

An exploratory study on the safety effects of speed limit reduction policy in Brisbane and Melbourne CBDs

Md. Kamruzzaman¹, Ashim Kumar Debnath², Vasili Bourdaniotis³

¹ Monash Art Design & Architecture, Monash University, 900 Dandenong Road, Caulfield East VIC 3145, Australia

² School of Engineering, Faculty of Science, Engineering & Built Environment, Deakin University, Locked Bag 20000, Geelong, VIC 3220, Australia

³ Strategic Planner, Mackay Regional Council, Mackay, QLD 4740

Email for correspondence: md.kamruzzaman@monash.edu

Abstract

Transport authorities around the world have implemented a range of bicycle safety measures (minimum passing distance, helmet law, speed limit of motorized traffic, use of illumination equipment) to reduce the rate of crashes and thereby to enhance the level of cycling. However, a comparative assessment of the impacts of such interventions is rare because both the nature and time of interventions vary between jurisdictions. This paper presents an explorative study of the safety outcomes of a speed reduction policy in the Central Business Districts of two major cities in Australia (Brisbane and Melbourne). The paper used police reported historical bicycle crash data spanning over the period of 2006-2016 to evaluate the policy. Comparisons were made between before and after the implementation of the policy within a city, and between the cities using descriptive statistical analysis. Results show that the reduction of speed limits was associated with reduction in crash rates. However, the effect was more pronounced in Melbourne than in Brisbane. Challenges faced in evaluating the safety effects of the policies and the need for future research to robustly identify their impacts are discussed in this paper.

Keywords: Cycling Safety Policy; Speed Limit Reduction; Crash Rate; Crash Severity; Longitudinal Analysis

1 Introduction

Strategies to promote cycling are increasingly being incorporated in the policy circle around the world because of its multiple policy co-benefits (e.g. improved health, reduced congestion and greenhouse gas emissions) (Daley & Rissel, 2011; Pucher et al., 2010). The main issue plaguing the promotion of cycling is that it is inherently a risky activity especially when undertaken within contemporary, car dominated cities, where the provision of adequate bicycle infrastructure is not often present (Wardman, et al., 2007). Cars and other motor vehicles present the largest threat to cyclists riding on the roads (Appleby & Webster, 2016). As a result, the most widely accepted policy

option to avoid the interaction between bicycle and motor vehicles is the protected bike lanes. Protected bike lanes have been tested rigorously to judge their effectiveness in deterring people from using the roads to ride their bicycles. A study undertaken in New Orleans, Parker, et al. (2013) concluded that people would rather ride on a protected bike lane than through the streets of the city (even though the latter route is shorter in distance). However, despite bike lanes being effective at reducing interaction with motor vehicles, it is inefficient and nearly impossible to integrate into all existing dense built up areas due to space and cost requirements (Luo, 2015). These limitations make it impossible to eliminate the possibility of interaction between bicycles and motor vehicles. As a result, several surrogate safety policy measures (referred to as road rules) have been implemented across the world particularly targeting those who share a road. These road rules (e.g., minimum overtaking/passing distance for motorists, mandatory helmet use by the cyclists) dictate the conduct which must be undertaken by road users, both by cyclists and motor vehicles, in order to preserve a civil and ordered road network free of crashes.

Road rules to protect cyclists have existed since the use of cycling as a mode of transport (Appleby & Webster, 2016). While the benefits of cycling safety measures have been well documented with regard to their effects on increasing cycling ridership, there is an apparent lack of research pertaining to how such policies affect the rate of cycling crashes. For these safety policies to be successful, they must satisfy two key criteria: first, they must aim to have a material impact on the safety of cyclists; and second, they must promote a perception of safety to the public (Hamann, 2013; Chataway et al., 2014). This research focuses on this first criterion, and aims to provide insights into the effectiveness of lowered speed limit policy on central business districts (CBDs) using two Australian cities (Melbourne and Brisbane) as case studies. Section 2 provides a summary of the literature on different bicycle safety measures and their effectiveness. The data and method applied to address the research objective is discussed in Section 3. Section 4 presents the results of this study. The key findings of this study are discussed in policy terms in Section 5. Section 6 concludes this study.

2 Effects of bicycle safety measures (road rules)

This review focuses on the effectiveness of five key bicycle safety measures: the use of shared path, the use of illumination equipment on bicycles, mandatory use of helmet, vehicular speed reduction, and minimum passing distance.

Due to the size and speed differences between motor vehicles and bicycles, cyclists possess a far greater potential to be injured or killed compared to people occupying motor vehicles (Appleby & Webster, 2016). This is especially apparent around large intersections, along roads with tram lines and within a close proximity to shopping centers and entertainment precincts (Vandenbulcke, et al., 2014). While there is less risk commonly associated with riding on a footpath or shared use path, this does not necessarily mean that all dangers do not exist. The risk of collision with pedestrians and other cyclists is still present when riding in such environments. In fact, a higher proportion of cycling related incidents occurs in such environments (albeit the injury severity is low) in comparison to cycling on-road (de Rome, et al., 2014).

The visibility of cyclists also appears to be a major concern in the safety literature. Poor visibility can result in an increase in the likelihood of crashes as well as injury severity (Kim et al., 2007). Studies have shown that night time lighting and heavy rain/fog doubles the likelihood of fatalities occurring as a result of collisions. The poor

visibility in these conditions impairs the reaction time available to road users, leading to collisions at greater speeds and thus causing more severe injuries. Countermeasures which have been suggested to combat this problem not only include the provision of more effective street lighting but also encouraging the use of illumination equipment on bicycles, such as lights and reflectors (Kim et al., 2007, Wood et al., 2009).

The effects of mandatory helmet policy have been studied by some researchers. They found that helmets are an excellent measure to reduce the severity of cycling crashes, often reducing the severity of a crash from potentially fatal to a mere minor injury (Franklyn, 2010; Bateman-House, 2014). It is also to be noted here that the use of helmets is a preventative measure for reducing injury when crash occurs – not to prevent crashes. The primary goal of cycling safety policies should be more proactive to reduce the overall rates of crashes.

Limiting speed for vehicular traffic is a commonly applied road rule to safeguard cyclists. An example of such a strategy can best be seen in northern European countries where the implementation of lower average speed limits (<30km/h) of the roads offer a much safer environment for cyclists, resulting in a lower likelihood of bicycle crashes, when compared to roads seen in other countries such as in Australia (~60km/h) (Pucher et al., 2011). The severity of injuries is also intrinsically linked to speed limit. As the maximum allowable speed of a road increases so does the probability of more serious injuries such as hospitalizations and fatalities (Isaksson-Hellman, 2012). This risk is even further increased when speeding is a contributing factor of crashes, both on the part of the cyclist and motorist, leading to a possible tripling of the likelihood for a fatality to occur (Kim et al., 2007).

Minimum passing distance, the distance between motor vehicles and bicycles while overtaking, is a road rule recently being implemented across many cities (Love et al., 2012; Walker, 2007; Debnath et al., 2018). Transport for London (2005) reported that bicycle collisions that were most conducive to result in fatalities were those that took place during overtaking maneuvers. As such, many countries including Australia, France, Spain and the United States, have enacted safety measures mandating that certain safe passing distances must be maintained between motor vehicles and bicycles (Love et al., 2012; Schramm et al., 2016). These distances can range between 1m to 1.5m. However, despite being obligated by law, motorists were found to be non-compliant with the law in Baltimore, US, (Love et al., 2012) and Queensland, Australia (Debnath et al., 2018).

The above review clearly suggests that despite few studies have investigated the compliance of road rules in different contexts, their effects on actually reducing the number of crashes is an understudied topic. In addition, most often studies investigated their effects in a narrow context and rarely evaluated the effects across different jurisdictions which limit the validity of findings.

3 Method

The aim of this study is to evaluate the effects of lowered speed limits on crash rates. To address the aim, the study used Melbourne and Brisbane— the capital cities of Victoria and Queensland respectively. The CBDs of these cities were selected to the study the impacts of the policy due to their contemporariness of introducing the policy.

3.1 Study contexts and related road rules

Various policies are being implemented to increase the level of cycling in Australia. A nationwide survey by Austroads (2017) in Australia revealed that about 16% of the Australian population rode bicycles every week in 2017 (22% rode at least once in a month). Australia is divided into six states and two territories and the responsibility to provide an adequate riding environment and implement safety measures falls on the state/territory governments. As a result, it is possible that some policies are only applicable in certain states.

Australia is the first country in the world to implement mandatory bicycle helmet laws, which require all bicycle riders to wear an approved bicycle helmet and securely fasten it on the rider's head. Studies have shown that more than 98% cyclists obey this rule (Debnath et al., 2016). Minimum passing distance laws in Australia, which require motorists overtaking a cyclist to maintain at least 1m lateral gap on 60 km/h (or lower) roads and at least 1.5m on 70 km/h (or higher) roads, have also been identified as effective measures (Schramm et al., 2016). Some Australian states have lowered speed limits across most streets in their CBDs to reduce crash occurrence and the severity of crashes. Similarly, policies on mandatory use of bicycle lighting and reflective equipment have been implemented to make cyclists more conspicuous in the road environment. Policies around the development and upgrading of cycling infrastructures (e.g., bicycle lanes, paths, cyclist friendly pavement markers etc.) have also been implemented across Australia. Some of the Australian states saw the policy implementations with accompanying education campaigns and road rules changes (Queensland Parliament, 2013). While many of the policies and changes have been the subject of research, limited research has been conducted on evaluating the lowered speed limit in the CBDs.

This research carefully selected Melbourne and Brisbane as the case study areas because of their common policies on speed reduction within the CBD settings. The policies were also implemented within a short time gap between the cities which are likely to provide unbiased comparison. A reduction to the posted speed limits on CBD streets was introduced in response to a number of pedestrian and cyclist fatalities within the CBD of Brisbane and Melbourne. In Brisbane, the measure was introduced in October 2009, lowering the speed limit of all street, except Ann and Turbot Streets, to 40km/h. Three years later, in October 2012, Melbourne also adopted the same measure across all CBD streets. The study locations allow cycling almost all months in a year. About 17% of Melbourne's 4.9M inhabitants and 14% of Brisbane's 2.4M inhabitants ride a bicycle at least once in a week (Austroads, 2017).

3.2 Crash and exposure data

To derive bicycle crash rates at a given circumstance or location, two types of data are needed: number of cyclist-involved crashes, and a measure of exposure to the crashes. Crash numbers were obtained from the police-reported crash databases maintained by the respective state transport authorities in Queensland and Victoria. The crash data sets have a variety of information related to crash occurrence, its factors, characteristics of vehicles and road users involved etc. The data sets contain information about all type of crashes. This study extracted only those crashes in which at least one cyclist was involved.

To compare the safety impacts of the cycling policies in terms of the risk of crashes, it is important to carefully select appropriate exposure data (Christie et al., 2007). A

review of the various types of exposure data used in cycling safety research shows that studies primarily used bicycle volumes, distance ridden, and time ridden as exposure data (Vanparijs et al., 2015). While such exposure data have been reported to be useful, they are often available only for specific site. In the context of this study, such exposure data were not available, and therefore, alternative measures of exposure were considered. As the policies studied in this research are related to large areas (two major cities in Australia), a general measure of the number of cyclists in the two cities was first considered to use as exposure data. The National Cycling Participation Survey of Australia reports cycling participation rate as a proportion of the population size in an area which could be used to obtain the number of cyclists in the two cities. This survey collected data every two years since 2011, therefore, no data sets were available before the implementation of the 40 km/h limit in Brisbane CBD. In addition, the survey reported that cycling participation in the Queensland and Victoria states did not vary markedly (varied between 17% and 20% of population size during 2011-2017). Since the cycling participation rates were relatively consistent and that cycling participation rates prior to 2011 was not available, population size was used as an exposure measure in this research. While population size was used in the absence of more appropriate exposure data, it is noted that population size may not be the ideal exposure measure for analysing cycling safety. Historical population data sets were obtained from Australian Bureau of Statistics (ABS, 2017) to obtain the crash rates per population units in the studied locations. The Greater Capital City Statistical Area structure (ABS, 2019) was used to obtain the population data for the two cities.

Data spanning at least three years prior to and following the introduction the policy measure were secured in order to allow sufficient elapse time for any noticeable changes in the crash rates. As a result, crash data for 2006-2016 were considered in this study because the speed reduction policy was implemented in 2009 in Brisbane. Given the data sets contain all types of crashes across the states, only the data relevant to the research objectives were extracted. For example, the crashes that occurred within the CBD settings of Brisbane and Melbourne and involved at least one cyclist were extracted to study the effects of reducing speed limits.

Using the population size of the analysed locations, crash rates were obtained for each subset of the crash data sets. Trends in the crash rates were observed and compared with respect to the introduction of the policies analysed. In addition to crash rates, the crash severity distributions were also analysed.

4 Results

Prior to comparing the crash rates before and after the implementation of the speed limit reduction policy, the population size and crash counts in the two cities are analysed (see Figure 1 and 2). While the population steadily increased in both cities, no clear patterns were observed in the crash counts. During the study period between 2006 and 2016, 416 and 216 bicycle-involved crashes occurred in the CBD areas of Melbourne and Brisbane, respectively. Yearly crash counts fluctuated between 24 and 47 in Melbourne and between 7 and 22 in Brisbane.

Figure 1: Yearly population and crash counts in Brisbane

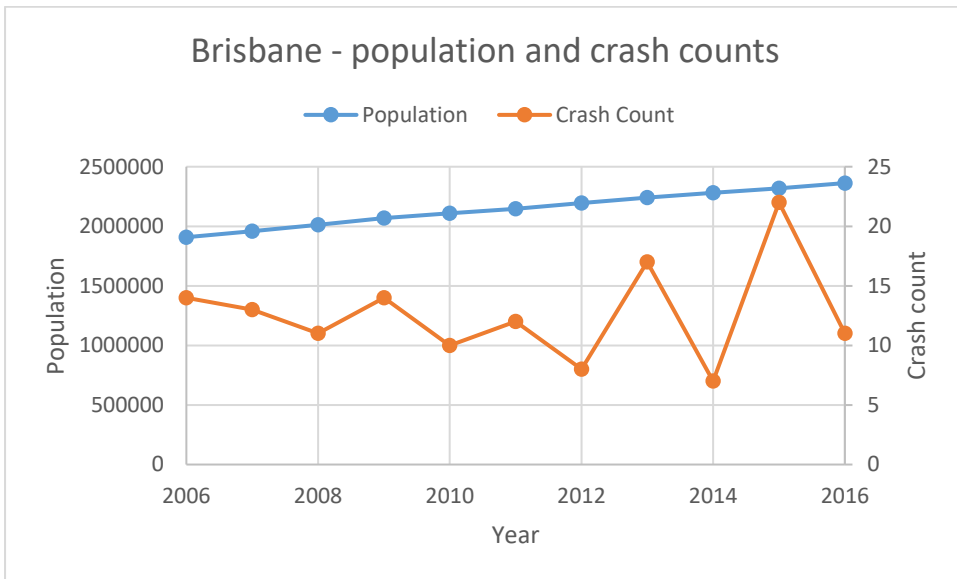


Figure 2: Yearly population and crash counts in Melbourne

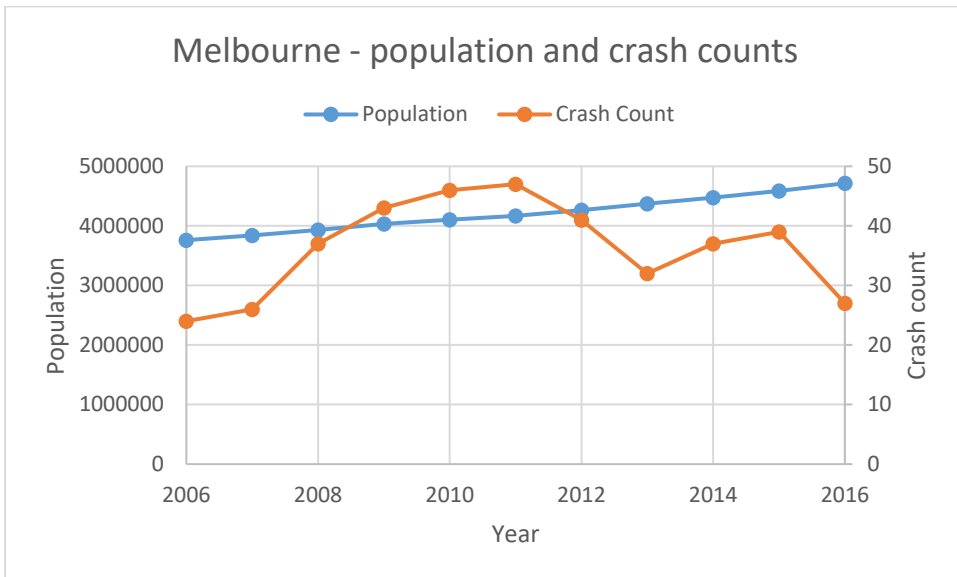


Figure 3 presents the yearly distributions of the crash rates per 1,000,000 inhabitants. Note that the trend lines presented in the figure were produced based on the ‘before’ data and were projected to the ‘after’ period to allow visual comparison against the actual ‘after’ data. These linear trend lines showed a higher R^2 value for Melbourne than Brisbane, partly due to longer time period considered for Melbourne (7 years vs 4 years for Brisbane) and variability between years. The relatively small R^2 values also suggest that it is not desirable to derive conclusions based on the projected trend lines.

Within Brisbane no persistent reduction in overall bicycle crash rate has been observed. Prior to the change in speed limit in 2009, the yearly occurrence rate of bicycle crashes was 7.7 per 1,000,000 inhabitants. Within the first three years after its introduction, a downward trend was observed resulting in a reduction of the crash rate to 4.4 crashes per 1,000,000 inhabitants in 2012. However, since this initial reduction,

the rate of crashes fluctuated heavily. Both 2013 and 2015 experienced higher overall crash rates well above the rates prior to the change in speed limit, at 9.3 and 12.0 crashes per 1,000,000 inhabitants, respectively.

On the other hand, within Melbourne a notable reduction in crash rate was observed after the changes in speed limit in 2012. Prior to the change in 2012, the crash rate was 12 crashes per 1,000,000 inhabitants. One year after the implementation in 2013, a 33% reduction was observed to approximately 8 crashes per 1,000,000 inhabitants. In the years following, the rate increased slightly, however, has since fallen further to 6 crashes per 1,000,000 inhabitants, netting an overall reduction in bicycle crash rate, since the lowering of CBD speed limits, by 50%.

Figure 3: Yearly crash rates per 1,000,000 population in Brisbane and Melbourne CBDs

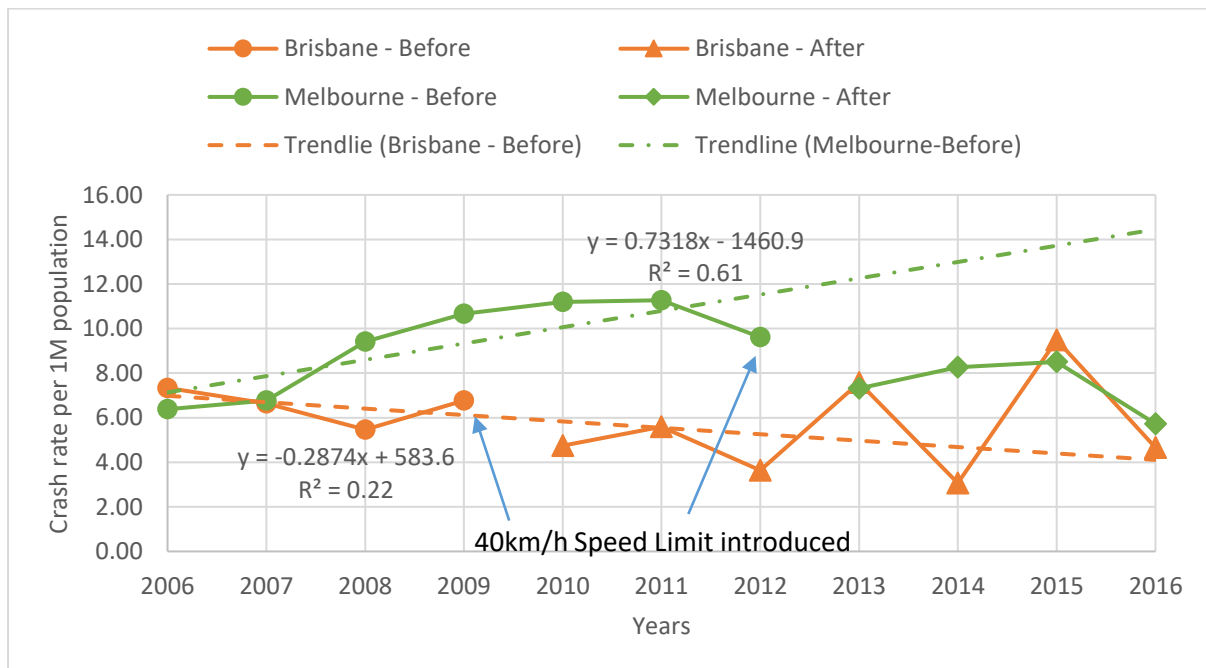
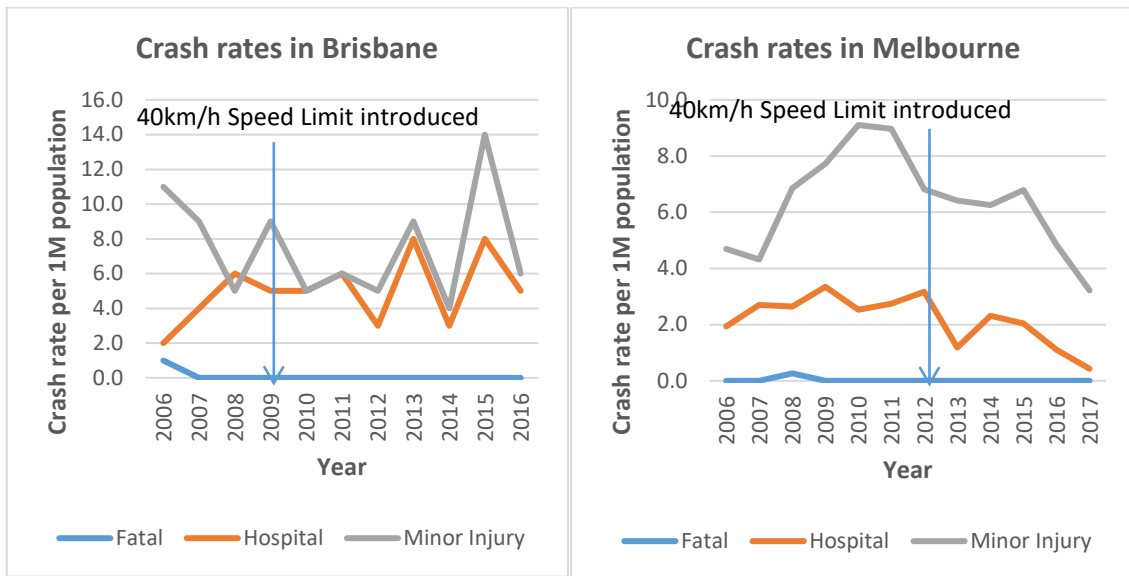


Figure 4 outlines the severity of crashes before and after the policy was introduced. In Brisbane, the general trends observed within the data were similar to the total crash rate mentioned previously. The rate of minor injuries experienced a small decrease in occurrence immediately after the implementation of the policy and then abrupt changes were observed in the trend. In contrast, little effect was evident in the hospitalizations and fatal injuries.

In Melbourne, after the policy implementation, no reduction in the rate of minor injuries initially occurred, remaining at about 6.0 crashes per 1,000,000 inhabitants until 2016, where it fell to 4.8 crashes. Contrarily, the rate of hospitalizations fell by 60% from 3.2 to 1.2 crashes per 1,000,000 inhabitants in 2013, immediately after the implementation, where it has remained stable since after seeing a small spike in the following two years.

Figure 4: Yearly crash rates per 1,000,000 population by injury severity classification in Brisbane CBD (left) and Melbourne CBD (right)



5 Discussion

The speed limit of city streets was reduced to 40km/h within the CBDs of Melbourne and Brisbane with an aim of reducing both the likelihood and severity of bicycle collisions. Determining whether the objectives were achieved proved to be difficult due to the low occurrence rate of cycling crashes both at baseline and follow-up, and also due to the difficulty of sourcing proper exposure information. Nonetheless, some observations regarding the effectiveness of this measure were made. Based on the total rate of bicycle crashes, it appears to have had a greater impact of the policy in Melbourne than Brisbane. While the data analysed in this study was not sufficient to further investigate the potential reasons for greater effects in Melbourne than in Brisbane, it can be speculated that the time of introducing the policies could have an influence. Melbourne introduced the policy in 2012 (3 years after Brisbane) and it has seen a significant increase in population size in the recent years (making the crash rate lower per capita), whereas the cycling participation rate has dropped slightly in the recent years (Austroads, 2017). Taken all together, the crash rate has dropped due to sudden increase in population and decline in cyclist numbers. Further research is needed to explore the interrelationships between population, cycling participation, and safety outcomes.

With regard to the severity of crashes, the change to a 40km/h speed limit was associated with an overall reduction in more serious crashes. This was observed in both cities as the percentage of minor injuries grew relative to that of hospitalizations. Additionally, since implementation of the policy, no fatalities have been recorded in either city. These findings align with those found within existing literature which has identified that lower speed limits result in less severe crashes (Kim et al., 2007). From an analysis of cycling crashes in London, Aldred et al. (2018) found 21% reductions in the odds of injury on roads with 20mph (32 km/h) speed limits than roads with 30mph (48 km/h) speed limits.

Several challenges were faced in the evaluation of the studied policy. First, a lack of representative cycling exposure data was the key challenge in evaluating the safety impacts of the policies. Population size was used as an alternative measure of exposure to express the crash rates per unit population size. Due to this simplification of the exposure data, the findings from this research should be considered as indicative and interpreted with caution. Further research should target using more appropriate measures of exposure. Data sources other than the cycling participation survey could be considered as potential exposure information. Examples of potential data sources include the ABS's journey to work data and cyclist counts on representative corridors or at cordon boundaries. Future research should target examining the usefulness of these and other data sources as potential exposure information in evaluating the effects of the speed limit reduction policy.

Second, due to small timeframe in the periods after implementation of the policies and absence of appropriate exposure data, it was not possible to test the statistical reliability of the results observed. While this challenge is relevant for many crash types which are random in occurrence leading to low counts per observation area of time period, an alternative approach of evaluation might involve the use of proactive safety evaluation techniques, such as using traffic conflicts or near-misses as a surrogate of the crashes. It is, however, noted that any application of the proactive techniques require careful planning and data collection before the policies are introduced. Given that the policies were implemented in the past, applying the proactive techniques is likely to be difficult in the absence of any data collected before the implementation of the policies.

Third, in addition to the inability of testing statistical significance, the results presented in this paper is subjected to the common under-reporting issues related to cycling crashes. Cycling crashes, primarily the single bicycle crashes, are often under-reported in the police-reported crash database. However, it is expected that the rate of under-reporting remained constant prior to and following the implementation of the policy which suggests that the results as reported in this study are defensible. Moreover, the extent of under-reporting is lower for higher severity crashes than the lower severity crashes – this suggests that the safety outcomes of the policies reported here are not subject to high under-reporting bias because the policy effects were found to be more pronounced on more serious crashes. However, the varying rates of under-reporting could be a key concern in studies relying on crash data, including the current study.

While this study presents an overview of the safety effects of the speed limit reduction policy, it is acknowledged that the observed effects on crash rates may not entirely be the effect of the studied policy. However, other cycling and general road safety policies (e.g., introduction of minimum passing distance rule, education campaigns) or general road infrastructure and control system improvements might have contributed to the observed crash rates. While further research is needed to isolate the effects of the policies running concurrently, the results of the current study should be carefully interpreted by keeping the above mentioned limitations in mind.

6 Conclusions

This paper presents bicycle safety evaluation of speed limit reduction policy in Melbourne and Brisbane CBD. Results obtained through an analysis of police-reported

crash data indicated that the reduced speed limits in CBD had greater effects in Melbourne than in Brisbane in terms of reducing the rates of cycling crashes. Greater effects were also observed for more serious crashes (hospitalised) than minor injury crashes. While this study sheds some light on the overall safety impacts of the studied policy, limited number of observations and absence of appropriate exposure data hindered the ability to test statistical significance of the obtained results.

References

- ABS. Census Table Builder – Method of Travel to Work (MTWP) by Australia [Statistics]. Retrieved from Australian Bureau of Statistics website on 12 June 2017 <https://quest.censusdata.abs.gov.au/webapi/jsf/tableView/tableView.xhtml>
- ABS. Australian Statistical Geography Standard (ASGS). Retrieved from Australian Bureau of Statistics website on 16 August 2019 [https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+\(ASGS\)](https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS))
- Aldred, R., Goodman, A., Gulliver, J., Woodcock, J. 2018. Cycling injury risk in London: A case-control study exploring the impact of cycle volumes, motor vehicle volumes, and road characteristics including speed limits. *Accident Analysis & Prevention*. 117, 75-84
- Appleby, G. J., Webster, A. 2016. Cycling and the law. *University of New South Wales Law Journal*. 39(1), 129-164
- Austrroads. 2017 National Australian Cycling Participation Survey. AP-C91-17, June, 2017.
- Bateman-House, A. 2014. Bikes, helmets, and public health: Decision-making when goods collide. *Journal Information*, 104(6), 986–992.
- Chataway, E. S., Kaplan, S., Nielsen, T. A. S., Prato, C. G. 2014. Safety perceptions and reported behavior related to cycling in mixed traffic: A comparison between Brisbane and Copenhagen. *Transportation research part F: traffic psychology and behaviour*, 23, 32-43.
- Christie, N., Cairns, S., Towner, E., Ward, H. 2007. How exposure information can enhance our understanding of child traffic “death leagues”. *Injury Prevention*, 13(2), 125–129.
- Daley, M., Rissel, C. 2011. Perspectives and images of cycling as a barrier or facilitator of cycling. *Transport policy*, 18(1), 211-216.
- de Rome, L. 2014. Bicycle crashes in different riding environments in the Australian capital territory. *Traffic injury prevention*, 15 (1), 81.
- Debnath, A.K., Haworth, N., Schramm, A. Williamson., A. 2016. Observational Study of Compliance with Queensland Bicycle Helmet Laws. *Accident Analysis & Prevention*, Vol. 97, 146–152.
- Debnath, A.K., Haworth, N., Schramm, A., Heesch, K.C., Somoray, K. 2018. Factors influencing noncompliance with bicycle passing distance laws. *Accident Analysis & Prevention*, 115, 137-142.
- Franklyn, M. 2010. Evaluation of bike helmets. *Injury*, 41, S34.
- Hamann, C., Peek-Asa, C. 2013. On-road bicycle facilities and bicycle crashes in Iowa, 2007–2010. *Accident Analysis & Prevention*, 56, 103-109.
- Isaksson-Hellman, I. 2012. A study of bicycle and passenger car collisions based on insurance claims data. In *Annals of Advances in Automotive Medicine/Annual*

- Scientific Conference (Vol. 56, p. 3). Association for the Advancement of Automotive Medicine.
- Kim, J. K., Kim, S., Ulfarsson, G. F., Porrello, L. A., 2007. Bicyclist injury severities in bicycle–motor vehicle accidents. *Accident Analysis & Prevention*, 39(2), 238-251.
- Love, D. C., Breaud, A., Burns, S., Margulies, J., Romano, M., Lawrence, R. 2012. Is the three-foot bicycle passing law working in Baltimore, Maryland?. *Accident Analysis & Prevention*, 48, 451-456.
- Luo, Y. 2015. Modeling the interactions between car and bicycle in heterogeneous traffic. *Journal of advanced transportation*, 49 (1), 29-47.
- Parker, K. M., Rice, J., Gustat, J., Ruley, J., Spriggs, A., Johnson, C. 2013. Effect of bike lane infrastructure improvements on ridership in one New Orleans neighborhood. *Annals of behavioral medicine*, 45(1), 101-107.
- Pucher, J., Dill, J., Handy, S. 2010. Infrastructure, programs, and policies to increase bicycling: an international review. *Preventive medicine*, 50, 106-125.
- Pucher, J., Buehler, R., Seinen, M. 2011. Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transportation research part A: policy and practice*, 45(6), 451-475.
- Queensland Parliament, 2013. Report No 39 - Inquiry into Cycling Issues. November 2013.
- Schramm, A.J., Haworth, N., Heesch, K., Watson, A., Debnath, A. K., 2016. Evaluation of the Queensland minimum passing distance road rule. Research Report: Centre for Accident Research and Road Safety – Queensland.
- TMR. Bicycle Road Rules and Safety. Transport and Main Roads, Retrieved from <https://www.qld.gov.au/transport/safety/rules/wheeled-devices/bicycle#night>, August, 2018.
- Transport for London. 2005. Pedal Cyclist Casualties in Greater London. Retrieved from the Transport for London website <http://content.tfl.gov.uk/pedal-cyclist-casualties-04-05.pdf>
- Vandenbulcke, G., Thomas, I., Panis, L. I. 2014. Predicting cycling accident risk in Brussels: a spatial case–control approach. *Accident Analysis & Prevention*, 62, 341-357.
- Vanparis, J., Panis, L.I., Meeusen, R., de Geus, B. 2015. Exposure measurement in bicycle safety analysis: A review of the literature. *Accident Analysis and Prevention*, 84, 9-19.
- Walker, I. 2007. Drivers overtaking bicyclists: Objective data on the effects of riding position, helmet use, vehicle type and apparent gender. *Accident Analysis & Prevention*, 39(2), 417-425.
- Wardman, M., Tight, M., Page, M. 2007. Factors influencing the propensity to cycle to work. *Transportation Research Part A: Policy and Practice*, 41(4), 339-350.
- Wood, J. M., Lacherez, P. F., Marszalek, R. P., King, M. J. (2009). Drivers' and cyclists' experiences of sharing the road: Incidents, attitudes and perceptions of visibility. *Accident Analysis & Prevention*, 41(4), 772-776.