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Exploring the spatial-temporal influence of the COVID-19 pandemic on road crashes in Greater Perth

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Abstract

The COVID-19 lockdowns and restrictions in Greater Perth significantly affected the road network and safety outcomes. This paper uses a spatial-temporal approach to examine their impact on road safety and trends that emerged. The analysis revealed a 35% reduction in crashes during the early 2020 outbreak compared to the same period in 2019, before gradually increasing to pre-pandemic levels by 2021 as the network returned to 'normal'. The temporary reduction in crashes was not uniform with fatal and severe collisions showing a smaller decrease than other lower severity crashes while active transport users were overrepresented in the statistics during the lockdowns and restrictions. Demographic characteristics including occupation ('white' and 'blue' collar), distance from the Perth Central Business District (CBD) and vehicles per household also influenced the demand for the road network and crash trends. Interestingly, there was a significant reduction in crashes around strategic employment centres while there was a smaller decrease around neighbourhood centres as people still travelled for essential goods. Implications for policymakers include the continued need for targeted road safety campaigns and education to improve road safety to a level seen during the pandemic. Further, investment in active transport infrastructure and the application of frameworks such as Movement and Place may enhance safety by reducing conflicts between private vehicles and active transport users.

1. Introduction

The COVID-19 pandemic had an immediate and significant impact on travel patterns and road network demand in Greater Perth. This paper uses a spatial-temporal approach to analyse the influence of lockdowns and restrictions on road crashes. The analysis compares crash characteristics in 2019, during the pandemic outbreak (March to May 2020), and one year later (March to May 2021). The study examines various factors, including severity, road user type, distance from Perth CBD, and proximity to business areas and neighbourhood centres. Demographic factors such as income, essential/non-essential occupations, and vehicles per household were also considered.

This paper contributes a better understanding of the influence that the pandemic lockdowns and restrictions had on crashes in Greater Perth and supports strategies to improve road safety. This paper also contributes to the wider literature on the influence of COVID-19 restrictions on road

safety in Australia and provides a contracting perspective on the severe and extended lockdowns that occurred in other cities.

2. Literature review

Lockdowns and restrictions on gatherings, including mandated mask-wearing, were important measures to curb the spread of COVID-19 within the community. Unsurprisingly, the lockdowns and restrictions contributed to changes in transport demand and travel patterns in cities around the world. Studies by Marra et al. (2022), Tiikkaja & Viri (2021), Abdullah et al. (2020), Shelat et al. (2022), and Eisenmann et al. (2021) found that public transport usage decreased due to fewer services, government restrictions, and increased concerns about infection. By comparison, private vehicles and active transport became more attractive due to their perceived safety of having fewer public interactions and the potential transmission of COVID-19 (Abdullah et al., 2021; Loa et al., 2021; Moslem et al., 2020).

The lockdowns and restrictions led to an overall reduction in the number and distance of journeys (Chen et al., 2022), except for travel to purchase groceries and essential goods which increased (Wang et al., 2022). This is a notable and important shift from the primary purpose of travel before the panic which was for work and study activities (Abdullah et al., 2020).

Demographic and socio-economic characteristics also influence an individual's risk perception, travel behaviours and mode choice (Schaefer et al., 2021; Rahimi et al., 2021; Simon et al., 2021; Das et al., 2021; Rafiq et al., 2022). An American study by Simon et al. (2021) found that people with higher incomes (above US$90,000) travelled less during the pandemic while Rahimi et al. (2021) found that those on extremely low incomes of less than US$20,000 also recorded fewer journeys. These findings suggest that wealthier people may be able to avoid travel, while lower-income individuals do it out of necessity as they are unable to afford protective equipment. Within the Australian context, wealthy people may have been able to work from home while lower income individuals may have been eligible for the JobKeeper subsidy which reduced the need to travel for work (Australian Government, 2020).

Other factors including age, gender and educational attainment also influenced travel during the pandemic (Das et al., 2021; Chen et al., 2022; Downey et al., 2022). An Indian study (Das et al., 2021) found that young males were most likely to use public transport during the pandemic while Vallejo-Borda et al. (2022) explained that elderly people tend to shift from public transport to private vehicles given active transport is not conducive to frailty and mobility restrictions. Downey et al. (2022) found that people with lower educational attainment were less likely to use public transport in the future while those with higher educational attainment were more likely to use it in the future. Also, highly educated and older people are more responsive to enforcement measures such as wearing face masks and maintaining social distancing, while young and single people had a preference for non-compulsory measures such as disinfection frequency when using public transport (Chen et al., 2022).

3. Approach

This paper explored the influence of the COVID-19 pandemic on road crashes in Perth whilst accounting for the human and environmental factors described in the literature review. Table 1 outlines the factors considered in the analysis.

Table 1: Road crash factors

Crash Factors	Factors analysed in this paper
Human factors	Vulnerable road user group (i.e., motorcycle, bicycle and pedestrian)
	Demographic considerations (i.e., numbers of vehicles per household; concentration of essential industries; household income decile)
Environmental factors	Location of crashes (i.e., midblock/intersection)
	Location of crashes by distance from the Perth CBD (i.e., 20km or less; between 21-40km; 41km and above; and regional WA)
	Typology of surrounding areas of crash locations (i.e., distance to business activity centres and residential areas)

To explore the impacts of COVID-19 on road safety in Greater Perth, the analysis followed these key steps:

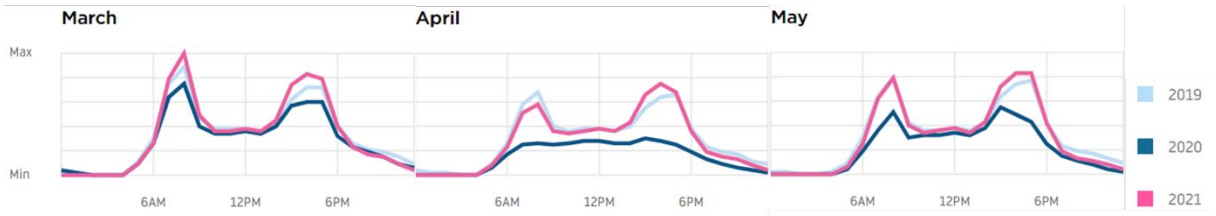
- Reviewed Western Australian Government public health announcements to track COVID-19 lockdowns and restrictions which were in place from March to June 2020. A series of restrictions were in place between March and June 2020, with three snap lockdowns as tighter restrictions (e.g., reduced gatherings) in 2021.
- Cleaned and prepared road crash data published by Main Roads Western Australia (Main Roads 2021). The dataset contained 132,230 crashes across Western Australia between 1 July 2017 and 31 December 2021
- Collected supporting datasets from sources like Google Mobility, TomTom, and the Australian Bureau of Statistics (ABS) to provide context for road crash findings. Australian Broadcasting Corporation (ABC) articles were used to identify key milestones and public discourse about road network impacts.
- Determined the spatial parameters of the analysis. The data was analysed at a Statistical Area 2 (SA2) level, which was then aggregated by distance from the Perth CBD (0-20km, 20-40km, 41km+). Additional spatial analysis of crashes around Strategic Metropolitan Activity Centres (SMACs) and neighbourhood centres was completed. Neighbourhood centres were identified based on the presence of one or more supermarkets, such as Coles, Woolworths or IGA.
- Determined the temporal parameters of the analysis. The analysis focused on March to May 2020 which aligns with the outbreak of COVID-19 in Greater Perth and the rapid introduction of restrictions. The same period was also analysed in 2019 and 2021 to identify trends, while the calendar years (i.e., 12 month periods) were also examined to understand the longer-term macro impacts.

There are several limitations to the analysis. Firstly, the analysis is descriptive only and does not control for changes in demand for the road network. While analysis of TomTom data and total volume of fuel consumed as a proxy for network demand identified a reduction in activity, it was challenging to establish a city-wide estimate. Traffic counters were considered, however, they are impacted by outages, nearby construction or other network activity/events. Secondly, the analysis is primarily focused on the impact from March to May in 2019 to 2021 which aligns with the outbreak of COVID-19 (plus a year before and after). Other trends that occurred across the year may not have been identified. Lastly, the analysis is interested in absolute and proportional changes in crashes, without applying statistical methodologies to understand the results.

4. Results

The road network activity was significantly impacted by COVID-19 restrictions implemented in late March 2020, as shown by TomTom data in Figure 1. Demand from March to April 2020 (dark blue) was substantially lower than 2019 levels (light blue) before returning to pre-pandemic levels in 2021 (pink). Furthermore, an analysis by Reed & Biermann (2021) indicates that demand on the road network around the CBD fell by about 30% during the outbreak of COVID-19 in early 2020, while demand in suburban areas fell by around 35%. Demand gradually returns across 2020 and 2021, noting there are dips associated with snap lockdowns.

Figure 1: Indicative vehicle volume in Greater Perth (selected months) (TomTom, 2022)

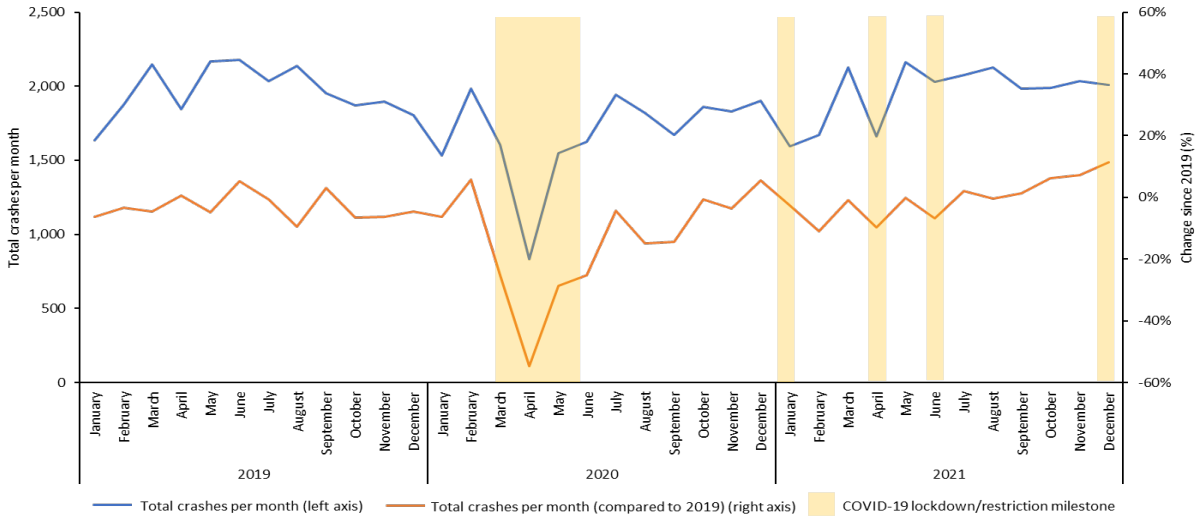


It is speculated that this reduction in activity on the road network contributed to fewer crashes. Between March to May 2020, there was a 35% reduction in crashes (or 2,100 crashes) compared to the corresponding period in 2019. The number of crashes remained below 2019 levels for all months in 2020 except December, before gradually increasing in the second half of 2021, indicating a return to 'normal' road network activity.

Figure 2 shows the long-term trend of road crashes in absolute terms and compared to the corresponding period in 2019 (note, 2019 was compared to 2018). The light yellow shading denotes key lockdown and restriction events, which generally correspond with a reduction in road crashes, coinciding with a reduction in road network activity.

The longer-term trends show mixed results for road safety outcomes. The improved road safety outcomes observed during early to mid-2020 have eroded and returned to baseline levels.

Figure 2: Greater Perth long-term road crashes, per month



4.1 Trends by crash type and user group

Between March and May 2020, there was a 35% overall reduction in crashes, compared to the same period in 2019. This was driven by fewer Property Damage Only (PDO) crashes, such as rear-end collisions, that typically occur in congested conditions (Hughes, Kaffine & Kaffine, 2022). Fatal and hospitalisation crashes also decreased, but to a smaller extent (6% and 23%,

respectively). This may be partly explained by Hughes, Kaffine & Kaffine (2022) who found that PDO crashes fell with network demand while the easing of congestion may have allowed for faster speeds and more severe crashes. From March to May 2021, crashes returned to 3% baseline levels, which aligns with a return in demand for the road network (ABC, 2021).

However, vulnerable road and active transport users experienced a different trend. Cyclists and pedestrians saw a reduction in crashes of 4% and 28% respectively between March and May 2020, followed by an increase above baseline levels in 2021 (7% and 5% respectively). This relative increase in crashes may be attributed to a sharp rise in physical activities on the road after the outbreak of the pandemic (RAC, 2020), which contributed to more collisions between private vehicles and active transport users. This finding is supported by ARRB (2021) which identified increased cyclist fatalities during COVID-19 restrictions and suggested increased activity and conflicts with private vehicles may be the cause. Notably, there was a shift of crashes from the midblock to intersections (4 percentage point shift) which may have contributed to more collisions with vulnerable road users.

4.2 Trends by distance from the Perth CBD

Crash reduction rates varied by distance from the Perth CBD. During the initial outbreak (March to May 2020), crashes within 20km of the Perth CBD fell by 37% compared to the Greater Perth average of 35%. Outer suburbs of Greater Perth (41km+) experienced a smaller reduction of 27% while regional Western Australia had an average decrease of 25%.

The larger reductions close to the CBD may be influenced by demographic factors, such as the greater representation of ‘white collar’ employees who typically have higher educational attainment, greater income and the ability to work from home. This observation resonates with some of the findings from the literature review.

Conversely, the higher share of ‘blue collar’ employees further from the Perth CBD and the nature of their occupations (i.e., hands on jobs) likely contributed to the need to drive and a smaller reduction in crashes. The number of vehicles per household was also higher in the outer suburbs compared to the inner city areas (up to 2.2 vehicles per household compared to 1.9) which may contribute to the ease of driving and demand for the network.

4.3 Impacts on SMACs and neighbourhood centres

During the COVID-19 lockdowns and restrictions, travel for work and leisure purposes decreased, while travel for essential activities such as purchasing food and supplies was permitted. Google Mobility data showed that activity around grocery and pharmacy outlets dropped in March 2020 before returning to pre-pandemic levels by late May and remaining stable (Google LLC, 2020).

Analysis was completed to understand the impact of restrictions on crashes around SMACs and neighbourhood centres. The analysis captured crashes within 1km of SMACs and 500 metres of neighbourhood centres.

From March to May 2020, SMACs experienced a 41% reduction in crashes, with areas such as Perth, Morley, and Joondalup experiencing the largest reduction due to the high proportion of ‘white collar’ workers who could work from home and reduced retail activity. Neighbourhood centres saw a 36% reduction in crashes, which is similar to the Greater Perth average and may reflect sustained demand for essential goods. These findings are consistent with a study by Chand et al. (2021) who found that crashes in Sydney shifted from business areas to suburban centres during the pandemic. From March to May 2021, crashes around SMACs and neighbourhood centres were 13% and 5% below baseline levels, respectively, which may reflect the slower return of activity to business areas.

5. Discussion

During the pandemic, the demand for the road network fell sharply, leading to a 35% decline in crashes across Greater Perth from March to May 2020 compared to the same period in 2019. However, the improved safety outcomes were quickly eroded as demand returned and by 2021 the total crashes were around 3% below the baseline. The findings in this paper align with ARRB (2021) which observed that fatal and hospital crashes fell by less than the reduction in road network demand while increased active transport activity may have contributed to proportionally more crashes involving pedestrians and cyclists.

Demographic factors such as vehicles per household, the concentration of essential occupations and income may explain the crash trends. The higher number of vehicles per household in the middle to outer suburbs (up to 2.2 vehicles), likely due to limited transport alternatives, contributed to proportionally higher demand on the road network during the pandemic. Furthermore, the concentration of sectors with essential occupations that often require face-to-face engagement, such as healthcare, education and construction, is higher in the outer suburbs, meaning employees had to travel during the restrictions. This may explain the smaller reduction in road crashes when restrictions were introduced in 2020 (inner city areas saw a reduction in crashes of 37% and outer areas reduced by 27%, while the Greater Perth average was 35%).

The pandemic saw a sharp rise in working from home as the community was urged to avoid travelling to their workplace. Sectors that had more non-essential occupations often characterised as ‘white collar’ higher-income jobs, experienced the largest uptake in working from home as they could do so remotely. The concentration of non-essential occupations and highest income were found within 10km of the Perth CBD, in suburbs such as Claremont, Leederville and Victoria Park. The ability to work from home, financial security, and access to active transport infrastructure may have contributed to the 37% reduction in crashes described above.

6. Conclusion

The pandemic was touted as a once-in-a-hundred-year event. While there is no certainty of when a similar event may occur again, policymakers can learn and apply valuable lessons to improve road safety. Firstly, the analysis demonstrates that the improved safety at the outbreak of the pandemic was temporary only and by 2021, the crashes have returned to the long-term average. This highlights the need for policymakers to implement effective education campaigns that promote safe driving behaviour and invest in infrastructure improvements in sections of the road network with high casualties.

Secondly, the analysis identified that cyclists and pedestrians were over-represented in the crash statistics during the outbreak of the pandemic. While longer-term analysis over 2021 suggests the proportion of crashes has declined, there is a need for a safe and connected active transport network. This may be achieved through investment in dedicated active transport corridors, wombat crossings and pedestrian caution lights at intersections will ensure safety maintained into the future.

Lastly, there are opportunities to address conflicts between competing transport modes by applying frameworks such as the Movement and Place (NSW Government, 2023; Department of Transport, 2022). The framework specifically addresses road conflicts that pedestrians and cyclists face and contributes to enhancing safety, as well as advancing broader placemaking and active transport goals. Similarly, better designating roads arterial roads and highways for private vehicles and freight may also enhance network outcomes and safety.

There are significant opportunities to expand the study if a more comprehensive dataset on traffic demand was available for Greater Perth. This could be particularly useful around SMACs, neighbourhood centres and local roads that saw shifts in the volume of crashes but do not have supporting traffic demand data (tube counters and other measures are generally confirmed to major corridors). The data could allow for a detailed and statistically robust assessment of crash trends while controlling for demand and other events on the network. Further, a comprehensive dataset of traffic demand across Greater Perth may also enable better integration of the demographic variables and understanding of the impact that COVID-19 had on network activity.

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