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Short Communication

Coronavirus disease 2019: What could be the effects on Road safety?

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ABSTRACT

In March 2020, the World Health Organization declared COVID-19 a world-wide pandemic. Countries introduced public health measures to contain and reduce its spread. These measures included closures of educational institutions, non-essential businesses, events and activities, as well as working from and staying at home requirements. These measures have led to an economic downturn of unprecedented proportions. Generally, as economic activity declines, travel decreases and drivers are exposed to a lower risk of collisions. However, research on previous economic downturns suggests economic downturns differentially affect driver behaviours and situations. COVID-19 pandemic effects on road safety are currently unknown. However, preliminary information on factors such as the increased stress and anxiety brought about by the COVID-19 pandemic, more "free" (idle) time, increased consumption of alcohol and drugs, and greater opportunities for speeding and stunt driving, might well have the opposite effect on road safety. Using an interactionist model we identify research questions for researchers to consider on potential person and situation factors associated with COVID-19 that could affect road safety during and after the pandemic. Collaborative efforts by researchers, and public and private sectors will be needed to gather data and develop road safety strategies in relation to the new reality of COVID-19.

1. Introduction

In December 2019 in Wuhan, China, a cluster of cases of "pneumonia of unknown origin" was reported which subsequently was confirmed (Hui et al., 2020; Sohrabi et al., 2020) and named coronavirus disease 2019 (COVID-19) by the World Health Organization (World Health Organization, 2020). By March 2020, the WHO had declared COVID-19 a world-wide pandemic with 216 countries, areas or territories showing 10,719,646 cases and 517,337 deaths combined as of July 2, 2020 (World Health Organization, 2020).

This pandemic led to a series of worldwide public health measures to contain and reduce its spread. In many countries the measures included physical distancing measures, such as the "lockdown" of educational institutions, restaurants, bars, retail and other non-essential businesses, banning public events, such as sporting events, concerts, theatre shows and encouraging or requiring teleworking from home

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Check for updates and staying at home (de Vos, 2020d). These physical distancing measures have had major economic effects; world Gross Domestic Product (GDP), a measure of economic activity, decreased as many businesses and activities closed and international trade and travel plummeted (United Nations Department of Economic and Social Affairs Economic Analysis, 2020). For example, in Canada real GDP fell by 7.2 % in March 2020 with declines in 19 out of 20 industrial sectors (Statistics Canada, 2020). Moreover, economic activity has further reduced by communally imposed voluntary and mandatory self-quarantine measures and the high unemployment levels (International Labour Organization, 2020).

Since this pandemic has created an economic crisis (Conference Board of Canada, 2020), one would anticipate changes in road travel and road safety. The overall question for road safety professionals is what effects could COVID-19 have on road safety now and after the pandemic subsides and importantly, what can we learn about road safety in general from the natural experiment afforded by transiently but substantially reduced traffic levels? The remainder of this article will identify questions for road safety professionals to consider.

2. Economic downturns and traffic safety

Economic indicators are associated with road fatalities through exposure and risk; as economic activity declines, travel decreases and drivers are exposed to a lower risk of collisions (Antoniou et al., 2016). Indeed, during this COVID-19 pandemic fewer vehicles have been observed on roads (Carter, 2020; de Vos, 2020d; Lockwood et al., 2020). Existing research that has examined effects of economic indicators on road safety has generally found economic downturns associated with reductions in road fatalities (Lamm et al., 1985; Lloyd et al., 2015; Wagenaar, 1984; Wegman et al., 2017; Yannis et al., 2014). However, substantive variation in trends was also found among countries and across time periods (e.g., Antoniou et al., 2016; Wegman et al., 2017). Moreover, pre-existing trends may moderate economic downturn effects (Antoniou et al., 2016).

No published articles have been found on the economic downturn effects of COVID-19 on road fatalities. Recently, Shilling and Waetjen (2020) presented California's preliminary data on total and casualty (injury/fatality) collisions on state highways during the COVID-19 pandemic; approximately a 50 % reduction in total and casualty collisions was found from March 1, 2020 to April 30, 2020 during the lockdown of non-essential businesses compared to the period before the lockdown and to a similar time period in 2019. However, some regions showed very little reduction. Carter (2020) similarly presented North Carolina's total and casualty collisions data for the COVID-19 lockdown period of March 15, 2020 to May 16, 2020. Compared to pre-lockdown baseline, total collisions decreased by 50 %, fatal collisions decreased by 10 % while curiously casualty collisions increased by 6%, which was attributed to the higher proportion of single-vehicle collisions during this period (Carter, 2020). Occupational Health and Safety (2020) citing National Safety Council data, reported a 14 % increase in fatality rates in March 2020. Examining the statistic of miles driven, there was a drop of 8.6 % compared to the same time period in 2019, while the mileage fatality rate per 100 million miles driven was 1.22 in March 2020, compared to 1.07 in the previous year. During the first three months of 2020 the following states experienced an increase in number of roadway fatalities: Arkansas (16 %), California (8%), Connecticut (42 %), Illinois (11 %), Louisiana (23 %), Nevada (10 %), New York (17 %), North Carolina (10 %), Oklahoma (9%), Tennessee (6%), and Texas (6%). However, a number of states experienced a decrease in roadway fatalities: Arizona (-4%), Hawaii (-32 %), Idaho (-28 %), Iowa (-13 %), Maryland (-13 %), Michigan (-12 %), Oregon (-24 %), and South Carolina (-12 %). Clearly these differences should be explored. It is presently difficult to explain this disparity of roadway fatalities across the United States. Regional differences in topography, driving culture, police recording procedures, roadway type, driver age/gender, season, or weather differences may be possible explanatory factors. As more data become available over time, it may be possible to pinpoint variables that may be influencing roadway deaths.

Positive effects of economic downturns on road safety can be influenced through a number of mechanisms: 1) exposure - reductions in vehicle kilometres travelled (VKT); 2) traffic composition - a decrease in number of higher risk drivers on roads; 3) road user behaviour – less disposable income for entertainment and leisure activities, hence less driving and less alcohol and other drug use; 4) vehicle fleet purchase or renewal – decrease in vehicle sales leading to less driving (Lloyd et al., 2015; Organization for Economic Cooperation and Development/ International Transport Forum (OECD/ITF), 2015; Wegman et al., 2017; Yannis et al., 2014).

However, economic downturns can also have varied effects on road travel and safety. Studies have shown that economic downturns differentially affected driver behaviours. For example, Maheshri and Winston (2016), examining the effects of the 2008 recession in Ohio, found that a one percentage point increase in unemployment caused drivers to decrease their VKT no more than 0.15 km per day. "Risky" driver groups (drivers in collisions, drivers over 60 years of age, drivers of older vehicles) reduced their VKT while the safer driver groups (collision-free drivers, drivers less than 60 years of age and drivers of newer vehicles) increased their VKT as the unemployment rate in their county increased. One possibility offered for these differential effects was that risky drivers may become more risk averse during economic downturns while the economic downturn could have induced the younger (safer) drivers to look further afield for employment opportunities, thus increasing their VKT (Maheshri and Winston, 2016).

He (2016) similarly examined the effects of the 2008 recession by analyzing data for all American states except the District of Columbia from 2003 to 2013. However, she found that the reduced fatality *rate* (fewer fatalities per VKT) accounted for 88 % of the reduction in the total number of fatalities, while VKT contributed little to the reduction in fatalities (He, 2016). Specifically, large reductions were found in large truck, speeding-related and alcohol-related fatalities (He, 2016).

Yet, it is important to point out the unprecedented nature and severity of this pandemic that may not resemble anything seen before. The previously cited studies on road safety effects of economic downturns may not be applicable. World Bank baseline forecast expects a 5.2 % contraction in global GDP in 2020, "the deepest global recession in decades, despite the extraordinary efforts of governments to counter the downturn with fiscal and monetary policy support" (World Bank Group p. xv). Closure of jurisdictional borders and physical distancing measures are additional unique features of the pandemic that have substantively affected driving (Carter, 2020; de Vos, 2020d). For example, the number of U.S. travellers entering Canada by vehicles in May 2020 through land ports was down 96 %, while the number of Canadians returning from the United States through land ports was down 95 % compared to May 2019 (StatCan 2020).

Thus, variations in effects and trends may reflect differential effects of situations on road users and how they interact with the environment. There may be subgroups of people or situations where the effects of economic downturns on collisions and casualties are more nuanced. For example, vulnerable subpopulations, such as those of minority or low socioeconomic status (SES) are more likely to be frontline and essential workers (Rho et al., 2020), and thus their required travel to and from their workplaces would affect their exposure and risk differently than those who could work from home. Situationally, those residing in rural locations might also not be able to reduce their driving and thus their exposure and risk may not be equivalent to those residing in urban locations. Wegman et al. (2017) rightly point out that the positive relationship between economic downturn and road fatalities may be grossly simplified as "there are complex interactions between macroeconomic conditions, travel behaviour and risk factors" (p. 53) that are not fully understood. Application of the interactionist model (Vingilis and Mann, 1986) that examines both person- and situation-factors may

be a useful framework by which to reflect on some research questions on possible COVID-19 pandemic effects on road safety.

3. Potential effects of COVID-19 on road safety

3.1. Person factors

3.1.1. High risk and/or vulnerable groups

Recent news stories have suggested that speeding and stunt driving, common behaviours among young males (Vingilis et al., 2013; Wiesenthal and Singhal, 2012), have been occurring with greater frequency during COVID-19 in jurisdictions internationally (Australian Road Safety Foundation, 2020; BBC, 2020; Bellon, 2020; Bergal, 2020; City News, 2020; Dickinson, 2020), as well as speeding-related collisions (Paparella, 2020; Thompson, 2020). Concurrently, many social media video posts with titles such as "Covid-19 INFECTS the streets", "Covid can't shut this down!", "BUSTED for STREET RACING during Quarantine", "Social Distancing Tournament", demonstrating street racing and stunt driving, have been uploaded on social media with thousands of views. Speeding and stunt driving offences may have increased in some jurisdictions. For example, a city of Toronto April 15, 2020 news release indicated that despite a dramatic decline in traffic volumes, Toronto Police reported a 35 % increase in speeding and an almost 200 % increase in stunt driving offences from March 15-31, 2020, compared to the same period last year (City of Toronto, 2020). Similarly, Kaji et al. (2020) reported that the California Highway Patrol issued almost 2500 citations for driving over 100 miles per hour from mid-March to mid-April 2020, an 87 % increase over 2019. In the United States, there was a 30 % increase in drivers speeding in excess of 100 miles per hour. However, it would be important to assess whether these preliminary findings are short-term and local or a longer-term trend.

Recent preliminary data analysis from the United States suggests some increase in speeding-related collisions. Carter (2020) found the proportion of all collisions in North Carolina that were speed-related increased from 1% before the pandemic lockdown to 2% during the lockdown, although total speeding-related collisions decreased during this period from the 5-year average of previous years. Preliminary data from Virginia indicated that during the period of March 13, 2020 through April 30, 2020, speeding-related collisions accounted for more than 23 % of total collisions, an 18.5 % increase over the same period last year and 19 % higher than the 5-year average (Lockwood et al., 2020). Furthermore, speeding-related fatalities accounted for approximately 48 % of overall fatalities during this time period, 41 % higher than the 5-year average (Lockwood et al., 2020). Hence, preliminary data have shown jurisdictional variations in speed and in speeding-related fatalities, but could small cohorts of drivers, especially young males, be excessively speeding due to lower traffic congestion on roadways? Moreover, could more speeding lead to more collisions and to greater injury severity in resulting collisions? Vehicle velocity is one determinant of collision risk and injury severity (Kröyer et al., 2014; Moore et al., 1995; Richards, 2010); however, with less traffic congestion, what is the collision risk of speeding?

Another vulnerable road user that could be affected by COVID-19 is the novice driver learning to drive. During COVID-19, jurisdictions have engaged in different policies regarding novice drivers; for example, some American states have repealed requirements for teen drivers to pass their road tests before acquiring their drivers' licences (National Safety Council, 2020). Other jurisdictions, such as Ontario, Canada (Ministry of Transportation of Ontario, 2020), extended the expiration date of the novice class licence. Research could be conducted to determine not only whether collisions rates of novice drivers have increased or decreased during the pandemic period, but also on possible mediating factors. For example, driving experience gained over the first six months or more of driving does provide improvements to driving safety (McCarrt et al., 2009; Simons-Morton and Ehsani, 2016). Driving experience could be affected in a number of ways. Novice class drivers may have had an opportunity to gain their first driving experience on less crowded roads and some may end up having to spend a longer time in novice phases than would typically be the case. The lighter traffic and longer driving period could provide novice drivers with the opportunity to develop further their basic driving skills (Simons-Morton and Ehsani, 2016) which could reduce their collision risk. Alternatively, some novice drivers may be driving less during COVID-19, thereby effectively putting a driving experience gap within the period during which they would normally be gaining experience and full licensure. As such, if their graduated licensing period overlaps entirely with the COVID-19 lockdown, they may simply not gain the intended experience. Could they be at higher collision risk?

On the other end of the spectrum, since the COVID-19 infection fatality ratio is much higher for persons over 60 years of age (4.5 %) than those under 60 (1.4 %) (Verity et al., 2020), older drivers may be adhering to physical distancing recommendations more stringently. Thus, will older adults be driving less and reduce their road fatality rates more than other age cohorts during the pandemic? Once physical distancing measures are lifted, will some drivers, particularly older adults with dementia and mild cognitive impairment and already declining driving skills, be at particular risk once they resume driving after a lengthy period without practice? Will other drivers become accustomed to life without vehicles, and be reluctant to resume driving (McNamara et al., 2013)? Yet, driving cessation has been associated with various adverse consequences in older adults, including decreased quality of life and increased psychological distress (e.g., Ragland et al., 2005; Satariano et al., 2005). Will social and psychological challenges increase for some older adults during and after the pandemic due to lost personal transportation and fear of public transportation?

Another change associated with the pandemic is increased alcohol sales (Benzie, 2020; Sharpe, 2020) and substance use. For example, a recent NANOS Poll commissioned by the Canadian Centre on Substance Use and Addiction (2020) found that 25 % of surveyed adults reported drinking more alcohol during the pandemic. Additionally, 6% of all respondents reported using more cannabis, with 14 % of those aged 18-34 years reporting using more cannabis. Reasons cited for increased use were a lack of regular schedule, boredom and stress. Questions to be asked are whether other countries are seeing increases in consumption of alcohol and other substances. Is consumption occurring during weekdays and daytime hours? If consumption is higher, will it continue after the pandemic? Importantly, will the increased use of alcohol and other substances lead to increases in prevalence of impaired drivers? Moreover, with restaurants, bars, concerts and other venues locked down in many jurisdictions and limitations on the number of people who can congregate together, driving in vehicles can be a way for people, particularly young people, to "interact". Could substance use mix with speeding and racing activities to become a viable entertainment for more young people than pre-pandemic? Additionally, could mental health issues associated with COVID-19 affect road safety? Multiple studies from around the globe have identified high levels of stress, anxiety, and depression during the pandemic, with greater risk for psychological symptoms among the young, females, and those of lower SES or greater financial instability (e.g., Ahmed et al., 2020; González-Sanguino et al., 2020; Liu et al., 2020). Stress, anxiety, and depressive symptomology have previously been identified as risk factors for aggressive or risky driver behaviour and collision risk (Dula et al., 2010; Wickens et al., 2013, 2014), calling into question whether the impact of the pandemic on mental health may, in turn, impact road user behaviour and safety, particularly among at-risk groups.

Other vulnerable groups to examine are pedestrians, bicyclists, and other non-motorized road users. With fitness facilities closed but walking encouraged (Hogan, 2020), could pedestrian and bicyclist injuries and fatalities increase because more people may be walking or biking (Brown, 2020)? Additionally, physical distancing on sidewalks may lead to walking on roadways to maintain the 2-metre distancing recommendation and clear roads offer an unparalleled opportunity for drivers to speed (Walton, 2020). Children would be at increased risk with many children not in school because of school lockdowns. A recent survey conducted by the British Columbia Automobile Association (2020) found that 52 % of respondents reported seeing more children playing outside and 56 % noted more children biking; yet, respondents also reported observing drivers speeding excessively (49 %) and not obeying stop signs (43 %) in residential areas. Emptier roads could also lead to other risky road users. A social media video surfaced from Toronto, Canada showing three people skateboarding down an off-ramp of an expressway (Yuen, 2020). Hence, examination of pedestrian, bicyclist and other road user casualties disaggregated by person factors (e.g., age and gender) and situation factors (e.g., locations, time of day, etc.) would provide important information on COVID-19 road safety effects.

Long-haul truck drivers are another group to examine. Amid the COVID-19 pandemic, long-haul truck drivers are experiencing significant changes to their work that may be affecting their health and safety. Current travel restrictions for the general public mean roads are less congested and therefore possibly safer for essential workers such as truck drivers. However, some news reports (Fitzpatrick, 2020; Zadorsky, 2020) suggest that other drivers may be travelling at higher speeds and taking more risks. Survey evidence indicates increased online shopping in the United States, the United Kingdom and Germany for all goods since the pandemic (Kunst, 2020). Similarly, in Canada online sales increased over 120 % in April 2020 compared to the same time period in 2019 (Evans, 2020). However, the initial, large demand on long-haul truck drivers to restock goods at the beginning of the pandemic has been followed by unpredictable load demands due to slowing and now re-opening of the economy. It is not certain how these situations may be affecting long-haul truck drivers.

Prior to COVID-19, truckers had a shortage of public rest areas and roadside venues for meals and washrooms; however, the situation has been exacerbated by the pandemic (Canadian Trucking Alliance, 2020; Reynolds, 2020). Moreover, the health of truck drivers, many of whom suffer from cardiometabolic diseases, such as type II diabetes (Ronna et al., 2016), could be affected by limited access to food and rest while driving during the pandemic which could affect collision risk.

Given these person factor observations, it would be critical to examine not only overall collision, casualty and moving violation trends and types (e.g., single vs multiple vehicle, hit and run, etc.,) and patterns of collisions (e.g., time of day, day of week) before, during and after the pandemic, including the anticipated waves of the pandemic, but also trends by gender, age and subgroups as well as mediators and moderators.

3.2. Situation factors

Recommendations for people to maintain a 2-metre distance from others has made the use of public transit a challenge; hence, those who need to travel may be more likely to use their vehicles to avoid possible exposure to COVID-19 (Bucsky, 2020). When the pandemic is over, will the public be ready to use public transit or will they remain in their vehicles, thereby increasing traffic density, frustration and collision risk? Some evidence suggests that individuals are opting to buy less safe but cheaper modes of transportation, such as motorcycles and e-bikes, which could affect road safety as many governments have poor safety standards in place (Weaver, 2020). Additionally, if people are driving, are they on their phones more to stay socially connected with family and friends? Has there been a reduction in traffic enforcement as police officers have become ill or otherwise respond to increased business break-ins, vehicle thefts, domestic incidents and other crimes (Dazio, 2020; Fitzpatrick, 2020)?

Gasoline price changes are another situational factor to consider in relation to road safety. Gasoline prices have generally reduced due to decreased demand during the COVID-19 lockdown but price swings have also been experienced by different nations (Bloomberg News, 2020).

Although research results are mixed on whether gasoline prices have short-term effects on road safety (Austin, 2008; Chi et al., 2010), lower gasoline prices should be associated with increased road fatalities (Grabowski and Morrisey, 2004). However, complex and varied patterns related to gasoline prices and road safety have been identified regarding age, gender, unemployment status, and collision type and severity (Ahangari et al., 2014; Austin, 2008; Chi et al., 2010, 2013; Grabowski and Morrisey, 2004) that should be investigated in relation to the current pandemic.

Finally, could COVID-19 affect the health of citizens because of transportation barriers? Many individuals, particularly low SES individuals or older adults rely on family, friends, taxis or public transit to provide transportation to and from health care professionals; yet due to physical distancing people may be reluctant to use or provide these services or the services may be reduced or unavailable. However, many health care providers have been offering virtual care, although research could explore the degree of availability of transportation or virtual care globally. For example, according to Canadian Institute for Health Information data, the percentage of health care delivered virtually in Canada went from 8 to 18% before the pandemic to two thirds of all visits (mostly via telephone) during the pandemic (Canada Health Infoway, 2020; Macleod, 2020). A Canadian Medical Association (2020) survey found 91 % of Canadians who had used virtual care were very satisfied with the experience. Additionally, one survey in Hamilton, Ontario showed 87 % of health care providers would like to continue with this form of health care delivery (Hristova, 2020). Given that both patients and health care providers seem very satisfied with virtual care, could health care travel be significantly reduced in the long term for the general population and could this trend be global? Moreover, could it have any road safety impact?

However, not all health care visits can be virtual. Could trauma care be affected? In jurisdictions with high rates of hospitalized COVID-19 patients, could persons not seriously injured in road collisions be reluctant to present to emergency departments for fear of exposure to COVID-19 and could care of seriously injured persons be somewhat compromised in some jurisdictions with hospital over capacity (Williams, 2020)?

In summary, this natural experiment could have many different effects on road safety both during and after the pandemic.

- Economic factors are only one aspect of the pandemic that could influence road safety. Generally less traffic would be expected to reduce collisions, injuries and deaths. Other factors such as the increased stress and anxiety brought about by the pandemic, more "free" (idle) time, increased consumption of alcohol and drugs, and greater opportunities for speeding and stunt driving, might well have the opposite effect on road safety. For example, how many collisions do risky drivers actually cause during the pandemic when their aggressive actions are rendered more possible and observable because of decreased traffic? Clearly, the relationship between collision reducing factors and potential collision increasing factors is not straightforward. There could also be interactions between factors that could complicate the situation.
- As restrictions ease, new patterns of behaviour will likely emerge. Working from home could become more prominent and would lessen the need for daily commuting. Those who do return to the workplace may be reluctant to use crowded public transit and choose to commute using private vehicles instead.
- The increase in alcohol and drug use, especially at different times and days, may persist thereby increasing the potential for impaired driving.
- Increased levels of stress may affect driving behaviour and collision risk. Those experiencing mental health problems such as depression and anxiety may be differentially affected.

- It will be important to monitor traffic collisions during the pandemic, the expected pandemic waves and in the post-pandemic period as well as many of the ongoing social and behavioural changes that were initiated during this time. There is a need for quality disaggregated, longitudinal data to examine changes and trends in VKT, and other road safety indicators over longer periods of time (as restrictions are introduced, lifted, and then reintroduced with future COVID-19 surges necessitating it as such). Better understanding of the relationships between the factors could lead to new insights into the factors that have negative effects on road safety as well as those that might have positive effects.
- Finally, collaborative efforts by researchers and public (e.g., police, hospitals, government, etc.,) and private (e.g., insurance, commercial transportation, etc.,) sectors will be needed to gather data and develop road safety strategies in relation to the new reality of COVID-19. Moreover, as many of the changes may be structural, long lasting and have morbidity and mortality impact, research funding agencies should provide increased resources to support research on this topic.

CRediT authorship contribution statement

Evelyn Vingilis: Conceptualization, Methodology, Writing - original draft. **Doug Beirness:** Conceptualization, Writing - review & editing. **Paul Boase:** Conceptualization, Writing - review & editing. **Patrick Byrne:** Conceptualization, Writing - review & editing. **Jennifer Johnson:** Conceptualization, Writing - review & editing. **Brian Jonah:** Conceptualization, Writing - review & editing. **Brian Jonah:** Conceptualization, Writing - review & editing. **Robert E. Mann:** Conceptualization, Writing - review & editing. **Mark J. Rapoport:** Conceptualization, Writing - review & editing. **Jane Seeley:** Conceptualization, Writing - review & editing. **Christine M. Wickens:** Conceptualization, Writing - review & editing. **David L. Wiesenthal:** Conceptualization, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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