MONASH University

The tyranny of distance: Geographic variation in access to health care and service utilisation for people with serious injury

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Abbreviations

ABS	**Australian Bureau of Statistics**
AHP	**Allied health professional**
ARIA	**Accessibility/Remoteness Index of Australia**
CCI	**Charlson Comorbidity Index**
DALYs	**Disability adjusted life years**
ED	**Emergency department**
GCS	**Glasgow Coma Scale**
GIS	**Geographic information system**
GP	**General practitioner**
ISS	**Injury Severity Score**
LGA	**Local Government Area**
LMIC	**Low- and middle-income countries**
MTS	**Major Trauma Service**
OT	**Occupational therapy**
PT	**Physical therapies**
SCI	**Spinal cord injury**
SCIS	**Spinal Community Integration Service**
TAC	**Transport Accident Commission**
TBI	**Traumatic brain injury**
VSTR	**Victorian State Trauma Registry**
VSTS	**Victorian State Trauma System**

Abstract

Background

In Australia, where you live has an impact on your risk of serious injury and your recovery. People living in regional areas have an increased risk of hospitalisation due to injury compared to people in metropolitan areas. However, most specialised trauma centres are located in major cities. Consequently, when patients are discharged from hospital, they are often a long way from specialised care. Accessibility to health care is defined as the ability of a population to obtain available health services. This ability is determined by economic, geographical, consumer, organisational, and informational factors which may be barriers or facilitators to obtaining services. Thus, many factors can be barriers impacting access to health care and recovery from injury.

Methods

A scoping review of peer-reviewed literature was undertaken to investigate the relationship between geographic location and outcomes following injury. A qualitative study was undertaken, exploring the perspectives of allied health professionals (AHPs) involved in the care of people with serious injury post-hospital discharge in rural and urban areas of Victoria, Australia. Twenty-five semi-structured interviews were completed with AHPs and analysed using thematic analysis underpinned by interpretive phenomenology.

Two quantitative studies were completed using linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC) for people

injured between 2006 and 2016. These were population-based, registry cohort studies using geospatial analyses at a Local Government Area (LGA) level to explore the distances travelled to post-discharge health services and their relationship with service use for people with orthopaedic, brain and spinal cord injuries across metropolitan and regional Victoria in the first three years following hospital discharge. Each participant's residential address was classified as metropolitan or regional based on the 2016 Accessibility/Remoteness Index of Australia (ARIA+) scale.

Results

The scoping review identified that mortality outcomes were worse for people in regional areas following injury. However, there was no consistency in the differences in functional health outcomes between metropolitan and rural groups. Qualitative research identified that allied health professionals in metropolitan and regional settings faced a number of barriers to post- discharge service delivery for people with serious injuries. Limited availability of necessary health professionals was consistently reported, particularly access to psychological services. Access to health care was also felt to be limited by: a) a reliance on others for transportation; b) emotional stress of travel; c) the exacerbation of symptoms such as pain and fatigue with travel; and d) greater travel time.

Results of the quantitative studies supported the qualitative findings, showing that people in regional LGAs travelled further to access health services following serious injury. The number of people using services declined with each subsequent year beyond hospital discharge. When explored by type of injury, the adjusted odds of

General Practitioner (GP) service use for regional participants was 76% higher than for metropolitan participants in the orthopaedic and brain injury groups. People with spinal cord injury living in regional areas had 72% lower adjusted odds of accessing mental health, 82% lower adjusted odds of accessing physical therapies and 76% lower adjusted odds of accessing OT services compared to people living in major cities. For all injuries and service types, people in regional areas used fewer services than people residing in major cities after adjusting for covariates.

Conclusion

The research presented in this thesis examined access to post-discharge health services and health service utilisation for people with serious injuries in metropolitan and regional Victoria. People in regional areas travelled further to access services and used services in lower frequency relative to their metro counterparts, with the exception of GP services. Qualitative research suggested that the limited availability of services and health professionals in regional areas, combined with challenges of travelling to services, contributed to the lower service utilisation. Alternate service delivery methods, including the use of technology and telehealth, may reduce the associated burden of travel for those in regional areas and improve equitable access to post-discharge health care.

Publications

Keeves J, Gabbe BJ, Arnup S, Ekegren CL, Beck B. (2022) Travelling for treatment: The association between injury type and service utilisation in metropolitan and regional Victoria. Submitted for publication in *International Journal for Environmental and Public Health Research*, September 2022.

Keeves J, Gabbe BJ, Ekegren CL, Fry R, Beck B. (2021). Regional variation in travel to health services following transport-related major trauma. *Injury*. doi:10.1016/j.injury.2021.12.011

Keeves, J., Braaf, S. C., Ekegren, C. L., Beck, B., & J Gabbe, B. (2021). Access to health care following serious injury: perspectives of allied health professionals in urban and regional settings. *International journal of environmental research and public health*, *18*(3), 1230.

Keeves, J., Braaf, S. C., Ekegren, C. L., Beck, B., & Gabbe, B. J. (2021). Caring for people with serious injuries in urban and regional communities: A qualitative investigation of health care providers' perceptions. *Disability and rehabilitation*, *43*(21), 3052-3060.

Keeves J, Ekegren CL, Beck B, Gabbe BJ. (2019). The relationship between geographic location and outcomes following injury: A scoping review. *Injury*. 50(11):1826-1838.

Conference presentations

Keeves J, Gabbe BJ, Ekegren C, Fry R & Beck B. *People in regional areas travel further to access health services following transport-related major trauma*. Oral presentation at: The National Allied Health Conference; August 9-12 2021, virtual.

Keeves J, Braaf S, Ekegren C, Beck B, Gabbe BJ. *Physiotherapists caring for patients with traumatic neurological injuries in the community have trans-disciplinary roles.* Oral presentation at: Australian Physiotherapy Conference; October 17-19 2019; Adelaide, Australia.

Keeves J, Braaf S, Ekegren C, Beck B, Gabbe BJ. *"When you live regionally you just don't havethat access." Provider perceptions of access to health care for seriously injured patients beyond hospital discharge.* Oral presentation at: Australasian Trauma Society Conference; October 3-6 2019; Sydney, Australia. **(Awarded prize for Best Allied Health Oral Presentation)**

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- Postgraduate Research Scholarship, Monash University, 2020

Declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge, this thesis contains no material published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes four papers published in peer reviewed journals and one paper submitted for publication. The core theme of the thesis is geographic variation in access to health services and health care utilisation following major traumatic injury. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Prehospital, Emergency and Trauma Research Group within the School of Public Health and Preventive Medicine under the supervision of Professor Belinda Gabbe, Dr Ben Beck and Dr Christina Ekegren.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research. In the case of Chapters Two, Three and Four my contribution to the work involved the following:

Thesis Chapter	Publication Title	Status	Nature and percent of student contribution	Co-author(s) name, nature and percent of contribution	Co-authors, Monash student Y/N
2	The relationship between geographic location and outcomes following injury: A scoping review	Published	70% - responsible for designed, data extraction, data synthesis, interpretation of results and writing of manuscript.	1) Prof Belinda Gabbe, 10% - study design, writing of manuscript 2) Dr Christina Ekegren, 10% - study design, writing of manuscript 3) Dr Ben Beck, 10% - study design, writing of manuscript	No
3	Caring for people with serious injuries in urban and regional communities: a qualitative investigation of health care providers' perceptions	Published	70% - responsible for designed, data extraction, analysis, interpretation of results and writing of manuscript.	1) Dr Sandra Reeder, 15% - study design, data analysis, writing of manuscript 2) Prof Belinda Gabbe, 5% - study design, writing of manuscript 3) Dr Christina Ekegren, 5% - study design, writing of manuscript 4) Dr Ben Beck, 5% - study design, writing of manuscript	No
3	Access to Health care Following Serious Injury: Perspectives of Allied Health Professionals in Urban and Regional Settings	Published	70% - responsible for study design, data extraction, analysis, interpretation of results and writing of manuscript.	1) Dr Sandra Reeder, 15% - study design, data analysis, writing of manuscript 2) Prof Belinda Gabbe, 5% - study design, writing of manuscript	No

				3)	Dr Christina Ekegren, 5% - study design, writing of manuscript	
				4)	Dr Ben Beck, 5% - study design, writing of manuscript	
4	Regional variation in travel to health services following transport-related major trauma	Published	70% - responsible for study design, data analysis, interpretation of results and writing of manuscript.	1)	Dr Ben Beck, 10% - data analysis and interpretation, writing of manuscript	No
				2)	Prof Belinda Gabbe, 10% - data analysis and interpretation, study design, writing of manuscript	
				3)	Dr Christina Ekegren, 5% - study design, writing of manuscript	
				4)	Dr Rich Fry, 5% - study design, writing of manuscript	
4	Travelling for treatment: The association between injury type and service utilisation in metropolitan and regional Victoria.	Submitted	70% - responsible for study design, data analysis, interpretation of results and writing of manuscript.	1)	Dr Sarah Arnup, 10% - data analysis and interpretation, writing of manuscript	No
				2)	Prof Belinda Gabbe, 10% - data analysis and interpretation, study design, writing of manuscript	
				3)	Dr Christina Ekegren, 5% -	

	study design, writing of manuscript 4) Dr Ben Beck, 5% - study design, writing of manuscript

I have renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

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Date: 30th May 2022

I hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor name: Professor Belinda Gabbe

Main Supervisor signature: 

Date: 1st June 2022

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Chapter One: Introduction

1.1 Background

1.1.1 The Burden of Serious Injury

Serious injuries are a global public health problem. Serious injury includes spinal cord injury (SCI), traumatic brain injury (TBI) or other orthopaedic injuries that require an emergency hospital admission.[1] In Australia, injury accounts for approximately 9% of the burden of disease [2] and has the fourth highest costs of $10.25 million per year.[3] Injury remains the leading cause of death and disability in Australians up to 45 years of age and results in almost half a million hospitalisations annually.[4] Australia-wide, more than 8000 people with serious injuries are admitted to major trauma hospitals each year.[5] Reducing the injury burden from serious injury is a priority area for trauma system design and health research.[5]

1.1.2 Trauma Systems

1.1.2.1 Acute Trauma Care

Globally, 'regionalised' trauma systems are widely recognised as best-practice in trauma care with the establishment of these systems clearly shown to improve survival rates[1, 6-9] and functional outcomes following serious injury.[10, 11] These systems involve processes to ensure timely transport of seriously injured patients to a small number of specialised trauma centres with appropriately trained staff and expertise to manage these complex patients.[1, 12] Coordinating pre-hospital care, retrieval services and acute care ensures the best chance of survival for people who are seriously injured. The acute management, however, is only one phase of the journey for an injured

individual. The World Health Organization (WHO) and the American College of Surgeons-Committee on Trauma suggest that best-practice care of a person with serious injuries in a regionalised trauma system requires coordinated efforts along the entire patient pathway from pre-hospital and acute care, through to rehabilitation, and community re-integration to optimise outcomes.[13, 14] However, the extent to which this is occurs is unclear and requires further investigation.

1.1.2.2 Trauma Care Beyond Hospital Discharge

For survivors of serious injury, the path to recovery often involves long-lasting, complex and expensive health care needs.[11, 15, 16] Despite most patients requiring an extended period of rehabilitation and post-discharge involvement with numerous medical and allied health services, guidance around the best models of rehabilitation and service delivery are notably absent.[13, 14] One of the inherent challenges for regionalised trauma systems is that post- discharge health care is multi-faceted and coordinating the range of health services involved in a patient's recovery can be difficult.[12] Rehabilitation following traumatic injury is critical to maximise the quality of survival and reduce the burden of serious injury.[17] In Australia, there are only clear rehabilitation pathways for people with severe brain or spinal cord injuries, despite 59% of people sustaining injuries without neurotrauma.[18]

In the UK, trauma systems are addressing the issue of care continuity by integrating rehabilitation and other outpatient services into the definitive care hospital.[9] Australian research has also suggested that providing 'in-house' trauma services at

designated trauma centres may be more efficient and cost-effective than transferring patients to externalrehabilitation providers.[19] However, implementation of this strategy is less feasible in Australia, due to many people residing far from metropolitan trauma centres and a preference for their care to be provided in their local communities. Therefore, the capacity for major trauma centres to effectively manage the broad range of needs for seriously injured patients may not be realistic and there is a need to develop post-discharge procedures and resources suitable for the Australian setting.

At present, limited research exists to inform post-discharge service delivery models. Improving our understanding of health care utilisation beyond hospital discharge is essential for establishing a pathway to accessing adequately skilled health professionals in the community and reducing the burden of injury.

1.1.3 Patient Outcomes following Serious Injury

With improved survival following serious injury, more people are living in the community with injury related disability. Patterns of recovery are prolonged in nature with 80% of survivors experiencing functional limitations at one-year post injury.[11] Many continue to report ongoing problems with mobility, interference from pain and psychological dysfunction at three years post injury.[15]

Previous qualitative research with Victorian trauma patients suggested they were dissatisfied with post-discharge care. Specific concerns included poor coordination of care following discharge from hospital, a lack of access to appropriate carers and

deficiencies in the expertise amongst clinicians involved in post-discharge care.[20-22] Furthermore, anxiety about the future continued to persist at three years following injury.[20]

1.1.4 Access to Health care

Globally, access to health care is central to delivering effective health systems. Access to health care is not an easily defined concept. Kahn and Bhardwaj described access or accessibility as the ability of a population or a segment of the population to reach and use available health services. This ability is determined by economic, temporal, geographical, architectural, organisational, and informational factors which may be barriers or facilitators to obtaining services.[23]

Accessibility as a concept has been described in a number of different ways. Donabedian defined accessibility to consist of two key concepts: socio-organisational access, referring to whether an organisations health care structure is sufficient to meet the needs of society as a whole; and geographic access, involving the physical and temporal distances of health care users to necessary services.[24] Other researchers have placed more emphasis on the actual utilisation of services, wait times to receive care and individual satisfaction with health care as measures of accessibility.[25-27] More recently, a complex framework of an individual's ability to access health care that considered the interactions of factors pertaining to both the accessibility of a health service, as well as the experiences and context of the health care-seeker was developed by Levesque and colleagues (Figure 1).[28]

This framework (Figure 1) reflects an integration of both the supply and demand factors that determine an individual's ability to use a health service. A number of these constructs are also interrelated, particularly in relation to geographical access. For example, the geographic location of a service can also impact the affordability due to the associated transportation costs, and the service may be more challenging to reach for someone with mobility issues or if cultural and social norms place less importance on health care.

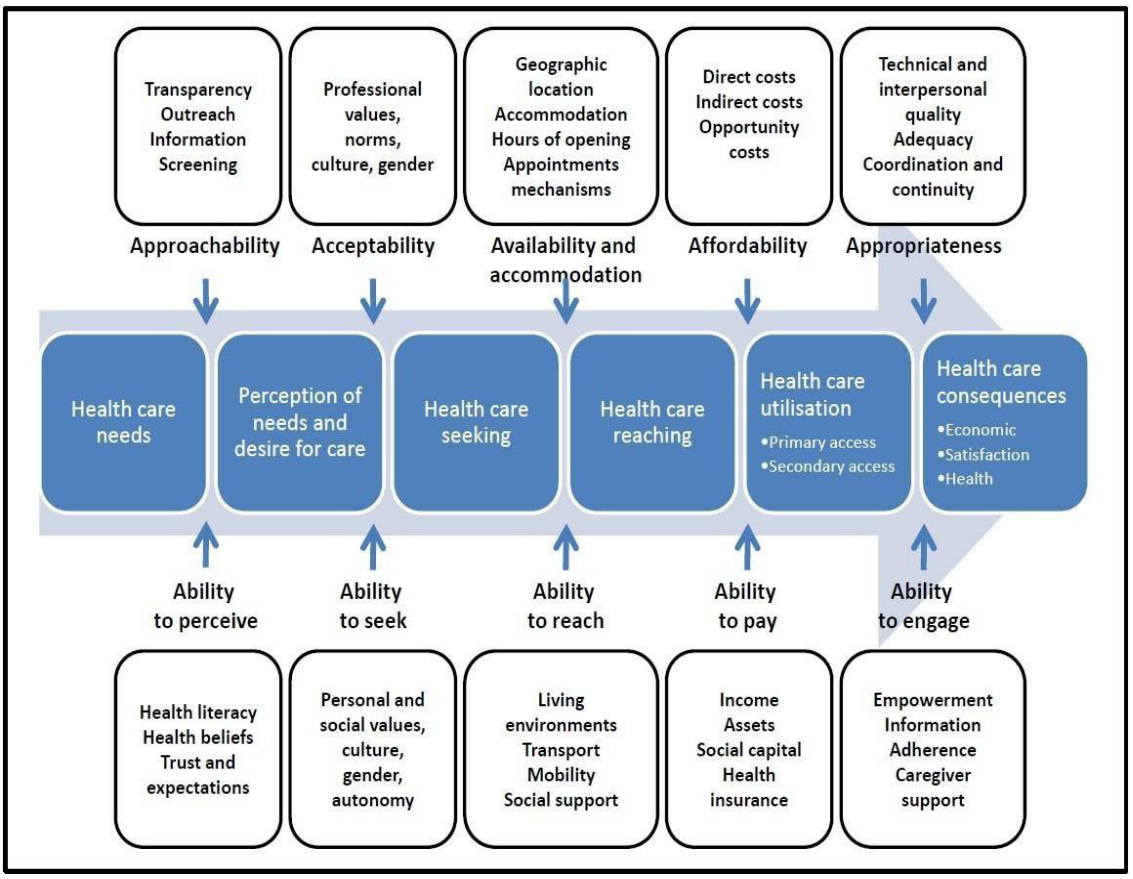

Figure 1. Conceptual framework of access to health care, adapted from Levesque et al, 2013

In Australia, where you live not only has an impact on your risk of serious injury, but also your recovery and ability to receive necessary health care.[22, 29, 30] Geographic

location shapes health experiences and opportunity to access health care through socioeconomic status, health literacy and education, availability of and distance to health services, physical conditions and psychological exposures.[31] In regionalised trauma systems, it is unclear whether the centralisation of trauma services in inner metropolitan facilities may result in a disparity of access to necessary care following discharge, particularly for people living in outer metropolitan and regional areas. Known factors impacting access to care following serious injury include, but are not limited to, the geographic location of services, difficulties with transportation, distance to travel and coordination of care from acute to post-discharge health care.[21, 22, 29, 31-33]

The disparity in access and availability to necessary health care following injury often disproportionately affects people in regional areas.[34-41] Whilst some research has suggested that people in regional areas accept increased travel as a routine part of their lifestyle choice,[42, 43] the distance required to travel for health services can exacerbate persistent symptoms such as pain, anxiety, dizziness and fatigue.[29] Furthermore, across a broad range of health contexts, a recent systematic review found that people required to travel a greater distance to health services had poorer health outcomes.[44]

1.1.5 Geospatial Analysis in Health Research

Using spatial methods in health research can be beneficial to investigate individual and area-level physical environmental, socio-economic and cultural factors that can influence health across different spatial levels, e.g. individual, neighbourhood, local council.[44] Spatial accessibility provides a summary measure of two components of

access, the volume of services provided relative to size of the population and the proximity of services provided relative to the location of the population.[45]

Measuring spatial accessibility can involve quantifying the potential to reach health services, using travel distances and/or availability; and measuring realised health care utilisation with consideration of spatial factors.[46] Whilst a number of studies have used geospatial methods when studying accessibility, a variety of approaches have been used.[46-48] Guagliargo, 2004[46], suggested that measures of spatial accessibility can be classified into four groups:

1. Provider to population ratio

Computed within bordered areas, they use population data that is readily available for areas such as states, health service regions or postcodes and incorporate a numerator that provides an indication of health service capacity, e.g. number of clinics, General Practitioners or hospital beds.[46] These ratios enable gross comparisons of services between large spatial or service areas, however do not include any measure of distance or account for people moving in and out of the spatial area.

2. Distance to nearest provider

This is a commonly used measure of spatial accessibility, typically involving the distance measured from a patient's residence or population centre, such as the geometric centroid of a postcode, depending on available data.[46] Distances can be measured in Euclidean format, i.e. a straight line, distance along a road or rail system or distance via a public transportation network. This measure is limited by the fact that it doesn't take into consideration traffic congestion in metropolitan areas and the fact that there may be a number of providers available at similar distances. Thus, distance

to the nearest provider is not the most ideal model of spatial accessibility, unless considered in combination with service availability

3. Average distance to a set of providers

This method was developed to provide a combined measure of accessibility, i.e. distance, and availability. It also uses the distance from a patient's residence or population centroid and the travel distance to all providers within a defined geographic area is summed and average.[46] This measure also does not account for people moving across geographical boundaries to seek health care.

4. Gravity models of provider influence

These models combine accessibility and availability, with examination of movements between two sites, e.g. a patient's residential location and a health service. Gravity model equations are based on Newton's Law of Gravitation.[49] In the simplest form, gravity models take into account the decreasing likelihood of accessing a service with increasing distance from the service location.[46, 47]

Another model, the two-step floating catchment area (2SFCA) method, developed by Luo and Wang[48], expands on the gravity model assessing the availability of a service as a ratio of service providers to their surrounding population, within a certain amount of travel time from the provider, and subsequently summing the ratios around each residential location, thus considering both supply and demand.

In other health conditions, spatial accessibility measures have been used in health research to explore the spatial distribution of populations of interest, to develop health promotion initiatives and identify areas of limited access to health care [45, 50, 51]. Spatial methods are important to enable research to account for the associations

between social and environmental factors relative to geographic distribution. With advances in technology and software, computing complex spatial methodology is now more user-friendly for researchers, making these methods more accessible and measurements more precise.[50]

Despite the potential benefits of geospatial analysis to address public health issues, the use of spatial methodology in injury research has been limited.[51] In injury research, spatial accessibility has primarily been explored via distance to nearest provider models and mapping of data to visualise health service locations spatially.[47-49] Only one study has employed the 2SFCA model to explore spatial accessibility and socioeconomic characteristics associated with injury.[52]

A paucity of research exists applying methods of geospatial analysis to understand accessibility to post-discharge health services following injury. Given the overrepresentation of rural patients that are seriously injured in Australia, it is critical to understand whether variation exists in health service utilisation due to geographic region of residence and the factors that impact accessibility of health care for patients following injury.

1.1.6 Qualitative Research Methods in Health Research

Qualitative research aims to help us understand social phenomena in natural environments, to reveal the experiences and perspectives of participants, such as patient and professional health beliefs and service-user experiences.[53] Qualitative research methods enable research to understand the 'how' and 'why' of a research

question that is not possible to uncover with quantitative research alone. Exploring the lived experiences of participants can also provide rationale for quantitative research or inform areas with limited previous investigation.[53]

There are a range of qualitative methods than can be used to provide an understanding of a research context, such as observation, surveys, in-depth interviews and focus groups.[53] Qualitative methods can also be used as a validation tool for quantitative studies as part of the triangulation process, comparing different research methods for convergence [54]

In injury research, there has been wide uptake of qualitative methods to explore perspectives of different patient groups and caregivers.[55-57] Specifically, qualitative studies have improved our understanding of barriers to post-discharge health care for people with serious injury that exist from the perspectives of patients or their carers.[20-22, 34, 37, 40, 58, 59]. Two studies from the United Kingdom have also explored the perspectives of healthcare providers, with these research findings used to offer recommendations on the post-discharge care of people with serious injury.[60, 61]. In Australia, no research exists exploring the experiences and perspectives of health care providers, nor has there been research focused on how the experiences of health care providers and patients with serious injury differs for people in different geographical regions.

1.2 Research context

Victoria is the second-most populous state of Australia with a population of 6.46 million people. [62]Of this population, 76% reside in metropolitan areas, 23% in regional towns and <1% in areas considered to be 'Remote' or 'Very Remote' (Figure 2).[62]

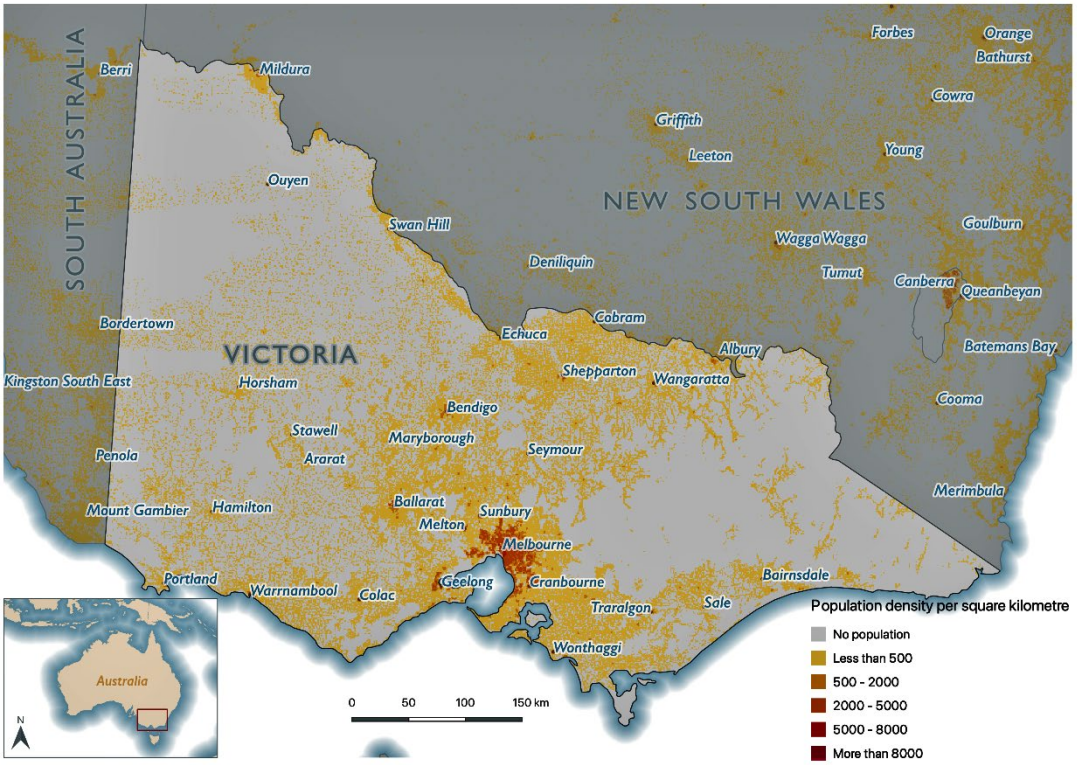

Figure 2. Population density map of Victoria, Australia

1.2.1 The Victorian State Trauma System

Victoria has an inclusive trauma system which directs injured people to the most appropriate facility according to pre-hospital and inter-hospital transport guidelines. Victoria has three designated major trauma services (MTS); two adult (The Royal Melbourne Hospital and The Alfred), and one paediatric (The Royal Children's Hospital), which are all located in inner metropolitan Melbourne. These centres provide definitive care for 77% of major trauma cases in Victoria.[18] The Victorian State

Trauma System (VSTS) is widely considered the gold standard for design of trauma systems with many interstate and international trauma systems based on this model of care.[18] A key factor contributing to the success of the VSTS is the ability to monitor and analyse trauma care and outcomes due to the high-quality data provided through the Victorian State Trauma Registry (VSTR).

Whilst clear guidelines and numerous resources exist for the acute management of trauma patients within the VSTS, there is no direction on how care should be coordinated beyond hospital discharge. Further attention has recently shifted to explore facilities providing inpatient rehabilitation care to people following traumatic injury. People with serious neurotrauma, that is, traumatic brain injury (TBI) and spinal cord injury (SCI), are more likely to receive rehabilitation at state-based specialised centres.[18] For people without serious neurotrauma, the number of people being discharged to inpatient rehabilitation facilities has declined, and over one hundred different providers manage these complex patients. Given the high prevalence of disability amongst trauma survivors, both with and without serious neurotrauma, it is pertinent to consider the whole pathway of trauma care from acute management, to specialised rehabilitation and community care.[18]

1.2.2 Victorian State Trauma Registry (VSTR)

The VSTR is a population-based registry that collects data about all people who experience major trauma and are managed in Victoria.[63] The registry includes data about prehospital care, pre-existing health conditions, injury characteristics and complications, and discharge information. A case is included in the registry if any of the

following criteria are satisfied: (1) death due to injury; (2)an Injury Severity Score (ISS) >12, based on the Abbreviated Injury Scale (AIS) 2005 version, 2008 update; (3) admission to an intensive care unit > 24 hours; (4) or an injury requiring urgent surgery.[1] Whilst patients do have the opportunity to opt-off the registry, less than 0.5% of cases choose to be removed.[1]

The registry collects the Transport Accident Commission (TAC) claim number for relevant cases. The VSTR receives quarterly data from participating health services which identifies TAC patients based on their claim number or transport-related injury codes. Data linkage between the VSTR and the TAC occurs yearly and involves claim numbers and other identifiers to ensure that any missing or incorrect claim numbers or patient details are updated. A number of stages are involved in the standardised linkage process to ensure secure data transfer and complete capture of eligible TAC patients by the VSTR, without patient-level data being provided to the TAC. The registry aims to enable research that can inform policy and practice to reduce preventable deaths and disability from major trauma.[18]

1.2.3 Funding for Traumatic Injury

Funding for injury care in Australia varies depending on state-based legislation. In Victoria there are two main injury insurance schemes. Both are no-fault third-party insurers, with one primarily covering transport-related injury, the TAC, and the other, WorkSafe covering workplace injury. These injury insurance schemes provide compensation for medical expenses, rehabilitation and support services, as well as financial assistance. For people not compensated by these schemes, care is funded by

Medicare, Australia's publicly funded universal health care system for all citizens and permanent residents, and/or private health insurance**.** In 2016, the National Disability Insurance Scheme (NDIS) was introduced at a federal level to provide individualised support for Australians under the age of 65 years, living with permanent and significant disability.[64]

1.2.3.1 Transport Accident Commission

The TAC is the Victoria's no-fault third-party injury insurance scheme that provides compensation for medical expenses, rehabilitation, support services and financial assistance for people who have sustained transport-related injury. People are covered by the TAC if their injuries were sustained as a result of driving a car, motorcycle, bus, train or tram. Cyclists injured by a collision with a moving or stationary motor vehicle (after 9 July 2014) are also covered by the TAC. Pedestrians are covered by the TAC when their injuries arose as a direct result of impact with a motor vehicle, motorcycle, train or tram. Full details of eligible claimants and expenses covered by the TAC are outlined in the Transport Accident Act 1986.[65] In 2019-20, 26% of Victorians with major trauma were identified as TAC compensable.[18]

The TAC is a claims-based system and routinely collects data on all payments made relating to an individual claim, including medical and rehabilitation expenses. Injured individuals consent to the TAC collecting data relating to their claims and to the data being used for research purposes. Additionally, the TAC has close to 100% capture of post-discharge health services that they have paid for, including details of service type

and service description, service date, service provider number, amount paid as well as whether the service was in- or out-of-hospital. Records of service provider numbers, discipline and associated provider locations are also held by the TAC.

1.2.3.2 WorkSafe Victoria

For people injured at work or travelling to or from their workplace, WorkSafe Victoria provides injury insurance through the WorkCover scheme. WorkCover is a system of statute based, compulsory insurance that provides support and entitlements to workers, insuring that employers from the impact of economic and non-economic loss as a result of an injured worker. It is compulsory that an employer registers for WorkCover insurance if they a) have annual wages greater than, or expected to be greater than $7500; or b) employee any trainees or apprentices.

The WorkCover scheme provides compensation for medical expenses, rehabilitation, support services and financial assistance for injured workers. Additionally, WorkCover also assists in the provision of suitable employment or modifications for an injured work to return to work. Further details on the compensation and supports received through the WorkCover scheme are described in the Accident Compensation (WorkCover Insurance) Act 1993[66] and the Workplace Injury Rehabilitation and Compensation Act 2013.[67]

1.2.3.3 The National Disability Insurance Scheme

The National Disability Insurance Scheme (NDIS) was introduced in 2016 as an Australia-wide policy reform to provide individualised funding for self-directed disability care and support for Australians under the age of 65 years, emphasising individual choice and control.[64] The aim of this significant reform was to improve equity of service delivery, levels of participation and quality of life amongst people with disabilities and their families.[68] This funding system remains in its infancy with the rollout in Victoria occurring between 2016 to 2019. Since its commencement however, clinicians and people with disabilities have reported difficulty accessing and negotiating the NDIS systems.[64, 69, 70] Some NDIS users have reported that the administrative burden of using the NDIS system outweighs the benefits of the scheme due to the need to synthesize complex information to receive funding and care [71]. The NDIS model has great potential to assist people living with injury-related disability. However, a number of challenges with implementation must be addressed through continuous improvement of the scheme to optimise the functionality of this reform for participants. [71]

1.2.2 Serious Injury in Victoria, Australia

Data from the VSTR provides an overview of people with serious injuries in Victoria that meetthe VSTR 'major trauma' inclusion criteria. Transport-related injuries and falls made up 82% of the 3,613 major trauma events in Victoria for 2019-20.[18] People with major trauma were predominantly male (70%) and had a median acute hospital length of stay (LOS) of 6.6 days. In recent years, a higher percentage of people with major

trauma have been discharged directly home, rather than to an inpatient rehabilitation facility. The percentage of people with major trauma discharged to an inpatient rehabilitation facility declined from 41% in 2015-16 to 30%in 2019-20.[18]

Over the last five years there has been a consistently greater incidence of hospitalised major trauma patients residing in regional Victoria compared to metropolitan Melbourne (71.3 vs 42.7 per 100,000 population).[18] With a greater proportion of people with serious injuries being discharged directly home from hospital, and one-third of major trauma patients living outside of metropolitan Melbourne, improved understanding of access to health care post-discharge is critical to optimising service delivery and health outcomes. Additionally, since the pandemic, due to people relocating from metropolitan to regional areas, regional populations are increasing in size.[72]

1.3 Summary and Rationale

Due to the advances in trauma care and the reduced risk of dying from injury, understanding patterns of recovery following serious injury, and decreasing the injury burden from non-fatal outcomes have become key areas for research and health policy development.[8, 10] People with major trauma in regional areas may have greater difficulties accessing necessary care as a result of resources and expertise being primarily located in metropolitan areas.[34-41] As approximately one third of major trauma patients live in regional areas, there is an even greater need to ensure that there are adequate community-based services available for trauma patients in outer urban and regional areas. [4]

There is a need to improve our understanding of the impact of regionalised trauma care and service access on long-term outcomes for people with serious injuries. Augmenting our understanding of these issues is key to developing policies, enhancing methods for delivering trauma care and improving interactions between trauma survivors, funding bodies and health care providers. This research will contribute to our understanding of how the regionalised model of trauma care functions beyond hospital discharge and with the aim of minimising the risk of disparity in access to services for those outside of metropolitan centres.

1.4 Research Aims & Objectives

This research explored health care service utilisation across different geographic regions for people with serious injury. This research also aimed to understand the perspectives of community-based health care providers involved in the care of seriously injured patients and whether geographic location adds additional challenges to meeting patients' needs.

Research objectives:

1. Review the available literature to explore the association between geographic location and outcomes following injury;

2. Describe the factors perceived by AHPs to influence the care of people with serious injury beyond hospital discharge across regional and urban Victoria;

3. Explore factors perceived by AHPs to affect access to post-discharge health care for people with serious injuries in urban and regional areas of Victoria;

4. Explore geographic variation in health service use and distances travelled to health services in the first three years post hospital discharge for people with transport-related serious injury; and

5. Describe geographic variation in patterns of health service use in the first three years post hospital discharge for different injury groups.

1.5 Thesis overview

This PhD thesis includes one submitted and four published manuscripts across five chapters (Table 1).Chapter One provided an overview of the background and rationale for this research as well as describing the Victorian context in which this research was conducted. Chapter Two includes a published scoping review of the literature examining the relationship between rural and urban areas and different types of health outcomes. Outcomes examined included mortalityoutcomes, in-hospital outcomes and recovery outcomes.

In Chapters Three and Four, the results of four studies are presented. These chapters also include a background of the research and present expanded descriptions of the methodology discussed in the accompanying papers. Chapter Three details the qualitative research undertaken exploring the barriers and facilitators perceived by AHPs in caring for people following serious injury across different geographic regions of Victoria. The first paper of Chapter Three discusses caring for people with serious injury in diverse geographic areas, and the second explains factors perceived to influence access to post-discharge health care following serious injury.

Chapter Four includes two quantitative studies using geospatial analysis to understand distances travelled to health services by people with transport-related major trauma. The first paper of Chapter Four focuses on the regional variation in distance travelled to health services for all major trauma patients by Local Government Area. The second paper examines the differences in service use and distance travelled to health services by geographic location between three key injury groups, orthopaedic injury, traumatic brain injury (TBI), and spinal cord injury (SCI).

The final chapter, Chapter Five, provides a critical overview of the research program of the thesis. This includes examining the strengths and limitations of the research, highlighting thekey findings and carefully considering the implications of this research on policy and practicefor the provision of health care beyond hospital discharge following serious injury. Lastly, Chapter Five presents a series of recommendations for future research to better understand how geography impacts health care utilisation and outcomes following serious injury.

Table 1. Thesis Overview

Chapter	***Contents***	***Research objectives***
Chapter One	Introduction	Describe the background and context of the thesis topic. Describe the rationale, aims and objectives of the thesis. Provide an overview of the thesis structure.
Chapter Two	**Manuscript:** *The relationship between geographic location and outcomes following injury: A scoping review*	Review literature on the geographic variation in outcomes following injury
Chapter Three	**Manuscript:** *Caring for people with serious injuries in urban and regional communities: a qualitative investigation of health care providers' perceptions* **Manuscript:** *Access to Health care Following Serious Injury: Perspectives of Allied Health Professionals in Urban and Regional Settings*	Describe the factors perceived by AHPs to influence care of people following serious injury beyond hospital discharge across regional and urban Victoria. Explore factors perceived by allied health professionals to affect access to post-discharge health care for people with serious injuries in urban and regional areas of Victoria.

Chapter Four	**Manuscript:** *Spatial variation in travel to health services following transport-related majortrauma*	Explore geographic variation in health service use and distances travelled tohealth services in the first three years post hospital discharge for people with transport-related serious injury; and
	Manuscript: *Travelling for treatment: Association between injury type and services use in metropolitan and regional Victoria, Australia*	Describe geographic variation in patterns of health service use in the first three years post hospital discharge for different injury groups.
Chapter Five	Discussion and conclusions	Discuss the strengths and limitations of the thesis. Summarise the key findings of this work. Provide recommendations for practice, policy and future research.

Chapter Two: Literature review

2.1 Introduction

With improved trauma care and survival following injury, research over the last decade has shifted focus from injury mortality and optimal acute care to understanding the recovery of people living with serious injury. Chapter One outlined the burden that traumatic injury poses to our society, and the potential for regionalised trauma systems to create disparity in access to post-discharge health care for people living in rural areas. Chapter One also highlighted that, following serious injury, people often experience poor mental and physical recovery, but demonstrated that the effect of geography on health outcomes following injury is not well understood.

The aim of this paper was to address the evidence gap in our understanding of geographic variation in outcomes following injury. This scoping review examined mortality outcomes, in- hospital outcomes and recovery outcomes by geographic location in injured populations. This study addressed the first research objective for this thesis.

2.2 Paper One

2.1.1 Manuscript

Keeves J, Ekegren CL, Beck B, Gabbe BJ. (2019). The relationship between geographic location and outcomes following injury: A scoping review. *Injury*. 50(11):1826-1838.

Details of the review search strategy are provided in Appendix 1. An expanded table of results for included studies is included in Appendix 2.

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The relationship between geographic location and outcomes following injury: A scoping review

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ABSTRACT

Introduction: Globally, injury incidence and injury-fatality rates are higher in regional and remote areas. Recovery following serious injury is complex and requires a multi-disciplinary approach to management and community re-integration to optimise outcomes. A significant knowledge gap exists in understanding the regional variations in hospital and post-discharge outcomes following serious injury. The aim of this study was to review the evidence exploring the association between the geographic location, including both location of the event and place of residence, and outcomes following injury.
Materials and Methods: A scoping review was used to investigate this topic and provide insight into geographic variation in outcomes following traumatic injury. Seven electronic databases and reference lists of relevant articles were searched from inception to October 2018. Studies were included if they measured injury-related mortality, outcomes associated with hospital admission, post-injury physical or psychological function and analysed these outcomes in relation to geographic location.
Results: Of the 2,213 studies identified, 47 studies were included revealing three key groups of outcomes: mortality (n = 35), other in-hospital outcomes (n = 8); and recovery-focused outcomes (n = 12). A variety of measures were used to classify rurality across studies with inconsistent definitions of rurality/remoteness. Of the studies reporting injury-related mortality, findings suggest that there is a greater risk of fatality in rural areas overall and in the pre-hospital phase. For those patients that survived to hospital, the majority of studies included identified no difference in mortality between rural and urban patient groups. In the small number of studies that reported other in-hospital and recovery outcomes no consistent trends were identified.
Conclusion: Rural patients had a higher overall and pre-hospital mortality following injury. However, once admitted to hospital, there was no significant difference in mortality. Inconsistencies were noted across measures of rurality measures highlighting the need for more specific and consistent international classification methods. Given the paucity of data on the impact of geography on non-mortality outcomes, there is a clear need to develop a larger evidence base on regional variation in recovery following injury to inform the optimisation of post-discharge care services.

Contents

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Introduction

Regionalised trauma systems (RTS) are widely recognised as best-practice in trauma care, with the establishment of these systems shown to improve survival rates [1–4] and longer term functional outcomes [5,6] following serious injury. These systems involve the implementation of processes to ensure timely transport of seriously injured patients to specialised trauma centres with appropriately trained staff and expertise to manage these complex patients [3,7]. As a result of these advances and the reduced risk of dying from injury, understanding patterns of recovery following serious injury, and decreasing the injury burden from non-fatal outcomes has become a key area for research and health policy development [4,6].

Globally, injury incidence has been noted to be higher in regional and remote areas relative to urban areas [8–10]. There is also evidence to suggest that fatality rates are higher in regional and remote areas [11–18]. However, no published reviews were located that compared outcomes between geographic locations. This is particularly important due to the complexities of providing appropriate and timely acute and rehabilitation care of trauma patients in outer urban, regional and remote areas to ensure adequate and equitable provision of care in these areas.

For survivors of serious injury, resource and health care service utilisation is complex, long term and expensive [19]. Research has shown that patterns of recovery are prolonged in nature with 80% of survivors experiencing functional limitations at one-year post injury [5] and continue to report ongoing problems with mobility, pain, usual care and anxiety/depression at three years post injury [20]. Both the World Health Organization (WHO) and the American College of Surgeons-COmmittee on Trauma (ACS-COT) have recognised that best practice of an injured individual in a RTS requires coordinated efforts along the entire patient pathway from pre-hospital care through to rehabilitation, and community re-integration to optimise outcomes [21,22].

A potential limitation of regionalised trauma systems is the centralisation of major trauma resources and expertise in metropolitan areas [23–25], particularly in relation to rehabilitation [26]. In Australia, approximately 35% of patients hospitalised as a result of injury reside in regional and remote areas [27]. It is important to acknowledge that interventions designed to reduce injury-related mortality have not changed the rate of hospitalisations following injury [27] and there remains a significant knowledge gap in understanding the regional variations in hospital and post-discharge outcomes following serious injury. Therefore, the aim of this study was to review the evidence exploring the association between the geographic location, including both location of the event and place of residence, and outcomes following injury.

Materials and methods

A scoping review was undertaken to provide new perspectives and inform research in the area of outcomes following injury. The design of this review was guided by the scoping review framework developed by Arksey and O'Malley [28] and refined by more recent publications [29,30]. Steps included formulating a research question; identifying relevant studies for review; selecting relevant literature to be synthesized; charting data to identify key themes and concepts and collating and summarising the findings.

Identification of relevant studies

A systematic search strategy which included a combination of controlled vocabulary (MeSH) and free text terms was formulated to identify relevant peer-reviewed studies published up until October 2018 (Supplementary Material). The search strategy was reviewed by and conducted in association with a senior librarian who verified the methodology. The search was conducted in the following electronic databases on 24 October 2018: MEDLINE, Embase, Scopus, Web of Science and CINAHL. PubMed was also searched for articles published between January 1 2018 – October 24, 2018 to capture those not yet indexed with MeSH headings and therefore not identified with Ovid Medline. Google Scholar was searched to identify any additional peer-reviewed literature not found in other databases with the first 100 results reviewed. Forward citation searching of included studies was also carried out using Google Scholar as well as backward citation searches via reference lists of the included articles. Results were screened on title and abstract, with those remaining undergoing full-text review.

Selection of literature to be synthesized

All mechanisms of unintentional traumatic injury were included in this review. Studies were included if they measured injury-related mortality, outcomes associated with hospital admission, and physical or psychological function following injury. To be included in this review studies were required to analyse these outcomes in relation to geographic location, reporting both a rural and urban cohort. Injury-related mortality studies were included if they specified statistics relating to overall mortality, pre-hospital mortality or in-hospital mortality. In-hospital mortality was defined as mortality occurring between presentation to an emergency department through to hospital discharge and also included 30-day mortality outcomes. Longer-term outcomes relating to patients' recovery included, but were not limited to, measures of psychological and physical function, return to work, and health-related quality of life.

Studies were excluded if the primary outcome of interest was in relation to healthcare utilisation, trauma systems, resource organisation, transfer time, injury or injury-mortality risk explanatory factors, injury incidence or injury hospitalisation rates or Emergency Department presentations. Editorial or commentary pieces were excluded but otherwise there were no restrictions on design or type of study included. Research that were solely based on self-reported injury surveys as the outcome measure were excluded, as were those including only children (aged 15 years of age or under) or not published in English.

Data describing the study demographic, statistics and outcome measures reported, rurality classification methods and whether rurality was classified by place of residence or place of injury in the included studies were extracted. Data were summarised in Microsoft Excel to identify key outcomes explored in the literature. This enabled the sorting of studies geographically, and according to

primary outcome investigated. Due to the heterogeneity of the literature in this field, a qualitative synthesis of outcomes according to key themes and concepts identified was conducted.

Results

Our search strategy yielded 2213 non-duplicate articles, of which 2114 were excluded after screening of titles and abstracts. A total of 99 papers underwent full-text review, of which 52 were excluded (see Fig. 1). The 47 included studies were classified into three key groups of outcomes: mortality (n = 35), other in-hospital outcomes (n = 8); and recovery-focused outcomes (n = 12). In-hospital mortality was reported within mortality outcomes. Other in-hospital outcomes were reported separately and included hospital length of stay, intensive care unit (ICU) length of stay, ICU admission and 28-day re-admission rates.

Study characteristics

Countries of origin included United States of America (USA) (n = 19), Australia (n = 9), Canada (n = 5), Scotland (n = 2), Taiwan (n = 3), China (n = 2), Norway (n = 1), South Africa (n = 1), Ireland (n = 1), Finland (n = 1), Sweden (n = 1), Sudan (n = 1) and Guyana (n = 1). Of the studies reporting pre-hospital and in-hospital outcomes (n = 35), geographic status was classified similarly by place of injury event (n = 17) and place of usual residence (n = 18). For studies reporting long-term outcomes, geographic status was classified more commonly by place of usual residence (n = 9), compared to place of injury (n = 2). Most studies included cases of all ages (n = 28) or only adults (n = 15). Two studies focused on adolescents [35,36] and two on older adults (≥ 65 years of age) [37,38].

All studies included in this review had large sample sizes that were representative their target populations, limiting the risk of selection bias. The number of participants ranged from 275 to 883,473 participants in mortality studies, 412 to 256,536 participants in hospital related outcome studies, and 78 to 34,933 participants in studies on recovery outcomes. These studies also utilised outcome measures that were reliable, valid and relevant to the constructs being measured. As all studies were retrospective cohort studies, important methodological factors must be considered due to the impact of potential biases. Retrospective studies may result in poorer quality of results due an inability to control for potential risk factors that may have influenced the outcome if this information was not collected with the data collection. Further information on confounding factors addressed in specific papers are reported within each outcome group. Whilst adjustment for potential confounding factors in statistical analyses was variable, outcomes measured were relevant to the constructs being assessed.

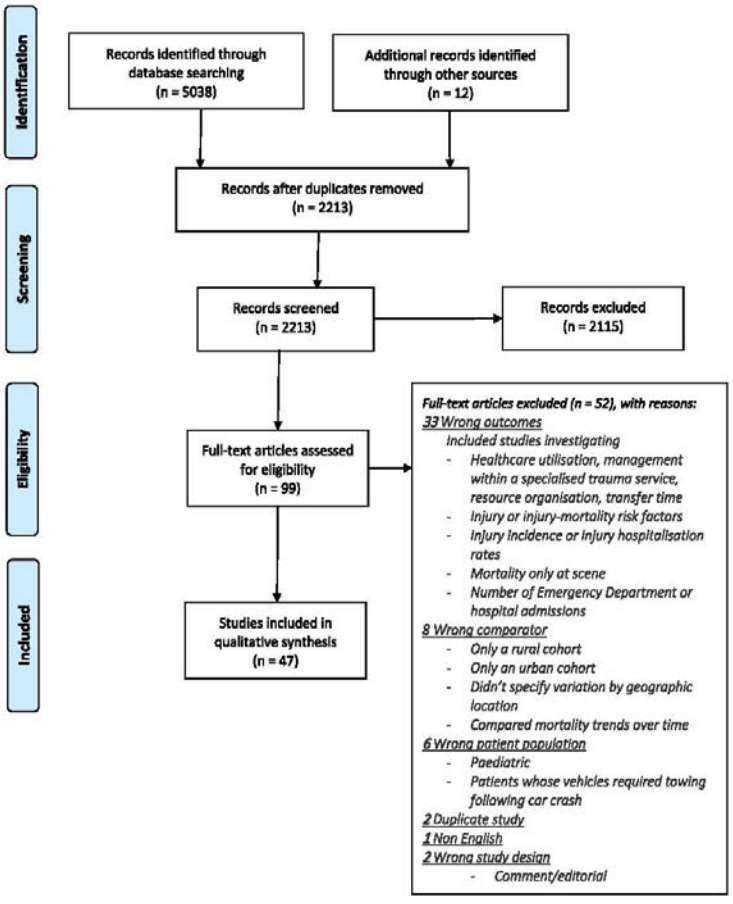

Fig. 1. Systematic Citation Review Process.

A variety of measures were used to classify rurality (Table 1). Population density was the most common measure (n = 11). There was inconsistency however between studies using this measure in definitions considered to be rural. For example, one study from the USA [31] considered the most rural group to be counties with a population < 25,000. In contrast, a Norwegian study [32] described the most rural group as counties with less than 9 people per square kilometre while a Scottish study [33] classified the most rural district as those with less than 0.5 people per acre. The most consistent use of a rurality classification system was reflected in the Australian studies in which 75% referenced the Australian Statistical Geographical Standard Remoteness Area (ASGS RA) Classification [34] using the Accessibility Remoteness Index of Australia extended (ARIA+) value index to classify the degree of rurality. This index provides a geographical approach to classifying remoteness based on distance to service centres (populated localities). Other commonly used measures in the USA were the Rural-Urban Continuum Codes and Urban Influence Codes. These classify metropolitan counties by the population size and non-metropolitan counties by either the degree of urbanization and proximity to metropolitan areas.

Most studies included cases of all ages (n = 28) or only adults (n = 15). Two studies focused on adolescents [35,36] and two on older adults (≥ 65 years of age) [37,38].

Mortality outcomes

Of the studies which presented overall mortality statistics (n = 29), 93% (n = 27) reported statistically significantly higher mortality outcomes for those injured in rural areas or for rural residents (Table 2; for expanded tables with additional details such as full results, confounding factors adjusted for, data sources and classification methods see Supplementary Material). Statistical measures reported in the studies reviewed included Standardised Mortality Rate (SMR), injury-mortality rates, rate ratios, odds ratios (OR) and the proportion of fatalities that were patients from rural compared to urban areas. Of the studies that reported overall mortality rates (n = 20), there was variability in the denominators and adjustments for confounding factors, as well as populations studied, making direct comparison of studies difficult. Overall mortality was reported with the SMR (per 100,000), using population-based estimates as the denominator, in 12 studies.

One South African study reported the age-SMR to be significantly higher in the urban province for unintentional (non-transport) injury-related mortality, which included mechanisms of injury such as burns, drowning, falls and poisoning [39]. However, when the data were analysed for transport-related injury mortality, the age-SMR was significantly higher in the rural group [39].

Among studies which investigated pre-hospital mortality (n = 8), all reported significantly higher rates or likelihood of fatality in the rural groups, whether rurality was classified by place of injury or place of residence. The risk of pre-hospital fatality was reported as twice as likely in the rural group [40,41] with one study finding the likelihood of death-at-scene as five times greater for patients involved in a rural motor vehicle crash [42].

Only one of the 10 studies reporting in-hospital mortality found higher 30-day mortality rates for rural patients hospitalised for fall-related injuries [38]. Of the remaining studies, there was either lower in-hospital mortality for rural patients or no difference between urban and rural groups.

Table 1
Commonly Referenced Rural-Urban Classification Measures.

Classification Scale	Country	Description
Population Density [1]	Global	Measure of urbanization defined in scale, based on a distribution of population in an area of interest. Typically calculated as resident population of a land area as listed in a census and divided by the size of land area.
Australian Statistical Geographical Standard – Remoteness Area (ASGS RA) [2]	Australia	Geographical classification based on relative access to services and defined by ARIA + index values which measure remoteness of a point based on the physical road distance to the nearest urban centre (defined as a population cluster of 1000 or more people). 5-level scale; 'Major Cities', 'Inner Regional', 'Outer Regional', 'Remote' and 'Very Remote'. ARIA + is an extended version of previously used ARIA methodology.
Urban Influence Codes [1,3]	USA	12-level system. County-level, 2 metropolitan and 10 nonmetropolitan codes. Distinguishes metropolitan by population size of metro area, and nonmetropolitan by size of the largest city or town and proximity to metro and micropolitan areas.
Rural-Urban Continuum Codes [1]	USA	9-level scale; County-level. Takes into account adjacency to a larger economy but does not consider the large or small size of the adjacent area in their definition for non-core areas. Counts the entire urban population (as defined in the Census) within the county, rather than the city or town of largest size.
U.S Census Bureau Tracts [4]	USA	Census block level; To qualify as an urban area, the territory identified according to criteria must encompass at least 2500 people, at least 1500 of which reside outside institutional group quarters. "Rural" encompasses all population, housing, and territory not included within an urban area. Does not have stable boundaries over different Census years.
Office of Management and Budget (OMB) [5]	USA	Metropolitan Area (MA) and Non-Metropolitan Area (Non-MA) counties. MA = 1) at least one central county with a minimum population of 50,000 or a Census Bureau defined urbanized area and a total population of at least 100, 000; and 2) one or more outlying counties that have close economic and social relationships with the central county.
National Centre for Health Statistics (NCHS) Rural-Urban Classification [5]	USA	County-level; 6-level system: 4 metropolitan (large central metro, large fringe metro, medium metro, and small metro) and 2 nonmetropolitan (micropolitan and noncore). Based on population range and OMB delineation of metropolitan and micropolitan statistical areas.
Metropolitan Influence Zones, Canada [6]	Canada	The MIZ classification reflects the relative influence of an urban centre on a rural area. This classification system is applied at the census subdivision level and disaggregates non-Census Metropolitan Areas/Census Agglomerations (CMA/CAs)* into four zones of metropolitan influence (Strong MIZ, Moderate MIZ, Weak MIZ, No MIZ), primarily defined on the basis of commuting flows of the employed labour force to and from CMAs/CA.

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Table 2
Mortality Outcomes - Rural Vs Urban.

Better outcomes for rural patients
No difference in outcomes
Worse outcomes for rural patients

Country	Author(s)	Mortality Outcome	Measures reported/Denominator	Population Studied	Age (years)	n	Rurality Classification	Rurality Classified By
USA	Baker et al. 1987 [7]	Overall	MVC mortality rates per 100,000 population (denominator = US population estimates)	All injury-related fatalities from MVC in USA	All ages	127,110	Population density	Residence
	Beck et al. 2017 [8]	Overall	Age-adjusted MVC mortality rates per 100,000 population (denominator = US population estimates)	Passenger-vehicle-occupant deaths from MVCs	≥ 18	19,528	RUCC	Injury
	Brown et al. 2000 [9]	Overall	MVC mortality rates per 100,000 population(denominator = US population estimates)	All injury-related fatalities from MVC in USA	All ages	875,405	U.S. Census Bureau	Injury
		Pre-Hospital	Death at scene rate per 100,000 population using (denominator = US population estimates)	All deaths-at-scene following MVC		329,767		
	Clark et al. 2001[10]	Overall	Traffic fatality rates of elderly population per 100,000 people by quartiles of US county population density (denominator = population of US counties)	Elderly fatalities within 30 days of injury from a MVC	≥ 65	32,064	Other country specific	Injury
	Donaldson et al. 2006 [11]	Overall	Adjusted OR	All reported MVCs occurring on public roads in Utah that either resulted in passenger injury or had at least $1000 in property damage	All ages	514,648	RUCC	Injury
	Gabella et al. 1997 [12]	Overall	Age-adjusted mortality rate from TBI per 100,000 population and (denominator = US population estimates) and rate ratios	All TBI mortality cases in Colorado, involving Colorado residents	All ages	1312	U.S Census Bureau	Residence
		Pre-hospital	Age-adjusted mortality rate from TBI per 100,000 population (denominator = US population estimates) and rate ratios	All TBI mortality cases in Colorado where place of death was not 'inpatient'		855		
	McCowan et al. 2007 [13]	In-hospital	Adjusted OR	Patients transported to hospital by HEMS following blunt trauma	≥ 15	411	Population density	Injury
	Muelleman et al. 2007 [14]	Overall	OR	All fatal or injury-related MVC mortality (Nebraska)	All ages	225	UIC	Injury
		Pre-Hospital	OR	All MVC mortality-at-scene (Nebraska)		64		
	Newgard et al. 2017 [15]	Overall	% fatal injuries	Injured patients transported by 44 EMS agencies to 28 hospitals in Oregon and Washington	All ages	17, 633	Other country specific	Injury
		Pre-Hospital	% out-of-hospital deaths	Out-of-hospital deaths following injury recorded by EMS agencies (Oregon & Washington)		612		
	Peek-Asa et al. 2004 [16]	Overall	Age-adjusted mortality rates by urbanization level (per 100,000) using denominator of US county population	All unintentional traumatic injury captured by National Center for Health Statistics in the USA	All ages	Not stated	Other country specific	Residence
	Peura et al. 2015 [17]	Overall	Adjusted OR	All police-reported fatal MVC in 11 states of USA	All ages	26,582	RUCC	Injury
	Sihler et al. 2009 [18]	In-hospital	OR	Hospital admissions following traumatic injury	All ages	34,933	UIC	Injury

	Travis et al. 2012 [19]	Overall	Adjusted OR	Police-reported MVC resulting in injury	All ages	883,473	RUCC	Residence
	Zwerling et al. 2005 [20]	Overall	Injury fatality rate (per 1000 crashes with injury) in USA; Denominator = total crashes with injuries	All fatal and injury-related fatalities from MVC	≥ 16	53,049	Population density	Injury
AUSTRALIA	Chen et al. 2010 [21]	Overall	Fatality rate per 10,000 drivers (denominator = all licensed drivers) and relative risk	Police-recorded passenger vehicle crashes (NSW)	17-25	644	ASGS RA	Residence
	Fatovich et al. 2009 [22]	Overall	Age-SMR (per 100,000 PY): Denominator = Person-time at risk from all deaths	All trauma related deaths (WA)	All ages	101,425	ASGS RA	Injury
	Fatovich et al. 2011 [23]	Overall	OR mortality	All major trauma patients, ISS > 15 (WA)	All ages	3,333	ASGS RA	Injury
		In-hospital	OR mortality if survive to metro hospital admission	Major trauma patients (ISS > 15) who survive transport to Perth by RFDS				
	Mitchell & Chong 2010 [24]	Overall	Age- and gender-SMR (per 100,000); Denominator = age- and sex-specific population estimates	Injury-related mortality for NSW residents	All ages	11,577	ASGS RA	Residence
	Sukumar et al. 2016 [25]	In-hospital	30-day mortality rate adjusted for age, sex & comorbidities (denominator = all falls-related hospital admissions) and relative risk	All falls-related hospital admissions (NSW)	≥ 65	256,536	ASGS RA	Residence
CANADA	Bell et al. 2012 [26]	Overall	Age-standardized rate ratios	All transport-related pre-hospital, in-transport and in-hospital deaths in BC with ISS > 12	≥ 18	1,851	Population density	Residence
	Gomez et al. 2010 [27]	Pre-Hospital	Relative risk (OR)	Trauma-related deaths occurring prior to ED	All ages	1,877	Other country specific	Injury
		In-hospital	% deaths in-hospital	All trauma-related in-hospital deaths if survived to ED		1,609		
	Lagace et al. 2007 [28]	Overall	Age-adjusted standardised mortality ratios; Denominator = population estimates	All injury related MVC deaths	All ages	Not stated	ASGS RA (Aus); MIZ (Canada)	Residence
	Simons et al. 2010 [29]	Overall	Age- and sex-adjusted SMR for trauma-related deaths; Denominator = population estimates	All trauma related deaths (BC)	All ages	Not stated	Rural = NW BC; Urban = Vancouver Coastal Health Authority	Residence
		Pre-Hospital	% pre-hospital deaths	All trauma-related pre-hospital deaths (BC)				
		In-hospital	% in-hospital deaths	All injury related in-hospital deaths (BC)				
CHINA	Hu et al. 2010 [30]	Overall	Age- and gender- injury mortality rates (per 100,000); Denominator = deaths recorded in Chinese Death Registry	Injury-related deaths in China	All ages	~10% population	Population density	Residence
	Liu et al. 2012 [31]	Overall	Age- adjusted injury mortality rates (per 100,000); Denominator = population estimates and rate ratios	Injury-related deaths (Hubei Province)	All ages	9714	Other country specific	Residence
SCOTLAND	McGuffie et al. 2005 [32]	In-hospital	% injury-related deaths	All patients arrived to hospital with moderate or major injuries (ISS ≥ 8)	All ages	4,636	Population density	Injury
	Williams et al. 1991 [33]	Overall	Gender-SMRs (Denominator = Census population estimates)	Mortality from MVC in Scotland	All ages	6,643	Population density	Residence
IRELAND	Boland et al. 2005 [34]	Overall	SMR (per 100,000); Denominator = Census population estimates	All unintentional injury deaths in Ireland	All ages	18,185	Other country specific	Residence
SWEDEN	Gedeborg et al. 2010 [35]	Pre-Hospital	Morality rate per 100,000 PY (denominator = person-time at risk from population estimates) and adjusted OR	Pre-hospital injury-related deaths from MVC in Sweden	All ages	3,107	Population density	Residence

		In-hospital	Morality rate (per 100,000 PY); Adjusted OR	Death from MVC where the patient was a vehicle occupant with serious injuries and hospitalised > 1 day		832		
TAIWAN	Huang et al. 2017 [36]	In-hospital	Adjusted OR and % mortality	Hospital admissions for accidental falls in Taiwanese databases	≥ 65	9,438	Rural = Yilan County; Non-rural = other Taiwan	Residence
NORWAY	Kristiansen et al. 2014 [37]	Overall	Annual mortality rate (per 100,000); Denominator = Census population estimates	All injury-related deaths in Norway	16-66	8,466	Population density	Residence
		Pre-Hospital	% pre-hospital deaths	All injury-related pre-hospital deaths in Norway		6,589		
GUYANA	McWade et al. 2016 [38]	Overall	Mortality OR	Fatal MVC identified by police reports in Guyana	All ages	275	Not stated	Injury
SUDAN	Abdalla et al [39]	Overall	Age and gender adjusted SMR (per 100,000); Denominator = Census population estimates	All cause injury related mortality	≥ 5	~33,400	Other country specific	Injury
FINLAND	Raatiniemi et al. 2015 [40]	In-hospital	30-day mortality OR	All major trauma (ISS > 15) patients survived to hospital admission	All ages	472	Other country specific	Injury
SOUTH AFRICA	Sherriff et al. 2015 [41]	Overall	Age-SMR per 100,000 and RR; Denominator = population estimates	Unintentional (non-transport) injury-related mortality	All ages	17,289	Urban province = Gauteng; Rural province = Mpumalanga	Injury
		Overall	Age-SMR per 100,000 and RR; Denominator = population estimates.	Transport related injury mortality				

RUCC = Rural-Urban Continuum Codes; UIC = Urban Influence Codes; ASGS RA = Australian Statistical Geographical Standard Remoteness Area; ARIA = Accessibility/Remoteness Index of Australia; MIZ = Metropolitan influence Zones; SMR = Standardised Mortality Rate; NW BC = North West British Colombia; MVC = Motor Vehicle Crash; OR = Odds ratio; RFDS = Royal Flying Doctor Service; NSW = New South Wales; ED = Emergency Department

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[41] Sherriff B, MacKenzie S, Swart LA, Seedat MA, Bangdiwala SI, Ngude R. A comparison of urban-rural injury mortality rates across two South African provinces, 2007. International journal of injury control and safety promotion 2015;22(1):75-85.

Of all studies reporting mortality outcomes (n = 35), ten did not adjust for any potential confounding factors [13,15,32,33,41,43–47]. A number of papers adjusted for age (n = 8) [11,12,17,39,48–51]; age and gender (n = 5) [9,14,18,52,53]; and age, gender and injury severity (n = 3) [40,54,55]. One study adjusted for age and injury severity [56]. Nine studies adjusted for age as well as three or more additional confounders including injury severity, speed, time of day, comorbidities, socioeconomic status, time to first responder input and alcohol [37,38,40,42,57–61] (see Supplementary Material Table 1 for specific details).

In summary, despite variation in the mortality statistics reported, a significantly higher risk of mortality was reported for rural populations and this was particularly notable in regards to pre-hospital mortality statistics.

Other in-hospital outcomes

Eight studies reported in-hospital outcomes other than mortality (Table 3; for expanded tables with additional details such as full results, confounders adjusted for, data sources and classification methods see Supplementary Material). Hospital length of stay was the most commonly reported hospital-related outcome (n = 7); two studies found that rural patients experienced longer hospital stays [35,58], three studies found no differences between groups [33,54,62], and three studies reported a shorter hospital length of stay for rural residents [38,62,63]. Sukumar and colleagues [38] investigated patients older than 65 years, who were hospitalised for fall-related injuries, and found that although the hospital length of stay was shorter for rural residents, this group had a higher 28-day hospital readmission rate. Within studies that investigated other in-hospital outcomes there was little consistency in findings regarding geographic variation.

Two studies reporting in-hospital outcomes did not state whether confounders had been adjusted for [35,62], one study adjusted for age only [63] and five studies adjusted for age and other potential confounding factors [33,38,54,56,58] (see Supplementary Material Table 2 for full details).

Recovery outcomes

Twelve studies were identified which reported outcomes relating to recovery following injury (see Table 4; for expanded tables with additional details such as full results, data sources and classification methods see Supplementary Material). A wide variety of outcome measures, assessing a number of constructs, were captured at differing time points ranging from hospital discharge [35,55,64] to four years following injury [65]. Half of these studies reporting recovery outcomes did not adjust for confounders or did not state whether this was done [35,62,64,66–68]. Of the other six studies, various confounding factors were taken into consideration in the results including age, gender, occupation and post-traumatic amnesia [55,65,69–72] (see Supplementary Material Table 3 for full details).

All three studies which reported on disability at hospital discharge found poorer outcomes for rural patients [35,55,64], despite studying different populations. When patients were assessed at least 12 months following injury, no significant differences between rural and urban groups were found in seven of nine studies [62,65,66,68–71]. The two studies reporting worse post-discharge outcomes for rural patients included patients with traumatic brain injury (TBI); one dichotomised the Disability Rating Scale (DRS) into fully independent or dependent and found that a greater proportion of rural patients were dependent compared to urban counterparts [67], and the other reported rural patients to have significantly higher mental health illness and reduced social participation levels following brain injury [73]. Notably, two-thirds of the studies (n = 8) which investigated recovery outcomes in specific groups of injured patients such as TBI [62,64,66,67,69,69,70,71,73] and spinal cord injury (SCI) [62]. Two studies included all mechanisms of injury [55,65], however, only one of these explored outcomes beyond hospital discharge, and only included patients who required outpatient rehabilitation services [65].

Discussion

The aim of this review was to explore the association between geographic location and outcomes following injury. Most of the included studies focused on injury-related mortality outcomes, particularly in relation to road trauma, with a small number of studies also reporting other hospital-related and recovery outcomes. Our findings suggest that there is a greater risk of fatality in rural areas overall and in the pre-hospital phase. However, if the patient survives to hospital admission, rurality appeared to be less relevant to in-hospital mortality. In the small number of studies that reported outcomes other than mortality, the results did not conclusively suggest that rural patients experienced more or less favourable outcomes than the urban group. Within these studies however, a key finding that affected the interpretation of our results was the inconsistency and variability in the measurement and statistical reporting of outcomes, limiting the comparability between studies.

The papers included in this review suggest that geographic location may have an impact on injury mortality. The overall mortality findings of this study were consistent with general Australian population data which reported that between 2012-13 there was an increased age-standardised injury death rate with increasing remoteness [74]. Explanatory factors proposed for the increased mortality in rural areas following serious injury have included greater injury incidence, injury severity, longer emergency services response times and distance to health services, particularly specialised trauma centres [15,41,75]. Most recently, it was shown that distance to the nearest trauma centre was associated with an 8% increase in odds of death for every five-mile increase in distance, in addition to the effect of increased pre-hospital time [76]. Crash characteristics including high-speed collisions, head-on collisions, collisions involving a single vehicle with a stationery object, increased alcohol use, greater involvement of trucks and reduced occupant restraint use [16,43,77] have also been more commonly attributed to collisions in rural environments and potentially contribute to the increased risk of death in rural areas following injury, especially in the pre-hospital phase.

Our findings have highlighted the paucity of literature available and variable conclusions on the impact of geographic location on non-mortality hospital related outcomes. Inconsistency in findings

Table 3
Other in-hospital outcomes - Urban Vs Rural.

Country	Author(s)	Measures reported	Population Studied	Age (years)	n	Rurality Classification	Rurality Classified By
AUSTRALIA	Fatovich et al. 2011 [23]	Hospital LOS, ICU admission and ICU LOS	Patients admitted to metropolitan trauma centre following major trauma (ISS > 15)	All ages	3,333	ASGS RA	Injury
	Mitchell & Lower 2018 [65]	Hospital LOS and 28-day readmission	Patients in NSW admitted to hospital following injury	All ages	709,464	ASGS RA	Residence
	Sukumar et al. 2016 [25]	28 day re-admission	Fall-related injury hospitalisations in rural vs urban elderly populations	≥ 65	256,536	ASGS RA dichotomised	Residence
		Hospital LOS					
FINLAND	Raatiniemi et al. 2015 [40]	ICU LOS	Major trauma (ISS > 15) patients survived to hospital admission	All ages	472	Other country specific	Injury
USA	Mazurek, M.O. et al. 2011 [42]	SCI/TBI acute hospital LOS and TBI rehabilitation hospital LOS.	TBI/SCI patients enrolled in the Missouri Model SCI System and Missouri Model TBI System databases	≥ 18	152 TBI; 149 SCI	Population	Residence
		SCI rehabilitation hospital LOS					
	McCowan et al. 2007 [13]	Hospital LOS	Patients transported by HEMS following blunt trauma	≥ 15	412	Population density	Injury
TAIWAN	Chiang et al. 2006 [43]	Hospital LOS	Head injured adolescents in Taiwan with inpatient hospital stay	13-18	600	Other country specific	Injury
SCOTLAND	McGuffie et al. 2005 [32]	Hospital LOS and ICU LOS	All moderate and major trauma patients (ISS > 8) admitted to hospital for more than two days	All ages	4,636	Population density	Injury

Better outcomes for rural patients
No difference
Worse outcomes for rural patients

TBI: traumatic brain injury; SCI = spinal cord injury; LOS= length of stay; ASGS RA = Australian Statistical Geographical Standard Remoteness Area

[13] McCowan CL, Swanson ER, Thomas F, Handrahan DL. Outcomes of blunt trauma victims transported by hems from rural and urban scenes. Prehospital Emergency Care 2007;11(4):383-8.
[23] Fatovich DM, Phillips M, Langford SA, Jacobs IG. A comparison of metropolitan vs rural major trauma in Western Australia. Resuscitation 2011;82(7):886-90.
[25] Sukumar DW, Harvey LA, Mitchell RJ, Close JCT. The impact of geographical location on trends in hospitalisation rates and outcomes for fall-related injuries in older people. Australian and New Zealand Journal of Public Health 2016;40(4):342-8.
[32] McGuffie AC, Graham CA, Beard D, Henry JM, Fitzpatrick MO, Wilkie SC, et al. Scottish urban versus rural trauma outcome study. J Trauma 2005;59(3):632-8.
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[42] Mazurek MO, Johnstone B, Hagglund K, Mokelke E, Lammy A, Yamato Y. Geographic differences in traumatic brain injury and spinal cord injury rehabilitation. International Journal of Therapy and Rehabilitation 2011;18(10):551-6.
[43]Chiang MF, Chiu WT, Chao HJ, Chen WL, Chu SF, Chen SJ, et al. Head injuries in adolescents in Taiwan: a comparison between urban and rural groups. Surgical Neurology 2006;66(SUPPL. 2):S14-S9.

between studies reporting hospital length of stay may reflect the wide variation in methodology used [33,35,38,54,58]. A longer hospital length of stay was reported for rural patients in the studies that involved major trauma (ISS > 15) [58] and TBI populations [35]. This finding may be due to limited availability and access of inpatient rehabilitation or outpatient services required to facilitate discharge for more complex patients, resulting longer inpatient hospital stays for rural patients. Additionally, challenging home environments or a lack of alternate and accessible accommodation options may also create barriers for early hospital discharge as opposed to a patient in a metropolitan area who may have access to a wider range and number of services after discharge.

Traumatic injury is difficult to manage and effectively study due to the heterogeneity of the condition and the disparities that arise due to how the injured patient interacts with their social environment and health care system [78]. However, the management of an injured patient within a trauma system should involve coordinated efforts along the entire patient pathway from pre-hospital care to rehabilitation and community reintegration, to optimise outcomes [21,22]. Understanding potential disparity across distinct phases of trauma systems is important to ensure processes and interventions adequately meet patients' needs across the continuum of care [78]. In this review, studies measuring functional status at hospital discharge reported poorer outcomes for rural patients. However, at 12 months or more following injury there was minimal difference in outcomes between rural and urban patients. Of the studies that investigated outcomes beyond hospital discharge, the majority focussed on TBI [35,62,66,67,69–71,73] and spinal cord injury (SCI) [62] with only one study reporting longer term outcomes following all injuries [65] and one that was limited to patients following bone fracture due to workplace injury [72]. Despite being multi-site studies, all of the TBI/SCI cohorts investigated were sampled from well-established brain or spinal cord injury rehabilitation programs. This may represent a sample of patients who received a high standard of initial and follow-up care from specialised healthcare services. The fact that these groups have been investigated more frequently is also a reflection of the ongoing involvement they have with health professionals, and the availability of specific services to manage this population over longer periods following injury.

Given that the concept of geographic location or place is inextricably linked to the social determinants of health [79] it is also important to appreciate that factors such as socio-economic status, environmental factors, access to health services, risk-taking behaviours and in the case of traumatic injury, insurance status, are all likely to be contributing an individual's recovery following injury [78]. Whilst some studies have controlled for these potential confounders using multivariable analysis to isolate rurality or place as the primary variable of interest, where not controlled for, these factors can bias results. Due to the heterogeneity of populations studied and the paucity of the literature, it is unclear whether geographic location is a significant factor that impacts on long-term health outcomes following injury.

An important limitation of the literature included in review was the heterogeneity of the measures used to determine the degree of rurality in study populations. To understand the relationship

Table 4
Recovery outcomes - Rural vs Urban.

Country	Author (s)	Measures Reported	Population Studied	Time Post-Injury	Age (years)	n	Rurality Classification	Rurality Classified By
USA	Gontkovsky et al. 2006 [44]	Disability (DRS); Medical Complications	Patients admitted for TBI inpatient rehabilitation (single site)	12 months	≥16	111	Other country specific	Residence
	Johnstone et al. 2003 [45]	Successful employment; financials spent in vocational rehab	Patient with TBI who sought vocational rehabilitation services in Missouri	Mean = 9 years	18-57	78	Other country specific	Residence
	Mazurek et al. 2011 [42]	Disability (FIM), QoL (SWLS), alcohol use	Missouri Model SCI System and Missouri Model TBI System databases	12 months	≥ 18	152 TBI; 149 SCI	Population	Residence
	Schootman M et al. 1999 [46]	Disability (DRS dichotomised)	TBI patients recruited from Iowa Central Registry	12-18 months	≥ 18	292	Population density	Residence
	Sihler et al. 2009 [18]	Disability (FIM)	Patients admitted to hospital for injuries from 904 hospitals in the US	Hospital Discharge	All ages	34,933	UIC	Injury
	Young et al. 2008 [47]	Work disability -time off work (days) in 2yrs following injury; OR likelihood of being off work > 1 week	Injured workers seeking compensation for fracture from a USA insurance company (8-10% of US workers' compensation claims)	24 months	Working age	5,618	Population density	Residence
AUSTRALIA	Harradine et al. 2004 [48]	Disability (DRS); Acaptability (MPAI), Psychosocial Reintegration (SPRS), Medical outcomes (MOS-SF), General health (GHQ)	Patients referred to NSW BIRP (11 sites) with severe TBI (as measured by post traumatic amnesia (PTA) ≥ 1 day, and/or a Glasgow Coma Scale ≤ 8).	18 months	18-65	198	ARIA	Residence
	Ponsford et al. 2010 [49]	SOQ, GOS E, SIP, CHART, Alcohol use, Anxiety & depression (HADS), Drug abuse (DAST)	TBI patients admitted to metropolitan (single site) inpatient rehabilitation	24 months	≥ 18	959	Other country specific	Residence
	Simpson et al. 2016 [50]	Mental Health (HONOS ABI), Social participation (SPRS-2)	Patients referred to NSW BIRP (11 sites) with severe TBI (as measured by PTA ≥ 1 day, and/or a Glasgow Coma Scale ≤ 8).	24 months	18-65	508	ASGS RA	Residence
		Disability (DRS), Challenging behaviours (ORS), Care needs (CANS)						
TAIWAN	Chiang et al. 2006 [43]	Disability (GOS)	Patients hospitalised following TBI in a rural and urban Taiwanese county	Hospital Discharge	13-18	600	Other country specific	Injury
	Kuo et al. 2017 [51]	Disability (GOS)	Cyclists admitted to hospital with a traumatic brain injury	Hospital Discharge	All ages	812	Other country specific	Injury
CANADA	Sirois et al. 2009 [52]	Physical health (aSF12), Disability (FIM)	Trauma patients admitted to level I/II trauma centres in Quebec requiring rehabilitation following hospital discharge.	24-48 months	18-65	485	Other country specific	Residence

Better outcomes for rural patients
No difference
Worse outcomes for rural patients

GOS (E) = Glasgow Outcome Scale (Extended); DRS = Disability Rating Scale; FIM = Functional Independence Measure; MPAI = Mayo-Portland Adaptability Index; GHQ = General Health Questionnaire; MOS = Medical Outcomes Scale; SPRS (-2) = Sydney Psychological Reintegration Scale (-2); QoL = Quality of Life; HADS = Hospital Anxiety and Depression Scale; AUDIT = Alcohol Use Disorders Identification Test; SWLS = Satisfaction With Life Scale; CHART = Craig Handicap Assessment and Reporting Technique; DAST = Drug Abuse Screening Test; CANS = Care and Needs Scale; HONOS-ABI = Health of the Nation Outcome Scale-Acquired Brain Injury; aSF12 = Adjusted Short Form 12; TBI = Traumatic Brain Injury; ISS = Injury Severity Scale; SOQ = Structured Outcome Questionnaire; UIC = Urban Influence Codes; ASGS RA = Australian Statistical Geographical Standard Remoteness Area; ARIA = Accessibility/Remoteness Index of Australia; BIRP = Brain Injury Rehabilitation Program

[18] Sihler KC, Hemmila MR. Injuries in nonurban areas are associated with increased disability at hospital discharge. 2009.
[42] Mazurek MO, Johnstone B, Hagglund K, Mokelke E, Lammy A, Yamato Y. Geographic differences in traumatic brain injury and spinal cord injury rehabilitation. International Journal of Therapy and Rehabilitation 2011;18(10):551-6.
[43]Chiang MF, Chiu WT, Chao HJ, Chen WL, Chu SF, Chen SJ, et al. Head injuries in adolescents in Taiwan: a comparison between urban and rural groups. Surgical Neurology 2006;66(SUPPL. 2):S14-S9.
[44] Gontkovsky ST, Sherer M, Nick TG, Nakase-Thompson R, Yablon SA. Effect of urbanicity of residence on TBI outcome at one year post-injury. Brain Inj 2006;20(7):701-9.
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[50] Simpson GK, Daher M, Hodgkinson A, Strettles B. Comparing the injury profile, service use, outcomes, and comorbidities of people with severe TBI across urban, regional, and remote populations in New South Wales: A multicentre study. 2016.
[51] Kuo CY, Chiou HY, Lin JW, Tsai SH, Lin MR, Chiang YH, et al. Characteristics and clinical outcomes of head-injured cyclists with and without helmets in urban and rural areas of Taiwan: A 15-year study. Traffic Injury Prevention 2017;18(2):193-8.
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between differing levels rurality on health outcomes, 'rurality' must be defined and the consistent methods used to classify this construct used in the literature. Of the 47 studies included in this review, there were 14 different classifications of rurality. Population density was the most commonly reported method of classification however within this measure, there was significant inconsistencies in the population considered to be 'rural'. Population density also only measures a single construct, population, and doesn't take into consideration other factors associated with location that may impact health outcomes. Although more widely used in the literature, without consistent definitions of what population figures should be considered 'rural', comparison of findings across studies using population density to classify rurality remains difficult.

The ASGS RA [34] was referenced in most of the include papers from Australia. Whilst more consistently used in Australia studies, like population density, the ASGS RA only measures a single attribute for a construct that is multifactorial. An alternative measurement scale, the Index of Rural Access, was developed in Australia and combines the key elements of access to primary health services in rural areas, spatial accessibility, population health needs and mobility [80]. This measure provides a more sensitive classification method [80] and has the ability to identify access differences within rural populations at a much finer geographical level. Another key consideration regarding rurality classification methods is the variation in the size of the area each classification area represents and that often studies are reporting outcomes in broad regions dichotomised into 'rural' and 'urban' groups. For example, classifications of population density are examined at the county level and ASGS RA classifications are by postal code, each of which are relatively broad and encompass a variety of populations and services within each classification category. To improve the specificity of measurement across different spatial areas, a distance-based approach to analysis may be more beneficial. In the recent study by Jarman et al. [76], they effectively utilised a distance-based geospatial method to evaluate the association between distance to the nearest trauma centre and odds of death. With advances in geospatial methods, spatial analyses have been used increasingly in public health research as an effective method to explore patterns of injury and evaluate the spatial organisation and accessibility of acute trauma care systems [76,81–87]. Future research utilising geospatial methods to explore to the impact of location on healthcare service utilisation and longer-term outcomes following injury may be beneficial in this cohort.

There were also variations in the mortality statistics reported in the literature and in particular methods used to calculate mortality rates. Although SMR was most commonly used, it is a population based estimate and lacks specificity. Denominators used such as the Emergency Medical Services (EMS) attended population [44] and number of licenced drivers [57] in road trauma cohorts may provide more specific insight into variations in mortality rates. There was also large variation in the study population sizes which we were unable to account for when drawing conclusions due the heterogeneity of the literature and inability to conduct a meta-analysis.

Another limitation of the available literature was the heterogeneity of the study populations in regards to age group and injury profile. Traumatic injury is an inherently difficult area of research due to the heterogeneity of the condition, however, without further research on targeted groups of patients following traumatic injury, such as head injury and orthopaedic trauma, it is difficult to make inferences from the data. Furthermore, with the rapidly increasing number of older major trauma patients experiencing poor long-term outcomes [48], it may also be important to give further consideration and priority of research to geographic variation in outcomes following traumatic injury in older adults.

Finally, despite the majority of the world's burden of injury being borne by low and middle income countries (LMIC) [88] where the impact of rurality is likely to be amplified due to poverty and limited health care, there has been little research carried out on the impact of geography in these countries, highlighting another important area for future research.

As well as the limitations of the literature included in this review, other limitations of this scoping review must be considered. Firstly, although multiple databases were searched using broad search terms, there is always the possibility that not all relevant articles were identified by this strategy. Whilst there was only one reviewer conducting the review of available literature and data extraction, any papers where there was uncertainty in methodology or reporting of results were discussed with all authors until a consensus was reached. Additionally, because scoping reviews do not typically include a quality assessment of included studies, data synthesis and interpretation may be limited [89,90]. A strength of this paper however was the robust search strategy and identification of three major groups of outcomes explored in the literature. Thus, even if a relevant article was missed, it is unlikely that any other significant category of outcome was excluded from this review.

Conclusion

This review suggests that the overall and pre-hospital risk of death following injury is higher for rural patients. However, once admitted to hospital, there appears to be no difference in mortality. There was a paucity of data regarding the impact of geography on non-mortality outcomes and significant inconsistency in findings in the available literature related to the types of outcomes being reported, and time points after injury at which these are assessed. There was a paucity of data regarding the impact of geography on non-mortality outcomes and significant inconsistency in findings amongst available literature such as the types of outcomes being reported and time points after injury at which these are assessed. These inconsistencies need to be further explored to better understand whether rurality may influence longer term recovery outcomes following injury.

Furthermore, without consistent methods of classifying rurality and measures reported following injury it is difficult to make inferences from the already limited literature. Researchers may wish to consider the use of geographic information systems to develop a more specific and consistent international classification method to determine the impact of place on outcomes. Most importantly, additional research is necessary to develop a larger evidence base to enhance the understanding of geography on acute and long-term outcomes following injury.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.injury.2019.07.013.

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2.3 Updated Literature Review

As the literature search for this scoping review was conducted in October 2018, the initial search strategy was re-run on 8th March 2022 to capture any new literature published between 25th October 2018 and 8th March 2022. The databases Ovid Medline, Embase, Scopus, Web of Science and CINAHL were searched using the initial search strategy. There were 335 new publications identified for screening, with 17 publications identified as meetingthe inclusion and exclusion criteria (Table 2). One of these publications was the scoping review published as part of this thesis in 2019[73] so the results from that paper were not included in the table below.

Table 2. Summary of study characteristics identified in the updated literature review

MORTALITY OUTCOMES, Rural Vs Urban						
Country	**Author(s)**	**Measures reported**	**Population Studied**	**Age (years)**	**n**	**Rurality Classified By**
USA	Brown et al. 2019[74]	Overall mortality: Age-adjusted TBI SMR (per 100,000 persons)	CDC data used to identify TBI patients between 2008-14	All ages	Not stated	Residence
	Butts et al. 2019[75]	In-hospital mortality: % in-hospital deaths	All patients hospitalised as a result of an off-road vehicle injury at Cooper University Hospital, New Jersey, between 2005-16	All ages	528	Injury
	Curtin et al. 2020[76]	Overall mortality: Gender-SMR	All deaths from motor vehicle injuries in the USA between 2000-2018	15-24	Not stated	Residence
	Daugherty et al. 2022[77]	Overall mortality: SMR (per 100,000 persons)	CDC data for all TBI related deaths in 2017	All ages	61,134	Residence
	Jarman et al. 2019[78]	Overall mortality: Mortality rate (per 100,000 person-years), IRR	CDC data for all pre-hospital injury deaths from 1999-2016	All ages	1,108,211	Residence
	Olaisen et al. 2019[79]	Overall mortality: Age-SMR (per 100,000 persons)	Unintentional injury deaths from motor vehicle traffic injuries between 2014-17	All ages	Not stated	Residence

		Overall mortality: Age-SMR (per 100,000 persons)	Unintentional injury deaths from falls between 2014-17			
CHINA	Li et al. 2021[80]	Overall mortality: Age-adjusted SMR in tSCI (per 100,000 persons)	All tSCI-related deaths identified from the China Disease Surveillance Points between 2006-2016	All ages	2,368	Residence
	Li et al. 2020[81]	Overall mortality: Age-SMR (per 100,000 person-years)	All injury-related deaths identified from the China Disease Surveillance Points between 2010-2016	All ages	615,498	Residence
	Wang et al. 2019[82]	Overall mortality: Crude and age-adjusted mortality rate (per 100,000)	All deaths from motor vehicle crashes in China between 2006-2016	All ages	Not stated	Residence
CANADA	Altoijry et al. 2021[83]	In-hospital mortality: Adjusted OR	All hospital admissions with traumatic vascular-injury between 1991-2009	All ages	8,252	Residence
REPUBLIC OF GEORGIA	Lomia et al. 2020[84]	Overall mortality: % deaths	Women identified by national reproductive age mortality surveys who died as a result of road traffic injuries between March-December 2014	15-49	78	Residence
QATAR	Al-Thani et al. 2021[85]	In-hospital mortality: % in-hospital deaths	All trauma patients in Qatar transported by EMS to the level 1 trauma centre who required hospitalisation in 2017-18	All ages	1,761	Injury
UGANDA	Temizel et al. 2021[86]	In-hospital mortality: % in-hospital deaths	All patients admitted with road traffic injuries to an urban and rural hospital in Uganda between 1 January and 31 December 2016	All ages	951	Injury
NORWAY	Andersen et al. 2021[87]	Overall mortality: SMR (per 100,000)	All traumatic injuries and deaths of people residing in Norway between 2002-2016	≥ 16	3,766,422	Residence
OTHER IN-HOSPITAL OUTCOMES, Rural Vs Urban						
QATAR	Al-Thani et al. 2021[85]	Hospital LOS, ICU LOS	All trauma patients in Qatar transported by EMS to the level 1 trauma centre who required hospitalisation in 2017-18	All ages	1,761	Injury

RECOVERY OUTCOMES, Urban Vs Rural						
AUSTRALIA	Hennessy and Sullivan 2022 [88]	Symptoms (TIRR), Qualityof life (QOLIBRI), mental health (MHI), obstacles to service (SOS) and community integration (CIQ)	People admitted to Townsville Health Service with a TBI between October 2011-May 2012.Time since injury between 6-18 months.	≥ 18	91	Residence
CANADA	Macpherson et al. 2020 [89]	Paid disability days in first 12 months post injury	All nonfatal, work-related injuries and musculoskeletal disorders from 6 Canadian provincial workers' compensation boards between 2011-15	15-80	736,106	Residence
Better outcomes for rural patients						
No difference						
Worse outcomes for rural patients						

SMR = Standardised Mortality Rate; MVC = Motor Vehicle Crash; OR = Odds ratio; EMS = Emergency Medical Services; TSCI = traumatic spinal cord injury; TBI = traumatic brain injury; CDC = Centre for Disease Control; USA = United States of America; TIRR = The Institute of Rehabilitation Research symptom checklist; MHI = mental health inventory; QOLIBRI = quality of life after braininjury; SOS= Service obstacle scales; CIQ = community integration questionnaire

The high number of additional articles published since the original review was conducted highlights the growing emphasis on geography in injury-related research. Consistent with findings from the original scoping review, most available literature focused on the pre-hospital phase and injury-related mortality. These additional 16 studies complement the overall findings of the review, with no notable variation in the findings identified. Further research targeting functional and recovery focused outcomes will assist to improve our understanding of long- term trauma care, a key part of the trauma care pathway.

2.4 Summary of Chapter Two

The findings of this literature review highlight that a) most research has been conducted in the pre-hospital and acute phases of injury management, and b) mortality outcomes have been more commonly researched than in-hospital and recovery outcomes following injury. From this review, we found that people in rural areas had higher overall and pre-hospital mortality following injury. However, once admitted to hospital, there was no significant difference in mortality. In the small number of studies identified that reported other in-hospital and recovery outcomes, no consistent trends were identified in the difference between urban and regional groups.

This literature review also established that there were inconsistencies in how regionality was measured and classified in research, within individual countries and internationally, highlighting the need for a consistent classification system. Given the

paucity of data on the impact of geography on non-mortality outcomes, there is a clear need to develop a larger evidence base on regional variation in recovery following injury to inform the optimisation of post-discharge care services. Studies primarily exploring explanatory factors such as seatbelt, blood alcohol levels or gender as the exposure of interest with mortality as the primary outcome were excluded from this review. Given these studies are likely to have included geography as a covariate, it is important to acknowledge that there may be additional studies that can inform our understanding of geography on outcomes following injury.

The growth of this larger evidence base would be assisted by the creation and use of standardised reporting metrics and classification across research fields and across countries, for example, a consistent definition of a regional or rural area. The gaps in the literature regarding the impact of geography on recovery outcomes following injury were considered in the development of the program of research carried out in this thesis.

Chapter Three: The perspectives of allied health professionals involved in the care of people following serious injury in Victoria

3.1 Introduction

In Chapter Two, the findings of the literature review suggested that geography can impact outcomes following injury. Additionally, as presented in Chapter One, people with serious injuries often experience poor long-term health outcomes.[34-41] Allied health professionals play a key role in the care and recovery of people with serious injury.[90] To further understand how geography impacts people accessing care and health services beyond hospital discharge, an aim of this thesis was to understand the perspectives and experiences of AHPs caring for people with serious injury in urban and regional areas.

Previous research exploring the perspectives of injured people has reported the following barriers to recovery: poor coordination of care [21, 40, 58, 59, 91], limited mental health supports for patients and family caregivers [34, 37, 39, 59, 92] and a lack of access to appropriate paid attendant carers.[22, 41, 93]

The perspectives of health care providers have been used to inform improvements to servicemodels and pathways in the United Kingdom.[60] However, to our knowledge there has been no research to date that explored the factors that AHPs perceive to impact care following serious injury beyond hospital discharge.

The aims of the qualitative studies presented in this chapter were to:

1) Describe the factors perceived by AHPs to influence the care of people

following serious injury beyond hospital discharge across regional and urban Victoria; and

2) Explore factors perceived by AHPs to affect access to post-discharge health care forpeople with serious injuries in urban and regional areas of Victoria.

These studies address the second research objective for this thesis, to 'explore the barriers and enablers experienced by health care providers caring for people with serious injury across different geographical regions.

3.2 Ethics statement

Ethics approval for the two studies within this chapter was obtained from the Monash University Human Research Ethics (Study ID: 12705, 22/02/2019). The study advertisement used for recruitment and participant information sheet are provided in Appendix 3.

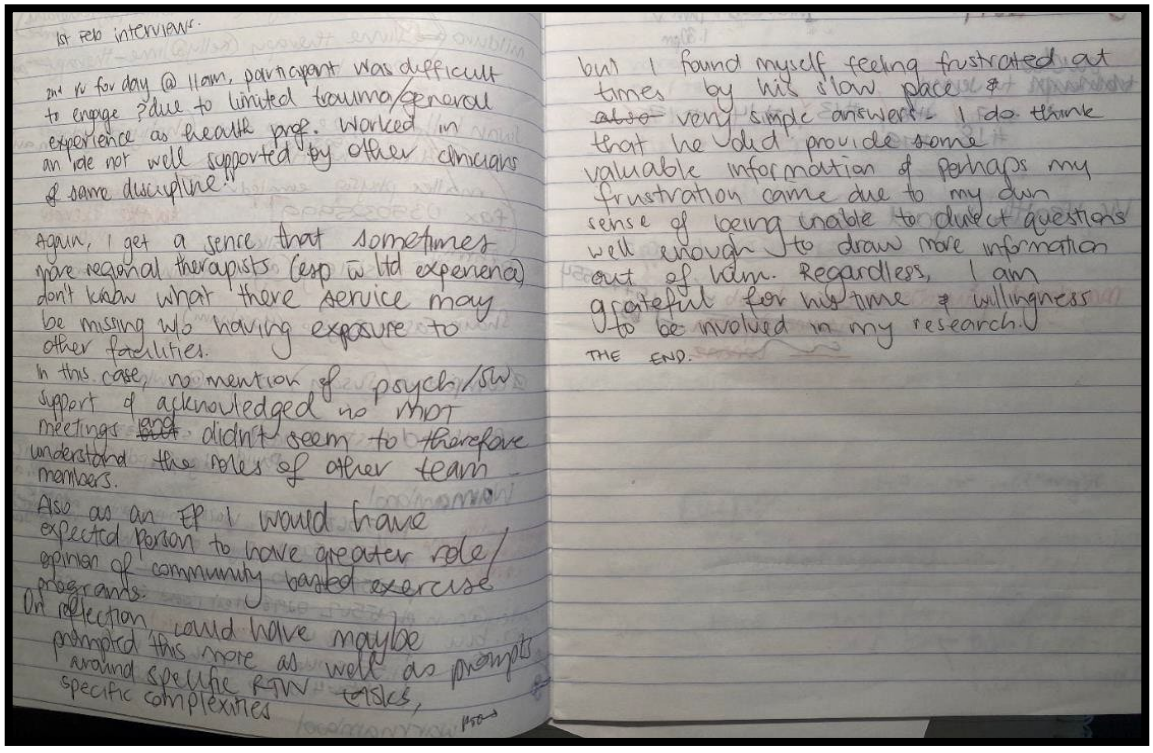
3.3 Critical reflexivity

3.3.1 Before the study

My experience as a physiotherapist working with trauma patients developed my interest in this subject and motivated me to undertake this project. I felt that clinicians could providevaluable insights into service delivery issues and processes that sometimes can go unseen by patients. Whilst I have worked in trauma rehabilitation for the last ten years, I was conscious of the fact that my experience was only one perspective and limited to a single, metropolitan centre. I wanted to gain further understanding of the perspectives of other allied health clinicians working across a variety of regions in both public and private rehabilitation settings.

3.3.2 During the study

Throughout this project, critical reflexivity was maintained by keeping a reflexive journal and meeting regularly with the research team to discuss the methodology and data collected. Following each interview, I would make notes about my confidence with the interviewing process and also the responses to my questions (Figure 3). I also used my reflexive journal to make comments on themes emerging from the interview process. After the first five interviews were transcribed, they were discussed in great detail withthe senior qualitative author (SB). In addition to discussing emerging themes, feedback was also provided on interviewing techniques and the interview guide. It was agreed that the quality of the data being collected was high and no amendments to the interview guide were necessary.


1st Feb interview.

2nd IV for day @ 11am, participant was difficult to engage ?due to limited trauma/general experience as health prof. Worked in an ide not well supported by other clinicians of same discipline.

Again, I get a sense that sometimes rural regional therapists (esp w ltd experience) don't know what there service may be missing w/o having exposure to other facilities.

In this case, no mention of psych/SW support of acknowledged no MDT meetings ~~and~~ didn't seem to therefore understand the roles of other team members.

Also as an EP I would have expected person to have greater role/ opinion of community based exercise programs.

On reflection could have maybe prompted this more as well as prompts around specific RTW issues, specific complexities

but I found myself feeling frustrated at times by his slow pace & ~~also~~ very simple answers. I do think that he did provide some valuable information & perhaps my frustration came due to my own sense of being unable to direct questions well enough to draw more information out of him. Regardless, I am grateful for his time & willingness to be involved in my research.

THE END.

Figure 3. Excerpt from reflexive journal following a participant interview

3.4 Paper Two

3.4.1 Overview

This paper is the first of two qualitative studies presented in this thesis. Interviews with AHPswere undertaken and a thematic analysis completed to reveal detailed insights into theprovision of care for people with serious injury. The findings described in this paper highlight a number of difficulties experienced by AHPs in caring for people with serious injury, as well as providingsuggestions for the improvement of service delivery models to optimise post-discharge health care.

3.4.2 Manuscript

Keeves, J., Braaf, S. C., Ekegren, C. L., Beck, B., & Gabbe, B. J. (2021). Caring for people with serious injuries in urban and regional communities: A qualitative investigation of health care providers' perceptions. *Disability and rehabilitation*, *43*(21), 3052-3060.

The interview guide used for papers two and three is sited in Appendix 4.

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ORIGINAL ARTICLE

Caring for people with serious injuries in urban and regional communities: a qualitative investigation of healthcare providers' perceptions

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ABSTRACT

Purpose: To understand the factors that affect the management of people after serious injury in urban and regional settings, beyond hospital discharge from the perspectives of allied health professionals (AHPs).

Materials and methods: An exploratory qualitative study of AHPs caring for people with serious injuries post-hospital discharge in urban and regional areas of Victoria, Australia was completed. Twenty-five semi-structured interviews were undertaken with AHPs and thematically analysed.

Results: Allied health professionals in urban and regional settings reported the benefits of a multi-disciplinary team to deliver high-quality care. However, a number of barriers to service delivery were identified that impacted on their ability to meet the needs of patients. These included insufficient psychological services, a shortage of available carers and an unmet need for external clinical support in regional areas. Communication between AHPs and other services, and care co-ordination of post-discharge services, was also highlighted as key areas to improve for optimal patient care.

Conclusions: Factors that influenced optimal patient management included the availability of psychological and carer services, communication between health professionals and coordination of post-discharge care. The experiences of AHPs can offer practical suggestions to optimise service delivery and post-discharge care for people with serious injuries.

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Geography; trauma; injury; allied health professionals; patient outcomes; interview

➤ IMPLICATIONS FOR REHABILITATION

- Allied health professionals (AHPs) face a number of challenges in the provision of optimal care to people with serious injuries.
- Improving the availability of psychological support and attendant carers is needed in regional areas.
- A designated care coordinator role may assist people with serious injuries transitioning between hospital and home to engage with necessary services and reduce administrative burden for AHPs.
- Telehealth may provide facilitate improved communication between health professionals and support regional clinicians caring for people with complex injuries.

Introduction

For survivors of serious injury, the path to recovery can be long and complex [1–3]. Disability following serious injury is often persistent, with pain, physical and emotional problems reported at three years [2,4] and up to 10 years post injury [5]. A number of barriers to recovery following serious injury have been identified in the literature that suggest sub-optimal quality of post-discharge healthcare. These include poor coordination of care [6–10], limited mental health supports for patients and family caregivers [9,11–15], a lack of access to appropriate paid attendant carers [8,16,17] and deficiencies in the expertise of community-based therapists [7,8,13,18,19]. Studies have also highlighted the disparity in access and availability to necessary healthcare following injury for people in rural areas with concerns that this may contribute to poorer long-term health outcomes [10,12,14–16,19–21].

To optimise patient outcomes, care should be coordinated along the entire pathway from the pre-hospital setting, to acute care, rehabilitation, and community reintegration [22,23]. Within regionalised trauma systems, specialised trauma care and expertise are usually concentrated in inner metropolitan areas [24]. However, in Australia, 35% of patients hospitalised as a result of injury reside in regional and remote areas [25]. Ensuring continuity of care and the availability of specialised post-discharge healthcare for those outside of metropolitan centres is necessary to meet the needs of these individuals. Currently, geographic variation in long-term health outcomes following injury is not well understood with inconsistent findings reported in the literature [26].

Caring for people with serious injuries is multifaceted, involving a team of healthcare providers [27]. Allied health professionals (AHPs) are an integral part of this treating team [28]. To date their perspectives on the provision of post-discharge care following serious injury has not been widely researched. A previous study exploring service provider perspectives in the UK identified psychological screening and support, as well as early access to adequate physiotherapy as key to improving sub-acute patient

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Supplemental data for this article can be accessed here.

care [29]. Understanding the experiences of AHPs can offer practical suggestions to optimise service delivery and post-discharge care for people with serious injuries [29].

The research questions for this qualitative study were:

1. What are the factors perceived by AHPs to influence care of people following serious injury beyond hospital discharge?
2. Is there variation in the perceived factors influencing care across AHPs in regional and urban settings?

Materials and methods

Setting

This study was an exploratory qualitative study involving Victorian AHPs experienced in caring for people with serious injuries beyond hospital discharge. The state of Victoria has a population of 6.46 million people, of which 76% reside in metropolitan Melbourne [30].

Victoria has operated a regionalised, inclusive trauma system since 2001. Three major trauma services in inner metropolitan Melbourne provide specialised care for people with serious injuries. Pre-hospital triage and inter-hospital transfer guidelines ensure the transport of patients to an appropriate hospital for management [31].

This project was approved by Monash University Human Resources Ethics Committee (ID: 12705).

Recruitment strategy

Allied health professionals with experience managing adults with serious injuries after hospital discharge were recruited from public and private healthcare settings. For the purpose of this study, serious injury was defined as spinal cord injury (SCI), traumatic brain injury (TBI), orthopaedic injury, as well as other injuries requiring an emergency admission. Purposive sampling based on geographic location of employment and clinical discipline ensured a variety of perspectives were captured. We aimed to recruit from three distinct geographic regions within Victoria; major cities, inner regional and outer regional/remote, according to Accessibility/Remoteness Index of Australia (ARIA) classifications [32].

Initial recruitment occurred through responses to advertisements in relevant special interest social media and newsletters/magazines of governing professional bodies. In the first three months of recruitment, AHPs were primarily from major cities and inner regional areas. To increase participants from outer regional areas, direct contact with health services *via* phone and email was added to the recruitment strategy. Ongoing recruitment also occurred through snowball sampling.

Interested participants were emailed a participant information sheet. A second email was sent seven to 10 days later to answer any questions and schedule an interview. Interviews were completed by video- or tele-conferencing, based on participant preference.

Data collection

Semi-structured interviews were conducted by the primary investigator (JK), a physiotherapist (PT) trained in qualitative interviewing techniques. An interview topic guide was used to explore enablers and challenges faced by AHPs in managing trauma patients (Supplement Material). Questions about resource availability, clinical support networks and experiences with different funding models were also asked. Probes were used to explore participants' responses and generate detailed information.

Verbal consent to participate and audio record was gained at the commencement of the interview. After 21 interviews, similar themes were evident in the inner regional and outer regional groups. In consultation with the research team, participant information from inner and outer regional areas were aggregated into one "regional" group and participant information from major cities was reclassified as the "urban" group. After 25 interviews, repetition was present in the transcripts and no new themes were evident.

Data analysis

Data analysis occurred concurrently with data collection. Each interview was professionally transcribed and loaded into NVivo 11 (QSR International Pty Ltd., Melbourne, Australia) for data management and coding. The Braun and Clarke model of thematic analysis was used for analysis [33]. Transcripts were read multiple times and coded after each interview to ensure descriptive validity, with the initial five transcripts double coded by two investigators (JK and SB) [34]. Using iterative and inductive processes, preliminary thematic groupings were identified and a thematic framework developed. Themes were further reviewed to ensure they were reflective of the dataset and a thematic map of the analysis generated. Themes and subthemes were finalised through discussion with a co-investigator (SB) until consensus was reached.

Rigour throughout the analysis process was ensured by keeping a reflexive journal about reflections on interviews, researcher positionality, and initial thematic ideas [35]. Negative case analysis, peer-review and researcher triangulation were also utilised throughout the analysis to optimise credibility of the research. Authors met weekly to discuss the development of the coding framework, themes, interpretation of the results and recommendations developed from this research [36].

Results

Participant characteristics

Semi-structured interviews were conducted with 25 AHPs across major cities, inner regional and outer regional geographic regions of Victoria, who were involved in the management of people with serious injury. Recruitment from remote regions of Victoria was unsuccessful. All interviews were completed between December 2018 and April 2019, with a median interview time of 46 min. Participants included 13 PTs, five occupational therapists (OTs), one social worker (SW), two neuropsychologists, and four exercise physiologists (EPs) (Table 1).

The results are described in relation to four key themes in the context of factors affecting the care of people following serious injuries across regional and urban communities (Table 2).

To illustrate these themes and sub-themes, selected participant quotes are provided. Following the quote, the participant's geographic region of health service, clinical discipline, gender, and age range (years) are provided for context.

Multi-disciplinary input for optimal patient care

Therapy teams should provide collaborative, patient-centred, and goal-based treatment

Allied health professionals working in regional and urban settings frequently reported the benefits of working within a multi-disciplinary

team to deliver high-quality patient care. Participants recognised the importance of regular communication amongst team members to discuss management of their patients. This enabled therapy to be goal-directed and centred on the individual needs of the patient.

> Making sure that they've got the necessary team members around them that are all communicating with them, and with each other… and making sure [all therapists] work towards that client's goals. So I think that's really the best thing that helps the client. (Urban_PT_Female_23-29)

> We work very collaboratively… there's regular communication, we have a case conference every week… there is the opportunity if a difficult or challenging case needs to be discussed. And we're very goal-focused…. (Regional_Other_Female_30-36)

Hospital-based multi-disciplinary teams in urban health services more consistently included rehabilitation physicians, neuropsychologists and psychologists than in regional services.

> It's quite a comprehensive team. It comprises of neuropsychology, psychology, [recreation] therapy, exercise physiology, speech, [occupational therapy], [physiotherapy]. We have rehabilitation physicians as well that are part of our team. We have a rehabilitation nurse. (Urban_PT_Female_30-36)

Table 1. Profile of allied health professionals.

Characteristic	
Age, years (mean (SD))	36.2 (8.5)
Gender	
Male	8 (32%)
Female	17 (68%)
Profession	
Physiotherapist	13 (52%)
Occupational therapist	5 (20%)
Exercise physiologist	4 (16%)
Other[a]	3 (12%)
Years of clinical experience	
1–4	4 (16%)
5–9	9 (36%)
10–14	4 (16%)
15+	7 (28%)
Healthcare setting	
Hospital outpatients	16 (64%)
Community-based	6 (24%)
Private practice	3 (12%)
Geographic region[b]	
Major city	8 (32%)
Statewide service	3 (12%)
Inner regional	10 (40%)
Outer regional	4 (16%)

[a]Other allied health = social worker; neuropsychologist.
[b]Geographic regions based on ARIA remoteness classifications [32].

In regional areas, the rehabilitation physician was reported to have infrequent involvement in care decisions made by the multidisciplinary team. In general, rehabilitation physicians were contacted only when additional assistance was sought by the therapy team.

> We have all allied health… as a smaller hospital, we are linked in with [names regional centre], and we have access to their rehab physicians… so if there's something going on that we think we need rehab physician input for then we can video-conference in with them, or they come down once a fortnight. (Regional, PT, Female, 23-29)

Limited specialised services shapes care delivered to patients

Regional-based AHPs reported that the care provided to people with serious injuries within their services was *"limited by funding and staffing – always. And also access to appropriate therapy places" (Regional_OT_Female_37-43).* In regional areas, AHPs were required to provide more generalised care and described feeling as though they were required to be *"a jack of all trades"*, managing patients with a wide variety of health conditions. Subsequently, they reported feeling unable to provide the intensity of therapy or lacking the specialised skills required to optimally care for people with seriously injuries.

> I think the public health system has just got to be set up better that we can access specialists. And I mean specialists, not just at the medical level but at the allied health level … we could do things a lot better and a lot quicker if we had the right resources. (Regional_OT_Female_30-36)

Insufficient psychological services available following serious injury was perceived as a barrier to providing optimal patient care by both regional and urban AHPs.

> I can't get up to [name of Victorian county town] a couple times a week in a crisis, it's too far. So they need a clinical [psychologist], but there's no clinical psyches that know how to manage the neuro side of the client…for country clients, it's really hard. (Statewide service_Other,_ Female_37-43)

> A lot more support [is required] for the post-traumatic, psychological issues that do arise, quite often by the time the client gets to the community rehab stage …that support's really hard to find. (Urban_PT_Female_30-36)

In regional settings, AHPs perceived a lack of funding as the primary reason for limited specialised psychology and counselling services. Limited psychologists in regional areas also meant that patient's mental health concerns were often managed by AHPs, who did not have sufficient psychological training.

> …as the service hasn't had psychology or neuropsychology for many, many years, it's sometimes difficult to justify with the powers that be

Table 2. Key themes and sub-themes identified.

Key theme	Sub-themes
Multi-disciplinary input for optimal patient care	Therapy teams should provide collaborative, patient-centred and goal-based treatment.
	Limited service provision shapes care delivered to patients.
	Lack of appropriate peer-oriented services limit ongoing physical activity participation and community re-integration.
Communication impacts on care delivery	Communication between allied health professionals across health services for continuity of care.
	Limited communication exists between allied health and medical professionals.
	Compensable funding bodies' communication with allied health professionals and patients can influence care.
Patient engagement with rehabilitation	Patients depend on allied health professionals to navigate health systems.
	Carers play an important role in patient care Mental health impacts rehabilitation and community re-integration.
Clinical support for allied health professionals	Interdisciplinary clinical support occurs within health services.
	Specialised outreach services are needed to optimise patient care.

because they see that as we have been managing that, whereas we're kind of like, well, it doesn't mean we've been managing well. (Regional_OT_Female_30-36)

We're very limited in terms of having access to neuropsychologists and the counsellors … often it's the allied health, the OTs and the like that end up dealing with a lot of those psychological issues that we're not necessarily specialised in. (Regional_OT_Female_43-49)

Lack of appropriate peer-oriented services limit ongoing physical activity participation and community re-integration

In urban areas, AHPs commented on the benefit of engaging specialised leisure services to ease the transition for patients returning to recreational activities in their communities. Regional AHPs did not have the same specialised services and reported limited availability of all-abilities recreational options. However, regional AHPs reported that if a patient had a pre-existing network (for example within a sports club), that network may be supportive and able to meet additional needs of the individual. This was perceived to assist patients' socialisation and involvement with community-based recreation.

For sport and recreation, we tend to often refer onto a recreational specialist … because they've got more knowledge and experience in that area. (Urban_PT_Female_23-29)

It's really hard to find all abilities, sport and recreation options for [patients] in the community, which can be an important part of integrating into peer-appropriate activity … sometimes you do see a greater acceptance if people were known in the community … they will embrace them and bring them back in the fold, and tolerate a lot of behavioural, cognitive, communication-type problems with some of our young head-injured clients. (Regional_PT_Male_37-43)

Across both regional and urban areas, AHPs noted a lack of available community groups for patients to participate in once discharged from a therapy service. Therapists reported that engaging patients in community groups or recreational activities aided the transition from individual therapy to self-driven physical activities. Whilst many AHPs offered to provide patients with independent gym programs to encourage maintenance of physical function, multiple barriers existed. Allied health professionals stated that community gyms were not always appropriate if patients required additional supervision. Further, some patients were not sufficiently motivated to perform gym-based exercise independently. Appropriate community groups were reported to be valuable for patients to continue with supervised physical activity whilst also benefiting from peer-support and socialisation to improve general wellbeing and assist community re-integration.

There's quite a few groups for older patients, but it's hard to access assisted gym groups for younger patients, especially younger patients with significant behavioural issues … so that they get the socialisation aspect as well as the fitness aspect. (Urban_PT_Female_51+)

Once they discharge officially from the hospital, to get them into a community-based exercise group or something like that can be quite difficult, just because there are not lots of trained facilitators, or I suppose venues that offer the right safety equipment, so that's a bit of a hurdle for us …. (Regional_EP_Male_23-29)

Communication impacts on care delivery

Communication between allied health professionals across health services aids continuity of care

Patients' clinical information was shared by AHPs across health services via a number of platforms including verbal, written, video-conferencing, and face-to-face. Handovers of patient information were reported as mostly comprehensive and AHPs felt comfortable contacting referrers to seek clarification if required. Therapists remarked on the importance of communicating clinical information between health services for continuity of care and building rapport with patients transitioning from another health service.

… if we nail [the transition], and by we, I mean the treating team, at one end, and us, the transition works so well, the client's trust is there, and you can really just get on with their rehab. But if it's not there you lose their trust really early, they think that you don't know what's going on. (Urban_PT_Female_30-36)

A thorough clinical handover was perceived to be particularly important for AHPs managing patients in the community or their home environments, to mitigate any potential safety risks as a result of challenging behaviours, a history of substance abuse or a complicated social situation.

Probably the [information] that is important is if there are any safety risks, if the person is violent or any concerns there, given that I'm actually visiting their home. (Statewide service_OT_Female_51+)

For AHPs managing patients who were not actively involved with a hospital service, accessing clinical information about the in-hospital care of the patient was reported to be more difficult.

The lack of information with these patients' years down the track is quite tricky, because you don't ever know what's directly as a result of the injury, or an indirect issue, or an issue that's been exacerbated because they had that accident. (Urban_OT_Female_30-36)

Limited communication exists between allied health and medical professionals

Consistently, AHPs reported that a lack of communication with medical professionals was a major barrier to providing optimal care to patients with serious injuries. Both regional and urban AHPs reported frustrations and concerns for patient care due to limited channels of communication with medical professionals. Generally, AHPs stated that the inability to seek guidance from surgeons and specialists, often delayed their patient's progression with rehabilitation. For example, difficulty accessing weight bearing status reports after orthopaedic reviews meant AHPs were commonly reliant on patients verbally relaying information from medical professionals.

… the amount of time it takes to chase the right person to get the right answer, and be confident in that answer … I hope this is okay because I've just changed a really big thing about this person's rehab. (Urban_PT_Female_30-36)

We don't often have access to their x-ray, MRIs, things of that nature through other health services … The correspondence from [medical] reviews in terms of changing their weight bearing status, for example, that information is not easily accessible to us as clinicians after the fact …. (Regional_EP_Male_23-29)

Compensable funding bodies' communication with allied health professionals and patients can influence care

Similar attitudes were reported by regional and urban AHPs in regards to managing patient care through compensable funding bodies. Many participants indicated that whilst some claims managers were communicative, responsive and supportive there was a lot of variability in the claim manager's understanding of patients' injuries and therapeutic needs.

… where [claims] managers have made contact with patients, and been down to visit … that seems to have a really positive effect for patients and their families, just in terms of less stress and anxiety. I think that can be quite powerful. (Regional_PT_Male_37-43)

Regular communication with claim managers was commonly identified to have a favourable impact on patient care. However, AHPs also reported that misunderstandings or unrealistic expectations of claim managers resulted in therapy delays. This often created additional administrative demands for AHPs due to lengthy justification and advocacy involved to get approval for necessary services or equipment, and had a negative effect on patients' psychological and physical wellbeing.

> You're just always fighting, it's not ever really easy… you go and see the client, and you have to put in funding requests and wait for approval. So it disturbs the flow of the therapy and the interactions you have with your client. (Urban_OT_Female_30-36)

Patient engagement with rehabilitation

Patients depend on allied health professionals to navigate health systems

Allied health professionals from urban and regional areas reported patients found the complexity of health systems and involvement with multiple health services and service providers very challenging to independently navigate. A lack of case management resulted in patients relying on AHPs to help them engage with and streamline therapy services.

> …you're addressing so many different areas of the client's life, and they're so lost in the system that they don't really know what to do. (Urban_OT_Female_30-36)

> I think that in social work, case planning, navigating systems and services, there's huge gaps. (Regional_Other_Female_30-36)

Most AHPs undertaking additional care coordination tasks for patients felt this added administrative burden to their role and reduced the time available to provide specialised care.

> …none of us are doing our roles, we're all doing case management to sort of manage the crisis, which are frequent with these really complex clients. (Statewide service_Other_Female_37-43)

Carers play an important role in patient care

Attendant carer support was identified by regional and urban AHPs as an important factor for optimising patients' independence and assisting with rehabilitation outside of dedicated therapy time.

> We've trained the carer in home exercise programs, walking program, different OT… it's been immensely beneficial for that client. (Urban_PT_Female_30-36)

However, there was a strong contrast between regional and urban clinicians' perspectives of the ability to engage paid attendant carers. In regional areas, the shortage of available carers with necessary skills and experience meant patients' needs were difficult to meet. As a result, a large proportion of patient care and support was provided by family or friends, placing additional strain on the family unit.

> Sometimes these people go back to environments where there's actually no services… so there's no organisation that would take on the personal care of someone with a serious head injury, for instance. So you're actually training family or friends as carers. (Regional_OT_Female_30-36)

Mental health impacts rehabilitation and community reintegration

Allied health professionals reported that their patients' pre- and post-injury mental health impacted their ability to engage in rehabilitation and reintegrate within their communities. Mental health issues were noted to influence patients' motivation, fatigue levels, and return to family and life roles. Mental health also impacted AHPs' ability to engage patients in rehabilitation included low mood, anxiety as a result of their social situation, post-traumatic stress symptoms as well as suicidal ideations.

> Certainly mental health, from a mental health perspective that's a huge either barrier or enabler to return to work and leisure. (Statewide service_PT_Female_37-43)

> They've got mental health issues before the accident, and drug and alcohol issues before the accident…at home all the psychosocial stuff takes over… basically we're servicing them not in our [clinical] specialties, because we're trying to keep them from killing themselves. (Statewide service_Other_Female_37-43)

Clinical support for allied health professionals

Interdisciplinary clinical support occurs within health services

Participants described a strong sense of support from rehabilitation physicians within their health services in both urban and regional settings. Rehabilitation physicians provided timely advice and regularly travelled to regional areas to consult in person.

> Our [rehabilitation] consultants are really responsive to therapists, particularly in rehab. We can email them and call them any time, and they'll call us back, which I know doesn't happen sometimes with other teams. (Urban_PT_Female_30-36)

> If there is something going on that we think we need a rehab physician input for, then we can video conference in with them, and they come down once a fortnight here. (Regional_PT_Female_23-29)

Support was also provided to AHPs from other AHPs within their health service. This was commonly reported to be an adequate resource. However, for some regional AHPs, a lack of specialised or senior clinical staff within their organisation or regional meant they were reliant on personal contacts to obtain additional advice.

> I'd probably start off with one of the more senior physios [for support] … then also just seeing whether the clients have a neuropsychologist or OT, and just debriefing with them…. (Urban_PT_Female_23-29)

> I have a little bit of a network of more specialised people that I can contact if I need help. Otherwise, within the hospital setting is a little bit limited in terms of clinical support because we have a pretty limited number of clinicians all in different areas. (Regional_Male_EP_23-29)

Specialised outreach services are needed to optimise patient care

The Spinal Community Integration Service (SCIS) run by the Victorian Spinal Cord Service was commonly reported by AHPs to be an excellent resource for therapists not familiar with SCI management or service availability across regional and urban areas.

> The statewide Spinal Cord Injury Service, has been really helpful to come out and do consults and to help problem solve around situations and other services. (Urban_PT_Female_23-39)

For people with other types of injuries, for example, TBI or multiple-orthopaedic injuries, specialised clinical support services to assist both patients and less experienced therapists with ongoing questions or concerns did not exist. Participants perceived this as a barrier to providing optimal patient care in regional environments. As regional AHPs were required to provide services to a wide range of people, AHPs unfamiliar with managing people with serious injuries described feeling *"thrown in the deep end"* with complex patient presentations *(Regional_EP_Male_30-36)*.

> When you work in a regional area you're a bit of a jack of all trades, rather than being able to specialise in a particular area, it's harder to get that speciality skills when you're having to cover so many bases. (Regional_OT_Female_44-50)

Discussion

This exploratory qualitative study provides insight into the perspectives of AHPs managing people with serious injuries across regional and urban settings. Factors that influenced optimal patient management included engagement with rehabilitation, health service delivery, and overarching models of health funding.

Both urban and regional AHPs believed in the importance of multidisciplinary and collaborative therapy teams in caring for patients, and reported that good communication enhanced continuity of care. Multi-disciplinary healthcare was reported in a study by Beckett et al. as the "ideal" model of trauma care, acknowledging that this is often impacted by resource limitation [29]. The lack of access to multi-disciplinary care and poor coordination of services has also been identified by patients following injury as a barrier to recovery in large qualitative studies from the UK and Australia [8,37,38]. Health services must recognise the importance of collaborative, multi-disciplinary input for people following serious injury in the acute setting and beyond hospital discharge to best meet the needs of an injured individual [29].

Ineffective transfer of information between health professionals in hospital and outpatient services can lead to adverse patient events [39–41]. In our study, participants highlighted the importance of effective information transfer between healthcare services for building a trusting and supportive relationship with patients [14]. Improved sharing of patient information may be an area for reform. For example, advances in online clinical information systems and telehealth for regional health providers may be beneficial for streamlining information transfer between allied health and medical professionals [42,43]. This is likely to improve patient outcomes through greater continuity of care of patients transitioning between health services and timely access to necessary clinical information for AHPs [39,41,44].

In TBI research, the lack of psychological services available in regional areas has been reported for over a decade [13,16,21]. Similar research has reported significantly higher unmet needs for regional community mental health services, drug and alcohol services and behavioural management compared to their urban counterparts [21]. Our study provides further insight into the impact of poor psychological wellbeing on patient's engagement with therapy, return to previous work and life roles, health outcomes and community reintegration [45,46]. The importance of timely access to mental health services for people following serious injury cannot be overlooked. As described by participants in this study, when psychological services are limited OTs and PTs may be required to provide psychological support beyond their level of training [47]. Dealing with patients' complex psychological issues, can result in work-related stress, compassion fatigue, and burnout for AHPs [47–49]. If the inequity of psychological services between regional and urban health services is not addressed, the wellbeing of both injured patients and AHPs may be compromised [4].

Being unable to independently navigate health systems has been reported as a barrier to recovery and a source of stress and anxiety for people following injury [4,6–10]. Patients can receive large amounts and complex information at hospital discharge regarding their injury status, medication advice and referral to outpatient health services. Barriers can include healthcare providers having insufficient time with patients to deliver health information clearly [29], low health literacy of trauma patients [50] and impaired cognition due to sedative medications or the distraction of pain [43,51]. The rehabilitation phase may be better for communicating health information as there is often more time available during consultations [9]. However, when AHPs are required to adopt the coordinator role, their capacity to treat within their clinical speciality can be compromised [28,52]. A designated SW or nursing specialists in care coordinator role may assist with effective health and social support services coordination and provide ongoing health-related education to patients and/or families to optimise patient outcomes [7,9,53,54].

Complexities of healthcare systems for people following serious injury have also been reported in the Australian literature in regards to the National Disability Insurance Scheme (NDIS) [55–58]. The NDIS was recently established to provide individualised support for Australians under the age of 65 years, living with permanent and significant disability [59]. This funding system remains in its infancy with the rollout in Victoria occurring between 2016 and 2019. The NDIS model has great potential to assist people living with disability. Similar to the findings in our study about injury insurers, clinicians, and people with disabilities have reported difficult accessing and negotiating the NDIS systems [55–57]. Furthermore, a lack of flexibility to redistribute funds to areas that would optimise an individual's independence or be more meaningful to improve quality of life limit the functionality of the current NDIS model [58]. Additional education and support for patients and healthcare providers about the NDIS may improve the ability for this scheme to meet the specific and variable needs of people living with disability [57].

Paid-attendant carers can assist individuals and families of people with serious injuries to promote health, independence, and quality of life [7,14,17]. In regional areas where paid carers may be unavailable, informal care tasks including personal care, transportation needs and advocacy are commonly taken on by families [15,60]. Ensuring counselling, support or respite periods are available for these families should also be considered by AHPs caring for people with serious injuries [16,60,61]. Peer-support systems that are focused on the family unit as well as the injured individual may reduce physical and emotional strain on families caring for people with complex care needs [7,15,17,61]. Additional initiatives and programs to provide necessary training or paid attendant care may help to improve patient outcomes, particularly in regional areas.

Allied health professionals commonly referenced their role in facilitating community integration for people with serious injuries. Consistent with the findings of this study, limited appropriate peer-oriented exercise and social groups, has been highlighted as a barrier to community engagement and satisfaction with recovery following serious injury, particularly in regional settings [10,14,62]. For people who are not physically or cognitively able to return to pre-injury recreational activities, involvement in physical activity can improve social connectedness, physical activity levels, and enhance resilience following injury [10,63–66]. Whilst some AHPs have identified part of their role is supporting ongoing physical activity, this role does not consistently lie within one clinical discipline [67]. Ensuring that health professionals have adequate knowledge and information of available services in conjunction with an increased availability of community groups may be necessary to promote physical activity and socialisation beyond therapy for people with serious injuries.

People with serious injuries often need treatment from specialised therapists after hospital discharge. Previous studies have identified that being unable to access specialist care is a barrier to recovery [7,8,13,18,19]. Within the Spinal Cord Injury Service of Victoria, specialised AHPs are employed to assist community therapists with managing people with SCI. Participants in this study made numerous positive references to this service in ensuring quality care for people with SCI. In contrast, AHPs identified

that a similar support service for other injury groups did not exist. A clinical outreach or support service may be particularly beneficial for regional AHPs who do not have specialised clinical support within their health service [68]. With technological advances, telehealth and online education have the potential to assist regional AHPs accessing professional development and peer-support, and may also improve job satisfaction and staff retention in regional regions [68]. To best support regional healthcare providers, we must further understand their specific needs for successful implementation and adoption of telehealth or other technological innovations [69].

Limitations

Whilst this study offers valuable insights into the experiences of AHPs caring for people with serious injuries, there are some limitations. In Victoria, less than one percent of the population reside in "Remote" and "Very Remote" communities, thus recruitment from these areas was not possible [30]. As such, the barriers identified by participants from regional areas may be exacerbated for other, more remote parts of Australia.

The diverse group of patient conditions managed by AHPs in this study under the definition of "seriously injured" may be considered a limitation. However, this reflects the heterogeneity that exists within a this population and the wide variety of allied health providers involved in their care. Finally, this study only involved a subset of AHPs and did not include the experiences of psychologists, speech pathologists, nurses or medical professionals, nor did we include the perspectives of people with serious injuries or caregivers in this study. This may be an area for future research.

Conclusions

This research has identified that there are both similarities and differences experienced by regional and urban AHPs involved in post-discharge care of people with serious injuries. There is an urgent need to improve the availability of psychological services in regional areas. A designated care coordinator may improve the streamlining and engagement with necessary health services to enhance quality of care for these patients with complex needs. There may be a role for advances in health information systems and telemedicine to improve communication between health professionals and support regional clinicians. However, further research into how the implementation of these technologies can benefit patients and health professionals is necessary. Whilst AHPs play a key role in community reintegration for people following serious injuries, the availability of appropriate community groups promoting physical activity and social interaction is limited. Additional research is necessary to better understand the diverse experiences of AHPs across regional and urban areas to develop policy and practices for optimal post-discharge healthcare for people with serious injuries.

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Disclosure statement

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3.5 Paper Three

3.5.1 Overview

While Paper Two outlined the similarities and differences experienced by AHPs caring for people with serious injuries in urban and regional Victoria, the following paper provides further insights into the issues perceived by AHPs to impact access to health care for people with serious injury in both urban and regional areas.

3.5.2 Manuscript

Keeves, J., Braaf, S. C., Ekegren, C. L., Beck, B., & J Gabbe, B. (2021). Access to health care following serious injury: perspectives of allied health professionals in urban and regional settings. *International journal of environmental research and public health*, *18*(3), 1230.

The COnsolidated criteria for REporting Qualitative research (COREQ) checklist used for thisstudy can be found in Appendix 5. Supplementary supporting quotes are presented in Appendix 6.

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Regional variation in travel to health services following transport-related major trauma

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ABSTRACT

Introduction: Post-discharge healthcare needs are complex and persistent for people following major trauma. A number of geographic barriers to accessing healthcare exist, particularly for people in regional areas. The aim of this study was to explore regional variation in the distances travelled to access health services and identify patterns of health service use in the first three years following transport-related major trauma.

Methods: This registry-based cohort study used linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC). Victorians who sustained major trauma from a transport-related event between January 1 2006 and December 31 2016, with at least three years of follow-up TAC claims data were included in the study. Geospatial mapping of the median distance travelled to medical and allied health services was conducted for each Victorian Local Government Area.

Results: In the first three years post-discharge, 4,964 people (75.6%) visited a general practitioner, 5058 (77.0%) saw other medical professionals, 2269 (34.6%) accessed mental health services, 2154 (32.8%) saw an occupational therapist and 4404 (67.0%) attended a physical therapy service. Geospatial mapping revealed that people in regional Local Government Area travelled further distances to access health services. Specific clustering of increased travel distances was observed in regional areas of the far west and north-east of Victoria. The number of people using services declined with each subsequent year beyond hospital discharge. However, the number of trips were consistent over time for those still engaged in services.

Conclusions: Distances travelled to access health services vary across geographic regions and may result in an increased travel burden for those in some regional Local Government Area. Understanding gaps in health services by geographic region can assist to improve service availability. Alternate service delivery methods, such as telehealth, may assist to reduce the associated burden of travel for those in regional areas.

Introduction

Developments in trauma systems and acute trauma care have improved survival rates [1–3] and functional outcomes following injury [4,5]. However, the majority of major trauma patients continue to experience poor long-term mental and physical health outcomes [6]. People with transport-related injuries, in particular, have reported discontinuity of post-discharge health care and difficulties accessing necessary follow-up care and rehabilitation [7,8].

Inclusive trauma systems are considered the gold standard of trauma care, providing an organised pre-hospital and triage pathway to specialised tertiary care [1]. However, the role of geography in accessing health services following major trauma is not well understood. With specialised trauma centres commonly located in metropolitan areas, there is potential for disparity of access to necessary post-discharge care, especially for patients residing in regional areas [9]. Travel distance to services has been a reported barrier to accessing healthcare, disproportionately affecting people living outside of metropolitan areas [10]. People who are required to travel further to access healthcare also commonly experience poorer long-term health outcomes [11].

To our knowledge, no research has investigated the variation in post-discharge health service use across geographic regions following transport-related major trauma. Geospatial analyses have been

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used to identify gaps in service availability and patterns of healthcare usage for people following transport-related injury [12] and a range of other health conditions [13–15]. These methods have not yet been applied to major trauma populations. This study used geospatial analysis to explore regional variation in the distances travelled to access health services by local government areas (LGAs) and identify patterns of health service use up to three years following transport-related major trauma.

Materials and methods

Study design

Registry-based cohort study using linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC).

Setting and participants

Victoria is a state of Australia with a population of 6.46 million people including over 2 million people outside of metropolitan Melbourne (see population distribution in Supplementary Material, Figure 1) [16]. Victoria has an inclusive trauma system with two adult, and one paediatric, major trauma centres, located in metropolitan Melbourne. These services provide definitive care for 79% of major trauma cases in Victoria [9].

Participants

Victorians who sustained major trauma from a transport-related event, with a TAC compensation claim between January 1 2006 and December 31 2016 were identified within the VSTR. Cases were included if they were aged 18 years or older at the time of injury and had at least three years of TAC claims data available after their date of acute hospital discharge. Participants were excluded if they did not survive to three years post-discharge or their residential street address was unknown, incomplete or outside of Victoria (Supplementary Material, Figure 2).

Data sources

Transport accident commission

The TAC is the state's no-fault third-party injury insurance scheme providing compensation for medical expenses, rehabilitation, support services and financial assistance for people who have sustained transport-related injury. As well as capturing data pertaining to an individual claim, the TAC captures detailed information regarding post-discharge health services for which they have paid, including details of service type and service description, service date and associated provider locations.

Victorian state trauma registry

The VSTR is a population-based registry that collects data about all people with major trauma in Victoria, defined as: death due to injury; an Injury Severity Score (ISS; based on the Abbreviated Injury Scale (AIS) 2005 version, 2008 update) >12; admission to an intensive care unit (ICU) > 24 hours; or an injury requiring urgent surgery [2]. The registry includes data about prehospital care, pre-existing health conditions, injury characteristics and complications, and discharge information. The opt-out rate is <1% [2]. Claims data from the TAC are provided to the registry based on matching of the claim number. This is a standardised and secure process which ensures that no patient-level data are provided to the TAC.

Fig. 1. Map of Victorian Local Government Areas with the Greater Melbourne region outlined.

Procedures

The TAC provided data relating to TAC claims, client and service provider addresses for all TAC funded services between January 1 2006 and December 31 2019. Any records without TAC claim numbers were removed to ensure the sample included only cases with a transport-related injury event.

Services were assigned to five categories for analysis, based on the most commonly used: General Practitioner (GP), other medical professionals (that is any doctor who is not a General Practitioner, e.g. neurologists, pathologists, psychiatrists, surgeons), physical therapies, mental health and occupational therapy (OT). Mental health included psychology, social work and case management. Physical therapies incorporated physiotherapy, exercise physiology and hydrotherapy.

Demographic characteristics, including age at the time of injury, sex, nature of injury, discharge destination, injury severity (ISS (AIS 2005, 2008 update)) mechanism of injury and pre-existing health conditions (Charlson Comorbidity Index) [17] were extracted from the VSTR (Fig. 1).

Local government areas (LGAs) were chosen as the geographic area for analysis. The choice of LGAs was data-driven, to ensure sufficient numbers in each spatial unit. Victoria is divided into 80 LGAs including unincorporated areas of Victoria. Melbourne metropolitan areas were considered to be LGAs within the Greater Melbourne region (n = 31) and regional areas of LGAs outside of this region (n = 48) (Fig. 2) [18]. Participants' LGAs were determined based on their home address at the date of hospital discharge.

The Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) by LGA was used as a proxy for socioeconomic status [19]. The Accessibility/Remoteness Index of Australia (AIRA+) according to LGA was sourced from the Australian Bureau of Statistics (ABS) and categorised into major city, inner regional and outer regional areas, based on average index values for postcodes within that LGA [20].

Geospatial procedures

Geocoding, the process of linking geographic coordinates to a description of a location, was completed for each participant's street address in RStudio version 3.5.1 [21]. Geocodes were cross-checked manually for 100 random addresses using Google Maps. Service provider locations were also geocoded by street address, with incomplete provider locations completed manually using Google Maps and a subset of the coordinates confirmed using Google Maps.

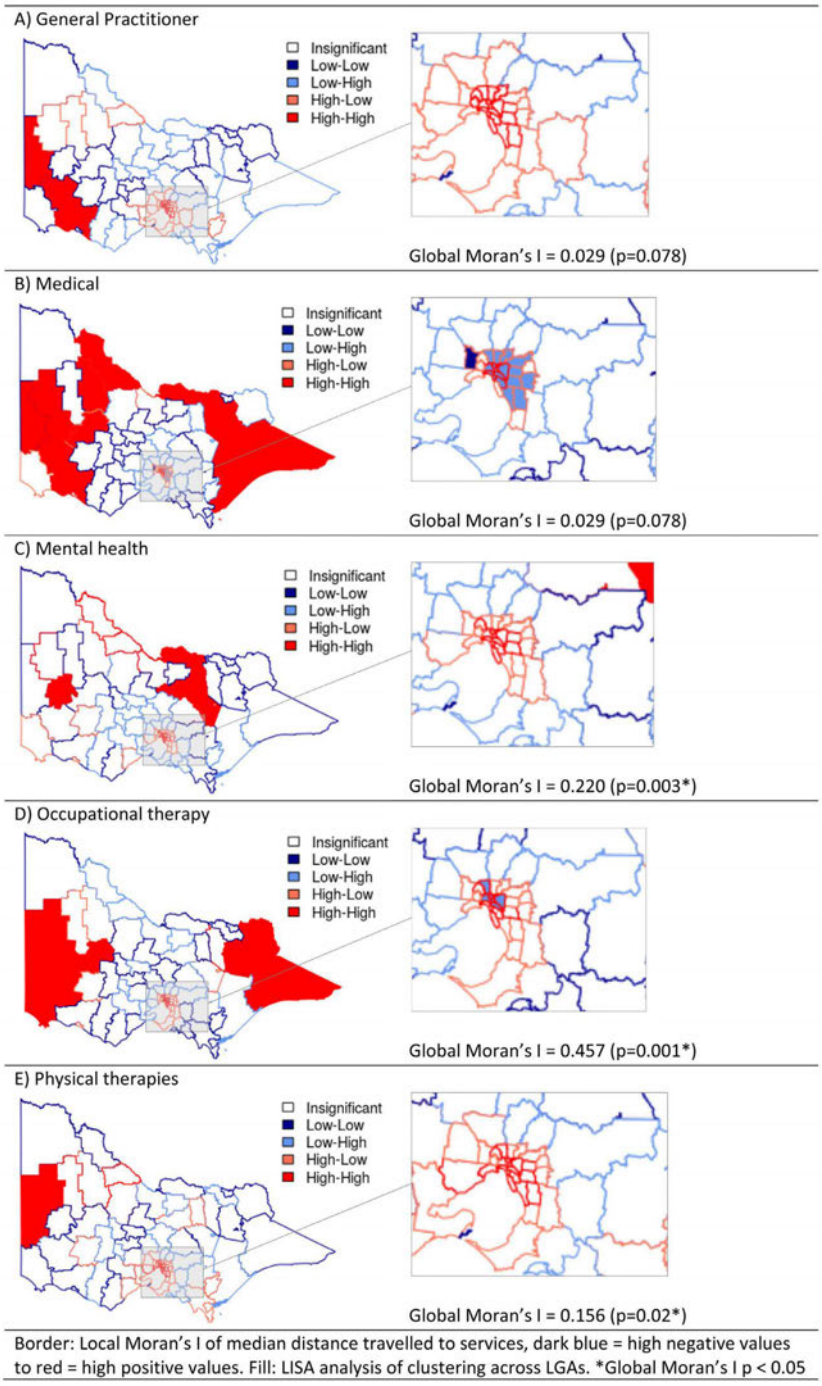

Fig. 2. Geospatial clustering with LISA analysis by LGA.

As multiple locations could exist for a single service provider, we mapped all travel distances (using Here Routing API (https://developer.here.com) and calculated the distance to the nearest provider. This decision was made under the assumption that people would visit the closest provider to their homes.

Data analysis

Summary statistics were used to describe the distance travelled to access services and the number of services utilised in each category over three years and by LGA. The number of trips per person were calculated among people using the service. To identify patterns in regional variation, geospatial mapping of the median distance travelled was completed for each service category, by LGA.

Local Moran's I was used as a local indication of spatial autocorrelation (LISA) statistic to indicate clustering of similarly large or small distances travelled to services across LGAs relative to the mean travel distance, as well as spatial outliers where large distances are surrounded by smaller values and vice-versa [22]. LISA analysis was run using a row standardised spatial weights matrix based on the number of neighbours surrounding each LGA.

Global Moran's I was calculated to assess spatial correlation in the sample [23] and Local Moran's I used as a local indication of spatial autocorrelation (LISA) statistic to explore spatial clustering in the distances travelled by LGA.

Data analysis was completed in Stata 16.0 with geospatial analysis and mapping conducted using RStudio version 3.5.1 [21].

Ethics approval

The VSTR has ethics approval from the Department of Health and Human Services Human Research Ethics Committee (HREC) (reference_11/14), Monash University and all trauma receiving hospitals in the system. This study was approved by the Monash University HREC (Project ID 18433).

Results

Out of 8,112 transport-related major trauma cases, 80.9% (n = 6564) were eligible with at least three years of TAC claims data and a known discharge address, and were included in the study (see Supplementary Material, Figure 2). Participant characteristics are presented in Table 1.

In the first three years post-discharge, 4,964 people (75.6%) visited a GP for injury-related services, 5,058 (77.0%) saw other medical professionals, 2,269 (34.6%) accessed mental health services, 2,154 (32.8%) saw an OT and, 4,404 (67.0%) attended a physical therapy service (Table 2). The total number of people using health services declined over time across all categories. However, the median number of trips per person remained consistent over time in each service, except for physical therapies where the number of trips per person reduced from 23 in year-one, to 18 trips in year-two and 14 in year-three (Table 2). Median trip distances in the three-year period and for each year post-discharge are also shown in Table 2 for each service. Full summary statistics of distances travelled by individual LGA in each service category can be found in Supplementary Material (Table 2).

Areas of significant spatial clustering were identified by LISA analysis (Fig. 2). High-high clusters indicated areas of larger travel distances where there were similarly high values in neighbouring LGAs than would be expected by chance. In contrast, the high-low and low-high clusters reflect spatial outliers indicating LGAs where higher distances travelled are surrounded by lower distances than would be expected by chance and vice-versa.

Table 1
Participant characteristics (n = 6564).

	N	(%)
Gender		
Male	4501	(68.6%)
Age group, years		
18-24	1452	(22.1%)
25-34	1232	(19.8%)
35-44	1131	(17.2%)
45-54	986	(15.0%)
55-64	728	(11.1%)
65-74	539	(8.2%)
75+	496	(7.6%)
Injury Severity Score (ISS), median (IQR)	18	(14-26)
Charlson Comorbidity Index[17] weight (CCI)[a]		
0	4049	(61.7%)
1	1950	(29.7%)
>1	508	(7.7%)
Acute hospital LOS (days), median (IQR)	9	(5-17)
Remoteness classification (ARIA+ 2016)		
Major cities	4460	(67.9%)
Inner regional	4634	(24.9%)
Outer regional	470	(7.2%)
Socioeconomic status (IRSAD)		
1 (most disadvantaged)	1033	(15.7%)
2	662	(10.1 %)
3	1213	(18.5%)
4	1913	(29.1%)
5 (least disadvantaged)	1743	(26.6%)
Nature of injury		
Isolated head injury	173	(2.6%)
Spinal cord injury	152	(2.3%)
Head and other associated injuries	1766	(26.9%)
Multi-trauma and/or other system injuries	4318	(57.7%)
Orthopaedic injuries only	784	(10.5%)
Discharge destination		
Home	2255	(34.4%)
Other (e.g. inpatient rehabilitation)	4309	(65.6%)
Road user[b]		
Motor vehicle driver or passenger	3804	(58.0%)
Motorcyclist	1427	(21.7%)
Pedestrian	883	(13.5%)
Bicyclist	332	(5.1%)
Train/Tram user	12	(0.2%)

[a] n = 57 missing.
[b] n = 106 missing.
Abbreviations: LOS, length of stay; IQR, Interquartile Range; ARIA+, Accessibility/Remoteness Index of Australia; IRSAD, Index of Relative Socio-economic Advantage and Disadvantage.

General practitioner

Seventy-five percent of LGAs across Victoria had a median travel distance per person of less than 10km (Fig. 3A). In metropolitan areas, the median travel distance was 4.2km (IQR 1.9-9.6) compared to regional LGAs where the median travel distance was 6.2 km (IQR 1.9-20.2). High-high spatial clustering of increased travel distance was notable in the south-west of Victoria (Fig. 2).

Medical

People travelled further to attend other medical appointments than GP appointments with a median distance travelled of 17.5km (IQR 7.6-43.6). Spatial analyses demonstrated higher median travel distances per person in regional LGAs (median = 86.5km; IQR 28.7-158.3), compared to metropolitan LGAs (median = 13.5km; IQR 6.9-25.6), Fig. 3B. Large high-high spatial clusters were identified in the far east and far west of Victoria aligning with the largest distances travelled (Fig. 2). A cluster of low-high spatial outliers were also identified in innermost metropolitan areas (Fig. 2).

Table 2
Service usage and distanced travelled by service type in first three years post-hospital discharge.

Service Type	Overall (3 years)	Year 1	Year 2	Year 3
General Practitioner				
Participants using service (n, %)	4964 (75.6)	4604 (70.1)	2889 (44.0)	2201 (33.5)
Trips per person (median, IQR)	10 (3-26)	5 (2-11)	5 (2-10)	5 (2-10)
Trip distance (km), per person				
All LGAs (median, IQR)	4.5 (1.9-12.2)	4.4 (1.9-12.3)	4.6 (2.0-12.8)	5.1 (2.1-14.4)
Metropolitan LGAs (median, IQR)	4.2 (1.9-9.6)	-	-	-
Regional LGAs (median, IQR)	6.2 (1.9-20.2)	-	-	-
Medical (other)				
Participants using service (n, %)	5058 (77.0)	4619 (70.4)	2733 (41.6)	1909 (29.1)
Trips per person (median, IQR)	5 (2-12)	3 (2-6)	3 (1-5)	2 (1-4)
Trip distance (km), per person				
All LGAs (median, IQR)	17.9 (7.7-44.8)	17.7 (7.5-44.0)	18.0 (7.8-44.4)	19.3 (8.1-49.0)
Metropolitan LGAs (median, IQR)	13.5 (6.9-25.6)	-	-	-
Regional LGAs (median, IQR)	86.5 (28.7-158.3)	-	-	-
Mental health				
Participants using service (n, %)	2269 (34.6)	(25.9)	1369 (20.9)	1039 (15.8)
Trips per person (median, IQR)	14 (5-38)	6 (3-13)	8 (3-17)	9 (3-16)
Trip distance (km), per person				
All LGAs (median, IQR)	12.5 (5.3-28.8)	13.3 (5.2-29.7)	12.1 (5.2-29.7)	13.4 (6.0-29.7)
Metropolitan LGAs (median, IQR)	11.3 (5.2-23.7)	-	-	-
Regional LGAs (median, IQR)	24.0 (6.0-88.9)	-	-	-
Occupational therapy				
Participants using service (n, %)	2154 (32.8)	1799 (27.4)	943 (14.4)	634 (9.66)
Trips per person (median, IQR)	12 (4-39)	8 (3-20)	9 (2-27)	10 (3-29)
Trip distance (km), per person				
All LGAs (median, IQR)	18.2 (8.0-35.9)	16.8 (6.9-33.7)	19.9 (9.7-37.7)	22.4 (10.9-40.9)
Metropolitan LGAs (median, IQR)	16.6 (8.0-28.4)	-	-	-
Regional LGAs (median, IQR)	52.5 (9.4-99.5)	-	-	-
Physical therapies				
Participants using service (n, %)	4404 (67.0)	3930 (59.9)	2309 (35.2)	1581 (24.1)
Trips per person (median, IQR)	36 (12-75)	23 (9-48)	18 (7-42)	14 (5-32)
Trip distance (km), per person				
All LGAs (median, IQR)	7.6 (3.0-20.3)	7.9 (3.0-20.4)	7.6 (3.0-21.4)	3.2 (8.1-22.2)
Metropolitan LGAs (median, IQR)	7.0 (3.0-17.1)	-	-	-
Regional LGAs (median, IQR)	10.6 (3.0-33.5)	-	-	-

Abbreviations: Km, kilometres; IQR, interquartile range; LGAs, local government areas.

Mental health

Areas of increased distance were apparent in the north-east and far west regions of Victoria (Fig. 3C). The variation in median travel distance per person was notable between metropolitan and regional LGAs with median distances 11.3km (IQR 5.2-23.1) in metropolitan LGAs relative to a median of 24.0km (IQR 6.0-88.9) in regional LGAs. High-high spatial clusters were identified in the north-east part of the state and far west Victoria (Fig. 2).

Occupational therapy

The median distance travelled for people in metropolitan LGAs was 16.6km (IQR 8.0-28.4). This is in contrast to regional LGAs where the median distance per person was 52.5km (IQR 9.4-99.5). Additionally, the median distance travelled per person in fourteen regional LGAs (17.7%), was over 120km (Fig. 3D). Large high-high spatial clusters were also evident in these areas of increased distance travelled through far east and far west Victoria (Fig. 2). Smaller low-high outlier clusters were observed in inner-metropolitan LGAs (Fig. 2).

Physical therapies

A number of regional LGAs had higher median travel distances relative to metropolitan LGAs particularly in western areas of Victoria (Fig. 3E) with the median distance travelled from regional LGAs being 10.6km (IQR 3.0-33.5). This was greater than the median distance travelled from metropolitan LGAs of 7.0km (IQR 3.0-17.1). A small high-high spatial cluster was identified in far west Victoria (Fig. 2).

Discussion

In the first three years following transport-related major trauma, people in regional LGAs commonly travelled further to access health services than those living in metropolitan LGAs. Specific clustering of increased travel distances was observed in regional LGAs in the far west and north-east of Victoria indicating specific areas of larger travel distances where there are similarly high values in neighbouring LGAs. The number of people using services (GP, medical, mental health, physical therapies, OT) declined with each subsequent year beyond discharge. However, the number of trips were consistent over time for people still engaged in services, except for physical therapies where the number of trips reduced over time.

To our knowledge, this is the first study to explore variation in distances travelled to health services following traumatic injury. Limited studies have previously explored this concept with one study finding no significant association between travel time and access to gynaecological services and another reporting the need for people living with HIV to travel further distances to access healthcare [14,15]. Across all service categories, the median distance travelled in regional LGAs, was further than travelled in metropolitan LGAs. The increased travel distance may reflect the known shortages of specialised care in regional areas [24,25]. Travelling long distances to access services can exacerbate symptoms associated with injury [8]. For people having to attend multiple therapies and medical appointments, the productivity and time lost due to travel may also negatively impact return to work and life roles in the years following hospital discharge. Exploring alternative models of service delivery such as telehealth and outreach

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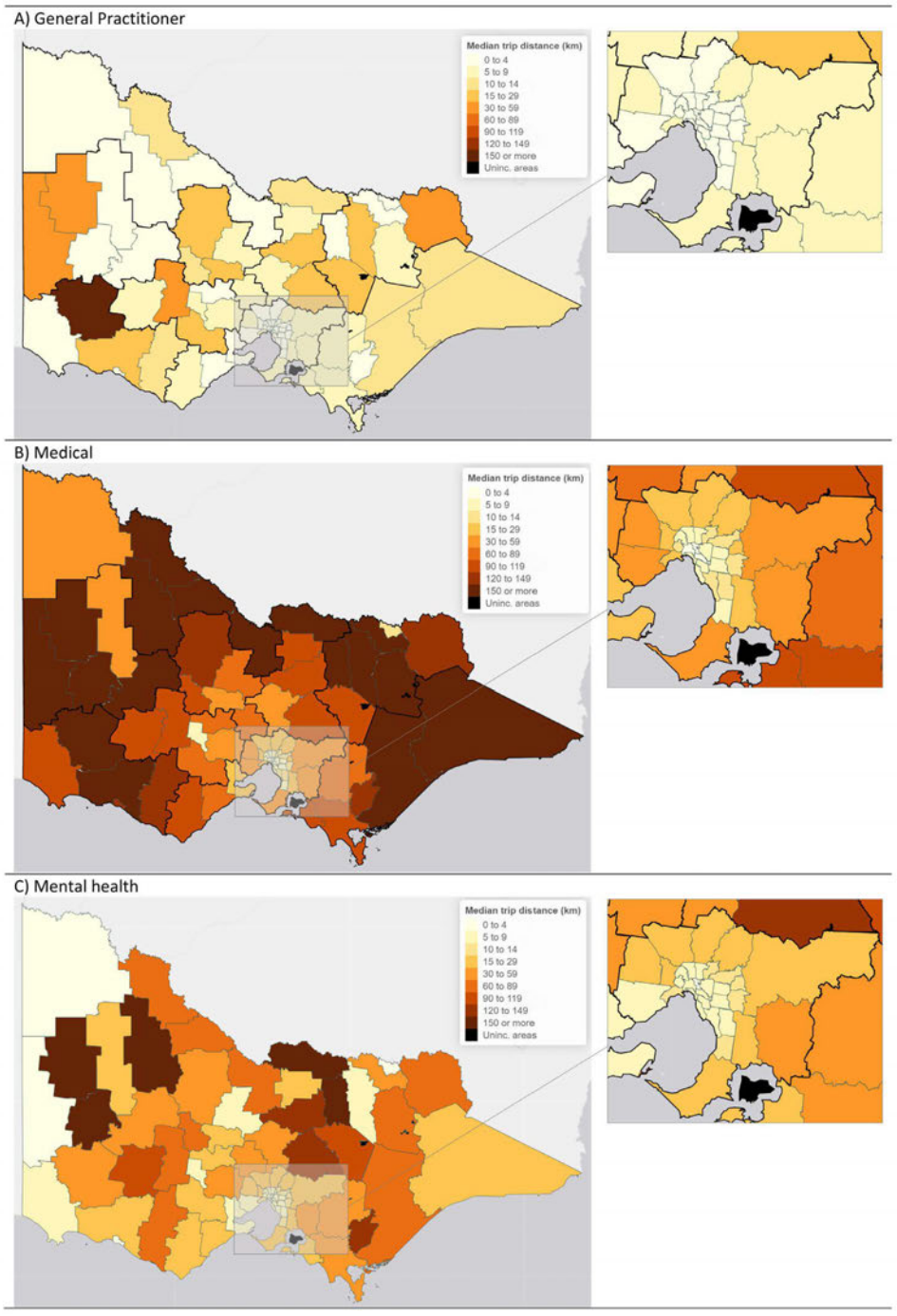

Fig. 3. Median trip distance travelled per person by local government area.

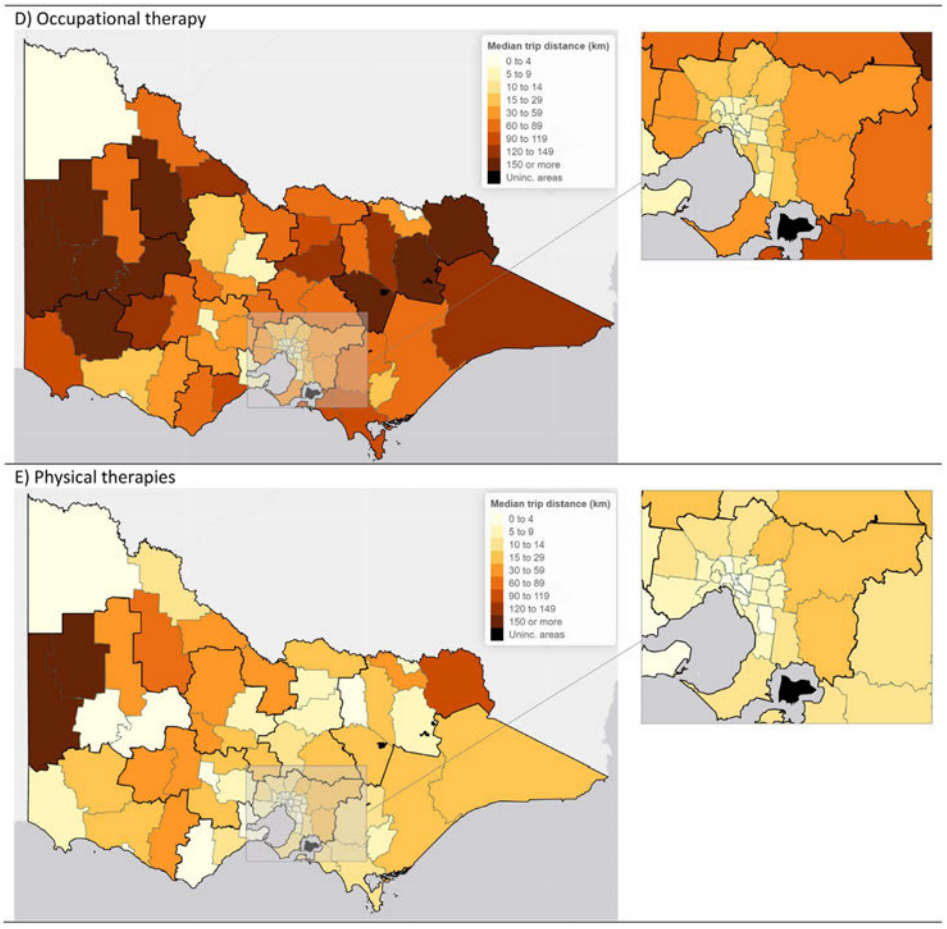

Fig. 3. Continued

clinics, or increased investment in regional services, may help to improve accessibility and reduce the associated burden of travel in this population [26].

With improved survival following traumatic injury, it is essential to understand patterns of long-term service usage and where gaps in services may for certain geographic areas. We found a higher rate of GP and mental health service use than has been previously reported in people following traumatic injury [25]. This may have been due to the study being limited to people covered by insurance as a result of their transport-related injury. However, the sustained engagement in health services, particularly GP, physical therapies and mental health services over the three-year period, reinforce the need for equitable access and availability of health services for people following transport-related major trauma. This is particularly important in populations claiming compensation for their injuries, as compensable patients have been shown to have a slower, prolonged recovery with improvements in outcomes beyond two years post injury [6]. A coordinated approach to post-discharge care to ensure the rehabilitation needs of this population are met is important to optimise long-term health outcomes [27].

In this study the percentage of people using services reduced over time whilst the number of visits remained consistent. This may be due to the type of clientele requiring longer term health services. Participants no longer requiring input are likely to have had a good functional recovery, compared to those with ongoing disability who have a need for services up to three years following injury [28]. Previous research on service in orthopaedic trauma patients found that injury severity was not a predictor of service use. However, people with greater disability and those who were receiving compensation were significantly more likely to be using services at six months [28]. The inclusion of people receiving compensation in the current study may also have contributed to their prolonged service use.

Major trauma patients are typically younger, as is reflected in the current study population. Due to the omission of people whose injuries were sustained as a result of falls, domestic violence, self-harm, stabbing and burns in this study, there was less representation of major trauma in older persons. Between 2007 and 2016 the number of major trauma patients aged older 65 years more than doubled [29]. In Victoria, low and high falls accounted for 47% of major trauma in 2019–20 and of patients injured in a low fall,

80.2% were aged 65 years or older [30]. Further research is necessary to understand if age may be a factor influencing access to health services and whether there are additional challenges faced by older persons with major traumatic injuries.

The current study is a large population-based capture of people following transport-related major trauma. Additionally, this study involved the linkage of large data sets with near-complete capture of post-discharge services funded by TAC. One limitation was that it was not possible to establish the exact location of service provision if a service provider worked across multiple sites. To conservatively manage this issue, we used the shortest distance to a provider from an individual's residence, assuming that patients are most likely to travel to the closest facility available for that specific provider. Additionally, it was not possible to ascertain the date of discharge from rehabilitation hospitals for those not discharged directly home from acute care. This may have impacted the distance of travel if follow up appointments were attended during a rehabilitation stay and not from an individual's residential address. However, with the service descriptions included in the TAC data it was possible to identify most outpatient services and thus this issue is unlikely to have impacted the results. This study assumed that people were accessing services from their home rather than a place of work which may affect the distance travelled. Furthermore, to enable analysis of this data we assumed that all participants used the same mode of transport, i.e. car travel, to access services. Whilst this may not always be the case, as patients funded by TAC compensation can receive reimbursement for taxi travel or motorised travel expenses, it is likely that participants would preferentially choose this option over public transport, cycling or walking.

Conclusion

Recovery following transport-related major trauma is complex and involves numerous health professions for years following hospital discharge. This paper highlights spatial inequalities in access to health services, the magnitude of which varies by service type, thus placing an increased burden on people in some regional LGAs. These findings contribute to our understanding of access to health services follow transport-related major trauma and reinforce the need for long-term access to allied health and medical professionals up to three years following hospital discharge. Additional research exploring what factors contribute to the existing spatial clusters will provide insights into the lack of necessary services in certain geographic areas. These data will also enable further research into the potential association between distances travelled to health services and health outcomes. This work is necessary to direct ongoing research efforts into the potential need for a coordinated, long-term approach to post-discharge care for optimal recovery following transport-related major trauma.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2021.12.011.

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3. 6 Summary of Chapter Three

The two studies presented in this chapter provide important insights into post-discharge care of people following serious injury across urban and regional Victoria from the perspectives of health care providers. The results suggest that allied health professionals experience a number of challenges in the provision of optimal care to people following serious injury with issues affecting people in both urban and regional areas.

The limited availability of necessary health professionals, particularly mental health providers was perceived to impact on an individual's ability to access required care and impacted the ability for other AHPs to meet the needs of their patients if they were required to provide additional psychological support, often which was outside their scope of practice. Additional barriers to accessing health care included the reliance on others for transportation and large travel durations to reach care. Notably, this work also highlighted the willingness of AHPs to implement telehealth services to improve the ability for people to access health services and improve communication between health care providers caring for people following serious injury.

This research was conducted prior to the coronavirus (COVID-19) pandemic when telehealth services were not routinely offered to patients. With the necessity for implementation of telehealth services during COVID-19, great progress has been made in telehealth over the last year. This research supports the need for these learnings to be sustainable beyond the pandemic to improve access to care and reduce the travel burden commonly experienced by people with serious injury.

Chapter Four: Quantifying regional variation in access to health services and service use following transport-related major trauma

4.1 Introduction

Through the studies described in Chapter Three it was evident that AHPs perceived many inherent challenges for people with serious injury livingin regional areas of Victoria receiving equitable post-discharge care. The perspectives ofallied health professionals in these studies aligned with previous research on post-discharge care involving major trauma patients and caregivers.[20-22] Particularly, AHPs identified the issues of travel distance to health care, transportation difficulties and limited availability of adequately trained providers.[22, 94] To optimise service delivery models beyond hospital discharge, it is necessary to better understand whether regional variation exists in distances travelled to health services and service utilisation following serious injury.

In undertaking this investigation health care, we used linked VSTR and TAC data with TAC data providing information on treatments received following transport-related injuries. In 2019-20, 35% of major trauma resulted from transport-related events and 31% of people with major trauma had a TAC claim number,[18] representing approximately 15% of all major trauma patients in Victoria.

The aims of the studies presented in this chapter were to:

1. Use geospatial analysis to explore the distances people travelled to access health servicesfollowing major transport-related injury.

2. Identify patterns of health service use in the first three years following transport-related major trauma.
3. Describe regional variation in service use and distance travelled to post-discharge health services for people with traumatic orthopaedic, brain and spinal cord injuries.

These studies address the third and fourth research objectives for this thesis.

4.2 Ethics statement

This study was approved by the Monash University HREC (Project ID 18433). The VSTR has ethics approval from the Department of Health and Human Services Human Research Ethics Committee (HREC) (reference_11/14), Monash University and all trauma receiving hospitals in the system.

4.3 Data Preparation

The following four linked datasets were used in this project:

1. Victorian State Trauma Registry extract of all major trauma patients injured between January 2006 to December 2016 (n=14,511).

2. TAC services data: all services paid for by the TAC to TAC clients between January2006 and December 2019 (observations=4,666,147).

3. TAC client data: all client street addresses held by the TAC since the date of initial claim, and the date a new residential address was lodged (n(records)=22,230).

4. TAC service provider addresses: full street addresses for all providers

servicing TAC clients (n(records)=1,048,576)

To merge the datasets into a working file for analysis, several preparatory steps were required.

i. Participant selection

Participants who had a TAC claim, were older than 18 years old and survived to three years following hospital discharge were identified from the VSTR data set. This dataset was then merged with the TAC client data based on a patient identification number. Participants were excluded if their address was listed as a Post Office box, was incomplete or unknown or if their residential address was outside of Victoria.

ii. Identification of relevant services

From the 4,666,088 service records, approximately 1.5 million were removed as they related to in-hospital services. The cleaned participant sample was then merged into theTAC service data with services not relating to post-discharge care removed, e.g. pathology, radiology and hospital fees. The service date anddate of discharge were both known so it was possible to exclude services received by the individual prior to discharge that had not been otherwise coded as 'in-hospital'. From the descriptions of services provided by the TAC it was not clear what items were relatingto medical or allied health services so it was necessary to closely examine each service description and re-classify the service category. Any services that were not centre-based (i.e. the client travelled to a provider location) were also excluded to ensure travel distances were accurately reported. This meant that any home-based or community-based services, including workplace visits, were

not included in this study.

iii. Determine client address at date of service

If a client had multiple addresses on record, it was necessary to determine the client's address at the time of each service. This was possible as the date an individual changed their address was recorded by the TAC in the client address data. The dataset ofparticipants' addresses was merged with the service data and a single address for each client was determined for each service record.

iv. Link service provider addresses data with TAC services data

The service provider addresses were merged with the TAC services data and client address data. Unlike the client addresses, there were multiple addresses pertaining to asingle provider number and provider due to the fact that they often practiced from variety of locations. As the specific location of where the service was provided could not be determined, we included all service provider locations and then used the closest provider location to an individual's place of residence. Any incomplete service provider locations were entered manually usingGoogle Maps and addresses listed as Post Office boxes removed.

v. Geocoding

All unique client addresses and service provider addresses were then exported into RStudio version 3.5.1, R Core Team, Vienna, Austria (RStudio)[95] to ascertain all corresponding geographic coordinates, geocodes, for each location using a Google Application Programming Interface (API) and the 'mapsapi' package. The geocodes from a random selection of 100 addresses were then manually cross-checked for quality using Google Maps, with 98% accuracy.

vi. Trip distance calculation

Once the geocodes were computed for all client and service provider addresses, it waspossible to commence the geospatial analysis to determine trip distances. The travel time and distances were calculated in RStudio[95] using the HERE Routing API (https://developer.here.com) for each route.

vii. Sensitivity analysis

Sensitivity analysis comparing the minimum distance to median distance travelled when therewere multiple provider addresses suggested that, when aggregated by LGA, there was less than 10km difference between the minimum and median values in 99% of LGAs (78 of 79). Therefore, we chose to use the minimum (shortest) distance between service provider and aclient's residential address under the assumption that people are most likely to travel to the nearest provider location for care.

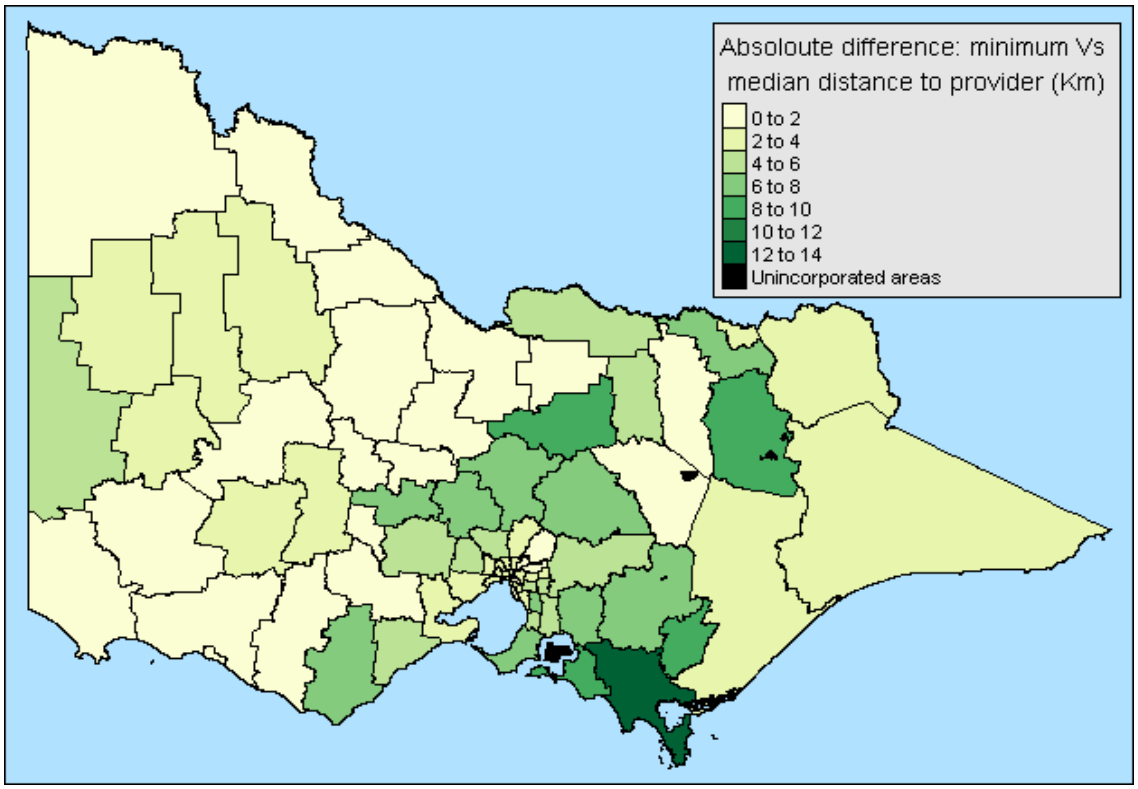

Figure 4. Absolute difference between minimum and median distance to provider by Local Government Area

4.4 Spatial unit: Local Government Areas

For the geospatial element of the project, we chose to use Local Government Areas (LGAs) as the spatial unit (Figure 5). Local Government Areas are administrative boundaries defining an area that local governments are responsible for managing. As geographical areas, LGAs are distinct, with established data profiles and are commonly used to support healthservice planning and policy development. The Australian Bureau of Statistics (ABS) providegeographic boundaries for LGAs in each state and territory. For this study, a shapefile of Victorian LGA boundaries was downloaded from the ABS website and imported into RStudio[95] The median distances travelled in each service category were aggregated at an individual-level by LGA for analysis. The map of Victorian LGAs was used to visually represent the geospatial analysis of trip distance by LGA. Median values were used due to the heavily skewed distribution of the data. The histograms of trip distance by LGA are presented in Appendix 7.

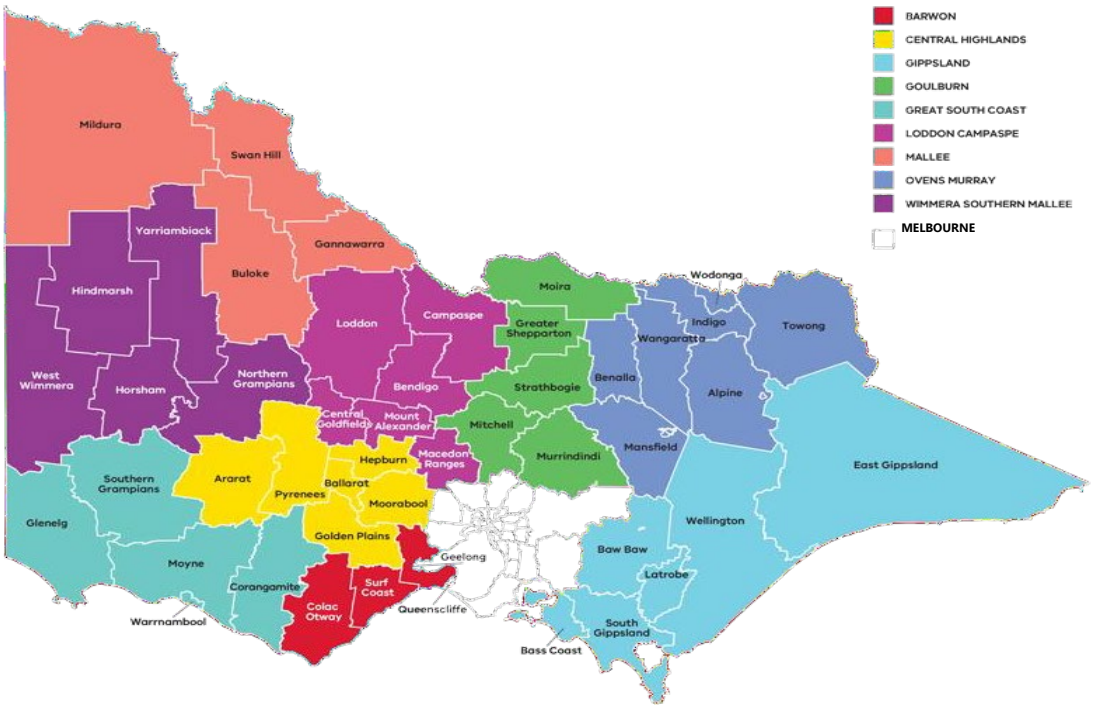

Figure 5. Map of Victoria by Local Government Area and geographic regions

4.5 Paper Four

4.5.1 Overview

In Paper Three, the findings showed that AHPs perceived that challenges to accessing health care exist for people with serious injuries in both metropolitan and regional areas. Particularly for people in regional areas, long travel distances and associated costs were reported to be significant barriers to accessing necessary care. The next paper used geospatial analysis to explore regional variation in distances travelled to health services for Victorian major trauma patients in the first three years following hospital discharge.

4.5.2 Manuscript

Keeves J, Gabbe BJ, Ekegren CL, Fry R, Beck B. (2021). Regional variation in travel to health services following transport-related major trauma. *Injury*. doi:10.1016/j.injury.2021.12.011

Supplementary material for this paper is presented in Appendix 8.

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Regional variation in travel to health services following transport-related major trauma

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ABSTRACT

Introduction: Post-discharge healthcare needs are complex and persistent for people following major trauma. A number of geographic barriers to accessing healthcare exist, particularly for people in regional areas. The aim of this study was to explore regional variation in the distances travelled to access health services and identify patterns of health service use in the first three years following transport-related major trauma.

Methods: This registry-based cohort study used linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC). Victorians who sustained major trauma from a transport-related event between January 1 2006 and December 31 2016, with at least three years of follow-up TAC claims data were included in the study. Geospatial mapping of the median distance travelled to medical and allied health services was conducted for each Victorian Local Government Area.

Results: In the first three years post-discharge, 4,964 people (75.6%) visited a general practitioner, 5058 (77.0%) saw other medical professionals, 2269 (34.6%) accessed mental health services, 2154 (32.8%) saw an occupational therapist and 4404 (67.0%) attended a physical therapy service. Geospatial mapping revealed that people in regional Local Government Area travelled further distances to access health services. Specific clustering of increased travel distances was observed in regional areas of the far west and north-east of Victoria. The number of people using services declined with each subsequent year beyond hospital discharge. However, the number of trips were consistent over time for those still engaged in services.

Conclusions: Distances travelled to access health services vary across geographic regions and may result in an increased travel burden for those in some regional Local Government Area. Understanding gaps in health services by geographic region can assist to improve service availability. Alternate service delivery methods, such as telehealth, may assist to reduce the associated burden of travel for those in regional areas.

Introduction

Developments in trauma systems and acute trauma care have improved survival rates [1–3] and functional outcomes following injury [4,5]. However, the majority of major trauma patients continue to experience poor long-term mental and physical health outcomes [6]. People with transport-related injuries, in particular, have reported discontinuity of post-discharge health care and difficulties accessing necessary follow-up care and rehabilitation [7,8].

Inclusive trauma systems are considered the gold standard of trauma care, providing an organised pre-hospital and triage pathway to specialised tertiary care [1]. However, the role of geography in accessing health services following major trauma is not well understood. With specialised trauma centres commonly located in metropolitan areas, there is potential for disparity of access to necessary post-discharge care, especially for patients residing in regional areas [9]. Travel distance to services has been a reported barrier to accessing healthcare, disproportionately affecting people living outside of metropolitan areas [10]. People who are required to travel further to access healthcare also commonly experience poorer long-term health outcomes [11].

To our knowledge, no research has investigated the variation in post-discharge health service use across geographic regions following transport-related major trauma. Geospatial analyses have been

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used to identify gaps in service availability and patterns of healthcare usage for people following transport-related injury [12] and a range of other health conditions [13–15]. These methods have not yet been applied to major trauma populations. This study used geospatial analysis to explore regional variation in the distances travelled to access health services by local government areas (LGAs) and identify patterns of health service use up to three years following transport-related major trauma.

Materials and methods

Study design

Registry-based cohort study using linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC).

Setting and participants

Victoria is a state of Australia with a population of 6.46 million people including over 2 million people outside of metropolitan Melbourne (see population distribution in Supplementary Material, Figure 1) [16]. Victoria has an inclusive trauma system with two adult, and one paediatric, major trauma centres, located in metropolitan Melbourne. These services provide definitive care for 79% of major trauma cases in Victoria [9].

Participants

Victorians who sustained major trauma from a transport-related event, with a TAC compensation claim between January 1 2006 and December 31 2016 were identified within the VSTR. Cases were included if they were aged 18 years or older at the time of injury and had at least three years of TAC claims data available after their date of acute hospital discharge. Participants were excluded if they did not survive to three years post-discharge or their residential street address was unknown, incomplete or outside of Victoria (Supplementary Material, Figure 2).

Data sources

Transport accident commission

The TAC is the state's no-fault third-party injury insurance scheme providing compensation for medical expenses, rehabilitation, support services and financial assistance for people who have sustained transport-related injury. As well as capturing data pertaining to an individual claim, the TAC captures detailed information regarding post-discharge health services for which they have paid, including details of service type and service description, service date and associated provider locations.

Victorian state trauma registry

The VSTR is a population-based registry that collects data about all people with major trauma in Victoria, defined as: death due to injury; an Injury Severity Score (ISS; based on the Abbreviated Injury Scale (AIS) 2005 version, 2008 update) >12; admission to an intensive care unit (ICU) > 24 hours; or an injury requiring urgent surgery [2]. The registry includes data about prehospital care, pre-existing health conditions, injury characteristics and complications, and discharge information. The opt-out rate is <1% [2]. Claims data from the TAC are provided to the registry based on matching of the claim number. This is a standardised and secure process which ensures that no patient-level data are provided to the TAC.

Fig. 1. Map of Victorian Local Government Areas with the Greater Melbourne region outlined.

Procedures

The TAC provided data relating to TAC claims, client and service provider addresses for all TAC funded services between January 1 2006 and December 31 2019. Any records without TAC claim numbers were removed to ensure the sample included only cases with a transport-related injury event.

Services were assigned to five categories for analysis, based on the most commonly used: General Practitioner (GP), other medical professionals (that is any doctor who is not a General Practitioner, e.g. neurologists, pathologists, psychiatrists, surgeons), physical therapies, mental health and occupational therapy (OT). Mental health included psychology, social work and case management. Physical therapies incorporated physiotherapy, exercise physiology and hydrotherapy.

Demographic characteristics, including age at the time of injury, sex, nature of injury, discharge destination, injury severity (ISS (AIS 2005, 2008 update)) mechanism of injury and pre-existing health conditions (Charlson Comorbidity Index) [17] were extracted from the VSTR (Fig. 1).

Local government areas (LGAs) were chosen as the geographic area for analysis. The choice of LGAs was data-driven, to ensure sufficient numbers in each spatial unit. Victoria is divided into 80 LGAs including unincorporated areas of Victoria. Melbourne metropolitan areas were considered to be LGAs within the Greater Melbourne region (n = 31) and regional areas of LGAs outside of this region (n = 48) (Fig. 2) [18]. Participants' LGAs were determined based on their home address at the date of hospital discharge.

The Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) by LGA was used as a proxy for socioeconomic status [19]. The Accessibility/Remoteness Index of Australia (AIRA+) according to LGA was sourced from the Australian Bureau of Statistics (ABS) and categorised into major city, inner regional and outer regional areas, based on average index values for postcodes within that LGA [20].

Geospatial procedures

Geocoding, the process of linking geographic coordinates to a description of a location, was completed for each participant's street address in RStudio version 3.5.1 [21]. Geocodes were cross-checked manually for 100 random addresses using Google Maps. Service provider locations were also geocoded by street address, with incomplete provider locations completed manually using Google Maps and a subset of the coordinates confirmed using Google Maps.

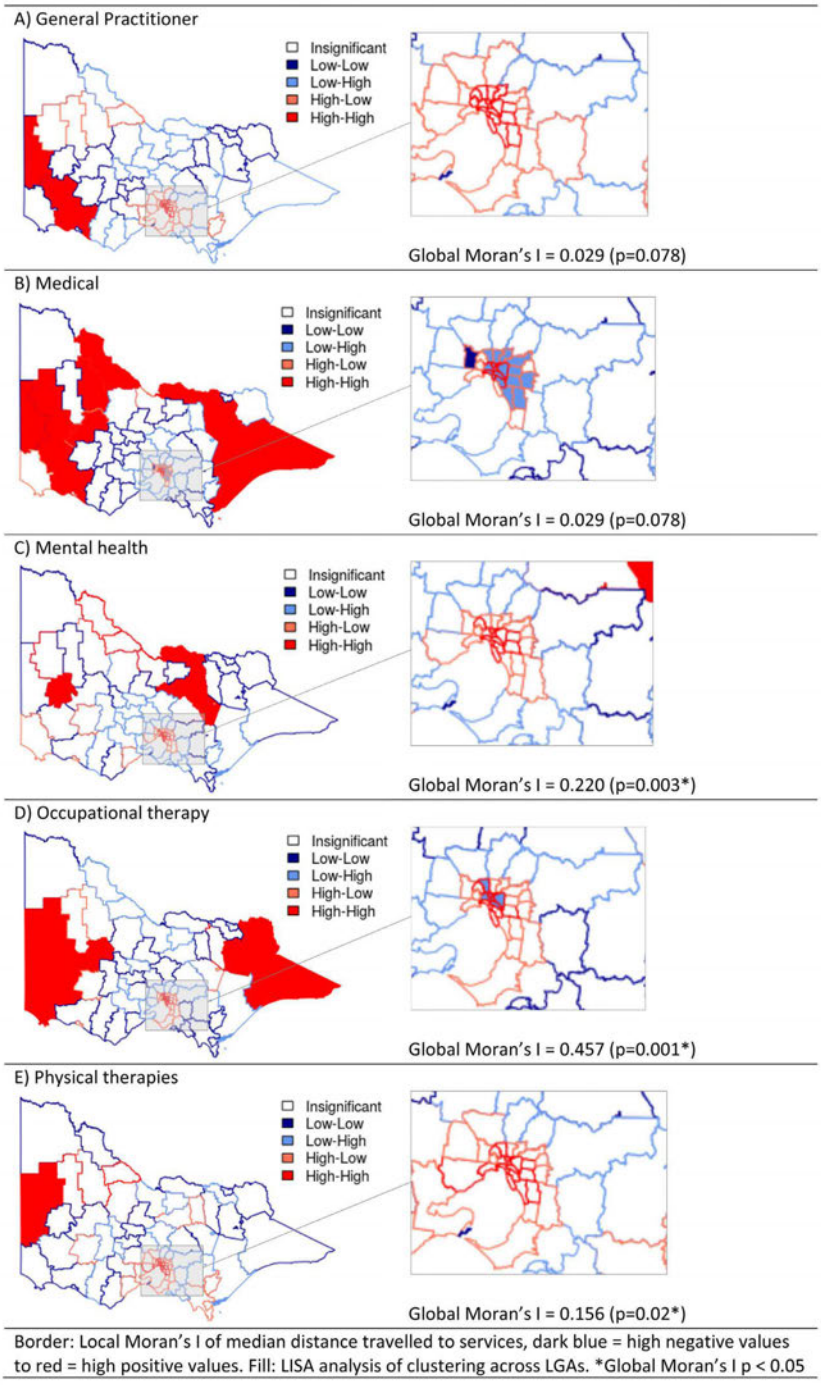

Fig. 2. Geospatial clustering with LISA analysis by LGA.

As multiple locations could exist for a single service provider, we mapped all travel distances (using Here Routing API (https://developer.here.com) and calculated the distance to the nearest provider. This decision was made under the assumption that people would visit the closest provider to their homes.

Data analysis

Summary statistics were used to describe the distance travelled to access services and the number of services utilised in each category over three years and by LGA. The number of trips per person were calculated among people using the service. To identify patterns in regional variation, geospatial mapping of the median distance travelled was completed for each service category, by LGA.

Local Moran's I was used as a local indication of spatial autocorrelation (LISA) statistic to indicate clustering of similarly large or small distances travelled to services across LGAs relative to the mean travel distance, as well as spatial outliers where large distances are surrounded by smaller values and vice-versa [22]. LISA analysis was run using a row standardised spatial weights matrix based on the number of neighbours surrounding each LGA.

Global Moran's I was calculated to assess spatial correlation in the sample [23] and Local Moran's I used as a local indication of spatial autocorrelation (LISA) statistic to explore spatial clustering in the distances travelled by LGA.

Data analysis was completed in Stata 16.0 with geospatial analysis and mapping conducted using RStudio version 3.5.1 [21].

Ethics approval

The VSTR has ethics approval from the Department of Health and Human Services Human Research Ethics Committee (HREC) (reference_11/14), Monash University and all trauma receiving hospitals in the system. This study was approved by the Monash University HREC (Project ID 18433).

Results

Out of 8,112 transport-related major trauma cases, 80.9% (n = 6564) were eligible with at least three years of TAC claims data and a known discharge address, and were included in the study (see Supplementary Material, Figure 2). Participant characteristics are presented in Table 1.

In the first three years post-discharge, 4,964 people (75.6%) visited a GP for injury-related services, 5,058 (77.0%) saw other medical professionals, 2,269 (34.6%) accessed mental health services, 2,154 (32.8%) saw an OT and, 4,404 (67.0%) attended a physical therapy service (Table 2). The total number of people using health services declined over time across all categories. However, the median number of trips per person remained consistent over time in each service, except for physical therapies where the number of trips per person reduced from 23 in year-one, to 18 trips in year-two and 14 in year-three (Table 2). Median trip distances in the three-year period and for each year post-discharge are also shown in Table 2 for each service. Full summary statistics of distances travelled by individual LGA in each service category can be found in Supplementary Material (Table 2).

Areas of significant spatial clustering were identified by LISA analysis (Fig. 2). High-high clusters indicated areas of larger travel distances where there were similarly high values in neighbouring LGAs than would be expected by chance. In contrast, the high-low and low-high clusters reflect spatial outliers indicating LGAs where higher distances travelled are surrounded by lower distances than would be expected by chance and vice-versa.

Table 1
Participant characteristics (n = 6564).

	N	(%)
Gender		
Male	4501	(68.6%)
Age group, years		
18-24	1452	(22.1%)
25-34	1232	(19.8%)
35-44	1131	(17.2%)
45-54	986	(15.0%)
55-64	728	(11.1%)
65-74	539	(8.2%)
75+	496	(7.6%)
Injury Severity Score (ISS), median (IQR)	18	(14-26)
Charlson Comorbidity Index[17] weight (CCI)[a]		
0	4049	(61.7%)
1	1950	(29.7%)
>1	508	(7.7%)
Acute hospital LOS (days), median (IQR)	9	(5-17)
Remoteness classification (ARIA+ 2016)		
Major cities	4460	(67.9%)
Inner regional	4634	(24.9%)
Outer regional	470	(7.2%)
Socioeconomic status (IRSAD)		
1 (most disadvantaged)	1033	(15.7%)
2	662	(10.1 %)
3	1213	(18.5%)
4	1913	(29.1%)
5 (least disadvantaged)	1743	(26.6%)
Nature of injury		
Isolated head injury	173	(2.6%)
Spinal cord injury	152	(2.3%)
Head and other associated injuries	1766	(26.9%)
Multi-trauma and/or other system injuries	4318	(57.7%)
Orthopaedic injuries only	784	(10.5%)
Discharge destination		
Home	2255	(34.4%)
Other (e.g. inpatient rehabilitation)	4309	(65.6%)
Road user[b]		
Motor vehicle driver or passenger	3804	(58.0%)
Motorcyclist	1427	(21.7%)
Pedestrian	883	(13.5%)
Bicyclist	332	(5.1%)
Train/Tram user	12	(0.2%)

[a] n = 57 missing.
[b] n = 106 missing.
Abbreviations: LOS, length of stay; IQR, Interquartile Range; ARIA+, Accessibility/Remoteness Index of Australia; IRSAD, Index of Relative Socio-economic Advantage and Disadvantage.

General practitioner

Seventy-five percent of LGAs across Victoria had a median travel distance per person of less than 10km (Fig. 3A). In metropolitan areas, the median travel distance was 4.2km (IQR 1.9-9.6) compared to regional LGAs where the median travel distance was 6.2 km (IQR 1.9-20.2). High-high spatial clustering of increased travel distance was notable in the south-west of Victoria (Fig. 2).

Medical

People travelled further to attend other medical appointments than GP appointments with a median distance travelled of 17.5km (IQR 7.6-43.6). Spatial analyses demonstrated higher median travel distances per person in regional LGAs (median = 86.5km; IQR 28.7-158.3), compared to metropolitan LGAs (median = 13.5km; IQR 6.9-25.6), Fig. 3B. Large high-high spatial clusters were identified in the far east and far west of Victoria aligning with the largest distances travelled (Fig. 2). A cluster of low-high spatial outliers were also identified in innermost metropolitan areas (Fig. 2).

Table 2
Service usage and distanced travelled by service type in first three years post-hospital discharge.

Service Type	Overall (3 years)	Year 1	Year 2	Year 3
General Practitioner				
Participants using service (n, %)	4964 (75.6)	4604 (70.1)	2889 (44.0)	2201 (33.5)
Trips per person (median, IQR)	10 (3-26)	5 (2-11)	5 (2-10)	5 (2-10)
Trip distance (km), per person				
All LGAs (median, IQR)	4.5 (1.9-12.2)	4.4 (1.9-12.3)	4.6 (2.0-12.8)	5.1 (2.1-14.4)
Metropolitan LGAs (median, IQR)	4.2 (1.9-9.6)	-	-	-
Regional LGAs (median, IQR)	6.2 (1.9-20.2)	-	-	-
Medical (other)				
Participants using service (n, %)	5058 (77.0)	4619 (70.4)	2733 (41.6)	1909 (29.1)
Trips per person (median, IQR)	5 (2-12)	3 (2-6)	3 (1-5)	2 (1-4)
Trip distance (km), per person				
All LGAs (median, IQR)	17.9 (7.7-44.8)	17.7 (7.5-44.0)	18.0 (7.8-44.4)	19.3 (8.1-49.0)
Metropolitan LGAs (median, IQR)	13.5 (6.9-25.6)	-	-	-
Regional LGAs (median, IQR)	86.5 (28.7-158.3)	-	-	-
Mental health				
Participants using service (n, %)	2269 (34.6)	(25.9)	1369 (20.9)	1039 (15.8)
Trips per person (median, IQR)	14 (5-38)	6 (3-13)	8 (3-17)	9 (3-16)
Trip distance (km), per person				
All LGAs (median, IQR)	12.5 (5.3-28.8)	13.3 (5.2-29.7)	12.1 (5.2-29.7)	13.4 (6.0-29.7)
Metropolitan LGAs (median, IQR)	11.3 (5.2-23.7)	-	-	-
Regional LGAs (median, IQR)	24.0 (6.0-88.9)	-	-	-
Occupational therapy				
Participants using service (n, %)	2154 (32.8)	1799 (27.4)	943 (14.4)	634 (9.66)
Trips per person (median, IQR)	12 (4-39)	8 (3-20)	9 (2-27)	10 (3-29)
Trip distance (km), per person				
All LGAs (median, IQR)	18.2 (8.0-35.9)	16.8 (6.9-33.7)	19.9 (9.7-37.7)	22.4 (10.9-40.9)
Metropolitan LGAs (median, IQR)	16.6 (8.0-28.4)	-	-	-
Regional LGAs (median, IQR)	52.5 (9.4-99.5)	-	-	-
Physical therapies				
Participants using service (n, %)	4404 (67.0)	3930 (59.9)	2309 (35.2)	1581 (24.1)
Trips per person (median, IQR)	36 (12-75)	23 (9-48)	18 (7-42)	14 (5-32)
Trip distance (km), per person				
All LGAs (median, IQR)	7.6 (3.0-20.3)	7.9 (3.0-20.4)	7.6 (3.0-21.4)	3.2 (8.1-22.2)
Metropolitan LGAs (median, IQR)	7.0 (3.0-17.1)	-	-	-
Regional LGAs (median, IQR)	10.6 (3.0-33.5)	-	-	-

Abbreviations: Km, kilometres; IQR, interquartile range; LGAs, local government areas.

Mental health

Areas of increased distance were apparent in the north-east and far west regions of Victoria (Fig. 3C). The variation in median travel distance per person was notable between metropolitan and regional LGAs with median distances 11.3km (IQR 5.2-23.1) in metropolitan LGAs relative to a median of 24.0km (IQR 6.0-88.9) in regional LGAs. High-high spatial clusters were identified in the north-east part of the state and far west Victoria (Fig. 2).

Occupational therapy

The median distance travelled for people in metropolitan LGAs was 16.6km (IQR 8.0-28.4). This is in contrast to regional LGAs where the median distance per person was 52.5km (IQR 9.4-99.5). Additionally, the median distance travelled per person in fourteen regional LGAs (17.7%), was over 120km (Fig. 3D). Large high-high spatial clusters were also evident in these areas of increased distance travelled through far east and far west Victoria (Fig. 2). Smaller low-high outlier clusters were observed in inner-metropolitan LGAs (Fig. 2).

Physical therapies

A number of regional LGAs had higher median travel distances relative to metropolitan LGAs particularly in western areas of Victoria (Fig. 3E) with the median distance travelled from regional LGAs being 10.6km (IQR 3.0-33.5). This was greater than the median distance travelled from metropolitan LGAs of 7.0km (IQR 3.0-17.1). A small high-high spatial cluster was identified in far west Victoria (Fig. 2).

Discussion

In the first three years following transport-related major trauma, people in regional LGAs commonly travelled further to access health services than those living in metropolitan LGAs. Specific clustering of increased travel distances was observed in regional LGAs in the far west and north-east of Victoria indicating specific areas of larger travel distances where there are similarly high values in neighbouring LGAs. The number of people using services (GP, medical, mental health, physical therapies, OT) declined with each subsequent year beyond discharge. However, the number of trips were consistent over time for people still engaged in services, except for physical therapies where the number of trips reduced over time.

To our knowledge, this is the first study to explore variation in distances travelled to health services following traumatic injury. Limited studies have previously explored this concept with one study finding no significant association between travel time and access to gynaecological services and another reporting the need for people living with HIV to travel further distances to access healthcare [14,15]. Across all service categories, the median distance travelled in regional LGAs, was further than travelled in metropolitan LGAs. The increased travel distance may reflect the known shortages of specialised care in regional areas [24,25]. Travelling long distances to access services can exacerbate symptoms associated with injury [8]. For people having to attend multiple therapies and medical appointments, the productivity and time lost due to travel may also negatively impact return to work and life roles in the years following hospital discharge. Exploring alternative models of service delivery such as telehealth and outreach

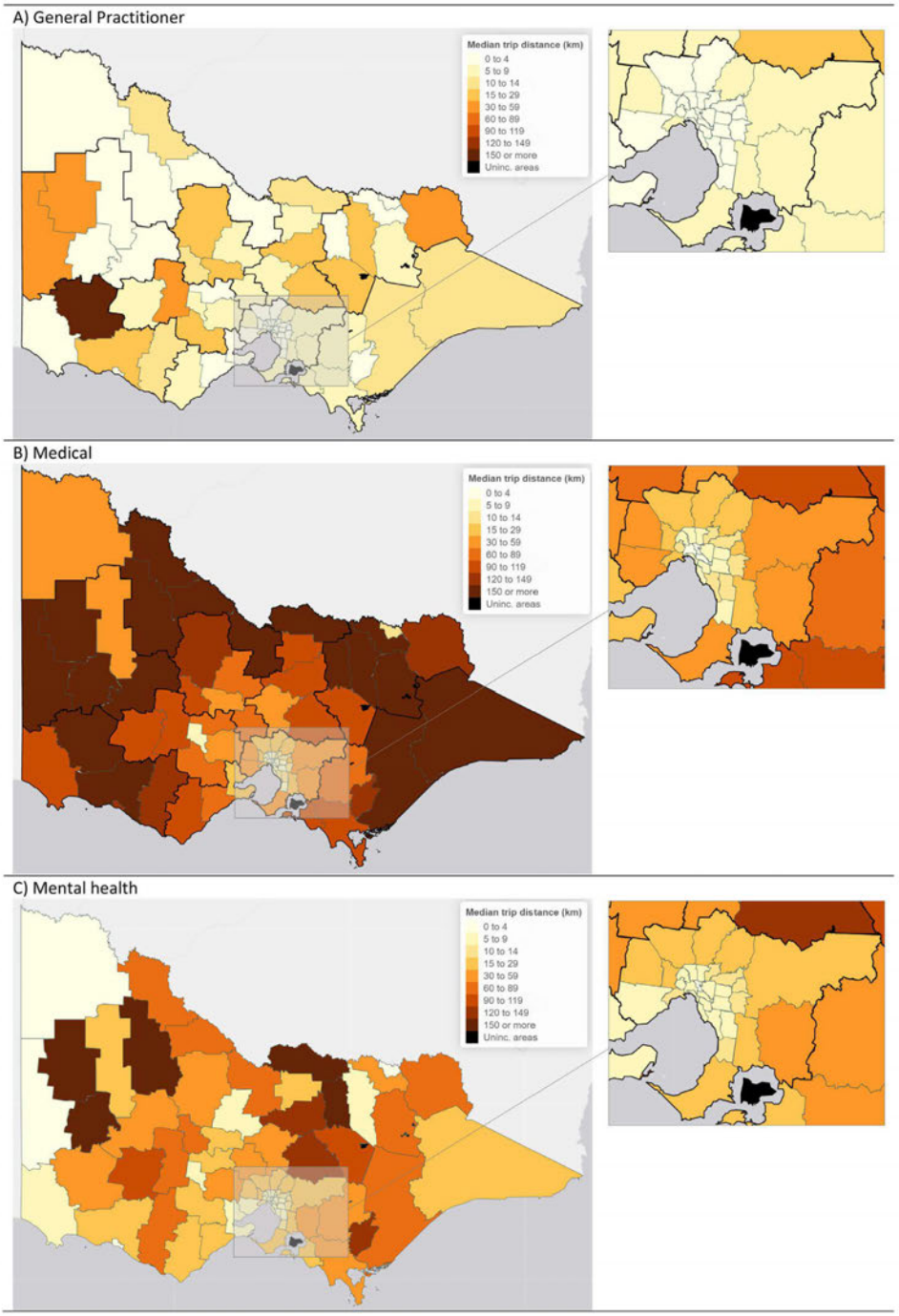

Fig. 3. Median trip distance travelled per person by local government area.

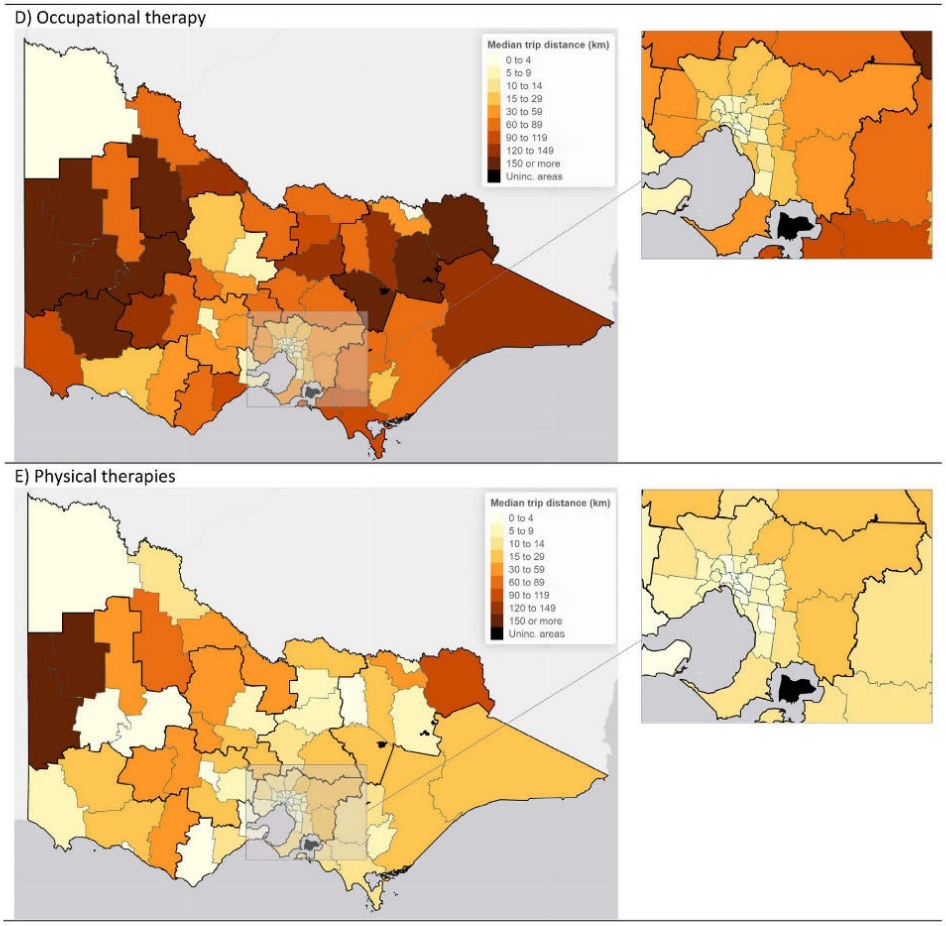

Fig. 3. Continued

clinics, or increased investment in regional services, may help to improve accessibility and reduce the associated burden of travel in this population [26].

With improved survival following traumatic injury, it is essential to understand patterns of long-term service usage and where gaps in services may for certain geographic areas. We found a higher rate of GP and mental health service use than has been previously reported in people following traumatic injury [25]. This may have been due to the study being limited to people covered by insurance as a result of their transport-related injury. However, the sustained engagement in health services, particularly GP, physical therapies and mental health services over the three-year period, reinforce the need for equitable access and availability of health services for people following transport-related major trauma. This is particularly important in populations claiming compensation for their injuries, as compensable patients have been shown to have a slower, prolonged recovery with improvements in outcomes beyond two years post injury [6]. A coordinated approach to post-discharge care to ensure the rehabilitation needs of this population are met is important to optimise long-term health outcomes [27].

In this study the percentage of people using services reduced over time whilst the number of visits remained consistent. This may be due to the type of clientele requiring longer term health services. Participants no longer requiring input are likely to have had a good functional recovery, compared to those with ongoing disability who have a need for services up to three years following injury [28]. Previous research on service in orthopaedic trauma patients found that injury severity was not a predictor of service use. However, people with greater disability and those who were receiving compensation were significantly more likely to be using services at six months [28]. The inclusion of people receiving compensation in the current study may also have contributed to their prolonged service use.

Major trauma patients are typically younger, as is reflected in the current study population. Due to the omission of people whose injuries were sustained as a result of falls, domestic violence, self-harm, stabbing and burns in this study, there was less representation of major trauma in older persons. Between 2007 and 2016 the number of major trauma patients aged older 65 years more than doubled [29]. In Victoria, low and high falls accounted for 47% of major trauma in 2019–20 and of patients injured in a low fall,

80.2% were aged 65 years or older [30]. Further research is necessary to understand if age may be a factor influencing access to health services and whether there are additional challenges faced by older persons with major traumatic injuries.

The current study is a large population-based capture of people following transport-related major trauma. Additionally, this study involved the linkage of large data sets with near-complete capture of post-discharge services funded by TAC. One limitation was that it was not possible to establish the exact location of service provision if a service provider worked across multiple sites. To conservatively manage this issue, we used the shortest distance to a provider from an individual's residence, assuming that patients are most likely to travel to the closest facility available for that specific provider. Additionally, it was not possible to ascertain the date of discharge from rehabilitation hospitals for those not discharged directly home from acute care. This may have impacted the distance of travel if follow up appointments were attended during a rehabilitation stay and not from an individual's residential address. However, with the service descriptions included in the TAC data it was possible to identify most outpatient services and thus this issue is unlikely to have impacted the results. This study assumed that people were accessing services from their home rather than a place of work which may affect the distance travelled. Furthermore, to enable analysis of this data we assumed that all participants used the same mode of transport, i.e. car travel, to access services. Whilst this may not always be the case, as patients funded by TAC compensation can receive reimbursement for taxi travel or motorised travel expenses, it is likely that participants would preferentially choose this option over public transport, cycling or walking.

Conclusion

Recovery following transport-related major trauma is complex and involves numerous health professions for years following hospital discharge. This paper highlights spatial inequalities in access to health services, the magnitude of which varies by service type, thus placing an increased burden on people in some regional LGAs. These findings contribute to our understanding of access to health services follow transport-related major trauma and reinforce the need for long-term access to allied health and medical professionals up to three years following hospital discharge. Additional research exploring what factors contribute to the existing spatial clusters will provide insights into the lack of necessary services in certain geographic areas. These data will also enable further research into the potential association between distances travelled to health services and health outcomes. This work is necessary to direct ongoing research efforts into the potential need for a coordinated, long-term approach to post-discharge care for optimal recovery following transport-related major trauma.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2021.12.011.

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4.6 Paper Five

4.6.1 Overview

In Paper Four, geospatial analysis was used to quantify distances travelled to health services and patterns of health service use by major trauma patients in the first three years following hospital discharge. A key finding of this paper was that people in regional LGAs travelled further to access health services than those in metropolitan LGAs. Due to the heterogeneity of trauma populations and varying health care needs depending on the type of injury and injury severity, it can be difficult to provide specific and translatable recommendations from research findings. Therefore, investigation of service usage in specific injury types is warranted.

The fifth and final paper presented in this thesis provides a more in-depth analysis of regional differences in health service use for three distinct groups of people with serious injuries. These were people with orthopaedic injuries, traumatic brain injury (TBI) and spinal cord injury (SCI). Traumatic brain injury and SCI are severely disabling conditions and due to the complexity of these injuries can be incredibly burdensome for patients, clinicians and families.[96] People with orthopaedic injuries also experience poor health outcomes and have multi-faceted health care needs beyond their acute hospital care.[15, 97] This final study compared health service use, frequency of accessing health services and distances travelled to health care for people with orthopaedic, brain and spinal cord injury in metropolitan and regional Victoria between 2006-2016.

4.6.2 Manuscript

The following paper was submitted for publication in the *International Journal of Environmental and Public Health Research* on September 5th 2022.

Keeves J, Gabbe BJ, Arnup S, Ekegren CL, Beck B. (2022) Travelling for treatment: The association between injury type and service utilisation in metropolitan and regional Victoria. *Submitted for publication.*

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Checklist used in this paper for methodological rigour is presented in Appendix 9.

International Journal of Environmental Research and Public Health

MDPI

Article

Travelling for treatment: Association between injury type and service utilization in metropolitan and regional Victoria

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Abstract: This study aimed to describe regional variation in service use and distance travelled to post-discharge health services in the first three years following hospital discharge for people with transport-related orthopaedic, brain and spinal cord injuries. Using linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC) we identified 1,597 people who had sustained transport-related orthopaedic, brain or spinal cord injuries between 2006 and 2016 and met the study inclusion criteria. The adjusted odds of GP service use for regional participants were 76% higher than for metropolitan participants in the orthopaedic and traumatic brain injury (TBI) groups. People with spinal cord injury (SCI) living in regional areas had 72% lower adjusted odds of accessing mental health, 76% lower adjusted odds of accessing OT services and 82% lower adjusted odds of accessing physical therapies compared to people living in major cities. People with a TBI living in regional areas on average travelled significantly further to access all post-discharge health services compared to people with TBI in major cities. For visits to medical services, the median trip distance for regional participants was 76.61km (95%CI: 16.01-132.21) for orthopaedic injuries was, 104.05km (95% CI: 51.55-182.78) for TBI was and 68.70km (95%CI: 8.34-139.84) for SCI. Disparity in service use and distance travelled to health services exists between metropolitan Melbourne and regional Victoria following serious injury.

Keywords: serious injury, traumatic brain injury, orthopaedic injury, spinal cord injury, road trauma, access to healthcare, healthcare utilisation, geography

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1. Introduction

Transport-related injuries are expected to become the third leading cause of disability worldwide by 2030.[1] Despite advances in trauma care, people with orthopaedic injury, traumatic brain injury (TBI) and spinal cord injury (SCI) continue to experience long-term physical disability, psychological dysfunction and interference from pain.[2-4] There is a need to understand whether long term outcomes for people with serious transport-related injury can be improved through a coordinated and revised approach to post-discharge healthcare.

Urban and regional disparities in access to care exist, with people living in regional areas travelling further to access post-discharge healthcare after major trauma.[5] Both people with serious injury and health professionals have reported limited availability and difficulties accessing necessary care as barriers to health service delivery following injury, particularly for people living in regional areas.[6-8] It is unclear whether these barriers to post-discharge care are more significant for people in regional areas as a result of regionalised trauma system design, which centralises higher-level trauma centres in inner metropolitan areas.

Despite survivors of serious injury having long-term and complex healthcare needs, the level of specialised care provided beyond hospital discharge varies depending on the

type of injury.[4, 5, 9] People with TBI and SCI are more likely to receive rehabilitation from specialised services due to the complexity of these injuries.[10] After an orthopaedic injury however, there is no clear pathway for rehabilitation once discharged from a major trauma centre.[10] Given the high prevalence of disability amongst trauma survivors, both with and without serious neurotrauma, consideration for the whole pathway of trauma care from acute management, to specialised rehabilitation and community care is pertinent.[10]

This novel study aimed to understand how different injury populations use post-discharge health services across regional and metropolitan areas and explore the distances travelled to health services in the first three years following hospital discharge. Improving our understanding of post-discharge service utilisation is an important step in ensuring necessary services are accessible and available for people with transport-related serious injury.

2. Materials and Methods

2.1. Study Design

This registry-based cohort study used linked data from the Victorian State Trauma Registry (VSTR) and the Transport Accident Commission (TAC). This study follows the Strengthening of Reporting of Observational Studies in Epidemiology checklist.[11]

Victoria is the second most populous state of Australia with a population of 6.46 million people, including over 2 million people residing outside the Greater Melbourne region.[12] Victoria has an inclusive trauma system consisting of two adult, and one paediatric major trauma centres, located in metropolitan Melbourne.

The population-based VSTR collects data about all people with major trauma in Victoria with major trauma defined as: (1) death due to injury; (2) an Injury Severity Score (ISS; based on the Abbreviated Injury Scale (AIS) 2005 version, 2008 update) >12; (3) admission to an intensive care unit >24 hours; (4) or an injury requiring urgent surgery.[13] The registry has an opt-out rate <1% and includes data on prehospital care, pre-existing health conditions, injury characteristics and complications, and discharge information.[13]

The TAC is Victoria's no-fault third-party insurer for people who have sustained a transport-related injury, covering medical treatment, rehabilitation, support services and financial assistance. People are covered by the TAC if their injuries are sustained as a result of driving a car, motorcycle, bus, train or tram. Cyclists injured in a collision with a moving or stationary motor vehicle (after 9 July 2014) are also covered by TAC. Pedestrians are covered by the TAC when their injuries arise as a direct result of impact with a motor vehicle, motorcycle, train or tram. Full details of eligible claimants and expenses covered by the TAC are outlined in the Transport Accident Act 1986.[14] The TAC collect data pertaining to an individual claim, including detailed information regarding the post-discharge health services paid for by the TAC. These data include details of the date and type of service, service description and where the service provider is located. The TAC provides these data to the VSTR, linked by claim number. A standardised and secure process is followed to ensure that no patient-level data are provided to the TAC by the VSTR.

2.2. Participants

Victorians who sustained major trauma from a transport-related event between January 1 2006 and December 31 2016, with a TAC compensation claim, were identified within the VSTR. People were included if they sustained isolated orthopaedic injuries, a moderate to severe TBI or SCI; were aged 18 years or older at the time of injury; had three-years of TAC claims data; and resided in Victoria with a known residential address (Figure 1). The orthopaedic group consisted of people who had sustained an extremity injury with AIS score >1 and/or spine injury with AIS two or three and no other injury with AIS >1.[15] Traumatic brain injury (TBI) cases were considered to be moderate or severe if they had a head injury with an AIS severity score >2 and the first recorded Glasgow Coma Scale (GCS) score <13, with or without other system injuries.[15] Mild traumatic brain injuries are not captured by the VSTR unless sustained with other system injures so were

excluded from this study. Spinal cord injury was defined as an injury to the spine with an AIS severity score >3, with or without other injuries. [15]

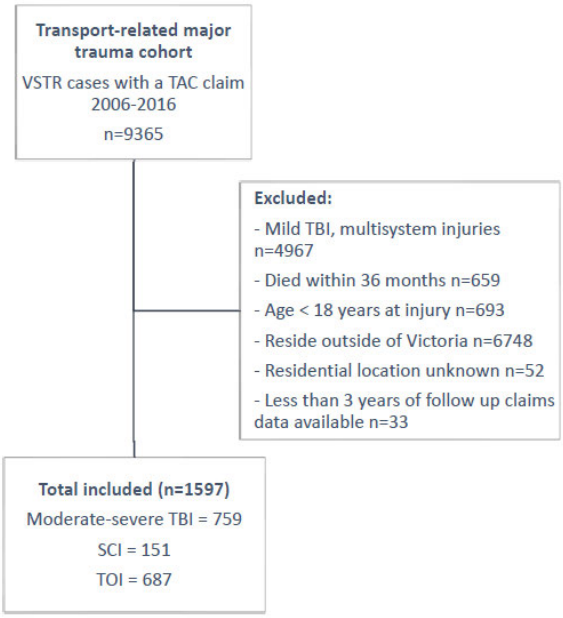

Figure 1. Flow diagram of inclusion criteria.

2.3. Variables

The three key outcomes of interest in this study were: service use, the number of trips per person and distance travelled to health services in the first three years following hospital discharge. Service use was defined as the percentage of participants who used a health service at some point within the study period. The number of trips per person refers to the number of times a health service was visited by service users. Distance travelled was the median trip distance per person from their residential location to the provider location, measured in kilometres.

Health services were categorised as: General Practitioner (GP), other medical professionals (e.g. neurologists, pathologists, psychiatrists, surgeons), mental health services (psychology, social work and case management), physical therapies (physiotherapy, exercise physiology and hydrotherapy) and occupational therapy (OT). Speech pathology was excluded as this service was used almost exclusively by TBI participants.

2.4. Data measurement

Demographic information, pre-existing health conditions, injury diagnosis and severity, hospital length of stay and discharge status were extracted from the registry. Data relating to a TAC claim, client address and service provider locations were provided by the TAC for all services funded between January 1 2006 and December 31 2019.

Each participant's residential address at the date of hospital discharge was mapped by their Local Government Area (LGA) to the Accessibility/Remoteness Index of Australia 2016 (ARIA+) and categorised into major city, inner regional and outer regional.[16] For analysis, the metropolitan group consisted of people living in 'Major Cities' and the regional group as people living in 'Inner Regional' or 'Outer Regional' areas (Figure 2). No participants were residing in 'Remote' or 'Very Remote' areas by the ARIA+ classification index. Socioeconomic status was categorised using The Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) according to LGA.[17]

Figure 2. Flow diagram of inclusion criteria.

Geographic coordinates for each participant's address and service provider address were compiled through geocoding in RStudio version 3.5.1, and a random sample of 100 were manually checked using Google Maps.[18] Any incomplete provider addresses locations were entered manually using Google Maps to obtain coordinates. For a single provider it was possible for multiple locations to exist. We mapped the travel distances for all locations using Here Routing API (https://developer.here.com) and used the shortest distance, assuming that people would visit the closest provider location to their homes.

2.5. Statistical methods

Summary statistics were used to describe demographic information, injury characteristics and service use outcomes. Medians and interquartile range were reported for skewed categorical variables and frequencies and percentages for categorical variables.

Regression models were used to provide estimates of the association between the outcomes of interest and region by injury type. Models were run for each outcome using region as an interaction term with injury type. All models were adjusted for the covariates of age group, sex, Charlson Comorbidity Index, ISS and IRSAD based on factors known to impact healthcare utilisation.[19,20] Multivariable logistic regression was used for service use (yes/no), negative binomial regression for the number of trips per person, while a general estimating equation (GEE) was used to model distance travelled to services used. For the GEE, a Gaussian model and identity link was used, and an exchangeable correlation was assumed between trips to the same service within each individual. Adjusted odds ratios (OR) and incidence rate ratios (IRR), and the corresponding 95% confidence intervals were calculated for the logistic and negative binomial regression models, respectively. As distance travelled was positively skewed, the data were log transformed before modelling. Model fit was evaluated for concordance and discrimination using residual plots.[21] All analyses were completed in Stata Version 16.0 with the exception of the geospatial analyses which were conducted using RStudio version 3.5.1.[18]

3. Results

There were 9,365 cases of transport-related major trauma identified from the VSTR; 17.1% (n=1,597) were eligible for this study (Figure 1). The characteristics of included participants for each injury group are presented in Table 1.

Table 1. Demographics and Injury Characteristics of Participants

Across all injury groups, most participants were men and the median age was 33 years (IQR 23-48). Thirty-five percent of participants resided in regional areas. Most participants were injured in motor vehicle or motorcycle crashes. The SCI group had the longest length of acute hospital stay. In the first three years following hospital discharge, the

	All cases (1597)	**TOI** (687)	**TBI** (759)	**SCI** (151)
	n (%)	n (%)	n (%)	n (%)
Gender				
Male	1122 (70.3)	461 (67.1)	537 (70.8)	124 (82.1)
Female	475 (29.7)	226 (32.9)	222 (29.2)	27 (17.9)
Age group, years				
18-24	480 (30.1)	153 (22.1)	297 (39.1)	31 (20.5)
25-34	367 (23.0)	151 (22.0)	175 (23.1)	41 (27.2)
35-44	275 (17.2)	123 (17.9)	123 (16.2)	29 (19.2)
45-54	206 (12.9)	104 (15.1)	82 (10.8)	20 (13.2)
55-64	120 (7.5)	67 (9.8)	42 (5.5)	11 (7.3)
65-74	76 (4.8)	39 (5.7)	24 (3.1)	13 (8.6)
75+	73 (4.6)	51 (7.4)	16 (2.1)	6 (4.0)
Injury Severity Score, median (IQR)	20 (13-29)	13 (9-14)	29 (22-38)	29 (24-33)
CCI[22] weight (CCI)[1]				
0	857 (53.5)	521 (75.6)	235 (30.8)	101 (66.4)
1	582 (36.4)	126 (18.3)	424 (55.6)	33 (21.7)
>1	142 (8.9)	32 (4.6)	98 (12.9)	13 (8.6)
Acute hospital LOS (days), median (IQR)	13 (7-24)	8 (5-13)	18 (11-29)	24 (13-39)
Region (ARIA+ 2016)				
Major cities	1040 (65.1)	441 (65.2)	507 (66.8)	92 (60.9)
Inner regional	438 (27.4)	184 (26.8)	205 (27.0)	49 (32.5)
Outer regional	119 (7.5)	62 (9.0)	47 (6.2)	10 (6.6)
Socioeconomic status (IRSAD)				
1 (most disadvantaged)	268 (16.8)	128 (18.6)	118 (15.5)	22 (14.5)
2	168 (10.5)	72 (10.5)	81 (10.6)	15 (9.9)
3	309 (19.3)	128 (18.6)	150 (19.8)	31 (20.5)
4	432 (27.1)	189 (27.5)	202 (26.6)	41 (27.2)
5 (least disadvantaged)	420 (26.3)	170 (24.7)	208 (27.4)	42 (27.8)
Discharge destination				
Home	287 (18.0)	237 (34.5)	41 (5.4)	9 (6.0)
Other (e.g. inpatient rehabilitation)	1310 (82.0)	450 (65.4)	718 (94.6)	142 (94.0)
Road user[2]				
Motor vehicle driver or passenger	881 (55.2)	348 (50.6)	451 (59.5)	82 (53.9)
Motorcyclist	347 (21.7)	198 (28.8)	99 (13.0)	50 (32.9)
Pedestrian	244 (15.4)	85 (12.4)	154 (20.3)	6 (4.0)
Bicyclist	91 (5.7)	42 (6.1)	41 (5.4)	8 (5.3)

[1]n=19 missing

[2]n=34 other or missing

LOS = length of stay; IQR = Interquartile Range; CCI = Charlson Comorbidity Index, ARIA+ = Accessibility/Remoteness Index of Australia; IRSAD = Index of Relative Socio-economic Advantage and Disadvantage

1,597 participants visited health services 159,090 times for GP services, other medical appointments, mental health services, physical therapies and OT (Table 2).

Table 2. All services used by participants in the first three years post discharge by injury type.

	All cases (n=1597)		**TBI** (n=759)		**SCI** (n=151)		**TOI** (n=687)	
	n	%	n	%	n	%	n	%
Physiotherapy	59,532	30.7	27,556	27.0	9,667	31.7	22,309	36.5
Occupational Therapy	34,268	17.7	23,026	22.5	6,557	21.5	4,685	7.7
GP Consult	20,078	10.4	8,791	8.6	2,937	9.6	8,350	13.7
Psychology	18,907	9.7	14,480	14.1	1,285	4.2	3,142	5.1
Nursing	13,289	6.9	2,436	2.4	6,032	19.8	4,821	7.9
Medical (other)	10,972	5.7	6,315	6.2	803	2.6	3,854	6.3
Speech Therapy	8,373	4.3	8,143	7.9	165	0.5	65	0.1
Hydrotherapy	6,917	3.6	1,727	1.7	233	0.8	4,957	8.1
Exercise Physiology	6,832	3.5	1,816	1.8	839	2.8	4,177	6.8
Vocational counselling	4,175	2.2	1,720	1.7	359	1.2	2,096	3.4
Social Work	1,792	0.9	1,203	1.2	313	1.0	276	0.5
Psychiatry	1,584	0.8	1,049	1.0	80	0.3	455	0.7
Podiatry	1,193	0.6	348	0.3	551	1.8	294	0.5
Osteopathy	1,017	0.5	306	0.3	112	0.4	599	1.0
Dental	990	0.5	864	0.8	55	0.2	71	0.1
Dietitian	800	0.4	511	0.5	186	0.6	103	0.2
Case Conferences	741	0.4	444	0.4	30	0.1	267	0.4
Chiropractor	680	0.4	380	0.4	66	0.2	234	0.4
Attendant carer	623	0.3	444	0.4	119	0.4	60	0.1
Paramedical (other)	557	0.3	443	0.4	36	0.1	78	0.1
Acupuncture	468	0.2	275	0.3	29	0.1	164	0.3
Optical	291	0.2	257	0.3	6	<0.1	28	<0.1
Total	194,079		102,534		30,460		61,085	

Figure 3 provides a summary of the key findings from the multivariable regression analysis for service use, number of trips and distances travelled to services. More specific results from the models for each outcome and injury group are reported in each section below.

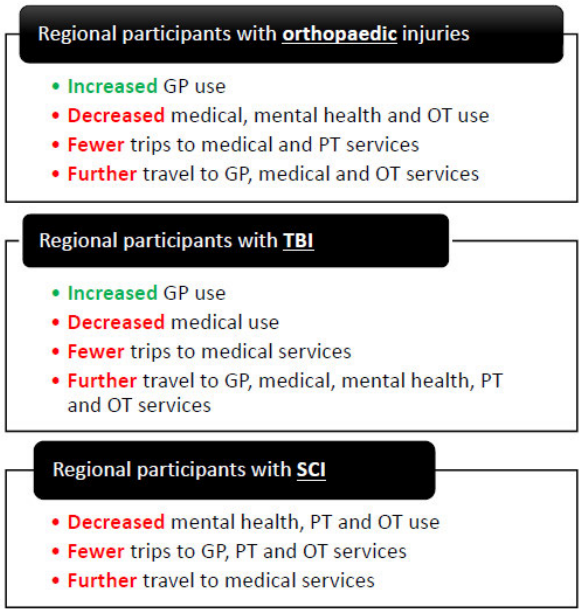

Figure 3. Summary of key findings for regional participants compared to participants in major cities

3.1. Service use

The adjusted proportion of people using GP services were higher for regional participants in all injury groups (Figure 4). Across all other services, the adjusted proportions for service use were greater for people living in major cities, compared to people living in regional areas, except for people with TBI accessing mental health services.

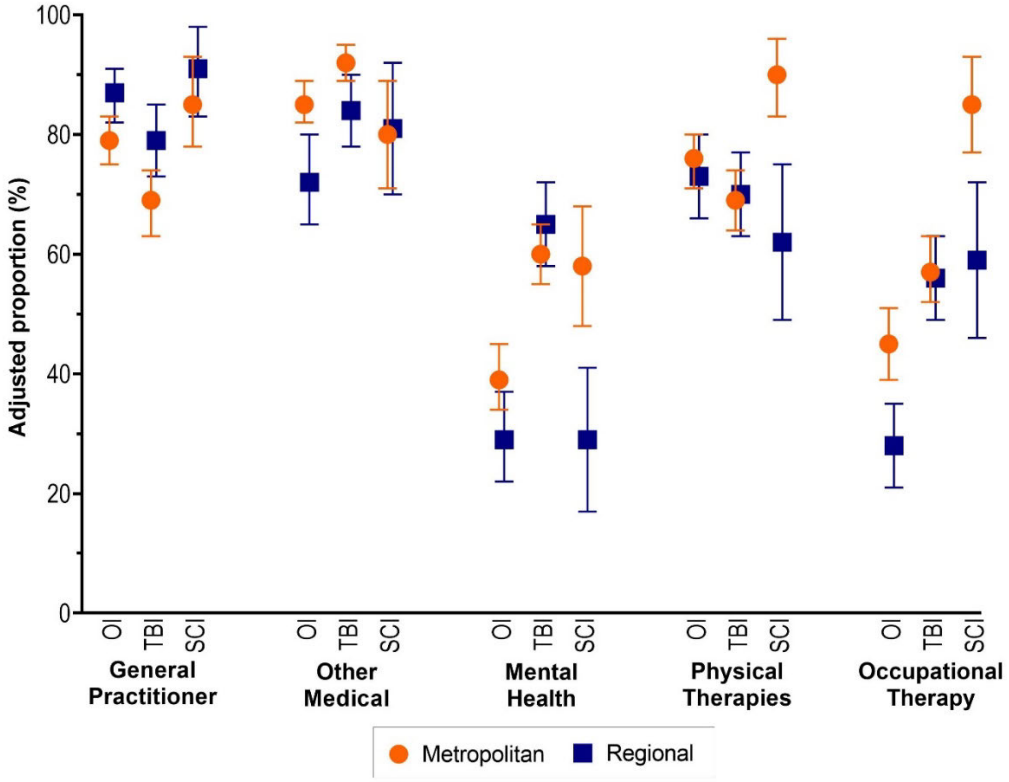

Figure 4. Adjusted proportion of service use by injury group and region

The adjusted odds of GP service use for regional participants were 76% higher than for metropolitan participants in the orthopaedic and TBI groups (Table 3). For regional participants, the adjusted odds of using medical services were 56% lower than metropolitan participants in the orthopaedic group and 57% lower in the TBI group (Table 3). People with orthopaedic injuries had 37% lower adjusted odds of attending mental health services and 45% lower adjusted odds of using occupational therapy services if they were living in regional areas, compared to metropolitan areas. People with SCI living in regional areas had 72% lower adjusted odds of accessing mental health, 82% lower adjusted odds of accessing physical therapies and 76% lower adjusted odds of accessing OT services compared to people living in major cities (Table 3).

Table 3. Regional variation in service use and number of trips per person in the first three years following hospital discharge determined by Multivariable Regression Analysis

	Participants using service (n, %)	Service Use, Adjusted OR (95%CI)	P*	Trips per person, Median (IQR)	Adjusted IRR (95%CI)	P†
General Practitioner						
TOI						
Major cities	329 (74.6)	Reference		9 (4-22)	Reference	
Regional	206 (83.7)	1.76 (1.1-2.9)	**0.02**	9 (3-21)	0.81 (0.66-0.99)	**0.04**
TBI						
Major cities	370 (73.0)	Reference		9 (3-18)	Reference	
Regional	211 (83.7)	1.76 (1.1-2.8)	**0.02**	10 (4-22)	0.90 (0.75-1.1)	0.31
SCI						
Major cities	80 (87.0)	Reference		18.5 (10.5-30)	Reference	
Regional	54 (91.5)	1.73 (0.5-5.4)	0.35	15 (6-23)	0.65 (0.5-0.9)	**0.02**
Medical Specialists						
TOI						
Major cities	360 (81.6)	Reference		5 (2-11)	Reference	
Regional	160 (65.0)	0.44 (0.28-0.70)	**0.001**	3 (2-8)	0.71 (0.6-0.9)	**<.001**
TBI						
Major cities	477 (94.1)	Reference		8 (4-14)	Reference	
Regional	220 (87.3)	0.43 (0.24-0.78)	**0.01**	5 (3-9.5)	0.65 (0.6-0.8)	**<.001**
SCI						
Major cities	76 (82.6)	Reference		4 (2-9.5)	Reference	
Regional	49 (83.1)	1.07 (0.42-2.70)	0.89	4 (2-8)	0.90 (0.6-1.2)	0.51
Mental Health						
TOI						
Major cities	158 (35.8)	Reference		11 (4-26)	Reference	
Regional	56 (22.8)	0.63 (0.41-0.96)	**0.03**	7 (4-23)	0.88 (0.6-1.3)	0.47

TBI						
Major cities	330 (65.1)	Reference		23.5 (8-54)	Reference	
Regional	169 (67.1)	1.23 (0.84-1.81)	0.29	16 (6-36)	0.78 (0.6-1.0)	**0.05**
SCI						
Major cities	57 (62.0)	Reference		14 (7-35)	Reference	
Regional	17 (28.8)	0.28 (0.1-0.6)	**0.001**	10 (4-17)	0.84 (0.5-1.5)	0.58
Physical Therapies						
TOI						
Major cities	322 (73.0)	Reference		42 (15-102)	Reference	
Regional	176 (71.5)	0.87 (0.57-1.33)	0.54	34 (14-74.5)	0.76 (0.6-0.9)	**0.01**
TBI						
Major cities	355 (70.0)	Reference		40 (14-85)	Reference	
Regional	181 (71.8)	1.08 (0.72-1.62)	0.71	34 (10-72)	0.81 (0.6-1.0)	0.07
SCI						
Major cities	84 (91.3)	Reference		87 (41-131.5)	Reference	
Regional	39 (66.1)	0.18 (0.07-0.45)	**<.001**	46 (9-92)	0.63 (0.41-0.95)	**0.03**
Occupational Therapy						
TOI						
Major cities	165 (37.4)	Reference		9 (2-25)	Reference	
Regional	55 (22.4)	0.45 (0.29-0.69)	**<.001**	4 (2-22)	0.76 (0.5-1.1)	0.17
TBI						
Major cities	317 (62.5)	Reference		30 (8-73)	Reference	
Regional	154 (61.1)	0.95 (0.65-1.39)	0.81	24.5 (5-57)	0.89 (0.7-1.2)	0.40
SCI						
Major cities	81 (88.0)	Reference		49 (14-93)	Reference	
Regional	39 (66.1)	0.24 (0.10-0.58)	**0.001**	11 (3-62)	0.55 (0.3-0.9)	**0.01**

*P value for the logistic regression analysis of service use

†P value for negative binomial regression analysis of number of trips, per person, for participants who used that service.

P values in bold type are significant. IQR = interquartile range, OR = odds ratio, IRR = incidence rate ratio

3.2. Number of trips

For all injuries and service types, people in regional areas used fewer services than people residing in major cities after adjusting for covariates (Figure 5). In the orthopaedic group, the mean number of trips for participants in regional areas compared to major cities was 29% less for medical services and 24% less for physical therapy services (Table 3). The mean number of trips for people living with TBI in regional areas was 35% less than in major cities for medical services (Table 3). For SCI, the mean number of trips for regional participants compared to major cities was 35% less for GPs, 37% less for physical therapy and 45% less for OT services (Table 3).

Physical therapies were the most commonly used service across all injury groups in the first three years post-discharge (Figure 5). People in metropolitan and regional areas with a TBI used more mental health services but less physical therapy services than people with orthopaedic injuries and SCI (Figure 5).

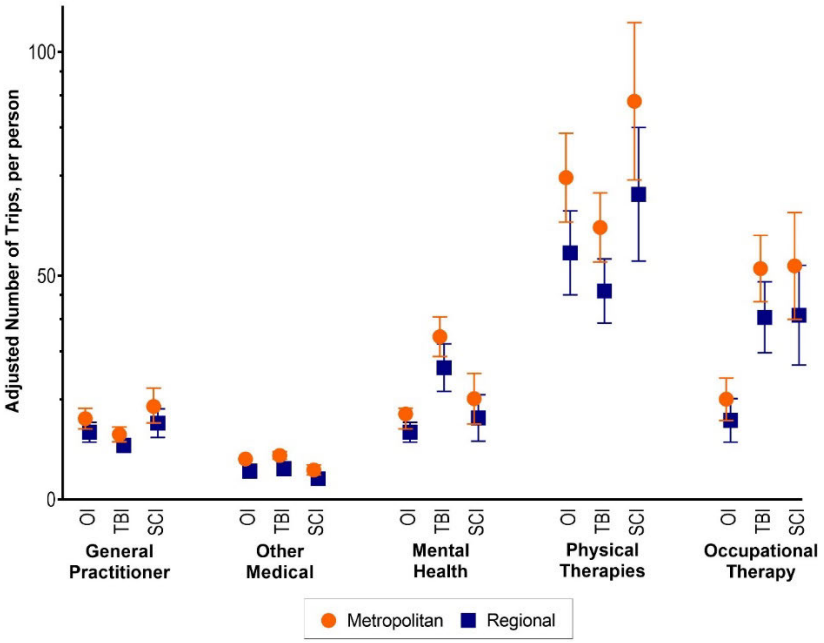

Figure 5. Adjusted number of trips to services in the first three years post discharge by service type and injury group.

3.3. Distance travelled

People with a TBI living in regional areas on average travelled significantly further to access all post-discharge health services compared to people with TBI in major cities (Figure 6). Comparatively, in the SCI group, regional participants travelled further only to attend medical services (RGM 2.66, 95%CI 1.63-4.36) (Figure 6).

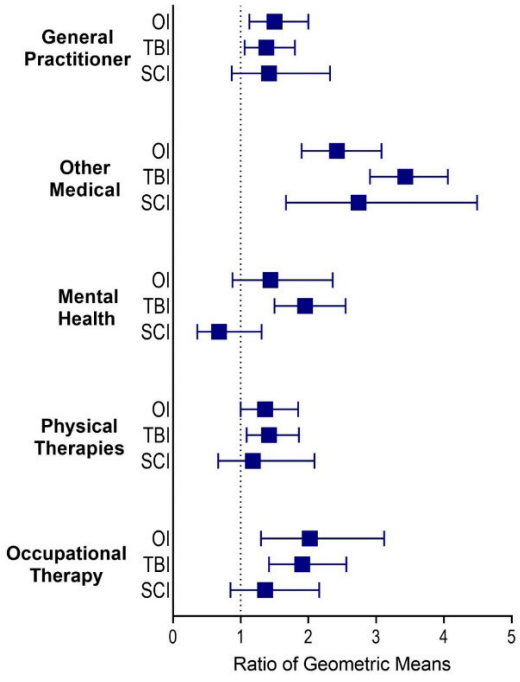

Figure 6. Ratio of geometric means for distance travelled by people in regional areas compared to major cities by injury group and service type.

People in regional areas with orthopaedic injuries travelled 1.4 times further to see a GP (95%CI 1.06-1.88), 2.26 times further to attend other medical services (95%CI 1.76-2.89) and 1.7 times further to OT services than people with orthopaedic injuries in major cities (95%CI 1.06-2.62, p=0.03).

For visits to medical services, the median trip distance for regional participants with orthopaedic injuries was 76.61km (95%CI: 16.01-132.21), for TBI was 104.05km (95% CI: 51.55-182.78) and for SCI was 68.70km (95%CI: 8.34-139.84) (Figure 7). Comparatively, the median trip distances for participants in major cities were between 9.44km (95%CI 4.92-23.05) and 13.50km (95% CI 6.65-25.59) (Figure 6). People with a TBI in regional areas on average travelled further than regional participants with orthopaedic injuries and SCIs for all services (Figure 7).

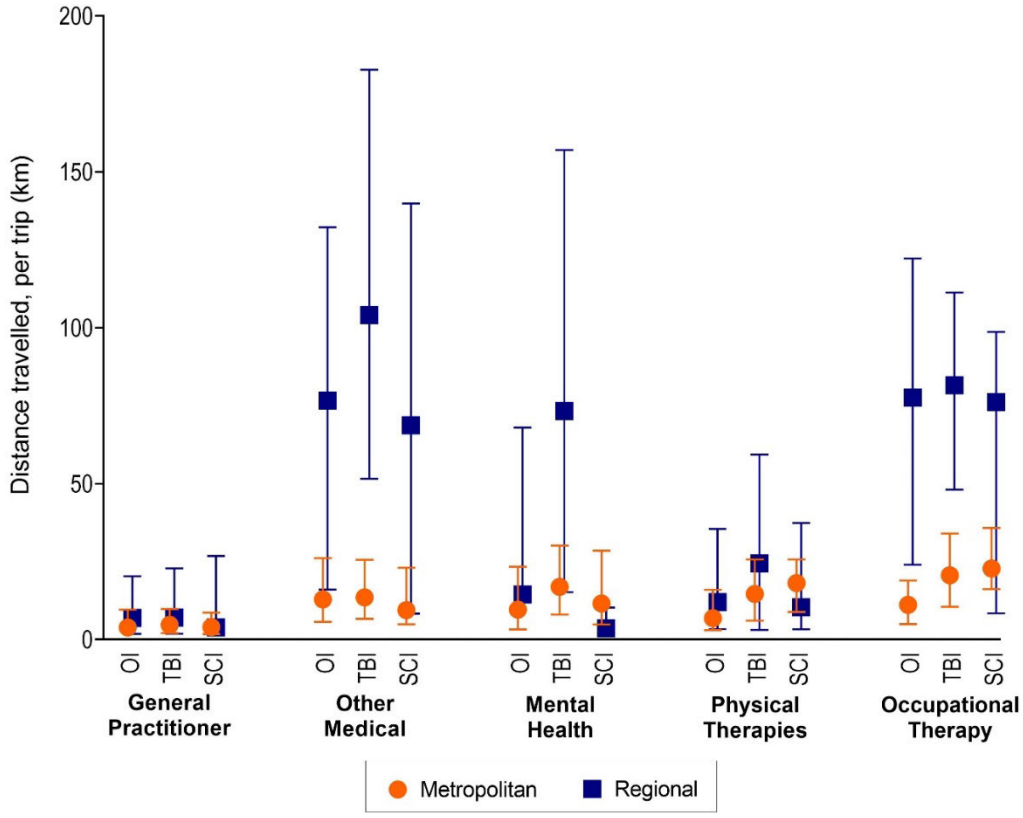

Figure 7. Median and IQR of raw distances travelled to healthcare by service type and injury group.

4. Discussion

In this study, we compared health service usage and distances travelled by people with orthopaedic, brain and spinal cord injuries across regional and metropolitan Victoria in the first three years following hospital discharge. For most services and injury types, people in regional areas used fewer services, but travelled further to access them, than people in metropolitan areas. People with orthopaedic injuries and TBI in regional areas had greater odds of seeing a GP compared to their metropolitan counterparts. This research provides an important contribution to our understanding of how geography impacts healthcare utilisation following major trauma.

We found that regional participants with orthopaedic injuries and TBI had greater odds of attending GP services than metropolitan participants, despite having to travel

further. This may be explained by people in metropolitan areas living closer to trauma centres with better access to specialised rehabilitation providers, and therefore being less reliant on their local GPs.[23-25] Following major trauma, GPs play a critical role in providing ongoing community support, monitoring for secondary complications of injury, psychosocial issues and assisting return to work.[26] For people living in metropolitan areas it is possible that these issues may be monitored by a specialised rehabilitation team including allied health and specialist physicians. This finding highlights the importance of regional based GPs being having adequate knowledge of complications of injury and a network of specialists that may be able to carry out shared virtual consults to ensure timely and effective management, closer to home.[27]

Consistent with previous research, our findings suggest that people with serious injuries living in regional areas use fewer health services than their metropolitan counterparts.[28-31] Having to travel further to access healthcare for people in regional areas may limit accessibility.[5, 8, 24] Compounding the challenge of distance, transportation difficulties[6, 8, 29, 32] and a limited availability of skilled providers[7, 33] have been reported as barriers to accessing necessary services for people with orthopaedic injuries, TBI and SCI, particularly for those in regional areas. A key consequence of reduced service use is that people with serious injuries living in regional areas often report higher unmet care needs.[25, 30, 34-36] Ensuring the availability of local infrastructure or alternate service delivery methods is essential for people with serious injury due to the chronicity of the condition.[8, 34, 37]

In this study we found that for all injury types, people living in regional areas travelled further than people in metropolitan areas to access all services. However, after adjusting for covariates, findings were more nuanced. People living in regional areas with TBI travelled significantly further to all health services than those in metropolitan areas, whereas for people with SCI, a significant difference between was only found for travel to medical services, based on region. Due to the complexity and long-term issues associated with SCI, people with SCI may choose to live in areas where they can access necessary services.[24] In comparison, given the varying degree of severity of TBI, some people with TBI may place less importance on ease of service access and availability when deciding where they want to reside. These findings reinforce the importance of specialised telehealth services and outreach clinics for people in regional areas with TBI to reduce travel burden and ensure access to adequately skilled healthcare services.

4.1. Study limitations

This population-based cohort study provides novel insights into geographic variation in healthcare use following transport-related orthopaedic, brain and spinal cord injury. However, a limitation of this work was that due to multiple service provider locations being provided, we assumed that an individual attended the closest facility to their home and used the shortest trip distance. This study also only included services that were centre-based and so for people with TBI and SCI who are likely to have received services in the community or at home, the number of services used may be underrepresented. This also includes care from the Spinal Community Integration Service, a Victorian program that provides people with SCI assistance with returning home and participating in their communities in the first 12 months following discharge. Due to the nature of how these services are billed to the TAC, it was not possible to ascertain specific details of what services were provided on exact dates and at specific locations. However, as this was the same for both regional and metropolitan participants, this is unlikely to have impacted the regional variation within groups. It was also assumed that participants all travelled by car to attend services. Due to the reimbursement available for taxi travel and motorised travel expenses for TAC patients, it is most likely that participants would choose one of these options over human-powered or public transport.

5. Conclusions

Health service use following traumatic orthopaedic, brain and spinal cord injury is complex and continues for years following the initial injury. This research has identified disparity in service use and distances travelled to health services across metropolitan and regional Victoria following serious injury. With people in regional areas using fewer services, except for GPs, and attending these services less often, there is a risk of unmet service needs for these individuals. An increased travel distance to services is one factor that may be contributing to the inequality in access to healthcare in regional compared to metropolitan areas. These findings reinforce the need for a review of how specialised rehabilitation services are delivered to people residing in regional areas following major trauma and whether access to post-discharge services are available to everyone long-term, regardless of where they reside. Further research exploring whether there is an association between service use, distance travelled and health outcomes is necessary to ensure post-discharge care is optimised for people with serious injuries.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Monash University Human Research Ethics Committee (HREC) (Project ID 18433, 10/04/2019). The VSTR has ethics approval from the Department of Health and Human Services HREC (reference_11/14), Monash University and all trauma receiving hospitals.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Appendix A. Strengthening The Reporting of OBservational Studies in Epidemiology (STROBE) Statement Checklist

		Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			

Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	3-4 n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2-3
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	Fig 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	4 4-5 n/a n/a -
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	5 n/a Fig 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1

		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (e.g, average and total amount)	5
Outcome data	15 *	Report numbers of outcome events or summary measures over time	5-8

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4.7 Summary of Chapter Four

The findings of the research presented in this chapter highlighted that people living in regional Victoria travelled further to access post-discharge health services after serious injury. This work provides quantitative data support what has been suspected by clinicians and researchers anecdotally, that distance to health services may be a barrier to accessing necessary health services for people with serious injuries. The distances travelled by survivors of injury also varied depending on the type of health service. The greatest distances travelled were to medical specialist services, whereas people did not travel as far to attend general practitioners and physical therapy services.

People in regional areas used fewer services, except for GP services, and attended these services less often. This was particularly significant for people with SCI in regional areas who had 72% lower odds of accessing mental health services, 82% lower odds of accessing physical therapies and 76% lower odds of accessing OT services compared to people with SCI in major cities. These results highlight the need to understand the impact of geography on post-discharge health care in a regionalised trauma system. Further studies are warranted to investigate whether the differences in service use and distances travelled to health services impact long-term health outcomes for people with serious injuries.

Chapter Five: Discussion and Conclusion

5.1 Introduction

The overarching aim of this thesis was to explore geographic variation in access to health care and health care utilisation for people with serious injury. The path to recovery following serious injury involves a protracted period of complex health care needs and multiple interactions with health professionals. Despite improvements in trauma systems, there are still deficiencies in a number of areas, particularly with respect to patients' discharge from hospital, and their post-discharge care in the community, with people following serious injury continuing to experience a high degree of long-term morbidity.

The research presented in this thesis adds valuable insights into the impact of geographic location on health care utilisation and access to services for people with serious injuries. The scoping review undertaken used peer-reviewed literature to investigate whether any scientific evidence exists to suggest a variation in health outcomes based on a metropolitan or regional location. Subsequent studies involved qualitative research to present the perspectives of health care providers working with seriously injury patients in metropolitan and regional Victoria, and quantitative research to evaluate the distances travelled and frequency of health service use for people with serious injuries.

This final chapter outlines a summary of the overall strengths and limitations of this program of research. The key findings from this research will be further discussed and reflected upon in the context of the current Victorian State Trauma System. Based on

the key findings, recommendations for service development and future research are provided in the hope of optimising post-discharge care for people with serious injuries across the state of Victoria.

5.2 Strengths and Limitations

The strengths and limitations of each individual study are discussed within the manuscripts presented in Chapters Two to Four. This section provides a broad overview of the strengths and limitations of this program of research in its entirety.

Including qualitative, epidemiological and geospatial research methods in this research was a key strength, providing a comprehensive examination of access to health care and service utilisation for people with serious injuries in the Victorian State Trauma System. The qualitative insights and experiences of AHPs working with people after serious injury provided rich information have the potential to inform service delivery and support meaningful change. A notable strength of this research was the use of registry data in the quantitative studies. This enabled a large, population-based capture of people with transport-related injuries in Victoria. The geospatial research, the first of its kind in Australia, determined distances travelled to post-discharge health services by LGA. The methods for each study presented have been well described to allow reproducibility.

A notable limitation of the quantitative research was the focus on only people with transport-related injuries. People who sustain transport-related injuries are typically younger in age, have fewer comorbidities and have their medical expenses covered by

injury insurance providers.[119] Between 2007 and 2016 the number of major trauma patients aged older than 65 years more than doubled, increasing from 25% to 37% of the major trauma population.[120] Older age reduces a person's physiological ability to recover from an injury.[121] Injuries in older adults also result in poorer health outcomes for equivalent or less severe injury compared with younger populations.[122] With an increasing incidence of major trauma in people aged over 65 years, it is important to consider the health care needs of this group and how accessibility issues may differ to people with transport-related injuries.[123]

Additionally, participants were selected from a database of TAC claims so their medical expenses were covered by the TAC. Previous research on chronic conditions has suggested that health insurance increases allied health service utilisation.[124] Given the chronicity of serious injury, understanding health service utilisation in a non-compensable population would be beneficial to determine whether compensation status may also be a factor impacting access to post-discharge health services. Further research is necessary to determine whether there are additional challenges to accessing health services faced by older people and people without injury insurance. This information will help inform trauma system design and optimise service delivery for the wider major trauma population.

A further limitation of this work was that this research was conducted in Australia, a high-income country with an excellent standard of health care, a well-established trauma system and comprehensive medical coverage f.or injury. Whilst an inclusive trauma system and the associated VSTR enables the collection of high-quality data for accurate analysis and reporting of patient demographics, injury characteristics and

outcomes, the majority of the world's burden of injury is borne by low- and middle-income countries (LMICs).[125] Due to financial stresses and limited resources, implementation of trauma systems based on the models and research findings from high-income countries can create challenges for people in LMICs.[126] However, learnings from this research may contribute to planning and coordination of post-discharge health care in LMICs to optimise pre-existing resources and local stakeholders.

5.3 Summary of Key Findings and Recommendations

The overarching aim of the research included in this thesis was to explore geographic variation in post-discharge health care utilisation and travel to health care for people following serious injury. As defined in Chapter One, there were five key research objectives which formed this program of work:

1. Review the available literature to explore the association between geographic location and outcomes following injury;
2. Describe the factors perceived by AHPs to influence the care of people with serious injury beyond hospital discharge across regional and urban Victoria;
3. Explore factors perceived by AHPs to affect access to post-discharge health care for people with serious injuries in urban and regional areas of Victoria.
4. Explore geographic variation in health service use and distances travelled to health services in the first three years post hospital discharge for people with transport-related serious injury; and

5. Describe geographic variation in patterns of health service use in the first three years post hospital discharge for different injury groups.

Table 3. Summary of key findings

Chapter	Methodology	Objective	Key findings
Two	Scoping review	Explore the regional variation in outcomes following injury	Injury-related mortality is greater for people in regional areas Inconsistent definitions of rurality make it difficult to compare research findings
Three	Qualitative	Explore the barriers and enablers experienced by health professionals caring for seriously injured patients across different geographical regions	Telehealth services are underutilised as a method of service delivery due to cultural resistance to change and an unfamiliarity with technology Multidisciplinary input with a coordinated, patient-centred approach is important for optimal patient care Skills shortages and limited resources in regional areas limit the availability of necessary services Insufficient access to mental health services is a widespread issue across all of Victoria Specialised trauma outreach services may benefit patients and therapists People rely on financial assistance and social supports to assist in transportation to services
Four	Registry-based, retrospective cohort study	Explore regional variation in travel to post-discharge health services and	Participants residing in regional areas travelled further to services than people in metropolitan areas

Geospatial analysis	service use for people with transport-related serious injury	People with serious injury have sustained engagement in post-discharge health services in the first three years following injury
	Describe the patterns of distance travelled and service use for people in metropolitan and regional Victoria with transport-related orthopaedic, brain and spinal cord injury	People in regional areas used fewer services than people residing in major cities People with TBI in regional areas travelled further than people with TBI in major cities for all health services Regional participants with orthopaedic and brain injuries saw a GP more than their metropolitan counterparts People with SCI in regional areas used less mental health, physical therapy and OT services than people with SCI in metropolitan areas

The key findings, and subsequent recommendations, from this research were as follows:

1. **To understand the impact of geography on health outcomes other than mortality, a consistent definition of regionality or rurality is important and further research is required.**

   This finding was based on the evidence from the literature review completed and described in Chapter Two. This review highlighted that people in rural areas had a higher overall and pre-hospital mortality following injury, but there was no significant difference in mortality once admitted to hospital. A small number of

studies presented in this review reported in-hospital and recovery-focused outcomes. Of these studies, there was no consistent trend suggesting a difference in health outcomes for people in rural areas.

***Recommendation**:* Due to the inconsistencies in the classification of metropolitan and regional or rural groups in injury research, a distance-based approach to analysis may be more beneficial to standardise research and effectively evaluate the impact of geography in different settings. Additionally, further research investigating the association between geography and recovery-focused health outcomes is required to inform health service delivery following serious injury.

2. **Telehealth services are underutilised as a method of service delivery due to cultural resistance to change and an unfamiliarity with technology**

From the perspectives of the AHPs involved in the studies presented in Chapter Three, prior to the pandemic, telehealth services were underutilised in the post-discharge care of people with serious injury. Participants perceived telehealth to be beneficial to reduce physical discomfort and financial costs associated with prolonged travel to health care as well as to improve the availability of services in high demand, such as mental health. The findings in Chapter Three also suggest that whilst AHPs were motivated to adopt telehealth models, there was resistance from other practitioners, health services and funding bodies which limited the success of telehealth for people with serious injury.

Recommendation: Telehealth should be prioritised by allied health and

medical teams to reduce the burden associated with travelling to appointments, particularly for people in regional areas. Telehealth and technology are also likely to be beneficial in the provision of professional support and guidance for less experienced providers managing complex trauma patients. Education and training may be necessary to overcome any barriers to telehealth as a result of health professionals being unfamiliar with telehealth practices and technology. It will be important that health services and funding bodies are supportive of telehealth and review service delivery models, billing structures and resources for the long-term success of telehealth and integration within the pre-existing models of care and service delivery.

3. **Multi-disciplinary input with a coordinated and patient-centred approach to post-discharge care is important for optimal patient care.**

   In Chapter Three, the lack of coordination from acute hospitals or rehabilitation providers to outpatient services was reported to result in delays commencing services and difficulty finding adequately skilled health care providers. The lack of a dedicated care coordinator can result in AHPs assisting with navigating health services and funding services instead of providing clinical care.

   Recommendation: A streamlined referral process from inpatient to outpatient care is necessary to minimise delays in commencing outpatient services. A designated care-coordinator from the tertiary trauma centre may assist to improve the continuity of care, as well as coordinating specialist appointments and investigations at tertiary clinics beyond discharge. The care-coordinator

could also be responsible in facilitating telehealth services where appropriate on behalf of the patient with the trauma centre for review appointments and optimising scheduling so that patients required to travel from regional areas can reduce the amount of time away from their family, work and social commitments.

4. **Insufficient access to mental health services is a widespread issue across metropolitan and regional areas of Victoria.**

In Chapter Three, the lack of mental health services available to people with serious injury was highlighted as a barrier to post-discharge care across metropolitan and regional Victoria. The level of psychology, neuropsychology and social work services in regional areas was identified as insufficient to meet patient needs, resulting in extensive wait periods for these services. As a result, other AHPs were often required to provide additional psychosocial support, which they may not be trained in, limiting their ability to provide other necessary care. For people without injury insurance, the cost of psychology services was an additional barrier to receiving treatment. The substantial gap between the session fee and Medicare rebate resulted in these services being out of reach for some with serious injury, particularly if they were unable to work as a result of their injuries. This finding is also supported by the results of the final paper presented in which people with orthopaedic injuries and spinal cord injuries in regional areas used mental health services less than people with these injuries in metropolitan areas

***Recommendation*:** Improving the availability of mental health services must be

prioritised to ensure necessary care and support can be provided for people with serious injury beyond hospital discharge, in regional and metropolitan Victoria. Funding models for non-compensable patients with serious injury should also be revised to reduce the out-of-pocket expenses often associated with mental health care. Telehealth services may provide an additional opportunity to improve the availability of services in areas that have limited mental health care providers. Improving access to mental health services may help to improve psychosocial outcomes and quality of life for survivors of serious injury.

5. **Skills shortages and limited resources in regional areas negatively affects the availability of necessary services**

In additional to the lack of mental health care identified, an inadequate number of other AHPs available in regional areas was also perceived to contribute to people with serious injury experiencing delays in commencing post-discharge care or being unable to attend services as frequently as people in metropolitan areas. In Chapter Three, the importance of attendant carers to augment therapies and provide transportation assistance in regional areas was identified by AHPs. Limited access to carer support in regional areas resulted in an additional burden on friends and family to assist people with accessing services. A shortage of carers and fewer available wheelchair taxis in regional areas was also raised as a contributing factor to difficulty accessing services.

Recommendation: Telehealth and technological advances can facilitate professional support and co-treatments of people with serious injury for service

providers with less experience or who lack confidence in specific skills are also likely to be beneficial in the provision of professional support and guidance for less experienced providers managing people with complex injuries. Additional funding or incentives to improve the availability of attendant carers in regional areas for people requiring regular assistance with daily activities is likely to be beneficial to people with serious injury and reduce the burden on their family members. This is particularly important in situations where a family member is unable to participate in their regular paid employment as a result of the care needs they are required to provide, adding to the financial strain and emotional stress likely to be felt by the family unit.

6. **Specialised trauma outreach services may benefit complex patients and support less experienced health professionals**

From the studies presented in Chapter Three, there has been a need identified for additional support to be provided to people with complex serious injury in outer urban and regional areas, where specialised health professionals are less common. This gap in service was particularly noted for people with traumatic brain injury, complex orthopaedic injuries and chronic pain. Comparatively, AHPs reported the benefit of the state-wide Spinal Community Integration Service (SCIS) that exists in Victoria to assist both people with SCI and their local health care providers.

Recommendation: Developing a specialised outreach program that is community based and trauma specific, with different multidisciplinary specialist teams for orthopaedic and neurotrauma, is likely to improve the quality of post-discharge care for people in regional areas. Having a specialised

outreach service that involves the injured person and their local treatment team is likely to also foster constructive professional relationships and upskilling of regional AHPs. Improving the skills and knowledge of regional AHPs is likely to help bridge the gap between a specialist outreach service that may be linked to a major trauma service, and community based AHPs. This service could also be developed to include a care-coordinator for each individual to assist the transition from hospital to community-based services and act as a point of reference to provide support and answer additional questions from patients trying to navigate complex health care and funding systems.

7. **People rely on financial assistance and social supports to assist in transportation to services**

The studies in Chapter Three found that for people in outer metropolitan and regional areas, an identified barrier to accessing health care was the need for assistance with transport to services. For compensable patients with access to funding for taxi transport, the issue was primarily in regional areas with a shortage of taxi services, particularly wheelchair taxis, for people requiring wheelchairs. For non-compensable patients, a lack of financial support often led to a reliance on family and friends to assist with travel to appointments for people who were unable to drive because of their injuries or use public transport. Issues with transport are likely to be more limiting for people in regional areas who are travelling further distances to access post-discharge health care, as presented in Chapter Four.

Recommendation: There is a need to optimise an individual's ability to reach a physical service or offer alternate service delivery such as home-based care or telehealth. For people unable to drive, who aren't receiving compensation for their injuries, having subsidised taxi transport may make it easier to attend services, without placing additional burden on their social networks. Additionally, for people unable to drive and living in regions not well serviced by taxi transport, ensuring that there are carers available to assist with transportation to health services or financial assistance for family or friends providing support, may also reduce some of the difficulties in access associated with transportation. The distribution and growth of urban areas must be considered as a factor in planning for new health services or satellite sites to optimise access to health care.[127]

8. **Participants residing in regional areas travelled further to services than people in metropolitan areas**

Chapter Four found that people living in regional areas of Victoria travelled further to post-discharge health services than people in metropolitan areas in the first three years post-discharge. Specific clustering of increased travel distances was observed in the far west and north-east Victorian LGAs, indicating areas of greater travel distances where there are similarly high values in neighbouring LGAs. People living in the outer metropolitan LGAs of Wyndham, Melton, Hume, Whittlesea, Nillumbik, Yarra Ranges, Cardinia, Casey and Mornington Peninsula travelled further than people living in other metropolitan LGAs. When examined by injury group, multivariable modelling found that people with TBI in regional areas

travelled further than people with TBI in major cities for all post-discharge health services examined.

***Recommendation*:** These data should be used to inform further work in understanding the gaps in health services available to people with serious injuries in outer metropolitan and regional Victoria. Working with regional health services to address skills shortages and establishing specialist outreach clinics in regional centres may assist to reduce the travel burden for people with serious injury. Additionally, ensuring that telehealth services are available for certain post-discharge health care is likely to reduce travel distances required for people in outer metropolitan and regional Victoria. Particularly, for people with TBI, travelling additional distances to care is likely to create a burden on their caregivers so ensuring that adequate assistance with transport and carers are available is important.

9. **People with serious injury have sustained engagement in post-discharge health services in the first three years following injury**

The data presented in Chapter Four highlights that people with serious injury continue to engage in medical and allied health services in the first three years following hospital discharge. Whilst the number of people using post-discharge services declined each year after discharge, the median number of trips were consistent over time for people still engaged in services, except for physical therapies where the number of trips reduced over time.

***Recommendation*:** Health services must be equipped to manage the care of some people for several years following injury. In conjunction with sub-acute

services, support to transition people requiring long-term therapy into community-based care must be available.

10. Regional participants with orthopaedic and brain injuries saw a GP more than metropolitan counterparts

The data presented in Chapter Four also suggest that people with an orthopaedic or moderate-severe brain injury in regional areas had 76% greater adjusted odds of attending a GP following serious injury than people in metropolitan areas. This may be explained by people in metropolitan areas having more frequent and easier access to specialised rehabilitation providers, thus being less reliant on their local GPs.

Recommendation: This finding highlights the importance of regional GPs having adequate knowledge of serious injury and injury-related complications to provide a high-standard of care to their patients. Further qualitative research with regional based GPs involved in the care of people with serious injury is necessary to give context to this finding and guide the development of specific recommendations to optimise medical care for people in regional areas. A designated care-coordinator from the trauma centre may also assist regional GPs in managing complex patients, acting as a point of reference to clarify post-operative instructions or recommendations relating to an injury or to connect the GP to a specific medical specialist or AHPs for further advice.

11. People in regional areas with orthopaedic and brain injuries used fewer medical services and attended less frequently than people residing in major cities

The second study presented in Chapter Four found that people with orthopaedic and brain injuries in regional areas had lower odds of attending medical services following hospital discharge than people in metropolitan areas and, of those who did attend, they saw medical professionals less frequently than people in metropolitan areas. A reason for this may be that people with serious injury in regional areas are required to travel much further to medical specialist appointments, commonly located at tertiary trauma centres, in inner metropolitan Melbourne and therefore, may not attend scheduled appointments or have fewer appointments scheduled. For people with orthopaedic injury and TBI in this study, we found that people in regional areas travelled a median distance of 77km and 104km respectively to attend medical services. In addition to the travel burden associated with greater travel distances, in Chapter Three, AHPs noted that the stress and anxiety of travelling into Melbourne for appointments was often a barrier to people receiving necessary medical follow up.

Recommendation: Utilising telehealth where possible to reduce the mental, physical and often financial burden associated with attending medical reviews in inner metropolitan facilities may improve the accessibility of medical services for people in regional areas. Additionally, minimising the in-clinic wait times of medical appointments may improve compliance for people attending from regional areas whose fatigue and other injury-related symptoms are easily exacerbated.

12. People with SCI in regional areas used fewer allied health services than people with SCI in metropolitan areas.

From the final study presented in this thesis, the results suggest that people with SCI in regional areas used fewer mental health, physical therapy and OT services than people with SCI in metropolitan areas. Additionally, of the people with SCI who did use these services, people in regional areas attended physical therapies and OT services less frequently than their metropolitan counterparts. This finding supports the qualitative research from Chapter Three where participants reported that people living in regional areas often have difficulty with transportation if they require carers to assist them with therapy access or are reliant on wheelchair taxis, which are often in limited supply.

Recommendation: People with SCI are often dependent on others for assistance with transportation, particularly if they are awaiting modifications to their own vehicle to drive independently. Ensuring that there are sufficient wheelchair taxis available in both metropolitan and regional issues may improve transportation issues. The Government must be involved in planning to improve supply to ensure response times for accessible (wheelchair) taxis are the same as for other taxis, as stipulated under the Disability Discrimination Act, 1992 [128] Where wheelchair taxi transport is unavailable, helping people with SCI to find carers to assist with transportation, outside of their family network, may help to improve difficulties with transport. Additionally, people awaiting vehicle modifications for independence in regional areas should be prioritised and the jobs incentivised to ensure these changes can be made in a timely manner.

5.4 Implications for Health Service Planning

The results presented throughout this thesis highlight the impact of geography on accessing post-discharge health services for people with serious injury in Victoria. From the findings of this research, continuity of care, availability of services and accessibility (reduced travel) are highlighted as priorities for improving post-discharge care of people with serious injury, with recommendations for service development described in Figure 6. These recommendations are further discussed below in relation to this program of research, the VSTS and previous literature from other jurisdictions.

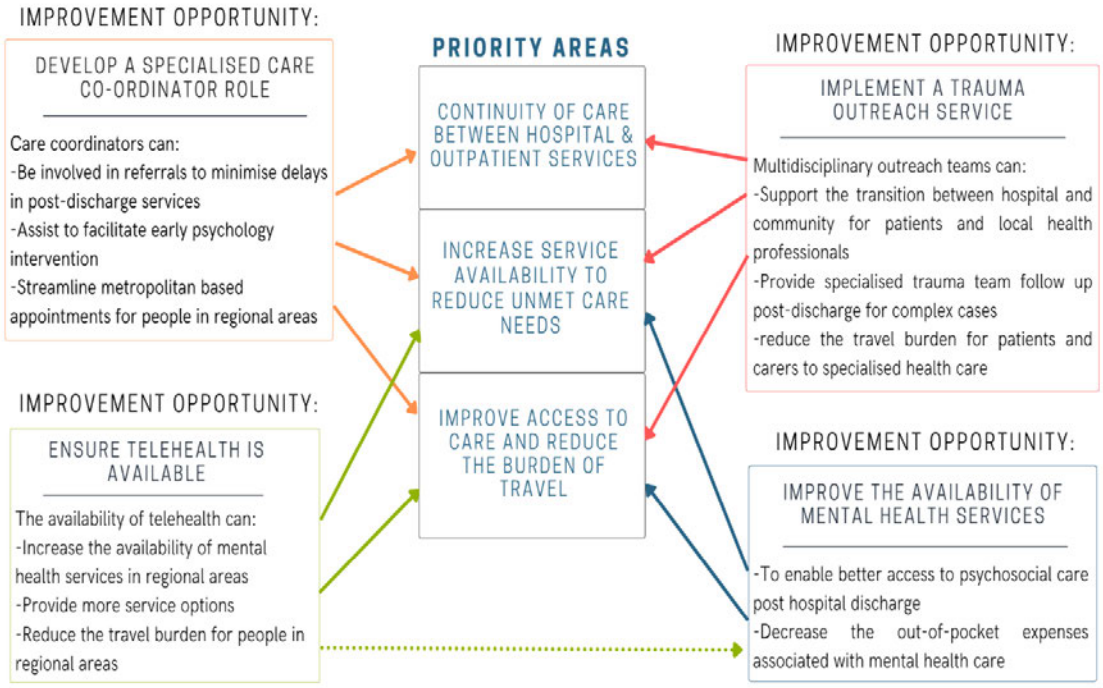

Figure 6. Summary of key priorities and opportunities for service development improvement

A lack of continuity of care between acute, rehabilitation and community services following serious injury has been well-documented as a barrier to recovery in this population and is reinforced by the findings of this work [21, 129] The integration of acute trauma care and rehabilitation services has been found to be a more efficient and cost-effective model of care than having these as standalone services, as well as providing better continuity of care.[19] However, with one-third of seriously injured Victorians residing in regional areas, this may not feasible due to the prolonged amount of time people would often be required to spend far away from the homes, families and communities.[19] Instead, establishing a care-coordinator role to link acute services with rehabilitation and community care may improve continuity of care for people with serious injury. A care-coordinator could act as a single point of contact for patients and treating health professionals to improve communication between health care providers and continuity of care.[94] At a minimum, providing people with serious injury with a multidisciplinary trauma team consult in the first six weeks following discharge is likely to improve continuity of care and ensure that recommended post-discharge care referrals have been completed and services established.[129, 131]

The findings of Paper Five suggest that people living in regional areas attend GPs more than people in metropolitan areas following serious injury. Previous research has reported that people with TBI have an expectation that their GP will connect them to the necessary services and if a GP fails to do this, it can result in persistent and unmet care needs.[21] Having a designated trauma centre care coordinator may also assist regional GPs to make referrals or connect people with serious injury to specialists. Having an established post-discharge care pathway for survivors of serious injury that

is streamlined and specialised will ensure more equitable access to care and a supported transition from acute to post-discharge services. Improving post-discharge care for people with serious injury is likely to positively impact the patient experience as well as long-term health and vocational outcomes.

The data presented in this thesis strongly supports the implementation of telehealth services for post-discharge medical and allied health services as one solution to overcome access issues and skills shortages for people recovering from serious injury, especially for people in regional areas.[29, 30, 91, 132] Telehealth is defined as telecommunications and information technologies used to share information, and provide clinical care, education, public health, and administrative services at a distance.[133]

In recent years, there has been a substantial increase in telehealth-related research, supporting the feasibility and effectiveness of telehealth services, particularly in regional areas.[134] Incorporating assistive technology in health care provides greater opportunity to connect individuals with necessary services and enables professional support networks for health care providers outside of major metropolitan centres.[135, 136] Despite the advantages of telehealth being described by research, there was limited uptake of this as a regular service option until recently, with barriers to telehealth including technological difficulties, funding limitations and privacy issues.[137-139]

Since the commencement of this research however, the COVID-19 pandemic has required many health services to drastically change how they deliver health care, particularly in Victoria, where lengthy periods of lockdown have restricted face-to-face appointments. With more widespread uptake of telehealth services throughout the

COVID-19 pandemic, concerns around digital literacy skills for service providers and service users, infrastructure development and client acceptability are now better understood.[136, 140-142] The progress made in the availability of telehealth services throughout the pandemic[143] is likely to improve access to care and reduce the physical, mental and financial stress of travel for those with the capacity to engage in such services.[143, 144] However, for these learnings to be sustainable beyond the pandemic, long-term telehealth implementation will require ongoing support from funding bodies. There must also be recognition of the multifaceted assistive technology ecosystem, described by the WHO, including the 1) the person; 2) the technology products; 3) personnel; 4) service provision and 5) the governing policies, that must be coordinated for integration of service delivery via telehealth within current models of care.[136, 141, 145]

Improving the availability and subsequent access to mental health services in regional areas must be a health priority. In Australia, 90% of neuropsychologists practice in metropolitan areas.[146] Telehealth can provide an effective, alternative method of accessing mental health services to help alleviate the issue of skills shortages and the burden of travel in regional areas.[146-148] Allied health professionals also reported that a lack of funding and service availability limited accessibility of mental health services.[29, 30] In both urban and regional areas, people with TBI report unmet needs in regards to psychological and social wellbeing services.[88] Following transport-related injury, people living in metropolitan areas and areas of lower socioeconomic advantage are at higher risk of worsening or persistent problems with pain, anxiety and depression.[119] In light of this, consideration must be given to improving access to psychology services

for people both in regional and metropolitan areas. People with serious injury are also at greater risk of financial hardship.[149, 150] Ensuring that funding of mental health service is prioritised for compensable and non-compensable patients may improve engagement with mental health services and patient outcomes.

In addition to the wider adoption of telehealth practices, further consideration of how to best provide services to people in regional areas is necessary. People living in regional areas with serious injury, particularly TBI, report more unmet service needs than people in metropolitan areas.[38, 88, 151, 152] The primary reasons identified for these unmet rehabilitation needs were the unequal geographic distribution of services, lack of transportation and unaffordability of available services.[152] In circumstances where telehealth is not as feasible, such as with 'hands-on' assessment or treatment, where the safety of an individual is at risk, or if there are obstacles to effective communication such as language barriers or cognitive deficits, telehealth and/or outreach models of service delivery warrant investigation to improve accessibility for people in outer urban and regional areas.

In Victoria, specialised community-based SCI care is provided by the Spinal Community Integration Service. This service aids people with a new SCI, for the first 12 months post discharge, to support the individual, carers, family and health professionals to access specialist knowledge and assist with transition to home from hospital and with community integration.[153] Developing a similar community outreach service for people with TBI and complex orthopaedic injuries may assist with continuity of care, address unmet service needs and reduce the need for people in regional areas to travel to metropolitan centres to receive specialised trauma care.[130, 154] Alternatively,

implementing regular specialised, multidisciplinary, outreach clinics in regional centres targeting people in the first three months post-hospital discharge may improve the accessibility and availability of specialised care.[129, 131] These clinics could also involve local health professionals and be used as a pathway to upskill regional health professionals and improve communication between trauma centres and community-based services.

From the findings of this research, continuity of care, availability of services and accessibility (reduced travel) are highlighted as priorities for improving post-discharge care of people with serious injury, with recommendations for service development described in Figure 6.

5.5 Recommendations for Future Research

The findings from this thesis provide a foundation for further research investigating the impact of access to services on health outcomes and rationale for continued investigation into alternate models of service delivery for people with serious injuries. To better understand post-discharge care and develop guidelines for best practice rehabilitation and community-based trauma care, further research is recommended targeting the following areas:

1. **Exploring the relationship between distance travelled to services and service use and health outcomes**

   This foundational research can be expanded on to explore the relationship between health outcomes and service use using VSTR data. To make specific recommendations about best-practice post-discharge care, understanding whether

the geographic variation in distances travelled and service use is associated with health outcomes is essential.

2. **Evaluating the feasibility, cost-effectiveness and patient satisfaction of telehealth services**

   With the increased uptake of telehealth services as a result of the COVID-19 pandemic, there is a great opportunity to evaluate the use of telehealth services for people with serious injury. The TAC has introduced new billing codes for telehealth services in response to the pandemic which will enable analysis of outcomes for people with serious injury who have used telehealth services. Understanding telehealth from the perspectives of service providers and people recovering from serious injury will be of interest in determining the optimal delivery of telehealth services and how these services have been received by users. Research investigating telehealth from the perspectives of service users, service providers and funding bodies is currently underway and due for completion in 2022.

3. **Exploring access to services and service utilisation in people with serious injury over the age of 65**

   In the changing landscape of major trauma where an increasing number of people injured are over 65 years of age, understanding any specific difficulties experienced by, or factors to improve accessibility in, this population is warranted. Without established and well-organised data collection on service use in a non-compensable cohort, it is difficult to explore patterns of service use in older adults injured as a result of falls or other unintentional injury. Qualitative research targeting older

adults and their care providers may assist to provide greater insights on any additional barriers experienced by older adults in metropolitan and regional areas.

5.6 Concluding Remarks

The overarching aim of this research was to explore geographic variation in access to health care and health service utilisation for people in metropolitan and regional Victoria with serious injuries. At present, no guidelines exist to inform post-discharge health care within the Victorian State Trauma System. This thesis has confirmed that, for people with serious injuries, where you live matters when it comes to accessing post-discharge health services. People in regional areas are often required to travel further than people in metropolitan areas and access fewer health services following serious injury. A number of specific challenges to providing care across metropolitan and regional areas have been identified by this work, with recommendations developed to inform key stakeholders involved in the planning and funding of post-discharge health services within the VSTS. It is hoped that the findings of this research can be used to reduce the disparity in access to services for people living in regional Victoria and optimise long-term health outcomes for people with serious injuries.

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Appendices

Appendix 1: Search strategy for scoping review

SEARCH STRATEGY
(search completed 23-24 October 2018)

Research question:
What is known from the existing literature about the relationship between geographic place of injury or geographic location of residence on outcomes following traumatic injury.

Does geographic location (of incident or location of residence) effect outcome following trauma?

Limit to: Peer reviewed Journals, English language

Database	Keywords	Controlled vocab	Search strategy	Results	
Ovid Medline	Trauma Geography Rural Urban Mortality Outcome Injury	Mortality Hospital Mortality Outcome Assessment (Health care) Treatment Outcome Geography Urban Population Suburban Population Rural Population Wounds and Injuries Accidents, Traffic Accidents, Occupational Accidents, Home Accidental Falls	[Hospital mortality OR Mortality OR Accidents, Traffic (Mortality) OR Accidents, Occupational (Mortality) OR Accidents, Home (Mortality) OR Accidental Falls (Mortality) OR Outcome Assessment (health care) OR Treatment Outcome] **AND** [Geography OR Urban Population OR Suburban Population OR Rural Population] **AND** [Accident, Traffic OR Accidents, Occupational OR Accidents, Home OR Accidental Falls OR Wounds and Injuries OR trauma]	416	**Total records identified= 4934** **Duplicates removed = 1232** **Abstracts to screen = 832 (excluded n = 749)** **Full texts to screen: N = 98 (excluded n = 52)**

					Peer-reviewed articles retained: n= 46
Embase	Trauma Wounds and Injuries Motor vehicle crash Traffic accident Geography Rural Urban Mortality Outcome	Mortality Hospital Mortality Outcome Assessment Health Care Quality Treatment Outcome Geography Urban Population Suburban Population Rural Population Rural Urban Difference Injury Accident, Traffic Accident, Occupational	[Hospital mortality OR Mortality OR Treatment Outcome OR Outcome Assessment OR Health Care Quality] AND [Geography OR Urban Population OR Suburban Population OR Rural Population OR Rural Urban Difference] AND [Accident, Traffic OR Accident, Occupational OR Injury OR trauma]	526	
Scopus	Trauma Injury Geography Rural Urban Mortality Morbidity Outcome	n/a	[trauma OR "traffic accident"] AND [urban OR metropolitan OR city OR suburban AND rural] AND [mortality OR "function"]	397	

CINAHL	Trauma Wounds and Injuries Geography Rural Urban Mortality Outcome	Hospital Mortality Mortality Outcome Assessment Health Care Delivery Patient Care Quality of Health Care Geographic Location Urban Population Suburban Population Rural Population Trauma Wounds and Injuries Accidents, Traffic Accidents, Occupational Accidental Falls	[Hospital mortality OR Mortality OR Treatment Outcome OR Outcome Assessment OR Health Care Delivery OR Quality of Health Care OR Patient Care] AND [Geographic Location OR Population Characteristics OR Urban Population OR Suburban Population OR Rural Population] AND [Accident, Traffic OR Wounds and Injuries OR Trauma OR Accidents, Occupational OR Accidental Falls OR Trauma]	310	
Web of science	Trauma Injury Geography Rural Urban Mortality Outcome	n/a	[trauma OR "traffic accident"] AND [urban AND rural] AND [mortality OR outcome OR recovery]	434	
PubMed	Trauma Geography Rural Urban Mortality Outcome	Not utilized 'All Fields' keyword search used to capture publications not yet indexed with MeSH headings	[Mortality OR Outcome OR Fatality] ALL FIELDS **AND** [Geograph* OR Urban OR Suburban OR Rural] ALL FIELDS **AND** [Accident* OR traffic OR transport OR trauma OR	263	

			Motor Vehicle Crash] ALL FIELDS **Pubmed searched only 1 Jan 2018-October 24 2018 search to capture publications not yet indexed with MeSH headings and therefore not identified using Ovid Medline search strategy.		

Additional records identified through other sources = 12

Appendix 2: Expanded tables of results for 'The relationship between geographic location and outcomes following injury: A scoping review'

Table 1 Mortality Outcomes - Rural Vs Urban

Country	Author(s)	Mortality Outcome	Measures reported/ Denominator	Results	Population Studied	Age	n (% Urban/Rural if available)	Rurality Classification	Rurality Classified By	Data Source	Confounders Adjusted For
USA	Baker et al. 1987 [1]	Overall	MVC mortality rates per 100,000 population (denominator = US population estimates)	Emerald City, Nevada (lowest PD) = 558/100,000; Hudson, New Jersey (middle PD) = 4.3/100,000; Manhattan, New York (high PD) = 2.5/100,000; High compared to lowest PD death rate: r = -0.67, p<0.0001	All injury-related fatalities from MVC in USA	All ages	127,110	Population density into percentiles; from 1970 census data	Residence (County)	NHTSA - FARS data 1979-1981	Unadjusted
	Beck et al. 2017 [2]	Overall	Age-adjusted MVC mortality rates per 100,000 population (denominator = US population estimates)	Most urban to most rural across census regions: South, 6.8 to 29.2; Midwest, 5.3 to 25.8; West 3.9 to 40.0; Northeast, 3.5 to 10.8	Passenger-vehicle-occupant deaths from MVCs	≥ 18	19,528	RUCC collapsed into six levels	Injury	FARS data and Behavioural Risk Factor Surveillance System 2014	Age
	Brown et al. 2000 [3]	Overall	MVC mortality rates per 100,000 population (denominator = US population estimates) and OR	Rural = 42.71 per 100,000 (95%CI 38.41-47.01); Urban = 10.43 per 100,000 (95%CI 8.92-11.94); OR 4.10 (95%CI 3.83-4.39; p<0.0001)	All injury-related fatalities from MVC in USA	All ages	875405 (41.9% urban; 58.1% rural)	U.S. Census Bureau	Injury	FARS from NHTSA 1977-96	Not stated
		Pre-Hospital	Death at scene rate per 100,000 population using (denominator = US population estimates) and OR	Rural = 18.3 per 100,000 population (95% CI = 16.24-21.31; p<0.0001); 3.01; Urban = 2.79 per 100,00 population (95%CI = 2.35-3.23;p<0.0001). Rural crash victims were significantly more likely than urban to be declared dead at the scene (p<0.0001; OR = 2.12, 95% CI: 2.10–2.14).	All deaths-at-scene following MVC		329,767				
	Clark et al. 2001 [4]	Overall	Traffic fatality rates per 100,000 people by quartiles of US county population density (denominator = population of US counties) separated into	Younger rate per 100,000 population = 30.8; 25.8; 19.8; 8.2. Older rate per 100,000 population = 34.9; 28.6; 26.9; 14.1	Elderly fatalities within 30 days of injury from a MVC	≥ 65yr	32064 (26,169 <65yrs; 5,895 > 65yrs)	Population density (per Square Mile): Grouped 0-16.5; 16.5-40.2; 40.2-99.3; >99.3	Injury	FARS were obtained from the NHTSA for 1997	Unadjusted

		younger (Y; < 65yrs) and older (O; 65yrs)								
Donaldson et al. 2006 [5]	Overall	Adjusted OR of death within 30 days of MVC	Unadjusted = Rural crashes 4.5 times more likely to have a fatal outcome than urban crashes. Adjusted Urban RR = 2.8 (95% CI: 2.2–3.5) and Rural RR = 1.2 (95% CI: 0.8–1.7)	All reported MVCs occurring on public roads in Utah that either resulted in passenger injury or had at least $1000 in property damage	All ages	514,648	RUCC dichotomised into metropolitan and non-metropolitan counties with OMB definitions	Injury	Utah state database (1996-2001)	Behavioral, road, and crash characteristics.
Gabella et al. 1997 [6]	Overall	Age-adjusted mortality rate from TBI per 100,000 population and (denominator = US population estimates) and rate ratios	Rural, remote rate = 33.8 (95% CI 23.8-43.8) Rural, non-remote rate = 25.5 (95% CI 22.1-29.0) Other metro rate = 18.6 (95% CI 16.6-20.5) Urban (Denver-Boulder) rate = 18.1 (95% CI = 16.7-19.6). Rate ratio (Urban vs Rural, remote) = 1.9	All TBI mortality cases in Colorado, involving Colorado residents	All ages	1312	U.S. Census Bureau	Residence	Colorado Department of Public Health traumatic brain injury surveillance (1991-1992)	Age
	Pre-hospital	Age-adjusted mortality rate from TBI per 100,000 population (denominator = US population estimates) and rate ratios	Rural, remote rate = 27.7 (95% CI 18.5-36.9) Rural, non-remote rate = 18.6 (95% CI 15.6-21.5) Other metro rate = 12.6 (95% CI 11.0-14.2) Urban (Denver-Boulder) rate = 10.0 (95% CI = 8.9-11.0); Rate ratio (Urban vs Rural, remote) = 2.8	All TBI mortality cases in Colorado, where place of death was not 'inpatient'		855				
McCowan et al. 2007 [7]	In-	Adjusted OR	No significant mortality differences between the two groups (p=0.074).	Patients transported by HEMS following blunt trauma	≥ 15	411 (Urban = 65.8%; Rural = 34.2%)	Population density: Rural = less than 99 people/square mile.	Injury	HEMS transports in 2001. Blunt trauma patients were identified from HEMS transport records and the trauma registries at three Level I trauma centres.	Age, gender, ISS
Muelleman et al. 2007 [8]	Overall	OR	OR = 1.98 (95%CI = 1.18–3.31) in most rural group (small, non-adjacent rural counties)	All fatal or injury-related MVC mortality (Nebraska)	All ages	225	UIC grouped into 4 categories: 1) Small metropolitan statistical areas (counties with < 1,000,000 residents	Injury	1996 through 1999 from Nebraska Crash Outcome Data Evaluation System (CODES)	Speed limit, age, alcohol involvement, and ISS

	Peura et al. 2015 [11]	Overall	Adjusted OR (Rural/Very Rural groups compared to Urban) in those with ('police-reported') severe injuries	Compared to urban (RUCC 1–3) crashes, rural crashes with severe injuries had 23% increased adjusted odds of death (aOR 1.23, 95% CI 1.16–1.31) and individuals in very rural counties had a 31% increased adjusted odds of death (aOR 1.31, 95% CI 1.18–1.46).	All police-reported fatal MVC in 11 states of USA	All ages	26,582	RUCC (Grouped 1-3 = urban; 5-4 = party rural; 6-7 = rural; 8-9 = very rural)	Injury	National Highway Traffic Safety Administration (NHTSA) State Data System (SDS) from 11 states 2005-07	Age, seat belt use, ejection from the vehicle; alcohol involvement, speed, crash time of day, involvement of a single vehicle, or on interstate highways
	Sihler et al. 2009 [12]	In-hospital	OR	The likelihood of death was lower for those injured in both suburban areas (OR = 0.74, 95% CI: 0.64–0.86) and rural areas (OR = 0.69, 95% CI: 0.53–0.90), compared with urban areas.	Hospital admissions following traumatic injury	All ages	34,933	UIC - collapsed into 3 categories, urban/suburban/rural	Injury	National Trauma Data Bank for injuries occurred in 2001 through 2005 (doesn't capture all rural hospitals)	Age, gender, injury severity and treating institution
	Travis et al. 2012 [13]	Overall	Adjusted OR (95%CI)	Urban = referent; Partly rural = 1.18 (0.92-1.50); Rural = 1.24 (0.59 - 2.63); Very rural = 2.31 (1.68-3.18)	Police-reported MVC resulting in injury	All ages	883,473	RUCC (1-3 = urban; 5-4 = partly rural; 6-7 = rural; 8-9 = very rural)	Residence	National Automotive Sampling System - General Estimates System (NASS-GES) maintained by the NHTSA 2002-08	Age, gender, speed, rollover, early morning time, seatbelt use
	Zwerling et al. 2005 [14]	Overall	Injury fatality rate (per 1000 crashes with injury), denominator = total crashes with injuries. Fatal crash incidence density (per 100 million miles driven), denominator = vehicle miles driven	Injury fatality rate: Urban = 8.79, Rural = 26.27. Fatal crash incidence density: Urban = 1.28, Rural = 2.86	All fatal and injury-related fatalities from MVC	> 16yrs	53,049	Population: Rural < 25,000; Urban > 25,000	Injury	FARS from the NHTSA in 2001	Unadjusted
AUSTRALIA	Chen et al. 2010 [15]	Overall	Fatality rate per 10,000 drivers (denominator = all licensed drivers) and relative risk	Risk of driver fatality 2007: Rural RR = 6.0; 1997 Rural RR = 3.6. Fatality rate (2007) rural = 3.2; regional = 1.0; urban = 0.5 per 10,000 licenced drivers	Police-recorded passenger vehicle crashes (NSW)	17-25yr	644	ASGS into 3 categories - urban (metro), regional (inner regional) and rural (outer regional, remote, very remote)	Residence	Road Traffic Authority of NSW data (1997-2007)	Age, gender, rurality of residence, SES
	Fatovich et al. 2009 [16]	Overall	Age-SMR (per 100,000 PY): Denominator = Person-time at risk from all deaths	RR death of Very remote compared to Major city = 4.28 (95% CI 3.93–4.68). The standardized age-specific death rates: major city = 24.09 per 100,000 PY, Very	All trauma related deaths (WA)	All ages	101,425	ASGS RA	Injury	Death Registry data from the Royal Flying Doctor Service (RFDS) database supplemented with Trauma Registry data (1997-2006)	Age

						54%; Most rural = 18%)	urban, 1-50% = moderate rurality, > 50% = most rural				
		In-hospital	% deaths in-hospital	Of all deaths occuring following injury in most rural areas 22% occurred in-hospital compared to 60% most urban deaths which occurred in hospital. Among patients surviving long enough to reach hospital, there was a threefold increase in the risk of ED death among those injured in a region with limited access to trauma center care	All trauma-related in-hospital deaths if survived to ED	1609 (Most urban = 51%; Moderate rurality = 43; Most rural = 6%)					
	Lagace et al 2007 [22]	Overall	Age-adjusted standardised mortality ratios; Denominator = population estimates	Risks were more than two times higher in rural areas than urban. Canada: SMRs 1.98 to 2.96; Australia SMRs 1.65 to 3.81.	All injury related MVC deaths	All ages	Not stated	ASGS RA (Aus); MIZ (Canada)	Residence	Mortality records from the Canadian Annual Mortality Database and Australian Institute of Health and Welfare.	Age, gender
	Simons et al 2010 [23]	Pre-Hospital	% pre-hospital deaths	82% trauma deaths in NW BC occur prehospital. Particularly evident for MVC where 77% of deaths are occurring at scene in NW BC when compared with 48% in the more urban jurisdiction of VCHA	All trauma-related pre-hospital deaths (BC)	**All ages**	**Not stated**	**Urban = Vancouver Coastal Health Authority and Fraser Health Authority; Urban and Rural = Vancouver Island Health Authority; Rural-Remote = NW BC**	**Residence**	**Discharge Abstract Database (DAD) data were collected for all trauma-related admissions and linked with BC Coroner's office deaths data.**	Unadjusted
		In-hospital	% in-hospital deaths	17.6% trauma deaths in NW BC occur in-hospital compared to urban jurisdictions where 27.9-32% deaths occurred in-hospital	All injury related in-hospital deaths (BC)						
CHINA	Hu et al. 2010 [24]	Overall	Age- and gender-injury mortality rates (per 100,000); Denominator = deaths recorded in Chinese Death Registry	The overall injury death rate for males was 60.1/100,000 in rural areas compared with 40.9 in urban areas; for females, the respective rates were 31.5 and 23.6/100,000	Injury-related deaths in China	All ages	~10% population	Population density: Rural = counties < 2,000ppl; Urban = counties > 2,000ppl	Residence	Chinese Death Cause Registration data, 2006	Age
	Liu et al 2012 [25]	Overall	Age- adjusted injury mortality rates (per 100,000); Denominator = population	The age-adjusted injury death rate for males was 81.6/100,000 in rural areas compared with 37.0/100,000 in urban areas; for females, the	Injury-related deaths (Hubei Province)	All ages	9714 (Urban = 12%; Rural = 88%)	Urban- city population size (large, middle-sized, small city); Rural - class 1 -3 based on	Residence	Disease Surveillance Points (DSP) system from Hubei Province Centers for Disease Control and Preventio (2006-08)	Age

		In-hospital	Morality rate (per 100,000 PY); Adjusted OR	Multivariable analysis indicated no association between hospital mortality and low population density. The adjusted OR for low population density was 0.83 (95% CI 0.48 to 1.45) and for medium population density 1.06 (95% CI 0.69 to 1.67)	Death from MVC where the patient was a vehicle occupant with serious injuries and hospitalised > 1 day		832				during study period (early/late)
TAIWAN	Huang et al. 2017 [30]	In-hospital	Adjusted OR and % mortality	Rural group had a significantly lower risk of mortality after falls than the non-rural group (adjusted odds ratio =0.32, 95% confidence interval =0.28–0.37, P,0.001).	Hospital admissions for accidental falls in Taiwanese databases	>65 years	9,438	Rural = Yilan County; Non-rural = other Taiwan	Residence	Taiwan National Health Insurance Research Database - Inpatient Database of Yilan County & Longitudinal Cohort Database (2006-09)	Age, gender, comorbidity, number of medications, inappropriate medication use
NORWAY	Kristiansen et al. 2014 [31]	Overall	Annual mortality rate (per 100,000); Denominator = Census population estimates	The most rural areas had 52% higher trauma mortality rates compared to the most urban areas. The median annual county mortality rate ranged from 23.0 in Akershus to 44.7 in Finnmark, the latter being the most rural and northern county	All injury-related deaths in Norway	16-66yrs	8,466	Population density: Most rural = <18.2 inh/km2, rural = 18.2–76.9 inh/km2, central = 77.0–442.7 inh/km2, and most central = >442.7 inh/km2	Residence	Cause of Death Registry, Statistics Norway. Population statistics ffrom Norwegian Social Science Data Services (NSD), 1998-2007	Unadjusted
		Pre-Hospital	Proportion of pre-hospital deaths	The proportion of prehospital deaths decreased for each level of population density. Finnmark (most rural) had a significantly higher proportion of prehospital deaths (86%) than the remaining counties (P = .008).	All injury-related pre-hospital deaths in Norway		6,589				
GUYANA	McWade et al. 2017 [32]	Overall	Mortality OR	Fatal collisions, compared to collisions resulting in serious injury, were more likely to occur in rural areas (OR 2.27, 95% CI 1.58 to 3.27).	Fatal MVC identified by police reports in Guyana	All ages	275 (Rural = 72%; Urban = 28%)	Not stated	Injury	Police report data collected from two police divisions in the Demerara-Mahaica and Mahaica-Berbice regions of Guyana (three year period 2012-2015)	Unadjusted
SUDAN	Abdalla et al. 2017 [33]	Overall	Age and gender adjusted SMR (per 100,000); Denominator = Census population estimates	Urban = 94/100,000; Rural = 117/100,000	All cause injury related mortality	≥ 5	~33,400	Sudan rural-urban census classification	Injury	2008 national census mortality data with mortuary data to construct unintentional and intentional injury mortality estimates	Age, gender

FINLAND	Raatiniemi et al. 2015 [34]	In-hospital	30-day mortality OR	Logistic regression model for 30-day mortality - the odds ratio (OR) for the urban municipality was 2.8 (95 % confidence interval 1.0 to 7.9, P = 0.05) compared to rural municipality	All major trauma (ISS > 15) patients survived to hospital admission	All ages	472 (Rural = 53%; Urban = 47%)	Statistics Finland definitions dichotomised Rural (Rural & Semi-Urban) and Urban (Urban); 3-level system based on municipality; According to percentage of the population that lives in urban settlements and population of the largest urban settlement in the municipality.	Injury	All trauma patients treated by FinnHEMS and recorded as trauma patients in the electronic HEMS database. 30-day mortality data was retrieved from the Causes of Death Registry (Statistics Finland) 2012-13	Injury severity (ISS), age
SOUTH AFRICA	Sherriff et al. 2015 [35]	Overall	Age-SMR per 100,000 (Denominator = population estimates) and urban-rural rate ratio (RR)	Urban ASMR = 18.30 (17.38–19.21) Rural ASMR = 13.19 (11.86–14.52). RR = 1.39 (1.25–1.54)	Unintentional (non-transport) injury-related mortality	All ages	17,289	Urban province = Gauteng; Rural province = Mpumalanga	Injury	National Injury Mortality Surveillance System 2007	Age
		Overall	Age-SMR per 100,000 (Denominator = population estimates) and urban-rural rate ratio (RR)	Transport-related injury mortality rates were significantly higher in the rural province (66.57/100,000 versus 45.83/100,000; (RR = 0.69 [0.66–0.71])	Transport-related injury mortality						

RUCC = Rural-Urban Continuum Codes; UIC = Urban Influence Codes; ASGS RA = Australian Statistical Geographical Standard Remoteness Area; ARIA = Accessibility/Remoteness Index of Australia; MIZ = Metropolitan Influence Zones; SMR = Standardised Mortality Rate; NW BC = North West British Colombia; MVC = Motor Vehicle Crash; EMS = Emergency Medical Services; OR = Odds ratio; RFDS = Royal Flying Doctor Service; NSW = New South Wales; ED = Emergency Department; PD = population density; FARS = Fatality Analysis Reporting System; NHTSA = National Highway Traffic Safety Administration

Table 2 Other in-hospital outcomes - Urban Vs Rural

Country	Author(s)	Measures reported	Results	Population Studied	Age (years)	n	Rurality Classification	Rurality Classified By	Data Source	Confounders adjusted for
AUSTRALIA	Fatovich et al. 2011 [17]	Hospital LOS, ICU admission and ICU LOS	Significantly longer hospital LOS (12 vs 9 days, p < 0.001) and ICU LOS (5 vs 4 days, p=0.001) in the rural group and a greater proportion of rural patients admitted to ICU (52.9% vs 37.1%, p < 0.001).	Patients admitted to metropolitan trauma centre following major trauma (ISS > 15)	All ages	3,333	ASGS RA	Injury	Data from the Royal Flying Doctor Service (RFDS) and Trauma Registries; 01/07/1997 -30/06/2008	Age , ISS, time to first provider input
	Mitchell & Lower 2018 [36]	Age-adjusted hospital LOS and 28-day readmission	Hopsital LOS (mean): Urban = 6.1 days; Rural = 5.9 days. 28-day readmission %: Urban = 13.4, Rural = 12.6	Patients in NSW admitted to hospital following injury	All ages	709464 (Urban = 70%; Rural = 30%)	ASGS RA	Residence	Mortality data from NSW Registry of Births, Deaths and Marriages linked to patient-level hospitalisation data; January 2010 - June 2014	Age
	Sukumar et al. 2016 [19]	Hospital LOS	Rural residents = shorter median LOS (5 vs 7 days, p<0.0001),	Fall-related injury hospitalisations in rural vs urban elderly populations	≥ 65	256,536	ASGS Remoteness Area dichotomised to Urban (Major Cities & Inner Regional) and Rural (Outer Regional, Remote and Very Remote)	Residence	A linked dataset (NSW Admitted Patient Data Collection (APDC) and the NSW Registry of Births, Deaths and Marriages (RBDM) mortality data) of all admissions of NSW residents aged 65 and older, hospitalised at least once for a fall-related injury between 2003 and 2012	Age, gender and comorbidity
		28-day readmission	Rural residents readmitted more than urban (ARR 1.12; 95%CI 1.08–1.16, p<0.0001).							
USA	Mazurek, M.O. et al. 2011 [37]	Hospital (acute) LOS and hospital (rehab) LOS. Mean (SD) days	TBI: Hospital (acute) LOS - Rural = 16.6 (10.2); Urban = 15.5 (12.2). P = 0.22; Hospital (rehab) LOS - Rural = 32.6 (33.6), Urban = 26.8 (16.1). P = 0.86	TBI/SCI patients enrolled in the Missouri Model SCI System and Missouri Model TBI System databases	≥ 18	152 TBI (Rural = 75%; Urban = 25%).	US Census Bureau boundaries (population); Rural < 2,500 people	Residence	National Institute on Disability and Rehabilitation Research (Missouri SCI & TBI system) 2011	Not stated
		Hospital (acute) LOS and hospital (rehab) LOS. Mean (SD) days	Urban SCI residents had significantly longer rehabilitation hospital stays (p = 0.03). SCI: Hospital (acute) LOS - Rural = 19.5 (17.0), Urban = 22.6 (15.9). P = 0.17; Hospital (rehab) LOS - Rural = 36.9 (21.8), Urban = 45.6 (20.8). P = 0.03.			149 SCI (Rural = 76, Urban = 24%)				

	McCowan et al. 2007 [7]	Hospital LOS	No difference on regression model (p = 0.243)	Patients transported by HEMS following blunt trauma at hospital discharge	≥ 15	412; Urban = 65.8%; Rural = 34.2%	Population density: Rural = less than 99 people/square mile.	Injury	HEMS transports in 2001. Blunt trauma patients were identified from HEMS transport records and the trauma registries at three Level I trauma centres	Age, gender, and ISS
FINLAND	Raatiniemi et al. 2015 [34]	ICU LOS	40.3 % (190/472) of patients were admitted to the ICU; no difference between the groups for length of ICU stay.	Major trauma (ISS > 15) patients survived to hospital admission	All ages	472 (Rural = 53%; Urban = 47%)	Statistics Finland definitions dichotomised Rural (Rural & Semi-Urban) and Urban (Urban)	Injury (municipality)	All trauma patients treated by FinnHEMS and recorded as trauma patients in the electronic HEMS database. 30-day mortality data was retrieved from the Statistics Finland Cause of Death Registry; 1/01/2012 - 31/12/2013	Injury severity (ISS), age
TAIWAN	Chiang et al. 2006 [38]	Hospital LOS	The mean hospital stay was shorter in the urban group than rural group (P < .001). 13-15years: Urban = 5.19 days/Rural = 9.82 days; 16-18years: Urban = 7.62/ Rural = 7.78 days	Head injured adolescents in Taiwan with inpatient hospital stay	13-18	600	Urban = Taipei City (population density 9,835 per square kilometer); Rural = Hualien County (population density 72.7 per square kilometer)	Injury	Taiwan Head Injury Registry; July 1, 2001, to June 30, 2004	Not stated
SCOTLAND	McGuffie et al. 2005 [26]	Hospital LOS, ICU admission and ICU LOS	Logistic regression analysis did not indicate that population density had an effect on determining ICU admission. There were no differences between urban and rural patients in terms of length of intensive care stay (median 2 days, p = 0.4, Mann Whitney) or total in-patient stay (median 8 days, p = 0.7, Mann Whitney). Population density was not considered a significant factor when total length of stay was modeled using multiple regression analysis.	All moderate and major trauma patients (ISS > 8) admitted to hospital for more than two days	All ages	4636; Urban =85%; Rural = 15%	Population density: Rural = < 0.5 persons per acre; Urban = > 0.5 persons per acre	Injury	Patients eligible for entry to Scottish Trauma Audit Group (STAG) database and admitted to hospital for more than 2 days in west and south-west regions of Scotland; November 1998 and October 2000	Age, RTS, ISS, mechanism of injury, type of injury, the presence of a paramedic at scene, initial triage area and ambulance response time, on-scene time, and transfer to hospital time

Table 3 Recovery outcomes - Rural vs Urban

Country	Author (s)	Measures Reported	Results	Population Studied	Time Post-Injury	Age (years)	n	Rurality Classification	Rurality Classified By	Data Source	Confounders adjusted for

	Young A.E. et al. 2008 [42]	Work disability - time off work (days) in 2yrs following injury; OR likelihood of being off work > 1 week	The claimants with higher rurality experienced less work disability than those with lower rurality. This relationship remained after control for the impact of age, gender, part of body injured, occupation, and industry. Likelihood of being off work for > 1 week was greater in urban group, adjusted-OR = 0.86 (95% CI 0.79-0.94)	Injured workers seeking compensation for a bone fracture from an insurance company in USA (managing 8-10% of US workers' compensation claims)	24 months	Working age	11576| workers off work > 8 days n= 5618 (Urban = 67%; Rural = 33%)	Population density (US Census Bureau). Grouped as % scores derived by dividing the number of people defined as living in a "rural" area of a zip code by the total population of the zip code and then multiplying by 100. (Dichotomised to 0-9% = urban; 10-100% rural for analysis)	Residence	Insurance company records. 8-10% of US workers' compensation coverage. All workers new and accepted workers' compensation claim for a bone fracture in 2008.	Age, gender, part of body injured, occupation, and industry
AUSTRALIA	Harradine et al. 2004 [43]	Disability (DRS); Adaptability (MPAI), Psychosocial Reintegration (SPRS), Medical outcomes (MOS-SF), General health (GHQ)	No statistically significant differences were found between rural and urban groups at 18 month follow up	Patients referred to NSW BIRP (11 sites) with severe TBI (as measured by post traumatic amnesia (PTA) ≥ 1 day, and/or a Glasgow Coma Scale ≤ 8).	18 months	18-65	198 (Urban = 74%, Rural = 26%); At 18 month follow-up n=144 (Urban = 76%; Rural = 24%)	ARIA - dichotomised into 'Rural' and 'Urban'	Residence	11 sites BIRP NSW. 1 October 1999 and 30 September 2001	Unequal group sizes
	Ponsford et al. 2010 [44]	SOQ, GOS -E, SIP, CHART, Alcohol use, HADS, DAST	No statistically significant differences were found between rural and urban outcomes. There was a trend for regional dwellers to be less likely to report dizziness, impulsivity and socially inappropriate behaviour, and to be less likely to report being socially isolated and feeling anxious than those living in the city. All nonsignificant trends suggest better outcomes for regional residents.	TBI patients admitted to metropolitan (single site) inpatient rehabilitation	24 months	≥ 18	959 (Urban = 67%; Rural = 33%)	Rural = Residing > 25kms from Melbourne CBD; Urban = < 25km from CBD	Residence	Patients treated at Epworth Hospital TBI rehabilitation facility. 1984-2006	Age, post-traumatic amnesia
	Simpson, G. et al. 2016 [45]	Mental Health (HONOS-ABI); Social participation (SPRS-2)	Clients residing in remote areas had significantly higher mental health comorbidities (HoNOS-ABI) and significantly lower levels ofsocial participation (SPRS-2) than clients from urban areas	Patients referred to NSW BIRP (11 sites) with severe TBI (as measured by PTA ≥ 1 day, and/or a Glasgow Coma Scale ≤ 8).	24 months	18-65	503 (66% urban, 34% regional /remote)	ASGS RA	Residence	11 sites NSW Brain Injuyr Rehabilitation Program (BIRP). 2016	Unadjusted
		Disability (DRS), Challenging behaviours (OBS), Care needs (CANS)	No differences in scores for challenging behavior (Overt Behaviour Scale Clinical Weighted Score), functional status (DRS), or levels of care and support needs (CANS) were found								

TAIWAN	Chiang et al. 2006 [38]	Disability (GOS)	Outcomes at discharge were significantly better in urban areas (p = .032)	Patients hospitalised following TBI in a rural and urban Taiwanese county	Hospital Discharge	13-18	600	Urban = Taipei City (population density 9,835 per square kilometer); Rural = Hualien County (population density 72.7 per square kilometer)	Injury	Taiwan Head Injury Registry; July 2001 to June 2004	Unadjusted
	Kuo et al. 2017 [46]	Disability (GOS) - dichotomised to moderately disabled to dead (GOS 1-4) or good recovery (GOS 5)	Urban: 16.8% = Moderately disabled to dead; 83.2% = good recovery; Rural: 26.4% = Moderately disabled to dead; 73.6% = good recovery	Cyclists admitted to hospital with a traumatic brain injury	Hospital discharge	All ages	812 (Urban = 66%; Rural = 34%)	Urban = Taipei City (population density 9,835 per square kilometer); Rural = Hualien County (population density 72.7 per square kilometer)	Injury	Taiwan Head Injury Registry; July 1998 - June 2013	Unadjusted
CANADA	Sirois M. J. et al. 2009 [47]	Physical health (aSF12), Disability (FIM)	Adjusted-SF-12 and functional independence measure scores were similar across regions. The unadjusted SF-12 physical function score was 7 significant points lower in patients from LARS regions.	Multiple trauma patients admitted to level I/II trauma centers in Quebec requiring rehabilitation following hospital discharge.	24-48 months	18-65	435	Each health region was classified based on availability of services according to Quebec Association of Rehabilitation Centers (AERDPQ) inventory of services available. Best availability (BARS); partial availability (PARS) and limited availability of rehabilitation services (LARS)	Residence	Quebec Trauma Registry - patients requiring rehabilitation services following hospital discharge in 2009	Adjusted

GOS (-E) = Glasgow Outcome Scale (-Extended); DRS = Disability Rating Scale; FIM = Functional Independence Measure; MPAI = Mayo-Portland Adaptability Index; GHQ = General Health Questionnaire; MOS = Medical Outcomes Scale; SPRS (-2) = Sydney Psychological Reintegration Scale (-2); QoL = Quality of Life; HADS = Hospital Anxiety and Depression Scale; AUDIT = Alcohol Use Disorders Indentification Test; SWLS = Satisfaction With Life Scale; CHART = Craig Handicap Assessment and Reporting Technique; DAST = Drug Abuse Screening Test; CANS = Care and Needs Scale; HONOS-ABI = Health of the Nation Outcome Scale-Acquired Brain Injury; aSF12 = Adjusted Short Form 12; TBI = Traumatic Brain Injury; SOQ = Structured Outcome Questionnaire; UIC = Urban Influence Codes; ASGS RA = Australian Statistical Geographical Standard Remoteness Area; ARIA = Accessibility/Remoteness Index of Australia; BIRP = Brain Injury Rehabilitation Program

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Appendix 3: Study Advertisement and Participant Information Sheet (Chapter Three)

MONASH University

Seeking health care providers who are involved in the management of seriously injured patients across rural and metropolitan Victoria.

You are invited to take part in this research project as a health care provider who currently manages or have experience managing seriously injured patients in the last twelve months.

This project aims to explore the experiences of clinicians working with trauma patients beyond hospital discharge, and the factors that health care providers feel helped or hindered them to provide adequate care for these patients in the community.

Participating in this project will involve completing a **single videoconference or telephone interview,** which will **take less than one hour.**

Participation in this research is voluntary; there will be no financial remuneration.

If you are interested in being a part of this study, please contact Jemma Keeves (jemma.keeves@monash.edu) who can provide you with further details or answer any questions that you might have.

MONASH University

PARTICIPANT INFORMATION SHEET
– Health Service Providers –

Project ID: 12705
Project title: Understanding the challenges associated with treating seriously injured trauma patients in the community

Chief Investigator:
Professor Belinda Gabbe
School of Public Health & Preventative Medicine,
Monash University
Phone: 03 9903 0951
email: belinda.gabbe@monash.edu

Student Investigator:
Jemma Keeves
PhD Candidate
Monash University
Phone: 0422 869 759
email: jemma.keeves@monash.edu

You are being invited to take part in this project because you currently manage, or have had experience managing, seriously injured patients in the last twelve months.

Please read this Participant Information Sheet in full before deciding whether to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?
This research project aims to explore the experiences of clinicians working with trauma patients beyond hospital discharge, and the factors that health care providers feel helped or hindered them to provide adequate care for these patients in the community.

This Participant Information Sheet tells you about the research project. It explains what is involved to help you decide if you want to take part. Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with a relative, friend or colleague. Participation in this research is voluntary. If you don't wish to take part, you don't have to. This copy of the Participant Information Sheet is yours to keep.

If you are agreeable to participating, an investigator involved in the project will contact you to confirm your consent to participate in this project and ask you to complete a single teleconference or telephone interview, which will take less than one hour. The interview will be scheduled at a time that suits you and you can take part in the interview at any place of your choosing.

The interview will ask questions about your role and your experiences in treating trauma patients. This will include topics such as challenges faced in managing trauma patients, availability of resources, support from experienced trauma clinicians and tertiary centres, and experiences with compensation providers. You will be free to refuse to answer any questions and you can cease the interview at any time. You may also take a break during the interview if you wish to do so. The interview will be recorded and then transcribed for analysis by members of the research team. You will be able to obtain a written transcript or copy of the recording if you would like to do so.

What is the purpose of this research project?
Each year in Victoria, many people sustain injuries and many are admitted to a major trauma service located in inner metropolitan Melbourne for their initial care. About one third of patients are from regional areas in Victoria and can be discharged directly home or to another metropolitan facility for inpatient rehabilitation.

The experiences of community-based health providers caring for seriously injured patients are currently unknown and, in particular, whether geographic location adds additional challenges to meeting their patient's needs. This project will involve in-depth interviews with people who have had experience treating seriously injured patients in the community to provide insight into barriers and enablers associated with different geographic locations.
This research project will involve participants from a variety of health services across metropolitan, inner regional and outer regional areas of Victoria. We hope around 30 participants will take part in this project.

The project involves researchers from Monash University and Epworth Hospital and will contribute towards the PhD of the student investigator, Jemma Keeves. This research has been partially funded by the Epworth Research Institute.

Why were you chosen for this research?
You have been chosen for this research as a health care provider who responded to the project information flyer advertised on relevant special interest social media accounts or through professional governing bodies.

Consenting to participate in the project and withdrawing from the research
At the commencement of the interview, you will be asked to acknowledge that you have received this participant information sheet, have read the participant information sheet, and consent to participate. This will be recorded with the remainder of the interview as a record of your consent.

Participation in any research project is voluntary. If you do not wish to take part, you do not have to. You can withdraw from the project during the interview by letting the interview know that you do not wish to continue to participate. If you decide to withdraw from the project after the interview is complete, please contact a member of the research team. Once the data analysis has commenced it may not be possible to withdraw from the project.

Your decision whether to take part or not, or to take part and then withdraw, will not affect your relationship with the researchers, Monash University or your employer.

Possible benefits and risks to participants
There will be no direct benefits from participating in this project. You will have the opportunity to discuss your experiences managing trauma patients in the community and any issues you have encountered, particularly in regards to your ability to provide the best care for your patients.

The findings of this research will help us understand the experiences of community-based health providers caring for seriously injured patients in the community and the challenges or enablers experienced. This information has the potential to transform the way rehabilitation is provided to trauma patients following hospital discharge. A greater understanding of how your geographic location affects your experiences when treating trauma patients will also inform service design and delivery to optimise post-discharge health services.

We do not expect that there are any possible risks associated with participating in this project as the interviews will only involve questions about your experiences in managing trauma patients following hospital discharge. If you become upset or distressed as a result of your participation in the research, the interviewer is able to provide you with contact details of appropriate counselling and support services that you can access free of charge, and additional services that may be appropriate for your circumstances. Alternatively, the interviewer can contact the services on your behalf if you would prefer and arrange an appointment or a phone call from these services.

A list of these agencies and services are provided here for your records. These counselling and support services are provided by staff who are not members of the research team.

Lifeline 24 hour counselling	Free counselling – Marriage, Family & Personal	13 11 14
Road Trauma Support Services	Free counselling by professionals with specialist training for road trauma victims	1300 367 797

Australian Institute of Professional Counsellors	Counselling – Marriage, Family & Personal	1800 622 489
Victorian Council of Social Service	Community Advisory Services	(03) 9654 5050

Confidentiality

Any information obtained in connection with this project that can identify you will remain confidential and will only be used for the purposes of this research project. Information will only be disclosed with your permission, or in compliance with the law. Only the researchers involved with this project and the Monash University Human Research Ethics Committee can have access to this information.

The information you give us will be de-identified. This means that we will remove your name and give your information a special code number. Only the research team will be able to break the code to match your name to your code number. In any publication or presentation, information will be provided in such a way that you cannot be identified, except with your permission.

Storage of data

All information will be stored securely in a locked filing cabinet in the School of Public Health and Preventive Medicine at Monash University. Information will also be stored on a two-factor password-protected computer database.

All information will be kept for 7 years. After this time, all information (electronic and hard copy) will be destroyed. All participants have the right to access, and request correction of, their information in accordance with the Freedom of Information Act 1982 (Vic.). If you would like a copy of the interview you participate in, this can be arranged for you.

Results

At the end of the project, we will send you a summary of the project results. It is anticipated that the results of the project will be available by January 2020.

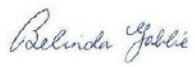
Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics Committee (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
Room 111, Chancellery Building D,
26 Sports Walk, Clayton Campus
Research Office
Monash University VIC 3800

Tel: +61 3 9905 2052 Email: muhrec@monash.edu Fax: +61 3 9905 3831

Thank you,



Professor Belinda Gabbe

You are invited to take part in this research project as a health care provider who currentlymanages or have experience managing seriously injured patients in the last twelve months.

This project aims to explore the experiences of clinicians working with trauma patients beyond hospital discharge, and the factors that health care providers feel helped or hindered them to provide adequate care for these patients in the community. Participating in this project will involve completing a **single videoconference or telephone interview,** which will **take less than one hour.**

Participation in this research is voluntary; there will be no financial remuneration.

If you are interested in being a part of this study, please contact Jemma Keeves (jemma.keeves@monash.edu) who can provide you with further details or answer any questions that you might have.

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Appendix 4: Interview Guide for qualitative studies (Chapter Three)

Qualitative Study Interview Topic Guide: Health Service Providers

Centre:
Interviewee:
Date:
Study ID:

My name is Jemma, thank you for responding to the advertisement and agreeing to this interview.

Do you give permission for this interview to be recorded?

☐ Permission given _ _ Interviewer initials

Do you acknowledge that you have received and read the Participant Information Sheet?

☐ Acknowledgement given Interviewer initials

Before we begin the interview, are there any questions you would like to ask?

Do you acknowledge that you have had the opportunity to ask questions and are satisfied with the answers received?

☐ Acknowledgement given Interviewer initials

Do you understand that information about you will be kept confidential and that in any publications or presentations the data will be presented in a manner that does not identify you?

☐ Acknowledgement given Interviewer initialsDo

you agree to participate in this study as it is described?

☐ Consent given Interviewer initials

During the interview, I will ask you some questions about your role, the type of patients you treat and you're your experiences with managing trauma patients in the community. I would like you to speak freely about your experiences. You may withdraw from the study at any time during the interview or choose not to answer any questions.

Participant attributes	
Age	
Gender	
Profession	
Job title (manager/senior/junior)	
Years of experience do you have as a health professional? 0-2; 3-6; 7-10: 10-14: 15+	
Years of experience in current role? 0-2; 3-6; 7-10: 10-14: 15+	
Type of rehabilitation setting? Community vs private practice vs hospital outpatient setting	
Public or private setting?	
Treatment of compensable patients?	
Geographic remoteness region (ARIA)	
Postcode of health care facility	

I would like to start by asking you about your role and the type of injured patients you treat. To clarify, this interview will be focusing on the management of patients that have been injured, requiring a non-elective hospitalization because of injury.

Injury can include intentional and unintentional causes for example road traffic accidents, falls, gunshot wounds

1. The injured patients

- What are your experiences with treating trauma patient's post-hospital discharge?
    - Probe: Have you experienced any particularly complex or difficult patients?
- What type/s of seriously injured patients do you treat?
    - Probe: multiple orthopaedic trauma; TBI; SCI; falls

2. Treatment of injury

- Can you tell me about the types of treatment and services that you offer to seriously injured patients?
    - How do you feel about providing care to seriously injured patients?
- What information or advice did you receive about your patient's injury?
    - Is there any other information would you have liked to receive and from who?

- What supports are available to you when you need advice on or assistance with treating a seriously injured patient?
- Do you feel that the service you provide are able to meet the needs of your patients?
    - How could they be improved?
    - What other services do you feel are required in your local area to better meet the needs of injured patients?

3. Resources

- What resources are available to you when caring for seriously injured patients?
- What additional resources do you feel would enable you improve the care of seriously injured patients, if any?
- Can you tell me about your experiences in receiving support from more experienced clinicians or a time you have provided support for more isolated services providers?

4. Experience with funding bodies.

TAC or WorkSafe participants

- Do you provide care for seriously injured patients who are funded by TAC or WorkSafe for their injury?
- Can you tell us about your experiences with compensable funding bodies?
- Have your experiences with these injury insurers changed over time?

- Is there anything you feel could be done differently by TAC/Worksafe to help your patient's recovery?
- Is there anything the injury insurers could do differently to work effectively with service providers?

Private health insured participants

- Can you tell us about your experiences with private health insurers and care of seriously injured patients?
- Is there anything you feel could have been done differently by health insurers to help your patient's recovery?
- Is there anything the injury insurers could do differently to work effectively with service providers?

5. General

- How do you feel about being able to ensure adequate continuity of care between acute hospitals and your service?
- Can you tell me about your experiences with other services or policies relating to optimising different aspects of your patients care?
    - For example, health, transportation, disability or rehabilitation for your patients?
- What else can you tell us about trauma care in your community, specific issues you face, and barriers or facilitators to optimal care for seriously injured patients?

That was the last question. Do you have anything else you would like to add or is there anything that I have not covered that you thought I should?

Do you have any questions about what we have discussed?

Thank you for your time and involvement in this research.

Appendix 5: COREQ checklist used for 'Access to health care following serious injury: Perspectives of allied health professionals in urban and regional settings'

COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscriptwhere you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	2
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	1-2
Occupation	3	What was their occupation at the time of the study?	2
Gender	4	Was the researcher male or female?	2
Experience and training	5	What experience or training did the researcher have?	2
Relationship with participants			
Relationship established	6	Was a relationship established prior to study commencement?	2
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	2, Appendix A
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	2, Table 1
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g.grounded theory, discourse analysis, ethnography, phenomenology, content analysis	3
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	2
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail,	2

		email	
Sample size	12	How many participants were in the study?	3
Non-participation	13	How many people refused to participate or dropped out? Reasons?	3
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	3
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	2-3
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	3, Table 2
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	3, Appendix B
Repeat interviews	18	Were repeat inter views carried out? If yes, how many?	3
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	3
Field notes	20	Were field notes made during and/or after the inter view or focus group?	Table 1
Duration	21	What was the duration of the inter views or focus group?	3
Data saturation	22	Was data saturation discussed?	3
Transcripts returned	23	Were transcripts returned to participants for comment and/or	No

Topic	Item No.	Guide Questions/Description	Reported Page No.
		correction?	
Domain 3: analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	3
Description of the coding tree	25	Did authors provide a description of the coding tree?	No
Derivation of themes	26	Were themes identified in advance or derived from the data?	3
Software	27	What software, if applicable, was used to manage the data?	3
Participant checking	28	Did participants provide feedback on the findings?	Table 1

Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	4-7
Data and findings consistent	30	Was there consistency between the data presented and the findings?	4-7
Clarity of major themes	31	Were major themes clearly presented in the findings?	4-7 Figure 1
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	4-7

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklistfor interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Appendix 6: Supplementary table of supporting quotes for 'Access to health care following serious injury: Perspectives of allied health professionals in urban and regional settings'

1. Administrative delays and complex systems impede access to health care
"…unfortunately, the most common scenario is that the referral from the metro hospital hasn't been activated, so whether it's been lost or not sent through in a timely way. So they've been discharged from hospital, sent back to [regional town] and then no follow-up rehab has happened... we would see those guyspotentially four, five, unfortunately sometimes six months post-accident. Probably not six months, maybe more like four months. It's more common to get that than a direct referral from a metro hospital in the orthopaedic and pain rehab clinics especially. That's not so the case for spinal clinic, the referrals for spinaltend to be a little bit more successful in getting from metro to Bendigo." *17_Regional_EP_M_30-36* "…making things a little bit more kind of user-friendly so the patients can actually access what they want.I think that's sort of part of the benefit to the NDIS is having a bit more of that decision-making, like empowering the patient, but if the system is too complicated for them to be able to navigate, then it just putsthat same barrier backup that the NDIS is trying to address." 2_Regional_EP_M_23-29 "Claims with [Injury_Insurer_1]… they still require a lot more information than what [Injury_Insurer_2]does have, there's a lot more report writing … giving them every inch or millimetre of information to getthings approved." 8_Regional_OT_F_44-51
2. Availability of appropriate services affects access to health care

"…that's a real key, that if clients were provided with the emotional support and the psychological support right from the word go, and that ability for them to be able to accept their injury, and work withthe allied health professionals, then they would have much more positive outcomes…I think the key things are the people that have had traumatic events need to be provided with services to deal with their psychological and emotional health, which isn't being done effectively at the moment. Their care servicesneed to be improved in this area." *8_Regional_OT_F_44-51*

"Psychology would also be really helpful for the team, but we, as I said, just have the neuropsyche, and largely assessment based. At the moment psychology just has to be through GP, getting onto a (mental health) care plan. There sort of used to be a tiny bit of access we could get through the hospital for people who had been seen by hospital psychologists. But it's pretty little access now" *6_Urban_PT_F_22-29*

"There's a real gap with social work services in our community, and even access in psychology. Because even the Medicare rebate in psychology is out of reach for a lot of people. Navigating mental health plans,but also then there is still a huge gap, like you're talking 60, 80 a hundred dollar gap for each psychology appointment. *That's not achievable for a lot of people*" *7_Regional_Other_F_30-36*

3. Physical ability to reach services (accessibility) can restrict health care utilisation

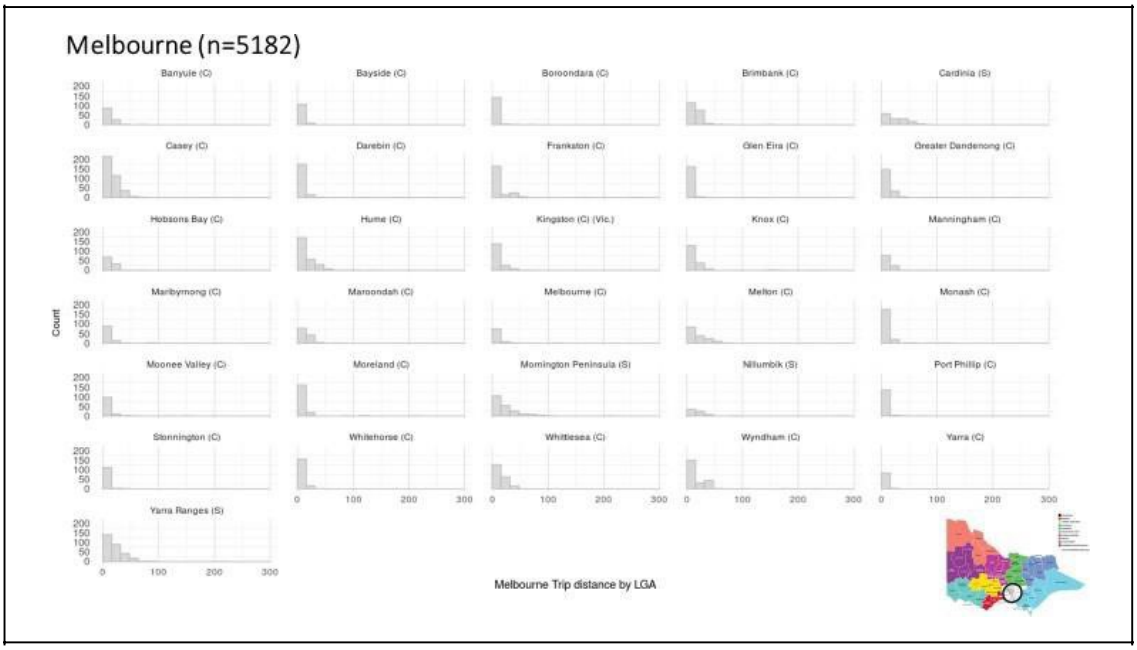
"Transportation is a real issue for a lot of people. And that has a flow-on effect for things like being able toattend therapy appointments. A lot of small towns don't have maxi taxis, and all of our clients need maxi taxis to get around, if they don't have their own

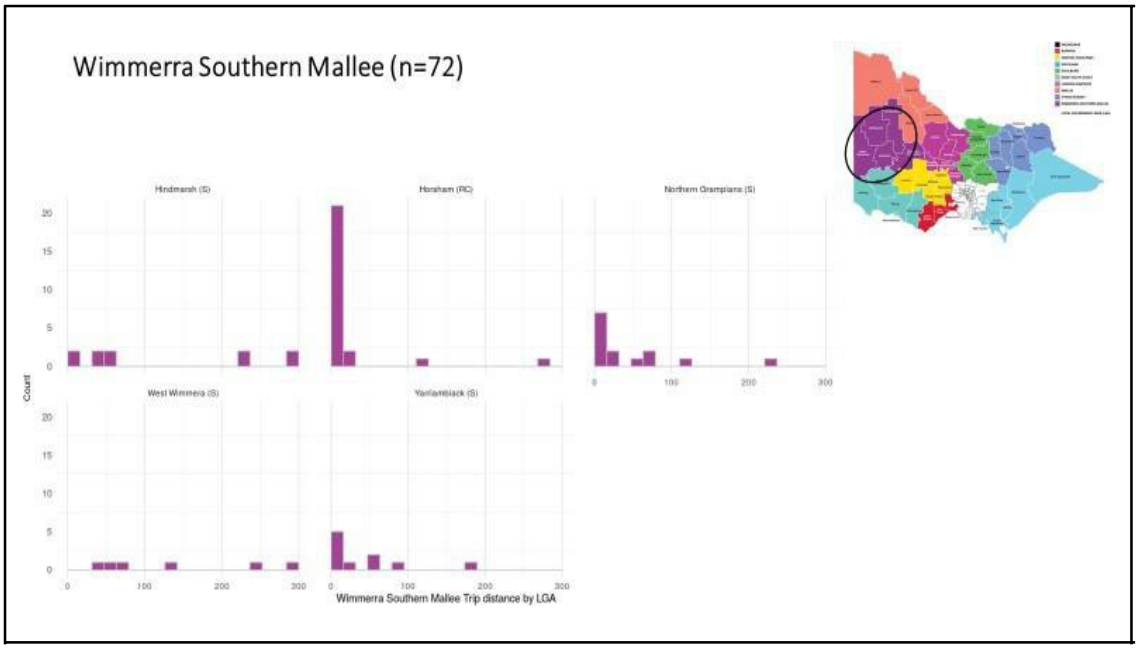
wheelchair accessible vans and things like that. So it is really challenging for a lot of the rural and regional clients." *12_Statewide_PT_F_30-36*

"I've got a client in [regional town] … [Injury_Insurer_2] will say we'll fund you a taxi transport to get to your appointment. Well, there is no taxi there. Everything's just much harder for them. They can't just jumpin a taxi or a train, or whatever, to get to see a doctor because firstly, they're three hours away, and they don't have taxis out in these areas sometimes." 14_Statewide_Other_F_37-43

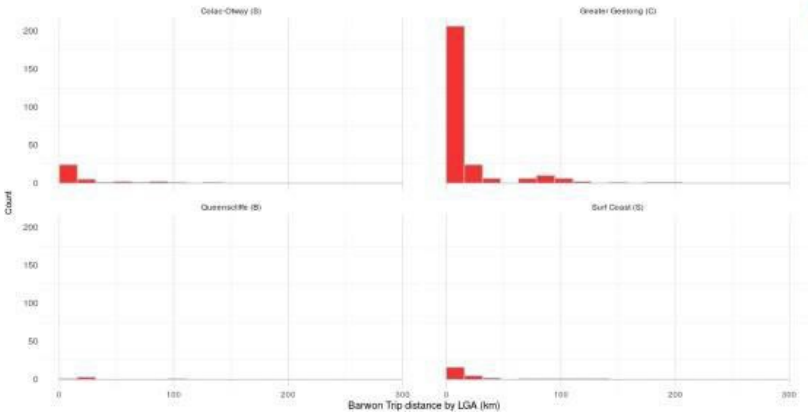
"There's problems when the patients go back to the acute hospitals, to the big trauma hospitals in the city, for reviews and plans and all that kind of thing, and probably 50 per cent of the time the communication back from there is not very good. And so that leads to anxiety and concern about what's going on. And a lot of people from the country don't like going up to the big city, or the big city hospitals, they find it reallystressful and annoying..." *3_Urban_Other_F_37-43*

Appendix 7: Histograms of trip distance by LGA (Chapter Four)

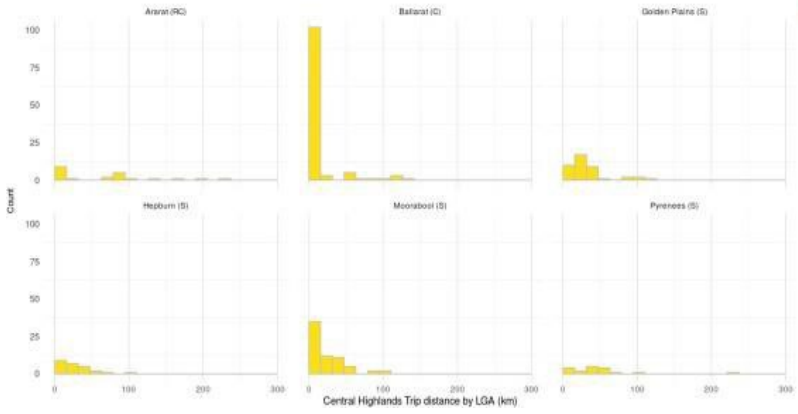




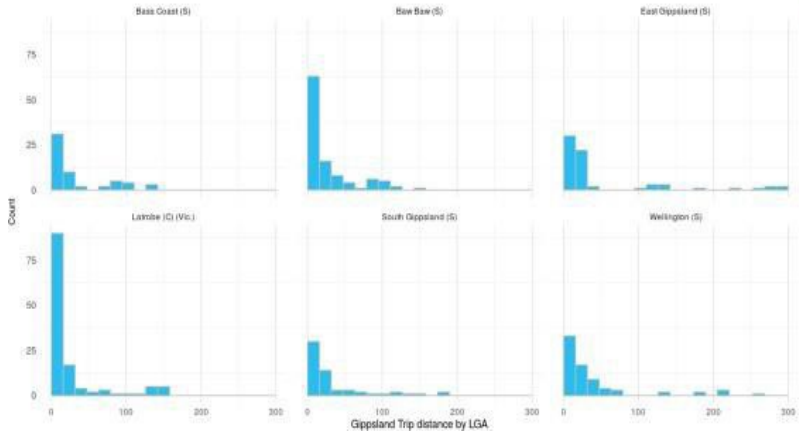
Barwon (n=334)



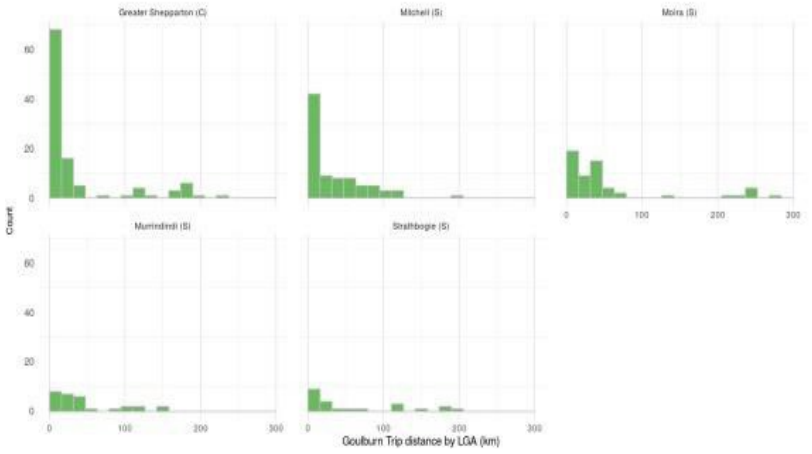
Central Highlands (n=292)



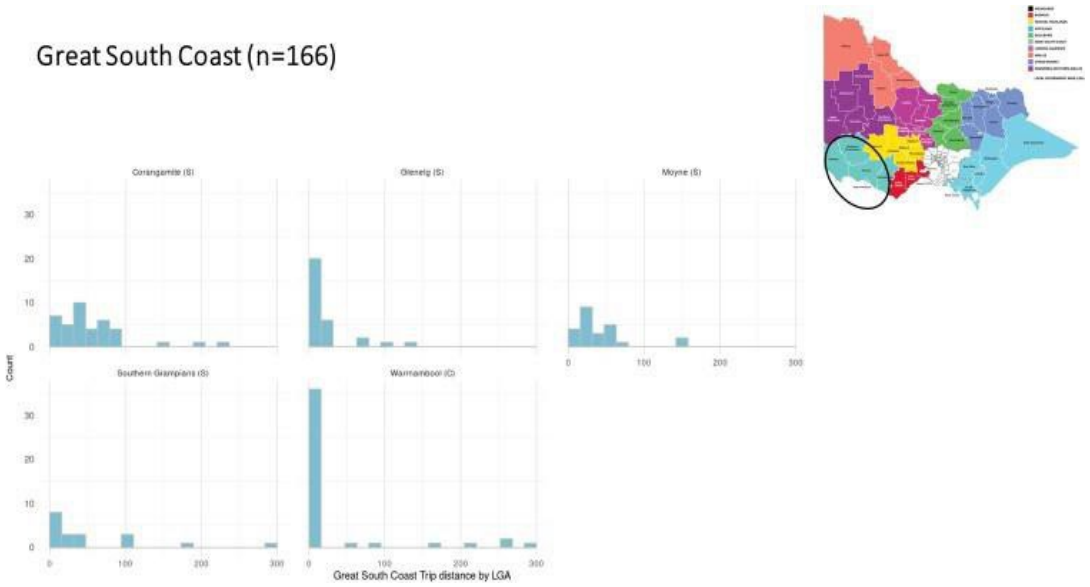
Gippsland (n=498)



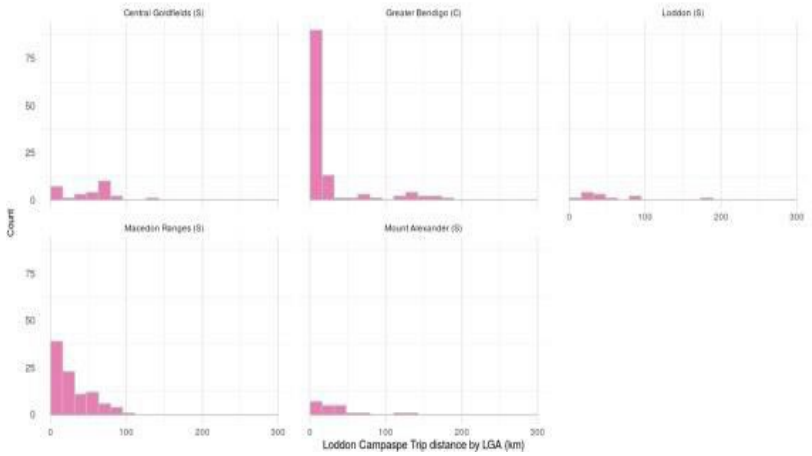
Goulburn (n=302)

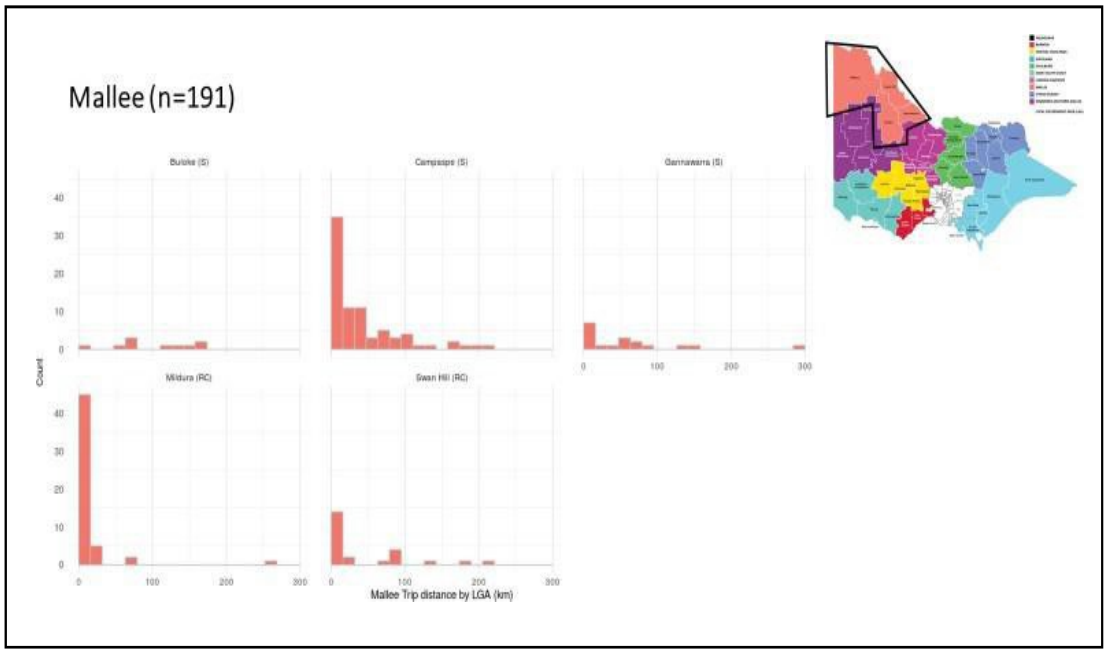


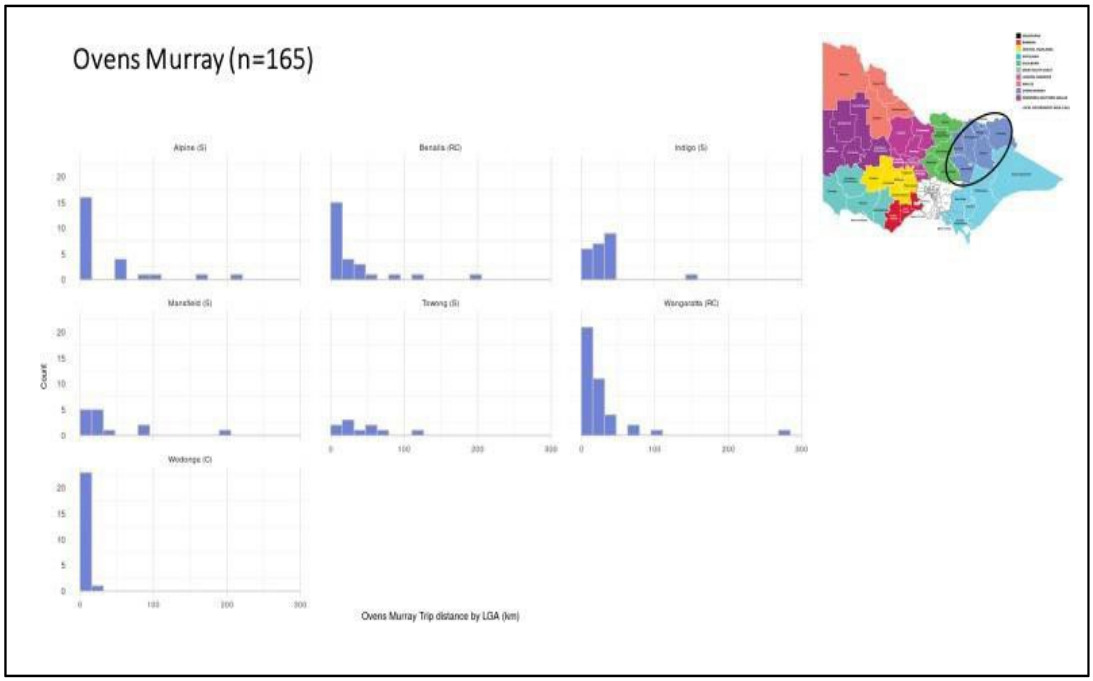
Great South Coast (n=166)



Loddon Campaspe (n=277)




Mallee (n=191)
Buloke (S)
Campaspe (S)
Gannawarra (S)
Mildura (RC)
Swan Hill (RC)
Count
Mallee Trip distance by LGA (km)


Ovens Murray (n=165)
Alpine (S)
Benalla (RC)
Indigo (S)
Mansfield (S)
Towong (S)
Wangaratta (RC)
Wodonga (C)
Count
Ovens Murray Trip distance by LGA (km)

Appendix 8: Supplementary material, 'Regional variation in travel to health services following transport-related injury'

Supplementary Methods

Transport-related injuries were defined as caused by circumstances involving at least on motorisedvehicle, a vehicle that operates on roads or rails (i.e. trains and trams), or a non-motorised vehicle (e.g. pedal cyclists).

Figure 1 Victoria Population Density

Five nature of injury categories were assigned using the AIS 2005 (2008 update) diagnosis codes representing the most common traumatic injury groups. Mechanism of injury was collapsed into the five most common transport-related causes of injury (motor vehicle occupant, motorcyclist, pedestrian, pedal cyclist and tram/train) with one remaining category for missing data. Age was categorised into seven groups to aid with describing the study population due to the skewed distribution of age in the sample. The Charlson Comorbidity Index[1] (CCI) weightings were used to describe pre-existing health conditions[2]. The Index of Relative Socioeconomic Advantage and Disadvantage(IRSAD) was used as a measure of socioeconomic status based on the client's residential LGA at time of discharge with socioeconomic advantage ranging from 1 (most disadvantaged) to 5 (most advantaged)[3].

Geographical boundaries

LGAs are geographical areas with defined data profiles which are commonly used to support health service planning and policy development. The population of Melbourne metropolitan LGAs range from64,174 (Nillumbik) to 312,789 (Casey), compared to regional LGAs where populations range from 2,929 (Queenscliffe) to 239,529 (Geelong)[4], see Supplementary material, Table 1 for full LGA characteristics. For this study the 2019 LGA boundaries were obtained from the Australian Bureau of Statistics (ABS) in a shapefile format, containing the geometry of each LGA as well as the LGA name and code[5]

Geospatial procedures

A matrix of all participant residential addresses and service provider addresses was completed for each individual service provided. Variation in travel distance due to a change in residential

address was inconsequential as the date which an individual's address changed was known and matched to the specific service episode.

Sensitivity analysis comparing the minimum distance to median distance travelled when there were multiple provider addresses suggested that, when aggregated by LGA, there was less than 10km difference between the minimum and median values in 99% of LGAs (78 of 79). Therefore, we chose to use the minimum (shortest) distance between service provider and a client's residential address under the assumption that people are most likely to travel to the nearest provider location for care.

The median distance travelled and median number of trips in each service category were aggregatedat an individual level by LGA for analysis. Median values were used due to the heavily skewed distribution of the data.

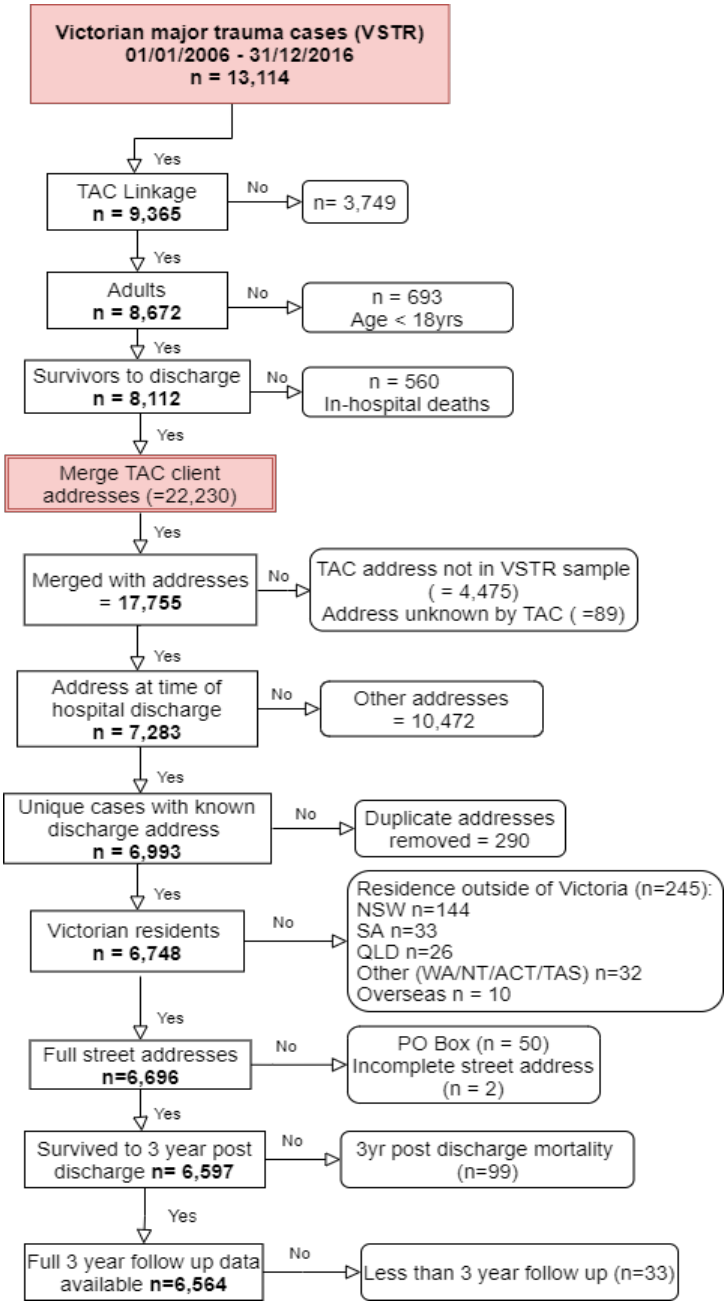


Figure 2. Study sample flowchart

Table 1. Local Government Area (LGA) characteristics

LGA code	LGA name	Region type	Classification	n, sample	Area (Km^2)	Population, 2016	IRSAD, state decile
20110	Alpine	Shire	Regional	22	4,788	12,578	5
20260	Ararat	Rural City	Regional	18	4,211	11,745	1
20570	Ballarat	City	Regional	104	739	103,500	4
20660	Banyule	City	Metropolitan	101	63	127,447	9
20740	Bass Coast	Shire	Regional	50	866	33,464	3
20830	Baw Baw	Shire	Regional	94	4,028	49,296	6
20910	Bayside	City	Metropolitan	92	37	102,912	10
21010	Benalla	Rural City	Regional	23	2,353	13,982	2
21110	Boroondara	City	Metropolitan	131	60	177,276	10
21180	Brimbank	City	Metropolitan	169	123	204,190	1
21270	Buloke	Shire	Regional	9	8,000	6,284	3
21370	Campaspe	Shire	Regional	66	4,519	37,595	3
21450	Cardinia	Shire	Metropolitan	117	1,283	97,573	8
21610	Casey	City	Metropolitan	325	409	312,789	7
21670	Central Goldfields	Shire	Regional	23	1,533	13,087	1
21750	Colac-Otway	Shire	Regional	33	3,437	21,362	3
21830	Corangamite	Shire	Regional	34	4,407	16,243	4
21890	Darebin	City	Metropolitan	172	53	155,126	7
22110	East Gippsland	Shire	Regional	64	20,940	45,600	3
22170	Frankston	City	Metropolitan	187	130	139,502	6
22250	Gannawarra	Shire	Regional	17	3,735	10,567	3
22310	Glen Eira	City	Metropolitan	151	39	148,583	10
22410	Glenelg	Shire	Regional	30	6,219	19,759	2
22490	Golden Plains	Shire	Regional	37	2,703	22,016	8
22620	Greater Bendigo	City	Regional	104	3,000	112,267	4

LGA code	LGA name	Region type	Classification	n, sample	Area (Km^2)	Population, 2016	IRSAD, state decile
22670	Greater Dandenong	City	Regional	168	130	160,222	1
22750	Greater Geelong	City	Regional	226	1,248	239,529	6
22830	Greater Shepparton	City	Regional	87	2,422	65,072	2
22910	Hepburn	Shire	Regional	22	1,473	15,525	6
22980	Hindmarsh	Shire	Regional	10	7,524	5,784	2
23110	Hobsons Bay	City	Metropolitan	37	64	93,445	7
23190	Horsham	Rural City	Regional	104	4,267	19,884	4
23270	Hume	City	Metropolitan	168	504	207,041	2
23350	Indigo	Shire	Regional	226	2,040	16,165	8
23430	Kingston	City	Metropolitan	87	91	158,941	9
23670	Knox	City	Metropolitan	22	114	160,353	9
23810	Latrobe	City	Regional	10	1,426	74,622	1
23940	Loddon	Shire	Regional	90	6,696	7,558	2
24130	Macedon Ranges	Shire	Regional	22	1,748	47,480	9
24210	Manningham	City	Metropolitan	243	113	122,570	9
24250	Mansfield	Shire	Regional	21	3,844	8,674	7
24330	Maribyrnong	City	Metropolitan	163	31	86,942	6
24410	Maroondah	City	Metropolitan	110	61	114,800	9
24600	Melbourne	City	Metropolitan	80	37	146,096	7
24650	Melton	City	Metropolitan	132	528	141,420	5
24780	Mildura	Rural City	Regional	47	22,082	54,658	1
24850	Mitchell	Shire	Regional	76	2,862	41,795	6
24900	Moira	Shire	Regional	47	4,046	29,486	2
24970	Monash	City	Metropolitan	174	81	192,625	9
25060	Moonee Valley	City	Metropolitan	95	43	122,871	8
25150	Moorabool	Shire	Regional	64	2,111	32,672	7
25250	Moreland	City	Metropolitan	163	51	172,294	7

LGA code	LGA name	Region type	Classification	n, sample	Area (Km^2)	Population, 2016	IRSAD, state decile
25340	Mornington Peninsula	Shire	Metropolitan	185	724	161,528	8
25430	Mount Alexander	Shire	Regional	20	1,530	19,097	6
25490	Moyne	Shire	Regional	21	5,482	16,737	8
25620	Murrindindi	Shire	Regional	27	3,880	14,052	6
25710	Nillumbik	Shire	Regional	63	432	64,174	10
25810	Northern Grampians	Shire	Regional	11	5,730	11,570	1
25900	Port Phillip	City	Metropolitan	130	21	108,627	10
25990	Pyrenees	Shire	Regional	16	3,435	7,316	3
26080	Queenscliffe	Borough	Regional	5	9	2,929	10
26170	South Gippsland	Shire	Regional	52	3,296	29,122	5
26260	Southern Grampians	Shire	Regional	26	6,654	16,123	5
26350	Stonnington	City	Metropolitan	102	26	111,003	10
26430	Strathbogie	Shire	Regional	20	3,303	10,357	4
26490	Surf Coast	Shire	Regional	27	1,553	30,465	10
26610	Swan Hill	Rural City	Regional	22	6,115	20,896	2
26670	Towong	Shire	Regional	11	6,675	6,046	5
26700	Wangaratta	Rural City	Regional	35	3,645	28,592	4
26730	Warrnambool	City	Regional	36	121	34,242	5
26810	Wellington	Shire	Regional	64	10,817	43,530	4
26890	West Wimmera	Shire	Regional	9	9,108	3,937	5
26980	Whitehorse	City	Metropolitan	154	64	169,641	9
27070	Whittlesea	City	Metropolitan	180	490	207,058	5
27170	Wodonga	City	Regional	24	433	40,100	4
27260	Wyndham	City	Metropolitan	187	542	227,008	7
27350	Yarra	City	Metropolitan	80	20	92,894	8
27450	Yarra Ranges	Shire	Metropolitan	263	2,468	155,226	8
27630	Yarriambiack	Shire	Regional	8	7,326	6,743	1

Table 2: Distance travelled per person to services by LGA in the first three years following hospital discharge

General Practitioners: Trip distance per person by LGA (km)									
			Overall		Year 1		Year 2		Year 3
Region	LGA Name	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)
Melbourne	Banyule	76	3.6 (1.6-7.3)	77	5.5 (3.3-7.5)	48	6 (3.6-9.8)	36	5.9 (3.6-7.1)
	Bayside	72	3.1 (1.2-7.3)	34	18.3 (10.7-36.3)	22	21.6 (10.7-38.3)	16	21.2 (3.2-37.3)
	Boroondara	85	3.3 (1.6-5.9)	17	4.6 (2-16.5)	12	7.8 (2.1-22.1)	11	6.1 (2.2-16.5)
	Brimbank	102	4.4 (3.1-9.3)	49	3.9 (1.8-22.5)	34	3.7 (1.8-14.3)	24	4.8 (2-23.7)
	Cardinia	91	5.6 (2.1-16.3)	13	33.5 (23.9-43.6)	6	31.3 (26.9-38.5)	*	30.2 (13.6-43.6)
	Casey	246	5 (2.4-10.7)	41	9 (1.9-36.7)	31	9 (1.5-36.6)	21	10.3 (1.9-37.2)
	Darebin	124	3.5 (1.8-7)	81	8.5 (1.7-16)	42	10.6 (1.7-20.2)	27	11.3 (3-20.9)
	Frankston	152	4.5 (2.6-8.8)	51	14.5 (3.5-23.7)	30	17 (2.9-24.4)	24	12 (3.1-23.5)
	Glen Eira	103	3.2 (1.4-6.4)	90	3.2 (1.8-14.3)	55	3.2 (1.9-16.3)	48	2.6 (1.6-12.4)
	Greater Dandenong	106	4.1 (2-7.8)	47	7.1 (1.7-18.1)	31	11.6 (2.4-18.1)	23	11.6 (5.6-18.1)
	Hobsons Bay	72	5 (1.7-12.5)	58	11.4 (2.8-19.6)	28	10.7 (2.9-17.3)	26	9 (2.1-23.6)
	Hume	186	3.4 (1.7-8.8)	63	5.4 (2.4-17)	40	5.2 (2.2-17.8)	33	7.1 (2.2-21.6)
	Kingston	114	3.3 (1.7-7.3)	61	5.7 (1.6-26)	43	13.8 (1.7-28.4)	34	15.4 (4.9-29.4)
	Knox	113	5.2 (2.5-9.9)	37	13.5 (1.9-39.2)	22	14.7 (1.9-39.2)	15	2 (1.1-39.2)
	Manningham	59	4.2 (1.6-9.5)	22	21.1 (1.4-39.6)	15	20 (2.6-28.9)	9	18.2 (16.7-21.1)
	Maribyrnong	51	3.9 (1-8.1)	16	15.2 (1.2-25.2)	8	18.3 (1.9-25.2)	5	17.4 (1.9-19.7)
	Maroondah	78	5.2 (2.8-10)	28	14.8 (1.2-26.6)	22	7.9 (1.1-27)	9	1.2 (1.1-4.4)
	Melbourne	49	3 (0.9-7.1)	23	3.5 (1-16.8)	14	2.3 (0.7-8.2)	9	4.4 (1.5-8.4)
	Melton	100	6.1 (2.8-18)	16	22.9 (8.6-31)	10	17.9 (4.1-28.7)	9	19.3 (4.1-28.7)
	Monash	116	4.2 (2.1-9.3)	13	303.8 (153.2-317.7)	6	235.6 (44.8-324.7)	6	317.8 (153.2-324.7)
	Moonee Valley	64	3.5 (1.3-7.5)	31	2.7 (1.3-3.8)	20	1.4 (0.7-3.3)	14	2.9 (1.2-3.8)
	Moreland	126	3.2 (1.7-7.4)	20	9.9 (1.3-39.5)	10	18.3 (1.4-68.6)	7	18.2 (6.2-64.8)
	Mornington Peninsula	145	6.7 (2.4-15.2)	78	6.6 (3.3-10.9)	51	6.5 (3.4-12.3)	38	6.6 (3.8-20.2)
	Nillumbik	49	7.6 (2.7-11.8)	10	23.3 (15.4-27.9)	*	42.1 (12.8-70.5)	*	70.5 (58.8-82.3)
	Port Phillip	97	2.6 (1.1-6)	74	9.6 (3.2-18.5)	43	9.4 (2.5-20.2)	33	11.8 (4.9-27.9)
	Stonnington	74	1.6 (1-3.8)	12	11.6 (2.1-18.2)	8	18.1 (4.5-21.3)	8	14.3 (3.9-20.6)
	Whitehorse	92	3.5 (1.7-7.4)	8	0.9 (0.5-92.4)	6	2 (0.4-72.9)	5	44.5 (0.4-72.9)
	Whittlesea	136	4.8 (2.4-12.7)	51	3.8 (1.4-20.3)	37	2.3 (1.5-15.1)	29	3.8 (1.5-26.5)
	Wyndham	132	3.7 (2.3-9.3)	15	17.5 (1-32.1)	10	1.4 (0.9-21.6)	9	1.4 (0.9-21.6)
	Yarra	52	2.4 (1.6-7)	39	3.3 (1.7-13.8)	24	3.3 (1.4-14.9)	14	3.4 (1.7-12.6)
	Yarra Ranges	219	6.7 (2.7-13.4)	13	8.8 (1.3-14)	5	9.3 (1.3-11.7)	5	9.3 (1.3-11.7)
Barwon	Colac-Otway	28	10.8 (1.6-21.6)	67	3.3 (1.4-7.3)	49	3.7 (1.8-9.1)	35	3.4 (1.4-6.5)
	Greater Geelong	166	3.2 (1.8-8.1)	67	2.9 (1.1-6)	38	3.6 (2-7.1)	30	3.6 (1-10)

General Practitioners: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Queenscliffe	*	19.5 (8.1-61.6)	*	19.5 (8.1-61.6)	*	23.3 (15.7-99.9)	*	23.3 (15.7-99.9)
	Surf Coast	21	4 (1-18.1)	97	4.2 (2.8-7.5)	64	4.8 (3.2-10.8)	66	5.1 (3.1-10.9)
Central Highlands	Ararat	17	9 (1.5-90.8)	85	6.5 (2.4-16.9)	57	8 (2.6-23.3)	42	8.6 (2.1-23)
	Ballarat	83	5.7 (3.5-7.8)	227	4.7 (2.4-10.7)	143	4.9 (2.4-10.7)	117	5.6 (2.5-13.6)
	Golden Plains	34	19.8 (10.9-36.3)	112	3.4 (1.8-6.8)	81	3.5 (1.7-6.8)	50	5.5 (2.2-8.4)
	Hepburn	20	4.6 (2-17.5)	141	4.6 (2.7-9.2)	97	4.6 (2.7-9.2)	78	5.3 (2.4-9.7)
	Moorabool	52	4.9 (2-21.1)	92	3.8 (1.6-7.3)	50	3.7 (2.5-7.3)	42	4.8 (2.5-10.6)
	Pyrenees	13	33.5 (23.9-43.6)	95	3.2 (1.6-7.2)	64	4.1 (2.1-8.1)	48	4.5 (2.5-9.6)
Gippsland	Bass Coast	44	8.8 (1.8-37.2)	64	5.3 (2-14.4)	32	4.1 (1.8-19.3)	30	4 (1.4-12)
	Baw Baw	85	8.9 (1.8-17.8)	172	3.3 (1.7-7.1)	118	3.7 (2-9.1)	95	3.5 (2-11.2)
	East Gippsland	54	12.1 (2.4-23.6)	107	2.9 (1.6-7.8)	73	2.9 (1.5-7.4)	58	4.2 (1.7-8.5)
	Latrobe	98	3.1 (1.8-14.3)	105	5.2 (2.4-9.6)	60	4.2 (2.4-7.3)	47	5.2 (2.2-10.7)
	South Gippsland	49	7.2 (1.7-17)	52	4.4 (1.7-11.4)	32	4.5 (1.3-12)	23	3.3 (1.2-11.5)
	Wellington	59	11.5 (2.8-22.5)	47	2.7 (1-6.5)	27	3.2 (0.7-8.7)	21	2.4 (0.9-8.7)
Goulburn	Greater Shepparton	67	5.1 (2.3-15.3)	73	5 (3.1-9.6)	45	5.5 (2.9-13.1)	31	4.4 (1.9-14.8)
	Mitchell	65	9.1 (1.5-27.4)	43	2.7 (0.7-7.1)	25	3.7 (1.8-7.1)	14	5 (1.8-12.8)
	Moira	41	13 (1.5-35.2)	93	5 (2.8-12.7)	67	7 (2.5-19.4)	50	9.3 (2.6-20.7)
	Murrindindi	22	20.8 (1.4-33.2)	107	4 (2.1-9)	62	3.8 (2.1-8.5)	42	3.5 (2-8.5)
	Strathbogie	16	18 (1.8-25.2)	57	3.6 (1.1-7.3)	29	2.4 (0.9-9.8)	25	2.4 (0.8-4.7)
Great South Coast	Corangamite	29	10.4 (1.3-25.6)	116	3.3 (1.3-7.8)	76	3 (1.7-7.3)	58	2.8 (1.5-7.4)
	Glenelg	23	3.4 (0.8-8.4)	141	5.7 (2.3-15.2)	78	7.4 (2.5-15.2)	59	10.1 (2.4-17.8)
	Moyne	17	21.4 (13.1-28.7)	47	6 (2.5-13.2)	26	8 (5.2-16.8)	20	6.3 (3.3-10)
	Southern Grampians	16	308.3 (99-318.3)	94	2.6 (1.3-6)	53	2.4 (1-7)	41	2.6 (1.1-7.9)
	Warrnambool	31	2.3 (1-3.3)	69	1.7 (1-3.3)	36	2 (0.9-5.6)	29	2.5 (0.9-4.8)
Loddon Campaspe	Central Goldfields	20	9.9 (1.3-39.5)	85	3.5 (1.7-6.7)	44	3.6 (1.4-9)	35	4.4 (1.6-9.7)
	Greater Bendigo	81	6 (3.4-10.9)	121	5.2 (2.5-13.2)	83	5.8 (2.5-12.9)	61	6.3 (2.9-14.5)
	Loddon	10	23.3 (15.4-27.9)	121	3.6 (2.2-8.1)	87	3.8 (2.1-8)	68	3.9 (2.4-7.7)
	Macedon Ranges	77	9.4 (2.9-18.5)	44	2 (1.2-6.8)	31	2.7 (1.4-4.7)	19	2.6 (1.4-12.8)
	Mount Alexander	15	15.6 (2.2-19.9)	199	6.4 (2.6-13)	130	6.1 (2.6-16.3)	85	6.8 (2.6-22.8)
Mallee	Buloke	8	0.9 (0.5-107.1)	26	9.4 (1.9-18.5)	16	5.7 (1.2-34.1)	12	1.6 (0.4-14)
	Campaspe	57	3.8 (1.4-20.4)	148	3.1 (1.8-8)	103	3.5 (1.9-8.7)	90	3.7 (2.1-10.1)
	Gannawarra	16	1.6 (0.9-22)	*	5.8 (2.6-54.1)	*	23.3 (15.7-99.9)	*	23.3 (15.7-99.9)
	Mildura	40	3.3 (1.7-13.3)	21	4 (1-18.1)	10	7 (2.3-19.6)	9	4.3 (2.3-9.7)
	Swan Hill	13	8.8 (1.3-14)	17	4.3 (1.3-90.8)	10	15.7 (1.8-75.5)	5	9 (1.8-75)
	Alpine	19	6.4 (1.4-29.2)	19	6.4 (1.4-29.2)	8	3.8 (0.7-10)	8	10 (1.1-31.9)

General Practitioners: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Ovens Murray	Benalla	20	4.3 (2.1-26.2)	20	5.7 (2.3-27.9)	14	2.9 (1.7-20.9)	6	3.6 (1.7-28.6)
	Indigo	19	1.6 (0.4-26)	19	1.6 (0.4-27)	9	3.4 (1.6-23.4)	8	6.1 (1.6-22.7)
	Mansfield	12	19.8 (8.7-60.9)	12	19.7 (8.7-86.6)	6	17.6 (16.1-20.7)	*	19.8 (10-62)
	Towong	11	40 (25.5-60.1)	10	36.1 (25.5-60.1)	6	40.6 (15.8-65.1)	6	21.6 (14.3-55.7)
	Wangaratta	31	15.6 (2.4-26.8)	31	15.6 (2.4-26.8)	21	15.9 (2.4-26.8)	15	16 (1.8-65.6)
	Wodonga	22	4.7 (3.3-8.5)	20	4.7 (3.4-9.8)	11	3.5 (1.5-11)	7	1.5 (1.3-11)
Wimmerra Southern Mallee	Hindmarsh	9	57.4 (18.3-289.7)	8	140.3 (34.8-311.9)	5	57.4 (4.1-191.3)	5	57.4 (2.4-170.6)
	Horsham	21	2.6 (2-6.9)	21	3.1 (2-6.5)	13	3.1 (2.1-6.9)	13	3.4 (1.8-6.9)
	Northern Grampians	9	10.2 (2.2-20.9)	8	6.4 (2.1-19)	6	10 (2.2-20.9)	*	19.1 (10-122.6)
	West Wimmera	6	50.1 (40-56.2)	5	53.1 (47.1-56.2)	*	47.1 (4.5-53.1)	*	47.1 (47.1-47.1)
	Yarriambiack	8	8.9 (1.2-44.4)	8	8.9 (1.2-44.4)	5	15.6 (2.2-30.7)	*	16.4 (1.2-44.4)

*LGAs with < 5 cases; median value calculated on low cell count

Abbreviations: LGA, local government area; IQR, interquartile range; km, kilometres

Medical (other): Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Melbourne	Banyule	77	10.9 (8-16.3)	69	11.3 (7.8-16.4)	40	13.2 (9.6-17.7)	32	9.8 (7.5-16)
	Bayside	73	8.4 (5-14.8)	70	8.6 (5.1-14)	33	9.6 (6-16)	29	9.7 (6-16)
	Boroondara	105	5.2 (3.4-7.4)	99	5.2 (3.4-7.5)	52	6 (3.8-7.9)	25	6.7 (4.6-9.3)
	Brimbank	131	20.7 (15.9-26.1)	125	21.8 (17.1-26.1)	63	22.4 (14.1-28.6)	52	22.6 (12.8-26.7)
	Cardinia	90	42.2 (34.9-52.8)	84	42.7 (34.4-54.8)	45	41.3 (35.9-56)	28	38.9 (19-54.2)
	Casey	271	19.4 (13.6-27.9)	250	20.4 (14.9-28.8)	152	19.1 (13.2-27.9)	104	17.9 (10.6-28.8)
	Darebin	145	7.7 (5.9-11)	127	7.3 (5.3-10.3)	80	8.4 (6.1-11.6)	51	8.5 (6.7-12.3)
	Frankston	146	8.7 (4.7-30.8)	136	8 (4.4-30.6)	81	16.9 (6-34)	59	17.7 (4.8-37.9)
	Glen Eira	116	7.8 (5.7-11.2)	108	7.9 (5.9-10.9)	56	7.8 (5.4-10.1)	39	7.1 (4.3-9.9)
	Greater Dandenong	135	12.2 (8.1-18.5)	127	11.6 (8.1-18.7)	84	11.6 (7.7-18.2)	54	12.7 (7.5-20)
	Hobsons Bay	72	16.9 (13.2-23.6)	70	16.7 (13.5-24.3)	36	16.8 (13.5-25.7)	24	16.9 (15.6-25)
	Hume	195	20.7 (12.2-32.4)	175	21.3 (12.6-33.9)	107	19.6 (10.7-27.6)	91	21.1 (10.7-32.4)
	Kingston	129	13.3 (8.9-18.8)	121	13.8 (8.7-19.6)	72	11.2 (7.3-16.3)	54	14 (9.5-19.9)
	Knox	132	12.2 (7.1-22.3)	121	12.4 (7.1-22.2)	72	11.9 (6.2-22.6)	46	11.9 (5.9-25.7)
	Manningham	74	13.7 (7.3-19.2)	65	13.9 (7.4-18.2)	39	15.5 (9.5-20.9)	30	15.1 (9.4-23.5)
	Maribyrnong	78	12.2 (8.1-14.4)	74	11.9 (8.1-14.3)	39	12.8 (11.5-14.8)	25	12.1 (10.8-14.4)
	Maroondah	88	20.6 (10.7-25.7)	81	20.7 (11-25.5)	45	19.3 (9.4-26)	30	20.4 (9.8-24.7)

Medical (other): Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Melbourne	62	4.3 (3-7.8)	58	4.1 (2.8-7.8)	31	4.8 (3.2-7.8)	18	4.4 (2.8-8.5)
	Melton	101	32.5 (23.3-45.2)	91	34.4 (25.6-46.4)	62	34.6 (21.9-45.3)	48	30.8 (15.3-39.4)
	Monash	149	8.3 (5.8-11.6)	145	7.9 (5.7-11.4)	77	10.1 (6.8-13.8)	44	9.5 (6.8-15.3)
	Moonee Valley	66	9.1 (7.2-13)	60	8.5 (6.7-13.5)	34	9.8 (6.1-14.1)	27	11.5 (7.6-13)
	Moreland	129	8.4 (5.4-12.7)	116	8.4 (4.7-12.6)	76	7.8 (5.1-12.3)	47	9.2 (5.5-16)
	Mornington Peninsula	139	33 (20.1-56.1)	134	30.8 (18.1-57.1)	73	41.4 (23.2-65.4)	56	34.8 (12.4-68.2)
	Nillumbik	53	20.6 (15.7-25.1)	50	21.3 (14.8-25.1)	30	22.1 (15.1-25.4)	19	20.4 (17.1-23.9)
	Port Phillip	109	5.6 (4.2-6.7)	104	5.3 (3.7-6.7)	62	6.3 (4.3-7.2)	48	6.2 (4.3-7.4)
	Stonnington	84	4.1 (2.9-5.9)	81	4.4 (2.9-5.9)	54	4.6 (3-6.5)	27	4.6 (3.3-7.5)
	Whitehorse	120	10 (7.9-14.6)	105	9.8 (8-13.9)	62	10.6 (7.4-16.8)	45	10.3 (7.4-17)
	Whittlesea	145	17.8 (11.2-23.1)	132	18.1 (11.2-23.2)	85	19.9 (14.4-24.7)	55	17.5 (12-25)
	Wyndham	145	31.5 (17.3-35.2)	132	30.8 (18.7-35.1)	88	30 (6-34.7)	63	31.9 (7.4-35.6)
	Yarra	60	3.2 (1.6-5)	56	3 (1.3-4.3)	30	3 (1.3-4.7)	20	2.9 (1.6-4.5)
	Yarra Ranges	188	33.8 (21.9-44.5)	172	33.1 (20.8-44.9)	110	33.6 (22.5-42.8)	61	35.3 (23.4-43.1)
Barwon	Colac-Otway	22	114.3 (73.9-153.9)	18	104.4 (73.9-149.6)	9	157.4 (77-163.4)	8	77 (72.3-141.4)
	Greater Geelong	158	21.2 (6.1-74.5)	135	18.8 (6.9-78.3)	78	10.6 (6-67.5)	59	17.7 (5.5-80.7)
	Queenscliffe	5	95.7 (28.2-101.1)	5	95.7 (28.2-101.1)	*	104.5 (65.3-121.9)	*	89.5 (75.8-103.3)
	Surf Coast	18	64.2 (34.3-106.2)	17	66.7 (36.3-106.2)	9	37.4 (34-84.1)	8	42.2 (35.3-105.8)
Central Highlands	Ararat	16	98.4 (82.8-205.4)	14	132.4 (90.6-204.4)	8	167.7 (82.4-213.7)	*	137.8 (92.7-193.7)
	Ballarat	86	9.1 (4.8-115.4)	82	9.1 (4.8-118)	40	64.5 (4.8-119.8)	23	6.5 (3.9-119.1)
	Golden Plains	31	78.5 (28.2-101.5)	27	78.5 (28.2-101.5)	19	69.5 (31.9-89.1)	13	75.1 (24.6-101.2)
	Hepburn	17	74.4 (33.2-110)	16	80.5 (34.8-112.7)	*	26.9 (17.3-83.2)	*	17.5 (17.3-141.9)
	Moorabool	52	60.3 (39.1-68.2)	49	60.6 (49.2-67.7)	26	61.7 (54.7-72.1)	21	63.2 (60.3-80.1)
	Pyrenees	12	109.3 (37.4-167.1)	10	60.3 (43-166.7)	7	156.2 (31.7-163.6)	6	160.6 (156.2-167.5)
Gippsland	Bass Coast	40	103.4 (91.7-126.3)	36	103.2 (86.5-132.6)	22	111.3 (92.5-126.5)	17	106.6 (87.8-130.3)
	Baw Baw	57	81.5 (58.9-97.7)	50	81.5 (57.1-94)	21	84.9 (78.8-102.3)	19	92.6 (67.2-101.6)
	East Gippsland	42	266.9 (111.8-288.1)	40	266.9 (135.9-290)	20	254.4 (115.9-295.6)	16	277.2 (133.9-291.9)
	Latrobe	82	137.7 (61.5-152.9)	67	140.5 (68.8-156)	47	138.3 (20.6-153.2)	36	145.8 (52.2-158.4)
	South Gippsland	40	121.3 (97.8-148)	34	123.3 (102.6-148)	23	113.4 (78.4-137)	17	121.8 (117.7-151.3)
	Wellington	43	195.7 (77.2-212.2)	35	176.2 (62.1-208.4)	22	206.9 (173.7-221.7)	18	201.3 (184.8-211.1)
Goulburn	Greater Shepparton	65	120.5 (6.3-179.3)	56	71.1 (4.1-177.5)	44	149.8 (7.6-183.6)	24	165.6 (6.2-186)
	Mitchell	56	63.3 (50.5-92.5)	52	63.5 (50.5-92.8)	32	55.1 (44.8-76.7)	23	57.5 (45-82.6)
	Moira	29	148.7 (42.7-232.7)	25	189.8 (42.7-243.8)	14	194.2 (47.7-239.7)	12	108.1 (45.6-225.1)
	Murrindindi	21	88.4 (56.3-120.7)	19	88.4 (54.2-120.7)	10	72.6 (41.7-110.5)	7	75.8 (56.9-111.6)
	Strathbogie	16	117.1 (50.4-155.5)	15	120.9 (49.9-160.8)	8	117.8 (109.4-127.6)	6	108.5 (50.8-121.8)

Medical (other): Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Great South Coast	Corangamite	23	127.8 (64.1-192.3)	17	94.8 (64.1-192.3)	10	149 (108.6-190.6)	8	113.3 (48.3-130.2)
	Glenelg	22	103.7 (3.5-327)	19	156.5 (3.2-327)	10	100.8 (1.6-206.8)	7	45.3 (3.5-102)
	Moyne	12	178.6 (28-230.2)	11	214 (36.5-290.7)	7	214 (16.4-291.4)	*	219.2 (15.3-303.5)
	Southern Grampians	17	295.4 (98.9-306)	13	275.2 (98.9-298.8)	8	235.7 (61.1-320.9)	6	306.4 (296.4-337.1)
	Warrnambool	26	133.7 (3.7-255.8)	22	201.1 (4.7-257.9)	18	147.6 (2.5-257.9)	12	103 (3.6-258)
Loddon Campaspe	Central Goldfields	15	155.5 (67.6-167.6)	15	98.4 (65.9-167)	6	116.7 (70.1-167.6)	*	78.1 (72.1-101.5)
	Greater Bendigo	85	116.7 (8.8-143.3)	77	124 (13-152.2)	47	100.2 (8.8-146.4)	34	77.8 (13.2-144.2)
	Loddon	9	133.5 (99.8-175.3)	9	133.5 (115.8-187)	*	145.4 (108.1-166.3)	*	82 (82-82)
	Macedon Ranges	63	63.4 (52.7-76.9)	59	63.4 (53-76)	41	59.9 (44.2-71.8)	28	56.9 (47.3-84.1)
	Mount Alexander	12	62.7 (38.9-135.1)	10	48.7 (39.3-114.7)	6	81.9 (37.9-132.2)	5	132.2 (119.8-144.8)
Mallee	Buloke	7	168.2 (73-226.3)	6	142.7 (73-168.2)	*	195.1 (122.5-262.3)	*	170.9 (168.2-394.3)
	Campaspe	48	184.2 (82.6-203)	43	182.8 (75.3-207.6)	29	192.3 (113.4-208.1)	27	181.4 (84.8-211.3)
	Gannawarra	14	275.2 (142.2-298.6)	12	287.5 (278.7-300.1)	9	252.9 (130.6-286.6)	6	275.9 (242-299.3)
	Mildura	29	383.7 (7.7-540.3)	25	266.3 (5-539)	13	539.9 (291.4-549.7)	11	283 (4.2-540.3)
	Swan Hill	13	324.7 (187-345.2)	12	268.1 (187-349.2)	7	197.5 (114.8-347.5)	*	234.2 (180.9-309.8)
Ovens Murray	Alpine	13	155 (83.6-309.1)	10	203 (83.6-309.1)	8	314.1 (116.5-325.3)	6	77.2 (40.1-225.1)
	Benalla	16	162.6 (75-200.1)	14	193.1 (87-202.9)	11	194.3 (146.5-201.7)	5	201.7 (198.4-201.9)
	Indigo	15	281 (46.1-302.9)	12	275.5 (41.5-299)	7	281 (151.4-305.1)	5	305 (295.7-326.2)
	Mansfield	10	144.3 (107.9-181.7)	10	164.6 (107.9-181.7)	*	119.3 (113.8-185.7)	*	45.6 (20.7-70.5)
	Towong	6	98.9 (56.4-395)	6	98.9 (56.4-395)	*	284 (132.5-435.5)	*	231.6 (27.7-435.5)
	Wangaratta	29	73.7 (18.3-242.6)	24	209.3 (21.1-244.8)	22	105.4 (16-242.2)	14	182.9 (29.9-263.8)
	Wodonga	16	12.9 (8-300.8)	15	11 (7.4-301)	5	207.9 (11.9-292.8)	7	18.2 (3.5-300.6)
Wimmera Southern Mallee	Hindmarsh	8	345.1 (275.6-364.9)	8	345.1 (275.7-365)	*	238.3 (220.1-358.4)	*	238.6 (189-281.6)
	Horsham	13	186.1 (153.9-281.5)	12	187 (168.1-291.7)	7	187.9 (183.8-244.4)	8	189.2 (180.1-301.3)
	Northern Grampians	9	224.7 (190.7-235.1)	9	224 (132.5-235.1)	*	231.4 (226.2-242)	*	224.6 (106-226.8)
	West Wimmera	6	416.1 (203.5-425.2)	5	417.5 (414.3-425.2)	*	418.2 (164.9-427.2)	*	203.5 (203.5-203.5)
	Yarriambiack	*	23.2 (8.9-127.3)	*	30 (22.5-139.5)	*	30.7 (2.1-223.7)	*	113.1 (2.1-224)

*LGAs with < 5 cases; median value calculated on low cell count

Abbreviations: LGA, local government area; IQR, interquartile range; km, kilometres

Mental Health: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Melbourne	Banyule	35	12.5 (7.8-17.2)	24	11.7 (7.7-17)	22	13.1 (8-16.6)	20	14.2 (7.9-17.4)

Mental Health: Trip distance per person by LGA (km)									
			Overall		Year 1		Year 2		Year 3
Region	LGA Name	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)
	Bayside	36	8.2 (3.3-14.3)	29	7.9 (3.4-14.3)	23	5.9 (2.3-16.2)	10	14.3 (10-20)
	Boroondara	65	5.1 (3.5-8.5)	61	4.9 (3.4-7.6)	24	5.4 (3-9.1)	15	9.3 (4.9-16.4)
	Brimbank	61	18.1 (8.9-27.5)	36	24.5 (14-28.2)	35	18.1 (4.4-31.4)	29	11 (4.7-24.3)
	Cardinia	42	36.3 (19.8-50)	31	43.3 (33-51.1)	23	35.3 (5.4-45.6)	18	17.3 (4.3-35.3)
	Casey	115	19.1 (6.1-29.1)	96	21.2 (6.5-29.9)	71	19.7 (7.4-31.2)	55	23 (10.2-31.2)
	Darebin	67	9.3 (6.6-13.8)	50	9.4 (6.6-14.6)	44	8.6 (6.4-11.5)	30	9.4 (6.7-14.3)
	Frankston	81	13 (7.2-21.8)	68	11.9 (7.1-21.2)	50	14.3 (7-23.1)	41	13.9 (5.6-42.5)
	Glen Eira	40	9.4 (5.1-12.9)	30	8.3 (4.8-12.9)	27	8.8 (4.3-12.4)	14	9.3 (3-13.1)
	Greater Dandenong	47	9.4 (3.6-18.4)	33	8.7 (2.7-18.4)	26	5.2 (2.7-16.8)	25	8.6 (3.4-14.4)
	Hobsons Bay	36	14.7 (6.7-20.8)	26	16 (8.6-21.8)	26	11.6 (6.7-26)	19	10.2 (5.5-25.6)
	Hume	86	16.9 (7-28.1)	61	17.3 (5-31.6)	54	16.9 (10.2-28.1)	31	17 (9.4-22.9)
	Kingston	58	9.4 (5.7-16.9)	41	12.3 (5-18.8)	44	8.5 (5.9-16.6)	35	9.3 (5.9-17.6)
	Knox	50	11.3 (6-20.7)	33	10.9 (7.6-17.3)	34	12.3 (4.2-23.4)	27	15.3 (8.7-27.7)
	Manningham	34	10.5 (5-16.6)	30	11.9 (4.3-17.4)	22	9.8 (5-13.1)	14	11.4 (5.4-17.5)
	Maribyrnong	26	11.1 (5.2-16.2)	16	12.9 (5.5-15.6)	23	8.7 (5.1-14)	10	10.9 (8-14.7)
	Maroondah	40	12.2 (3.6-22.2)	29	10 (2.9-20.5)	23	8.8 (3.6-20.8)	19	11.4 (2.7-22.1)
	Melbourne	22	4.2 (2.1-12.2)	18	3.4 (2.1-10.4)	12	3.3 (1.6-7.8)	8	20.4 (4.2-36.9)
	Melton	49	26.7 (8.2-41.9)	37	31.3 (8.2-43.4)	31	21.9 (7-41.8)	25	18 (8.2-29.3)
	Monash	52	9.4 (5.4-15.7)	38	8.6 (5.2-13.4)	31	8.6 (5.1-15.9)	27	12 (5.1-22.7)
	Moonee Valley	24	9.1 (5.2-15.1)	18	9.6 (3.8-14.6)	13	5.9 (3.8-16.3)	8	7.8 (5.5-11.6)
	Moreland	67	8.9 (4.7-17.6)	45	7.8 (4.1-13.3)	39	10.4 (5.7-17)	34	10.4 (5.9-13.5)
	Mornington Peninsula	66	27.9 (9.4-44.7)	53	28.7 (9.9-46.7)	35	28.5 (9.4-49.6)	28	28.8 (7.2-60)
	Nillumbik	28	15.4 (8.6-26.4)	22	23 (9.5-25.9)	17	13.9 (6.1-29.6)	10	13.9 (9.5-16.7)
	Port Phillip	51	5.6 (3.6-7.1)	35	6 (3.9-8.4)	29	6.2 (3.6-9.1)	26	5.7 (4-9.7)
	Stonnington	50	5 (3.2-7.9)	40	4.2 (3.1-6.4)	27	6.4 (3.4-9.3)	20	6.2 (4.5-11.9)
	Whitehorse	49	10.2 (6.1-15.7)	32	9.6 (5.7-16.1)	24	10.3 (6.3-22.9)	20	10.6 (5.9-21.7)
	Whittlesea	64	16.5 (8.4-24.7)	42	20.5 (11.2-30)	34	12.6 (4.9-23.1)	31	15.3 (7.9-26.3)
	Wyndham	67	10 (5.2-29.6)	44	12.8 (5.6-31)	49	18 (5.6-29.7)	33	11.6 (5.8-27.4)
	Yarra	31	3.5 (1.9-6.8)	26	3.9 (2.5-8.6)	17	2.7 (1.8-5.8)	9	2.5 (1.8-6.9)
	Yarra Ranges	82	25.2 (9-35.6)	64	26 (11.1-38.3)	54	21.4 (6.8-31.4)	42	25.1 (9-35.2)
Barwon	Colac-Otway	9	3.2 (1-60.4)	7	2 (0.9-105)	5	3.2 (1-60.4)	*	2.1 (0.8-31.8)
	Greater Geelong	75	8 (4-13.4)	55	9.5 (5.4-18.3)	48	7.9 (4.7-15.2)	41	8.8 (4.2-12)
	Queenscliffe	*	66.7 (29.2-104.2)	*	66.7 (29.2-104.2)	*	104.2 (104.2-104.2)	0	
	Surf Coast	10	24.5 (4.1-46.4)	5	19.4 (2.2-25)	5	4.1 (2.2-36.8)	6	29.5 (7.1-46.5)
	Ararat	5	105.9 (91.8-113.4)	*	105.9 (76.3-196.5)	*	102.6 (91.8-113.4)	*	102.6 (91.8-113.4)

Mental Health: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Central Highlands	Ballarat	37	5.6 (4-12.2)	32	6.1 (4.5-14.6)	22	5.2 (3-7)	11	3.6 (3-6)
	Golden Plains	12	21.7 (19.7-24.4)	10	21.4 (19.2-24.4)	11	21.8 (20.2-26.3)	8	23.8 (22-46.6)
	Hepburn	*	23.6 (9.4-34.2)	*	18 (0.8-29.4)	*	34.2 (29.1-39.3)	*	23.7 (18-29.4)
	Moorabool	20	27 (11.4-56.7)	18	16.7 (5.8-59)	14	35.7 (12.2-51.3)	10	17.2 (10.6-49.8)
	Pyrenees	*	71.1 (32.1-98.1)	*	84.6 (71.1-98.1)	*	32.1 (32.1-32.1)	0	
Gippsland	Bass Coast	18	20.2 (1.9-101.4)	13	29.2 (1.9-88.3)	10	24.7 (9-101.4)	7	30 (1.1-66.7)
	Baw Baw	27	32.3 (8.8-88.5)	16	34.6 (8.8-83.3)	16	44.6 (8.8-88.2)	14	53.6 (8.8-94.2)
	East Gippsland	18	19.8 (3.7-114.1)	16	19.8 (4.9-200.9)	11	16.5 (3.7-114.1)	7	113.8 (13.4-290.5)
	Latrobe	30	81.2 (11.3-160.5)	24	37.2 (7.6-157.4)	23	36.5 (10.9-152.5)	20	37.5 (7.2-158.5)
	South Gippsland	15	33.9 (14.2-111.9)	9	40.6 (14.2-111.9)	9	33.9 (14.2-51.2)	9	26.2 (17-51.2)
	Wellington	24	64.8 (11.7-201.6)	19	47.4 (4.3-189)	16	64.8 (14.3-213.1)	14	60.2 (11.4-220.5)
Goulburn	Greater Shepparton	30	16.1 (5.6-149.2)	24	14.5 (4.9-59.2)	14	13.9 (4.7-169.5)	11	8.5 (4.7-180.5)
	Mitchell	27	49.6 (14.2-67.2)	21	55.6 (25.4-78.2)	20	27 (11.2-59.9)	15	49.6 (16-70.9)
	Moira	12	220.8 (44.6-242.6)	8	144.4 (40.1-252.4)	8	145.5 (38.1-242.6)	6	138.7 (42.4-239.6)
	Murrindindi	5	110.9 (39.6-126.5)	5	110.9 (39.6-126.9)	*	32.5 (19.9-233.4)	*	72.8 (19.9-125.8)
	Strathbogie	6	128.3 (68.1-152.9)	*	143 (100.6-168)	5	123.5 (68.1-152.9)	*	85.4 (17.9-152.9)
Great South Coast	Corangamite	7	91.8 (80.1-131)	6	106.8 (84.6-131)	*	68.7 (38.6-121.8)	*	84.3 (84.3-84.3)
	Glenelg	9	5 (1.2-16.8)	8	4.7 (1.2-12.4)	5	5 (4.4-16.8)	*	5 (1.2-18.5)
	Moyne	7	27.7 (17.9-30.6)	6	28.5 (24.3-30.6)	*	27.7 (17.9-224.4)	*	119.9 (15.3-224.4)
	Southern Grampians	6	73.5 (24.5-176)	*	176 (24.5-291.3)	*	13.9 (3.3-24.5)	*	73.5 (46.5-100.4)
	Warrnambool	16	3.2 (2.3-137.1)	15	3.4 (2.2-202.5)	7	4.1 (2.7-171.1)	9	4.5 (2.5-111.8)
Loddon Campaspe	Central Goldfields	5	53.8 (48.8-85.9)	5	53.8 (48.8-83.9)	*	48.8 (46.1-85.9)	*	48.8 (46.1-85.9)
	Greater Bendigo	45	8.2 (4.8-58.3)	32	8.8 (5.9-71.6)	18	5.7 (2.5-9.8)	15	8.2 (5.5-55.5)
	Loddon	3	50.5 (22.4-98.5)	2	60.5 (22.4-98.5)	*	74.5 (50.5-98.5)	0	
	Macedon Ranges	32	32.2 (9.2-63.3)	23	14.4 (8.8-59.5)	17	25.3 (9.4-63.2)	17	33.4 (12.4-63.3)
	Mount Alexander	7	22.9 (1.5-47.1)	5	10.5 (8.8-18.3)	*	27.5 (10.2-93.4)	6	29.5 (18.9-48.3)
Mallee	Buloke	5	168.3 (72.9-171.7)	*	164.6 (115.1-203.5)	*	106.4 (0.6-212.3)	*	120.7 (73-168.3)
	Campaspe	21	90 (30.1-187.9)	14	108 (40.2-182.8)	13	93.4 (47.7-209)	15	177.2 (24.5-209)
	Gannawarra	6	82.8 (59.4-282.3)	*	182.4 (81.8-283)	5	81.8 (59.4-282.3)	*	82.8 (70.6-183.4)
	Mildura	13	3.3 (2.7-16)	12	143.8 (2.7-541.8)	9	3.3 (2.9-284.6)	7	3.3 (2.7-5.3)
	Swan Hill	8	128.8 (8.6-348.8)	8	128.8 (8.6-348.8)	*	170.4 (0.8-356.6)	*	339.9 (11.3-373.3)
Ovens Murray	Alpine	*	178.9 (41.7-296.3)	*	187.7 (58.3-317.1)	*	82.5 (1-282.3)	*	138.2 (1-275.4)
	Benalla	10	196.9 (47.1-204.5)	8	125.2 (24.4-204.5)	5	195.7 (3.1-204.5)	*	195.7 (47.5-198)
	Indigo	8	31.4 (26.4-39.7)	7	31.3 (25.1-38.6)	5	31.4 (31.3-38.6)	*	31.4 (29.5-38.1)
	Mansfield	*	115.8 (18.8-212.7)	*	212.7 (212.7-212.7)	*	18.8 (18.8-18.8)	0	

Mental Health: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Towong	*	61.2 (27.2-358.3)	*	27.2 (27.2-27.2)	*	61.2 (27.2-358.3)	*	27.2 (27.2-27.2)
	Wangaratta	13	12.2 (1.8-23.6)	10	21.2 (2.3-37)	8	2.5 (1.7-21.5)	7	19.5 (1.4-23.6)
	Wodonga	8	6.2 (3-13.3)	5	4 (3.3-16.7)	5	8.4 (2.8-9.8)	*	11 (8.4-13.6)
Wimmerra Southern Mallee	Hindmarsh	5	238.5 (223.9-294)	5	224.6 (223.9-238.5)	3	223.9 (191.1-337.1)	2	207.5 (191.1-223.9)
	Horsham	7	22.5 (2.4-190)	6	102 (2.4-190)	5	189.9 (2.4-190)	4	189.7 (96.4-246.4)
	Northern Grampians	*	39 (29.1-49)	*	85.8 (29.1-142.5)	*	39 (29.1-49)	*	49 (49-49)
	West Wimmera	*	371.1 (371.1-371.1)	*	371.1 (371.1-371.1)	*	371.1 (371.1-371.1)	0	
	Yarriambiack	*	29.1 (0.9-57.2)	*	0.9 (0.9-0.9)	*	29.1 (0.9-57.2)	0	

*LGAs with < 5 cases; median value calculated on low cell count

Abbreviations: LGA, local government area; IQR, interquartile range; km, kilometres

Occupational Therapy: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Melbourne	Banyule	34	15.2 (10.4-19.1)	28	15.6 (13.3-18.9)	23	16.6 (13.7-19.3)	14	15.6 (9.9-19.1)
	Bayside	33	11.4 (8.4-14.3)	29	11.9 (8.4-15)	19	9.7 (6.8-14.2)	16	13.1 (9.3-22.1)
	Boroondara	76	5.7 (3.1-7.5)	68	5.3 (2.8-7.1)	21	6.6 (4.3-11.5)	12	9.9 (5-81.9)
	Brimbank	60	20.5 (14.5-26.7)	46	21 (17-24.9)	25	22.1 (6.1-26.6)	20	19.7 (8.7-31.2)
	Cardinia	38	44.9 (32.4-52)	33	46.1 (32.9-50.5)	19	47.4 (37.5-53)	15	42.8 (36.8-52.1)
	Casey	123	23.6 (15.4-35.2)	102	21.9 (15.4-33.2)	55	23.6 (15.8-35.3)	43	32.1 (17.6-42.8)
	Darebin	62	8.4 (6.4-15.6)	49	8.2 (5.3-15.8)	36	9.9 (5.9-18.3)	23	11.5 (6.8-22.8)
	Frankston	80	8.7 (4.7-34.8)	70	7.5 (3.3-22.5)	35	20.6 (6.4-39.8)	19	32.4 (7.4-41)
	Glen Eira	44	8.6 (5.8-11.5)	33	7.6 (5.8-10.3)	22	7.3 (5.7-9.3)	17	8.7 (8.2-19)
	Greater Dandenong	45	15.4 (7.9-23.9)	31	21.4 (5.4-24.4)	19	13.6 (7.9-23.5)	15	20.1 (14.7-22.8)
	Hobsons Bay	26	22.2 (15.7-26.3)	21	21.8 (16.6-25.7)	13	17.2 (15.7-25)	8	26.8 (20.8-30.1)
	Hume	87	19.8 (14.5-33.9)	75	19.8 (14.4-33.5)	30	29.3 (16.8-37.6)	17	33.5 (16.2-40.2)
	Kingston	55	14.8 (12.7-19.9)	46	15.8 (12.9-20.3)	31	14.8 (12.7-19.3)	26	14.6 (10.8-20.7)
	Knox	43	21.6 (15.5-25.4)	31	20.5 (15.1-25.2)	25	22.6 (17.7-29.1)	16	19.5 (15.5-26.4)
	Manningham	42	13.5 (4.1-18.6)	40	13.1 (3.6-18.7)	19	14.2 (7.5-18.9)	11	17.3 (8.1-18.3)
	Maribyrnong	34	14.5 (12.1-18.4)	28	14.7 (12.6-17.9)	15	14 (12.1-19.8)	8	11.4 (9.1-18.6)
	Maroondah	45	20.2 (11.3-25)	37	20 (10.5-23.8)	18	21.3 (15.8-28.3)	14	26.1 (18.5-36.2)
	Melbourne	25	5 (3.4-11.3)	21	4.3 (3.1-5.3)	13	5 (3.6-11.3)	6	24.3 (16.6-37.4)
	Melton	46	33.2 (21.8-44.7)	36	35 (21.9-47.9)	28	33.3 (22.2-40.8)	17	27.3 (22-36.2)
	Monash	44	9.9 (7-16.2)	37	9.9 (7.3-17.1)	27	11.5 (6.5-16.2)	17	13.3 (8.2-21.8)

Occupational Therapy: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Moonee Valley	33	10.5 (6.9-16)	30	9.9 (6.9-16)	9	11 (10.5-16.3)	*	19.9 (17.4-23.7)
	Moreland	72	5.9 (3.7-14.2)	57	5.2 (3.5-9.8)	30	12.6 (3.7-21)	20	16.9 (7.3-22.3)
	Mornington Peninsula	82	30.5 (19-43.9)	77	29.3 (19-40.1)	33	29.5 (17-44.7)	22	36.7 (24-61)
	Nillumbik	27	23.3 (19.5-26.9)	21	23.3 (19.5-26.9)	10	22.7 (18.7-27.3)	9	23.3 (20.5-24.2)
	Port Phillip	45	6.7 (5.4-8.4)	38	6.5 (5-9.8)	20	6.7 (5.6-7.6)	13	7.3 (6.3-12.9)
	Stonnington	40	4.2 (3-6.2)	39	4.2 (2.9-5.9)	17	5.2 (3.5-6.9)	9	6 (5.5-17)
	Whitehorse	69	10 (7.3-15.1)	58	9.9 (5.9-12.9)	27	10.6 (7.9-21.6)	20	10 (7.4-20.6)
	Whittlesea	63	21.8 (16.1-27.5)	52	22.2 (16.7-27)	19	25.5 (19.9-31.5)	13	22.4 (17.1-35)
	Wyndham	56	34 (29.3-37.7)	46	33.4 (28.3-36.4)	30	33.7 (27.5-36.6)	16	35.8 (32.8-44.7)
	Yarra	26	6 (2.7-13)	20	6 (2.6-10.7)	7	4 (1.5-10.3)	7	10.2 (2.9-17.5)
	Yarra Ranges	92	34.8 (23-49.8)	80	34.8 (22.1-49.8)	47	34 (24.6-51.7)	23	35.8 (27.6-52.7)
Barwon	Colac-Otway	7	77.8 (34.4-79.9)	7	77.8 (34.4-79.9)	*	75.1 (72.5-77.8)	*	77.8 (77.8-77.8)
	Greater Geelong	51	9 (5.7-29.5)	40	8.6 (4.5-29.6)	19	10.5 (7.1-78.2)	15	19.7 (7.3-78.2)
	Queenscliffe	*	63.5 (22.9-104.2)	*	104.2 (104.2-104.2)	*	63.5 (22.9-104.2)	0	
	Surf Coast	*	115.2 (36.7-121.5)	*	115.2 (36.4-121.5)	*	76 (36.7-115.2)	*	76 (36.7-115.2)
Central Highlands	Ararat	5	129.4 (92.5-165.6)	*	111 (83.7-163.2)	*	165.6 (165.6-165.6)	0	
	Ballarat	24	5.9 (4.6-6.8)	20	5.9 (4.5-6.8)	9	6.1 (5.9-7.7)	7	5.9 (4.4-6.3)
	Golden Plains	10	42.4 (25.4-98.6)	7	38.1 (19.1-88.8)	6	63.5 (29-104.9)	0	
	Hepburn	*	58.4 (25.3-77.4)	*	58.4 (25.3-77.4)	*	73 (73-73)	*	73 (73-73)
	Moorabool	16	61.3 (31.6-90.6)	14	61.3 (28.3-79.3)	5	77.3 (58.3-86.9)	*	48.9 (45.7-86.9)
	Pyrenees	*	71.1 (71.1-71.1)	*	71.1 (71.1-71.1)	0		0	
Gippsland	Bass Coast	10	98.4 (92.5-120.1)	10	98.4 (84.7-120.1)	6	97.2 (92.5-99.3)	5	97.6 (96.6-99.3)
	Baw Baw	17	91.8 (70-104.8)	13	90.1 (70-96.7)	7	91.8 (20-253.2)	6	123.4 (112-137.5)
	East Gippsland	8	133.1 (10.3-268.7)	6	23.1 (3.2-265.5)	*	237.3 (237.3-237.3)	*	256 (237.3-274.7)
	Latrobe	18	30.4 (7.6-118)	12	15.4 (5.4-72.3)	10	91.5 (12.9-118.6)	*	90.9 (32.8-139.8)
	South Gippsland	9	90.2 (73.9-110.7)	7	140.2 (73.9-160.6)	5	90.2 (77.3-110.7)	7	92.4 (72.7-127.2)
	Wellington	9	69 (62.8-210.5)	7	64 (39.9-210.5)	*	211.6 (198.1-225.2)	*	199.2 (198.1-200.4)
Goulbourn	Greater Shepparton	31	96.5 (8.6-180.1)	26	62.6 (7.6-167.9)	13	123.8 (19.4-182.8)	9	122.3 (90.5-183.7)
	Mitchell	22	70.9 (54.6-90.3)	20	70.9 (54.1-89.8)	9	67.2 (54.6-90.3)	5	54.6 (49.6-109.1)
	Moira	12	71.3 (55.8-225.5)	9	75.4 (55.2-220)	5	100.9 (56.8-230.9)	*	56.3 (47.8-261.1)
	Murrindindi	5	91.2 (43-105.6)	5	91.9 (43-105.6)	*	91.2 (91.2-91.2)	0	
	Strathbogie	*	98.1 (65.2-158.3)	*	125.4 (57.7-193)	*	98.1 (72.8-123.5)	0	
Great South Coast	Corangamite	*	41 (25.8-190.3)	*	25.8 (25.8-25.8)	*	190.3 (190.3-190.3)	*	41 (41-41)
	Glenelg	*	103.9 (98.2-132.4)	*	103.9 (98.2-132.4)	0		0	
	Moyne	6	22.7 (16.4-34)	6	22.7 (16.4-34)	0		0	

Occupational Therapy: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Southern Grampians	*	268.9 (98.9-303.3)	*	183.9 (98.9-268.9)	0		*	303.3 (303.3-303.3)
	Warrnambool	16	2.5 (1.8-4.3)	14	2.4 (1.7-4.2)	7	2.4 (1.5-3.1)	*	3.1 (2.3-198.8)
Loddon Campaspe	Central Goldfields	7	70.5 (54.4-79.2)	7	70.5 (54.4-79.2)	*	113.1 (70.5-155.6)	*	156 (156-156)
	Greater Bendigo	52	8 (5.7-17)	48	7.4 (5.7-19.3)	22	6.9 (4.2-14.2)	14	11.8 (3.8-44.6)
	Loddon	5	28.1 (26.4-43.8)	5	28.1 (26.4-43.8)	0		0	
	Macedon Ranges	33	61.7 (34.5-76.2)	29	62.7 (48.2-77.8)	14	76.8 (62.7-93.4)	9	59.8 (13-84.3)
	Mount Alexander	6	51.8 (39.4-121.1)	5	121.1 (37.8-132)	*	47.2 (39.4-56.5)	*	119.8 (56.5-132)
Mallee	Buloke	*	177.6 (152-211.1)	*	186.8 (135.7-235.4)	*	152 (135.7-168.3)	*	152 (135.7-168.3)
	Campaspe	24	87.2 (74.5-115.9)	20	84.6 (69.7-115.9)	13	91.9 (77.4-140.7)	11	89.1 (75.8-99.5)
	Gannawarra	9	117.5 (72.8-132.3)	6	131.7 (72.8-151.7)	*	131.1 (81.2-132.3)	*	82.2 (70-107.2)
	Mildura	10	4 (2.9-11.3)	8	3.3 (2.9-8)	*	5.4 (2.9-11.3)	*	11.3 (10.7-11.9)
	Swan Hill	8	12.8 (2.8-173.8)	7	9.4 (1-213.7)	*	67.5 (0.9-173.8)	*	213.7 (213.7-213.7)
Ovens Murray	Alpine	*	313.7 (66.6-337.7)	*	313.7 (298.2-337.7)	*	337.7 (337.7-337.7)	*	66.6 (66.6-66.6)
	Benalla	6	93.7 (65.2-215.1)	*	210.8 (65.5-215.1)	*	93.5 (52.4-168.5)	*	121.8 (65.2-215.1)
	Indigo	7	31.9 (22.7-40.9)	7	37.2 (22.7-87)	*	154.6 (40.9-268.3)	*	154.6 (36.4-283.3)
	Mansfield	*	212.2 (212.2-212.2)	*	212.2 (212.2-212.2)	0		0	
	Towong	*	264.5 (124.8-404.2)	*	264.5 (124.8-404.2)	0		0	
	Wangaratta	12	120.4 (22.4-255.1)	10	84.5 (40.1-274.9)	*	174.4 (32.9-462.9)	6	139.8 (13-278.9)
	Wodonga	*	4.1 (2.7-4.8)	*	4.8 (2.7-311.5)	*	4.5 (4.1-4.8)	*	341 (341-341)
Wimmerra Southern Mallee	Hindmarsh	*	237.9 (237.9-237.9)	0		0		*	237.9 (237.9-237.9)
	Horsham	*	186.1 (183.2-207.1)	*	207.1 (183.2-302.6)	*	94.1 (2.1-186.1)	0	
	Northern Grampians	*	130.5 (98.6-162.5)	*	130.5 (98.6-162.5)	0		0	
	West Wimmera	*	310.9 (310.9-310.9)	*	310.9 (310.9-310.9)	0		0	
	Yarriambiack	*	88.9 (88.9-88.9)	*	207.1 (207.1-207.1)	0		*	1.8 (1.8-1.8)

*LGAs with < 5 cases; median value calculated on low cell count

Abbreviations: LGA, local government area; IQR, interquartile range; km, kilometres

Physical Therapies: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
Melbourne	Banyule	62	7.8 (3.2-15.1)	57	9.3 (3.3-16.9)	37	8.2 (2.8-18.3)	22	7.7 (3.3-17.3)
	Bayside	75	5.7 (2-11.9)	64	5.5 (2-11.7)	40	6.5 (2.4-11.4)	34	7.7 (2.8-12)
	Boroondara	99	4.4 (2.6-6.8)	90	4.2 (2.6-6.8)	39	4 (1.1-7)	16	4.9 (2.8-10.8)
	Brimbank	108	10.3 (3.8-21.7)	100	14.3 (3.9-22.5)	61	6 (3-21.2)	42	6 (3-13.5)
	Cardinia	76	20.8 (4.7-42.9)	71	20.9 (4.4-42.8)	42	30.5 (6.3-43.1)	31	36.2 (11.8-48.5)

Physical Therapies: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Casey	219	10.9 (3.9-25.1)	186	10.8 (3.9-24.5)	126	10.8 (4.3-26.4)	89	13 (4.7-28.1)
	Darebin	114	7 (2.8-12.2)	101	6.5 (2.8-11.4)	54	7.4 (3.7-15.4)	31	8.8 (3.7-21.5)
	Frankston	148	6.1 (3.8-11.7)	138	5.9 (3.1-9.3)	75	6.4 (4.3-20.9)	59	6.2 (3.5-32.4)
	Glen Eira	103	5 (1.9-9)	87	5 (1.7-9.1)	54	3.7 (1.6-8.5)	31	3.9 (2.3-7.6)
	Greater Dandenong	83	4.6 (1.9-13.3)	66	4.8 (2-13.6)	38	4.4 (1.8-12.9)	28	4.4 (2-13.3)
	Hobsons Bay	56	5.5 (1.9-17.9)	52	5.7 (1.9-17.9)	33	4.9 (2.1-16.2)	22	7.1 (1.9-25)
	Hume	181	10.6 (3-18.7)	166	10.7 (3-18.9)	88	10.4 (2.9-17.9)	58	12.9 (4.5-21.4)
	Kingston	98	9 (3.4-15)	84	9 (2.9-16.4)	66	10.3 (5-14.8)	48	7.8 (4.5-14.6)
	Knox	84	7.1 (3.5-16.5)	64	8 (4-19.4)	45	6.3 (2.8-13.1)	40	6.8 (3.3-16.7)
	Manningham	62	7.4 (2.6-18.2)	59	7.5 (2.6-17.2)	34	7.6 (2.1-19.3)	20	12.4 (2.7-20.5)
	Maribyrnong	61	9.4 (2.6-14.4)	55	9.3 (2.6-14.2)	32	4.9 (2.4-11.7)	25	8.7 (1.8-12.5)
	Maroondah	80	7.4 (3.5-18)	67	7.4 (3.5-18)	40	6.9 (3.4-17.1)	26	5.2 (2.7-11.7)
	Melbourne	44	4.1 (2-7.7)	40	4 (2-6.4)	22	3.7 (1.8-5.1)	11	13.6 (3.9-26.2)
	Melton	98	12.9 (3.7-27.3)	84	13.4 (4.3-26.9)	52	11.9 (4.6-26)	42	11.9 (5.8-27.8)
	Monash	92	5.4 (3.1-9.8)	72	6.1 (3.2-10.1)	50	6.3 (3.4-10.7)	30	5.3 (2.6-9.8)
	Moonee Valley	71	7 (2.8-11)	66	7 (3-11)	30	5.8 (1.6-10.6)	18	2.8 (1.2-6.9)
	Moreland	117	4.9 (2.7-9.5)	100	4.7 (2.6-8.2)	62	5.7 (2.2-13.7)	39	10.5 (4.6-16.7)
	Mornington Peninsula	142	14.9 (5.1-29.5)	138	14.3 (5-28.9)	69	8.9 (4-22.7)	50	11.3 (4-27)
	Nillumbik	51	14.3 (6.3-25.6)	44	15.1 (7.6-25.9)	29	10.2 (2.8-15.9)	23	11.7 (5.2-13.7)
	Port Phillip	91	5 (2.1-7)	79	5 (1.9-6.9)	51	5.3 (2.1-7.5)	38	6 (2.8-8.7)
	Stonnington	72	3.8 (1.7-6.1)	65	3.9 (1.7-5.9)	30	4.8 (1.7-6.9)	21	4.7 (2-5.9)
	Whitehorse	104	7.9 (4.1-11.4)	91	8.7 (3.9-11.3)	49	7.4 (4-11.3)	35	7.3 (3.6-10.1)
	Whittlesea	127	13.7 (4.7-22.5)	108	14.1 (5-22.2)	71	12.2 (4.6-21.4)	49	9.1 (3.8-18.1)
	Wyndham	137	6.2 (2.7-25.7)	127	6.5 (2.8-27.7)	78	6.6 (2.8-27.4)	50	6.3 (3.2-18)
	Yarra	43	4.4 (1.6-7)	36	4.2 (1.5-7.4)	20	3.7 (1.9-8.7)	11	7 (3.8-16.1)
	Yarra Ranges	185	17.9 (6.7-29.8)	171	18.1 (6.8-30.2)	89	17 (5.8-28.8)	58	14.3 (5.1-27.4)
Barwon	Colac-Otway	21	4 (1.2-18.5)	19	7.7 (1.7-24.4)	8	1.4 (1.1-5.8)	7	1.7 (0.6-7.7)
	Greater Geelong	111	4.1 (1.9-8.3)	91	4.1 (1.9-9.3)	59	5.8 (2.3-10.3)	43	5.1 (2.3-10.4)
	Queenscliffe	5	22.9 (0.8-28.2)	*	25.5 (11.8-66.2)	*	104.3 (104.3-104.3)	*	50.6 (0.3-100.9)
	Surf Coast	12	19 (2.3-40.5)	12	25.4 (2.3-40.5)	*	2.8 (1.1-10.4)	*	10.4 (10.4-10.4)
Central Highlands	Ararat	5	73 (19.4-129.4)	5	73 (19.4-129.4)	*	19.4 (4.8-73)	0	
	Ballarat	75	4.9 (3.4-7.3)	68	5.1 (3.6-7.6)	34	5 (3.3-6.4)	23	4.6 (2.7-6.1)
	Golden Plains	25	18.7 (11-33)	23	18.7 (3.1-36.6)	14	17.8 (3.1-21.2)	11	19.3 (7.7-23.4)
	Hepburn	12	19.2 (14.1-37.2)	11	18.5 (10.9-38.2)	11	18.5 (5-38.2)	6	13.3 (5-38.2)
	Moorabool	52	8.9 (2.8-27.2)	51	12 (2.6-31.4)	25	6.4 (3.1-24.2)	18	8.4 (2.6-29.5)
	Pyrenees	12	32.5 (29.5-53.7)	12	32.5 (29.5-43.8)	8	36 (29.5-62.1)	*	39.8 (39.8-39.8)
Gippsland	Bass Coast	39	13.2 (2.6-29.5)	38	13.2 (2.6-28.3)	21	13.2 (5.8-29.5)	21	13.4 (7.5-96.6)

Physical Therapies: Trip distance per person by LGA (km)

Region	LGA Name	Overall n	Overall Median (IQR)	Year 1 n	Year 1 Median (IQR)	Year 2 n	Year 2 Median (IQR)	Year 3 n	Year 3 Median (IQR)
	Baw Baw	68	10.6 (4.9-30)	64	11 (3.8-28.2)	36	12.7 (5.2-34.4)	22	12.4 (3.9-30.4)
	East Gippsland	30	19.3 (4.9-116.1)	25	17.5 (2.4-40.5)	13	22.1 (4.9-40.5)	8	24.3 (17.2-168.8)
	Latrobe	85	6.3 (2.5-17.5)	76	3.6 (2.4-16.2)	52	5.2 (2.2-19.3)	42	3.3 (2.1-15.9)
	South Gippsland	30	11.3 (3.4-25.2)	27	9.8 (3.2-25.2)	18	20.2 (7.2-28.4)	12	13.7 (5.5-25.6)
	Wellington	43	16.4 (3.8-32.6)	41	16.4 (3.8-31.8)	20	23.8 (2.1-46.8)	15	39.7 (2.9-106)
Goulbourn	Greater Shepparton	53	7.9 (3.9-22.9)	53	7.9 (3.9-22.9)	32	6.7 (3.1-29)	25	6.7 (2.8-30.9)
	Mitchell	53	10.4 (1.7-33.6)	49	6.4 (1.7-26.5)	28	12.8 (1.6-31.6)	20	19.8 (2.6-39.1)
	Moira	36	27.3 (8.9-38.4)	31	28.1 (7.3-36.8)	22	20.7 (2.6-54)	12	21.7 (1.5-47.7)
	Murrindindi	17	28.6 (0.9-43)	17	28.6 (0.9-43)	10	20.5 (0.9-28.9)	5	21.1 (20-28.6)
	Strathbogie	11	18.1 (1.6-29.4)	10	10.6 (1.6-21.4)	*	23.8 (10.1-111.2)	*	111.2 (29.4-193)
Great South Coast	Corangamite	20	47.9 (32-70.3)	18	47.9 (30.4-74.4)	9	45.3 (21.4-59.7)	6	48.5 (45-64.5)
	Glenelg	23	7.5 (1.6-25.2)	21	4.7 (1.6-25.2)	14	6	8	2.3 (0.9-11.5)
	Moyne	13	27.7 (17.7-58)	13	27.7 (17.7-58)	9	19.4 (14.9-27.9)	5	15.3 (5.8-19.4)
	Southern Grampians	19	24.1 (0.8-97.3)	15	26.4 (0.8-98.9)	7	24.1 (8.2-45.9)	6	34.7 (23.6-45.9)
	Warrnambool	28	2.5 (1.4-3.9)	28	2.6 (1.2-4)	15	3.1 (1.6-4.2)	12	3.2 (2.4-4.1)
Loddon Campaspe	Central Goldfields	15	50 (17-69.6)	13	48.1 (17-67.4)	7	65.9 (7.2-79.2)	6	55.9 (7.2-65.9)
	Greater Bendigo	74	7.8 (4.7-13.5)	70	7.8 (4.7-13.5)	36	6.8 (4.7-14.7)	23	9.5 (4-28.7)
	Loddon	9	43.8 (28.1-49.6)	9	43.8 (28.1-49.6)	*	27.1 (24-81.9)	*	27.1 (27.1-27.1)
	Macedon Ranges	68	19.6 (7.1-48.3)	65	20.8 (7.5-47.7)	38	30.6 (10.8-57.6)	22	18.2 (7.6-50)
	Mount Alexander	10	27.3 (16.4-36.3)	8	19.4 (13.8-40.9)	5	34.7 (9.8-36.3)	7	36.3 (12.4-131.6)
Mallee	Buloke	7	77.7 (62.5-147.6)	6	75.5 (62.5-147.6)	4	97.2 (24.2-157.9)	3	168.3 (143.7-400.1)
	Campaspe	42	37.8 (6.4-70.7)	32	32.3 (5.8-48.6)	25	40 (6.6-88.6)	18	34.7 (6.6-91)
	Gannawarra	13	58.1 (16-73.5)	10	61.8 (2-80.4)	8	57.3 (25.5-72.8)	5	72.1 (58.1-90.7)
	Mildura	25	3.2 (2.6-5.4)	24	3.2 (2.6-7.4)	17	3 (2.5-5.4)	14	2.9 (2.3-5.4)
	Swan Hill	13	12.5 (1.7-18.2)	12	14 (2.8-115.8)	8	2.8 (1.3-12.8)	*	8.4 (1.4-15.4)
Ovens Murray	Alpine	15	7.5 (1.2-52.1)	15	7.5 (1.2-52.1)	7	48.6 (0.9-56.2)	7	12.3 (0.9-48.6)
	Benalla	18	2.7 (1.2-26.6)	18	2.7 (1.8-26.6)	12	12.8 (1.5-27.5)	7	8.9 (1.1-28.4)
	Indigo	15	34.7 (19-42.2)	15	34.7 (3.1-42.2)	8	37.3 (29.3-37.5)	*	37.3 (37.2-37.4)
	Mansfield	12	15.6 (2.9-19.7)	12	15.6 (2.9-19.7)	*	17.6 (8.6-19.7)	*	18.8 (0.8-20.5)
	Towong	6	95.5 (61.2-395)	6	95.5 (61.2-395)	*	30.6 (30.6-30.6)	*	45.6 (27.2-64)
	Wangaratta	26	16.9 (3.4-39.9)	23	16 (3.1-41.1)	19	22.8 (3.1-54.5)	10	3.9 (2.1-10.5)
	Wodonga	19	4.6 (2.2-8.8)	18	5.2 (3.1-11.8)	9	2.2 (1.3-8.4)	*	3.4 (1.5-6.5)
Wimmerra Southern Mallee	Hindmarsh	*	207.4 (123.4-254.6)	*	223.2 (55.2-288.6)	*	191.6 (55.2-286)	*	191.6 (191.6-191.6)
	Horsham	14	2.3 (1.7-5)	12	2.7 (1.7-6)	8	1.7 (1.1-3.5)	7	2.3 (1.1-188.6)
	Northern Grampians	*	1.8 (0.7-2.9)	*	2.9 (2.9-2.9)	*	1.8 (0.7-2.9)	*	0.7 (0.7-0.7)

Physical Therapies: Trip distance per person by LGA (km)									
		Overall		Year 1		Year 2		Year 3	
Region	LGA Name	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)
	West Wimmera	6	303.4 (298.6-390.1)	5	298.6 (245.4-302.1)	*	272 (245.4-298.6)	*	304.7 (245.4-390.1)
	Yarriambiack	*	30.6 (15.7-46.7)	*	26.5 (1.1-62.6)	*	30.7 (30.7-30.7)	*	30.4 (1.1-30.7)

*LGAs with < 5 cases; median value calculated on low cell count

Abbreviations: LGA, local government area; IQR, interquartile range; km, kilometres

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Appendix 9: Strengthening the reporting of observational studies in epidemiology (STROBE) Checklist used for the paper, 'Travelling for treatment: The association between injury type and service utilisation in metropolitan and regional Victoria'

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3-4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2-3
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	Fig 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4-5
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-	5

		up, and analysed	
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	Fig 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	5
Outcome data	15*	Report numbers of outcome events or summary measures over time	5-8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-8
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.