can be used as a proxy for this.
VISIBILITY
2. Ensure (quality) street lighting in areas of high pedestrian traffic Visibility is a major factor whether a crash results in death or serious injury, with dark roads with no streetlights posing a significantly higher risk for fatalities in pedestrian crashes.

Investing in good quality street lighting, particularly in high risk areas (explained above), is likely to reduce the number of crashes which result in death or serious injury.
The rollout of this measure can begin with locations identified as hotspots and in areas with high rates of walking as primary transport.

The intersections of speed and visibility should be considered when making decisions (i.e. where visibility cannot be increased, reducing speed should be a priority).

ALCOHOL AND OTHER DRUGS

3. Expand the enforcement of drink driving in populated areas, supported by emotive public persuasion campaigns

BAC limits are most effective when enforcement is consistent and highly visible, when detection of violation results in penalties that are certain, swift and sufficiently severe, and when supported by effective public persuasion campaigns. Most pedestrian crashes happen in populated areas so concentrated enforcement in these areas of higher risk should be a priority.

Effective programs should be accessible to reduce recidivism for people convicted of drink and drug driving. It is important that the police and judicial system have adequate resources for effective enforcement. The fines collected could be used to resource the ongoing enforcement.

4. Expand access to and availability of harm reduction services (i.e. Sobering Up Shelter beds)

Providing safe beds for intoxicated individuals without another safe place to be is paramount to reducing pedestrian crashes. This harm reduction measure ensures that people most vulnerable to pedestrian crashes are safely housed and receiving care during peak hours of risk (overnight).

Our qualitative data highlight that Sobering Up Shelters are frequently at capacity, suggesting there is a need to review the coverage and potential expansion of these services. These services may reduce the burden on frontline services like emergency departments and police watchhouses, and are cost-efficient, more appropriate and carry lower risks than the alternatives. They can also act as a key site for brief intervention and referral to other alcohol care.

5. Quality outreach and wraparound care including cultural, alcohol and other drugs, social and emotional wellbeing, primary care

People at greatest risk of pedestrian deaths evidently have complex health needs, beyond alcohol use. Enhancing the provision of quality assertive outreach and wraparound care can address these complex needs - which often underpin the behaviours visible to the public. Services best positioned to operate outreach or coordinate care may vary by location, but key service needs likely involve social and emotional wellbeing support, housing, cultural programs, alcohol care and primary health care. As noted above, Sobering Up Shelters and similar services are likely to act as key modes of entry to additional care.

6. Work with the Liquor Commission regarding concerns about outlets overserving

Informants also raised concerns about outlets overserving. Liquor licence holders are required to adhere to Responsible Service of Alcohol (RSA) requirements. The Liquor Commission overseas liquor licences and adherence to conditions. Working with the Liquor Commission regarding hotspot areas and the practices of nearby outlets may be beneficial

to increase compliance with licence conditions in a way that supports reduced alcohol harms.
7. Consider provision of safe spaces for people to consume alcohol Ensure there are adequate safe places for people who are intoxicated that avoid the need for individuals to gather in unsafe locations on the outskirts of towns. Explore successful models of safe drinking spaces from other jurisdictions (i.e. Managed Alcohol Programs, drinker's lounges) and work with local communities and services to trial ways of improving the safety of people who are intoxicated.
RISK ENVIRONMENTS
8. Ensure there are appropriate crossings available to access shops and transport This should focus on high pedestrian traffic areas, with highest priority given to permanent structures which provide goods and service for lower socioeconomic groups as they are the most likely to use walking as their primary transport.
9. Support local councils and communities to identify appropriate and feasible options to reduce transport disadvantage Solutions to improve transport disadvantage may include reviewing transport options available (i.e. community buses) or increasing the service reach and capacity of night patrols. Regular, reliable, accessible services are important. Local services are best placed to explore localised need.
10. Expand access to safe and appropriate accommodation in towns Our qualitative data highlight the links between pedestrian crashes and social determinants such as housing. In addition to short-term measures to keep people safe while in unstable housing, longer term solutions that address this determinant are important. Advocating for ongoing development of safe, appropriate accommodation is essential, even amid widespread shortages. Design of accommodation (particularly regarding location and access to services) should consider that residents are likely to be facing transport disadvantage and relying on walking.

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Appendix A - Overview of publicly available coroners' reports

The term 'pedestrian' was searched in the public repository of NT coronial inquests and findings. Six reports were returned, one which involves the death of a cyclist and so has been excluded. Brief summaries of the remaining five reports are summarised in Supplementary Table 1.

Although any death that occurs within the NT "that appears to have been unexpected, unnatural or violent or to have resulted, directly or indirectly, from an accident or injury" (*Coroners Act 1993 (NT), Part 3*) must be reported to the Coroner, not all reportable deaths will progress to public inquest. We note that since 2024 the current NT Coroner Elisabeth Armitage – due to the NT's extremely high rates of road deaths – has decided to deidentify and release findings made in chambers for road deaths. At the time of writing, no additional findings for pedestrian deaths have yet been released.

Supplementary Table 1: Summary of coronial reports on pedestrian deaths

Name	Date of death	Summary
Jonathan Hempel	4 June 2018	JH was an American working on and off in Australia, who had a wife and family in the US. While in Australia he began an affair with a woman who subsequently ran him over in her driveway. She refused to speak to the coroner and the matter was referred to the Department of Public Prosecutions.
Levi Griffiths	4 June 2011	LG was killed walking home on Girraween Rd in Howard Springs. He was returning from a party and was intoxicated. The driver was intoxicated. The driver did not notify police of the accident and attempted to cover up the crime (including moving the deceased body). The driver was found guilty of the crime, although he never admitted it. He was a member of Hell's Angels and his associates' cars and house had been bugged by police so they had evidence of them discussing the crash, including the drivers post-crash behaviour and intoxication.
Master C	8 July 2011	A 5 year old child waited for a car to pass but stepped into the path of the caravan it was towing.
Zachariah Foster	6 October 2006	ZF died on 6 October 2006 at Ali Curung from a blunt head injury caused when he was struck by a police vehicle. ZF was intoxicated. He had been drinking under the bridge at Wycliffe Well with family and was walking back home to Ali Curang on the sports weekend.
Kenny Alderson	16 May 2004	KA was hit by a police vehicle enroute to an emergency call where the vehicles lights and sirens were not activated. This occurred 5.00pm whilst KA was attempting to cross East Point Road. KA was drinking at the manmade lake with family member. Some family members walked back to Parap Tavern to buy more alcohol. A short time later KA left the lake to follow them and was hit.

Appendix B - Case study stories

The following three case studies have been drawn from qualitative interviews with community members describing the story of a pedestrian crash and pointing to factors seen as important in the crash. Pseudonyms have been used and identifiable information has been removed to protect confidentiality. It is intended that these stories can be used to exemplify factors found in quantitative and other qualitative data using stories from real people that may resonate.

"Bryan"

Bryan told us his story of being involved as a driver in a pedestrian crash. Bryan was a non-Indigenous man who lived in an urban area and had a job and family with young children at home. One night, after dark, he was drinking at home and realised he'd run out of cigarettes. He felt like he was good to drive and knew he didn't have to go far. He knew his local area, he'd done it a million times before with no problems. He jumped in his car and quickly drove up to the shops. He was almost there and turned the corner quickly to catch a green light. It all happened so fast. He hadn't seen the person crossing the road. It was dark, they were wearing dark clothing, he didn't see them. He panicked, and drove off, he couldn't think straight when it happened. He knew he was over the limit and just didn't know what to do in the moment. He eventually turned himself in.

Bryan went to prison and served his time. He lost his job. He lost his family. Even after leaving prison, he wasn't allowed to go home and had to live in a shelter. Years later, the crash impacted him every single day. All he'd had was time to think. He thought about the person who had been killed. He thought about their family. He thought about his family and everything he'd lost, in that single moment.

He didn't know how to make sense of it. The guilt was overwhelming. Why did he have to get in the car? Why did the person he hit have to be there, just at that moment? Why that night? Why him? If there was anything he could do to take it back he would.

"Ronald"

Ronald's sister Sheree told us his story. Ronald was a middle-aged Aboriginal man from remote NT. He'd left his community to live in a big town a few years earlier. There was lots of family and community politics and he'd been fed up, needed a break. He didn't have a fixed address in Darwin. He sometimes stayed with family in one community, sometimes another. Sheree knew that sometimes he didn't have anywhere at all to sleep, which worried her. She waited for updates on the phone from him to hear that he was okay and to tell him to come home. She was always telling her family to get off the alcohol, she saw it was causing big trouble. She didn't know why he was in the place he was that night. It was a big, long walk from where he was staying. It didn't make sense – was he at the shops all that way up the road? He'd been alone, by himself, walking along a road with an 80 kilometre per hour speed limit. She didn't know why he'd crossed, what he'd been trying to get to. A bus maybe? To get home? No one knew, because he was the only one who knew, and he'd died that night. It was late, after midnight. Up near a corner. It took the family a long time to find out. The phone calls had just stopped. She found out from someone else who had been in town, and had to make so many

phone calls to find out more. She couldn't find out anything about the driver. She didn't know if they'd been at fault, if there was anything that could have been done to save her brother. She heard the driver hadn't stopped. Would that have helped him? Could he have been saved? She wished her brother had just come home. She wished other people had been with him so they could have stopped him or helped him or could at least tell her what had happened. She hoped her family would learn from this but she saw nephews, cousins, other family members doing the same things Ronald had been doing. She wished there was something she could do. All she could do was try to keep telling them over and over again how important it was that they look after themselves and each other. Sheree wants others to know how much her brother meant to him. How much she missed him. How important he'd been to so many people around him.

Her brother isn't the only person she knows who died from being hit by a car. She knows of at least four other people from her community or family. There's constant grieving.

"Sabrina"

Sabrina has been between shelters and sleeping rough for more than 10 years. She's seen a lot in her time. She has family all across the NT, but hasn't been home to her own community for a long time. There's a lot of problems there, and it's been too long. She sometimes gets a bed at a shelter, but they're pretty hard to come by. She moves around a lot, sleeping outdoors across different parts of town, sometimes in communities where she knows people. She's used to it by now. She moves in and out of different social circles, depending who is around and how they're getting along and what feels safe. She has some big health problems, that she sometimes gets help with. She's been to hospital a few times but she hates it there. They're always trying to get her to go back in there but she loses track. Sabrina doesn't drink now but she used to, a bit. She was hit by a car a few years ago, but it wasn't going really fast. It was a bad night and she got hurt, but it's not the worst she's had. She's seen a lot. She doesn't remember the moment she got hit, she just knows she was on the street, there was a big argument going on and she was getting away from the trouble. She remembers being in hospital and she remembers hurting but she got out of there as quick as she could. She hates that place. She still has aches and pains but that could be from lots of things. She knows other people who have been hit and killed, lots who have been bumped and she sees people nearly getting bumped a lot. People just walk on the roads, everyone does it. They're just living their lives, they've got bigger troubles to worry about.