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Impact of COVID-19 on motor vehicle injuries and fatalities in older adults in Ontario, Canada

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ABSTRACT

Background: Older adults constitute the group most vulnerable to COVID-19 mortality. As a result, in North America and elsewhere, older adults have been strongly advised to shelter in place. Older adults also represent the fastest growing segment of licensed drivers.

Objective: We examined the change in injuries and fatalities sustained by younger and older drivers and pedestrians during the first month of the COVID-19 pandemic. We hypothesized that adults ages 80 years and over would have a proportionally larger reduction than the other drivers and pedestrians.

Methods: Using a cohort design, we compared the proportion of drivers and pedestrians involved in injuries and fatalities attributable to individuals aged 80 years and over, as recorded in the Ministry of Transportation of Ontario (Canada) database, between the 30 days prior to shelter-in-place related to the COVID-19 pandemic and the subsequent 30 days. By way of comparison, we conducted a similar comparison for younger age cohorts (16–24 years, 25–34 years, 35–54 years, 55–64 years, and 65–79 years).

Results: Drivers aged 80 years and over represented 21 per 1000 injuries and fatalities in the 30 days prior to March 17, 2020 (95% CI: 15–29), and 8 per 1000 injuries and fatalities in the 30 days beginning on that date (95% CI: 2–20), a 64.7% reduction (exp(β) post 0.353, 95% CI 0.105–0.892). Drivers in the 35–54 year age range underwent a significant but smaller reduction of 22.9%; no significant changes were seen for drivers in other age groups, or for pedestrians of any age.

Conclusions and relevance: The physical distancing measures that aimed to reduce the spread of COVID-19 resulted in a marked reduction in driver injuries and fatalities in the oldest old, illustrating the impact of physical distancing recommendations in this population. The excess mortality burden faced by the oldest adults during the COVID-19 pandemic, by direct exposure to the virus, may be indirectly mitigated by the reduction in road-related deaths in this cohort.

1. Introduction

Older adults are the fastest growing segment of the licensed driver population, with almost a doubling of licensed drivers aged 65 years and over since 1994. They rely on the automobile as their primary mode of transportation (Turcotte, 2012; Vrkljan et al., 2018). Although overall fatality rates due to motor vehicle collisions (MVCs) have declined substantially over recent decades among older adults, their MVC rate...
and injury rate per miles driven is lower than drivers less than 30 years of age and similar to drivers 30–65 years of age (Tefft, 2017). In contrast, the MVC fatality rate per miles driven of drivers age 80 and older was the highest of any age group (Roberts et al., 2008; Ang et al., 2017; Tefft, 2017), although the increased mortality rate may be in part an artifact of low mileage bias (Langford et al., 2006), increased fragility (Bayam et al., 2005), or different patterns of driving and types of roadways travelled (Keall and Frith, 2004, 2019). Older adults are also over-represented among pedestrian fatalities, accounting for 20–35% of such fatalities (Transportation Canada, 2011; Centres for Disease Control and Prevention, 2020). In Toronto, Canada’s most populous city, adults ages 55 years and over accounted for 71% of all pedestrian fatalities between 2016 and 2018 (Toronto Police, 2019).

Older adults are also the group most vulnerable to mortality associated with the COVID-19 pandemic (Wu and McGoogan, 2020). In China, early estimates of the case fatality rates for adults ages 80 years and over was 20.2% (Onder et al., 2020). At the end of March 2020, the infection fatality ratio outside of China was 1.4% for those less than age 60 years, and 4.5% in those 60 years of age and over (Verity et al., 2020). Adults over the age of 80 have a particularly high mortality rate, estimated at 10.1%, in France (Salje et al., 2020).

Shortly after the World Health Organization (WHO) declared the COVID-19 a worldwide pandemic on March 11, 2020, most jurisdictions in North America and Europe introduced physical distancing measures. On March 12, 2020, Ontario, Canada’s most populous province, closed all schools; on March 17, it declared a state of emergency. The senior driver license renewal program, requiring adults age 80 years and over to pass vision and cognitive screening tests and undergo a review of their driving record, was put on hold, affecting between 10,000 and 12,000 drivers per month. Similarly, requests for specialized on-road testing were put on hold, and mandatory reporting to the Ministry of Transportation of cognitively impaired drivers were considerably decreased as a result of fewer physician visits. Toronto saw a 15–20% reduction in traffic congestion relative to the previous year (TomTom Traffic Index, 2020). Other direct and indirect impacts of COVID-19 on road safety are less well understood. For example, the Governors Highway Safety Association in the United States documented multiple incidents of speeding and reckless driving during the pandemic (Governors Highway Safety Association (GHSA), 2020), MVCs and fatalities more than doubled in Minnesota, half of which were for speeding, careless, or negligent driving (Governors Highway Safety Association (GHSA), 2020). Similarly, in New York City, speeding tickets on March 27, 2020 doubled compared to a month earlier (Governors Highway Safety Association (GHSA), 2020).

Given uncertainties about the impact of COVID-19 on older drivers, we conducted a study to examine the magnitude of injuries and fatalities sustained by older drivers and pedestrians in the province of Ontario. Our focus was on drivers 80 years old and older (the “oldest old”) because of their elevated MVC fatality risk (Tefft, 2017) and high case fatality rates with COVID (Wu and McGoogan, 2020). We hypothesized that a large infection fatality ratio outside of China was 1.4% for those less than age 60 years, and 4.5% in those 60 years of age and over (Verity et al., 2020). Adults over the age of 80 have a particularly high mortality rate, estimated at 10.1%, in France (Salje et al., 2020).

We modelled the odds that a driver or pedestrian involved in an injury or fatality collision in the oldest old group, so the primary outcome is the proportion of injuries and fatalities sustained by drivers and pedestrians of all ages. If there is an underestimate due to delayed reporting, it should occur randomly in all age groups and the proportion should not be affected.

We compared the time-based changes in the number of injuries and fatalities in the oldest old group and other adult groups by way of comparison: younger young (age 16–24 years); older young (age 25–34 years); younger middle-age (age 35–54 years); older middle age (age 55–64 years); young old (age 65–79 years); and oldest old (age 80 years and over).

Descriptive data are presented. The Agresti-Coull method was used to compute 95% confidence intervals (CI) for population proportions. A difference-in-differences analysis was used to compare the change in proportion of injuries and fatalities among older senior drivers and pedestrians (i.e., aged 80+) between two points in time and across years (2018–2020). The time points were defined as a pre-period (i.e., February 17 to March 16) and post-period (i.e., March 17 to April 16).

We modelled the odds that a driver or pedestrian involved in an injury or fatality collision in the oldest old group, Odds_{80+}, as:

\[
\log(\text{Odds}_{80+}) = \beta_0 + \beta_Y + \beta_{\text{period}} + \beta_{Y\times\text{period}}
\]

where \(\beta_0\) is the baseline log odds in the pre-period of 2020; \(\beta_Y\) is the estimated mean difference in the log odds of the oldest old being in an injury or fatality collision between the comparison years (= 2018 or = 2019) and the reference year (Y = 2020) during the pre-period (\(\beta_{\text{period}} = 0\)) : \(\beta_{\text{period}}\) is the expected mean change in the log odds of being 80 or older in an injury or fatality collision from the pre- to post-periods in 2020 (\(\beta_{Y\times\text{period}} = 0\)). The remaining difference-in-difference estimators, \(\beta_{Y\times\text{period}}\), represent how the change in log odds of being 80 or older in an injury or fatality collision between the pre- and post-periods in the comparison years differ from what would be expected based on the observed change in the reference year. These parameters are non-zero only for the comparison years and the post-period. Confidence intervals were estimated by “inverting the likelihood ratio”. Statistical significance was determined at \(\alpha = 0.05\), without correction for multiple comparisons. Similar analyses were also conducted for the other age groups.

According to our hypothesis, we would expect exp(\(\beta_{\text{period}}\)) to be less
than one, indicating a decrease in odds for the oldest old of being in an injury or fatality collision in the 2020 post-period compared to the 2020 pre-period. We would also expect exp(β_{pre−post}) to be greater than one for both comparison years, indicating a lesser decrease in the odds of being 80+ years of age between the pre- to post-periods in 2018 and 2019 compared to 2020. In addition, we estimated the pre- to post-change in odds for 2018 and 2019 as exp(β_{post} + β_{2018−post}) and exp(β_{post} + β_{2019−post}) respectively, in order to examine whether drivers and pedestrians in the post-period were more likely to be 80+ years of age than in the pre-period for years prior to 2020.

3. Results

The oldest old group of drivers had a mean age of 83.8 ± 4.9 years and 50 % were male. The mean (± SD) age and gender of the other groups were: 71.0 ± 4.3 years and 68 % male for drivers 65–79 years of age; 59.0 ± 2.7 years and 69 % male for drivers 55–64 years of age; 43.4 ± 6.2 years and 58 % male for drivers 35–54 years of age; 29.2 ± 3.0 years and 67 % male for drivers 25–34 years of age; and 21 ± 2.1 years and 62 % male for drivers 16–24 years of age. Further breakdown (e.g., by geography) is not possible given small numbers.

The number of driver injuries and fatalities across all ages observed in the month before March 17 was 1859 in 2018, 1901 in 2019, and 1620 in 2020. Of those in 2020, 34 were among drivers in the oldest old group, representing 21 per 1000 injuries and fatalities across all ages (95 % CI: 15–29) (Table 1). In the month beginning March 17, the number of driver injuries and fatalities across all ages observed was 2065 in 2018, 1870 in 2019, and 532 in 2020. Of those in 2020, 4 were among drivers in the oldest old group, representing 8 per 1000 driver injuries and fatalities across all ages (95 % CI: 2–20).

The number of pedestrian injuries and fatalities across all ages observed in the month before March 17 was 243 in 2018, 191 in 2019, and 223 in 2020. Of those in 2020, 6 were among pedestrians in the oldest old group, representing 27 per 1000 injuries and fatalities across all ages (95 % CI: 11–59) (Table 1). In the month beginning March 17, the number of pedestrian injuries and fatalities across all ages observed was 269 in 2018, 231 in 2019, and 54 in 2020. Of those in 2020, only 1 was in the oldest old group (i.e., an 80-year-old male), representing 19 per 1000 pedestrian injuries and fatalities across all ages (95 % CI: 0–108). The mean (± SD) age and gender of the other groups were: 68.2 ± 3.2 years and 67 % male for pedestrians 65–79 years of age; 59.7 ± 2.5 years and 40 % male for pedestrians 55–64 years of age; 44.7 ± 6.2 years and 50 % male for pedestrians 35–54 years of age; 29.5 ± 2.4 years and 53 % male for pedestrians 25–34 years of age; and 20.5 ± 2.4 years and 30 % male for pedestrians 16–24 years of age. Similar to drivers, the numbers are insufficient to provide a demographic breakdown by additional variables.

Consistent with our hypothesis, the value of β_{post} generated by the difference-in-differences model for drivers indicates a 64.7 % lower odds of being an oldest old driver for those involved in an injury or fatality collision during the post-period as compared to the pre-period in 2020 (Table 2a). The values of interaction (difference-in-differences) terms, β_{2018−post} and β_{2019−post}, were both found to be significantly greater than one, indicating the change in the odds of an oldest old driver being in an injury or fatality collision from pre-to post-periods in 2018 and 2019 were smaller than in 2020. In fact, drivers in the post-period were, if anything, more likely to be oldest old than in the pre-period for 2018 and 2019, though this was not tested statistically. The model for pedestrians revealed a 31.8 % drop in the odds of an oldest old being in an injury or fatality collision in the post- vs. pre-period, but this reduction was not statistically significant (Table 2b).

Post-hoc difference-in-differences analyses were also performed on injury or fatality collisions involving drivers in which being from each of the other age ranges was considered as an outcome instead of being in the 80 and over age range. The odds of a driver being in the 35–54 range underwent a significant but smaller reduction (i.e., 22.9 % in comparison to 64.7 % for the 80+ group) from pre- to the post-periods in 2020, according to the value of β_{post} in Table 2c. Similar reductions or any other significant changes were not seen for the pedestrians in that age group, or in drivers and pedestrians of the other age groups (data not shown).

4. Discussion

Assessing data from the province of Ontario, Canada, we found a two-third decline in the proportion of driver injuries and fatalities in adults 80 years of age and older during the first month of the physical-distancing measures implemented after the COVID-19 pandemic was declared. We believe that our study is the first to assess the direct effect of a pandemic on injuries and fatalities in oldest old drivers or pedestrians and, indirectly, on the behavior of these older adults. Barnes et al. (2020) recently reported on a similar reduction in proportion of MVCs attributable to adults 65 years and older in the first 50 days of the COVID-19 pandemic in Louisiana, but they did not provide data for oldest old adults (Barnes et al., 2020). Preliminary information from the International Transport Forum indicates that almost all countries saw a decline in road fatalities during the initial lockdown associated with COVID (OECD Group, 2020) but again data was not stratified by age. We found that the physical distancing measures that aimed to reduce the

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Table 1
Number of Driver and Pedestrian Injuries and Fatalities Per 1000 Injuries and Fatalities by Age Group.

| AGE         | YEAR     | DRIVERS                      | PEDESTRIANS                    |
|-------------|----------|------------------------------|--------------------------------|
|             |          |     # per 1000 Driver Injuries and Fatalities Among All Age Groups (95 % Confidence Interval) |     # per 1000 Pedestrian Injuries and Fatalities Among All Age Groups (95 % Confidence Interval) |
| GROUP       |          | Month Before March 17        | Month Beginning March 17       |
|-------------|----------|------------------------------|--------------------------------|
| Young       | 2018     | 174 (157–192)                | 268 (215–327)                  |
| (Aged 16–24)| 2019     | 149 (134–166)                | 199 (181–281)                  |
| Older       | 2018     | 159 (142–177)                | 233 (182–312)                  |
| (Aged 25–34)| 2019     | 215 (197–234)                | 219 (191–275)                  |
| Young       | 2018     | 235 (217–255)                | 244 (235–244)                  |
| (Aged 55–64)| 2019     | 226 (206–247)                | 248 (237–278)                  |
| Middle-Aged| 2018     | 344 (323–366)                | 263 (246–270)                  |
| (Aged 35–54)| 2019     | 354 (333–376)                | 267 (247–288)                  |
| Older       | 2018     | 154 (139–172)                | 144 (136–152)                  |
| (Aged 55–64)| 2019     | 142 (127–157)                | 129 (123–136)                  |
| Young Old   | 2018     | 90 (78–104)                  | 111 (77–151)                   |
| (Aged 65–79)| 2019     | 94 (82–108)                  | 100 (97–133)                   |
| Older       | 2018     | 23 (20–26)                   | 21 (15–29)                     |
| (Aged 80+)  | 2019     | 8 (2–20)                     | 7 (11–59)                      |

CI: Confidence Interval, computed using the Agresti-Coull approach.
spread of COVID-19 and its associated morbidity and mortality appear to have resulted in a marked reduction in driver injuries and fatalities in the oldest old (i.e., those 80 years and older). Although the data available did not allow us to assess this directly, we attribute this marked reduction to the oldest old adhering strictly to the physical distancing measures and staying in their home, i.e., off the roads, to reduce their risk of being infected by COVID-19, and, as a result, reducing their exposure to road risks. Previous literature has shown that older adults drive less at night, perhaps in response to vision-related declines (Charlton et al., 2006). So it is not surprising that they would restrict their driving and mobility in the face of a new significant health threat. There was no similar reduction in the proportion of injuries and fatalities in the other age groups, apart from a smaller reduction in the 35–54 year group. The lack of reduction in the proportion of injuries and fatalities for the 16–24 year old group may reflect differences in telework opportunities. For example, Deng et al., 2020 identified that only 21% of 24 year old in Canada had jobs that allowed for teleworking, whereas 54 year old had that opportunity (Deng et al., 2020). Hence, the different requirements related to work and travel of these two younger age groups would be expected to affect their MVC injury and fatality risk differently. Additionally, the lockdown of schools, daycare and after school programs could further keep some parents age 35–54 year at home to care for their children (Statistics Canada, 2017). On the other hand, some young old adults are working or engaged in unpaid occupations, such as caregiving and volunteering. For example, 2015 Canadian data indicate that more than half of men 65 years of age and nearly 30% of men 70 years of age reported working, particularly as managers in agriculture, retail and wholesale trade, transport truck drivers, janitors, caretakers, or building superintendents (Statistics Canada, 2017). Again, it is possible that young old adults with these jobs had fewer teleworking opportunities and hence their driving exposure was not reduced. Moreover, the young old group may have been more likely than the oldest old to assist their own children with childcare when schools and daycares closed.

It is unclear why there was no similar significant reduction in pedestrian fatalities. This may be due to lack of power. However, it is possible that this relates to the altered forms of community mobility in these early days of the pandemic. For example, people tended to avoid mass transit, taxis, or carpools, but continued to walk for exercise, at times walking in live traffic in order to avoid proximity to other pedestrians on the sidewalk (Baruchman, 2020). A recent report suggests an increase in drugs and alcohol prevalence among road fatalities during the pandemic (Thomas et al., 2020), which in addition to an increase in reckless driving (Governors Highway Safety Association (GHSA, 2020) could make the roads particularly hazardous for pedestrians during this time.

These population-based results are of public health significance. Our early data can provide a benchmark or framework for assessing the impact on the implementation or lifting of physical distancing restrictions as the COVID-19 pandemic waxes and wanes. They dramatically illustrate the impact of the public health physical distancing recommendations for the oldest old. Our results also provide empirical evidence that the excess mortality burden faced by the oldest old during the COVID-19 pandemic, by direct exposure to the virus, may be mitigated indirectly by a reduction in road-related deaths in this age group (Colonna and Intini, 2020). Our data can inform modeling of mortality data; they also suggest that other similar factors may be at play and indirectly affect mortality. For instance, one would expect a decrease in mortality from the suspension of most elective surgeries and an increase in mortality due to decreased physician visits and medical attention or reluctance to present to hospitals for medical emergencies (Gunnell et al., 2020; Ueda et al., 2020; Zhao et al., 2020). Thus, the reduced fatalities among drivers, and other similar indirect factors that affect mortality during the COVID-19 pandemic, need to be taken into account by mortality models. Many of these models are typically limited to integrating observed vs. expected mortality rates (Salje et al., 2020; Wu et al., 2020).

### Table 2

| MODEL         | PARAMETER | COEFFICIENT $\beta$ | ODDS RATIO $\exp(\beta)$ | LOWER 95 % CI | UPPER 95 % CI |
|---------------|-----------|---------------------|---------------------------|---------------|---------------|
| (a) DRIVERS (Aged 80+) | $\beta_0$ | -3.84               | 0.021                     | 0.015         | 0.030*        |
|               | $\beta_{2018}$ | 0.075              | 1.078                     | 0.684         | 1.712         |
|               | $\beta_{2019}$ | 0.210              | 1.234                     | 0.796         | 1.935         |
|               | $\beta_{2020}$ | 0 (reference)      | 1.000                     | –             | –             |
|               | $\beta_{post}$ | -1.040             | 0.353                     | 0.105         | 0.892*        |
|               | $\beta_{pre}$ | 0 (reference)      | 1.000                     | –             | –             |
|               | $\beta_{2018,post}$ | 1.332         | 3.789                     | 1.375         | 13.459*       |
|               | $\beta_{2019,post}$ | 1.176         | 3.241                     | 1.179         | 11.489*       |
|               | $\beta_0$ | -3.59               | 0.028                     | 0.011         | 0.057         |
|               | $\beta_{2018}$ | 0.208              | 1.231                     | 0.422         | 3.793         |
|               | $\beta_{2019}$ | 0.319              | 1.376                     | 0.449         | 4.342         |
|               | $\beta_{2020}$ | 0 (reference)      | 1.000                     | –             | –             |
|               | $\beta_{post}$ | -0.382             | 0.682                     | 0.036         | 4.113         |
|               | $\beta_{pre}$ | 0 (reference)      | 1.000                     | –             | –             |
|               | $\beta_{2018,post}$ | 0.399         | 1.490                     | 0.189         | 31.909        |
|               | $\beta_{2019,post}$ | 0.655         | 1.926                     | 0.246         | 41.288        |
|               | $\beta_0$ | -0.592              | 0.553                     | 0.499         | 0.612*        |
|               | $\beta_{2018}$ | -0.052             | 0.949                     | 0.825         | 1.091         |
|               | $\beta_{2019}$ | -0.009             | 0.991                     | 0.863         | 1.138         |
|               | $\beta_{2020}$ | 0 (reference)      | 1.000                     | –             | –             |
|               | $\beta_{post}$ | -0.261             | 0.771                     | 0.622         | 0.951*        |
|               | $\beta_{pre}$ | 0 (reference)      | 1.000                     | –             | –             |
|               | $\beta_{2018,post}$ | 0.284         | 1.329                     | 1.037         | 1.707*        |
|               | $\beta_{2019,post}$ | 0.316         | 1.372                     | 1.070         | 1.764*        |

CI: Confidence Interval;

* Significant change in the proportion of injuries and fatalities attributable by age group, using the 95% profile likelihood confidence interval ($p < 0.05$).
et al., 2020). The availability of more sophisticated models is important given their use to guide health and public policy decisions in North America.

It is too early to know to what extent the reduction in MVC-related injuries outweighs the potential negative health costs related to the COVID-19 pandemic, although it is very unlikely that the reduction in fatalities approaches the massive death rate associated with the virus in the oldest-old. The COVID-19 pandemic provides an unprecedented naturalistic experiment of the short- and long-term direct and indirect consequences of a marked reduction in the population venturing outdoors, especially among older individuals. The extent to which COVID 19-related stay-at-home measures may have worsened social isolation and pre-existing health disparities in the oldest old is not yet fully appreciated (Hwang et al., 2020; Moore et al., 2020).

There are several limitations to the present study. First, the most recent MTO collision data likely underestimate the absolute number of injuries and fatalities, mainly during the COVID 2020 period, due to the time required for complete reporting. However, our use of proportions and our clear results mitigate this possible limitation. Another limitation is our inability to account for possible unmeasured confounders, including geography, weather, gas prices, gender, driving exposure, or the cognitive or functional status of individuals included in the sample. Finally, our data are relevant to a brief period and we do not know whether the dramatic short-term effects we observed will be maintained, amplified, or will dissipate over time.

Future work will need to examine motor vehicle injuries and fatalities as older adults restart venturing outdoors. Residual physical distancing measures may lead to reduced use of public transportation and a need to promote safer roads for all drivers and pedestrians. (De Vos, 2021) Once physical distancing measures are lifted, some older adults with mild cognitive impairment or dementia whose driving skills are already declining may be at particular risk when they resume driving after a lengthy period without practice. Others may have accommodated to life without driving and may be reluctant to resume driving.

Impact statement

We certify that this work is novel.

Declaration of Competing Interest

Mark Rapoport – no conflicts of interest. Research supported by Canadian Institutes of Health Research, Canadian Consortium on Neurodegeneration in Aging, Canadian Council on Motor Transportation Administration, the Canadian Medical Association/Joule, as well as the Sunnybrook Psychiatry Partnership.

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