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ABSTRACT

There have only been a limited number of previous road safety studies of recent arrivals (tourists and migrants) in Australia. The present report examined crashes in South Australia in which a road user (car driver, motorcycle rider, bicycle rider or pedestrian) who had recently arrived in Australia (i.e. country of birth was other than Australia and had been in Australia for one year or less) was injured and admitted to hospital. Records from the Royal Adelaide Hospital (RAH) in South Australia for 56 injured recently arrived road users from May 2014 to October 2017 were linked with police-reported crash data and results of forensic blood tests for alcohol and drugs. They comprised 2.7% of the total 2,037 crash-involved road users who were admitted to the RAH during this period, which indicates that they constitute only a small part of the road trauma in South Australia. Characteristics of the sample of recently arrived road users and their crashes were examined and comparisons made to 1,837 road users who were either born in Australia or had been in Australia for more than one year and who were admitted to the RAH over the same period. Recent arrivals were younger and more likely to be at-fault for their crashes. They did not differ from longer-term Australian road users in the likelihood of testing positive for alcohol and were less likely to test positive for a proscribed drug. Some of their crashes may have been due to unfamiliarity or confusion with either the road environment or the road rules in South Australia. Also, recently arrived car drivers were more likely to crash in rural areas and areas with high speed limits, to be involved in departed lane/off path type crashes, to experience longer delays in the arrival of medical care to the scene of their crashes, and to have been more severely injured. This report provided an important update on the road safety of a group of road users who have been largely overlooked by recent research. Countermeasures to improve their safety are discussed with reference to these findings.

KEYWORDS

Road users, tourists, migrants, crash characteristics, road safety, countermeasures

Summary

Australia welcomes large numbers of tourists and migrants into the country each year. Currently in South Australia, international visitors and new arrivals to the country are permitted to drive a car or ride a motorcycle using a valid licence from another country. This means that they do not have to become accustomed first to the South Australian road rules or driving environment.

There have only been a limited number of previous studies on the road safety of recent arrivals in Australia. These studies have indicated that the crashes of international drivers and motorcycle riders are less likely to involve high-risk driving behaviours such as alcohol intoxication compared to the crashes of Australian drivers and riders, but are more likely to result from unfamiliarity with local driving conditions and road rules. These past studies were undertaken 10 to 15 years ago and focussed on crashes involving car drivers and motorcycle riders, with little known about crashes involving recently arrived bicycle riders and pedestrians. The present report examined crashes in South Australia in which a road user (car driver, motorcycle rider, bicycle rider or pedestrian) who had recently arrived in Australia was injured and admitted to hospital.

Records from the Royal Adelaide Hospital (RAH) in South Australia for 56 recently arrived road users who were injured and admitted to hospital between May 2014 and October 2017 were linked with police-reported crash data and results of forensic blood tests for alcohol and drugs. These road users were defined as having recently arrived in Australia because their country of birth was other than Australia and they had been in Australia for one year or less. They comprised 2.7% of the total number of 2,037 crash-involved road users who were admitted to the RAH between May 2014 and October 2017, which indicates that they constitute only a small part of the road trauma in South Australia. Characteristics of the sample of recently arrived road users and their crashes were examined and comparisons made to 1,837 road users who were either born in Australia or had been in Australia for more than one year and who were admitted to the RAH over the same time period (referred to throughout the report as longer-term Australian road users).

Recently arrived road users were found to be younger and more likely to be responsible for their crashes than longer-term Australian road users, and more than two-thirds (69.6%) came from countries where driving occurs on the right side of the road (opposite to Australia). They did not differ from longer-term Australian road users in the likelihood of testing positive for alcohol and were less likely to test positive for a proscribed drug (THC, methamphetamine, MDMA). An in-depth examination of their crashes revealed that some may have been due to unfamiliarity or confusion with either the road environment or the road rules in South Australia. However, there were no clear cases in which a car driver or motorcycle rider from a right-side driving country was on the incorrect side of the road due to confusion and collided with another vehicle. Recently arrived car drivers were more likely to crash in rural areas and areas with high speed limits, to have been involved in departed lane/off path type crashes, to have experienced longer delays in the arrival of medical care to the scene of their crashes, and to have been more severely injured than longer-term Australian drivers. Linear regression was used to explore whether these differences between the crashes of recently arrived drivers and longer-term Australian drivers explained the higher injury severity for recently arrived drivers. Across the entire sample (recently arrived and longer-term Australian drivers combined), higher speed limits, departed lane/off path crashes and longer delays in medical care all significantly increased injury severity, which indicates that these differences between the crashes of the two groups explain, at least in part, the finding that recently arrived drivers were more severely injured in their crashes.

This report provided an important update on the safety of a group of road users who have been largely overlooked by recent research. Several road safety issues regarding recently arrived road users were

identified (e.g. more commonly at-fault, higher injury severity, find rural driving conditions difficult). Every effort should be made to keep people safe when they are new to Australia and use the roads. Based on the present findings, certain countermeasures are discussed that could improve the safety of recently arrived road users. These include: provision of information (through car rental businesses, driver training organisations or licensing authorities) to tourists and new arrivals on road rules and driving conditions in Australia; infrastructure changes that prevent access to the wrong side of the road (e.g. centre barriers and improved signage, lane marking and road geometry); infrastructure improvements that prevent departed lane/off path crashes (audio tactile lane markings, side barriers); improved vehicle technology to prevent departed lane/off path crashes (e.g. lane departure warnings, fatigue warnings) and reduce injury severity (e.g. automatic crash notification); and reduction of speed limits on rural roads from 110 to 100 km/h to reduce injury severity.

Note that this report was substantially completed in August 2020 and does not consider developments after that date.

Contents

1 Introduction

Australia is a popular destination for travellers from all over the world. According to Tourism Australia (2019), there were 9.2 million international visitor arrivals in 2018, which was a 4.9% increase from 2017. Table 1.1 uses data from Tourism Australia (2019) to list the 20 countries from which the largest numbers of international visitors to Australia came from in 2018. In South Australia, there were 457,000 internationals visitors from April 2018 to March 2019, which was a 4% decrease from the previous year (South Australian Tourism Commission, 2019). People travel to Australia for various reasons, such as holidaying or recreational purposes, visiting friends and family, business purposes, and study and educational purposes. A large number of migrants are also welcomed into the country each year. According to the Australian Bureau of Statistics (ABS, 2019), 526,271 individuals migrated to Australia from overseas during the financial year of 2017 to 2018, including 24,253 who migrated to South Australia.

Table 1.1
Countries with the largest numbers of international visitors to Australia in 2018

Country of origin	Number of international arrivals to Australia [a]	% of total international arrivals	Side of road driven on in country of origin
China	1,432,100	15.5	Right
New Zealand	1,384,900	15.0	Left
United States of America	789,100	8.5	Right
United Kingdom	733,400	7.9	Left
Japan	469,200	5.1	Left
Singapore	447,800	4.8	Left
Malaysia	401,100	4.3	Left
India	357,700	3.9	Left
Hong Kong	308,700	3.3	Left
South Korea	288,000	3.1	Right
Indonesia	208,800	2.3	Left
Germany	207,300	2.2	Right
Taiwan	202,800	2.2	Right
Canada	182,000	2.0	Right
Philippines	143,700	1.6	Right
France	142,600	1.5	Right
Vietnam	110,900	1.2	Right
Thailand	99,400	1.1	Left
Italy	77,900	0.8	Right
Ireland	62,400	0.7	Left

Source: Tourism Australia (2019)

[a] Numbers rounded to nearest hundred

Currently in South Australia, short-term visitors are permitted to drive a car, or ride a motorcycle, using a valid and current driver's licence from another country. They are only permitted, however, to drive or ride the same type of vehicle that their original licence allows and they must conform to any conditions that have been placed on their licence. If their original licence expires they are required to apply for a South Australian Driver's licence. People who have migrated to South Australia and have become permanent residents (i.e. have been issued with a visa allowing them to remain in Australia indefinitely) must transfer their overseas driver's licence to a South Australian driver's licence within 90 days. The driver licensing and testing standards from a range of countries are recognised in South Australia and if an individual has a licence from one of these countries then they are not required to undertake the testing procedure required to obtain a South Australian licence. This means that international visitors or new arrivals to South Australia can drive a car (or ride a motorcycle) on South

Australian roads without becoming accustomed first to the South Australian road rules or driving environment.

There have only been a limited number of previous studies into the road safety of recent arrivals in Australia. Wilks, Prendergast and Wood (2003) examined 307 deaths of overseas visitors to Australia between 1997 and 2000 that were recorded as accidental and found that land transport accidents (involving car occupants, pedestrians, bicycle riders, motorcycle riders, van/pick-up truck occupants, and bus occupants) were the main cause (accounting for 157 of the 307 accidental deaths). Similarly, Leggat and Wilks (2009) examined 247 accidental deaths of overseas visitors to Australia between 2001 and 2003 and also found that transportation accidents were the main cause, (accounting for 145 of the 247 accidental deaths).

Wilks, Watson and Hansen (2000) investigated police-reported crashes in Queensland between 1993 and 1998. During this period, there were 37 fatal crashes (1.3% of all drivers involved in fatal crashes), 412 hospitalisation crashes, 552 minor injury crashes and 1270 property damage only crashes involving international drivers and motorcycle riders (defined as those with an international driver's licence). Wilks et al. (2000) examined the serious crashes (fatality or hospitalisation) of these drivers and riders in detail and found they were less likely to involve high-risk driving behaviours such as alcohol intoxication compared to the serious crashes of Australian drivers and riders, but were more likely to result from unfamiliarity with local driving conditions. International drivers and riders were over-represented in crashes in which disorientation may have been a factor, such as 'failure to keep left' and 'head-on' crashes. This was particularly the case for those from countries where they drive on the right side of the road (compared to those from countries where they drive on the left side, which is the same as Australia). International drivers and riders were also less likely to be 60 years of age or older and to crash on roads with a 60 km/h speed limit compared to Australian drivers and riders, but were more likely to crash on roads with 100 and 110 km/h speed limits and to have crashes involving fatigue.

These studies suggest that international road users in Australia may have difficulty in unfamiliar driving environments and with unfamiliar road rules. It is possible that differences in road environments (e.g. different side of road driven on, long distances between destinations in rural Australia causing fatigue, different road signs causing confusion) and road rules (e.g. different speed limits potentially leading to inappropriate speeds) between various countries of origin and Australia could contribute to causing at least some of the crashes that recently arrived road users are involved in.

Studies from other countries have also demonstrated that unfamiliar road conditions may be a factor in the crashes of international drivers. Petridou, Askitopoulou, Vourvahakis, Skalkidis and Trichopoulos (1997) examined hospital data for road traffic crashes (car, motorcycle, other vehicle, pedestrian) between April and September 1995 in Crete. It was shown that foreign visitors from left-side driving countries (which is opposite to Crete, where driving is on the right side) who were injured in crashes were 2.5 times more frequently involved in crashes involving overtaking or other driving manoeuvres that would be difficult without practice or experience in driving on the side of the road that is opposite to the side driven on in their country of origin. Interestingly, it was also found that alcohol was reported as the primary cause of a significantly higher proportion of the crashes of international road users compared to the crashes of Greek nationals, which differs from the findings of the previously mentioned research in Australia by Wilks et al. (2000). This could be due to differences in the samples (e.g. Petridou et al., (2003) were not specific about how they defined foreign visitors but 'visitors' suggests a focus on tourists rather than migrants, the sample also included pedestrians), or differences between Crete and Australia in terms of the tourism industry (e.g. possibly based more on drinking and partying in an island holiday destination like Crete) or the population of recent arrivals (e.g. possibly a larger proportion may be tourists in Crete compared to Australia and a smaller

proportion may be migrants). Yoh, Okamoto, Inoi and Doi (2017) examined police-reported crash data from 2011 to 2015 in Japan (driving is on the left) and found that international drivers from North and South America (driving is on the right) were prone to head-on collisions.

The previous studies on international road users in Australia mentioned above – Leggat and Wilks (2009), Wilks et al. (2003) and Wilks et al. (2000) – were undertaken about 10 to 15 years ago and used data that are now at least 15 to 20 years old. They also predominantly focussed on car drivers and motorcycle riders. This was due to reliance on road crash databases in which the only available information from which recent arrivals could be identified was licensing data (e.g. whether they hold a valid Australian licence, a temporary licence or an international licence). Therefore, little is known about crashes involving bicycle riders and pedestrians who are recent arrivals (Wilks, et al., 2000). However, Mitchell, Williamson and Chung (2015) examined injury-related hospital admissions in New South Wales and found that overseas tourists were three times more likely to be hospitalised for pedestrian-related injuries compared to NSW residents. It is possible that, similar to car drivers and motorcycle riders, some of the crashes of international pedestrians and bicycle riders might involve a misunderstanding of local rules; for example, pedestrians from right-side driving countries might look the wrong way for traffic when crossing a road. The use of licensing data to identify international road users also means that their specific nationality is often not known and any differences between the driving conditions in their country of origin (e.g. which side of the road is driven on) and those in Australia are not explored.

The purpose of the present report was to undertake a detailed examination of crashes in South Australia in which an injured road user (car driver, motorcycle rider, bicycle rider or pedestrian) had recently arrived in Australia, and make comparisons to crashes in which an injured road user was either born in Australia or had been in Australia for more than one year. To do this, data were obtained from the Royal Adelaide Hospital (RAH) in South Australia for the period of May 2014 to October 2017. These hospital data were linked with corresponding police-reported crash data and the results of forensic blood tests for alcohol and drugs.

2 Method

2.1 Data

Data were collected for road users whose country of birth was other than Australia and who had been in Australia for one year or less. These road users had been injured in a road crash and admitted (four hours or more) to the RAH between May 2014 and October 2017. The total sample of injured road users who had recently arrived in Australia was 56. These included 30 (53.6%) car drivers (and car derivatives such as utility vehicles, station wagons and sports utility vehicles), 5 (8.9%) motorcycle riders (including 1 scooter rider), 9 (16.1%) bicycle riders and 12 (21.4%) pedestrians. For the purposes of comparison, data were also collected for road users who were either born in Australia or had been in Australia for more than one year (hereafter referred to as longer-term Australian road users). These longer-term Australian road users had also been injured in a road crash and admitted to the RAH over the same period. The total comparison sample was 1,837. These included 861 (46.9%) car drivers, 426 (23.2%) motorcycle riders (including 32 scooter riders), 379 (20.6%) bicycle riders and 171 (9.3%) pedestrians. The data collected and matched for each road user included: medical assessments and interventions undertaken during hospitalisation, police data relating to the crash, and forensic science data related to mandatory testing for alcohol and drugs.

2.1.1 Medical data

The medical data included ambulance service and medical retrieval records, emergency department records, and hospital in-patient records. Medical retrieval records included information about the crash gathered at the scene, the initial care given to the injured crash participants and the time (in minutes) between the crash and the arrival of medical care (ambulance). Emergency department records included injury surveys and documentation related to breath alcohol tests. Hospital in-patient records included patient demographics, detailed injury and medical intervention information, and discharge details. The patient demographics that were recorded included their age and gender, as well as specific questions about their country of birth and how long they had been in Australia. This information allowed recently arrived road users to be identified.

Injury information was coded according to the Abbreviated Injury Scale (AIS), which was developed by the Association for the Advancement of Automotive Medicine to classify and describe the threat to life associated with injuries. For the purposes of the AIS, each separate injury is given a severity score on a scale from one (minor) to six (currently untreatable). The AIS was last updated in 2008.

Each injured participant's AIS scores were converted to an Injury Severity Score (ISS) to give an overall measure of injury severity. The ISS is calculated by taking the three most severely injured body regions, squaring the number given to the most severe injury and summing these numbers. Only numbers one to five are used in this procedure, giving a maximum ISS score of 75. If any injury has an AIS score of six (untreatable), the ISS is automatically set to the maximum 75.

2.1.2 Police-reported crash data

Police-reported crash data were obtained from Vehicle Collision Reports (VCRs) and the Traffic Accident Reporting System (TARS). Information found in VCRs includes: date, time, day of the week and location (metropolitan or rural, road(s) where crash occurred, suburb where crash occurred, GPS coordinates) of the crash; vehicle type (e.g. car, motorcycle, bicycle or pedestrian); a description of the crash; crash type (e.g. single or multiple vehicle and head on, rollover, sideswipe, etc.); road surface (unsealed or sealed) and speed limit at the crash location; light conditions (day or night), weather conditions (raining or dry) and road conditions (wet or dry) at the time of the crash; restraint use (yes

or no); and the injury status of those involved in the crash. TARS includes all of this information, plus at-fault status (yes or no) for the drivers or riders involved in each crash.

2.1.3 Results of blood tests for alcohol and drugs

Since 1972, drivers, motorcycle riders, bicycle riders, vehicle occupants and pedestrians over the age of 14 years, who present to hospital as a result of a crash, have been required to undergo mandatory testing for blood alcohol concentration (BAC) in South Australia. Since July 2008, the mandatory screening has also included screening for three proscribed drugs: Methamphetamine, Delta-9-Tetrahydrocannabinol (THC) and 3,4-Methylenedioxymethamphetamine (MDMA). These tests require a blood sample to be taken by hospital medical personnel within eight hours of being involved in the collision, with most occurring within the first one to two hours following the crash. The samples are sent to, and tested by, the South Australian Forensic Science Centre. The results of these tests were made available for the road users in the present study following a confidentiality agreement.

2.2 Analyses

Characteristics of the sample of injured recently arrived road users (country of origin, side of road driven on in country of origin, age and gender) and characteristics of their crashes (at-fault status, blood test results for BAC and drugs, location) were examined, and comparisons made to injured longer-term Australian road users. Their crashes were then examined in detail for car drivers, motorcycle riders, bicycle riders and pedestrians separately through descriptions and interpretations of the narratives of the crashes. Statistical comparisons were made between recently arrived car drivers and longer-term Australian drivers for the characteristics of their crashes (day of week, time of day, crash location, crash type, road surface, speed limit, light conditions, weather conditions, road conditions, restraint use, at-fault status, and time taken for medical arrival at the crash) and the severity of their injuries (length of hospitalisation and ISS). Frequency counts, means, medians, chi-square tests and non-parametric Mann-Whitney *U*-tests were used for all comparisons. Such comparisons were not made for motorcyclists, bicyclists or pedestrians, due to there being too few cases. Finally, those variables for which there were statistically significant differences between recently arrived and longer-term Australian car drivers were entered as independent variables into a linear regression model to predict injury severity (ISS – dependent variable) for all drivers (recent arrivals and longer-term Australians combined). For all analyses, an alpha level of 0.05 was used to determine statistical significance.

3 Results

3.1 Sample characteristics

The 56 recently arrived road users[1] only comprised 2.7% of the total number of 2,037 crash-involved car drivers, motorcycle riders, bicycle riders and pedestrians who were admitted to the RAH between May 2014 and October 2017. They were born in a range of different countries. The countries included China (11), Germany (7), England (4), Taiwan (4), Hong Kong, India, Iran (3 each), Indonesia, South Korea, Malaysia, Vietnam (2 each), Afghanistan, Belgium, Brazil, Denmark, Egypt, France, Iraq, Nepal, Netherlands, Philippines, Scotland, Venezuela, and Wales (1 each). Of these countries, driving occurs on the left side of the road in England, Hong Kong, India, Indonesia, Malaysia, Nepal, Scotland and Wales, which is the same as in Australia. Therefore, 39 (69.6%) of the sample of 56 recently arrived road users came from countries where driving occurs on the right (opposite to Australia).

The age and gender distribution of the sample is presented in Table 3.1. Those between the ages of 20 and 29 comprised 58.9% of the crash-involved population, followed by 14.3% in the 16 to 19 age group and 10.7% in the 30 to 39 group. Females comprised 35.7% of the sample.

For the purposes of comparison, the age and gender profile of the total sample of 1,837 longer-term Australian road users[2] is also shown in Table 3.1. There was a similar representation of females (30.8% compared to 35.7% for recently arrived road users), with no statistically significant difference between the groups ($\chi^2_{(1)}$=0.6, p=.434). However, there were smaller proportions of road users in the 16 to 19 and 20 to 29 age groups for the comparison sample (6.3% and 19.3% compared to 14.3% and 58.9%) and larger proportions in all of the older age groups. The difference in the age distributions was statistically significant ($\chi^2_{(7)}$=65.4, p<.001).

Table 3.1
Age and gender of crash-involved recent arrivals compared to crash-involved individuals who have been in Australia for more than one year

Age category	Recent arrivals			In Australia for more than one year		
	Male % (*n*=36)	Female % (*n*=20)	Total % (*n*=56)	Male % (*n*=1,271)	Female % (*n*=566)	Total % (*n*=1,837)
16-19	3.6	10.7	14.3	3.9	2.4	6.3
20-29	41.1	17.9	58.9	13.0	6.3	19.3
30-39	8.9	1.8	10.7	11.8	4.1	15.9
40-49	1.8	1.8	3.6	12.9	4.1	17.0
50-59	3.6	0.0	3.6	12.4	4.5	16.9
60-69	1.8	3.6	5.4	8.1	3.3	11.4
70-79	1.8	0.0	1.8	3.2	3.7	6.9
80+	1.8	0.0	1.8	3.9	2.4	6.3
Total			100.0			100.0

3.2 Crash characteristics

Forty-three (84.3% of known) of the recently arrived road users were found to be at-fault for their crash, while eight (15.7% of known) were not at-fault and at-fault status was unknown for five road users. For the comparison sample of longer-term Australian road users, 1205 (68.0% of known) were

[1] Road users whose country of birth was other than Australia and who had been in Australia for one year or less.
[2] Road users who were either born in Australia or had been in Australia for more than one year.

at-fault, while 567 (32.0% of known) were not at-fault and at-fault status was unknown for 65 road users. This difference in the distributions was statistically significant ($\chi^2_{(1)}$=6.1, *p*=.013).

Comparisons were made between recently arrived road users and longer-term Australian road users in terms of the results of their blood and alcohol tests. Of the recently arrived road users for whom a blood alcohol concentration (BAC) was recorded, only two (4.3%) were positive (including one car driver and one pedestrian). Among the longer-term Australian road users, 183 (11.8%) recorded a positive BAC (including 92 car drivers, 25 motorcyclists, 25 bicyclists and 41 pedestrians). The difference between the groups in terms of positive BAC detections was not statistically significant ($\chi^2_{(1)}$=2.5, *p*=.112). Both (4.3%) recently arrived road users who recorded a positive BAC were above the legal limit of 0.05g/100ml for car drivers, motorcyclists and bicyclists. Among longer-term Australian road users, there were 168 (10.8%). This difference was also not statistically significant ($\chi^2_{(1)}$=2.1, *p*=.150).

With regard to drug screening results (tests for THC, methamphetamine and MDMA or 'ecstasy'), 45 of the recently arrived road users were drug negative, 10 had unknown drug status, and only one was drug positive (2.2% of known). Among longer-term Australian road users, there were 1,319 who were drug negative and 303 for whom drug status was unknown. This left 215 who screened positive for a proscribed drug (14.0% of known). This difference between recently arrived road users and longer-term Australian road users in the likelihood of testing positive to a proscribed drug was statistically significant ($\chi^2_{(1)}$=5.3, *p*=.021).

The recorded location of each crash involving a recently arrived road user was examined to determine the geographical distribution in South Australia and identify any locations where clusters of crashes occurred. For this purpose, clusters were considered to be locations where three or more crashes involving recently arrived road users occurred. Upon inspection, however, there were no such locations. There were two cases in which recently arrived car drivers were involved in crashes on the Stuart Highway in South Australia, but the distance between locations was 300 kilometres (approximately three-hour travel time). There were also two cases involving car drivers on the Eyre Highway, but the distance between locations was 96 kilometres (approximately one-hour travel time). It should be noted that, for this purpose, 56 is a small number of cases, particularly when divided between car drivers, motorcycle riders, bicycle riders and pedestrians. A larger number of cases may have identified some clusters. However, hospital data from a longer time period or from multiple hospitals would be required for a larger sample.

In the following sections the 56 crashes of recently arrived road users are examined in detail separately for car drivers, motorcycle riders, bicycle riders and pedestrians. Where possible comparisons are made to the crashes of road users who were either born in Australia or had been in Australia for more than one year.

3.2.1 Car drivers

This section examines the crashes of recently arrived car drivers in more detail. Table 3.2 provides a brief narrative of these 30 crashes, as well as any points of interest. Note that the information available for some of the crashes was limited and so some of the narratives in Table 3.2 are brief.

Table 3.2
Brief narrative and points of interest of crashes involving recently arrived drivers

	Type of crash	Side of road driven in country of origin	Brief narrative (RA = recently arrived driver)	Points of interest
1	Hit fixed object	Left-side	After passing a truck travelling in opposite direction (that was possibly close to or over the centre line), car (RA) wheels touched loose gravel on unsealed left shoulder, then overcorrected and hit tree.	110 km/h limit, 110 km/h approx. travelling speed
2	Right angle	Left-side	Car (RA) on terminating road of T-intersection. Intended to turn right. Required to give way. Pulled out and hit on the right side by another car.	60 km/h speed limit. Raining, road wet
3	Right angle	Left-side	Car (RA) on terminating road of T-intersection. Intended to turn right. Required to give way. Pulled out and hit on the right side by a truck.	84 years old driver. 100 km/h limit Truck travelling approximately 100 km/h
4	Head on	Left-side	Car (RA) travelled onto incorrect side of highway and into path of another car.	Driver admitted to falling asleep. Left front seat passenger killed. 100 km/h limit
5	Head on	Right-side	Car (RA) travelled onto incorrect side of highway and into path of another car.	110 km/h limit. Driver of other car killed
6	Hit fixed object	Right-side	Car (RA) travelling downhill when driver lost control and collided front-on with a tree on left side of road.	Driver positive for methamphetamine and MDMA Driver admitted travelling too fast 50 km/h limit, 60 km/h approx. travelling speed Raining, road wet
7	Side-swipe	Right-side	Car (RA) and truck travelling in adjacent lanes in same direction. Truck indicated to pull left into same lane as car but side-swiped it. Car spun and hit a kerb and a tree.	80 km/h limit
8	Right angle	Left-side	Car (RA) approaching cross intersection. Required to give way but travels through (possibly without slowing or stopping) and turns right to travel on intersecting road. Car is hit on right side by another car.	50 km/h limit
9	Hit fixed object	Right-side	While attempting to overtake a truck, car (RA) has left highway on right side, collided with a rock and a dirt embankment and then rolled.	Driver not wearing seatbelt and ejected Driver died after two days in hospital 110 km/h limit, 110 km/h approx. travelling speed
10	Right angle	Left-side	Car (RA) travelling on road when another car reversed out of driveway on left and hit the first car on front left. First car then collided with parked third car.	50 km/h limit, 50 km/h approx. travelling speed
11	Roll over	Left-side	Driver (RA) distracted while driving on highway. Wind pushed car slightly to right then driver overcorrected to left and rolled on dirt verge.	110km/h limit Between 100 and 110 km/h travelling speed Distracted by music on phone/dropped biscuit
12	Roll over	Left-side	Car (RA) overtaking another car on highway. While overtaking, first car entered 80 km/h work zone, then tried to slow and return to left lane but lost control and rolled.	110 km/h limit. Change to 80 km/h work zone

Table 3.2 Continued

	Type of crash	Side of road driven in country of origin	Brief narrative (RA = recently arrived driver)	Points of interest
13	Hit animal	Left-side	Car (RA) swerved to avoid cows on highway but hit one, then rolled down an embankment.	110 km/h limit
14	Roll over	Right-side	Car (RA) swerved to avoid a bird on highway, then overcorrected, drove onto an embankment and rolled.	110 km/h limit, 110 km/h approx. travelling speed
15	Hit fixed object	Right-side	Car (RA) collided with tree in centre median.	Driver had 0.21 BAC, not wearing seatbelt Raining, road wet
16	Right angle	Left-side	Car (RA) approaching cross road intersection. Required to give way but travels straight through without slowing or stopping. Car is hit on right side by another car and then hits electricity pole.	100 km/h limit, 80 km/h approx. impact speed
17	Hit fixed object	Right-side	Car (RA) travelling at high speed. Lost control on bend, went down an embankment and hit tree.	Unrestrained back seat passenger fell forward over front seat occupants 80 km/h limit, 100 km/h approx. travelling speed
18	Rear end	Right-side	Car (RA) on highway collided with rear-end of another car that was stationary and giving way to oncoming traffic while attempting to turn right.	80 km/h limit, 70 km/h approx. travelling speed
19	Left road – out of control	Right-side	Car (RA) lost control, left highway and rolled.	Left front seat passenger ejected 110 km/h limit, 110 km/h approx. travelling speed
20	Hit fixed object	Right-side	Car (RA) travelling downhill around sharp right bend. Driver stated that brakes failed. Car lost control then struck embankment and tree.	50 km/h limit
21	Right angle	Right-side	Car (RA) on terminating road of T-intersection. Intended to turn (unclear left or right). Required to stop at stop sign and give way to other vehicles. Slowed but did not stop and hit another car.	100 km/h limit
22	Hit fixed object	Right-side	Driver (RA) stated that steering wheel veered left and brakes failed. Car veered off road to left and hit tree.	60 km/h limit Between 50 and 60 km/h travelling speed
23	Hit fixed object	Right-side	Car (RA) left highway and collided with tree. Driver just finished 36-hour overnight work shift and admitted falling asleep.	110 km/h limit, 100km/h approx. travelling speed Due to fatigue
24	Hit fixed object	Right-side	Car (RA) mounted centre median on highway and collided with wire rope barrier. Continued over the centre median into opposite lanes and collided head on with another car.	Left front seat passenger killed Hit fixed object and head on 90 km/h limit, 90km/h approx. travelling speed
25	Hit fixed object	Right-side	Car (RA) hit tree and rolled over.	None

Table 3.2 Continued

	Type of crash	Side of road driven in country of origin	Brief narrative (RA = recently arrived driver)	Points of interest
26	Roll over	Right-side	Car (RA) left highway on left side onto unsealed verge. Driver overcorrected and car rolled on right side of highway.	110 km/h limit
27	Head on	Right-side	Car (RA) crossed centre line into opposite lane on left hand blind corner and collided head on with another car.	Learner driver without supervision 60 km/h limit. Raining, road wet
28	Hit fixed object	Right-side	Car (RA) approached sharp right bend at speed too high for corner. Veered to right across into opposite lane, swerved back to left side of road and collided with tree.	80 km/h limit, 25 km/h advisory speed for bend Travelling speed between 60 and 80 km/h
29	Head on	Right-side	Car (RA) collided head on with another car. Unclear which car travelled into opposite lane, but RA not at-fault so likely other car.	60 km/h limit
30	Head on	Right-side	Car crossed into opposite lane to overtake truck on highway. Car has collided head on with another car (RA).	Travelling from Queensland to Perth 110 km/h limit

Of the 30 crashes involving recently arrived car drivers, there were no clear cases in which a driver from a right-side driving country was on the incorrect side of the road due to confusion and collided with another vehicle (although it is possible that this occurred in cases 5 and 27 but the details of the crashes were too limited). There were four crashes (numbers 4, 5, 19 and 26), however, in which it is possible that the drivers were not familiar with driving long distances between destinations in the rural areas of Australia and fell asleep, which caused them to travel out of their lane (either to the left or right) and collide head on with a car travelling in the opposite direction or roll over. All four of these crashes were in rural areas of South Australia, on a road with a speed limit of 100 or 110 km/h and at a location some distance from the next town. These four cases also exclude those that were due to any other cause of fatigue (e.g. crash 23 in which the driver had just completed a 36-hour overnight work shift) or any other cause of the car losing control (e.g. crash 9 – overtaking, crash 11 – distraction, crashes 13 and 14 – swerving to avoid animals). It should be acknowledged, however, that these crashes cannot be stated definitively to be related to the driver falling asleep due to driving on long stretches of road (although the driver in case 4 admitted to falling asleep) and could be due to other factors that were not clear from the available information, such as distraction. It should also be acknowledged that drivers from all backgrounds (i.e. longer-term Australian drivers) can fall asleep when driving long distances in rural areas of Australia, not just recently arrived drivers.

There were also two right angle crashes (numbers 8 and 16) in which it is possible that the drivers were disoriented, confused or unaware of the road rules in Australia as to which vehicle is required to give-way at cross intersections. In both crashes, the recently arrived drivers were travelling on roads that were controlled by Give Way signs at the intersections. Therefore, the drivers were required to give way to all traffic on the intersecting roads. However, it was reported in both crashes that the recently arrived drivers continued through the intersections without slowing, stopping or giving way and were then hit by another vehicle. Again, however, these two crashes could be due to other factors, such as distraction, and such crashes would not be limited to recently arrived drivers. These two crashes at cross intersections were distinct from the right angle crashes at T-intersections (numbers 2, 3 and 21) in which the recently arrived drivers were turning from the terminating roads, a situation in which the road geometry itself largely dictates who must give way.

Table 3.3 summarises the results of Chi-square analyses comparing the 30 crashes involving recently arrived car drivers to the 861 crashes involving longer-term Australian car drivers. It can be seen that, compared to the crashes of longer-term Australian drivers, those of recently arrived drivers were overrepresented in rural areas and areas with speed limits of 70, 80, 90, 100 and 110 km/h. Recently arrived drivers were also more commonly at-fault for their crashes. Additionally, in the final comparison, recently arrived drivers can be seen to have been more likely than longer-term Australian drivers to have been involved in departed lane/off path type crashes (head on, hit fixed object, rollover and left road – out of control crashes combined) rather than other crash types (rear end, right angle, right turn, hit animal, hit object on road, hit parked vehicle and sideswipe combined).

Table 3.3
Characteristics of crashes involving recently arrived car drivers compared to longer-term Australian car drivers

Variable	Test statistic	Nature of difference
Day of week	$\chi^2_{(6)}$=3.8, *p*=.699	No difference (23.3% weekend & 76.7% weekdays for recently arrived drivers vs 27.3% & 72.7% for longer-term Aus drivers)
Time of day	$\chi^2_{(3)}$=3.6, *p*=.306	No difference (0.0% 00:00-05:59, 26.7% 06:00-11:59, 46.7% 12:00-17:59 & 26.7% 18:00-23:59 for recently arrived drivers vs 9.7%, 28.2%, 41.5% & 20.6% for longer-term Aus drivers)
Crash location	$\chi^2_{(1)}$=7.4, p=.007*	Recently arrived driver crashes more common in rural areas (70.0 vs 44.9%), longer-term Aus driver crashes more common in metro areas (55.1 vs 30.0%)
Single/multiple vehicle	$\chi^2_{(1)}$=1.3, *p*=.251	No difference (51.7% single & 48.3% multiple for recently arrived drivers vs 41.0% & 59.0% for longer-term Aus drivers)
Road surface	$\chi^2_{(1)}$=1.4, *p*=.235	No difference (100.0% sealed & 0.0% unsealed for recently arrived drivers vs 95.4% & 4.6% for longer-term Aus drivers)
Speed limit	$\chi^2_{(7)}$=10.4, *p*=.001*	Recently arrived driver crashes more common in 70, 80, 90, 100 & 110 km/h areas (72.4 vs 42.2%), longer-term Aus driver crashes more common in 40, 50 & 60 km/h areas (57.8 vs 27.6%)
Light conditions	$\chi^2_{(1)}$=0.5, *p*=.494	No difference (76.7% daylight & 23.3% night for recently arrived drivers vs 70.9% & 29.1% for longer-term Aus drivers)
Weather conditions	$\chi^2_{(1)}$=1.4, *p*=.233	No difference (13.8% raining & 86.2% not raining for recently arrived drivers vs 7.7% & 92.3% for longer-term Aus drivers)
Road conditions	$\chi^2_{(1)}$=0.2, *p*=.619	No difference (13.8% wet & 86.2% dry for recently arrived drivers vs 10.9% & 89.1% for longer-term Aus drivers)
Restraint use	$\chi^2_{(1)}$<0.1, *p*=.999	No difference (7.1% yes for recently arrived drivers vs 7.2% yes for longer-term Aus drivers)
At-fault	$\chi^2_{(1)}$=5.8, *p*=.016*	Recently arrived drivers more commonly at-fault (93.1% vs 73.1% for longer-term Aus drivers)
Depart roadway/off path crashes	$\chi^2_{(1)}$=5.0, *p*=.025*	Depart lane/off path crashes more common for recently arrived drivers (70.0% vs 49.2%)

* *p*<.05.

For the purposes of examining the severity of injury resulting from the crashes of recently arrived car drivers compared to longer-term Australian drivers, Table 3.4 shows the distribution of length of hospitalisation (in days) for the two groups of drivers. Note that this table only includes those who were hospitalised, so it takes no account of the proportion of drivers involved in injury crashes who were not injured severely enough themselves to attend hospital. Furthermore, cases in which the driver died after a period of hospitalisation were excluded from this examination. The most common length of hospitalisation for recently arrived drivers was between one and five days (50.0%). A small proportion were in hospital for 36 days or more (3.6%). Longer-term Australian drivers were more likely to require less than one day of hospitalisation (42.8% versus 14.3%) and between six and ten days (12.3% versus 3.6%). Recently arrived drivers were more likely to require between one and five days (50.0% versus 28.8%) and between 11 and 15 days (17.9% versus 6.1%). Due to the small numbers in the groups for recently arrived drivers, differences between the distributions could not be compared using a chi-square test.

Table 3.4
Length of hospitalisation in days for recently arrived drivers and longer-term Australian drivers

Number of days	Number of recently arrived drivers	% of included	Number of longer-term Australian drivers	% of included
< 1	4	14.3	359	42.8
1-5	14	50.0	242	28.8
6-10	1	3.6	103	12.3
11-15	5	17.9	51	6.1
16-20	2	7.1	36	4.3
21-25	1	3.6	18	2.1
26-30	0	0.0	9	1.1
31-35	0	0.0	11	1.3
36 +	1	3.6	10	1.2
Total included cases	28	100.0	839	100.0
Excluded cases[a]	2		22	
Total of all cases	30		861	

[a]Cases in which the driver died after a period of hospitalisation were excluded

The distribution of Injury Severity Scale (ISS) scores is shown in Table 3.5. The most common ISS for both recently arrived and longer-term Australian drivers was in the range between zero and four but the proportion of drivers with an ISS in this range was higher for longer-term Australian drivers (51.9% versus 36.7%). The mean ISS of 8.9 (*SD*=8.4) for recently arrived drivers was higher than the mean of 6.5 (*SD*=7.8) for longer-term Australian drivers. The sample sizes for the two groups of drivers were uneven so a non-parametric Mann-Whitney test was used to compare the ISS scores between the groups. The median of five for recently arrived drivers was higher than the median of four for longer-term Australian drivers and the difference was statistically significant (*U*=9,767.00, *p*=.022).

Table 3.5
ISS for injured recently arrived drivers and longer-term Australian drivers

ISS	Number of riders	%	Number of drivers	%
0-4	11	36.7	447	51.9
5-9	8	26.7	205	23.8
10-14	6	20.0	97	11.3
15-19	3	10.0	52	6.0
20-24	1	3.3	25	2.9
25-29	0	0.0	22	2.6
30+	1	3.3	13	1.5
Total	30	100.0	861	100.0

Possible reasons for the higher injury severity of crashes involving recently arrived drivers were explored. It was shown earlier that the crashes of recently arrived drivers were more common in rural areas and in speed zones of 70, 80, 90, 100 and 110 km/h, and were more commonly departed lane/off path type crashes than those of longer-term Australian drivers. It also took longer for medical care to arrive at crashes involving recently arrived drivers (median minutes between crash and arrival of medical care = 16) compared to those involving longer-term Australian drivers (median minutes = 11), (Mann-Whitney *U*=4,232.5, *p*=.003). In order to determine whether these differences between the crashes of recently arrived drivers and longer-term Australian drivers explained the difference in

severity, a linear regression model with speed limit (40, 50, 60, 70, 80, 90, 100 and 110 km/h), crash type (departed lane/off path crashes or not) and delays in medical care (time in minutes) as independent variables was used. A simple distinction between rural and metropolitan crashes was not included as an independent variable, as any effects of rural crashes increasing injury severity would likely be accounted for by the higher speed limits, frequency of departed lane/off path crashes and longer delays in medical care in rural areas. The dependent variable was ISS and data for all drivers (recently arrived and longer-term Australian combined) was included. The 'Enter' method of independent variable entry was used to include all independent variables in the model simultaneously. The model was statistically significant, $F(3, 615)=29.1$, $p<.001$, with the independent variables accounting for 12% of the variance in ISS (adjusted R^2). Table 3.6 shows that all three independent variables had significant effects. This demonstrates that, across the entire sample of seriously injured drivers, higher speed limits, departed lane/off path crashes and longer delays in medical care (all of which were more common in the crashes of recently arrived drivers) increased injury severity.

Table 3.6
Results of linear regression to predict injury severity (ISS) for drivers

Independent variables	B[a]	Beta[b]	*t*	*p*-Value
Speed limit	.02	.09	2.07	*.039
Departed lane/off path crash or not	.56	.14	3.36	*.001
Delay in medical attention	3.58	.24	5.86	*<.001

[a]The results for B are unstandardised coefficients.
[b]The results for Beta are standardised coefficients.
* $p<.05$.

3.2.2 Motorcycle riders

This section examines the crashes of recently arrived motorcycle riders in more detail. As there were only five crashes, it was not possible to undertake statistical comparisons with longer-term Australian motorcycle riders.

Two of the five crashes involving recently arrived motorcyclists were single vehicle crashes, including one in which the rider lost control and fell from the motorcycle while going around a bend at 60 km/h and one in which the rider had an unconscious collapse off the motorcycle (possibly due to being 73 years old, fatigued from a two-hour ride, a medical episode, or a combination of these) while approaching, and slowing for, a roundabout.

The other three were multiple vehicle crashes, including one in which a motorcyclist failed to give way through a cross road intersection and was hit by a car (as with the crashes of recently arrived car drivers at cross intersections, this could have been due to the rider being disoriented, confused or unaware of the road rules in Australia as to which vehicle is required to give-way), one in which a scooter rider rear-ended a stationary car in queuing traffic and one in which a motorcycle rider lost control around a bend and hit an oncoming car in the opposite lane. For the comparison sample of longer-term Australian motorcycle riders, 229 (53.9% of known) were single vehicle crashes and 196 (46.1% of known) were multiple vehicle crashes.

All recently arrived motorcyclists were wearing a helmet. This may reflect compulsory helmet laws in Australia, with recent arrival motorcyclists influenced by others to wear helmets. The compulsory helmet laws were also reflected in longer-term Australian motorcyclists, with 422 (99.3% of known) wearing a helmet.

Three of the recent arrival crashes were in rural areas of South Australia and two were in metropolitan areas. Four of the recently arrived motorcyclists were found to be at-fault for the crash and the at-fault

status for the fifth motorcyclists was unknown. The ISS scores for the recently arrived motorcyclists were ten, nine, five, four and one was unknown. In comparison, the mean ISS for longer-term Australian motorcyclists was 9.2 (*SD*=7.6).

3.2.3 Bicycle riders

The crashes of recently arrived bicycle riders are examined in this section. Again, there were only nine crashes so it was not possible to statistically compare these crashes to those of longer-term Australian bicycle riders. All nine crashes involving recently arrived bicyclists occurred in metropolitan areas.

The rider fell from their bicycle without any other road user being involved in three of the crashes. In terms of the other crashes, five involved collisions with cars and one involved a collision with a pedestrian. Of the collisions with cars, one bicyclist rear-ended a parked car, one was hit by a car that pulled out of a side road, one was hit on the right side by a car (other details unknown), and two were struck by cars while crossing over roads.

The two latter cases, in which the bicyclists tried to cross over roads, could have been due to unfamiliarity with the road environment or disorientation. The bicyclist in one case was riding on the left-most side of four lanes heading in one direction. The four lanes divided into two lanes turning left and two lanes continuing straight. The bicyclists pulled across the two lanes turning left to continue straight with the other two lanes. The bicyclist was hit by a car in the right lane of the two turning left. A witness stated that the bicyclist rode into traffic without pausing. In the other case, the bicyclist travelled straight through a signalised cross-intersection against a red light and was hit by a car from the left on the intersecting road that had a green light. The bicyclists were found to be at-fault in both crashes. Both bicyclists were from right-side driving countries.

Seven (75.5% of known) of the recently arrived bicyclists were wearing a helmet, while the helmet status was unknown for one bicyclist and one was wearing a turban wrap instead of a helmet (permissible in South Australia). Among longer-term Australian bicyclists, 355 (96.5% of known) were wearing a helmet. The ISS scores for the recently arrived bicyclists were 22, 14, 9, 6, 5, 4, 4, 2 and one was unknown (mean=8.3, *SD*=6.7). In comparison, the mean ISS for longer-term Australian bicyclists was 6.9 (*SD*=5.6).

3.2.4 Pedestrians

There were only 12 crashes involving pedestrians who were recently arrived to Australia, so it was not possible to statistically compare their crashes to those of longer-term Australian pedestrians. Furthermore, it was also difficult to determine exactly what occurred in these crashes according to the explanations and information available.

All 12 were hit by cars in metropolitan areas. Ten were hit by cars while crossing the road. The other two were injured in the same collision, in which they were walking through a car park at a shop when a car mounted the kerb and hit them. Of the 10 pedestrians struck while crossing the road, six were found to be at-fault, three were not at-fault, and the at-fault status was unknown for one.

The seven cases in which the recently arrived pedestrian was crossing the road and was either at-fault for the crash or the at-fault status was unknown were of particular interest as it is possible that all or some of these cases were due to unfamiliarity with the road environment or road rules. Six of these seven pedestrians were from right-side driving countries. The information was limited for the case in which the at-fault status was unknown. It was just stated that the pedestrian (from a right-side country) was crossing the road and hit by a slow-moving car. In one of the at-fault cases, the pedestrian (from a right-side country) was crossing a small side road where it intersected with a major road (i.e.

crossing the neck of a T-junction) and was hit by a vehicle turning left from the minor side road onto the major road. In another, the pedestrian (from a right-side country) was crossing a road with four lanes (two in each direction). The pedestrian made it across the first two lanes of one direction but was hit in the third lane (the first in the other direction). Similarly, in another case, the person (from a right-side country) was riding a skateboard and tried to cross a four-lane road. The skateboarder (who was not wearing a helmet) crossed the first two lanes of one direction and the third lane (the first in the opposite direction) but was hit while crossing the fourth lane. In another case, the pedestrian (from a left-side country) was crossing a six-lane road (three lanes in each direction) through a traffic signal-controlled cross-road intersection. The pedestrian made it across the first three lanes of one direction and reached the wide centre median/pedestrian refuge. There were separate pedestrian traffic signals for the three lanes in one direction and the three in the other direction. This meant that the six lanes could not be crossed at once; the pedestrian would have to cross the first three on a green signal and then wait in the refuge for a green signal to cross the other three lanes. It is possible that the pedestrian was not aware of this and kept walking or tried to rush across the second three lanes against a red signal. A car travelling straight through the intersection (on a green signal) on the road that the pedestrian was crossing hit the pedestrian in approximately the middle lane of the three. In another case, the pedestrian (from a right-side country) tried to run across a four-lane road (two in each direction) through a traffic signal-controlled cross road intersection, possibly at the end (or after the end) of the allocated green pedestrian crossing signal. The pedestrian made it across the first two lanes of one direction and then was hit by a car that was moving off at the lights with a green signal in one of the two lanes of the other direction. In the final case, the pedestrian (from a right-side country) was crossing a two-lane road (one lane in each direction) and was hit by a car in the first lane that they attempted to cross. This final case is the most likely to have involved the pedestrian looking in the wrong direction, as they were hit in the first lane that they attempted to cross and they were from a right-side country. It could also be due, however, to any number of other causes (e.g. the pedestrian looked in the right direction but simply failed to see the car).

The ISS scores for the recently arrived pedestrians were 44, 30, 24, 9, 6, 5, 5, 5, 5, 1, 1 and 1 (mean=11.3, *SD*=13.8). In comparison, the mean ISS for longer-term Australian pedestrians was 9.6 (*SD*=8.5)

4 Discussion

The purpose of this study was to examine crashes in South Australia in which a road user (car driver, motorcycle rider, bicycle rider or pedestrian) who had recently arrived in Australia was injured and admitted to the Royal Adelaide Hospital (RAH). The study involved the linking of hospital records, police-reported crash data and forensic tests of blood samples for alcohol and drugs. The crashes were examined in terms of the characteristics of the sample of injured, recently arrived road users and the characteristics of the crashes they were involved in. In summary, recently arrived road users were found to be younger and more likely to be responsible for their crashes than a comparison sample of longer-term Australian road users, and more than two-thirds (69.6%) came from countries where driving occurs on the right (opposite to Australia). Some of their crashes may have been due to unfamiliarity or confusion with either the road environment or the road rules in South Australia. Also, with regard to recently arrived car drivers, they were more likely to have crashed in rural areas, to have crashed on high-speed roads, to have departed lane/off path type crashes, to have experienced longer delays in the arrival of medical care, and to be more severely injured.

It was also found that recently arrived road users did not differ from the comparison sample of longer-term Australian road users in the likelihood of testing positive for alcohol and were less likely to test positive for a proscribed drug. This is consistent with previous research in Queensland by Wilks et al. (2000) who found that serious crashes involving international car drivers or motorcycle riders were less likely to involve high-risk driving behaviours such as alcohol intoxication than the serious crashes of Australian drivers and riders. Furthermore, the recently arrived road users in the present study only constituted 2.7% of the total number of car drivers, motorcycle riders, bicycle riders and pedestrians who were injured as a result of crashes and admitted to the RAH between May 2014 and October 2017. These two findings indicate that recently arrived road users are less likely to crash while impaired and constitute only a small part of the road trauma in South Australia. On the other hand, they were more commonly found to be at-fault in their crashes than longer-term Australian road users, which could be interpreted as indicative of greater crash risk. However, it should be noted that there may be some degree of bias in attributions of fault in crashes involving road users from other countries, particularly if they are not fluent in English and police at the scene have difficulty understanding them or they assume that they do not understand South Australian road rules. There may also be some degree of bias related to common perceptions of road users from other countries as being dangerous. However, as indicated above, they only constitute a small proportion of the road trauma in South Australia. The majority of road users who were admitted to the RAH were longer-term Australian road users (97.3%). This is similar to possible perceptions by rural residents that visitors (e.g. drivers who live in metropolitan areas) are those involved in rural crashes. However, the vast majority (61%) of drivers and riders killed or seriously injured in crashes on rural roads in South Australia actually live in rural areas of South Australia (Department of Planning, Transport and Infrastructure, 2017).

The crashes of recently arrived road users were examined in more detail in the present study for car drivers, motorcycle riders, bicycle riders and pedestrians separately. As mentioned above, the crashes of recently arrived drivers were overrepresented in rural areas and, likely in relation to this, areas with speed limits of 70, 80, 90, 100 and 110 km/h. Wilks et al. (2000) also found that international drivers in Queensland were more likely to be involved in a serious crash on 100 and 110 km/h speed limited roads and less likely on 60 km/h and under roads. This may be due to exposure. In particular for tourists, they may come to Australia, acquire a car and undertake a large driving holiday through rural areas, while any travel in urban areas may be undertaken through public transportation. Therefore, a larger proportion of their driving may be in rural areas, with any crashes being more likely to occur in these areas, too. However, this may also be some indication that recently arrived drivers find the

unique rural and remote driving environments of Australia, where vast distances are travelled between major population areas, more difficult than longer-term Australian drivers. Wilks et al. (2000) similarly identified that rural, rather than urban, conditions are difficult for international drivers. In particular, they may be more susceptible to fatigue while driving the vast distances compared to longer-term Australian drivers, who have had more experience driving in these conditions. Indeed, Wilks, Watson and Faulks (1999) have suggested that fatigue is often exacerbated by a lack of familiarity with the distances and conditions encountered while driving in Australia.

One of the key issues that this study set out to examine regarding recently arrived road users was whether their crashes were due, at least in some part, to unfamiliarity or confusion with either the road environment or the road rules in South Australia. There were no clear cases in which a car driver or motorcycle rider from a right-side driving country was on the incorrect side of the road due to confusion and collided with another vehicle. However, there were four crashes involving car drivers in which it is possible that they were not familiar with driving long distances between destinations in rural areas and fell asleep, which caused them to travel out of their lane and collide head on with a car travelling in the opposite direction or roll over. There were also two crashes involving car drivers and one involving a motorcyclist in which they failed to give way through a cross road intersection and were hit by another vehicle. It is possible that the recently arrived drivers and rider in these cases were disoriented, confused or unaware of the road rules in Australia as to which vehicle is required to give-way at cross intersections. There was one case in which a pedestrian from a right-side driving country possibly looked in the wrong direction before crossing the road and was hit by a vehicle. There was also one case in which a recently arrived bicycle rider pulled across two lanes of traffic without looking and one in which a recently arrived bicycle rider rode through an intersection against a red light. These cases indicate that unfamiliarity or confusion with either the road environment or the road rules *could* be a contributing factor in at least some of the crashes of recently arrived road users in South Australia. However, the crashes examined in this study may have been caused by a number of other factors which could not be identified in the available information and these other factors may also contribute to the crashes of longer-term Australian drivers (e.g. distraction).

The finding that recently arrived car drivers were more severely injured in their crashes compared to longer-term Australian car drivers was found to be, at least in part, due to differences in the circumstances of their crashes. The crashes of recently arrived drivers were more likely to occur in areas with speed limits of 70, 80, 90, 100 and 110 km/h, to be departed lane/off path type crashes and to have involved a considerable delay before the arrival of medical care. Linear regression found that these variables increased injury severity (ISS) across the entire sample of drivers. The higher severity of crashes involving recently arrived drivers makes it imperative to find ways to both prevent their crashes and mitigate the resulting injuries. The following section suggests a range of possible countermeasures to do this.

4.1 Countermeasures

This study did not find any clear evidence that drivers who had recently arrived in South Australia from right-side driving countries had crashes in which they were on the wrong side of the road due to confusion and collided with another vehicle. However, it is possible that the data (from one hospital, for a period of three years and five months, only serious injury/hospital admissions) simply did not capture any instances of this or there was not enough detail in the narratives of the crashes to determine that this occurred (it possibly occurred in two cases but the details were too limited). If there continues to be a general concern about recently arrived drivers becoming confused and driving on the wrong side of the road, there could be benefit in novel approaches to informing them that driving is on the left in Australia, as well as informing them about specific road rules in Australia that they may not be familiar with. For example, information could be provided through car rental businesses for

tourists (either by hand when they complete paper work or presented in a prominent place in the car) or through driver training organisations or licensing authorities for people who intend to become permanent residents. Some such approaches to distributing information have been implemented in South Australia. In 2016 the Department of Planning, Transport and Infrastructure of the South Australian Government launched a series of four videos in a range of languages including English, French, German, Italian, Spanish, Chinese, Arabic and Dari which were to be promoted by hire car companies and tourism operators. The videos explain the laws regarding driving on an overseas licence, the road rules, and tips for driving safely on South Australian roads and in remote areas. These were developed in consultation with the South Australian Police, StudyAdelaide, Migration South Australia, Multicultural South Australia and the South Australian Tourism Commission. The videos were also made available to international students and new residents and can be found at http://www.mylicence.sa.gov.au/visitors_to_south_australia along with an online hazard perception test that can be used to get used to the feeling of driving on the left. Further to the videos, a "Welcome to South Australia - Know the Road Rules" postcard was produced. Postcards and “Drive on the Left in Australia” windscreen stickers can currently be ordered from the website mentioned above. Additionally, at the time of writing, a multi-lingual road rule and safety phone app called “DriveAbout” has released by the Australian Migrant Resource Centre (AMRC) and the South Australian Government for download on App Store and Google Play between 13 September and 13 October 2019. This driver education app is available in five foreign languages, Mandarin, Vietnamese, Arabic, Dari and Spanish as well as English.

It is also possible to increase the implementation of infrastructure measures that prevent access to the wrong side of the road. Such measures include dividing lanes of opposing traffic with centre barriers. and making access to the wrong side of the road difficult at the beginning and end points of highways, freeways and expressways. The latter can be achieved through improved signage and improved lane marking and road geometry.

There was one case, involving a pedestrian who had recently arrived from a right-side driving country, in which it is possible that they were looking in the wrong direction for traffic before they stepped onto the road and were hit by a car. Preventing pedestrians looking in the wrong direction when they cross a road is a difficult problem to address, as is preventing bicycle riders from making mistakes in the road system due to being unfamiliar with the road rules. There are no ideal places of contact through which information could be provided to recent arrivals about pedestrian or bicyclist safety, other than at the airport which would require considerable resources to both identify recent arrivals and distribute the information. In locations where large numbers of recent arrivals can be expected (e.g. in areas where there is a high concentration of international students), infrastructure that encourages pedestrians to cross at signalised pedestrian crossings rather than crossing mid-block could be installed (e.g. roadside pedestrian fencing).

In terms of the possible issue of fatigue in recently arrived drivers resulting from their inexperience in driving vast distances in rural Australia, information on the rural driving environment and how to minimise the risk of fatigue (e.g. plan travel, take regular rest stops, share driving and be aware of jet-lag) could be beneficial. Increasing the number of designated and sign-posted driver rest stops around rural Australia could also be warranted. Other countermeasures to reduce fatigue crashes include improvements in road infrastructure being consistently applied across the rural road network in Australia and the uptake of newer vehicles with advanced technology.

For road infrastructure, the addition of audio tactile lane markings to rural roads across Australia would help to alert drivers when they have fallen asleep and are about to drift out of their lane. As mentioned above, centre barriers prevent vehicles travelling into lanes of opposite direction and colliding head on

with other vehicles, and side barriers or adequate clear zones can help to prevent other departed lane/off path crashes such as hit fixed object and rollover crashes.

With regard to vehicle technology, passive lane departure warnings provide the same alert effect as audio tactile lane markings, while active lane departure systems can control the steering of a vehicle to keep it within the lane. Autonomous emergency braking could potentially help to prevent, or reduce the severity of, fatigue-related head on and hit fixed object crashes through the technology sensing an obstacle in the forward path and automatically braking the vehicle (in some instances, depending on the vehicle position, distances and whether the roadside object or other vehicle would be detected by the technology). In addition, driver fatigue warnings use steering angle sensors, inward facing cameras and time and distance monitors to detect if the driver is becoming fatigued or has been driving for a prolonged period, and can then provide a warning to take a break. In-vehicle safety features can take more than a decade to permeate the general vehicle fleet in Australia (Anderson, Hutchinson, Linke & Ponte, 2011). This may be accelerated in rental vehicles as the fleet is regularly updated. However, there is the possibility that many tourists (particularly those who are younger) and new migrants prefer to purchase a vehicle because it is cheaper than renting one over a long period. In this case it will take longer for these technologies to become common in the older vehicles that they purchase. These individuals could be encouraged to purchase the newest vehicles that they can afford that still have reasonably current safety features (e.g. cars that are four to five years old). Newer vehicles would also provide superior protection from serious or fatal injury in the event of a crash (Anderson & Doecke, 2010; Anderson & Hutchinson, 2010; Newstead, Watson & Cameron, 2008; Ryb, Dischinger & Ho, 2009).

It was found that recently arrived drivers were more likely to crash in areas with speed limits of 70, 80, 90, 100 and 110 km/h than longer-term Australian drivers and that a higher speed limit at the crash location increased injury severity. It has been well established in past research that high-speed travel is associated with an increased likelihood of a crash (through reduced vehicle control) and that a serious or fatal injury will result (through increased impact speed) (Archer, Fotheringham, Symmons & Corben, 2008; Elvik, Christensen & Amundsen, 2004; Kloeden, Ponte & McLean, 2001; Richards, 2010; Thompson, Baldock, Mathias & Wundersitz, 2013). Eleven (37%) of the 30 crashes involving recently arrived drivers in the present study occurred in areas with a speed limit of 110 km/h. A reduction in speed limits from 110 to 100 km/h on rural roads would decrease the number and severity of rural crashes (for all car occupants, not just recently arrived drivers). Previous research by Long, Kloeden, Hutchinson and McLean (2006) has shown that a reduction in the 110 km/h speed limit to 100 km/h on specific rural roads in South Australia reduced both the average travelling speed and the number of casualty crashes at these locations. A common objection to such speed limit reductions is that travel times would increase as a result. However, Dutschke and Woolley (2010) used data from Long et al. (2006) to show that there would only be small increases in travel times on rural roads in South Australia if speed limits were reduced from 110 to 100 km/h. An increase of between 4 and 10% was estimated, which only equates to between 2.2 and 5.5 minutes over a 100-kilometre journey.

Finally, given that recent arrivals were more likely to crash in rural areas and that it took longer for medical care to reach them, the severity of injury to recently arrived drivers could be lowered by reducing the average time taken to provide emergency medical care at rural crash sites. The provision of more emergency services in rural areas would be effective in achieving this but could be cost-prohibitive. However, reductions in the delays of medical care could be achieved by reducing delays in notification of emergency services that a crash has occurred. Such delays in notification likely result from the fact that many rural roads have little traffic, meaning that it often takes some time before a passer-by discovers the crash and contacts emergency services. Automatic Crash Notification (ACN) technology has the potential to reduce time-to-treatment for individuals involved in rural crashes and, consequently, decrease road fatalities and injury severity (Clark & Cushing, 2002; Ponte, Anderson &

Ryan, 2013; Sihvola, Luoma, Schirokoff, Salo & Karkola, 2009). When a vehicle fitted with ACN is involved in a crash, the technology automatically detects the incident (e.g. through airbag deployment, accelerometer), obtains information about severity (e.g. through change in velocity), and alerts emergency medical services and sends GPS-based coordinates of the location if necessary. ACN technology has not yet been widely deployed in vehicles manufactured for the Australian market. As mentioned in relation to other in-vehicle technologies above, this technology will hopefully permeate rental vehicles in Australia once it is widely deployed and as the fleet is updated. However, if many new arrivals to Australia buy older vehicles, they will miss out on the potential safety benefits of this technology.

4.2 Study limitations

The data in this study only included crashes in which the road user of interest (recently arrived or longer-term Australian car driver, motorcycle rider, bicycle rider or pedestrian) had been injured and admitted to hospital. The reason for this was that one of the central purposes of the study was to examine injury severity and the depth of detail required could only be obtained from detailed hospital admission records. However, a future study could also include all property-damage only crashes, minor injury crashes (e.g. private doctor or hospital treated) and crashes in which a road user died at the scene. This would also include crashes in which the road user of interest was involved (e.g. a recently arrived car driver) but was not admitted to hospital themselves.

Another limitation was that the level of detail in the narratives of the crashes was limited. This made it difficult to determine with certainty whether unfamiliarity with either the road environment or the road rules in South Australia actively contributed to the crashes of the recently arrived road users. Detailed descriptions of what happened in the crashes and what caused them, particularly from those involved, would be ideal for future research.

Finally, the sample of 56 recently arrived road users was small, particularly when divided into car drivers, motorcycle riders, bicycle riders and pedestrians. The small sample made it impossible to undertake statistical significance tests for various comparisons and identify locations where clusters of crashes occurred. Ideally, a future study of crashes involving recent arrivals would obtain a larger sample of data. It would also be beneficial to obtain data on the exact total number of crashes that recently arrived road users are involved in, for South Australia or possibly even Australia, not just admissions to one hospital in South Australia. Such data, combined with measures of exposure (e.g. exact population of recent arrivals in South Australia or Australia) and relevant data for longer-term Australian road users, would allow for examinations of the relative risk they pose on the road. However, it may be difficult to identify recent arrivals using criteria such as time in Australia being less than one year, as such information is unlikely to be included in all relevant databases (e.g. police-reported crash data). A key strength of the present study was that detailed data from hospital records were linked to police-reported crash data (as well as forensic blood tests).

4.3 Conclusions

Previous research on crashes involving recently arrived road users in Australia has been limited, particularly relating to crashes in South Australia and including bicycle riders and pedestrians. As a result, the road safety of this particular section of the road user population has been largely overlooked by recent research and is not well understood. The present study undertook a detailed examination of their crashes and identified several road safety issues (e.g. more commonly at-fault, higher severity of injury, finding rural driving conditions difficult). However, it is important to consider that beyond purely viewing the road safety of recent arrivals in terms of the risk that they pose on the road, it is fundamentally important that every effort possible is made to keep people safe when they

are new to the country and use the roads. It is important that Australia is a safe place in which to travel and live. Accordingly, this study suggested several ways in which the safety of recently arrived road users could be improved, and these measures would also have safety benefits for all road users in Australia.

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