A crash course in pandemic traffic

The COVID-19 pandemic brought effects both expected and surprising. One expected consequence of measures taken to curb the spread of the SARS-CoV-2 virus was a significant reduction in road traffic. Traffic density fell in all nations that instituted lockdowns of one form or another, forcing business closures and greatly suppressing human mobility. It also fell in nations resisting such measures. Sweden and the Netherlands, for example, never instituted full lockdowns, but other regulations still inhibited public movement. Across European nations, traffic densities fell between 25 and 75%, compared to 40% on average in the United States. Restrictions during the pandemic reduced vehicle mobility (defined as the number of trips) by more than 50% worldwide, with a decrease of 50 to 60% in Asian countries and 55 to 80% in European countries.

Another expected outcome was that, as a direct consequence of reduced road traffic, most nations also experienced a drop in the frequency of road accidents. According to a recent review of more than 100 research studies on global road accidents (Y. J. Yasin et al. *World J. Emerg. Surg.* **16**, 51; 2021), this reduction varied considerably by country, ranging from 26% in Canada to 74% in France, and 11 to 58% in the United States. Total traffic deaths also fell significantly in almost all nations, with exceptions including Denmark, Sweden, the Netherlands and the United States, where overall traffic deaths rose slightly. These exceptions presumably reflect other trends — in the United States, for example, a decade long shift to larger vehicles and greater use of alcohol, drugs and mobile phones.

But now for a surprise. Right alongside the prevailing reduction in accident frequency, the review also found a dramatic increase in the severity of road accidents and subsequent deaths. In Spain, the fraction of deadly crashes increased five-fold over the first year of the COVID-19 pandemic. Similarly, accidents involving extreme speeds became three times more likely in the United Kingdom. In the United States, numbers increased 65% in Boston and 167% in New York. They nearly quadrupled in Chicago.

This presents a puzzle. Why would less traffic lead to more deaths? Some explanations suggested in the media include psychological effects of the pandemic, such as road rage associated with the frustrations of public health restrictions and other disruptions to the ordinary rhythms of life. Instead, others have suggested that, perhaps, most of the people obeying travel restrictions were rule following, safer drivers, and their absence left the roads packed with more dangerous drivers — with unfortunate consequences. No doubt, these ideas may have some merit.

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But they also appear to overlook an even more primary factor linked to what we might call the physics of driving — a relatively simple relationship, well known to traffic experts, between roadway congestion and driving speeds. We tend to think of driving speeds as controlled by speed limits, but in many nations with significant traffic, this isn't true. Few drivers can go at their preferred speed, as other vehicles block their way. Hence, a general pattern is that less road congestion means more open roads and increased driving speeds, triggering an increase in the severity of accidents. This appears to be the primary cause of the global shift to more serious accidents.

Physicists have been modelling traffic for years using systems of fluid and fluid-like equations, which express a systematic inverse relationship between the density of traffic and road speed. Congestion on roads naturally limits drivers' speeds, as they have to be more cautious when constrained by other vehicles. Decades ago, early traffic researchers measured a systematic decline of driving speeds on roads with increasing road congestion, measured as vehicles per kilometre. According to a yet to be published study in California using detailed road traffic data, this key relationship between congestion and speed appears to be the main factor accounting for the dramatic rise in roadway deaths during the pandemic.

The lead author of this study, economist Jonathan Hughes of the University of Colorado, describes the effect in simple physical terms. "The 'speed effect' is the increase in traffic fatalities due to higher average traffic speeds," he told me by e-mail. "On many California highways, speed is typically limited by congestion not by speed limits or driver preferences. With many drivers staying home during the early COVID-19 period, the decrease in traffic allowed remaining drivers to drive faster, meaning that the crashes that did happen were more severe because they happened at higher speeds."

This is a plausible story, but is it the real explanation? To test the idea further, Hughes and colleagues reasoned that, because levels of traffic congestion vary across different regions in the state, regions with normally higher congestion ought to have shown more of an effect than those with lower congestion. That is, during pandemic conditions, the higher congestion regions should have experienced a larger shift in average driving velocities, and a bigger shift in severe accidents. Their data confirmed just this. The increase in deaths from extreme speeds was most pronounced in California counties with higher levels of congestion prior to the pandemic, suggesting this is where reduced congestion let drivers increase their speeds the most.

This explanation rests on a quite simple property of traffic flows, rather than any unusual psychological responses of individuals. That's not to discount that such factors played some role in what happened during the pandemic. But it also implies some rather disturbing conclusions regarding the consequences of other measures taken to reduce roadway traffic even in non-pandemic times. These include building more roadways, or even reducing the amount of traffic by encouraging the use of public transport. Any such effort, in so far as it succeeds in reducing traffic congestion, can be expected to push up driving speeds — and this naturally leads to accidents involving more kinetic energy and more severe injuries and deaths. There's a natural trade off. ❐

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