Social and geographical differences in road traffic injury in the Auckland region

Jamie Hosking, Shanthi Ameratunga, Daniel Exeter, Joanna Stewart

Section of Epidemiology and Biostatistics, School of Population Health, The University of Auckland

Produced for Auckland Transport, 2013.

ISBN: 978-0-473-24259-6

Acknowledgements

This report was informed by a stakeholder reference group, the members of which are listed below. This report does not necessarily represent the views of the host organisations of reference group members.

Laura Ager	ACC
Moses Alatini	Safekids New Zealand
Melanie Bartlett	New Zealand Transport Agency
Andrew Bell	Auckland Transport
Julie Chambers	Auckland District Health Board
Angie Cheong	Auckland Transport
Juanita deSenna	Auckland Transport
Greer Hawley	Auckland Transport
John Kelly	New Zealand Police
Peter Sandiford	Waitemata District Health Board

The assistance of the following people and organisations with this report was greatly appreciated:

Bridget Kool, Carol Chelimo, Sandar Tin Tin and Alex Macmillan, University of Auckland, for advice on hospitalisation and mortality data and analysis, census data, and travel survey data

David Drodskie, Auckland Transport, for providing CAS data

Simon Gianotti, ACC, for advice on ACC road traffic injury data

Joyce-Anne Raihania, Injury Prevention Network of Aotearoa New Zealand (IPNANZ), for advice on road traffic injuries among Māori

John Wallwork, New Zealand Transport Agency, for advice on use of Driver Licence Registry data

Ministry of Transport, for provision of New Zealand Household Travel Survey data

Koordinates.com and the Local Government Commission of the Department of Internal Affairs, for provision of data on Auckland local board areas

Findings from this research project have also been published in the following journal article: Hosking J, Ameratunga S, Exeter D, Stewart J, Bell A. Ethnic, socioeconomic and geographical inequalities in road traffic injury rates in the Auckland region. Aust NZ J Public Health 2013;37:162-7.

Contents

Executive summary

The objectives of this report were:

1. To describe social and geographical differences in road traffic injury in the Auckland region
2. To enable better targeting of resources for road traffic injury prevention to the communities at highest risk, by providing information that can be distributed by Auckland Transport to road safety stakeholders in the Auckland region

This report provides information on the characteristics of the people involved in crashes, particularly including the area of residence of those injured. This can help identify communities at risk, and complements existing information on the location of road traffic crashes (such as analysis of crash clusters and crash sites). This report focuses on Auckland, so Auckland residents injured outside Auckland were included in analyses, but non-Auckland residents injured in Auckland were not.

Overview of report

The report starts with a brief **literature review**, covering the strategic context and existing road traffic injury data (sections 1.1-1.4) and a brief review of peer-reviewed research published in academic journals relating to social and geographical differences in road traffic injury (section 1.5). This section also includes an assessment of the feasibility of using ACC data to describe road traffic injuries in the Auckland region (section 1.3).

The **methods for statistical and geographical information system (GIS) analysis** are described in detail in section 2.

Section 3 covers the results of the data analysis. **Per capita injury rates** are reported for different socio-demographic groups, calculated by combining road traffic deaths and hospitalisations with census population data, in sections 3.1-3.3. **Injuries per hour travelled** are reported, where data is available, in section 3.3, using New Zealand Household Travel Survey data. Section 3.4 includes **mapping of injury rates for geographical areas** including local board areas and census area units, as well as a brief assessment of the potential for mapping injuries in relation to school location. Section 3.5 compares results from analysis of Crash Analysis System (CAS) data and health sector mortality/hospitalisation data.

A discussion of the implications of the report findings is provided in section 4.

Methods

See section 2 for a full description of project methods.

Data sources

The main focus of this report was health sector hospitalisation and mortality data, which were extracted from the National Minimum Data Set (NMDS) and the Mortality Collection for 2000-8, the most recent years for which full data was available. Census data from Statistics New Zealand was used to provide population denominator data. Analyses were undertaken at four geographic levels: Auckland region, Auckland local boards and census area units, and ‘rest of New Zealand’ (for comparison with Auckland region trends).

Crash Analysis System (CAS) data was also analysed to compare differences between the census area units in which crashes occurred (as measured by CAS) and the census area units in which injured people lived (as measured by health sector data), and to examine differences in serious and fatal injury crashes between these two data sources.

New Zealand Household Travel Survey data was used to calculate road traffic injury rates per hour travelled by different travel modes, where data allowed.

Variables analysed

The focus of the analyses was identifying differences in road traffic injury rates by ethnicity, by area-level socio-economic deprivation, and by geographical area.

Other variables included were the age, gender and travel mode of the injured person, the year of injury, and injury severity (fatal injuries and non-fatal injury hospitalisations).

Statistical analysis

Road traffic injury rates and confidence intervals were calculated per 100,000 people. A regression analysis was undertaken to examine the association of age, gender, ethnicity and deprivation with injury rates.

Geographic information system (GIS) analysis

A GIS was used to map key results by census area unit and local board areas. Geographical data was sourced from Auckland Transport, Auckland Council and koordinates.com.

Key findings for the Auckland region

See section 3 for a full description of project results. This report specifically examines the following age groups: 0-14 years ('children'), 15-24 years ('youth'), 25-64 years ('adults') and 65 years and over ('older adults'). The descriptors associated with each age range ('children', 'youth', 'adults' and 'older adults') are used for convenience to refer to these age ranges in this report, although it is acknowledged that these provide imperfect descriptions of each age group.

Ethnic differences in road traffic injury risk (Figure 1)

- Māori resident in Auckland experience a significantly higher risk of road traffic injury than the 'Other Ethnicity' group[1] at all ages. For example, Māori children experience a 65% higher road traffic injury risk than children in the 'Other Ethnicity' group.
- Pacific children (but not other age groups) experience a 31% higher risk of road traffic injury than the 'Other Ethnicity' group
- While "Asian" children, youth and adults were at lower risk of road traffic injury than the 'Other Ethnicity' group, it is important to note that this is a highly heterogeneous category with potentially varying levels of risk for different communities. Routinely available health system databases are unable to support analyses that investigate if new migrants have different levels of road traffic injury risk compared with people who have resided in New Zealand for longer periods.

Socio-economic differences in road traffic injury risk (Figure 2)

- People living in more socio-economically deprived areas have a significantly higher risk of road traffic injury. There are ten deciles of socio-economic deprivation (using the New

[1] 'Other Ethnicity', in this report, refers to people who did not identify as Māori, Pacific or Asian. It includes NZ European and other ethnic groups.

Zealand Index of Deprivation, NZDep), and for each decile increase in NZDep there is a 3-11% increase in road traffic injury risk.

- The effect of deprivation varies by age group, but is lowest among older adults aged 65 and over (a 3% increase in road traffic injury rates per increase in decile) and highest among adults aged 25-64 years (an 11% increase in road traffic injury rates per increase in decile)

Injuries for different travel mode users

- The number of injuries (per 100,000 people) occurring while using different travel modes was calculated. Travel modes were classified as car/van occupants, pedestrians, cyclists, motorcyclists and all other modes.
- As this analysis could not take into account risk per hour or kilometre travelled, the differences between groups may be at least partly due to different amounts of travel by each travel mode.
- Among Māori, the number of car/van occupant injuries, pedestrian injuries and 'other mode' injuries[2] per capita was higher than the 'Other Ethnicity' group. The number of motorcyclist injuries per capita was lower among Māori than the 'Other Ethnicity' group
- Among Pacific populations, the number of car/van occupant injuries and pedestrian injuries per capita was higher than the 'Other Ethnicity' group. The number of cyclist injuries and motorcyclist injuries per capita was lower among Pacific populations than the 'Other Ethnicity' group
- Among Asian populations, the number of car/van occupant injuries, cyclist injuries and motorcyclist injuries per capita was lower than the 'Other Ethnicity' group
- Increasing socio-economic deprivation at the area level was associated with increases in the number of car/van occupant injuries and pedestrian injuries per capita, but was not associated with cyclist or motorcyclist injuries per capita

Geographical differences (Figure 3)

- Road traffic injury rates vary widely between different census area units in the Auckland region. Due to the relatively low number of injuries occurring in each census area unit, there is substantial uncertainty around estimated rates at this level
- Local boards in the Urban South road safety action plan area, with the exception of the Howick Local Board area, have particularly high road traffic injury rates
- In general, road traffic injury rates appear higher for residents of rural areas than for residents of urban areas, similar to the rural-urban differences seen in Crash Analysis System (CAS) data on crash location

Data quality

- The proportion of records with missing ethnicity data, and to a lesser extent age data, is much higher in CAS data than in health sector data, suggesting that it is preferable to use health sector data in the analysis and monitoring of ethnic differences in road traffic injuries
- CAS data provides useful information on the level of socio-economic deprivation in the area in which crashes occur, while health sector data provides useful information about socio-economic deprivation in the area of residence of injured people

[2] In this analysis, 'other modes' were modes that did not fall under the categories of 'car/van occupants', 'pedestrians', 'cyclists' or 'motorcyclists'

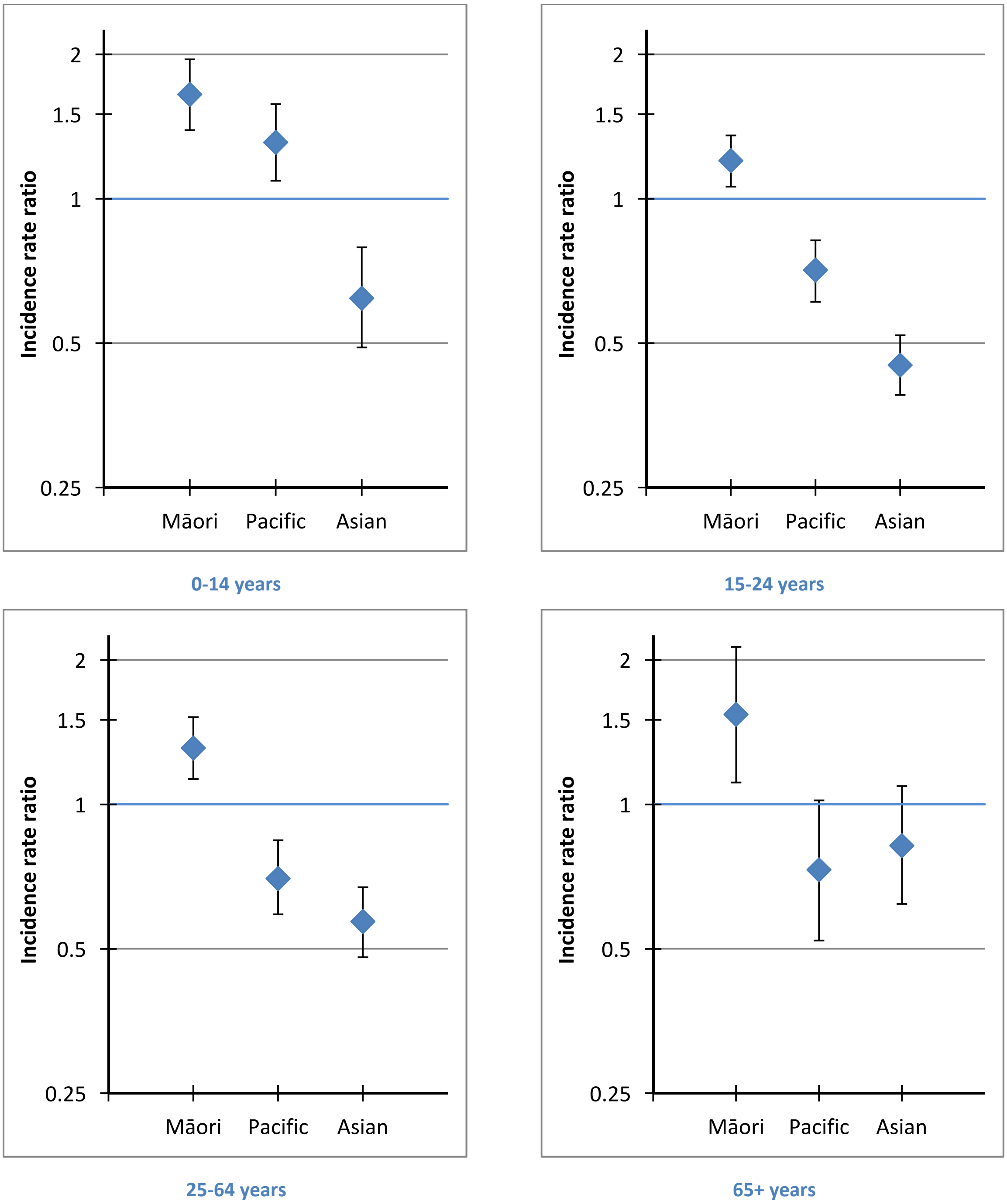

Figure 1: Effect of ethnicity on road traffic injury deaths and hospitalisations, 2000-8, Auckland region, by age group, adjusted for gender and deprivation (using National Minimum Data Set and Mortality Collection data).

Note: vertical axis uses log scale. Values less than one indicate a lower injury rate, and values greater than one a higher injury rate, compared with the NZ European/Other ethnicity group.

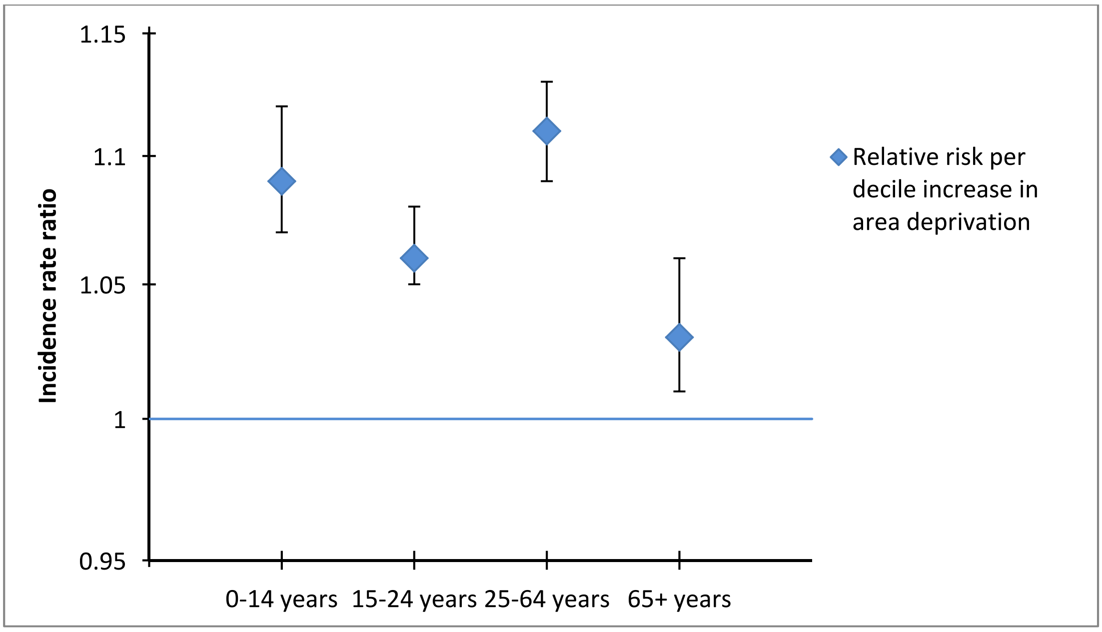

Figure 2: Effect of socio-economic deprivation on road traffic injury deaths and hospitalisations, 2000-8, Auckland region, by age group, adjusted for gender and ethnicity (using National Minimum Data Set and Mortality Collection data)

Note: vertical axis uses log scale.

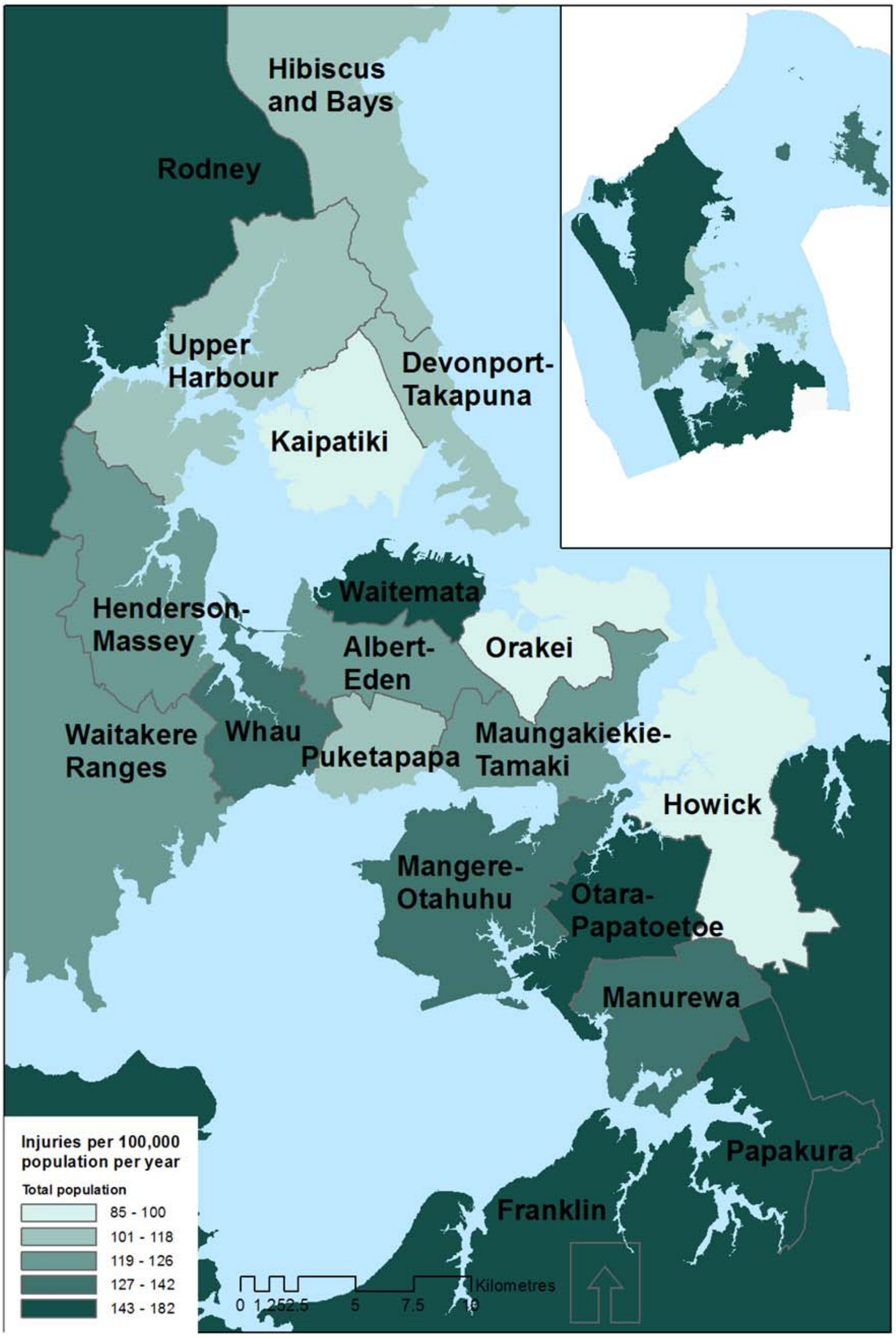

Figure 3: Road traffic injury deaths and hospitalisations by area of residence, local board level, Auckland region, 2000-8 (using National Minimum Data Set and Mortality Collection data)

Recommendations

In summary, this report has provided important new findings for the Auckland region. It has shown that injury rates are higher among Māori at all ages, among Pacific children, and among people living in more socio-economically deprived neighbourhoods. This report also investigated geographical differences in road traffic injury rates. Although smaller differences between geographical areas may be related to 'random' year to year fluctuations, larger geographical differences are likely to represent real differences in injury risk. This report has found that local board areas in the southern Auckland urban area (with the exception of Howick) have among the highest road traffic injury rates in the region. Rural areas also have elevated road traffic injury rates. Based on these findings, recommendations are presented below.

Priority groups for road traffic injury prevention

1. **Ethnic and socio-economic differences in road traffic injury rates in the Auckland region need to be monitored using health sector data**. This monitoring should take into how these differences are influenced by age and travel mode.
2. **Road traffic injury prevention efforts need to prioritise Māori, Pacific children, and people living in socio-economically deprived areas**, groups identified in this report as populations that are especially vulnerable to road traffic injury in the Auckland region.
3. **Areas with high levels of socio-economic deprivation, or with high proportions of Māori, or Pacific children, need to be prioritised** when implementing interventions to improve the safety of the travel environment, as people living in these areas are more likely to be involved in injury crashes.
4. **Efforts to reduce road traffic injury risk in vulnerable populations should emphasise interventions supported by strong evidence**, such as residential traffic calming/speed reduction measures and programmes to increase child restraint and seat belt use.
5. **Educational interventions for preventing road traffic injuries need to be designed to meet the needs of Māori and Pacific populations, and of people living in socio-economically deprived areas**.
6. **Where possible, interventions to reduce road traffic injury risk would benefit from integration with existing strategies**; for example, efforts to reduce road traffic injury risk for Māori could be integrated with the Whānau Ora programme, in discussion with the lead agency, Te Puni Kōkiri.
7. **Road safety interventions at school level could be prioritised, particularly focusing on socio-economically deprived schools with high proportions of Māori and Pacific children.**
8. **Current road safety efforts could usefully be reviewed to identify the extent to which they meet the needs of Māori, Pacific children and socio-economically deprived areas.**
9. **Particular attention needs to be given to providing safer environments for walking and cycling,** given the promotion of travel by these modes due to the co-benefits for health and climate change.

Data sources

10. **Health sector data and Crash Analysis System (CAS) data can be used in conjunction to monitor road traffic injuries in the Auckland region**, as health sector data provide valuable additional information on area of residence, neighbourhood socio-economic deprivation, and more reliable data on the ethnicity of injured people.
11. **The completeness and quality of CAS ethnicity data needs to be improved, especially for serious and fatal injuries,** as reliable data are needed to monitor ethnic differences in road traffic injury risk.

12. **Discussions are needed with the Ministry of Transport to identify opportunities for improving New Zealand Household Travel Survey data for the Auckland region** to provide better data on ethnicity, socio-economic deprivation, cycling and motorcycling.
13. **Road safety interventions at school level could be prioritised by using both CAS and health sector road traffic injury data, and could prioritise socio-economically deprived schools with high proportions of Māori and Pacific children.**
14. **ACC data for the Auckland region could be used to complement CAS and health sector data**, as ACC data provide useful information on health and disability support services costs. ACC data also provide information on injuries that may carry a lesser risk of death but a potentially important risk of longer-term disability. However, ACC data cannot currently be used to reliably measure ethnic differences in the incidence of injury.
15. **Driver licence register data may provide useful indicators of driver risk by geographical area**, an aspect requiring discussions with the New Zealand Transport Agency.
16. **Much could be gained from undertaking analyses of record-linked databases,** such as already being undertaken with the linkage of CAS and ACC databases.

1. Background

Injury is a major cause of disease burden in New Zealand, including deaths and hospitalisations as well as injuries that may be disabling, even if they are not life-threatening. There are known to be socio-demographic and geographical differences in injury burden in New Zealand, in a range of settings. For example, road traffic injury mortality rates for Māori among 1-74 year olds are higher than among non-Maori. Similarly, income is associated with road traffic injury mortality, with people on lower incomes having a higher risk of road traffic injury.[1]

However, despite the existence of national-level analyses, data specific to the Auckland region are more sparse. The national Crash Analysis System (CAS) is the primary transport tool for identifying where road injury occurs on Auckland's roading network, but it is limited by under-reporting issues, and the lack of information on the social identity of the individuals injured. Previous work on cyclist injuries found that for every cyclist injury recorded in CAS, an additional 0.92 cyclist injuries were recorded in St John's ambulance or ACC databases (but not in CAS).[2] CAS is also not fully integrated with other national road injury recording tools. This hampers the ability to target resources to those communities where the road traffic injury burden is greatest. Health sector data sets, such as the National Minimum Data Set (for hospital discharges) and the Mortality Collection (for deaths), provide robust information on ethnicity, as well as the residential location of injured people, allowing neighbourhood deprivation to be calculated. As such, these data sets enable the collection of additional information on the social identity of injured individuals, helping to identify vulnerable road user groups. This report uses health sector data to complement CAS data, with the goal of providing a more complete picture of road traffic injuries in the Auckland region. The most important information that is added by this health sector data is information on where injured individuals live, rather than where crashes occur, and the social identity of injured individuals. Understanding the social and residential characteristics of injured people can assist with prioritising interventions for particular social groups and residential areas that are shown to be at high risk.

This section reviews the strategic context for road traffic injury control in Auckland, existing data on road traffic injuries, and peer-reviewed research on the effects of social and geographical factors.

1.1 Strategic context

Improving transport system safety is one of the objectives of the Auckland Regional Land Transport Strategy 2010-2040. This strategy sets a specific target of having no more than 55 road deaths per year by 2020, and no more than 40 road deaths per year by 2040. Targets for serious injury were 418 by 2020 and 288 by 2040.[3] Similarly, the Auckland Plan sets a target of a 20% reduction in the number of child hospitalisations due to injury by 2025.[4] Although this target includes non-traffic injuries, road traffic injury is the leading cause of injury deaths among children.

The national Safer Journeys to 2020 Road Safety Strategy emphasises the need to create a safe system that reduces fatal and serious road injuries in the high-risk areas of alcohol/drugged driving, young drivers, motorcycling and speed-related crashes.[5] In addition to this, Auckland has been identified by NZ Transport Agency as requiring additional high-risk focus on reductions in fatal and serious road injuries for pedestrians and cyclists.[6]

Creating a safe Auckland transport system is a complex task that involves a combination of proven and cost-effective engineering, enforcement, education, legislative and planning measures across the safe system areas of safe roads & roadsides, safe speeds, safe vehicles and safe road users. Part of this challenge includes identifying the social make-up of those geographic communities within Auckland that are at higher risk of being involved in road trauma and developing targeted road safety interventions that are appropriate for these communities. Improving the health of vulnerable populations is a priority in both the New Zealand Health Strategy and the New Zealand Injury Prevention Strategy.

This gap in information was identified during planning for the 2010 Auckland Regional Land Transport Strategy (RLTS). Information on the presence and size of social and geographical differences in road traffic injury in the Auckland region will help to inform Auckland's Integrated Transport Plan and maximise its ability to target high-need populations, leading to reduced injury rates in high-need populations, and reduced social inequalities in injury.

The objectives of this project were also identified in the Auckland Regional Road Safety Plan 2009/12 as a task for completion between 2009/12, and the recent 2011 revision of the Auckland Regional Road Safety Plan by Auckland Transport continues to include this work as a key research task.

Drawing together information from different road traffic crash and injury databases can provide valuable strategic information at a regional and local level that allows Auckland road safety stakeholders to allocate appropriate prevention resources to the sub-populations with the greatest crash risk in the region. Providing information on the residential location of injured people can complement CAS data on crash location, and this may help with the integration of engineering and community transport perspectives. Related funding decisions for local and regional project delivery can over time help Auckland achieve a reduction in fatal and serious road injuries in the following priority road user areas: Pedestrian safety, Cycle safety, School safety, Alcohol/drugged driving safety, Young driver safety, Motorcycle safety, Restraints and Older road user safety.

1.2 Existing data on road traffic injuries in the Auckland region

Both fatal and non-fatal injuries and crashes are monitored in the Auckland region. The Auckland Regional Road Safety Plan 2009/12 collates crash data collected by the New Zealand Police and provided by the New Zealand Transport Agency (through the Crash Analysis System, CAS), as well as hospitalisation data provided by the Ministry of Transport.[7]

The annual number of road traffic deaths in the Auckland region, as measured by CAS, has decreased from 97 in 1998 to 51 in 2011. The number of serious injuries has shown less change, with 489 serious injuries in 1998 and 398 in 2011, while the number of minor injuries has risen from 2812 in 1998 to 3328 in 2011.[3]

The Auckland region population increased during this period, from 1.1 million in 1998 to nearly 1.5 million in 2011. Thus, although the total number of road traffic injuries (fatal and non-fatal) increased during this period, the number of injuries per capita decreased from 1998 to 2011.

From 2001 onwards, total casualties (fatal plus serious and minor injuries) per 100 million vehicle kilometres travelled (VKT) were also monitored, and decreased from a high of 38 in 2003 to a low of

[3] Figures in this section are taken from unpublished analysis by Auckland Transport using current Auckland Council boundaries

30.5 in 2011. The number of fatal or serious injuries per 100 million VKT declined from a high of 6.8 in 2002 to 3.6 in 2011.

The total number of deaths and hospitalisations of more than one day has reduced from 1077 in 1998 to 792 in 2011, as have per capita rates, from 9.5 per 10,000 in 1998 to 5.3 per 10,000 in 2011. When measured per 100 million VKT, the rate of deaths and hospitalisations of more than one day reached a high of 8.4 in 2006 and reduced to 6.4 in 2011.

Among pedestrians, in 1998 there were 24 deaths and 312 injuries, compared with 12 deaths and 341 casualties in 2011. Among cyclists, there were only 3 deaths but 135 injuries in 1998, compared with no deaths and 228 injuries in 2011. There were 14 deaths among motorcyclists in 1998, and 211 injuries, while in 2011 there were 7 deaths and 345 injuries.

New Zealand Transport Agency (NZTA) briefing notes for the Auckland region analyse crashes and injuries for each of six road safety areas, as well as for the region as a whole. The Auckland region has been divided into six Road Safety Action Plan areas. Two of these are rural (Rural North and Rural South) and four are urban (Urban North, Urban West, Urban Central and Urban South). The NZTA briefing notes identify the Rural South road safety area as having above average crash risk for many indicators. Cyclists and pedestrians are at high risk in all of the urban road safety areas, and motorcyclists are at high risk in the Urban Central area within Auckland.[6]

An additional NZTA document, the Communities At Risk Register, attempts to identify the local authorities with the highest risk of different crash types.[8] It ranks local authorities (including the six Auckland Road Safety Action Plan areas) by the number of injuries per amount of travel (measured either by million vehicle kilometres travelled, or million hours travelled). CAS data on the number of fatal or serious crashes are combined with New Zealand Household Travel Survey data on the amount of travel. The local authorities with the highest risk per amount of travel are identified as communities that may warrant strategic targeting of resources. As well as overall numbers of fatal and serious crashes, crash subgroups are also analysed, such as high-risk age groups, high-risk travel modes, crashes at intersections, alcohol- and speed-related crashes, and others. This analysis may help NZTA identify local authorities at highest risk, and may also help local authorities identify high-risk crash types within their communities. One drawback is the potential for communities (especially local authorities with smaller populations) to have high recorded crash rates due to random variation, rather than due to a high underlying crash risk. Travel survey estimates are also likely to be more variable in local authorities with smaller populations.

A report from the Auckland Regional Public Health Service calculated motor vehicle-related hospitalisations for the Auckland region, using geographic information system (GIS) techniques to map per capita hospitalisation rates for different census area units within Auckland, combining events from 2001 to 2004. The report found that motor vehicle-related hospitalisations had increased from 1997 to 2004. It also calculated rates for each of the seven territorial authorities within the region, finding the highest road traffic injury rates per capita in Rodney and Franklin districts.

The NZTA has published or drafted guides in several priority areas, which provide data on these areas as well as methods for assessing the risk of road traffic injuries. For example, the NZTA high-risk rural road guide provides guidance on identifying high-risk rural roads. Relevant factors include crash rates, collective risk and the presence of certain road infrastructure features. Risk may be measured either per kilometre of road or per vehicle kilometre travelled on the road. The guide provides methods for calculating crash risk, including the KiwiRAP Road Protection Score, the KiwiRAP star rating, the Road Infrastructure Safety Assessment (RISA) and the Road Asset Maintenance Management database. All of these methods focus on the characteristics of roads rather than on the socio-demographic characteristics of road users.[5]

A motorcycle guide is also being produced by NZTA, in order to improve motorcycling safety. High-risk motorcycle routes can be identified; these are roads with higher than average motorcycle crash rates. Targeting these high-risk routes may be an effective and cost-effective strategy for reducing crash risk. In addition, favoured motorcycle routes may be useful targets for reducing crash risk, as even if the crash risk per motorcyclist is not high, the high number of motorcyclists using these routes may mean that the absolute number of crashes is high.

A high-risk intersection guide is also being produced by the NZTA. High-risk intersections are those associated with higher crash risk, usually measured using serious and fatal crashes. Different methods exist for identifying high-risk intersections, including intersection crash history, risk prediction models (available for only a small subset of intersections). Crash rates may be calculated either by the number of crashes per unit time, or the number of crashes per vehicle movement per unit time. Crash prediction models such as KiwiRAP and RISA (used for rural roads) are not currently available for intersections, but could be developed in future. A level of safety service (LoSS) method can also be used for some intersections, which involves comparing the observed number of crashes to the number of crashes predicted by the 'flow only' crash prediction models in the NZTA Economic Evaluation Manual.

The New Zealand Injury Prevention Strategy (NZIPS) monitors national trends for different injury types, including road traffic injuries. As well as fatal injuries, NZIPS defines 'serious injuries' as those with a 6% or higher risk of mortality.[9] This is based on the International Classification of Disease (ICD)-based Injury Severity Score (ICISS) method.[10] However, results are not routinely produced for the Auckland region.

1.3 Road traffic injury data held by ACC

The Accident Compensation Corporation (ACC) has data on claims for different injury causes, including road traffic injuries. ACC publishes some statistics on road traffic injuries in the Auckland region, and its website shows that there were 76 new claims for fatal road traffic injuries in the Auckland region during the period from 1 July 2007 to 30 June 2008. The total number of new entitlement claims for road traffic injuries in the Auckland region during this period, including non-fatal injuries, was 1,505.[11] Entitlement claims are claims that include not only payments for medical fees but also additional payments such as weekly compensation.[12]

The ACC website also provides a tool for injury statistics that can report results by region. However, it also notes that the data this tool provides are approximate, and recommends that if data is required for research or analysis purposes, ACC should be contacted directly.[13]

Claims data held by ACC have several useful features. First, the relevant databases are updated monthly, so very recent information is available. Second, it can be used to calculate the actual cost of each injury to ACC. Third, because ACC data includes a medical diagnosis, it includes a good measure of injury severity. This stands in contrast to traffic crash reports, where police are required to judge injury severity.

There are several different ACC accounts that a road traffic injury can be classified under. The motor vehicle account includes injuries involving a motor vehicle (such as a cyclist injured in a collision with a motor vehicle). Injuries not involving a motor vehicle (such as a cyclist injured in a collision with a roadside object) are recorded either in the earner account or the non-earner account.

Stephenson et al investigated whether ACC or Ministry of Health (National Minimum Data Set and Mortality Collection) data sets were the most desirable to use as the basis for injury indicators. In doing so, they identified several disadvantages of ACC claims data. First, ACC entitlement claims tend to emphasise earners. Also, the codes used by ACC to describe the circumstances of injury are less detailed than the ICD codes used in the Ministry of Health data sets (although linking to Ministry of Health data sets is possible). Finally, the ICD codes used in the NMDS and Mortality Collection are also used by many other countries, facilitating international comparisons.[14] However, these disadvantages to using ACC data as the sole source of information may be at least partially mitigated by also using other data sources, such as CAS or Ministry of Health data sets.

A further issue affecting ACC data is access barriers. Barriers to accessing services for a particular group may lead to fewer ACC claims in that group relative to the number of injuries. For example, ACC data shows that treatment injury claim rates for Māori are less than half rates for non-Māori. Entitlement claim rates for Māori are 25% lower than for non-Māori, but serious injury claims are higher among Māori.[15] This suggests that Māori are proportionally less likely to make ACC claims for less serious injuries. Barriers to accessing ACC services have also been identified for Asian populations in New Zealand, and may explain low rates of ACC claims in Asian populations.[16]

ACC provides regular reports on claims data to government agencies including the Ministry of Transport and New Zealand Police. It would be possible, in principle, for ACC to provide reports to Auckland Transport in the same way on road traffic injury claims. Such a request could be explored through communication with the ACC Auckland office. ACC data is also commonly used by researchers. According to ACC research ethics guidelines, external data requests, except in the case of summary data, must be approved by the ACC Research Ethics Committee.[17]

ACC has undertaken a process of linking its road traffic injury claims data to other data sets such as CAS. A high proportion of injuries recorded in CAS data are able to be linked to ACC claims data. This linkage and analysis is undertaken regularly. Results suggest that a substantial proportion of 'serious injury' crashes, as recorded by CAS, are linked to medical fee claims only, and not entitlement claims. This suggests that in such cases the injury may not have been serious. Conversely, a small but significant proportion of CAS-reported 'minor injury' crashes can be linked to ACC entitlement claims, suggesting that in such cases the injury was serious. ACC also has other projects that link claims data to hospitalisation data, which may be rolled out more widely in future, but at present this work does not cover the entire Auckland region.

1.4 Other sources of road traffic injury and crash data

As well as NZ Police, the Ministry of Health and ACC, other organisations collect data relevant to road traffic injuries and crashes.

The Department of Labour is notified of occupational incidents causing serious harm, including employees suffering road traffic injuries. However, although this information is stored, it is not in a form that is readily accessible for analysis.

The Driver Licence Register, maintained by the New Zealand Transport Agency, contains data collected during the driver licensing process. While this register does not provide crash data, it may be able to provide data on risk factors for crashes such as speed infringements. Data on individual residence may also be able to be used to describe geographical patterns of risk. New Zealand Transport Agency analysts have indicated that although providing information to aid in profiling Auckland crash risk is technically feasible, it would require significant staff time, and thus would require a formal request from Auckland Transport.

Data on vehicle ownership may also be used to identify risk factors for crashes, as vehicle choice may be associated with risk-taking behaviour. In addition, some vehicle models are more likely to be driven by high-risk drivers. Thus, vehicle registration data could be used to identify some crash risk factors, and may also be able to identify the geographical distribution of these risk factors if data on residential location is available.

1.5 Research on social and geographical factors

This section briefly reviews peer-reviewed research on the effect of social and geographical factors on road traffic injuries, focusing on articles published in academic journals.

Literature review methods

MEDLINE was searched using terms for ethnic and socio-economic characteristics, geographical and spatial characteristics, and road traffic injuries. Due to the large number of citations returned by the search, search results were further restricted in three separate ways: a) restricted to New Zealand studies using search terms for New Zealand; b) restricted to review papers; c) restricted to the most recent studies, from 2008 onwards. Citations from each of these three groups were reviewed to identify original research or reviews relating to ethnic or socio-economic differences in road traffic injury, or to differences in road traffic injury by residential location. Additional studies were drawn on for context where necessary.

The New Zealand context

There is limited Auckland-specific information on social and geographical differences in road traffic injury. To date, the only Auckland-specific evidence identified in this review was a report from the Auckland Regional Public Health Service. This report found that between 2000 and 2004, hospitalisation rates per capita for road traffic injuries were higher among Māori than European and Pacific populations, with rates for the Asian population lowest of all.[18]

Nationally, Māori have poorer health status on a number of different dimensions, including road traffic injury. The New Zealand Census Mortality Study (NZCMS) found higher road traffic injury mortality rates among Māori, compared with the ‘European/Other’ population, among 1-74 year olds in New Zealand.[1] The overall burden of injury has been estimated to be approximately 50% higher in the Māori population, compared with non-Māori, non-Pacific populations, with road traffic injury the fourth highest cause of disease burden in Māori males.[18] Among children, road traffic injury hospitalisations from 2003-2007 were significantly higher for Māori compared with European, but lower for Pacific and Asian children. This pattern was largely the same for the subgroup of vehicle occupant injuries. Compared with European children, Pacific children were at higher risk of pedestrian injuries, but at lower risk of cyclist injuries. Māori children were at higher risk for all of these road user subgroups.[19] A study in 1996 found that Māori and Pacific children crossed more roads on average than children of other ethnicities.[20]

The NZCMS also showed that income was associated with road traffic injury mortality, with people on lower incomes having a higher risk of road traffic injury. This pattern was more consistent among men than women.[1] The same pattern was seen in a specific analysis for New Zealand children, which found that road traffic injury risk was 36% higher for children living in low-income compared with high-income households.[21] Children living in more deprived communities have been shown to have higher road traffic injury hospitalisation rates.[19] Studies in 1994 and 1996 found that children living in lower-income households tended to cross more roads, a potential contributor to high injury rates.[20, 22] A New Zealand cohort study found that lower socio-economic status was associated with higher road traffic injury rates according to some measures of socio-economic status (educational level and occupational status) but not others (neighbourhood income).[23]

International research – socio-economic status

Several reviews of the burden of road traffic injury note that within countries, groups with lower socio-economic status tend to bear a disproportionate share of the road traffic injury burden.[24-26] Evidence for this pattern comes from a range of different countries.

Socio-economic status can be measured at the area level or at the individual or household level. Both were independently associated with road traffic injury rates in a Norwegian study.[27] There is some variation between studies, with one Swedish study finding no effect of socio-economic status at area or individual level once other factors were taken into account,[28] whereas other Swedish studies have found socio-economic status (as measured by occupation) to have strong effects on road traffic injuries among young people.[29, 30]

Disadvantaged neighbourhoods had higher road traffic injury rates in a French study.[31] Another French study investigated risk per distance travelled by each mode, and found that young males living in deprived areas (compared with non-deprived areas) had higher injury risks per km travelled by car or motorcycle, but patterns for other modes and for females were inconsistent.[32] One study in Great Britain suggested that the factors responsible for socio-economic differences in child pedestrian injury were often context-specific, but included differences in availability of safe play areas, higher crime rates, traffic flow, traffic speed and access to health care services.[33]

A study in Chicago, USA found that disadvantaged neighbourhoods (those with high proportions of low-income and ethnic minority populations) had higher rates of road traffic crashes. In general, environmental factors (such as traffic characteristics) tended to explain differences in crash rates, while social characteristics of residents (e.g. income) tended to explain differences in per capita injury rates. Transit accessibility and pedestrian accessibility were higher in disadvantaged neighbourhoods, and were associated with more crashes, suggesting that transit and walking infrastructure needed to be accompanied by pedestrian safety improvements to avoid increasing crash rates.[34] However, the extent to which these findings are applicable to other contexts is dependent on the distribution of relevant factors (in this case transit accessibility and pedestrian accessibility), which may be different in other contexts. Another study in the USA found that area-level income was a strong predictor of pedestrian injuries within a neighbourhood.[35]

International research – ethnicity

As acknowledged by the World Report on Road Traffic Injury Prevention, ethnic minorities often experience a disproportionate burden from motor vehicle crashes.[26] In the USA, surveillance data indicates that road traffic injury rates among different ethnic groups were highest for the American Indian/Alaskan Native group, and lowest for the Asian/Pacific Islander group.[36] Another study in the USA found that black motorcyclists had higher mortality rates after crashes, despite higher levels of helmet use, suggesting that access to care or quality of care could influence mortality rates for this group.[37] In Australia, Indigenous populations have higher road traffic injury mortality rates, primarily due to elevated rates for infants and for adults aged 30-59 years.[38] A study in London, United Kingdom found that the black population had the highest road traffic injury rates, followed by the white population, with the lowest rates among the Asian population. These effects were independent of deprivation.[39] Another study in London found that while road traffic injury rates were declining, the decline for car occupants was greater in the white population than the black and Asian populations.[40] A Swedish study found that country of origin did not predict road traffic injuries, but socio-economic status (as measured by occupation) was a strong predictor.[29]

In summary, ethnic minority populations in many countries have higher road traffic injury rates than the majority population. However, there are exceptions to this rule. In particular, Asian populations in some countries have lower road traffic injury rates than other groups.

International research – geographical factors

Geographical analysis is often used to investigate patterns of road traffic crash locations.[41-43] As there is no clear population denominator for crash locations (since the people involved in crashes do not necessarily live locally), crash location data is not generally analysed as a rate per capita. However, crash locations can be analysed per kilometre of road, or per vehicle kilometre travelled on that road.[44] Also, crash data can be overlaid on maps of local population characteristics. Statter et al (2011) overlaid injury clusters on maps of small areas showing the proportion of African-American families, average income and the proportion of children in the local population.[45]

Road segments can be analysed to identify differences in injury rates for different road types. This approach was used to evaluate the effect of 20 mph zones (30 km/h zones) in London, finding that this road treatment reduced injuries by over 40%.[46]

A potential use of geographical analysis is to identify small areas in which high injury rates per capita occur.[47] Geographic analysis of large areas is also undertaken, such as mapping road traffic injury rates for Chinese,[48] Nigerian[49], Italian[50] or Turkish[51] provinces. For these large areas, the area in which the crash occurs is likely to be the same as the area in which the victims live for almost all cases. In analyses using smaller geographical areas, crashes are more likely to occur outside the victims' residential areas.

Geographical analysis can help identify the effect of area-level factors such as increased residential density, which is associated with lower injury rates.[52] A range of advanced modelling techniques exist that allow mapped injury rates to be adjusted to account for the influence of known risk factors such as age, sex and socio-economic status,[52] and allow mapping where the number of injuries per area is low.[53]

Analysis of crash or residential location can also be useful for investigating urban/rural differences in road traffic injuries and mortality. A study in the USA found that higher rural mortality rates from road traffic injuries were mainly due to an increased risk of death for injured people in rural areas.[54] An Australian study, which also found higher injury rates among rural residence for young drivers, suggested that the difference was due to higher speeds, fatigue, alcohol and failure to wear seat belts.[55]

2. Methods

This section describes the methods used to analyse health sector data, census data, travel survey data and Crash Analysis System (CAS) data. It also describes the methods used for Geographic Information System (GIS) analysis.

2.1 Hospitalisation and mortality data

Hospitalisation and mortality data were extracted from the National Minimum Data Set (NMDS) and the Mortality Collection for 2000-8. At the time of analysis, 2008 was the most recent mortality data available. Deaths were excluded from hospitalisation data to avoid double counting between hospitalisation and mortality data.

Hospitalisations were included if road traffic injury was the principal diagnosis. Hospital readmissions and day cases (where discharge was on the same day as admission) were excluded, as recommended by Langley et al.[56]

Data were analysed by region (Auckland compared with the rest of NZ), year, severity (fatal injuries compared with hospitalisations), age group, sex, ethnic group (including Māori, Pacific, Indian, Chinese, Other Asian and Other).

ICD-10 codes were used to identify events in which road traffic injury was the primary diagnosis, using the definition provided by the Centers for Disease Control and Prevention (CDC).[57] This definition also provided a method of classifying ICD-10 codes by the travel mode of the injured person. Travel modes were grouped, using this method, into car/van occupants, pedestrians, cyclists, motorcyclists and other modes. According to ICD-10, scooter and skateboard injuries are classified under the category of pedestrian injuries. Injuries to occupants of passenger vans and utility vehicles are included in the category 'car/van occupants'. A specific ICD code exists for injuries to occupants of passenger vans. In contrast, utility vehicles do not have a separate ICD code, and are combined with 4-6 wheeled vehicles for carrying goods (including utes, vans and pickup trucks) that do not require a special driver's licence.

Domicile codes for NMDS and Mortality Collection data were mapped to census area units (CAUs) using tables provided by the Ministry of Health.[58] During the study period of 2000-8, two censuses occurred (2001 and 2006), at each of which some CAUs underwent boundary changes, such as splitting into two or more CAUs, or merging with other CAUs. In the NMDS and Mortality Collection, these boundary changes from 2001 and 2006 were implemented from 1 July 2003 and 1 July 2008 onwards, respectively. A CAU boundary change makes it difficult to combine injuries occurring before with those occurring after the change, as there is no consistent boundary. To address this issue, for the CAU-level analysis we excluded all injuries occurring after 30 June 2008, thus removing the effect of boundary changes at the 2006 census. For CAUs that underwent a boundary change in

2001 (implemented in the NMDS and mortality collection from 1 July 2003 onwards), we calculated injury rates for the period 1 July 2003 to 30 June 2008 only. This affected 35 of the 359 CAUs according to 2001 boundaries. For CAUs that did not undergo a boundary change, we calculated injury rates for the longer period 1 January 2000 to 30 June 2008.

A small number of domicile codes are linked to district health board (DHB) or old area health board (AHB) boundaries, rather than to a CAU. Events with these domicile codes were excluded from CAU-level analyses, but were included in analyses at the level of the Auckland region (in the case of Auckland DHBs or AHBs). Overseas residents were excluded from the analysis.

CAUs were mapped to current Auckland Council local boards, using Statistics NZ definitions where possible. CAUs that could not be mapped using Statistics NZ data (e.g. due to parts of a CAU being in more than one local board) were analysed using a GIS, and the CAU was assigned to the local board that contained the largest proportion of the CAU area. Local board status was used to determine the road safety action plan area for each CAU (Rural North, Rural South, Urban North, Urban West, Urban Central or Urban South).

For the purposes of this analysis, Auckland regional boundaries were defined at CAU level, using the 2006 Statistics NZ classification. The current Auckland regional boundary intersects several CAUs. Since 2006, two of these CAUs (Buckland and South Waiuku) have been reclassified by Statistics NZ and are now considered to be inside the Auckland region. In order to match 2006 census data (which was used to calculate population denominators in this report) these CAUs were both classified according to their 2006 status (outside the Auckland region) for the purposes of this analysis.

NZDep scores (calculated at CAU level) were assigned to each CAU using University of Otago data.[59] An injury event occurring in a given year was assigned the NZDep score from the most recent census for the CAU in which the injured person lived.

Age was grouped as follows: 0-14 years (child), 15-24 years (youth), 25-64 years (adult) and 65 years and over (older adults). The descriptors associated with each age range (child, youth, adult and older adults) are used for convenience to refer to these age ranges in this report, although it is acknowledged that these provide imperfect descriptions of each age group.

Ethnicity data were extracted from mortality and hospitalisation data sets, and were classified by the following categories: Māori, Pacific Peoples, Indian, Chinese, Other Asian, Other Ethnicity. Where numerator or denominator numbers were too small to analyse separately by Indian, Chinese and Other Asian groups, these were combined into the category 'Total Asian'.

2.2 Crash Analysis System (CAS) data

Data on crash location and date, demographic details and crash severity were extracted from the CAS database for 1999-2008. A GIS was used to map crash location to 2006 census area units, as this was the most recent census during the study period. The Auckland region definition described above for health sector data was also applied to GIS data to determine whether crashes occurred within the Auckland region.

2.3 Census data

Data for the Auckland population for 1996, 2001 and 2006 censuses was provided by Statistics NZ. Population data was provided by age category, gender, ethnicity and NZDep2006 deciles. Ethnicity data was prioritised (to match the ethnicity classification used by the Ministry of Health) by the following categories: Māori, Pacific Peoples, Indian, Chinese, Other Asian and Other Ethnicity.

For non-census years, populations were calculated by linear interpolation (between 1996 and 2001, and between 2001 and 2006) or by linear extrapolation for years 2007 and 2008 (based on the gradient from 2001 to 2006). Total person years for the years 2000-2008 were calculated by summing populations for each of these nine years.

For the CAU-level analysis, it was not possible to interpolate or extrapolate population data due to boundary changes in some CAUs. Instead, for consistency with the numerator data sets (NMDS and mortality collection), 1996 census populations were used from January 2000 to June 2003, and 2001 census populations were used from July 2003 to June 2008. In fast-growing CAUs, this may lead to some underestimation of the population, and thus overestimation of injury rates.

2.4 Household Travel Survey data

New Zealand Household Travel Survey data was provided by the Ministry of Transport. Years 2-6 of the survey (July 2003 – June 2009) were analysed, as these years most closely corresponded to the data range for injury data; year 1 pilot data was not used.

Duration (hours) of travel per person by each mode was calculated for the Auckland region for the ethnic and age subgroups described above in order to determine the feasibility of a regression analysis using this data. Analyses published by the Ministry of Transport were also used to calculate the number of injuries per unit of travel.

2.5 Statistical analysis

Data were analysed using SAS 9.2 (SAS Institute, Cary, NC). 95% confidence intervals were calculated for road traffic injury rates using the adjusted Wald method.[60] The association of age, gender, ethnicity and deprivation with injury rates was examined using Poisson regression**,** with the number of injuries in each age, gender, ethnicity and deprivation sub-category as the outcome and the log of its population included as an offset. Overdispersion was adjusted for using the deviance scale parameter.

The potential for a regression analysis incorporating amount of travel by different modes was investigated, using travel data from the New Zealand Household Travel Survey. However, examination of survey data revealed that there were insufficient survey respondents in the Auckland region to provide valid estimates of amount of travel by age, ethnicity or deprivation. Accordingly, this analysis was not attempted. Instead, estimates of travel time by mode published by the Ministry of Transport were used to calculate injury risk per time travelled by each mode.

2.6 GIS analysis

ArcGIS 10 (Redlands, CA: Environmental Systems Research Institute) was used for geographical mapping of selected results. Shapefiles containing census area unit boundaries for 2001 and 2006, and Auckland local board boundaries as at July 2010, were obtained from koordinates.com, and were based on data from the Local Government Commission of the Department of Internal Affairs. A shapefile for current Auckland region boundaries was provided by Auckland Transport. CAS data were mapped using 2006 census area unit boundaries, while NMDS and mortality collection data was mapped using 2001 boundaries (see section 2.1).

Thematic maps of numbers or rates of road traffic injury deaths or hospitalisations in Auckland census area units were created, using shading to denote quintiles. Where there were no injuries in an area, or no population counts for a specific population subgroup, these were represented with specific shading.

3. Results

3.1 Time trends

Rates of fatal injuries fell in both Auckland and the rest of New Zealand from 2000 to 2008. However, while non-fatal injury hospitalisation rates fell for the rest of New Zealand, Auckland rates did not change significantly from 2000 to 2008 (Table 1, Figure 4). Fatal injury rates were lower in Auckland than the rest of New Zealand. However, non-fatal injury hospitalisation rates were no different in Auckland from the rest of New Zealand in 2000. By 2008, non-fatal rates were lower in the rest of New Zealand than in Auckland. For trends in absolute numbers of injuries, as measured by Ministry of Health and CAS data, see section 3.5.

Table 1: Trends in road traffic injury deaths and hospitalisations, Auckland, 2000-8

	Auckland			Rest of New Zealand		
Year	**Fatal injuries**	**Non-fatal injury hospitalisations**	**Total**	**Fatal injuries**	**Non-fatal injury hospitalisations**	**Total**
2000	7.4 (6 - 9.2)	115 (109 - 121)	122 (116 - 129)	13.3 (12 - 14.8)	119 (115 - 123)	129 (126 - 133)
2001	6.4 (5.1 - 8)	120 (114 - 127)	127 (120 - 133)	13.5 (12.2 - 15)	119 (115 - 123)	130 (127 - 134)
2002	9.4 (7.8 - 11.3)	125 (119 - 132)	135 (128 - 142)	11.3 (10.1 - 12.7)	110 (106 - 115)	126 (122 - 129)
2003	8.4 (6.9 - 10.2)	114 (108 - 120)	122 (116 - 129)	13.4 (12.1 - 14.9)	111 (107 - 115)	124 (120 - 127)
2004	7.2 (5.9 - 8.9)	112 (106 - 118)	119 (113 - 125)	12.4 (11.2 - 13.8)	107 (103 - 111)	119 (116 - 123)
2005	7 (5.7 - 8.6)	123 (117 - 129)	130 (124 - 137)	11.1 (9.9 - 12.5)	102 (98 - 106)	119 (115 - 122)
2006	6.2 (5 - 7.7)	132 (126 - 138)	138 (132 - 145)	10.8 (9.7 - 12.1)	99 (96 - 103)	119 (116 - 123)
2007	5.2 (4.1 - 6.6)	120 (114 - 126)	125 (119 - 131)	12.6 (11.4 - 14)	100 (97 - 104)	117 (113 - 120)
2008	4.3 (3.3 - 5.5)	112 (106 - 117)	116 (110 - 122)	10.3 (9.2 - 11.6)	101 (97 - 105)	113 (110 - 116)

Expressed as rates per 100,000 population (95% confidence intervals)

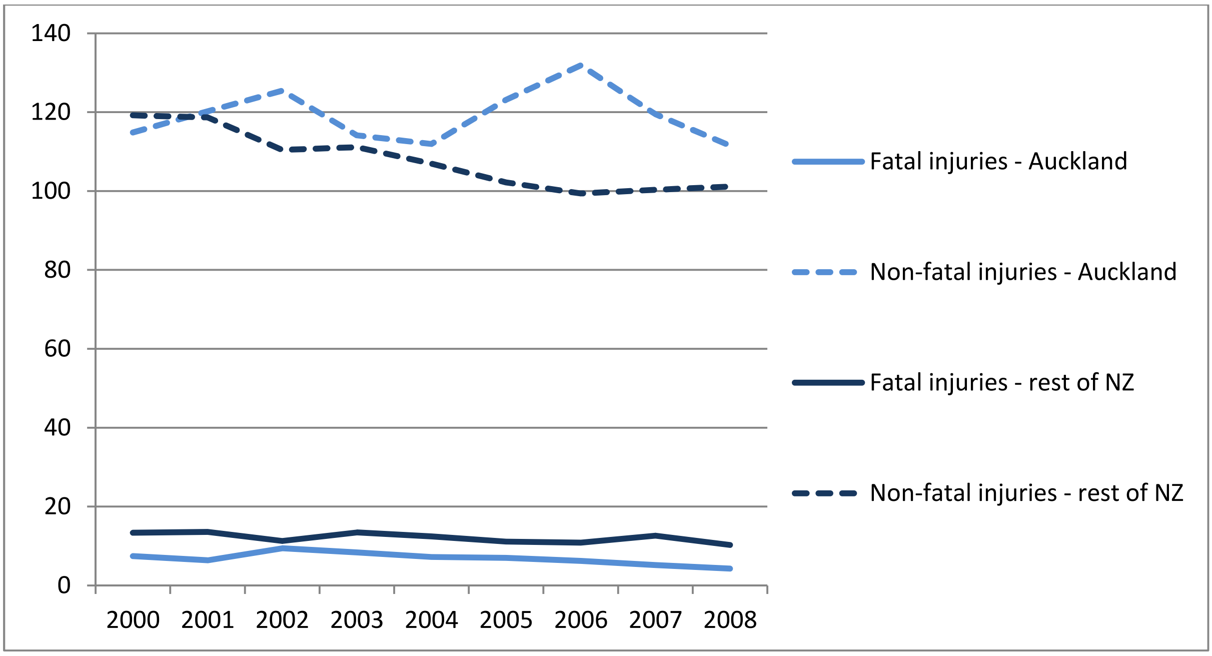

Figure 4: Road traffic injury deaths and hospitalisations, Auckland and rest of New Zealand, 2000-8, per 100,000 population

3.2 Social differences

In this section, the effects on road traffic injury rates of age, gender, ethnicity and area-level deprivation are considered.

Regression analysis allows the effect of multiple variables to be considered simultaneously. This method enables an assessment of the independent effects of each variable, such as identifying the independent effects of variables such as ethnicity and deprivation, which are known to be correlated.

Initial regression analysis showed that statistically significant interactions existed between age and gender, age and ethnicity, and age and deprivation. This means that the effects of gender, ethnicity and deprivation on injuries were different for different age groups. Therefore, separate regressions were conducted for each of the four age groups used in this report.

The results of the regression show that deprivation, ethnicity and gender were all independently and statistically significantly associated with road traffic injury rates in Auckland (Table 2).

Table 2: Age-stratified incidence rate ratios for effects of deprivation, gender and ethnicity on road traffic injuries, Auckland region, 2000-8

	Age group							
	0-14 years		15-24 years		25-64 years		65+ years	
	IRR (95%CI)	p value	IRR (95%CI)	p value	IRR (95%CI)	p value	IRR (95%CI)	p value
Deprivation (NZDep 2006 decile)	1.09 (1.07-1.12)	<.0001	1.06 (1.05-1.08)	<.0001	1.11 (1.09-1.13)	<.0001	1.03 (1.01-1.06)	0.0094
Ethnicity		<.0001		<.0001		<.0001		0.0056
Māori	1.65 (1.39-1.95)		1.20 (1.06-1.36)		1.31 (1.13-1.52)		1.54 (1.11-2.13)	
Pacific	1.31 (1.09-1.58)		0.71 (0.61-0.82)		0.70 (0.59-0.84)		0.73 (0.52-1.02)	
Asian	0.62 (0.49-0.79)		0.45 (0.39-0.52)		0.57 (0.48-0.67)		0.82 (0.62-1.09)	
Other Ethnicity (reference)	1		1		1		1	
Gender								
Female	0.69 (0.61-0.78)	<.0001	0.56 (0.51-0.62)	<.0001	0.54 (0.49-0.60)	<.0001	1.02 (0.89-1.17)	0.7457
Male (reference)	1		1		1		1	

IRR: Incidence rate ratio; 95%CI: 95% confidence interval

Area-level deprivation, as measured by the NZDep2006 index was associated with road traffic injury risk at all ages, but the effect of deprivation on injury was greater among children and adults than in older adults. On average, when controlling for the effects of gender and ethnicity, an increase in NZDep2006 by one decile was associated with a 9% increase in injury risk in children, and an 11% increase in adults, but only a 3% increase in injury risk in older adults (Figure 5**Error! Reference source not found.**). Figure 6 shows increasing injury rates with increasing levels of deprivation, for each age group, unadjusted for gender and ethnicity. This is also reflected in Table 3, which shows injury rates for each deprivation decile and age group, unadjusted for gender and ethnicity.

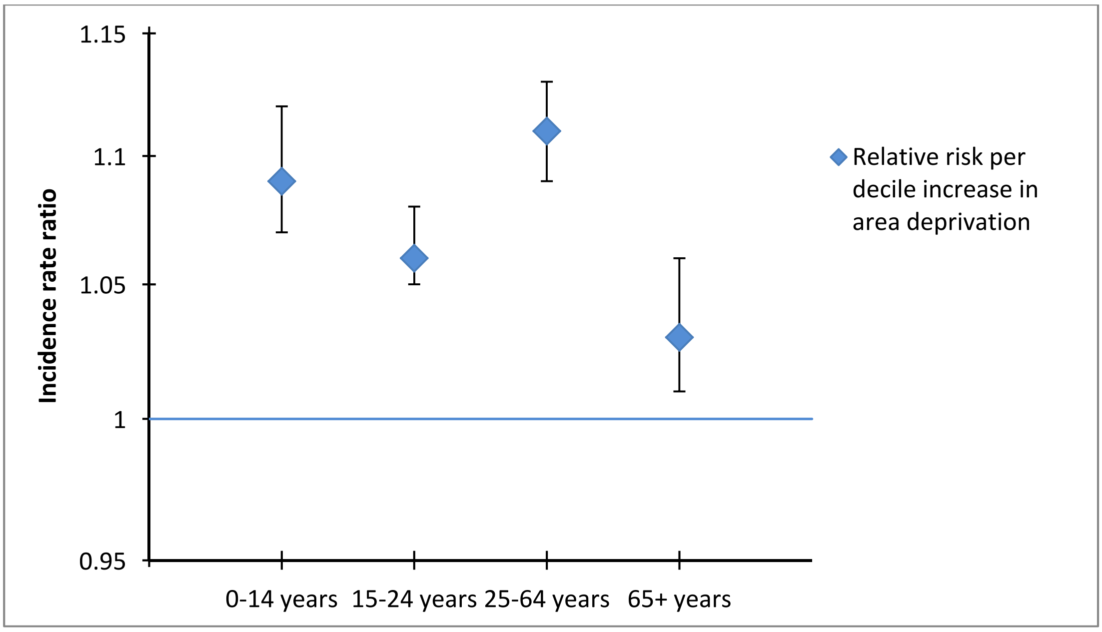

Figure 5: Effect of socio-economic deprivation on road traffic injury deaths and hospitalisations, 2000-8, Auckland region, by age group, adjusted for gender and ethnicity (using National Minimum Data Set and Mortality Collection data)

Note: vertical axis uses log scale.

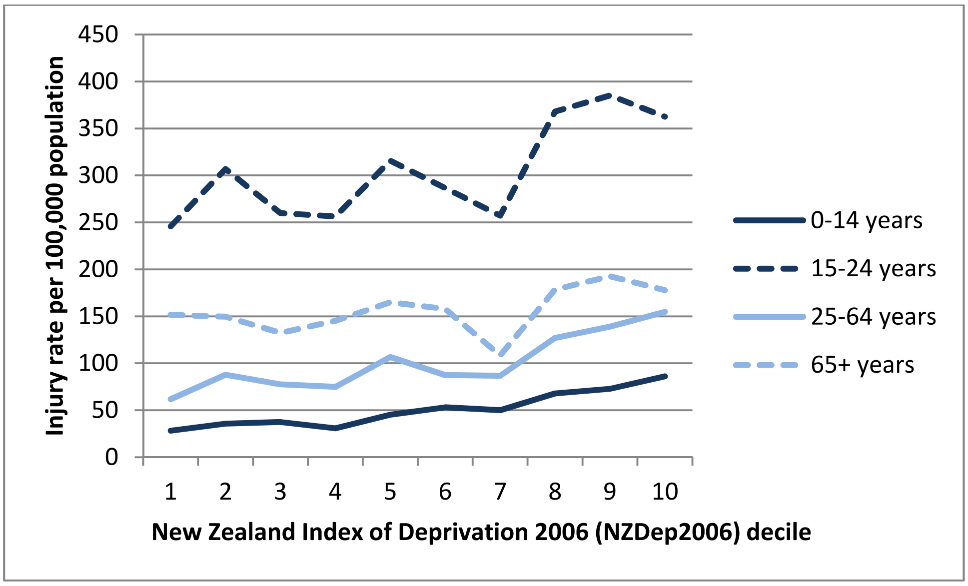

Figure 6: Road traffic injury deaths and hospitalisations by deprivation and age group, Auckland region, 2000-8

Table 3: Road traffic injury deaths and hospitalisations by deprivation and age group, Auckland region, 2000-8

Area deprivation (NZDep2006)	Age group			
	0-14	15-24	25-64	65+
1	28.3 (22.5 - 35.7)	245.8 (222.2 - 272.1)	61.8 (56.1 - 68.1)	151.6 (131.2 - 175.3)
2	35.8 (29.2 - 43.9)	306.8 (281.8 - 334.1)	87.8 (81.2 - 94.9)	149.6 (130.4 - 171.8)
3	37.4 (30.5 - 45.9)	259.9 (236.9 - 285.2)	77.6 (71.3 - 84.4)	132.4 (113.8 - 154.3)
4	30.9 (24.3 - 39.3)	256.4 (232.3 - 283)	74.9 (68.3 - 82.2)	145.2 (124.9 - 168.9)
5	45.3 (37 - 55.5)	315.8 (288.6 - 345.7)	106.7 (98.5 - 115.6)	164.9 (143.1 - 190.3)
6	53.1 (44.1 - 64)	286.6 (260.9 - 314.9)	87.5 (80 - 95.6)	158 (135.9 - 183.9)
7	50 (41.2 - 60.8)	257.2 (233.2 - 283.8)	86.7 (79.1 - 95)	108.5 (90.8 - 129.9)
8	68 (58.4 - 79.2)	368 (339.9 - 398.5)	127 (117.8 - 136.8)	178.5 (155.3 - 205.3)
9	72.9 (63.6 - 83.6)	385.1 (357 - 415.4)	139 (129.1 - 149.6)	192.7 (165.4 - 224.6)
10	86.2 (77.5 - 96)	362.6 (338.9 - 388)	154.7 (144.7 - 165.4)	177.8 (150.9 - 209.7)
Total	**53.5 (50.7 - 56.4)**	**311.8 (303.5 - 320.4)**	**99.1 (96.6 - 101.7)**	**153.6 (146.5 - 161.1)**

Expressed as rates per 100,000 population (95% confidence intervals)

Ethnicity was also associated with statistically significant differences in road traffic injury risk, after the effects of age, gender and deprivation were accounted for (Figure 7). Māori injury risk was highest at all ages, but the effect was particularly strong among Māori children, whose injury risk was 65% higher than children in the ‘Other Ethnicity’ group. In contrast, Asian populations had the lowest injury risk in all ages other than older adults, where risk was similar to the Pacific population. Māori children and youth had an injury risk 163% higher than Asian children and youth, and the injury risk for ‘Other Ethnicity’ children and youth was 61-122% higher than for Asian children and youth. The risk profile by age for Pacific peoples was mixed. Pacific children had a 31% higher injury risk than the ‘Other Ethnicity’ group and over twice that of Asian children, but youth and adults in the ‘Other Ethnicity’ group had an injury risk 41-43% higher than those of Pacific ethnicity. Table 4 shows injury rates by ethnic group and age group, including Asian subgroups, unadjusted for gender and deprivation. These suggest that among youth and adults, injury risk for the Chinese population was lower than Other Asian populations, with risk for the Indian population at an intermediate level.

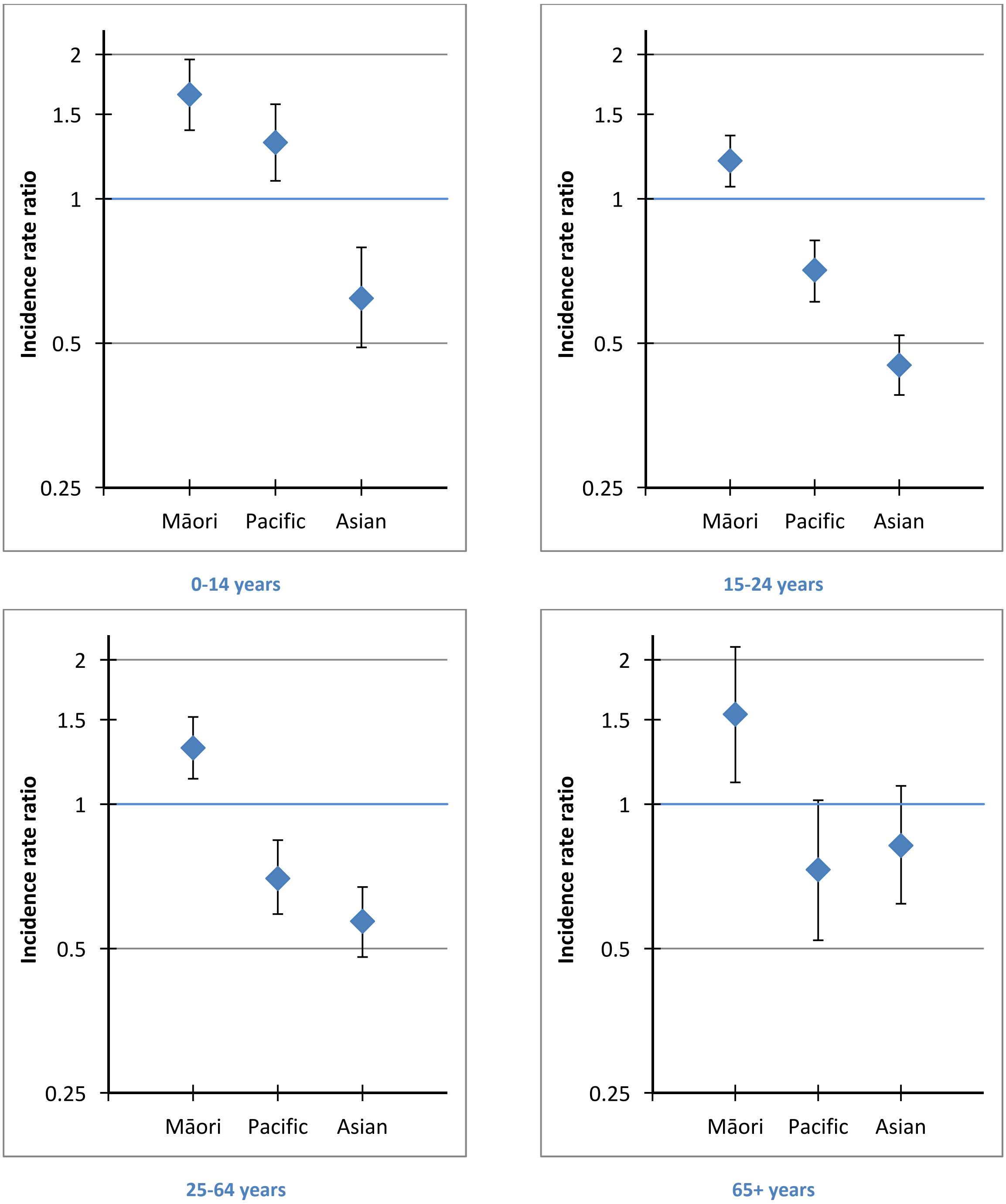

Figure 7: Effect of ethnicity on road traffic injury deaths and hospitalisations, 2000-8, Auckland region, by age group, adjusted for gender and deprivation (using National Minimum Data Set and Mortality Collection data).

Note: vertical axis uses log scale. Values less than one indicate a lower injury rate, and values greater than one a higher injury rate, compared with the NZ European/Other ethnicity group.

Table 4: Road traffic injury deaths and hospitalisations by ethnicity and age group, Auckland region, 2000-8 combined

Ethnic group	Age group			
	0-14 years	15-24 years	25-64 years	65+ years
Maori	89.7 (81.2 - 99.2)	487.8 (459.6 - 517.8)	169.7 (158.8 - 181.3)	232 (186.1 - 289.6)
Pacific	78.8 (71.1 - 87.2)	309.4 (288 - 332.6)	103.6 (95.7 - 112.1)	125.8 (100 - 158.4)
Chinese	28.7 (20.7 - 39.7)	122.6 (107.7 - 139.8)	50.8 (44.1 - 58.5)	129.3 (100.6 - 166.5)
Indian	26.8 (19.1 - 37.7)	199.1 (171.6 - 231.2)	68.2 (59.5 - 78.3)	79.9 (48.4 - 131.4)
Other Asian	32.3 (23.5 - 44.5)	231.1 (202.8 - 263.4)	80.3 (70 - 92.3)	215.9 (146.4 - 318.4)
Total Asian	29.2 (24.2 - 35.2)	169.3 (156.5 - 183.1)	64.3 (59.4 - 69.7)	130 (107.2 - 157.9)
Other Ethnicity	41.5 (37.9 - 45.4)	352.6 (339.6 - 366.3)	102 (98.8 - 105.4)	159.9 (151.8 - 168.5)
Total	**53.5 (50.7 - 56.4)**	**311.8 (303.5 - 320.4)**	**99.1 (96.6 - 101.7)**	**153.6 (146.5 - 161.1)**

Expressed as rates per 100,000 population (95% confidence intervals)
Total Asian is the sum of Chinese, Indian and Other Asian; Other Ethnicity includes NZ European and other ethnicities (including MELAA).

Female gender was associated with lower road traffic injury risk for children, youth and adults, but not among older adults. Apart from older adults, the reduction in risk for females varied from 31% in children to 46% in adults. These effects are also seen in the road traffic injury rates in Table 5.

Table 5: Road traffic injury deaths and hospitalisations by age and gender, Auckland region, 2000-8 combined

Age group	Gender	
	Female	Male
0-14	43.6 (40.1 - 47.5)	62.8 (58.6 - 67.3)
15-24	226.2 (216.2 - 236.6)	397.9 (384.7 - 411.7)
25-64	70.1 (67.2 - 73.1)	130.3 (126.2 - 134.6)
65+	156.4 (146.9 - 166.5)	150 (139.5 - 161.3)
Total	**96.5 (94 - 99.1)**	**157 (153.7 - 160.4)**

Expressed as rates per 100,000 population (95% confidence intervals)

3.3 Injuries while using different travel modes

Injury risk per capita

This section reports per capita rates of injuries while using different travel modes. It does not take into account the amount of travel by each mode (e.g. hours or travel or kilometres of travel by each travel mode), so cannot be used to assess which modes are more ‘dangerous’ or ‘risky’.

Car/van occupant injuries were more frequent than injuries to other mode users (Table 6). Car occupant injuries made up most of this group, with only a small proportion of injuries in this group involving van occupants (238 injuries, 0.8%). For youth and adults, the next most frequent injury type was motorcyclist injuries, whereas for children and older adults the next most frequent injury type was pedestrian injuries.

Table 6: Road traffic injuries by age group and mode, Auckland region, 2000-8

Mode	0-14 years	15-24 years	25-64 years	65+ years
Car/van occupants	25.1 (23.2 - 27.1)	230.7 (223.6 - 238.1)	64.6 (62.6 - 66.7)	114.4 (108.3 - 120.9)
Pedestrians	21.4 (19.6 - 23.2)	27.8 (25.4 - 30.4)	10.3 (9.5 - 11.1)	31.5 (28.3 - 34.9)
Cyclists	4.6 (3.8 - 5.5)	6.8 (5.7 - 8.2)	4.3 (3.8 - 4.9)	2.7 (1.9 - 3.9)
Motorcyclists	2.3 (1.8 - 3)	43.6 (40.6 - 46.9)	19.2 (18.1 - 20.3)	4.5 (3.4 - 5.9)
Other modes	0.1 (0 - 0.4)	2.9 (2.2 - 3.9)	0.7 (0.5 - 1)	0.5 (0.2 - 1.2)

Expressed as rates per 100,000 population (95% confidence intervals)

Road traffic injury rates were higher for males than females overall, but this effect was particularly pronounced for cyclist injuries (male cyclist injury rate approximately five times higher than female cyclist injury rate) and motorcyclist injuries (male motorcyclist injury rate almost eight times higher than female motorcyclist injury rate) (Table 7).

Table 7: Road traffic injuries by gender and mode, Auckland region, 2000-8

Mode	Female	Male
Car/van occupants	75.7 (73.5 - 77.9)	95.7 (93.2 - 98.4)
Pedestrians	14.4 (13.5 - 15.5)	20.7 (19.5 - 21.9)
Cyclists	1.6 (1.3 - 1.9)	7.8 (7.1 - 8.5)
Motorcyclists	4.1 (3.6 - 4.7)	31.8 (30.4 - 33.3)
Other modes	0.7 (0.6 - 1)	1 (0.8 - 1.4)

Expressed as rates per 100,000 population (95% confidence intervals)

Among Māori, rates for car/van occupant injuries, pedestrian injuries and injuries to users of other modes were higher than the 'Other Ethnicity' group, but the risk of cyclist injuries was not significantly different. Motorcyclist injuries were less common among Māori than the 'Other Ethnicity' group, but more common than among the Pacific or Asian populations (Table 8).

In the Pacific population, rates of injuries to car/van occupants and pedestrians were higher than the 'Other Ethnicity' population. However, the rate of cyclist injuries was half that of the 'Other Ethnicity' population, and the rates of motorcyclist injuries was less than a quarter that of the 'Other Ethnicity' population (Table 8).

In the Total Asian population, rates of injuries to car/van occupants, cyclists and motorcyclists were lower than in the 'Other Ethnicity' population, but rates of pedestrian injuries were not significantly different from the 'Other Ethnicity' population (Table 8).

Table 8: Road traffic injury deaths and hospitalisations by ethnicity and mode, Auckland region, 2000-8

	Māori	Pacific	Chinese	Indian	Other Asian	Total Asian	Other Ethnicity
Car/van occupants	147.3 (140.6 - 154.3)	97.9 (92.8 - 103.4)	46.7 (42.1 - 51.9)	63.3 (56.9 - 70.4)	75.2 (67.8 - 83.4)	59.5 (56 - 63.2)	82.4 (80.2 - 84.7)
Pedestrians	28.4 (25.6 - 31.6)	25.4 (22.8 - 28.2)	15.6 (13 - 18.7)	11.2 (8.7 - 14.5)	18.4 (15 - 22.8)	15 (13.3 - 17)	15.4 (14.5 - 16.4)
Cyclists	5.1 (3.9 - 6.5)	2.6 (1.8 - 3.6)	3 (1.9 - 4.5)	0.9 (0.3 - 2.3)	1 (0.4 - 2.6)	1.8 (1.3 - 2.6)	5.9 (5.4 - 6.6)
Motorcyclists	18.3 (16 - 20.9)	5.2 (4.1 - 6.5)	4 (2.8 - 5.8)	3.9 (2.5 - 6)	7.1 (5.1 - 10)	4.8 (3.9 - 6)	24.6 (23.4 - 25.9)
Other modes	2.1 (1.4 - 3.1)	1.2 (0.7 - 1.9)	0.4 (0.1 - 1.3)	0.7 (0.2 - 2)	0.8 (0.3 - 2.3)	0.6 (0.3 - 1.1)	0.7 (0.6 - 1)

Expressed as rates per 100,000 population (95% confidence intervals)
Total Asian is the sum of Chinese, Indian and Other Asian; Other Ethnicity includes NZ European and other ethnicities (including MELAA).

Rates of car/van occupant injuries and pedestrian injuries were much higher in the most deprived decile, compared with the least deprived decile. Injury rates for cyclists and motorcyclists were relatively constant across different deprivation deciles (Table 9).

Table 9: Road traffic injury deaths and hospitalisations by deprivation and mode, Auckland region, 2000-8

Area deprivation (NZDep2006)	Car/van occupants	Pedestrians	Cyclists	Motorcyclists	Other modes
1	57.4 (53.3 - 61.9)	9.9 (8.3 - 11.9)	5.1 (4 - 6.6)	13.9 (12 - 16.2)	0.8 (0.4 - 1.5)
2	74.1 (69.5 - 78.9)	13 (11.1 - 15.1)	5.7 (4.5 - 7.1)	19.6 (17.4 - 22.2)	0.7 (0.3 - 1.4)
3	67.6 (63.2 - 72.3)	11.1 (9.4 - 13.1)	4.8 (3.7 - 6.1)	16.5 (14.4 - 18.9)	0.3 (0.1 - 0.9)
4	66.7 (62.1 - 71.8)	12.6 (10.7 - 14.9)	3.5 (2.5 - 4.8)	16 (13.8 - 18.6)	0.5 (0.2 - 1.1)
5	84.3 (78.9 - 90.1)	19.6 (17.1 - 22.5)	6.1 (4.8 - 7.8)	20 (17.4 - 22.9)	1.1 (0.6 - 1.9)
6	79.2 (74 - 84.9)	15.1 (12.9 - 17.7)	4 (2.9 - 5.5)	18.6 (16.1 - 21.4)	0.4 (0.1 - 1.1)
7	72 (66.9 - 77.5)	14.8 (12.6 - 17.4)	2.9 (2 - 4.2)	17.4 (15 - 20.2)	1 (0.5 - 1.9)
8	106.5 (100.5 - 113)	24.1 (21.4 - 27.3)	4.5 (3.4 - 6)	19.4 (16.9 - 22.3)	1.4 (0.8 - 2.4)
9	117.5 (111.1 - 124.2)	23.9 (21.1 - 27)	4.8 (3.6 - 6.3)	18.9 (16.5 - 21.7)	1.1 (0.6 - 2)
10	122.6 (116.7 - 128.9)	30.8 (27.9 - 34.1)	4.1 (3.1 - 5.4)	14.2 (12.3 - 16.5)	1.6 (1 - 2.5)

Expressed as rates per 100,000 population (95% confidence intervals)

Injury risk per time travelled by mode

The numbers of injuries to people using each travel mode are strongly influenced by the amount of travel by each mode. The New Zealand Household Travel Survey provides data for the amount of travel (e.g. million hours per year) by different travel modes. These results are available for the Auckland region, but data on cycling and motorcycling are limited because of the relatively small proportion of survey respondents who used these modes. While travel duration for the Auckland region was available in 2003-5 for car/van occupants and pedestrians, the first data for cyclists became available in 2008-10, and motorcyclist data is still not available at the Auckland region level. National data is available for all these modes.

Table 10 shows that the risk of injury per time travelled is much higher for cyclists than for pedestrians or car/van occupants. It was not possible to estimate risk for motorcyclists or other modes, due to a lack of data at the Auckland region level. In this analysis, cyclist risk per time travelled may be underestimated, as national trends suggest that the amount of time spent cycling in 2008-10 was about 50% higher than in 2003-5.[61]

The Ministry of Transport has published national-level data on injury risk by amount of travel.[61] This national analysis found that motorcyclists were 17 times more likely to be killed or injured than car drivers per time spent travelling. The Ministry of Transport analysis found a higher risk for cyclists than pedestrians or car/van occupants per time travelled, consistent with Table 10. However, the Ministry of Transport analysis found the risk for car/van occupants to be slightly higher than pedestrians, whereas in Table 10 the reverse is true. This may be due to the use of different injury measures, as the analysis in Table 10 is restricted to more severe injuries (deaths and hospitalisations).

Table 10: Injury risk per million hours travelled, Auckland region, for selected modes

Travel mode	Duration of travel (million hours per year)	Number of injuries, 2000-8	Injuries per million hours travelled
Car/van occupant	380.7	9598	2.8
Pedestrian	59.3	1963	3.7
Cyclist	6.1	515	9.5
Motorcyclists	Not available	1975	Not available
Other modes	Not available	100	Not available

Note: travel duration estimates taken from 2003-5 New Zealand Household Travel Survey data for Auckland region, except for cycling. Cycling estimates were not available in 2003-5, so cycling estimate taken from earliest available years (2008-10).

3.4 Geographical differences

As shown by Figure 8 and Figure 9, which map injury rates for each local board area and for each census area unit (CAU), respectively, road traffic injury rates vary considerably across the Auckland region. Rates for each local board are also listed in Table 11.

The Auckland region has been divided into six Road Safety Action Plan areas. Two of these are rural (Rural North and Rural South) and four are urban (Urban North, Urban West, Urban Central and Urban South). There is variation in CAU-level injury rates within each of these road safety action plan areas. Some of these differences are likely to reflect random variations between small areas.

Estimated injury rates for small areas such as census area units have relatively wide confidence intervals. In small populations, it is more likely that a high injury rate could have occurred by chance. Appendix 1 presents a table of all census area units used in the analysis for the Auckland region, with their estimated injury rates and confidence intervals. Note that for the maps for population subgroups presented in Appendix 2, the populations are even smaller, so confidence intervals are even wider.

Road traffic injury rates generally appear higher for people living in rural areas. This may be related to greater distances travelled (due to more distant destinations), to higher speeds on rural roads, or poorer road quality. Within urban areas, high injury rates are seen in the Urban South road safety action plan area (with the exception of the Howick Local Board area). Waitemata and Whau are two other local board areas with high injury rates. While the rate for Great Barrier Island is also high, there were only 11 injuries in this area from 2000-8, resulting in a high level of uncertainty about this estimate, as shown by the wide confidence intervals (Table 11).

Additional maps of road traffic injury rates in the Auckland region by different age, gender, ethnicity and road user groups are presented in Appendix 2. These maps reflect the higher injury rates among Māori, males and 15-24 year olds, as well as the higher proportion of injuries to car/van occupants compared with pedestrians, cyclists, motorcyclists and users of other modes. When interpreting these data, it is important to note that these maps are not standardised for age or other variables, due to the difficulty of age-standardisation in small areas with low populations. For example, differences between maps of road traffic injuries for different ethnic groups may be partly due to differences in age structure between different ethnic groups.

Table 11: Road traffic injury deaths and hospitalisations by area of residence, local board level, Auckland region, 2000-8

Local Board Area	Rate
Rodney	182 (170 - 196)
Papakura	174 (161 - 188)
Otara-Papatoetoe	166 (156 - 176)
Franklin	156 (146 - 168)
Waitemata	143 (133 - 153)
Mangere-Otahuhu	138 (129 - 148)
Whau	136 (127 - 146)
Manurewa	135 (126 - 144)
Great Barrier	127 (69 - 232)
Maungakiekie-Tamaki	126 (118 - 136)
Henderson-Massey	125 (118 - 133)
Waitakere Ranges	124 (114 - 135)
Albert-Eden	119 (112 - 127)
Upper Harbour	117 (106 - 129)
Puketapapa	111 (102 - 122)
Waiheke	104 (82 - 132)
Devonport-Takapuna	101 (92 - 110)
Hibiscus and Bays	101 (94 - 108)
Kaipatiki	99 (92 - 107)
Orakei	99 (92 - 107)
Howick	85 (80 - 92)

Expressed as rates per 100,000 population (95% confidence intervals)

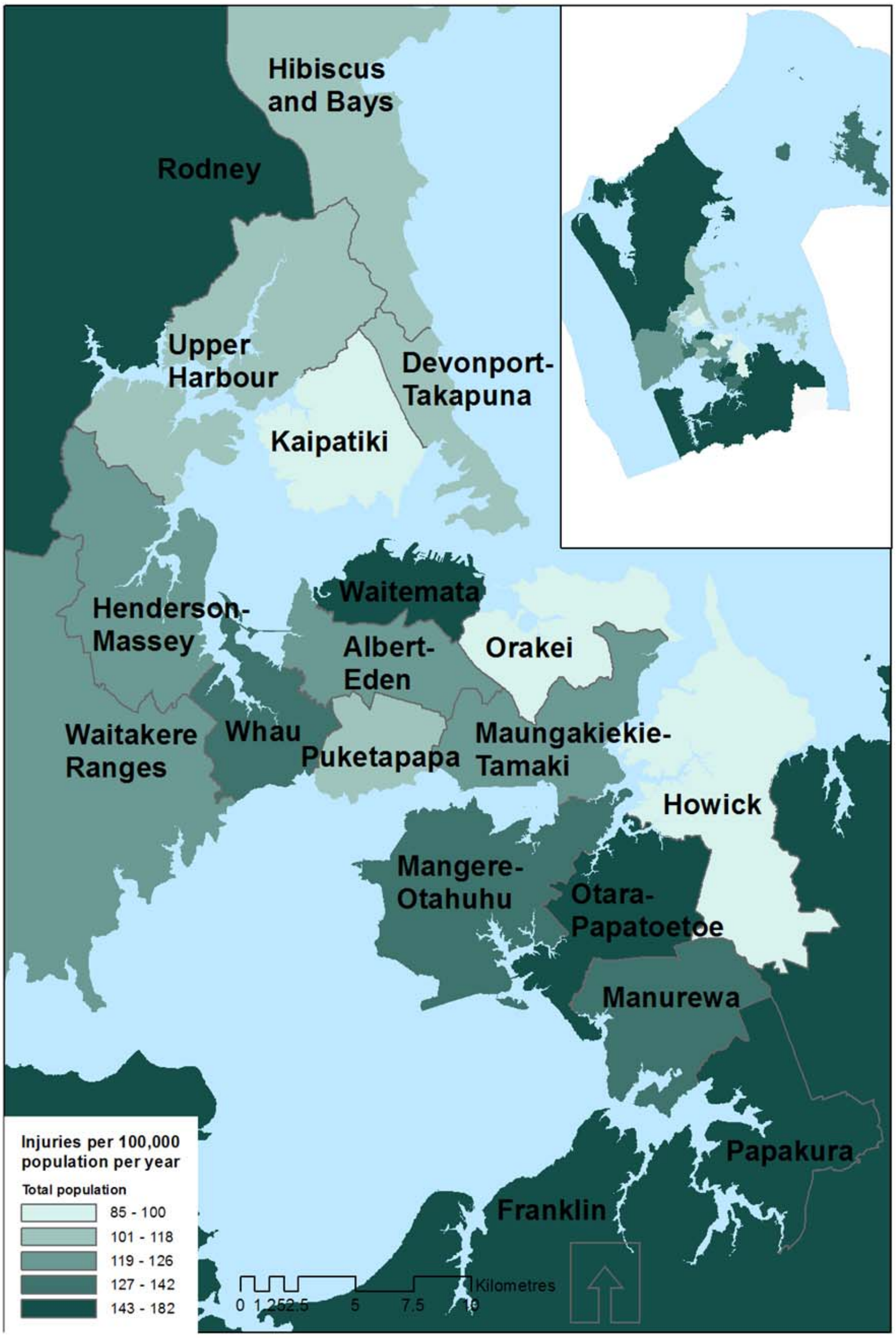

Figure 8: Road traffic injury deaths and hospitalisations by area of residence, local board level, Auckland region, 2000-8

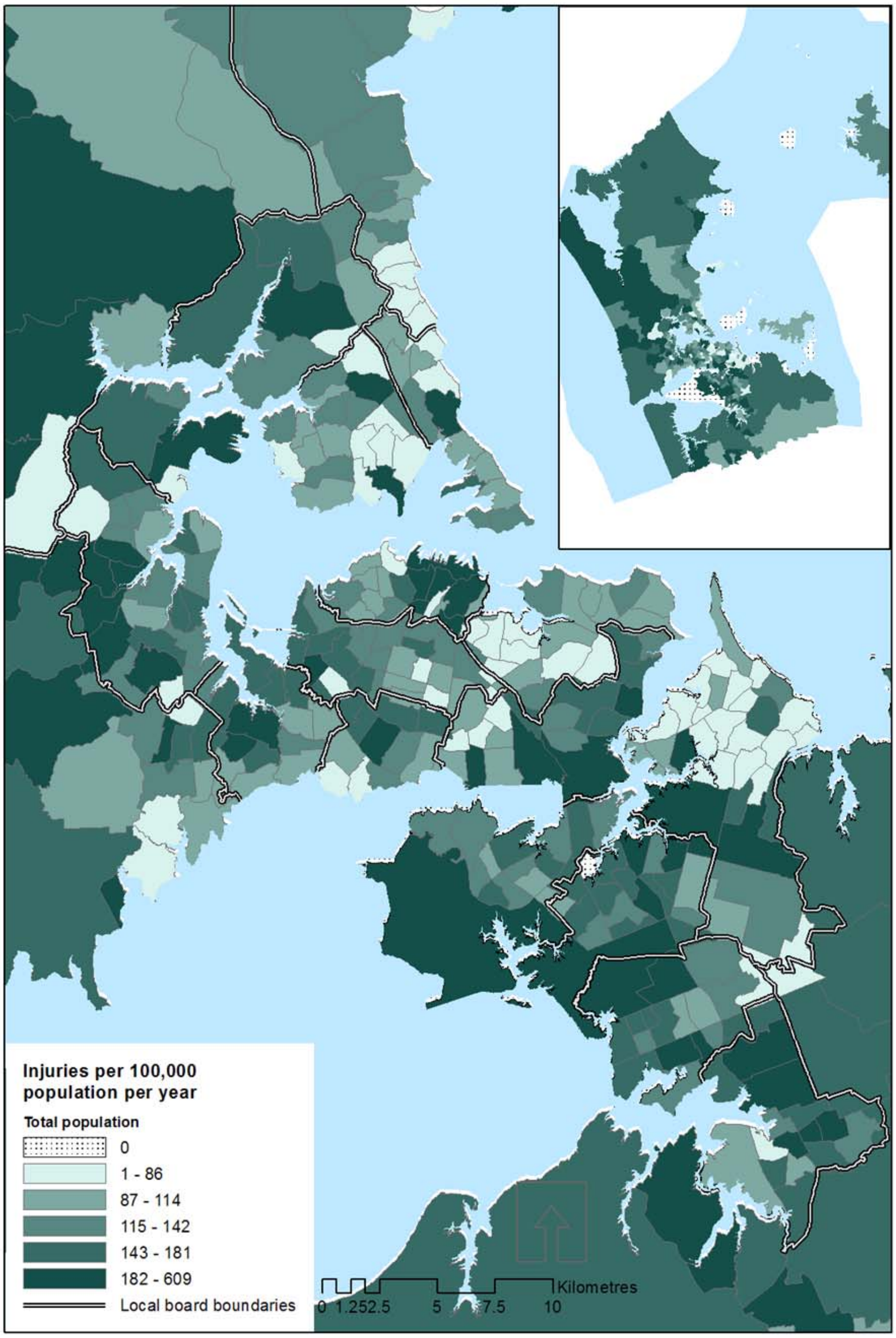

Figure 9: Road traffic injury deaths and hospitalisations by area of residence, census area unit level, Auckland region, January 2000-June 2008

Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

Injuries to schoolchildren

Schools are an important focus for road safety efforts. During the period from commencement of primary school to completion of secondary school (approximately 5-18 years of age) there is a change in the level of risk. As shown in Table 6, children aged 0-14 have a lower road traffic injury risk in comparison with youth aged 15-24, particularly from motorised travel modes. Given New Zealand's relatively poor performance on indicators of road traffic injury risk for young people more generally, it is useful to have data that is specific to the school-aged population that can inform school-focused strategies (Figure 10 and Table 12).

The road traffic injury rates for this age group show some differences from the rates for the total population. While injury rates are still high in rural areas, rates in southern urban Auckland are not as consistently elevated. Otara-Papatoetoe and Papakura still have high injury rates, as seen in the analysis for the total population. However, while injury rates for Mangere-Otahuhu and Manurewa are not low, they are not as high in this age group as for the total population. Waiheke has a high injury rate, but confidence intervals are wide, reflecting uncertainty due to a small population in this local board area. Among urban local board areas outside the Urban South area, Waitemata has the highest injury rate.

Table 12: Road traffic injury deaths and hospitalisations by local board area, 5-18 years, Auckland region, 2000-8

Local Board Area	Rate
Rodney Local Board Area	184 (158 - 214)
Waiheke Local Board Area	175 (113 - 270)
Otara-Papatoetoe Local Board Area	146 (128 - 165)
Waitemata Local Board Area	145 (117 - 179)
Franklin Local Board Area	144 (123 - 168)
Papakura Local Board Area	143 (119 - 171)
Whau Local Board Area	116 (98 - 137)
Maungakiekie-Tamaki Local Board Area	114 (96 - 135)
Waitakere Ranges Local Board Area	113 (93 - 138)
Upper Harbour Local Board Area	109 (88 - 135)
Mangere-Otahuhu Local Board Area	108 (93 - 125)
Manurewa Local Board Area	106 (91 - 123)
Albert-Eden Local Board Area	105 (89 - 123)
Henderson-Massey Local Board Area	101 (88 - 117)
Puketapapa Local Board Area	97 (79 - 119)
Hibiscus and Bays Local Board Area	88 (74 - 105)
Orakei Local Board Area	79 (64 - 97)
Kaipatiki Local Board Area	76 (62 - 92)
Howick Local Board Area	75 (64 - 88)
Devonport-Takapuna Local Board Area	74 (58 - 95)
Great Barrier Local Board Area	71 (0 - 449)

Expressed as rates per 100,000 population (95% confidence intervals)

Other analyses could be used to inform school-based road safety efforts, and examples are described below, though carrying out these analyses is beyond the scope of this report. The best analysis approach depends on the needs of those using the results, and the strategies considered most meaningful and applicable for the setting.

It is technically feasible to identify schools with high historical levels of road traffic injuries within a given radius of each school. Most simply, this can be done by applying GIS techniques to CAS data.

Ministry of Health data cannot be used for this purpose, as data is available at the census area unit level only.

It is theoretically possible to combine CAS and Ministry of Health data. For example, it would be possible to identify schools that have high numbers of injuries within a given radius (using CAS data) and that are located in CAUs or local board areas with high injury rates (using health sector data).

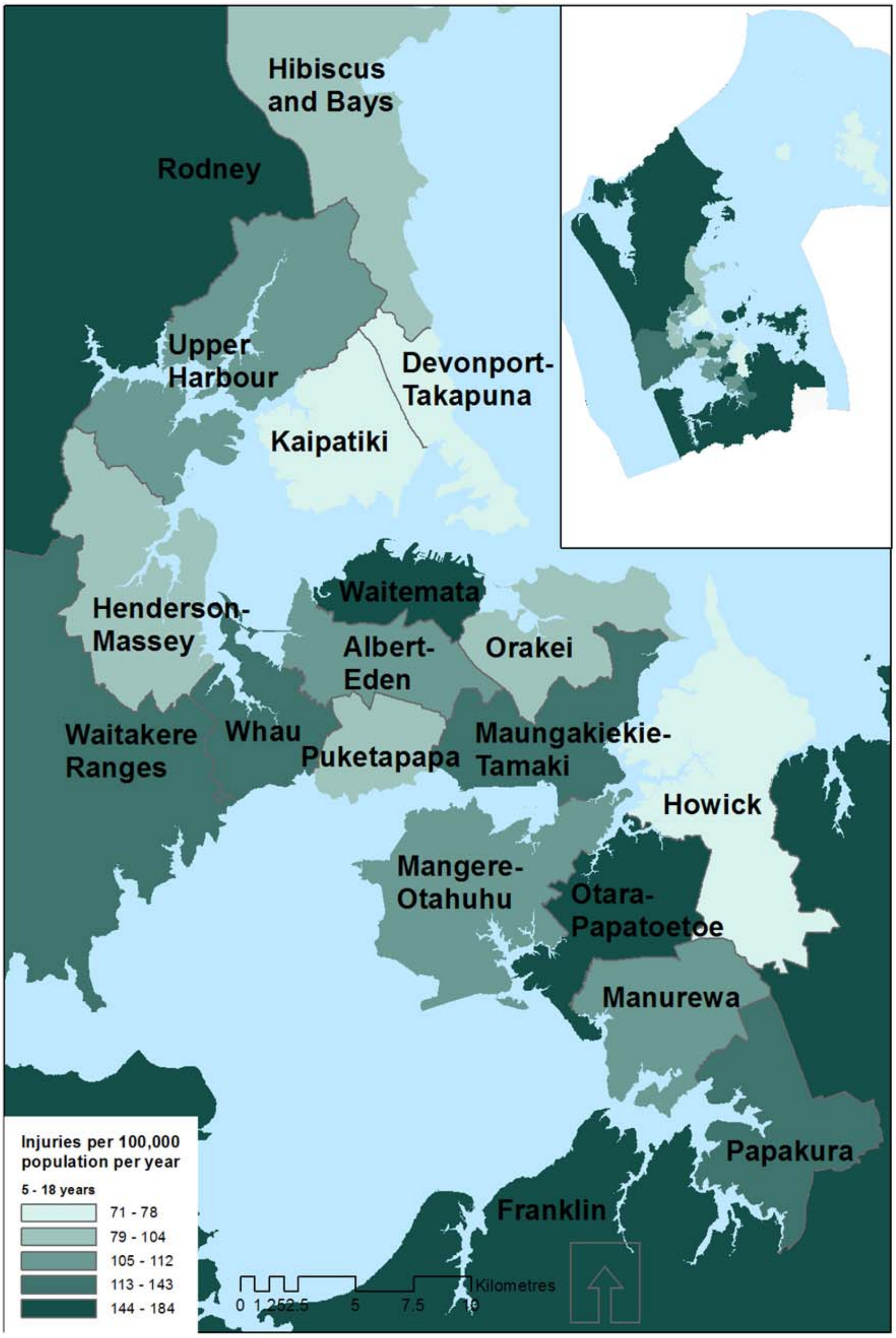

Figure 10: Road traffic injury deaths and hospitalisations by area of residence, 5-18 year olds, Auckland region, 2000-8

3.5 Comparing health sector and CAS data

The Crash Analysis System (CAS) is the primary source of road traffic injury and crash data used by Auckland Transport. CAS provides much useful information. However, it provides limited information on the social identity of injured people, and provides an incomplete record of serious injury crashes.

While CAS contains residential address data, this is not stored in a form that is routinely available for analysis. Ministry of Health data sets provide more information on social identity, and provide highly reliable records of hospitalisations and deaths, but no information on crash location. Thus, these two data sources may be complementary. Providing information from the Ministry of Health data sets alongside CAS data may provide a fuller picture of road traffic injuries and crashes.

For the purposes of this section, 'serious and fatal' road traffic injuries are considered to mean hospitalisations plus deaths (in the case of Ministry of Health data) or serious injury crashes plus fatal crashes (in the case of CAS data).

Injury severity and time trends

CAS and Ministry of Health data record similar numbers of deaths per year in the Auckland region (Figure 11). However, the number of hospitalisations recorded by Ministry of Health data is more than twice as high as the number of serious injuries recorded by CAS. This illustrates the large difference between the definitions of these two different measures of serious injury.

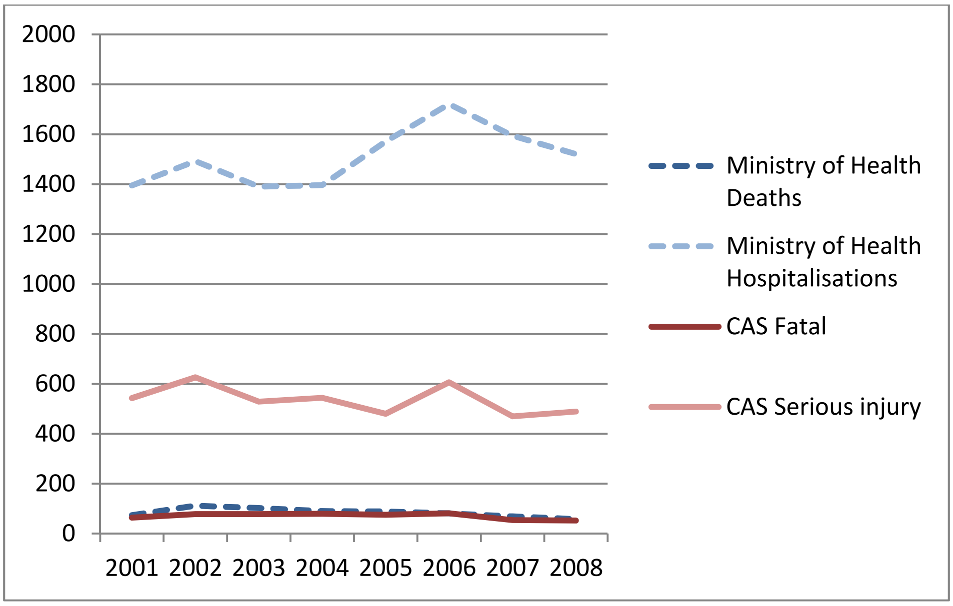

Figure 11: Serious and fatal road traffic injuries in the Auckland region in Ministry of Health and CAS data sets, 2001-8, by severity

An important difference between CAS and Ministry of Health data on road traffic injuries and crashes is that CAS records a greater range of crash severities. In CAS data, the number of minor injuries is several times higher than the number of serious injuries, and the number of non-injury crashes is several times higher again (Figure 12).

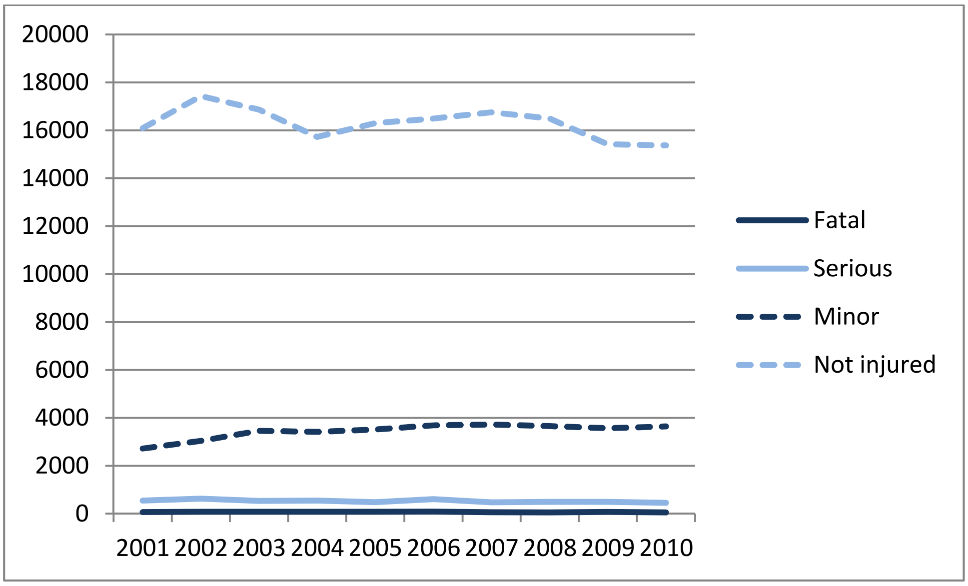

Figure 12: Road traffic crashes in the Auckland region in the CAS data set, 2001-10, by severity

Geographical distribution

Figure 8 maps rates of serious and fatal injuries occurring within each CAU. Compared with the map of health sector data on road traffic injury deaths and hospitalisations (Figure 8), CAS data shows especially high numbers of serious and fatal injuries in rural parts of the Auckland region (Figure 13). A key difference between these figures is that Figure 8 maps residential location, whereas Figure 13 maps crash location. The central business district and surrounding areas also have high numbers of serious and fatal injuries using CAS data, an effect seen to a lesser extent in the health sector data. Finally, the low injury rates in eastern parts of the Urban South area are less visible in CAS data.

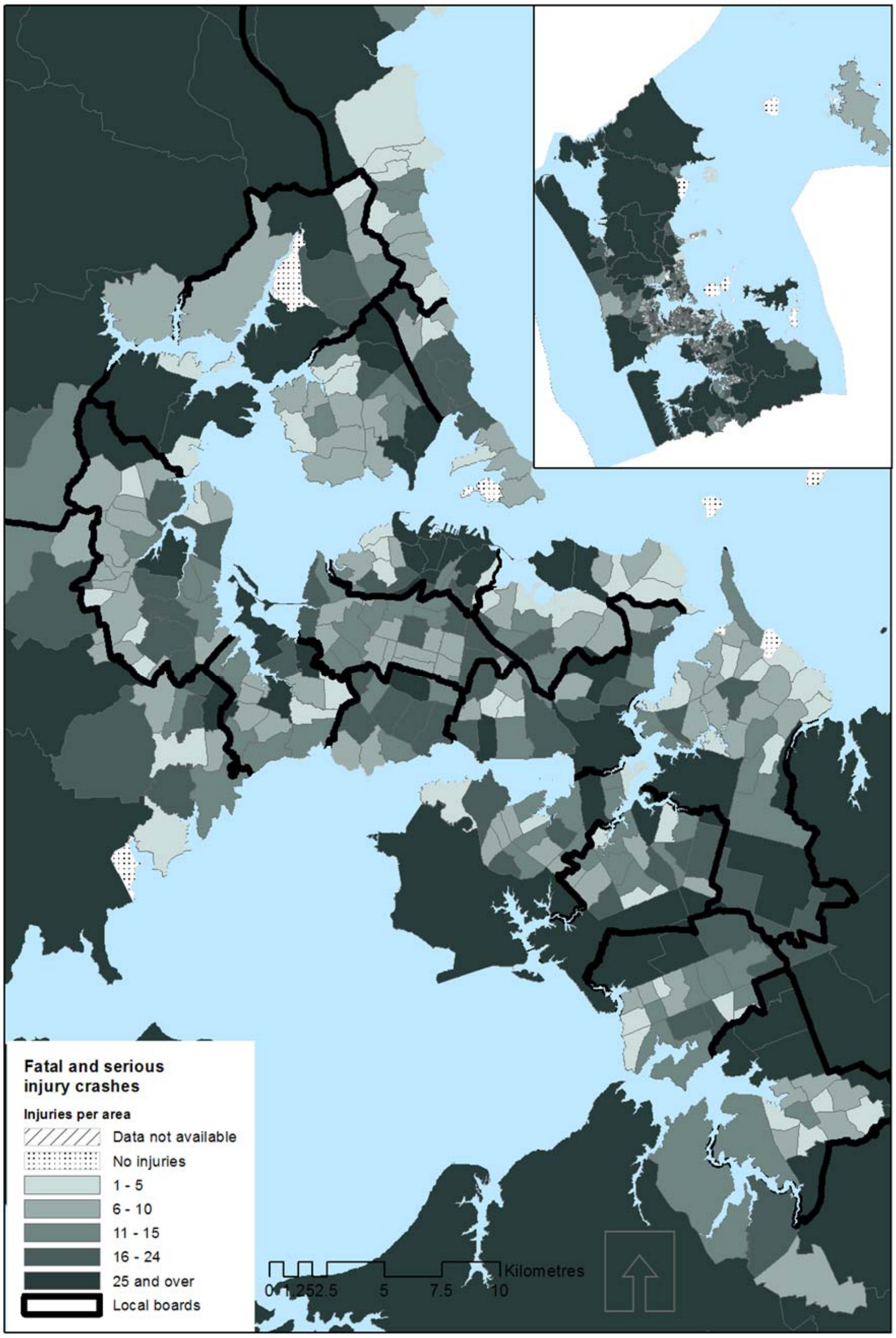

Figure 13: Fatal and serious road traffic injuries, by crash location, as measured by the Crash Analysis System, Auckland region, 2000-8

Age and gender

In both Ministry of Health and CAS data, the number of serious and fatal injuries is highest (and similar) in the 15-24 and 25-64 year old age groups (Table 13).

Table 13: Serious and fatal road traffic injuries in the Auckland region in Ministry of Health and CAS data sets, 2001-8, by age group

Data set	Ministry of Health		CAS	
Age range	**Injuries**	**%**	**Injuries**	**%**
0-14 years	1147	9.0%	380	8.3%
15-24 years	4689	36.8%	1861	40.4%
25-64 years	5335	41.8%	1966	42.7%
65+ years	1583	12.4%	398	8.6%
Total	**12754**	**100.0%**	**4605**	**100.0%**

Note: records with missing age data excluded

In both Ministry of Health and CAS data, males account for a higher proportion of injuries than females (Table 14). The proportion of injuries in females is higher in Ministry of Health data (39.5%) than in CAS data (34.7%).

Table 14: Serious and fatal road traffic injuries in the Auckland region in Ministry of Health and CAS data sets, 2001-8, by gender

Gender	Female		Male		Total	
Data source	**Injuries**	**%**	**Injuries**	**%**	**Injuries**	**%**
Ministry of Health	5035	39.5%	7719	60.5%	**12754**	**100.0%**
CAS	1669	34.7%	3145	65.3%	**4814**	**100.0%**

Note: records with missing gender data excluded

Ethnicity

CAS and Ministry of Health ethnicity data are collected in different ways, with the Ministry of Health data involving a more robust process. However, the quality of CAS ethnicity data for serious and fatal crashes has improved in recent years, with the proportion of these injuries with ethnicity recorded as unknown falling from 84% in 2001 to 6.2% in 2008. For the CAS data set in 2001 and 2002, the proportion of serious or fatal injuries for which ethnicity was unknown was 84% and 26%, respectively, so these years were excluded from this analysis.

A similar proportion of serious and fatal road traffic injuries were recorded for Māori in Ministry of Health and CAS data (Table 15). However, the proportion of injuries recorded for Pacific people appears much lower in CAS. In CAS, there also appears to be a higher proportion of injuries recorded for people of 'Other' ethnicity.

Table 15: Serious and fatal road traffic injuries in the Auckland region in Ministry of Health and CAS datasets, 2003-8, by prioritised ethnicity

Data source	Ministry of Health		CAS	
Ethnic group	**Injuries**	**%**	**Injuries**	**%**
Māori	1698	17.8%	535	17.1%
Pacific	1258	13.2%	258	8.2%
Asian	1037	10.9%	306	9.8%
Other	5531	58.1%	2037	65.0%
Total	**9524**	**100.0%**	**3136**	**100.0%**

Note: ethnicity was unknown for 157 serious and fatal injuries in the Ministry of Health data set, and 393 serious and fatal injuries in the CAS data set

Deprivation

Ministry of Health data records domicile codes for hospitalisations and deaths, which can be mapped to census area units. The NZDep index for each census area unit can then be assigned. CAS data includes deprivation recorded at the meshblock rather than census area unit level. As CAS records crash location, its deprivation data represents crash location rather than residential location. Both provide relatively complete information on area-level deprivation, with less than 1% of serious or fatal injuries having missing area unit or deprivation data.

Patterns of injury by deprivation appear different for Ministry of Health and CAS data (Table 16). In Ministry of Health data, the number of injuries in the most deprived area units is more than twice the number in the least deprived area units. This difference appears much less pronounced in CAS. This suggests that living in a deprived area may be a stronger predictor of injury risk than travel in a deprived area. However, a full analysis of differences in road traffic injuries by deprivation requires data on the populations within each decile, as has been analysed separately for Ministry of Health data.

The Ministry of Health data are also influenced by the number of people living in an area of each deprivation level. While the proportion of people living in each of the ten deprivation levels is very close to 10% per decile nationally, proportions for Auckland are a little different, ranging from 8.9% for decile 7 to 11.4% for decile 2. Although the number of Aucklanders living in decile 10 areas is relatively high (11.1%), this does not fully explain the higher number of injuries among this population compared with decile 1. In fact, although only 7.3% of injuries occurred among residents of decile 1 areas, 10.6% of Aucklanders live in decile 1 areas.

Table 16: Serious and fatal road traffic injuries in the Auckland region in Ministry of Health and CAS data sets, 2001-8, by deprivation as measured by NZDep index

Data source	Ministry of Health		CAS	
Deprivation decile	**Injuries**	**%**	**Injuries**	**%**
1	921	7.3%	395	8.2%
2	1266	10.0%	526	10.9%
3	1139	9.0%	573	11.9%
4	957	7.6%	406	8.4%
5	1253	9.9%	383	8.0%
6	1070	8.5%	551	11.4%
7	956	7.6%	474	9.8%
8	1492	11.8%	556	11.6%
9	1601	12.7%	419	8.7%
10	1994	15.8%	530	11.0%
Total	**12649**	**100.0%**	**4813**	**100.0%**

Note: deprivation was unknown for 105 serious and fatal injuries in the Ministry of Health data set, and 25 serious and fatal injuries in the CAS data set. Ministry of Health data reflects injuries among people living in an area with the stated deprivation level. CAS data reflects injuries related to crashes occurring in an area with the stated deprivation.

Travel mode

Ministry of Health and CAS data record similar proportions of injuries among the travel modes listed in Table 17, with small differences. The proportion of injuries recorded among pedestrians and cyclists in Ministry of Health data is similar to CAS data.

Table 17: Serious and fatal road traffic injuries in the Auckland region in Ministry of Health and CAS data sets, 2001-8, by travel mode of injured person

Data source	Ministry of Health		CAS	
Travel mode	**Injuries**	**%**	**Injuries**	**%**
Motor vehicle occupant	8656	67.9%	3075	63.6%
Motorcyclist	1789	14.0%	557	11.5%
Pedestrian	1745	13.7%	815	16.8%
Cyclist	467	3.7%	302	6.2%
Other	97	0.8%	89	1.8%
Total	**12754**	**100.0%**	**4838**	**100.0%**

4. Discussion

The analyses presented in this report demonstrate that road traffic injury deaths and hospitalisations in the Auckland region are more common in areas with high levels of socio-economic deprivation in general, and among Māori of all ages and Pacific children in particular. These effects are independent, so Māori living in high-deprivation areas are at particularly high risk. While road traffic injuries appeared to be less common among 'Asian' people, this is a highly diverse category that includes some ethnic communities that may be at increased risk, including new migrants. In addition, the 'Other Ethnicity' group combines a large number of people of NZ European ethnicity with a smaller number of people from Middle Eastern, Latin American and African ethnic groups, some of whom are new migrants, and this report was unable to analyse differences between these groups. Youth (aged 15-24) and older adults (aged 65 and over) have higher injury rates than adults aged 25-64. Although overall injury rates among children (aged 0-14) are lower, this is largely due to lower car/van occupant injury rates. Pedestrian injuries are more common among children than adults, while cyclist injuries are as common among children as in adults. Males have higher injury rates than females, except among older adults.

The above findings indicate that Māori, Pacific children and people living in socio-economically deprived areas are particularly vulnerable to road traffic injuries. This suggests that these groups should be prioritised in road safety efforts. Geographical analyses within the greater Auckland region suggest that the Urban South road safety action plan area, with the exception of the Howick Local Board area, should also be prioritised in road safety efforts. As these geographical analyses are based on the residential location of injured people rather than crash location, their findings are most relevant for interventions targeting the people living in high risk areas. Although some of these areas may also have high crash rates within their borders, information on areas with high numbers of crashes is best obtained from CAS data rather than health sector data.

It is well recognised that efforts to reduce the burden of road traffic injuries require attention to the road environment, engineering measures (particularly relating to vehicles and their safety features), effective enforcement of legislation, and educational interventions that raise awareness and influence safer road user behaviours. The findings of this report add weight to the argument that educational interventions cannot be considered in isolation from the wider social determinants of injuries, particularly including poverty and hazardous environments that make some communities more vulnerable than others. In particular, the findings indicate the need to develop strategies that are specifically designed with the needs of Māori, Pacific children and people living in socio-economically deprived areas in mind. One useful approach could be to integrate road safety efforts with other approaches that aim to serve vulnerable families. For example, Whanau Ora is an interagency approach that aims to reach all families in need to address their health and social needs. The potential for including road safety components in Whanau Ora activities could be explored further.

Interventions to reduce road traffic injuries should be supported by good evidence where possible. Organisations such as the World Health Organization and Eurosafe have reviewed the evidence of effectiveness of strategies for preventing road traffic injuries.[58, 62] Traffic calming is an environmental intervention that has been shown to lead to sustained reductions in road traffic injuries.[58, 61] The international literature reveals that implementing traffic calming measures in more deprived communities can reduce socio-economic inequalities in road traffic injury rates.[63] A study from the

United Kingdom demonstrated that implementing low-speed zones in more deprived areas prevented more injuries than implementing these zones in less deprived areas.[56] Prioritising environmental interventions in vulnerable neighbourhoods could therefore address an important unmet need in Auckland with regard to reducing ethnic and socioeconomic inequalities in road traffic injuries, as well as achieving overall reductions in injury rates. Although not all crashes occurring within vulnerable neighbourhoods involve residents of those neighbourhoods, residents are more likely than non-residents to benefit from local safety improvements.

Health sector data may be helpful in prioritising road safety interventions at the school level. As well as identifying schools with high numbers of nearby crashes (using CAS data), health sector data may help by identifying communities (either census area units or local board areas) that are at high risk of road traffic injuries, and schools in these areas could be prioritised. However, it should be noted that estimates of injury rates at the census area unit level have wide confidence intervals (Appendix 1), suggesting that care is needed in prioritising census area units based on this information alone. The findings of this report regarding the communities most at risk (Māori, Pacific children and residents of socio-economically deprived areas) can also assist decisions on which schools require attention as a priority.

The findings of this report are consistent with other research showing ethnic differences in road traffic injuries within Auckland[18] and within New Zealand,[1, 19] and research showing socio-economic differences at the New Zealand level.[1] While investigating the underlying causes of these differences was outside the scope of this report, this is an area requiring attention. Even more importantly, Auckland Transport, alongside other agencies in the sector, should take a lead role in evaluating the extent to which current and proposed strategies for road safety are likely to reduce the disproportionately high rates of injury among Māori, Pacific children and people living in socio-economically deprived areas.

The monitoring and evaluation functions of an effective road safety strategy also require attention to the availability and quality of existing data. For example, differences in the amount of travel by different modes (e.g. car/van occupants, pedestrians, cyclists, motorcyclists) may be one of the factors influencing ethnic and socio-economic differences in road traffic injury rates. However, the New Zealand Household Travel Survey (NZHTS) does not currently provide information analysed by ethnicity or deprivation. Some local authorities in New Zealand provide additional funding for the NZHTS in order to increase the survey sample size within their regions, which could be a potential avenue for obtaining data on ethnic and socio-economic differences in travel. For example, the New Zealand Health Survey 'oversamples' priority groups such as Māori and Pacific populations in order to ensure that good information is available for these groups. Better data is also needed for cyclists and motorcyclists, as these modes have a high crash risk per amount of travel.

Rural-urban differences are particularly striking when examining CAS data on crash location, but similar patterns are reflected in health sector data on the area of residence of injured people. Within urban areas, using health sector data, high injury rates were seen particularly in the Urban South road safety action plan area (with the exception of the Howick Local Board area).

The health sector database accessed for this analysis demonstrated two important features that CAS data lacks. It provides the residential location of injured people, including the level of deprivation of the area in which injured people live. It also provides more complete information on the social identity of injured people, especially ethnicity information. The CAS database provides crash location, time of crash, vehicle information and information on other parties involved in the crash. It contains information on crashes leading to minor injury, and non-injury crashes, although these are believed to substantially underestimate the true burden. It is more current than health sector data, particularly for fatal crashes, as there can be a 3-4 year lag time before health sector mortality data is available. The analyses of health sector data in this report are unable to detect more recent trends (from 2009 onwards).

ACC claims data have some useful features for monitoring road traffic injuries in the Auckland region: there is less of a delay between the date of injury and the date of data availability; cost to health and disability support services is included; and a medical diagnosis is included (in contrast to CAS data). ACC data also provide information on injuries that may carry a lesser risk of death but a potentially important risk of longer-term disability. This data source may thus have some value in monitoring road traffic injures in the Auckland region. However, ACC data cannot be used to reliably monitor ethnic differences in injury incidence, due to lower claims rates by some groups.

The NZTA Driver Licence Registry contains information on some injury risk factors, such as license status, that could be used to profile risk within the Auckland region. The potential for using this registry data requires further exploration with NZTA.

Appendices

Appendix 1: Census area units and injury rates

Table 18: Road traffic injury death and hospitalisation rates by area of residence for Auckland region census area units, January 2000-June 2008

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
516003	Abbotts Park	35	32825	106.6 (76.4 - 149)
522722	Aberfeldy	22	33350	66 (43.2 - 100.7)
616400	Aiguilles Island	0		0 (0 - 0)
518803	Akarana	75	39788	188.5 (150.3 - 236.7)
508701	Albany	8	4725	169.3 (80.5 - 342.4)
506632	Algies Bay-Mahurangi	38	6243	608.7 (442.5 - 838.1)
524001	Ambury	38	26709	142.3 (103.4 - 196.1)
524302	Aorere	47	41244	114 (85.6 - 152)
524121	Arahanga	15	15774	95.1 (56.6 - 158.9)
515500	Arch Hill	9	10199	88.2 (44.1 - 171.5)
523813	Ardmore	13	7431	174.9 (99.8 - 303.7)
512802	Armour Bay	8	3827	209 (99.5 - 422.6)
505904	Army Bay	9	11940	75.4 (37.7 - 146.5)
514103	Auckland Central East	85	17640	481.9 (389.7 - 596.4)
514102	Auckland Central West	34	16290	208.7 (148.8 - 293)
514101	Auckland Harbourside	15	7605	197.2 (117.3 - 329.5)
514600	Avondale South	45	36239	124.2 (92.6 - 166.7)
514802	Avondale West	54	31227	172.9 (132.4 - 226.2)
506901	Awaruku	32	27468	116.5 (82.2 - 165.3)
521151	Awhitu	34	19313	176 (125.5 - 247.2)
518201	Balmoral	46	43248	106.4 (79.6 - 142.4)
508120	Bayswater	33	20108	164.1 (116.4 - 231.6)
510010	Beachhaven North	56	41562	134.7 (103.7 - 175.4)
510020	Beachhaven South	27	36120	74.8 (51.1 - 109.5)
523300	Beachlands-Maraetai	60	36380	164.9 (128 - 212.8)
525002	Beaumont	32	16518	193.7 (136.7 - 274.9)
513620	Birdwood	20	10152	197 (126.2 - 307)
510210	Birkdale North	27	23808	113.4 (77.5 - 166.1)
510220	Birkdale South	29	29804	97.3 (67.4 - 140.6)
510500	Birkenhead East	23	31166	73.8 (48.8 - 111.6)
522603	Bleakhouse	8	15641	51.1 (24.3 - 103.5)
525922	Bledisloe Park	35	16863	207.6 (148.8 - 290)
514700	Blockhouse Bay	50	44690	111.9 (84.7 - 148)
521160	Bombay	10	6363	157.2 (81.9 - 295)
523101	Botany Downs	27	39234	68.8 (47 - 100.8)
521203	Bremner	5	2769	180.6 (65.7 - 439.2)
507101	Browns Bay	37	30440	121.6 (87.9 - 168.3)
616300	Browns Island	0		0 (0 - 0)
522601	Bucklands and Eastern Beaches	35	39555	88.5 (63.4 - 123.7)
522602	Bucklands Beach South	9	20093	44.8 (22.4 - 87.1)
524711	Burbank	39	25494	153 (111.6 - 210)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
523107	Burswood	3	8385	35.8 (7.4 - 111.8)
507500	Campbells Bay	11	18413	59.7 (32.2 - 108.9)
506615	Cape Rodney	81	45425	178.3 (143.4 - 222)
507710	Castor Bay	19	23618	80.4 (50.9 - 126.9)
510402	Chelsea	32	31371	102 (72 - 144.8)
524820	Clendon	86	49997	172 (139.3 - 212.7)
525200	Clevedon	25	16485	151.7 (102 - 225.5)
523721	Clover Park	48	38366	125.1 (94.2 - 166.4)
521502	Cockle Bay	22	36855	59.7 (39.1 - 91.2)
507720	Crown Hill	28	26256	106.6 (73.4 - 155.1)
511902	Crum Park	28	30635	91.4 (62.9 - 132.9)
506300	Dairy Flat-Redvale	13	13674	95.1 (54.2 - 165.1)
523109	Dannemora	24	16545	145.1 (96.8 - 217.5)
522301	Dingwall	34	22818	149 (106.3 - 209.2)
523712	Donegal Park	13	14115	92.1 (52.5 - 160)
521301	Drury	41	25718	159.4 (117.2 - 217.1)
512202	Durham Green	30	31880	94.1 (65.6 - 135.1)
523108	East Tamaki	20	3390	590 (378.2 - 918.2)
521112	Eden Road-Hill Top	11	4497	244.6 (132 - 445.6)
515600	Eden Terrace	12	10478	114.5 (63.6 - 203.5)
522920	Edgewater	28	30618	91.4 (62.9 - 133)
512401	Edmonton	38	24494	155.1 (112.7 - 213.8)
520201	Ellerslie North	63	46373	135.9 (106.1 - 174.2)
520202	Ellerslie South	25	14046	178 (119.8 - 264.6)
522723	Elsmore Park	9	21725	41.4 (20.7 - 80.5)
515801	Epsom Central	27	27102	99.6 (68.1 - 145.9)
515700	Epsom North	40	28149	142.1 (104.1 - 194.3)
515802	Epsom South	12	27485	43.7 (24.3 - 77.6)
513302	Fairdene	38	34602	109.8 (79.8 - 151.4)
524401	Favona	79	46050	171.6 (137.6 - 214.1)
523602	Ferguson	56	34595	161.9 (124.5 - 210.7)
520401	Ferndale	40	32225	124.1 (90.9 - 169.7)
523711	Flat Bush	20	21690	92.2 (59.1 - 143.8)
508510	Forrest Hill	37	41387	89.4 (64.7 - 123.8)
514000	Freemans Bay	45	31548	142.6 (106.4 - 191.5)
511401	Fruitvale	58	31340	185.1 (143 - 239.8)
506902	Glamorgan	31	25935	119.5 (83.8 - 170.6)
511100	Glen Eden East	87	50186	173.4 (140.5 - 214.1)
517002	Glen Innes East	29	23835	121.7 (84.3 - 175.8)
516900	Glen Innes North	39	40779	95.6 (69.8 - 131.3)
517001	Glen Innes West	58	35846	161.8 (125.1 - 209.7)
514402	Glenavon	45	40989	109.8 (81.9 - 147.4)
521152	Glenbrook	48	16017	299.7 (225.7 - 398.5)
511601	Glendene North	44	33131	132.8 (98.7 - 178.9)
511602	Glendene South	24	20528	116.9 (78 - 175.3)
508411	Glendhu	49	40529	120.9 (91.3 - 160.3)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
516800	Glendowie	31	31967	97 (68 - 138.4)
508310	Glenfield Central	42	35724	117.6 (86.8 - 159.5)
508320	Glenfield North	66	31578	209 (164.2 - 266.4)
523105	Golfland	9	10770	83.6 (41.8 - 162.4)
514302	Grafton East	5	5040	99.2 (36 - 241.5)
514301	Grafton West	4	5220	76.6 (23 - 206.7)
523401	Grange	23	16019	143.6 (94.9 - 217.1)
521000	Great Barrier Island	11	9044	121.6 (65.6 - 221.7)
512100	Green Bay	30	30071	99.8 (69.6 - 143.2)
509100	Greenhithe	41	32621	125.7 (92.4 - 171.2)
515420	Grey Lynn East	31	26637	116.4 (81.6 - 166.1)
515410	Grey Lynn West	26	27635	94.1 (63.8 - 138.8)
505905	Gulf Harbour	10	4635	215.7 (112.5 - 404.8)
522730	Half Moon Bay	24	28718	83.6 (55.7 - 125.3)
520402	Hamlin	48	37286	128.7 (96.9 - 171.2)
524530	Harania East	62	39594	156.6 (122.1 - 201.2)
524510	Harania North	46	32316	142.3 (106.5 - 190.5)
524520	Harania West	39	36261	107.6 (78.5 - 147.6)
505804	Hatfields Beach	24	9456	253.8 (169.3 - 380.3)
508020	Hauraki	46	45368	101.4 (75.9 - 135.7)
506800	Helensville	50	18362	272.3 (206.3 - 360)
510700	Henderson North	55	37347	147.3 (113 - 192.2)
510800	Henderson South	82	34016	241.1 (194.2 - 299.7)
513420	Herald	17	14171	120 (73.8 - 194.3)
515201	Herne Bay	23	24212	95 (62.8 - 143.7)
524901	Hillpark	39	37970	102.7 (74.9 - 141)
518702	Hillsborough East	37	32615	113.4 (82.1 - 157.1)
518701	Hillsborough West	59	49496	119.2 (92.3 - 154.1)
521201	Hingaia	3	3435	87.3 (18 - 272.7)
513430	Hobsonville	71	28139	252.3 (200 - 318.8)
524720	Homai East	65	45185	143.9 (112.8 - 183.7)
524712	Homai West	26	16944	153.4 (104.1 - 226.4)
521602	Howick Central	69	42279	163.2 (128.9 - 206.9)
521601	Howick West	14	20967	66.8 (38.9 - 113.7)
521132	Hunua	35	32384	108.1 (77.5 - 151)
523817	Hyperion	18	10260	175.4 (109.5 - 280.2)
617400	Inlet-Hobson Bay	0		0 (0 - 0)
617102	Inlet-Kaipara River	0		0 (0 - 0)
617604	Inlet-Manukau Harbour	0		0 (0 - 0)
617702	Inlets-Tamaki	0		0 (0 - 0)
520900	Islands-Motutapu, Rangitoto, Rakino	0	1092	0 (0 - 435.2)
616001	Kaikoura and Rangiahua Islands	0	104	0 (0 - 4394.5)
508210	Kaipatiki	41	32912	124.6 (91.6 - 169.7)
513800	Karekare	34	20091	169.2 (120.7 - 237.6)
506643	Kaukapakapa	55	17861	307.9 (236.4 - 401.8)
510401	Kauri Park	32	27671	115.6 (81.6 - 164.1)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
511901	Kaurilands	22	24446	90 (58.9 - 137.4)
506620	Kawau	0	903	0 (0 - 525.8)
511700	Kelston Central	51	32906	155 (117.7 - 204.4)
523110	Kilkenny	3	12270	24.4 (5 - 76.4)
513301	Kingdale	39	28656	136.1 (99.3 - 186.8)
521122	Kingseat	67	44574	150.3 (118.3 - 191.3)
517500	Kingsland	47	33780	139.1 (104.5 - 185.6)
516602	Kohimarama East	30	28058	106.9 (74.5 - 153.5)
516601	Kohimarama West	28	25793	108.6 (74.7 - 157.9)
524303	Kohuora	59	41249	143 (110.8 - 184.9)
512600	Konini	38	29664	128.1 (93.1 - 176.6)
505600	Kumeu	110	45854	239.9 (199.1 - 289.4)
512801	Laingholm	16	20580	77.7 (47.1 - 127.8)
507800	Lake Pupuke	35	41382	84.6 (60.6 - 118.2)
525101	Leabank	101	38964	259.2 (213.3 - 315.3)
505400	Leigh	8	3596	222.5 (105.8 - 449.7)
615900	Little Barrier Island	0	11	0 (0 - 30536.4)
508900	Long Bay	8	6188	129.3 (61.5 - 261.5)
513522	Lucken Point	11	36105	30.5 (16.4 - 55.6)
518901	Lynfield North	43	41115	104.6 (77.5 - 141.4)
518902	Lynfield South	19	33533	56.7 (35.8 - 89.4)
507400	Mairangi Bay	29	41121	70.5 (48.9 - 101.9)
524002	Mangere Bridge	54	44462	121.5 (93 - 158.9)
524111	Mangere Central	43	25502	168.6 (124.9 - 227.9)
524301	Mangere East	67	41846	160.1 (126 - 203.7)
524200	Mangere South	96	25551	375.7 (307.7 - 459.3)
524402	Mangere Station	3	2519	119.1 (24.6 - 371.7)
505902	Manly	39	46872	83.2 (60.7 - 114.2)
524601	Manukau Central	126	22979	548.3 (460.7 - 653.1)
525001	Manurewa Central	30	29957	100.1 (69.8 - 143.8)
524902	Manurewa East	27	18948	142.5 (97.4 - 208.7)
524112	Mascot	45	31919	141 (105.2 - 189.3)
525620	Massey Park	28	13641	205.3 (141.3 - 298.5)
506616	Matheson Bay	3	986	304.3 (63.5 - 946.6)
512201	Matipo	38	23249	163.4 (118.8 - 225.3)
523102	Maungamaungaroa	16	34334	46.6 (28.2 - 76.6)
518301	Maungawhau	30	30005	100 (69.7 - 143.6)
512500	Mcleod	58	40923	141.7 (109.5 - 183.7)
516301	Meadowbank North	47	48525	96.9 (72.7 - 129.2)
516302	Meadowbank South	29	39452	73.5 (50.9 - 106.2)
521501	Mellons Bay	32	24267	131.9 (93 - 187.1)
521902	Middlemore	0	699	0 (0 - 678.2)
523106	Millhouse	12	24090	49.8 (27.7 - 88.5)
516500	Mission Bay	47	43143	108.9 (81.8 - 145.3)
615800	Mokohinau Island	0		0 (0 - 0)
508610	Monarch Park	23	38760	59.3 (39.2 - 89.8)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
517800	Mt Albert Central	64	44250	144.6 (113.2 - 185.1)
518202	Mt Eden East	16	22653	70.6 (42.8 - 116.1)
518101	Mt Eden North	27	23216	116.3 (79.5 - 170.3)
518302	Mt Eden South	33	35991	91.7 (65 - 129.4)
516001	Mt Hobson	12	10398	115.4 (64.1 - 205)
519200	Mt St John	38	32043	118.6 (86.2 - 163.5)
509400	Mt Victoria	54	45039	119.9 (91.8 - 156.9)
520300	Mt Wellington North	80	49685	161 (129.3 - 200.7)
520500	Mt Wellington South	89	43935	202.6 (164.6 - 249.6)
506651	Muriwai Beach	43	16448	261.4 (193.7 - 353.3)
507300	Murrays Bay	20	36200	55.2 (35.4 - 86.2)
522712	Murvale	17	31095	54.7 (33.6 - 88.6)
509300	Narrow Neck	29	31106	93.2 (64.6 - 134.7)
511300	New Lynn North	94	51462	182.7 (149.3 - 223.8)
514500	New Windsor	49	48345	101.4 (76.5 - 134.4)
517400	Newmarket	42	12227	343.5 (253.6 - 465.8)
514200	Newton	17	5771	294.6 (181.3 - 476.7)
525630	North East Papakura	43	28731	149.7 (110.9 - 202.3)
508801	North Harbour	41	22155	185.1 (136.1 - 252)
509800	Northcote South	62	33674	184.1 (143.5 - 236.5)
508702	Northcross	16	11460	139.6 (84.5 - 229.5)
507102	Oaktree	36	34638	103.9 (74.8 - 144.6)
509701	Ocean View	24	34545	69.5 (46.3 - 104.2)
519300	One Tree Hill Central	20	19817	100.9 (64.6 - 157.3)
519400	One Tree Hill East	38	44115	86.1 (62.6 - 118.7)
519720	Onehunga North East	16	28604	55.9 (33.9 - 92)
519710	Onehunga North West	23	27830	82.6 (54.6 - 125)
519820	Onehunga South East	47	24234	193.9 (145.6 - 258.7)
519810	Onehunga South West	33	28890	114.2 (81 - 161.2)
525520	Opaheke	24	21936	109.4 (73 - 164)
513020	Opanuku	33	17192	191.9 (136.2 - 270.9)
516400	Orakei North	54	40908	132 (101.1 - 172.7)
516201	Orakei South	23	27545	83.5 (55.2 - 126.3)
519900	Oranga	31	30761	100.8 (70.7 - 143.8)
505805	Orewa	80	42644	187.6 (150.7 - 233.8)
523713	Ormiston	2	1710	117 (4.9 - 461.8)
521800	Otahuhu East	85	64385	132 (106.7 - 163.5)
521901	Otahuhu West	68	37518	181.2 (142.9 - 230.2)
523502	Otara East	76	37151	204.6 (163.4 - 256.5)
523501	Otara North	19	13646	139.2 (88.1 - 219.6)
523601	Otara South	46	28437	161.8 (121.1 - 216.5)
523402	Otara West	49	26114	187.6 (141.7 - 248.8)
512902	Otimai	22	19997	110 (72 - 168)
517903	Owairaka East	28	33692	83.1 (57.2 - 120.9)
517902	Owairaka West	39	21990	177.4 (129.4 - 243.4)
521111	Paerata-Cape Hill	10	6095	164.1 (85.5 - 308)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
525540	Pahurehure	18	25100	71.7 (44.8 - 114.6)
522910	Pakuranga Central	25	26705	93.6 (63 - 139.2)
523000	Pakuranga East	143	40034	357.2 (303.3 - 421)
522810	Pakuranga North	13	34773	37.4 (21.3 - 65)
520602	Panmure Basin	26	17375	149.6 (101.5 - 220.7)
525410	Papakura Central	39	16371	238.2 (173.8 - 326.9)
525610	Papakura East	133	38049	349.5 (295 - 414.5)
525420	Papakura North	26	18989	136.9 (92.9 - 202)
525510	Papakura South	19	13025	145.9 (92.3 - 230.1)
522202	Papatoetoe Central	43	32097	134 (99.3 - 181.1)
522302	Papatoetoe East	76	37821	200.9 (160.5 - 251.9)
522201	Papatoetoe North	64	37079	172.6 (135.1 - 220.9)
522100	Papatoetoe West	47	35630	131.9 (99 - 176)
506641	Parakai	20	9774	204.6 (131.1 - 318.9)
509000	Paremoremo East	25	17358	144 (96.9 - 214.1)
506400	Paremoremo West	4	3819	104.7 (31.5 - 282.4)
515901	Parnell East	20	17825	112.2 (71.9 - 174.9)
515902	Parnell West	120	32558	368.6 (308.3 - 441)
512901	Parrs Park	54	41673	129.6 (99.2 - 169.5)
521121	Patumahoe	18	18249	98.6 (61.6 - 157.6)
519500	Penrose	21	5028	417.7 (270.7 - 643.4)
522711	Pigeon Mountain North	22	24437	90 (58.9 - 137.5)
522721	Pigeon Mountain South	7	9821	71.3 (31.8 - 151.4)
508802	Pinehill	14	13260	105.6 (61.6 - 179.7)
515002	Point Chevalier East	44	34451	127.7 (95 - 172.1)
515003	Point Chevalier South	20	12663	157.9 (101.2 - 246.2)
515001	Point Chevalier West	43	27807	154.6 (114.6 - 209)
517100	Point England	52	34356	151.4 (115.3 - 199)
523111	Point View	29	10320	281 (194.7 - 405.8)
515302	Ponsonby East	25	27347	91.4 (61.5 - 135.9)
515301	Ponsonby West	22	20543	107.1 (70.1 - 163.5)
522400	Puhinui	50	28556	175.1 (132.6 - 231.5)
525910	Pukekohe North	144	48224	298.6 (253.7 - 351.8)
525921	Pukekohe West	43	40532	106.1 (78.6 - 143.4)
616200	Rakitu Island	0	26	0 (0 - 15592.9)
523816	Randwick Park	19	11355	167.3 (105.9 - 263.9)
513210	Ranui North	127	64905	195.7 (164.5 - 233)
505802	Red Beach	73	46445	157.2 (125 - 198)
525700	Red Hill	31	21809	142.1 (99.7 - 202.9)
523722	Redoubt North	65	35946	180.8 (141.8 - 231)
523820	Redoubt South	51	40937	124.6 (94.6 - 164.3)
516002	Remuera South	19	28965	65.6 (41.5 - 103.5)
516101	Remuera West	18	23645	76.1 (47.5 - 121.6)
511402	Rewarewa	45	31536	142.7 (106.4 - 191.6)
506652	Rewiti	20	14052	142.3 (91.2 - 221.9)
506653	Riverhead	35	18482	189.4 (135.7 - 264.6)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
514401	Roberton	55	36597	150.3 (115.3 - 196.1)
514801	Rosebank	52	34535	150.6 (114.7 - 198)
525530	Rosehill	42	25913	162.1 (119.7 - 219.9)
507200	Rothesay Bay	31	36938	83.9 (58.9 - 119.8)
524713	Rowandale	35	24722	141.6 (101.5 - 197.8)
513530	Royal Heights	48	47159	101.8 (76.6 - 135.4)
518600	Royal Oak	69	41871	164.8 (130.1 - 209)
513512	Royal Road West	16	12120	132 (79.9 - 217)
521302	Runciman	8	3546	225.6 (107.3 - 456)
517703	Sandringham East	37	26082	141.9 (102.6 - 196.4)
517701	Sandringham North	31	23937	129.5 (90.8 - 184.8)
517702	Sandringham West	50	34224	146.1 (110.7 - 193.2)
508110	Seacliffe	29	26774	108.3 (75 - 156.5)
523201	Shelly Park	13	17363	74.9 (42.7 - 130.1)
518102	Sherbourne	37	24086	153.6 (111.1 - 212.7)
506200	Silverdale North	12	9929	120.9 (67.2 - 214.7)
506000	Silverdale South	18	12780	140.8 (87.9 - 225)
506631	Snells Beach	34	24720	137.5 (98.1 - 193.1)
506642	South Head	20	9135	218.9 (140.3 - 341.2)
517901	Springleigh	60	20373	294.5 (228.6 - 379.9)
516700	St Heliers	52	38076	136.6 (104 - 179.6)
517200	St Johns	17	22427	75.8 (46.6 - 122.8)
517600	St Lukes	34	28895	117.7 (83.9 - 165.2)
515432	St Lukes North	7	5684	123.2 (54.9 - 261.5)
515202	St Marys	15	18716	80.1 (47.7 - 134)
509500	Stanley Bay	26	19047	136.5 (92.6 - 201.4)
505901	Stanmore Bay	90	69825	128.9 (104.8 - 158.7)
513220	Sturges North	26	13547	191.9 (130.2 - 283.1)
513010	Sturges South	60	48497	123.7 (96 - 159.6)
508620	Sunnybrae	15	22562	66.5 (39.5 - 111.1)
522820	Sunnyhills	13	24899	52.2 (29.8 - 90.7)
508520	Sunnynook	47	48366	97.2 (73 - 129.7)
511800	Sunnyvale	24	28931	83 (55.3 - 124.4)
515431	Surrey Crescent	26	23192	112.1 (76 - 165.4)
513100	Swanson	44	25608	171.8 (127.7 - 231.5)
506614	Tahekeroa	26	23097	112.6 (76.3 - 166.1)
523911	Takanini North	27	12885	209.5 (143.2 - 306.8)
523912	Takanini South	29	11415	254.1 (176 - 366.9)
523920	Takanini West	65	39125	166.1 (130.3 - 212.2)
508010	Takapuna Central	65	20937	310.5 (243.5 - 396.4)
520601	Tamaki	71	36110	196.6 (155.8 - 248.5)
511001	Tangutu	43	23556	182.5 (135.2 - 246.8)
508420	Target Road	28	48767	57.4 (39.5 - 83.5)
506613	Tauhoa-Puhoi	44	26928	163.4 (121.5 - 220.1)
513701	Taupaki	3	6729	44.6 (9.2 - 139.3)
512300	Te Atatu Central	42	29922	140.4 (103.6 - 190.4)

2001 CAU code	2001 CAU name	Injuries	Person years	Injury rate (95% CI)
520000	Te Papapa	22	24834	88.6 (58 - 135.3)
518500	Three Kings	71	39692	178.9 (141.8 - 226)
512000	Titirangi South	29	27389	105.9 (73.4 - 153)
506903	Torbay	36	36803	97.8 (70.4 - 136.1)
523814	Totara Heights	18	13590	132.5 (82.7 - 211.6)
509702	Tuff Crater	23	33497	68.7 (45.4 - 103.9)
523202	Turanga	14	9120	153.5 (89.5 - 261.2)
508803	Unsworth Heights	8	23100	34.6 (16.5 - 70.1)
524122	Viscount	41	33191	123.5 (90.8 - 168.2)
507000	Waiake	39	34142	114.2 (83.3 - 156.8)
516202	Waiata	24	34011	70.6 (47.1 - 105.8)
520801	Waiheke Island	65	57693	112.7 (88.3 - 143.9)
519002	Waikowhai East	45	33330	135 (100.7 - 181.3)
519001	Waikowhai West	15	26159	57.3 (34.1 - 95.9)
512700	Waima	16	19518	82 (49.6 - 134.8)
513631	Waimumu North	72	36575	196.9 (156.3 - 248.3)
513632	Waimumu South	61	31932	191 (148.6 - 245.9)
505700	Waipareira West	14	6695	209.1 (121.9 - 355.7)
523815	Wairere	3	5175	58 (12 - 181.1)
513702	Waitakere	39	15279	255.3 (186.3 - 350.3)
516102	Waitaramoa	23	32294	71.2 (47.1 - 107.7)
526101	Waiuku	101	45057	224.2 (184.5 - 272.7)
505803	Waiwera	2	2049	97.6 (4.1 - 385.6)
512402	Wakeling	44	30245	145.5 (108.2 - 196)
518801	Walmsley	46	29871	154 (115.3 - 206.1)
505500	Warkworth	62	22803	271.9 (212 - 349.3)
514900	Waterview	40	25473	157 (115 - 214.7)
525102	Wattle Farm	51	43548	117.1 (89 - 154.4)
505300	Wellsford	43	14475	297.1 (220.1 - 401.5)
518802	Wesley	37	20520	180.3 (130.4 - 249.6)
513521	West Harbour	44	38186	115.2 (85.7 - 155.2)
513610	West Massey	2	2966	67.4 (2.8 - 266.6)
513511	Westgate	5	3525	141.8 (51.6 - 345.2)
507900	Westlake	41	34095	120.3 (88.4 - 163.8)
515100	Westmere	46	37262	123.5 (92.4 - 165.2)
524810	Weymouth	90	51755	173.9 (141.5 - 214)
521202	Whangapouri Creek	11	4094	268.7 (145.1 - 489.4)
513410	Whenuapai West	24	16016	149.9 (100 - 224.6)
508220	Windy Ridge	28	26244	106.7 (73.4 - 155.2)
524602	Wiri	90	31157	288.9 (235 - 355.5)
508412	Witheford	20	21624	92.5 (59.2 - 144.2)
511002	Woodglen	53	30666	172.8 (132 - 226.7)

Expressed as rates per 100,000 population (95% confidence intervals). CAU: census area unit. Highlighted CAUs underwent boundary changes in 2001; for these CAUs, injury rates are calculated for the five year period from 1 Jul 2003. Note: populations (person years) for CAUs with rapid population growth may be underestimated, with corresponding overestimation of injury rates. See Methods section for detailed explanation.

Appendix 2: Maps

This section presents maps of injury deaths and hospitalisations for age, gender, ethnicity and travel mode subgroups for the Auckland region.

Reference map for Auckland region

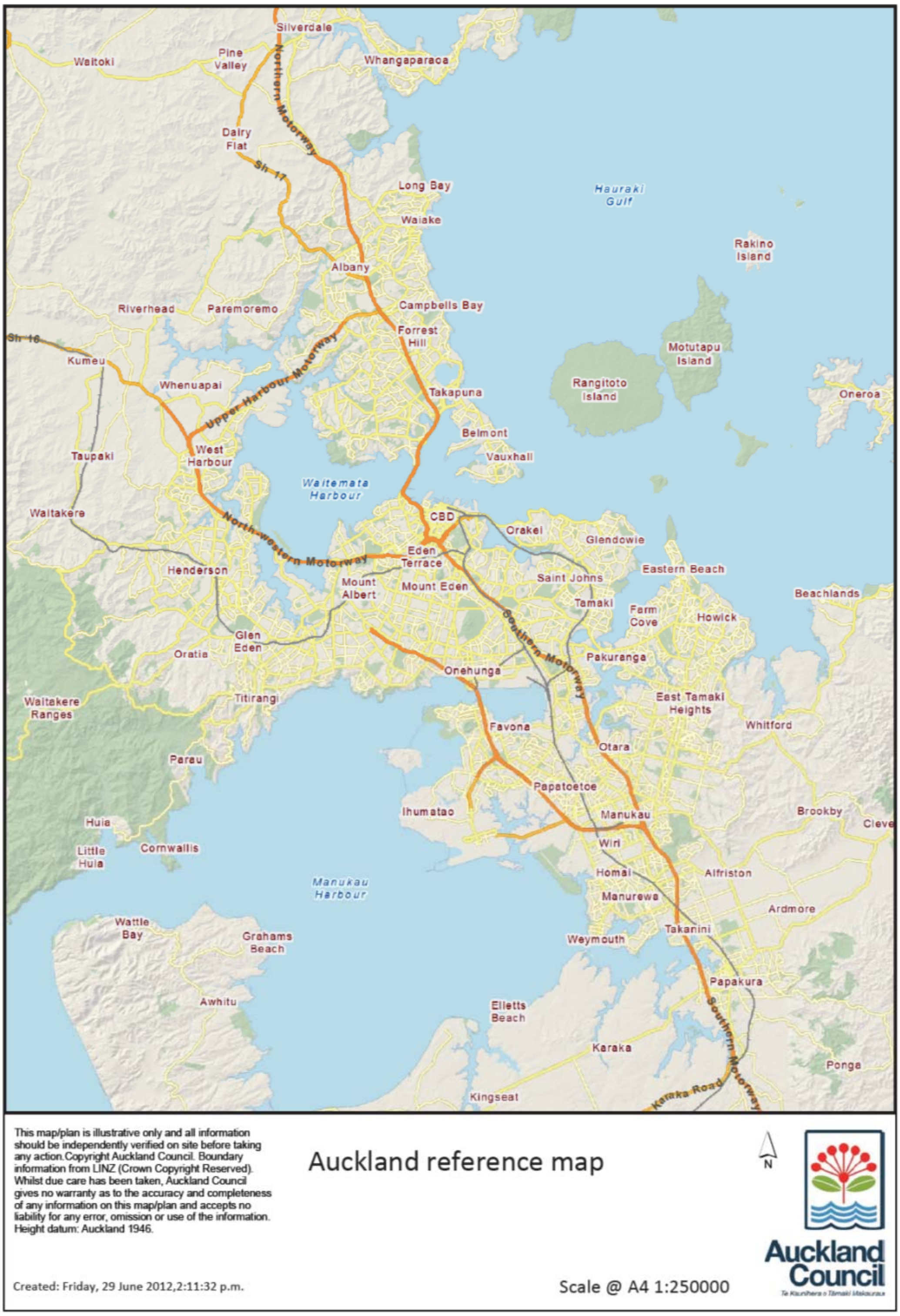

Figure 14: Auckland region reference map

Age groups, Auckland region

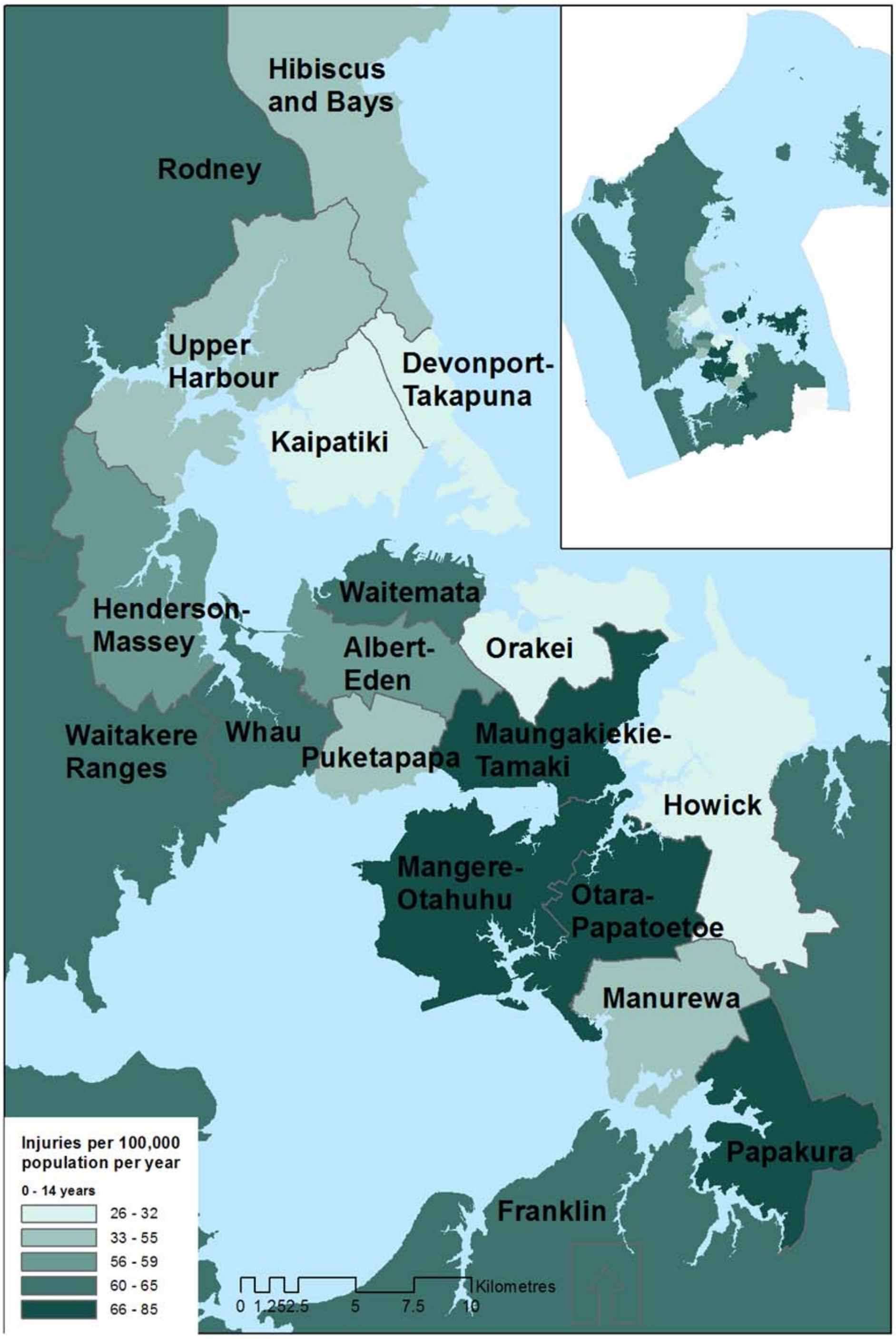

Figure 15: Road traffic injury deaths and hospitalisations by area of residence, 0-14 years, Auckland region, 2000-8

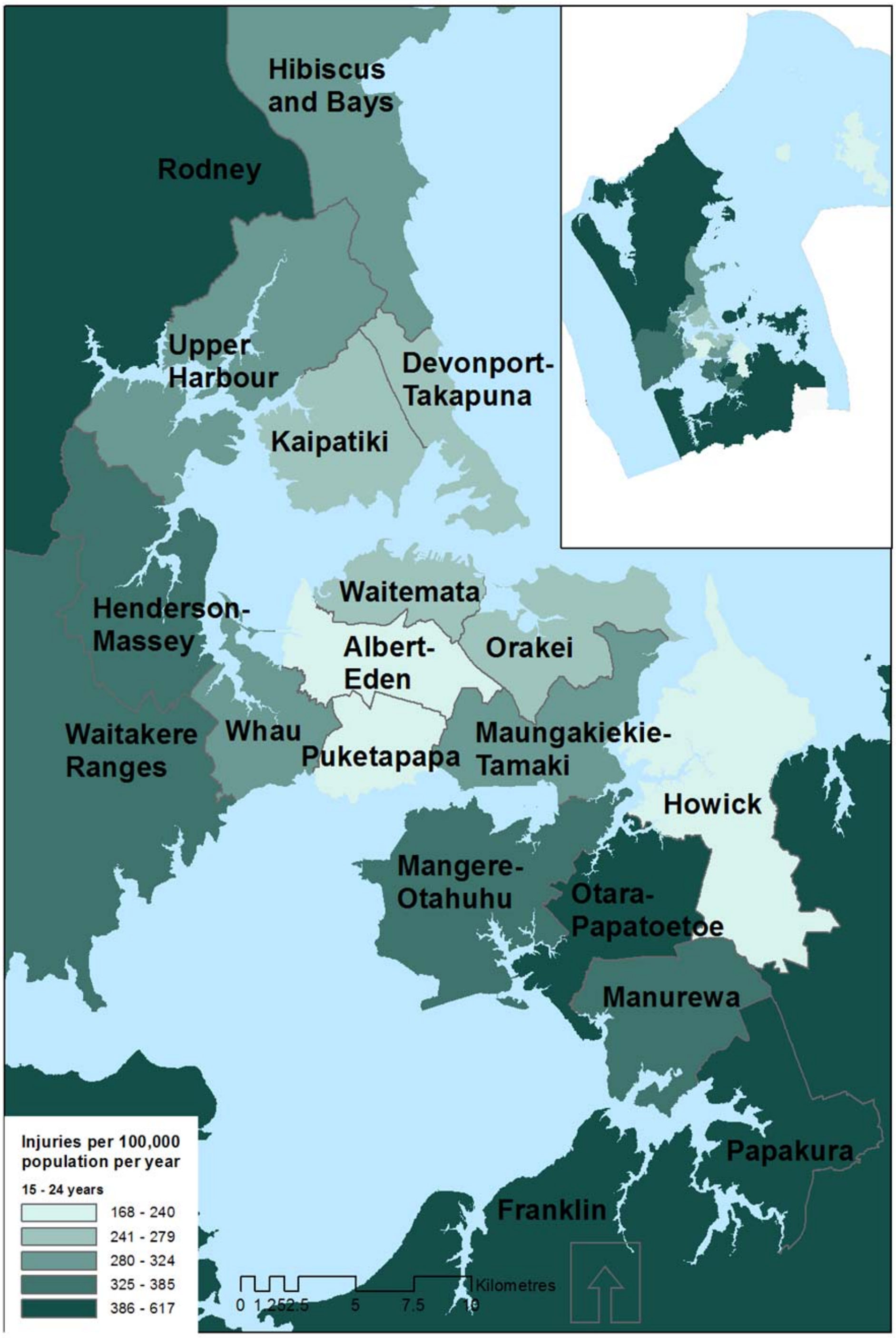

Figure 16: Road traffic injury deaths and hospitalisations by area of residence, 15-24 years, Auckland region, 2000-8

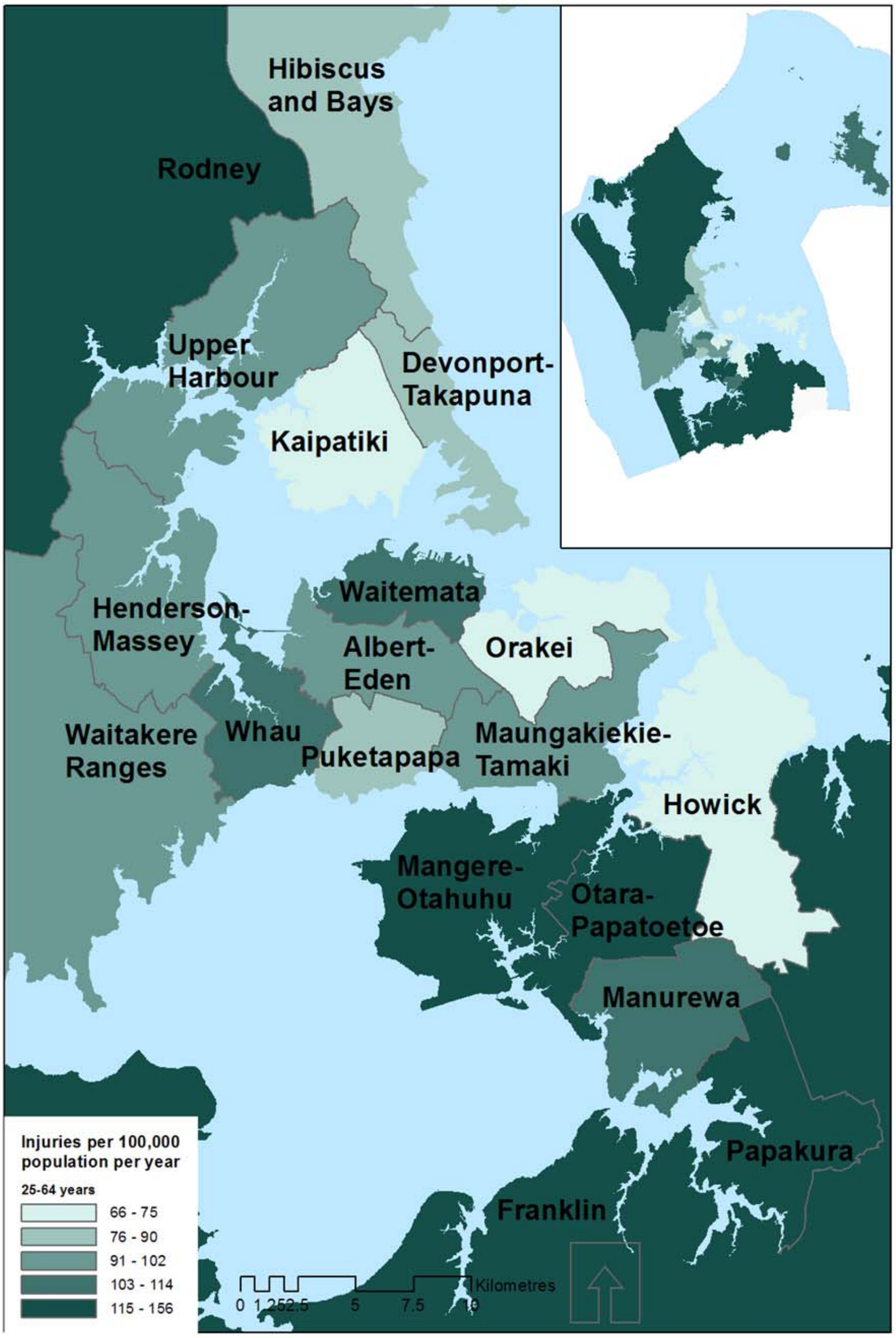

Figure 17: Road traffic injury deaths and hospitalisations by area of residence, 25-64 years, Auckland region, 2000-8

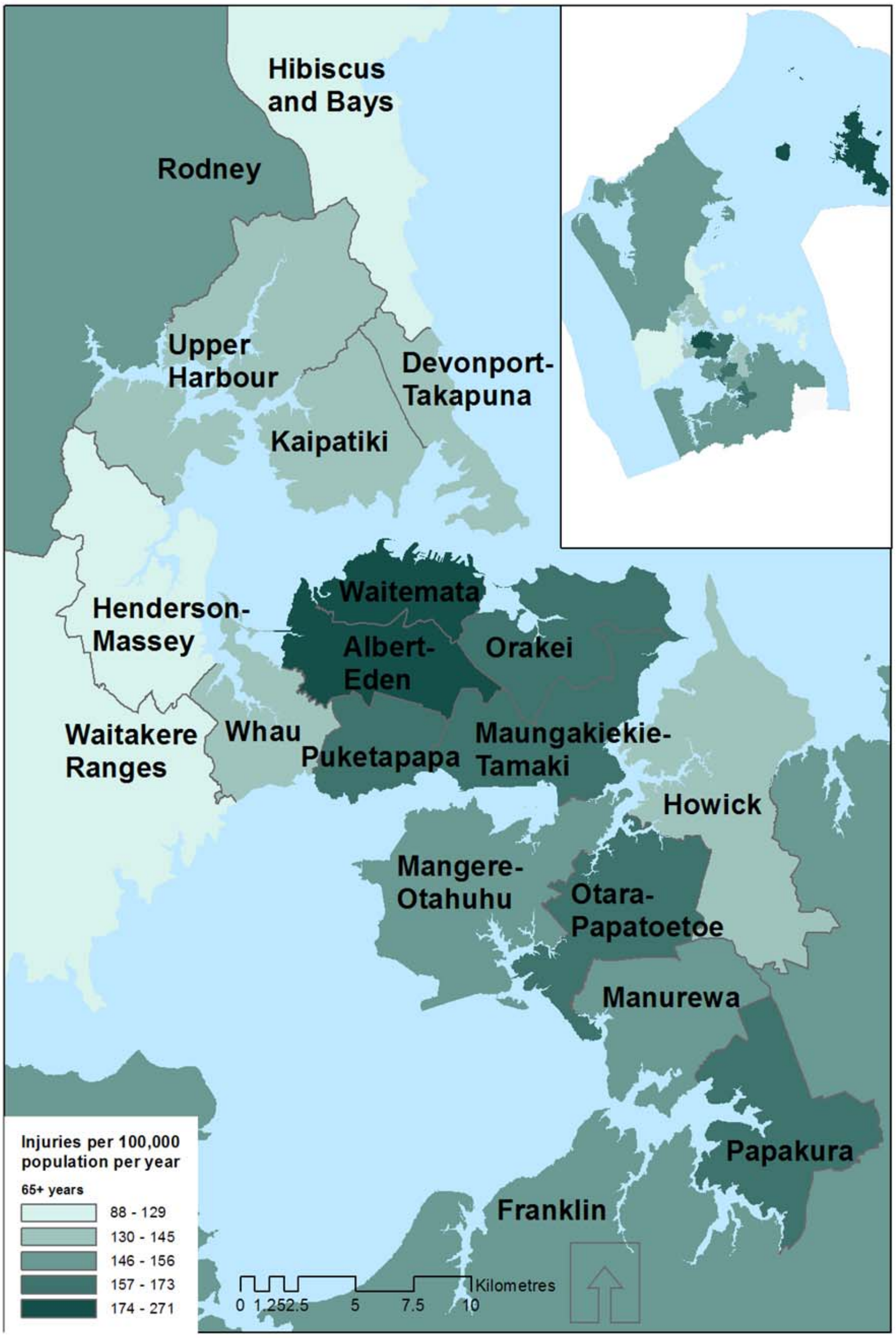

Figure 18: Road traffic injury deaths and hospitalisations by area of residence, 65+ years, Auckland region, 2000-8

Gender, Auckland region

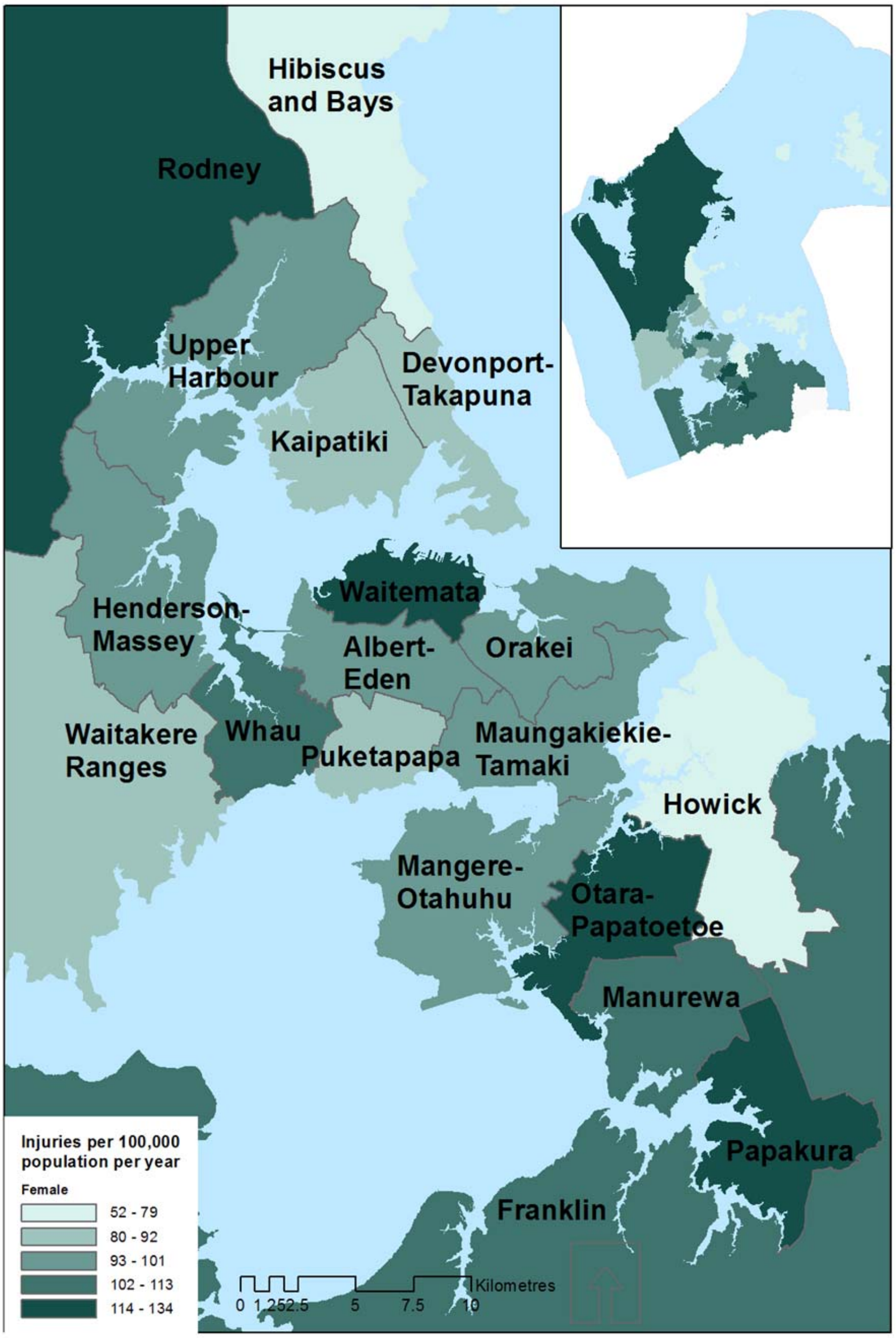

Figure 19: Road traffic injury deaths and hospitalisations by area of residence, females, Auckland region, 2000-8

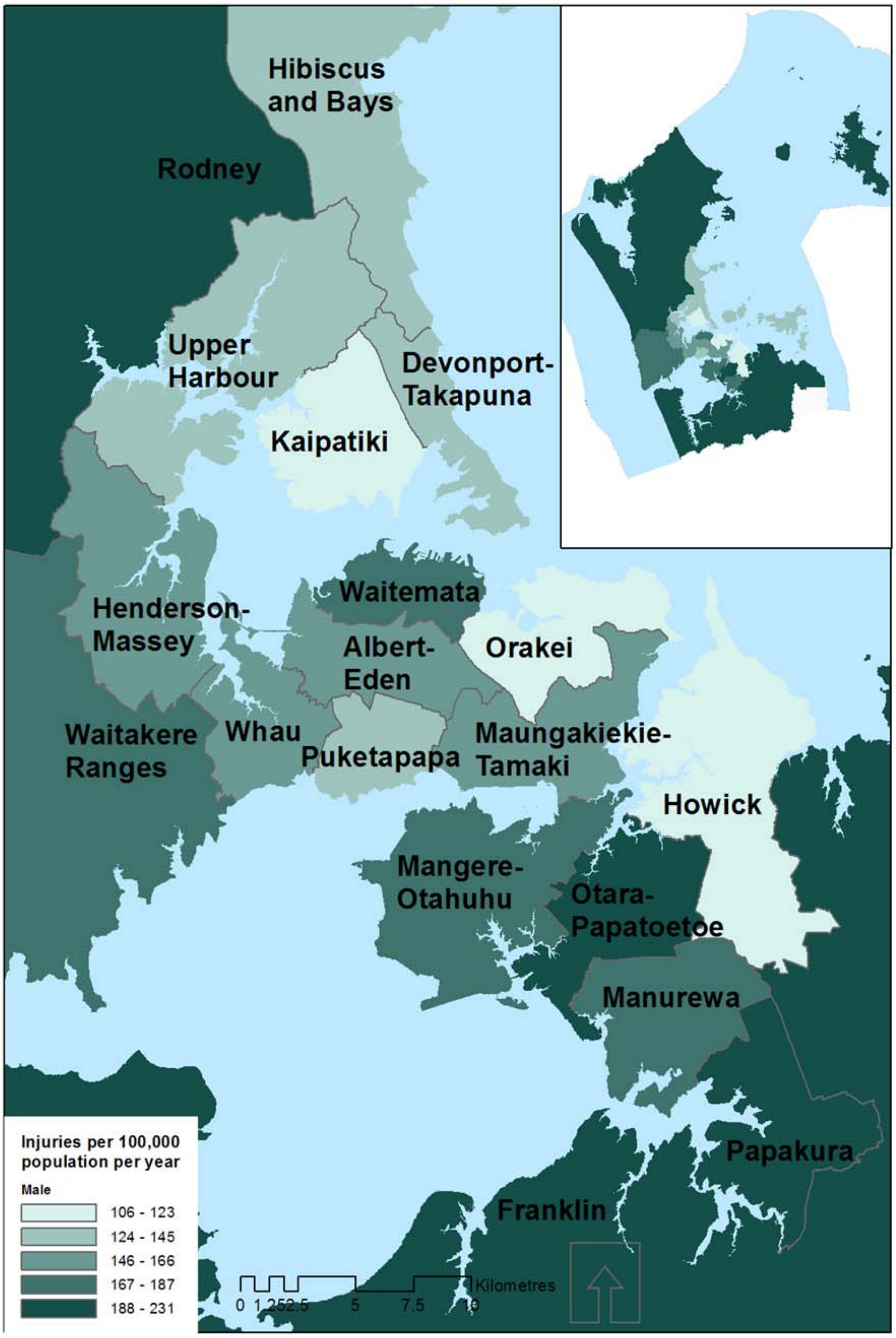

Figure 20: Road traffic injury deaths and hospitalisations by area of residence, males, Auckland region, 2000-8

Ethnic groups, Auckland region

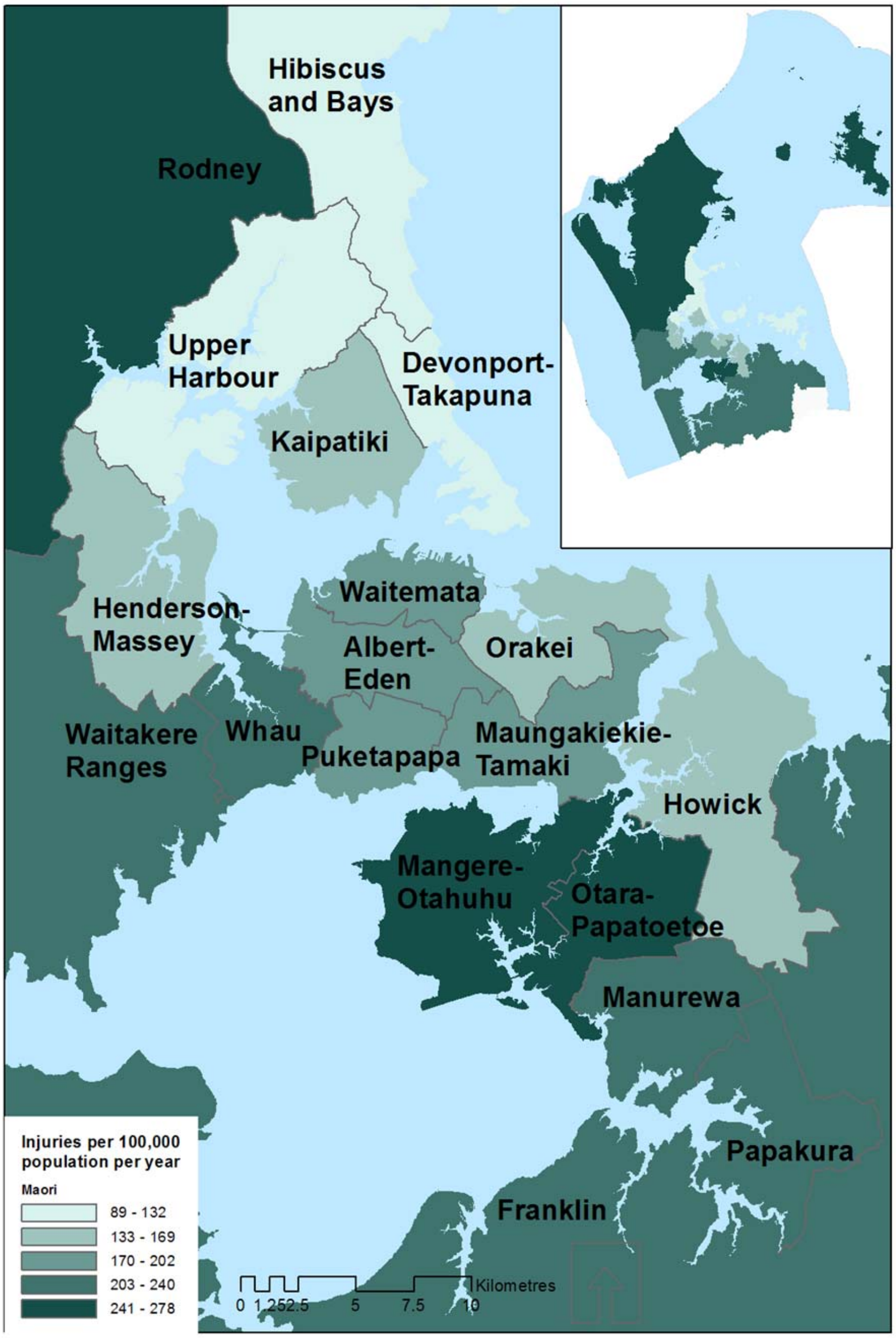

Figure 21: Road traffic injury deaths and hospitalisations by area of residence, Māori ethnic group, Auckland region, 2000-8

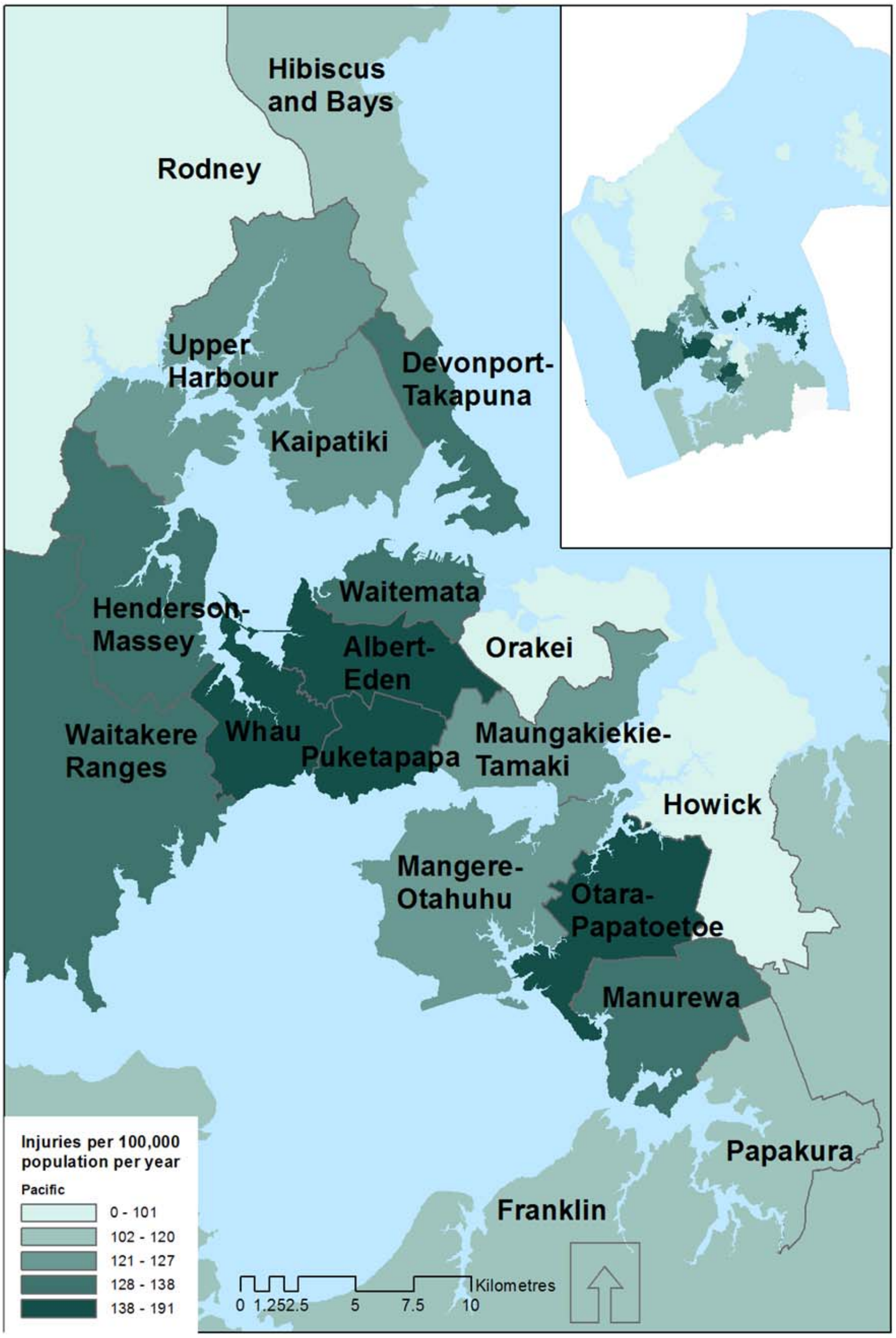

Figure 22: Road traffic injury deaths and hospitalisations by area of residence, Pacific ethnic group, Auckland region, 2000-8

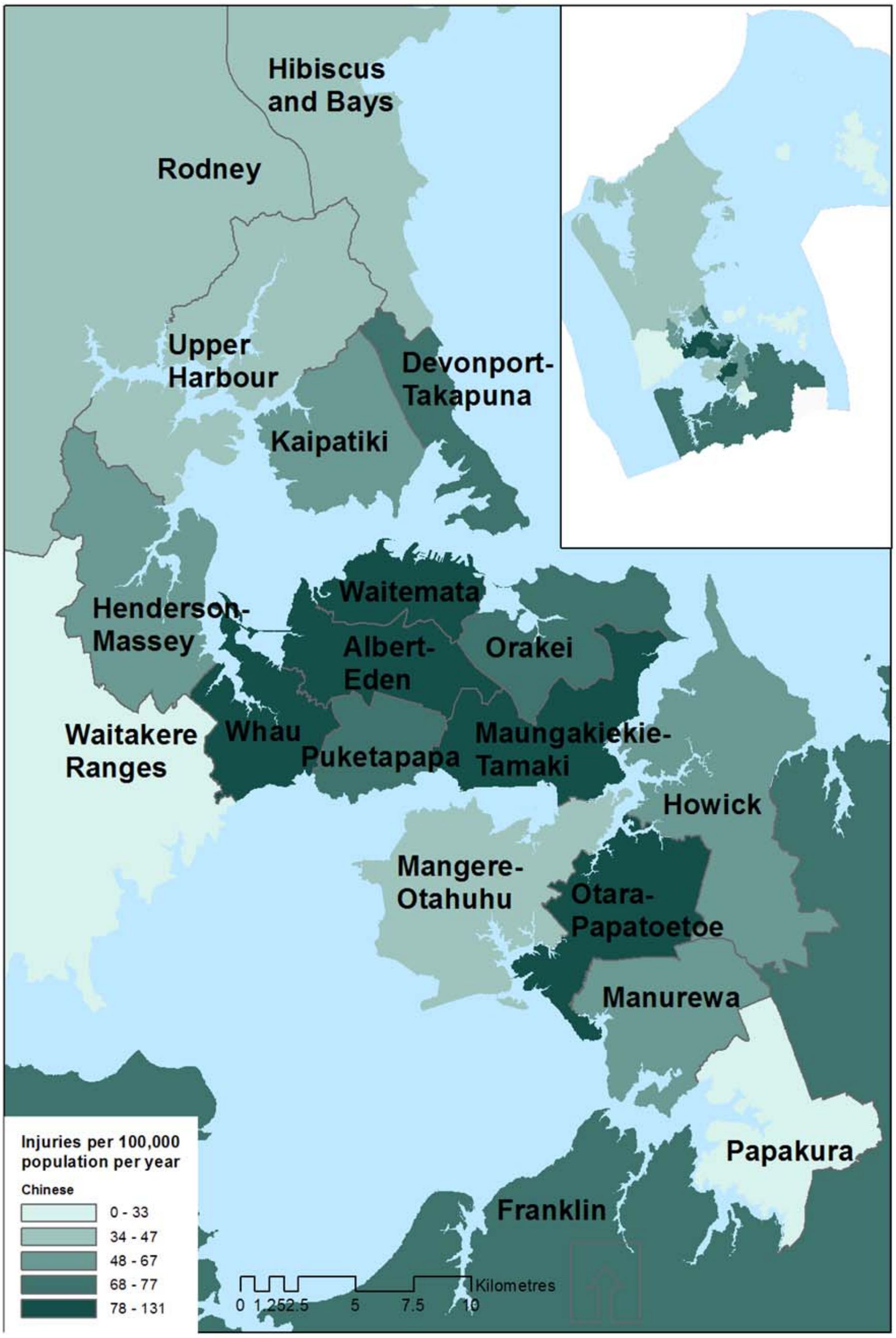

Figure 23: Road traffic injury deaths and hospitalisations by area of residence, Chinese ethnic group, Auckland region, 2000-8

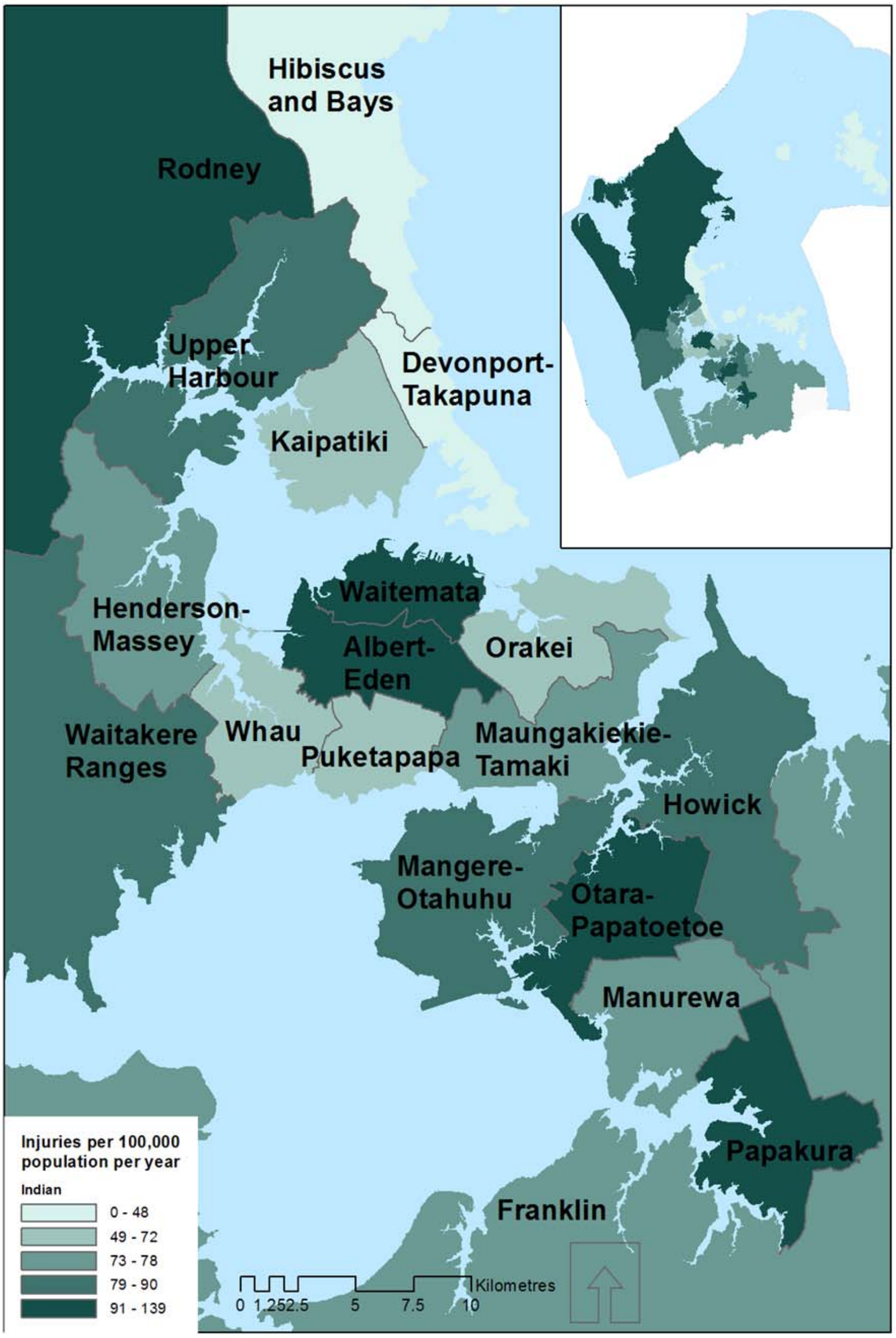

Figure 24: Road traffic injury deaths and hospitalisations by area of residence, Indian ethnic group, Auckland region, 2000-8

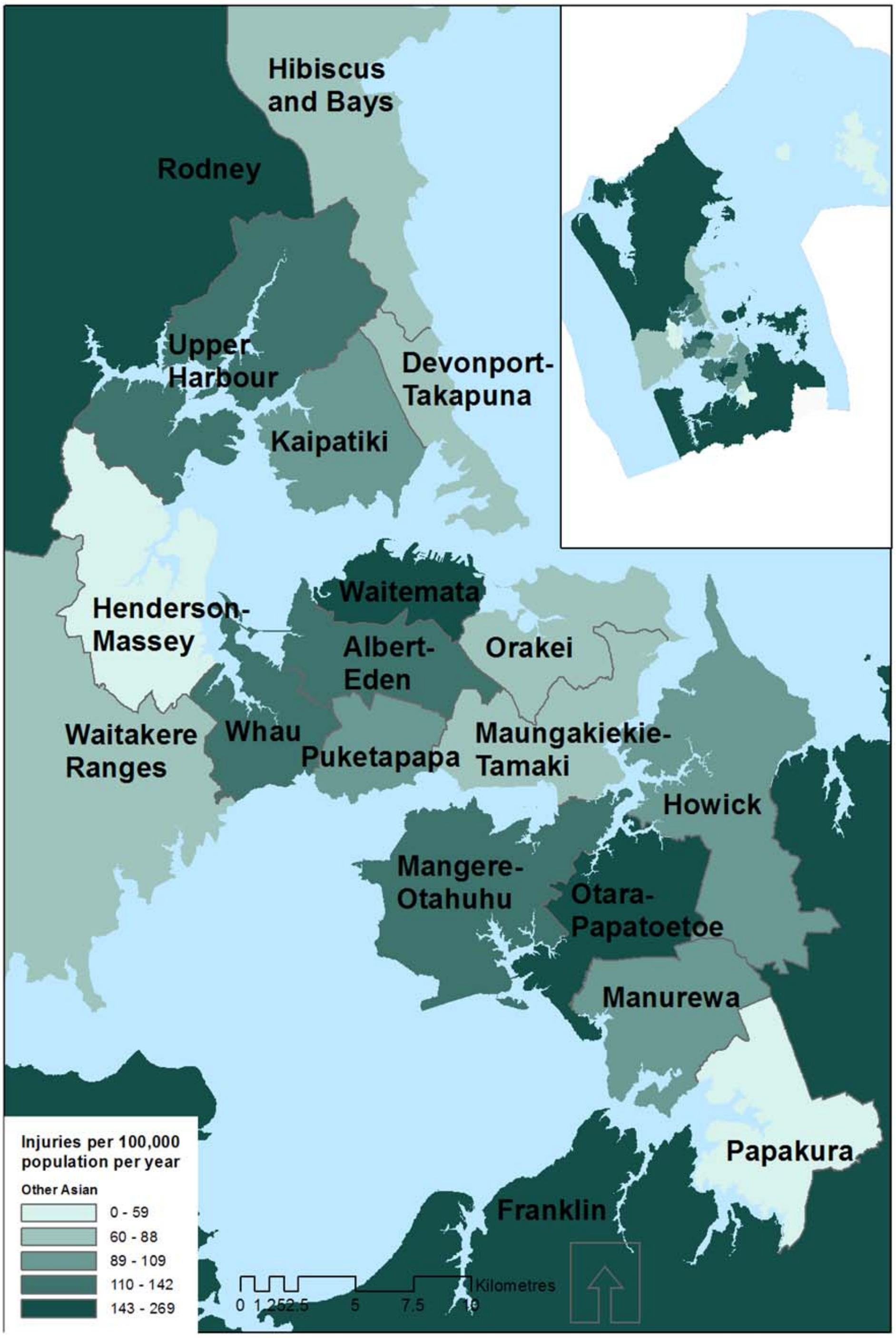

Figure 25: Road traffic injury deaths and hospitalisations by area of residence, Other Asian ethnic group, Auckland region, 2000-8

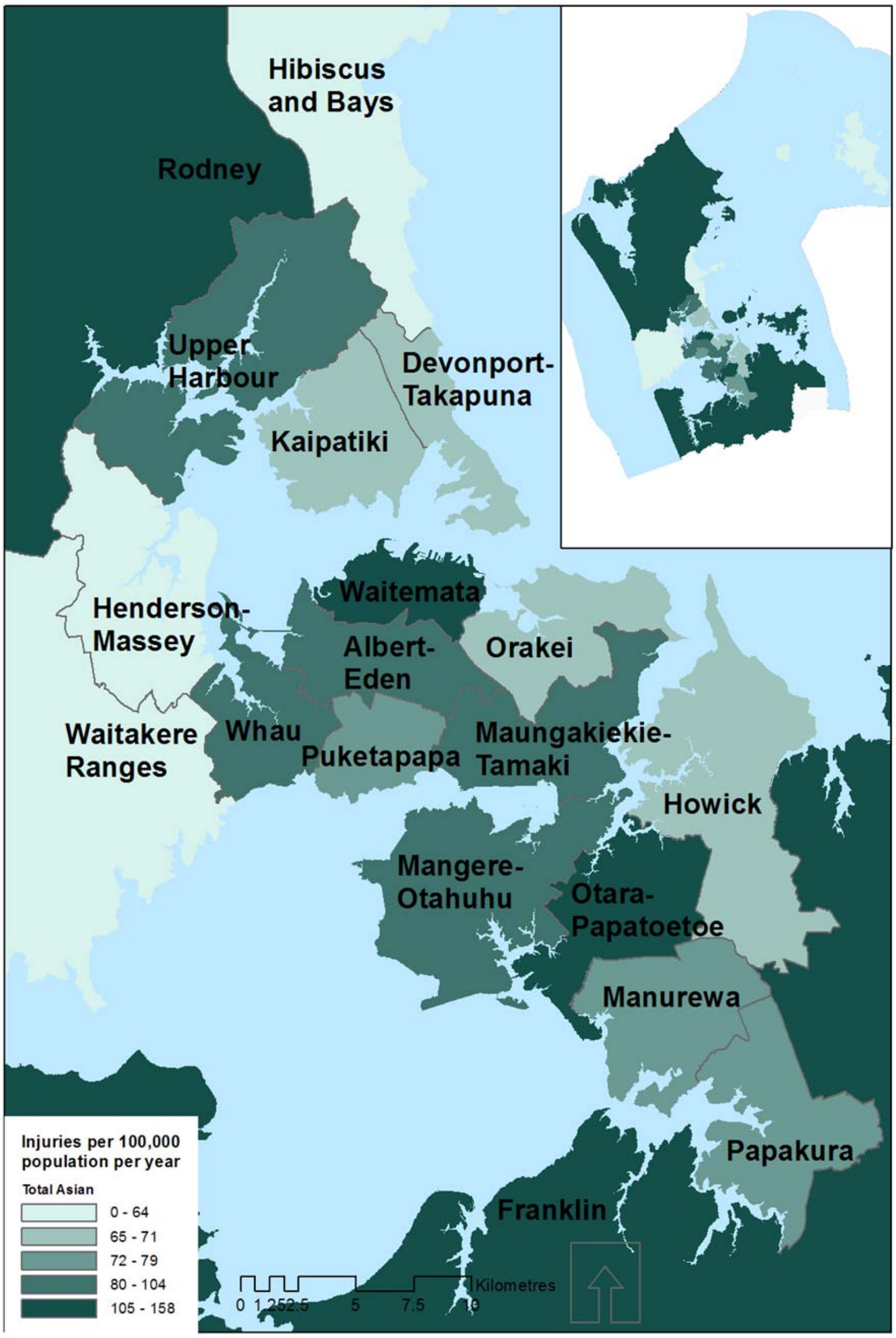

Figure 26: Road traffic injury deaths and hospitalisations by area of residence, Total Asian ethnic group, Auckland region, 2000-8

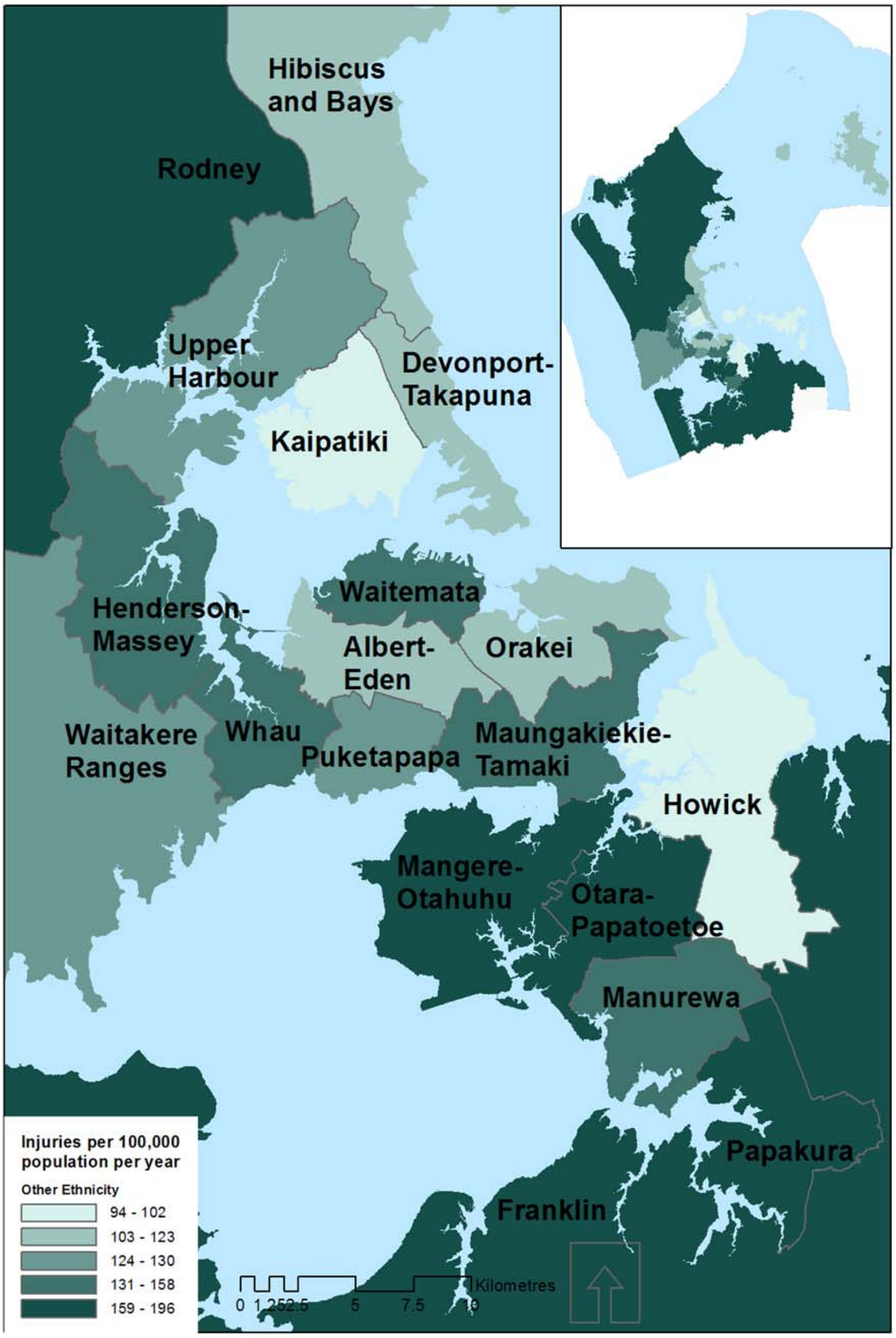

Figure 27: Road traffic injury deaths and hospitalisations by area of residence, New Zealand European/Other ethnic group , Auckland region, 2000-8

Injuries by travel mode, Auckland region

Note: these graphs by travel mode use a different shading scale for each map

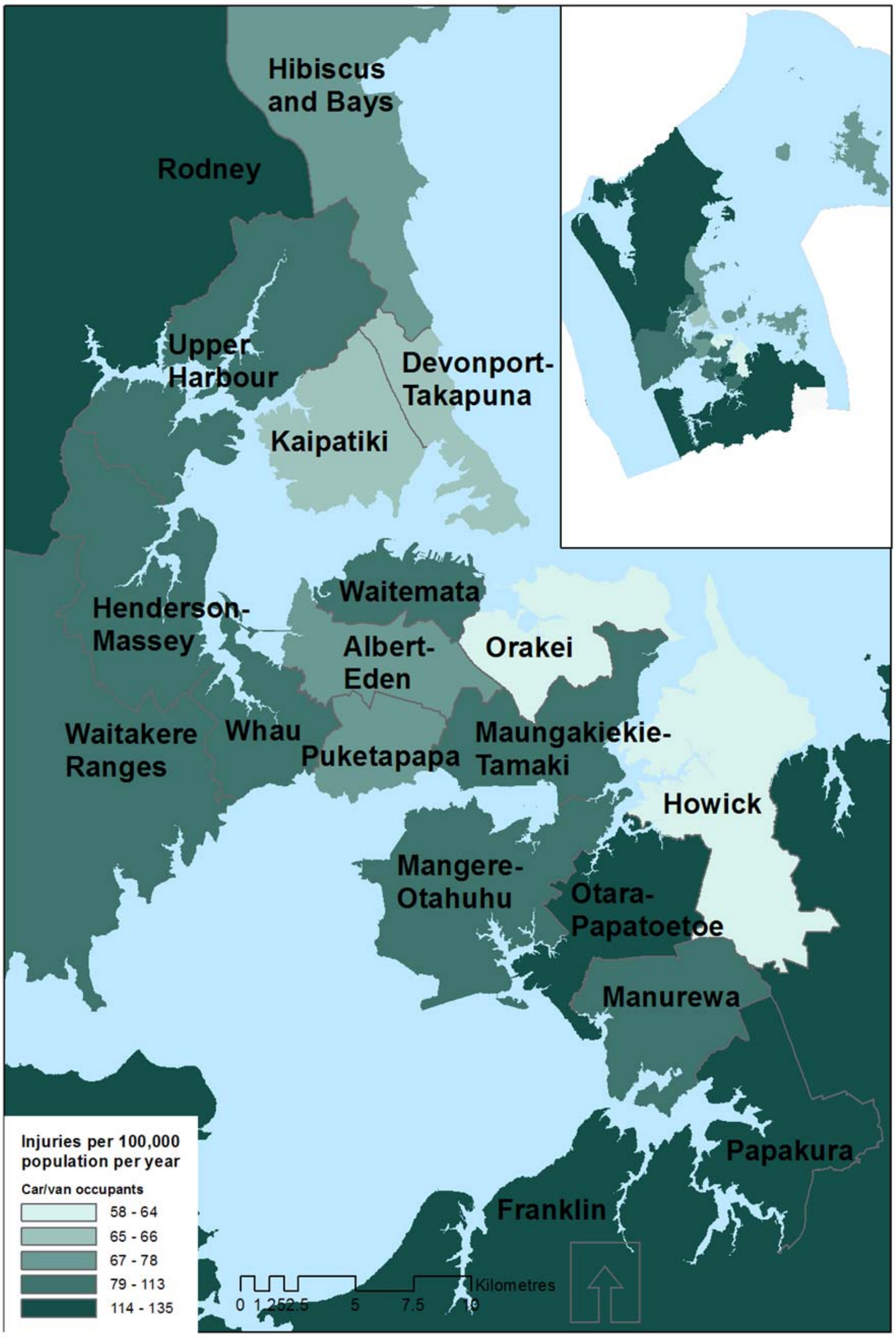

Figure 28: Road traffic injury deaths and hospitalisations by area of residence, car/van occupants, Auckland region, 2000-8

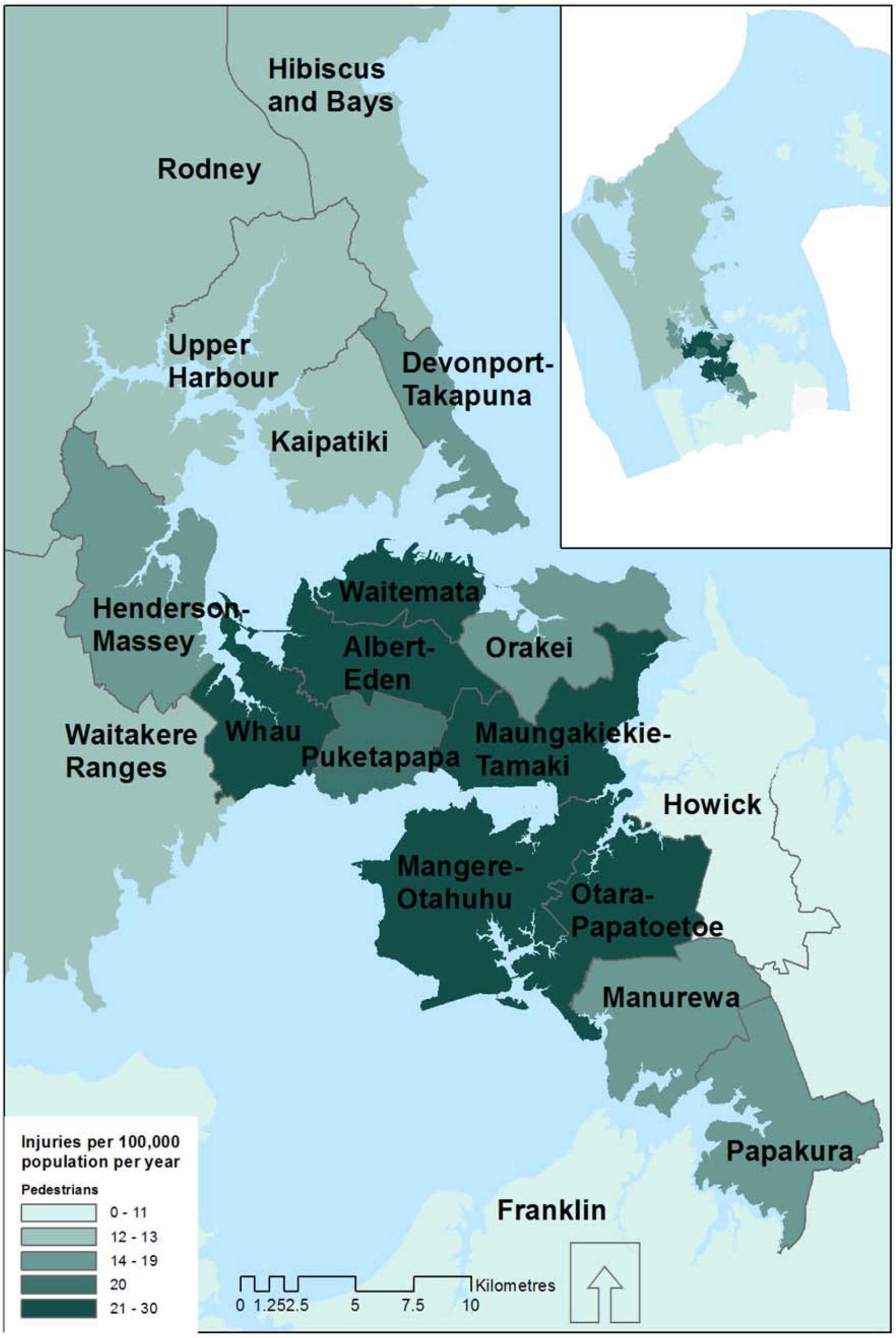

Figure 29: Road traffic injury deaths and hospitalisations by area of residence, pedestrians, Auckland region, 2000-8

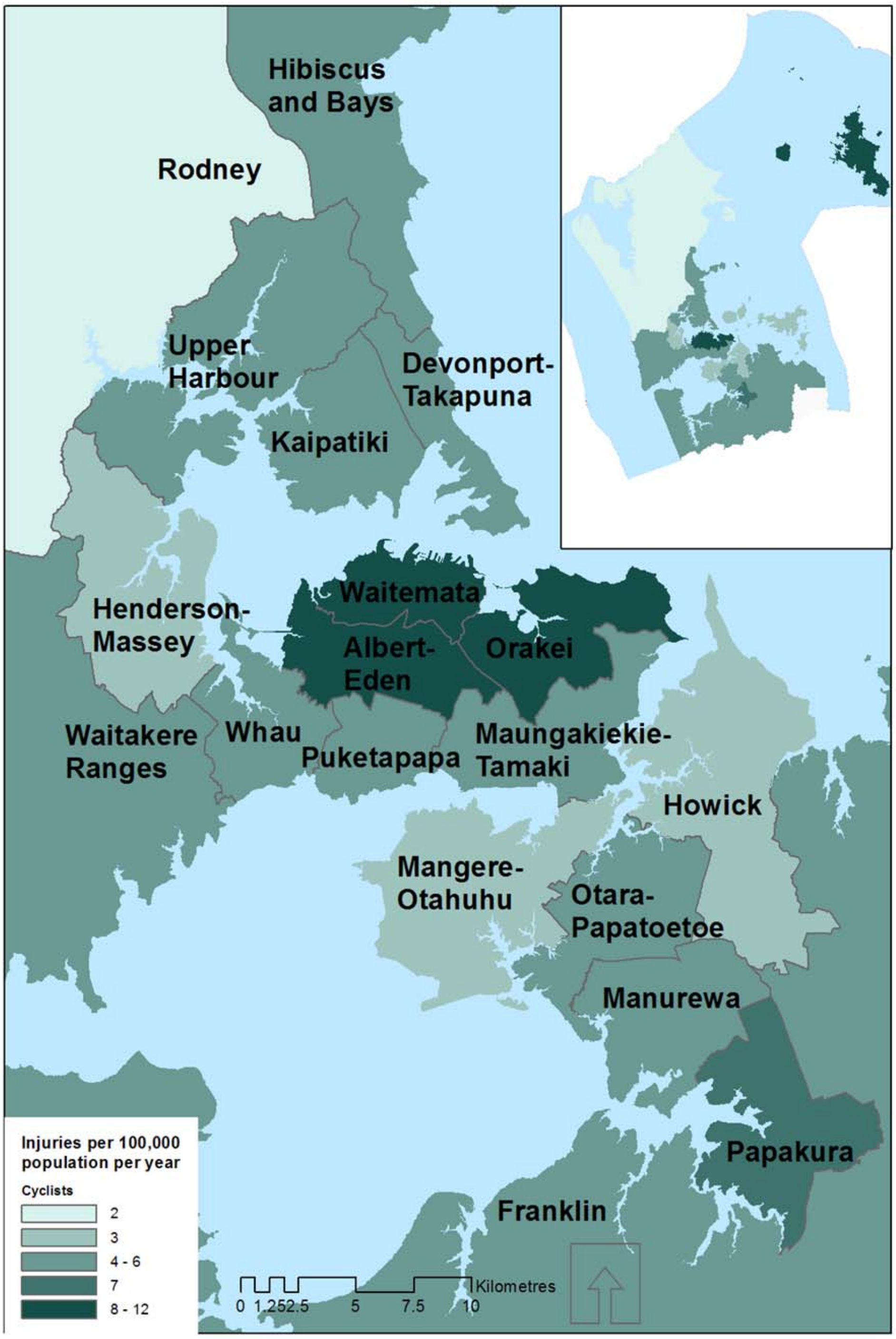

Figure 30: Road traffic injury deaths and hospitalisations by area of residence, cyclists, Auckland region, 2000-8

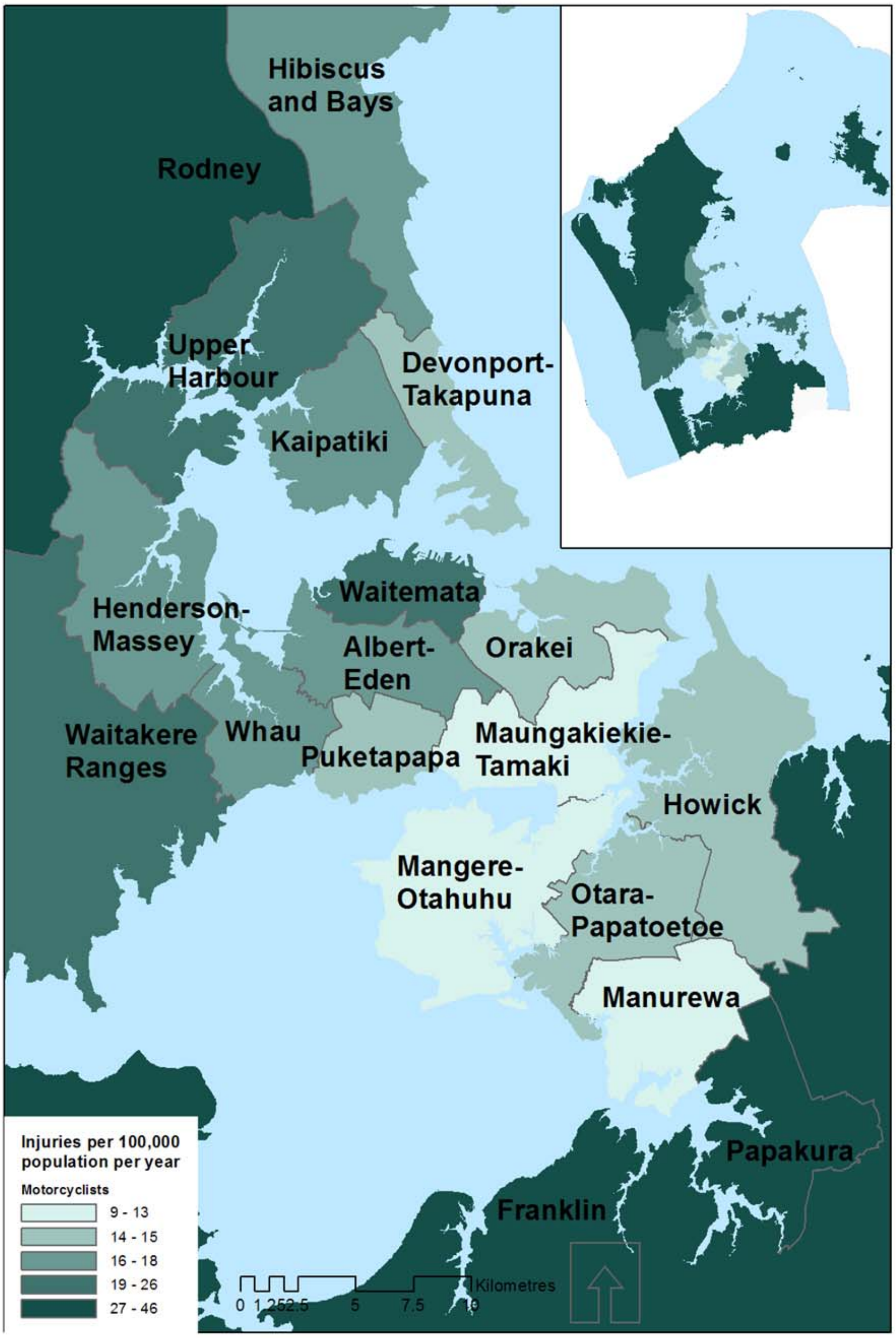

Figure 31: Road traffic injury deaths and hospitalisations by area of residence, motorcyclists, Auckland region, 2000-8

Figure 32: Road traffic injury deaths and hospitalisations by area of residence, other travel modes, Auckland region, 2000-8

Road Safety Action Plan areas

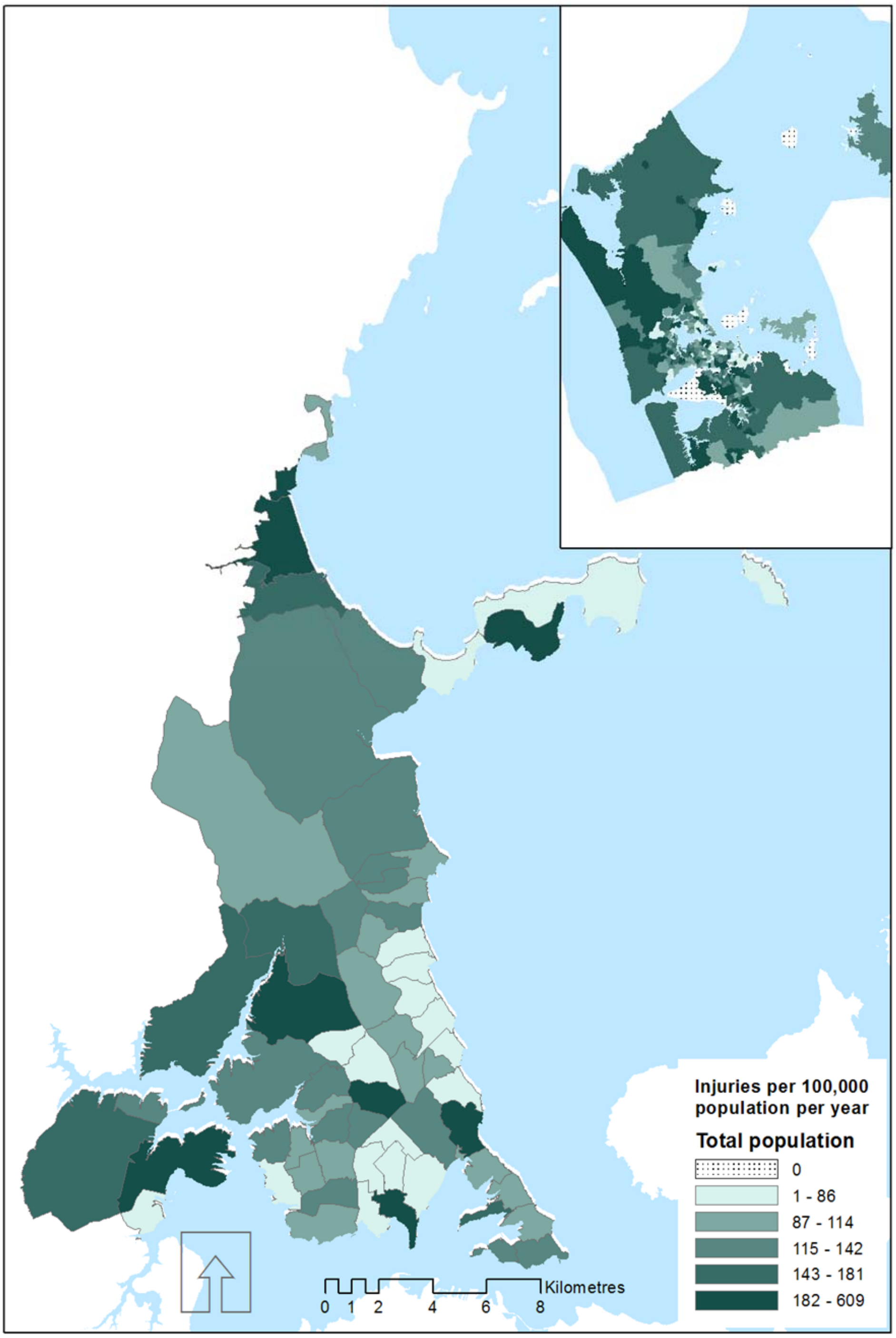

Figure 33: Road traffic injury deaths and hospitalisations by area of residence, Urban North and Auckland region, January 2000-June 2008

Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

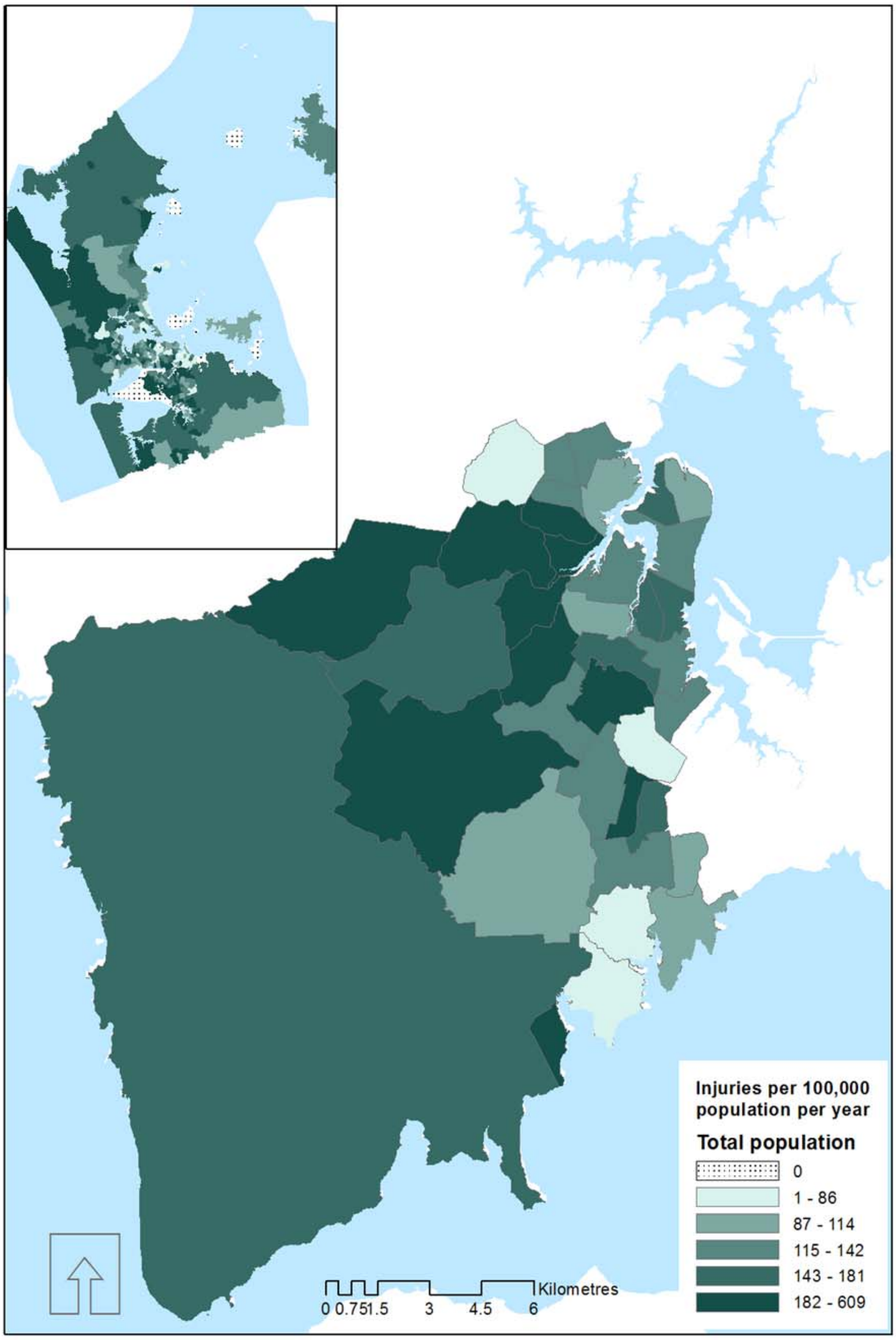

Figure 34: Road traffic injury deaths and hospitalisations by area of residence, Urban West and Auckland region, January 2000-June 2008

Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

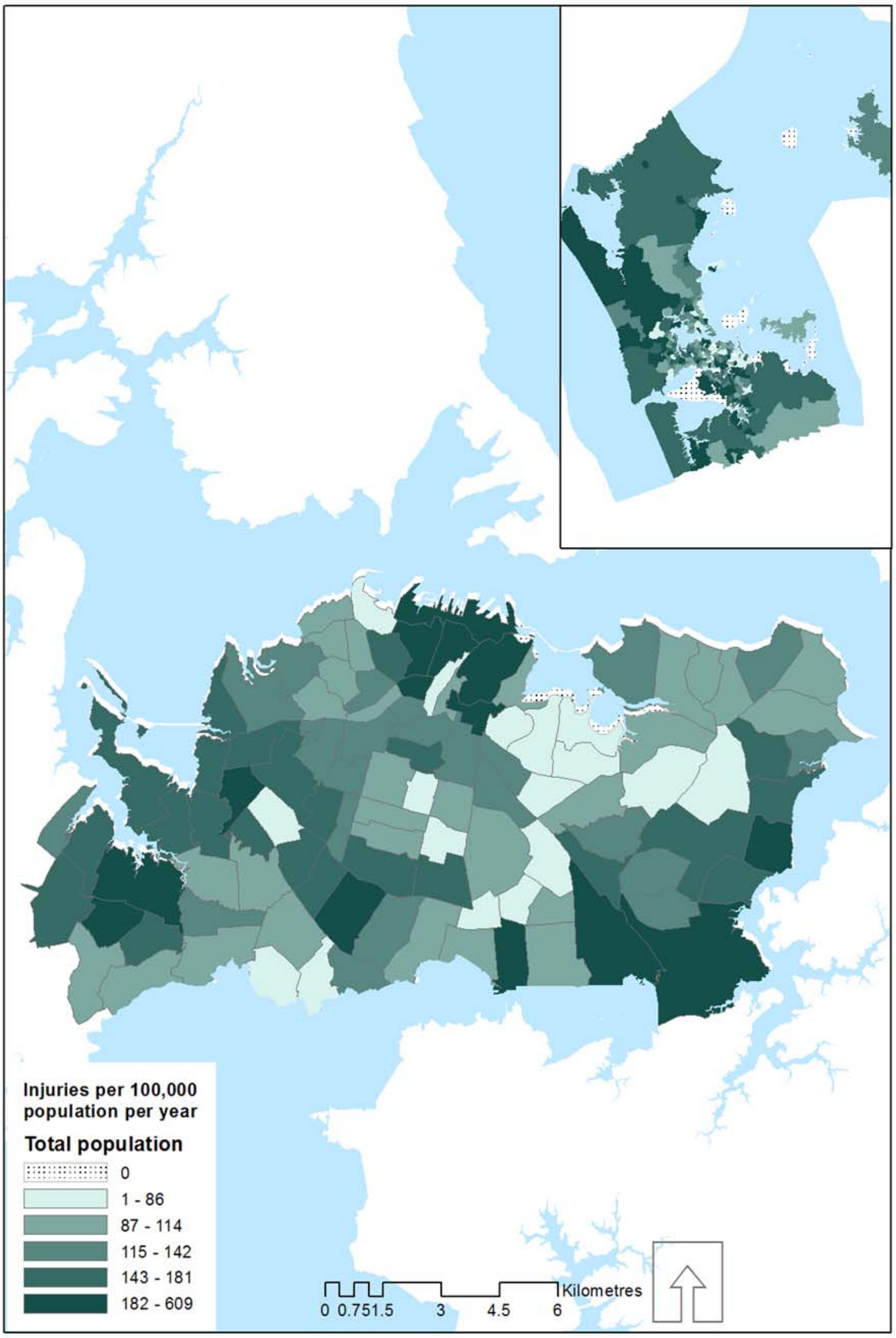

Figure 35: Road traffic injury deaths and hospitalisations by area of residence, Urban Central and Auckland region, January 2000-June 2008

Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

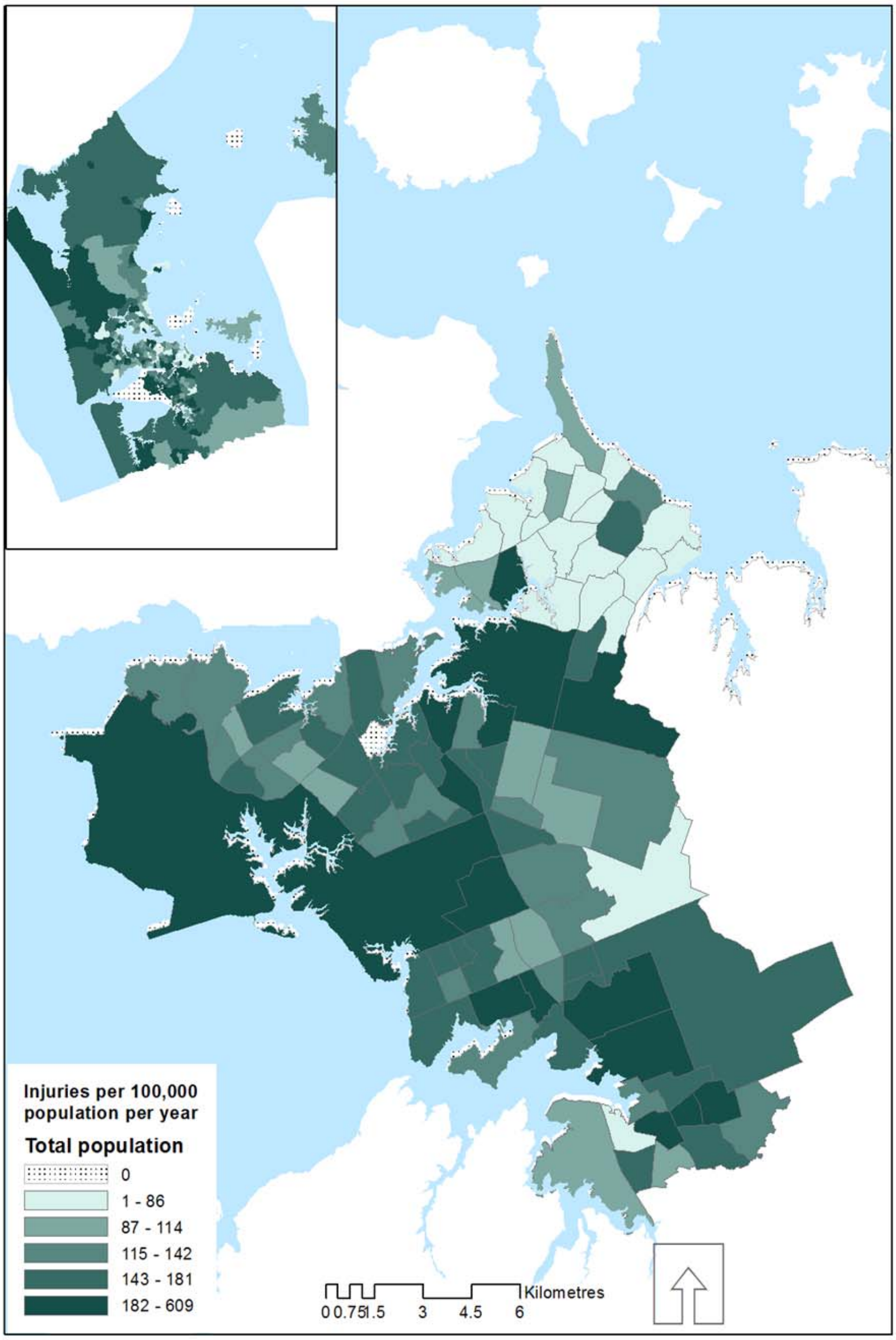

Figure 36: Road traffic injury deaths and hospitalisations by area of residence, Urban South and Auckland region, January 2000-June 2008

Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

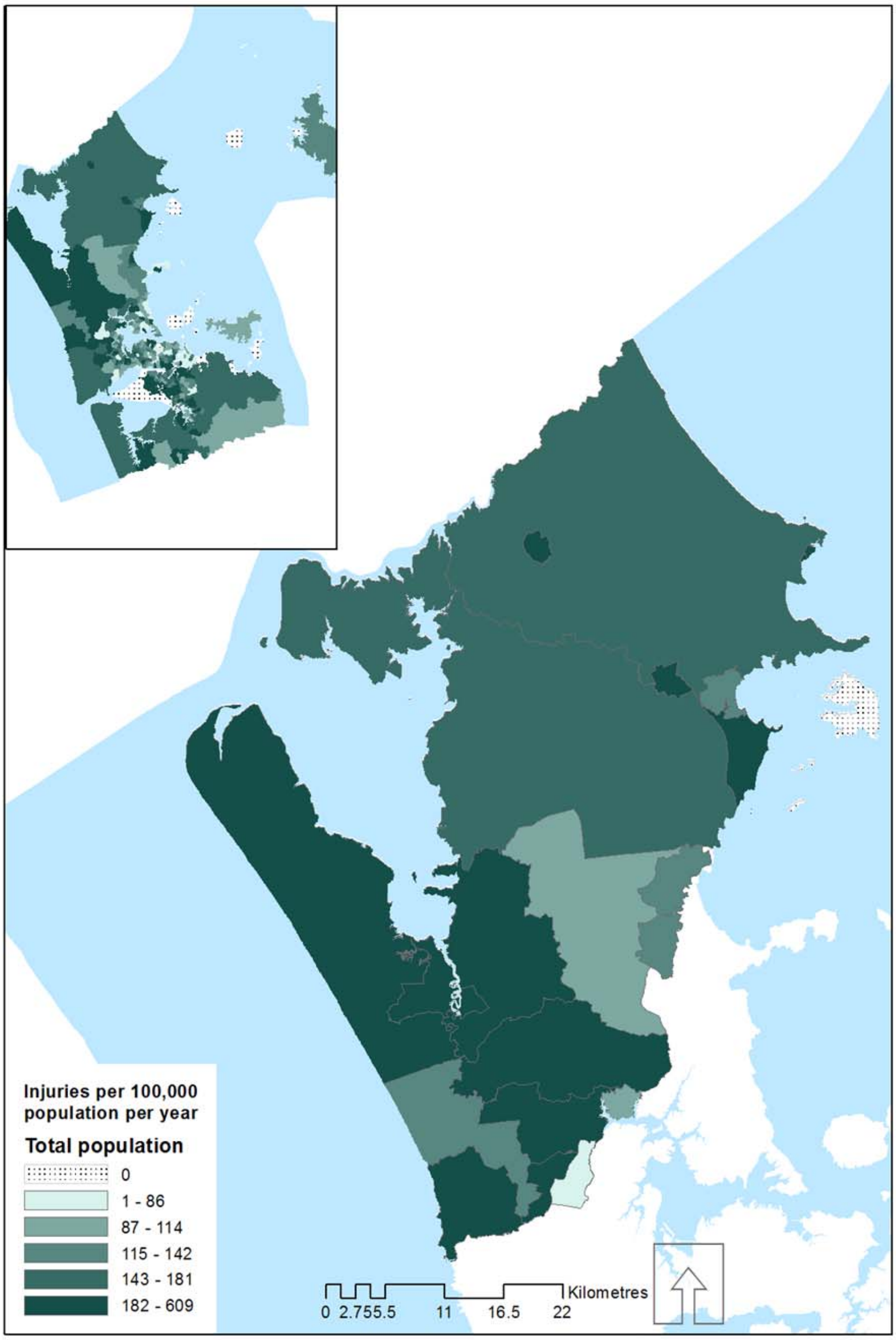

Figure 37: Road traffic injury deaths and hospitalisations by area of residence, Rural North and Auckland region, January 2000-June 2008

Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

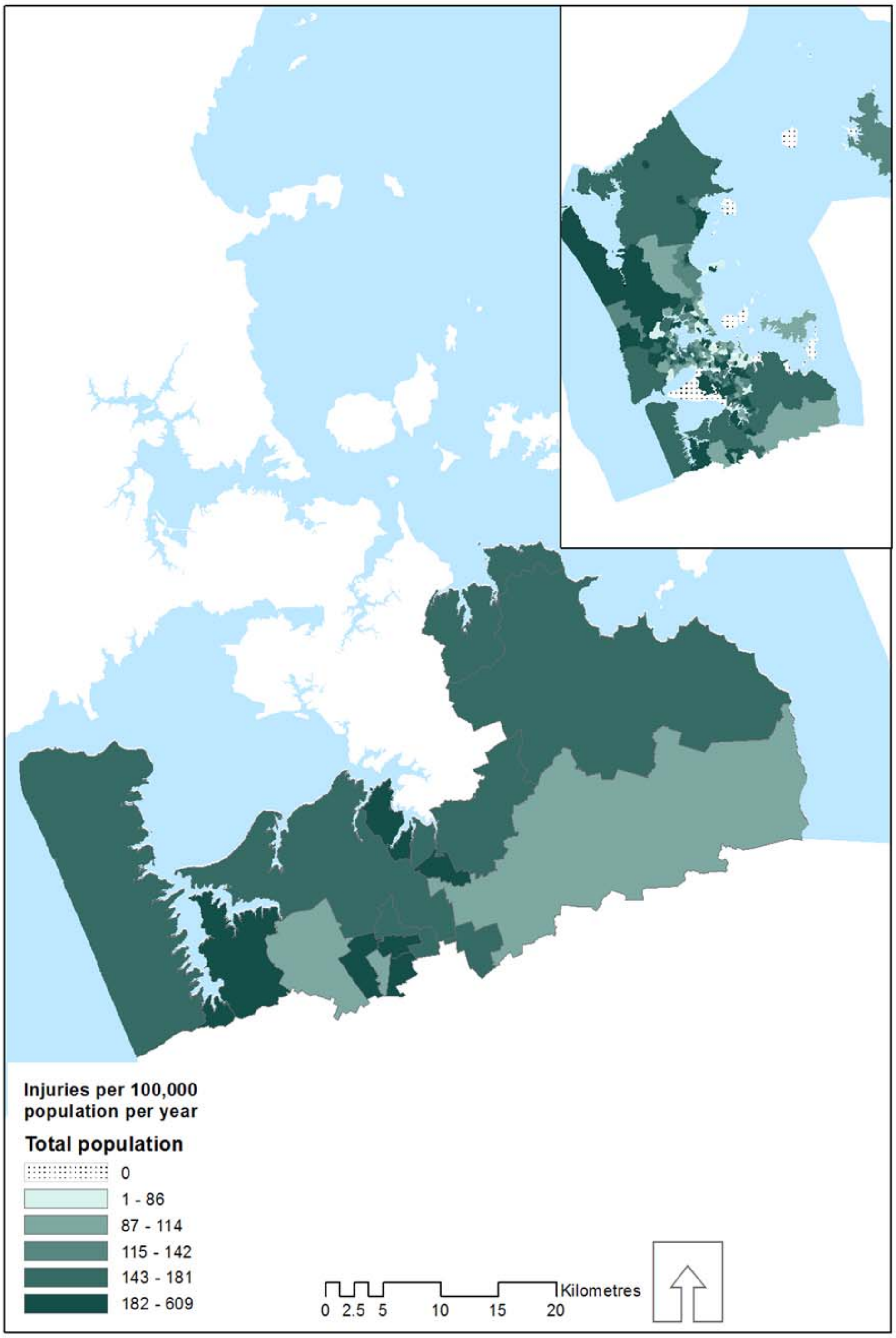

Figure 38: Road traffic injury deaths and hospitalisations by area of residence, Rural South and Auckland region, January 2000-June 2008
Note: Injury rates for census area units that underwent boundary changes in 2001 were calculated for the period July 2003-July 2008 only

Appendix 3: Glossary

ACC: Accident Compensation Corporation

AHB: Area Health Board

CAS: Crash Analysis System

CAU: Census Area Unit

CDC: Centers for Disease Control and Prevention

DHB: District Health Board

GIS: Geographical Information System

ICD: International Classification of Diseases

LoSS: Level of Safety Service

NMDS: National Minimum Data Set

NZCMS: New Zealand Census Mortality Study

NZDep: New Zealand Index of Deprivation

NZTA: New Zealand Transport Agency

RLTS: Regional Land Transport Strategy

RISA: Road Infrastructure Safety Assessment

VKT: vehicle kilometres travelled

References

1. Blakely T, Tobias M, Atkinson J, Yeh L-C, Huang K. Tracking disparity: trends in ethnic and socioeconomic inequalities in mortality, 1981–2004. Wellington (NZ): Ministry of Health; 2007.
2. Turner S. Survey of pedestrians and cyclists involved in crashes at Christchurch Hospital. IPENZ Transportation Group Conference; 2010 March; Christchurch. 2010.
3. Auckland Regional Council. Auckland regional land transport strategy 2010-2040. Auckland: Auckland Regional Council; 2010. http://www.arc.govt.nz/albany/fms/main/Documents/Transport/RLTS/RLTS%202009/Regional%20Land%20Transport%20Strategy%20(RLTS)%202010-2040.pdf
4. Auckland Council. The Auckland plan. Auckland: Auckland Council; 2012. http://theplan.theaucklandplan.govt.nz/
5. New Zealand Transport Agency. High-risk rural roads guide. Wellington: New Zealand Transport Agency; 2011. http://www.nzta.govt.nz/resources/high-risk-rural-roads-guide/docs/high-risk-rural-roads-guide.pdf
6. New Zealand Transport Agency. Briefing notes: crash analysis. A Safe System approach. Auckland region 2006 to 2010. Wellington: New Zealand Transport Agency; 2011. http://www.nzta.govt.nz/resources/briefing-notes-cas/docs/auckland-2011.pdf
7. Auckland Regional Transport Authority, RoadSafe Auckland. Auckland regional road safety plan 2009/12: creating a safer transport system for Aucklanders. Auckland (NZ): Auckland Regional Transport Authority; 2009. http://www.roadsafeauckland.org.nz/media/pdf/ARTA_Safety_Plan_2009-2012_%20low_res.pdf
8. New Zealand Transport Agency. Communities at risk register. Wellington: New Zealand Transport Agency; 2011. http://www.nzta.govt.nz/resources/communities-at-risk-register/register.html.
9. Proffitt C, Beacham M. The New Zealand injury prevention outcomes report – June 2012. Wellington: Accident Compensation Corporation (ACC); 2012. http://nzips.govt.nz/documents/nzips-outcome-report-june-2012.pdf
10. Statistics New Zealand. Serious injury outcome indicators - technical report. Wellington (NZ): Statistics New Zealand; 2011. http://www.stats.govt.nz/~/media/Statistics/browse-categories/health/injuries/serious-injury-outcome-indicators/serious-injury-outcome-indicators-technical-report.pdf
11. ACC. Frequently requested facts and stats. Wellington: Accident Compensation Corporation; 2010. http://www.acc.co.nz/about-acc/statistics/ABA00053.
12. ACC. How to read ACC statistics. Wellington: Accident Compensation Corporation; 2008. http://www.acc.co.nz/about-acc/statistics/ABA00066.
13. ACC. About the injury statistics tool. Wellington: Accident Compensation Corporation; 2012. http://www.acc.co.nz/about-acc/statistics/STAT0001.
14. Stephenson S, Langley J, Trotter M. Impact of injury in New Zealand. Dunedin: University of Otago; 2005. http://www.nzips.govt.nz/documents/impact-of-injury-feb05.pdf
15. ACC. Te tūroro Māori me o mahi: the Māori patient in your practice. Guidelines on Māori cultural competencies for providers. Wellington: ACC; 2004. http://www.acc.co.nz/PRD_EXT_CSMP/groups/external_providers/documents/guide/wcm2_020645.pdf
16. Sobrun-Maharaj A, Tse S, Hoque E. Barriers experienced by Asians in accessing injury-related services and compensations. Journal of Primary Health Care. 2010;2(1):43-53.
17. ACC Research Ethics Committee. Research ethics at ACC: summary of guidelines for staff. Wellington: Accident Compensation Corporation; 2007. http://www.acc.co.nz/PRD_EXT_CSMP/groups/external_communications/documents/guide/wcm001896.pdf
18. Auckland Regional Public Health Service. Improving health and wellbeing: a public health perspective for local authorities in the Auckland region. Auckland: Auckland Regional Public Health Service; 2006. http://www.arphs.govt.nz/Portals/0/About%20us/Publications%20and%20Reports/List%20of%20publications%20and%20reports/Generalreports/Improving%20health%20Akland%20local%20authorities/Sophar06.pdf
19. Alatini M. Analysis of unintentional child injury data in New Zealand: mortality (2001-2005) and morbidity (2003-2007). Auckland (NZ): Safekids; 2009. http://www.safekids.org.nz/Downloads/Research/Safekids%20Analysis%20VLR_2.pdf
20. Roberts I, Norton R, Taua B. Child pedestrian injury rates: the importance of "exposure to risk" relating to socioeconomic and ethnic differences, in Auckland, New Zealand. Journal of Epidemiology and Community Health. 1996 April 1, 1996;50(2):162-5.

21. Shaw C, Blakely T, Crampton P, Atkinson J. The contribution of causes of death to socioeconomic inequalities in child mortality: New Zealand 1981–1999. New Zealand Medical Journal. 2005;118(1227):U1779.
22. Roberts IG, Keall MD, Frith WJ. Pedestrian exposure and the risk of child pedestrian injury. Journal of Paediatrics and Child Health. 1994;30:220-3.
23. Whitlock G, Norton R, Clark T, Pledger M, Jackson R, MacMahon S. Motor vehicle driver injury and socioeconomic status: a cohort study with prospective and retrospective driver injuries. Journal of Epidemiology and Community Health. 2003 July 1, 2003;57(7):512-6.
24. Ameratunga S, Hijar M, Norton R. Road-traffic injuries: confronting disparities to address a global-health problem. The Lancet. 2006;367(9521):1533-40.
25. Laflamme L, Diderichsen F. Social differences in traffic injury risks in childhood and youth—a literature review and a research agenda. Injury Prevention. 2000 December 1, 2000;6(4):293-8.
26. Peden M, Scurfield R, Sleet D, et al., editors. World report on road traffic injury prevention. Geneva (CHE): World Health Organization; 2004.
27. Kristensen P, Kristiansen T, Rehn M, Gravseth HM, Bjerkedal T. Social inequalities in road traffic deaths at age 16–20 years among all 611 654 Norwegians born between 1967 and 1976: a multilevel analysis. Injury Prevention. 2012 February 1, 2012;18(1):3-9.
28. Laflamme L, Hasselberg M, Reimers A-M, Cavalini LT, Ponce de Leon A. Social determinants of child and adolescent traffic-related and intentional injuries: A multilevel study in Stockholm County. Social Science & Medicine. 2009;68(10):1826-34.
29. Hasselberg M, Laflamme L. Road traffic injuries among young car drivers by country of origin and socioeconomic position. Int J Public Health. 2008;53:40-5.
30. Hanna C, Hasselberg M, Laflamme L, Moller J. Road traffic crash circumstances and consequences among young unlicensed drivers: A Swedish cohort study on socioeconomic disparities. BMC Public Health. 2010;10(1):14.
31. Fleury D, Peytavin JF, Alam T, Brenac T. Excess accident risk among residents of deprived areas. Accident Analysis & Prevention. 2010;42(6):1653-60.
32. Licaj I, Haddak M, Pochet P, Chiron M. Contextual deprivation, daily travel and road traffic injuries among the young in the Rhône Département (France). Accident Analysis & Prevention. 2011;43(5):1617-23.
33. Green J, Muir H, Maher M. Child pedestrian casualties and deprivation. Accident Analysis & Prevention. 2011;43(3):714-23.
34. Cottrill CD, Thakuriah P. Evaluating pedestrian crashes in areas with high low-income or minority populations. Accident Analysis & Prevention. 2010;42(6):1718-28.
35. Chakravarthy B, Anderson CL, Ludlow J, Lotfipour S, Vaca FE. The Relationship of Pedestrian Injuries to Socioeconomic Characteristics in a Large Southern California County. Traffic Injury Prevention. 2010 2010/09/22;11(5):508-13.
36. West BA, Naumann RB. Motor vehicle-related deaths - United States, 2003-2007. MMWR. 2011;60:52-5.
37. Crompton JG, Pollack KM, Oyetunji T, et al. Racial disparities in motorcycle-related mortality: an analysis of the National Trauma Data Bank. The American Journal of Surgery. 2010;200(2):191-6.
38. Clapham K, Senserrick T, Ivers R, Lyford M, Stevenson M. Understanding the extent and impact of Indigenous road trauma. Injury. 2008;39, Supplement 5(0):S19-S23.
39. Steinbach R, Green J, Edwards P, Grundy C. 'Race' or place? Explaining ethnic variations in childhood pedestrian injury rates in London. Health & Place. 2010;16(1):34-42.
40. Malhotra N, Hutchings A, Edwards P. Does the decline in road traffic injury in London vary by ethnicity? Injury Prevention. 2008;14:333-7.
41. Razzak JA, Khan UR, Jalal S. Application of geographical information system (GIS) for mapping road traffic injuries using existing source of data in Karachi, Pakistan - a pilot study. J Pak Med Assoc. 2011;61(7):640-3.
42. Lateef MU. Spatial patterns monitoring of road traffic injuries in Karachi metropolis. International Journal of Injury Control and Safety Promotion. 2010 2011/06/01;18(2):97-105.
43. Weiner EJ, Tepas JJI. Application of Electronic Surveillance and Global Information System Mapping to Track the Epidemiology of Pediatric Pedestrian Injury. The Journal of Trauma and Acute Care Surgery. 2009;66(3):S10-S6 .1097/TA.0b013e3181937bc8.
44. Jones AP, Haynes R, Kennedy V, Harvey IM, Jewell T, Lea D. Geographical variations in mortality and morbidity from road traffic accidents in England and Wales. Health & Place. 2008;14(3):519-35.

45. Statter M, Schuble T, Harris-Rosado M, Liu D, Quinlan K. Targeting Pediatric Pedestrian Injury Prevention Efforts: Teasing the Information Through Spatial Analysis. The Journal of Trauma and Acute Care Surgery. 2011;71(5):S511-S6 10.1097/TA.0b013e31823a4b70.
46. Grundy C, Steinbach R, Edwards P, Green J, Armstrong B, Wilkinson P. Effect of 20 mph traffic speed zones on road injuries in London, 1986-2006: controlled interrupted time series analysis. BMJ. 2009;339:b4469.
47. Silva PHNdV, Lima MLCd, Moreira RdS, Souza WVd, Cabral APdS. Estudo espacial da mortalidade por acidentes de motocicleta em Pernambuco. Revista de Saúde Pública. 2011;45:409-15.
48. Hu G, Wen M, Baker TD, Baker SP. Road-traffic deaths in China, 1985–2005: threat and opportunity. Injury Prevention. 2008 June 1, 2008;14(3):149-53.
49. Ipingbemi O. Spatial analysis and socio-economic burden of road crashes in south-western Nigeria. International Journal of Injury Control and Safety Promotion. 2008 2008/06/01;15(2):99-108.
50. La Torre G, Van Beeck E, Quaranta G, Mannocci A, Ricciardi W. Determinants of within-country variation in traffic accident mortality in Italy: a geographical analysis. International Journal of Health Geographics. 2007;6(1):49.
51. Erdogan S. Explorative spatial analysis of traffic accident statistics and road mortality among the provinces of Turkey. Journal of Safety Research. 2009;40(5):341-51.
52. Spoerri A, Egger M, von Elm E. Mortality from road traffic accidents in Switzerland: Longitudinal and spatial analyses. Accident Analysis & Prevention. 2011;43(1):40-8.
53. Eksler V, Lassarre S. Evolution of road risk disparities at small-scale level: Example of Belgium. Journal of Safety Research. 2008;39(4):417-27.
54. Goldstein GP, Clark DE, Travis LL, Haskins AE. Explaining regional disparities in traffic mortality by decomposing conditional probabilities. Injury Prevention. 2011 January 6, 2011.
55. Chen HY, Senserrick T, Martiniuk ALC, et al. Fatal crash trends for Australian young drivers 1997-2007: Geographic and socioeconomic differentials. Journal of Safety Research. 2010;41:123-8.
56. Steinbach R, Grundy C, Edwards P, Wilkinson P, Green J. The impact of 20 mph traffic speed zones on inequalities in road casualties in London. Journal of Epidemiology and Community Health. 2011 October 1, 2011;65(10):921-6.
57. Centers for Disease Control and Prevention. External Cause of Injury Mortality Matrix for ICD-10. Atlanta (GA): Centers for Disease Control and Prevention; 2010. http://www.cdc.gov/nchs/data/ice/icd10_transcode.pdf.
58. MacKay M, Vincenten J, Brussoni M, Towner L. Child safety good practice guide: good investments in unintentional child injury prevention and safety promotion. Amsterdam: European Child Safety Alliance, Eurosafe; 2006.
59. Carver A, Timperio A, Crawford D. Playing it safe: The influence of neighbourhood safety on children's physical activity—A review. Health & Place. 2008;14(2):217-27.
60. Agresti A, Coull B. Approximation is better than “exact” for interval estimation of binomial proportions. Am Stat. 1998;52:119-26.
61. Bunn F, Collier T, Frost C, Ker K, Roberts I, Wentz R. Area-wide traffic calming for preventing traffic related injuries. Cochrane Database Syst Rev. 2003;1(1).
62. World Health Organization. Preventing injuries and violence: a guide for ministries of health. Geneva: World Health Organization; 2007. http://www.who.int/violence_injury_prevention/publications/injury_policy_planning/prevention_moh/en/index.html
63. Jones SJ, Lyons RA, John A, Palmer SR. Traffic calming policy can reduce inequalities in child pedestrian injuries: database study. Injury Prevention. 2005 June 1, 2005;11(3):152-6.