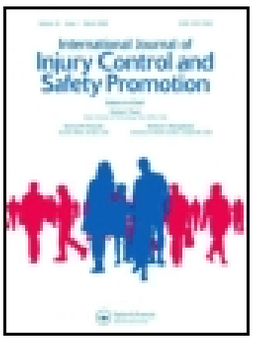

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Road safety status during COVID-19 pandemic: exploring public and road safety expert's opinions

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ABSTRACT

The main objective of this study is to investigate the status of traffic safety and the public perception of traffic safety during the during COVID-19 pandemic. Three different data sets are used in this study: road crash and traffic violation data from Qatar, and two separate questionnaire surveys (from general public and road safety experts). Results showed that during COVID-19 period, the total number of crashes in Qatar significantly reduced during the pandemic compared with the previous 5 years. However, the rates of serious and fatal injuries significantly increased. Regarding the general public perceptions, more than 80% reported that roads became safer while driving behaviours improved during the pandemic. On the other hand, more than 50% of the experts disagreed that roads became safer, 55% disagreed that driving behaviours improved and 70% agreed that less attention from governments was directed toward road safety during the pandemic. The findings from this study could help policy makers to understand the road safety status during the pandemic to make appropriate adjustments in the traffic laws and regulations on a temporary basis. This could help in reducing crash-related injuries and as a result reduce pressure on health and other emergency services.

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COVID-19 pandemic; traffic safety; public perception; road safety experts; driving behaviour; crash data

1. Introduction

Over the years, the transportation system played a significant role in affecting the spread of the contagious viruses (e.g. influenza A/H1N1, SARS and Ebola) (Xu et al., 2019; Zhang et al., 2011). According to Zhao et al. (2018), to prevent a large-scale outbreak of any disease, travel restrictions should be imposed at appropriate times. Recently, the new contagious coronavirus, also known as COVID-19, was declared to be a global pandemic on 11 March 2020 by the World Health Organization (WHO) (World Health Organization, 2020). By the end of 2020, WHO reported more than 82 million confirmed cases of the COVID-19 with more than 1.8 million confirmed deaths (World Health Organization, 2021a). Strict restrictions and policies were imposed in different countries to limit the spread of the COVID-19 including lockdowns, limiting work, education, shopping and/or physical activities and prohibiting social gathering. Moreover, many countries have prohibited air traveling by shutting down the airports. As a result, individuals' daily trips were significantly reduced which might have affected the traffic situations including traffic safety. Policy makers and researchers from different countries have shown a great interest in understanding the impacts of the COVID-19 pandemic on transport systems. Furthermore, underlying the impacts of the adopted restrictions on the transport system including traffic safety is crucial for each country, as every country has its unique set of preventive measures and circumstances.

In this article, a detailed analysis of the traffic safety status during the COVID-19 pandemic is conducted in the state of Qatar. This study looks at traffic safety from three perspectives, road crash records, general population of drivers and road safety expert opinions. The analysis is based on original surveys from residents of Qatar and road safety experts from the international community, and road crash data which would identify and clarify the impacts of the COVID-19 pandemic on traffic safety. Figure 1 shows the reported confirmed cases and the cumulative number of deaths due to COVID-19 on a daily basis in Qatar starting from 20 February 2020 until 31 December 2020 (JHU CSSE, 2021). In addition, the figure also exhibits the cumulative deaths due to Road Traffic Crashes (RTCs). By the end of the year 2020, 245 deaths were reported due to COVID-19, while 126 deaths were resulted from RTCs.

On 29 February 2020, the first positive case of the COVID-19 was reported in Qatar. Soon after that, the cases increased and the Qatar government imposed new

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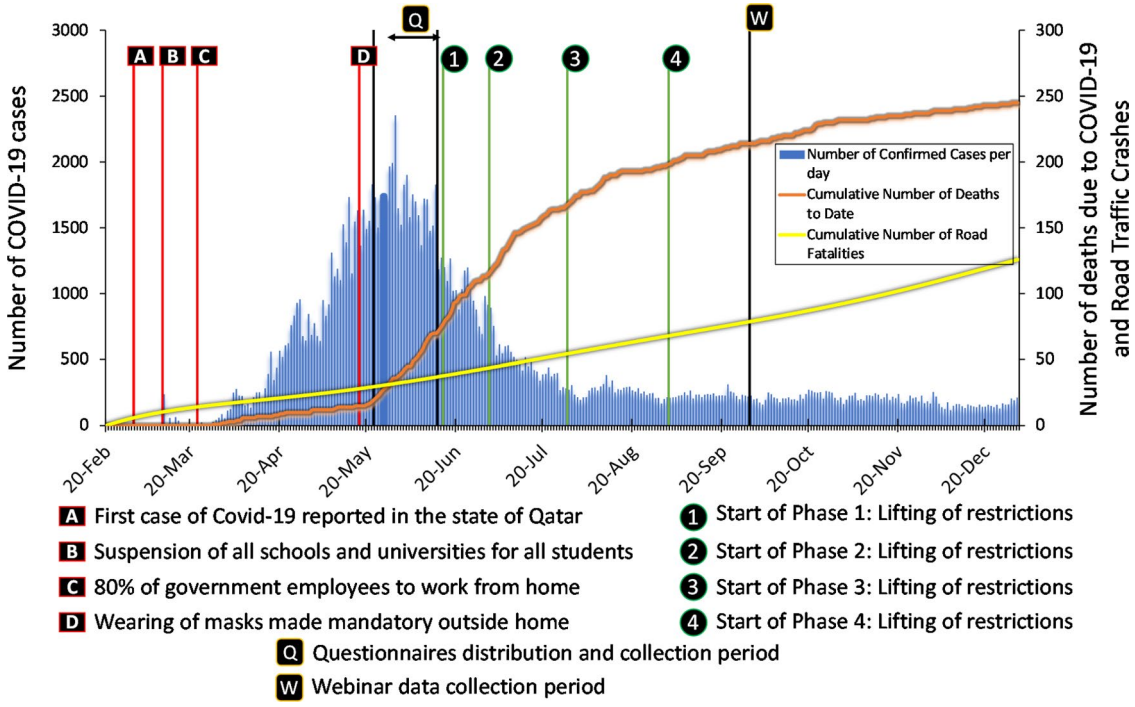


Figure 1. Daily new positive cases of COVID-19 and cumulative number of deaths from COVID-19 and crashes.

regulations to counteract the spread of the virus in the country such as the suspension of all schools and universities for all students on March 10 and work from home order for 80% of government employees on 22 March 2020 (Government Communications Office, 2020a; Hukoomi Qatar e-Government, 2020). However, a noticeable increase in the confirmed cases started at the beginning of April 2020. Therefore, further restrictions were applied starting from 17 May 2020 including the obligation of wearing a face mask outside the home, allowing only two persons to sit in a vehicle with the exceptions for families and taxis (i.e. maximum of three persons), physical activities are allowed only near the place of residence and the mandated orders to install the mobile application 'Ehteraz' for location tracking etc. (Gulf Times, 2020a, 2020b). To ensure that the orders are being followed, fines of as much as 200,000 QAR or up to 3 years of imprisonment were implemented in case of violation of these laws (World Gulf, 2020). As of 31 December 2020, more than 140 thousand confirmed cases of the COVID-19 were reported in Qatar, of which 245 infected individuals lost their lives (World Health Organization, 2021b). In order to ease the restrictions, the government executed a four-phase plan (Government Communications Office, 2020b). Although lifting of the restrictions were gradually applied, basic COVID-19 precaution measures were still mandatory at all times including wearing a face mask in public, having 'Ehteraz' mobile application, keeping social distancing and thermal screening before entering indoor places. The first phase of lifting the restrictions started on 15 June 2020. During that phase, several restrictions were partially lifted such as allowing an additional 20% of government employees to work in their workplace, reopening several public gardens in different areas and allowing 30% of the shops inside malls to reopen. In phase 2 (1 July 2020) and phase 3 (28 July 2020), restaurants were allowed to reopen and the allowable percent of employees in the workplace increased to 50% and 80% for phase 2 and phase 3, respectively. Furthermore, in phase 3, Qatar residents coming from low-risk countries (announced by the Ministry of Public Health) were allowed to enter the country. Eventually, on 1 September 2020 (phase 4), most of the restrictions were partially or fully lifted which included the reopening of schools with maximum attending students of 30% and reopening public transport with maximum capacity of 50%.

The restrictions associated with the COVID-19 pandemic have not only reduced traffic volumes on the roads but could also have altered driving behaviour. In this regard, Bavel et al. (2020) indicated that factors associated with psychological distress about the virus infections and the imposed governmental restrictions could also have strong impacts on individual driving behaviour. It has been witnessed around the world that traffic volume and congestion on the roads were reduced due to the imposed restrictions (Du et al., 2021; Google, 2021). However, as a negative consequence, this might have triggered certain drivers to commit unsafe driving behaviours such as speeding, mobile phone usage and stunt driving (Katrakazas et al., 2020; Vingilis et al., 2020). Therefore, the ratio of RTCs to the number of trips and/or the proportion of severe crashes might have been increased during the COVID-19 pandemic, even though lower number of TRCs are globally reported (Aloi et al., 2020; Brodeur et al., 2021; Oguzoglu, 2020; Qureshi et al., 2020; Saladié et al., 2020). Consequently, researchers have shown a great interest in quantifying the changes in traffic safety during the COVID-19. However,

it is also crucial to understand perceptions of individuals (general public and road safety experts) about traffic safety and driving behaviour during the COVID-19 pandemic.

The main objective of this article is to investigate the impacts of the COVID-19 pandemic on traffic safety in the state of Qatar as well as the drivers' perception about traffic safety during the pandemic. The analysis is carried out using crash data, and questionnaire surveys that were collected from the general public in the state of Qatar and road safety experts from the international community. This will allow us to compare the real-world traffic situations with individuals' perceptions of the improvement or deterioration of traffic safety during the pandemic.

The organization of this paper is as follows: Section 2 summarizes the existing literature related to the impacts of the COVID-19 on traffic safety. This has assisted in finding the gaps and formulating the research questions listed in Section 3. Section 4 contains a description of the collected data and sample descriptions. Section 5 presents the overall results of the impact that COVID-19 has had on traffic safety. Next, in Section 6, the main findings are discussed. The last section presents conclusions and policy-related recommendations.

2. Literature review

Figure 2 shows the percentage reduction in traffic fatalities in April 2020 compared with the average fatalities in April for the previous 3 years (2017–2019) for different countries. The figure is based on a report from the European Transport Safety Council (ETSC, 2020), which reported the reduction in traffic fatalities for several European countries. It can be seen from the figure that in most of the countries, there was a reduction in traffic fatalities with the highest reductions of 84%, 68% and 63% being observed in Italy, Belgium and Spain, respectively. However, some countries such as the Netherlands and Slovakia experienced an increase in traffic fatalities. While comparing Qatar with these countries, we found a similar trend to most EU countries where the number of fatalities in Qatar resulting from RTCs decreased by 51%.

In general, a reduction in both average daily traffic and number of RTCs was observed during COVID-19 pandemic around the world which is rational and expected. Saladié et al. (2020) investigated the impact of COVID-19 lockdown on RTCs and mobility trends in Tarragona province, Spain. Results from their study revealed that there was a reduction of 74.3% in RTCs during 6 weeks after a lockdown was imposed on 16 March 2020 compared with the 6 weeks before the lockdown. In addition, compared with the same period of lockdown in 2018–2019, RTCs decreased by 76%. This was accompanied by 62.9% of reduction in mobility trends between the before- and after-lockdown periods. Similar trends were found in Santander city, Spain, where RTCs and mobility of private vehicles were reduced by 67% and 76%, respectively, after the government imposed a lockdown (Aloi et al., 2020). Another study from Turkey showed that during the strict measures imposed by the government in April 2020, RTCs reduced by 60% with a reduction of 72% and 19% in deaths and injuries, respectively, compared with April 2019 (Oguzoglu, 2020).

In the United States, Qureshi et al. (2020) performed an in-depth analysis to study the impact of the mandated lockdown on RTCs using data from Missouri State Highway Patrol from 1 January 2020 to 15 May 2020. The study revealed that there was a significant reduction in RTCs resulting in no or minor injuries but not RTCs resulting in serious or fatal injuries. Moreover, after the expiry of the mandated lockdown orders, a significant increase in RTCs resulting in no or minor injuries was observed. Similar results were reported in another study showing that overall RTCs were reduced by 20% because of the safer-at-home orders, however, severe RTCs increased by 18% (Brodeur et al., 2021). According to the authors, the rise in the severe RTCs could be attributed to speeding behaviour

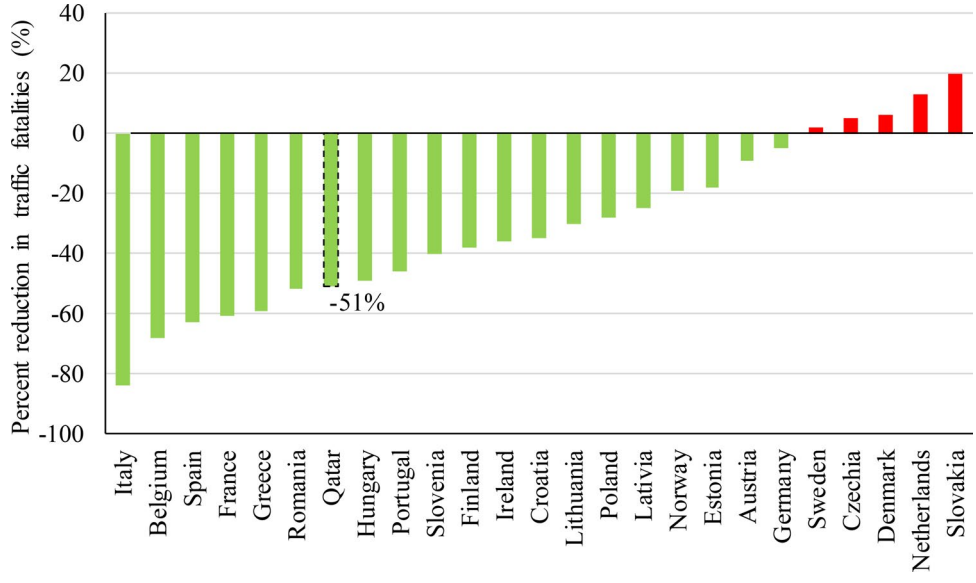


Figure 2. The reduction in traffic fatalities in Qatar and 20 European countries in April 2020 compared to April 2017–2019 average (ETSC, 2020).

adapted by some drivers. Doucette et al. (2021) conducted a time series analysis and found a significant increase by 2.29 times in a single vehicle crash rate on a mileage driven basis after the lockdown was imposed in the state of Connecticut. In addition, the authors reported a significant increase by 4.10 times in the rate for single vehicle fatal crashes. The authors argued that the reduced traffic volumes during COVID-19 would increase the likelihood of some risky driving behaviours such as speeding.

The annual spotlight report from the Governors Highway Safety Association (2020) presented a comprehensive analysis on the state and national trends in pedestrian deaths for January–June 2020. The report showed that despite the enormous reduction in traffic flow 2957 pedestrians were killed during the first 6 months of 2020, which is almost equal to the pedestrian fatalities for the first 6 months of 2019. Interestingly, compared with the first 6 months of 2019, the report estimated a 20% increase in the pedestrian fatality rate per one billion vehicle miles travelled for the first 6 months of 2020. According to the report, if the rate of pedestrian fatalities was similar to the first 6 months of 2019, around 600 fewer pedestrians would have been killed during the first half of 2020.

Inada et al. (2021) forecasted the number of fatal RTCs from 10 years data (i.e. January 2010 to February 2020) in Japan caused by speeding during the lockdown which started in March 2020. Based on the results, during the second month of the lockdown (April 2020), there was a significant increase in the observed ratio of speed-related fatal RTCs to that of non-speed-related fatal RTCs compared with the forecasted ratio. The results clearly indicated that drivers who continued driving during the lockdown were more likely to drive with higher speeds which resulted in fatal RTCs. Several other studies also indicated similar trends in speeding behaviour and speeding-related RTCs during the lockdown period (Kaji et al., 2020; Lockwood et al., 2020; Paparella, 2020; Shilling & Waetjen, 2020).

Katrakazas et al. (2020) studied the effect of the COVID-19 lockdown on driving behaviour with the help of a smartphone application in two different countries i.e. Greece and Saudi Arabia. The results revealed that compared with the normal situation before the COVID-19 pandemic, the trips were shortened, however, driving speed was increased by 6%–11% with harsh accelerations and decelerations. Moreover, mobile phone use while driving was increased by 42% during the 2 months of lockdown.

Based on the literature, most of the above-mentioned studies have focused on the impact of imposed restrictions on RTCs. A few have also investigated the severity of the RTCs. In addition, in most of the studies, comparison of RTCs during COVID-19 was done with a previous year without considering data from other prior years. Although traffic volume was significantly reduced when the restrictions were active, many drivers were still driving on those less congested roads. That might be the reason why speeding and aggressive driving behaviour was observed on the roads in different studies. This study goes one step ahead by investigating not only the real-world road safety situations but also the public and experts' perceptions about traffic safety and driving behaviour during the pandemic. To the extent of our knowledge, drivers' perception and perspective about road safety and driving behaviour during COVID-19 (i.e. reduced traffic volume) is not investigated. In addition, unlike many other countries, Qatar did not have a complete lockdown, allowing different activities to continue with limitations and restrictions. In accordance, Du et al. (2021), stated that the state of Qatar experienced a reduction in traffic demand ranging from 5% and reaching to more than 50% on 24 May 2020. Therefore, investigating the actual traffic safety situation with drivers' perception would allow us to fill this research gap. Studying this particular case for Qatar would be interesting due to its diverse driving population and aggressive driving behaviour (Alhajyaseen et al., 2020; Almallah et al., 2020; Hussain et al., 2019, 2020; Soliman et al., 2018; Timmermans et al., 2019a, 2020). In summary, we believe that the findings of this case study can be helpful for relevant authorities to enhance the COVID-19 and traffic-related policies.

3. Research questions

As mentioned above, the main objective of this article is to analyse the impacts that COVID-19 has had on traffic safety in the state of Qatar, including Qatar citizens perception of road safety during the pandemic. The following research questions will be addressed in this article:

1. To what extent did COVID-19 affect the RTCs and severity of RTCs in the State of Qatar?
2. How did the general public and road safety experts perceive road safety status and driving behaviour during the pandemic?
3. Did the COVID-19 pandemic affect the attention on road safety: based on road safety experts' opinions?

4. Methodology

4.1. Data collection

The data used in this paper is taken from questionnaire surveys (from general public in the state of Qatar as well as experts during a webinar) and road crash data in Qatar.

4.1.1. Questionnaire development

The purpose of the questionnaire was to capture public perceptions about road safety in the state of Qatar. The questionnaire was designed for residents of Qatar having a valid Qatari driving license. The questionnaire was composed of two different sections as explained below:

- Section I – Socio-demographic characteristics: The aim of this section was to collect data about the socio-demographic characteristics of each respondent, such as age, gender, occupational status, educational level, ethnicity and family setup etc.

- Section II – Perceptions about road safety and other contextual factors: This section comprised questions related to individuals' perceptions about road safety, driving behaviour and congestion status on the roads during COVID-19 pandemic. In addition, other contextual factors such as, work from home, number of owned vehicles and household income etc. were also included in the questionnaire.

The questionnaire was prepared in Arabic and English languages. For collecting the data a web-based survey tool named Qualtrics was used (Molnar, 2019). The questionnaire was spread with the general public through social media platforms after obtaining the ethical approval from Qatar University (QU-IRB). The data was collected during the peak spread of COVID-19 in Qatar which was from 22 May 2020 till 13 June 2020. At the beginning of the questionnaire, general information related to the questionnaire was mentioned and the respondents were required to consent electronically. In total, 505 respondents filled the questionnaire. To obtain the final sample, 101 respondents were excluded since they were either residing outside Qatar or did not possess a valid Qatari driving license. Therefore, we ended up with a final sample of 404 that was considered for the analyses.

4.1.2. Webinar questions development

In an international webinar entitled 'Global trends on the status of traffic safety under the COVID-19 pandemic' which was conducted on 29 September 2020 and organized by the World Conference on Transport Research Society (WCTRS), International Road Federation (IRF) and National Traffic Safety Committee of the State of Qatar, the attendees were asked to answer three different questions along with the regular demographic questions. Two of the three questions were related to individuals' perceptions about road safety and driving behaviour. The third question stated if the COVID-19 pandemic reduced the attention on road safety. Road safety experts from different international organizations including WHO, United Nations, International Association of Traffic and Safety Sciences (IATSS), World Bank Group (WBG), Washington State Department of Transportation and Asian Development Bank attended the webinar with common aims of mitigating road traffic causalities and addressing potential impacts of the current COVID-19 pandemic on road safety. In total, 153 respondents attended the webinar, of which 30 attendees did not answer at least one question. Thus, 123 respondents have answered all the questions, which were used in the analyses.

4.1.3. Road crash data

Crash data was obtained from the National Traffic Safety Committee of the State of Qatar. The data summarizes the number of total crashes, serious injuries and fatality crashes of driver, passenger and pedestrian from January 2015 to December 2020 for each month. Moreover, several other parameters such as the number of speeding tickets, passing traffic signal violations and other violations in 2019 and 2020 are also provided as aggregated values per month.

4.2. Sample description

4.2.1. Sample description of the public questionnaire

Table 1 presents the demographic characteristics of the collected sample ($N = 404$), as well as the population of Qatar (Planning and Statistics Authority, 2019a, 2019b, 2019c).

Table 1. Questionnaire respondents demographic characteristics.

Variable	Levels	Sample (%)	Population[a] (%)
Gender	Male	62.9	78.1
	Female	35.9	21.9
	Prefer not to say	1.2	
Age groups (years)	18 – 25	19.8	15.5
	26 – 35	25.0	40.8
	36 – 45	27.7	27.0
	46 – 55	20.3	11.5
	>55	7.2	5.2
Ethnicity	Qatari	14.4	9[b]
	Non-Qatari (Arab)	41.8	Other than Qatari: 91
	Asian (non-Arab)	20.3	
	European and Australian	13.1	
	American	6.7	
	African (non-Arab)	3.7	
Educational level	High school or lower	13.9	76[b]
	Bachelor or higher	86.1	24
Occupational status before COVID-19	Employed for wages	77.4	87.7[b]
	Self-employed	2.3	
	Unemployed	2.0	1.5[c]
	Students	17.4	5.1
	Housewife/househusband	0.9	5.6
Occupational status during COVID-19	No change after COVID-19	35.9	
	Working from home	46.0	
	Online Education	11.6	Not applicable
	Others	6.4	

[a]Demographic characteristics of the population in the state of Qatar (Planning and Statistics Authority, 2019a, 2019b, 2019c).
[b]As per the population aging 15 years and above.
[c]Includes disabled and retired population.

The sample consisted of 62.9% males and 35.9% females. While the rest (1.2%) of the sample did not disclose their gender. The respondents age varied between 18 and 67 (Mean: 38 years, standard deviation (SD): 11.7 years) with more than 70% of the respondents being less than 46 years of age. Among the different nationalities, 14.4% of the respondents were Qatari, 41.8% non-Qatari Arabs, 20.3% Asian (non-Arab), 13.1% European and Australian, 6.7% American and 3.7% African (non-Arab). As for the occupational status of the workers and students in the sample, 46% and 66% have been shifted to remote work and education during the pandemic, respectively. As per the comparison between the population data and sample data in Table 1, most of the demographic characteristics of the sample are at high scale of representation of the population. However, the sample was noted to be skewed towards the higher level of education (bachelor or higher). The reason for this might be the difficulty in delivering the questionnaires to the population with low income/education as the surveys were distributed online.

4.2.2. Sample description of the webinar

The final sample of the webinar ($N = 123$) consisted of 69.9% males vs. 30.1% females. Regarding the residential status, 51.2% of the respondents were residing in Asia, 13% in Africa, 8.9% in America while 26.8% were residing in Europe and Australia. At the time of the webinar, the respondents were residing in 41 different countries. It is worth mentioning that most of the respondents were affiliated with road safety-related international organizations or institutions.

4.3. Data analysis

The analyses were conducted in two major areas, one involved the crash data to investigate the impacts of the COVID-19 pandemic on road traffic safety in the state of Qatar, while the second aimed at understanding public and experts' perception level regarding traffic safety during the pandemic. In this regard, three different data sets were analysed.

The crash data was obtained from the National Traffic Safety Committee of the State of Qatar, which included 6 years of crash data (2015–2020) and data on traffic violations from the last 2 years (2019 and 2020). To investigate the impacts of the COVID-19 pandemic on crashes and violations, the available data was plotted using line graphs in terms of the number of crashes/violations and proportion of serious/fatal crashes in total crashes. In addition, to understand if the reduction/increase of crashes or violations was significant, *Z*-tests were conducted. *Z*-tests are widely used to find whether the observed changes in crashes or rate of injuries are statistically significant or not (Chimba et al., 2010; Khattak et al., 2018; Williams et al., 1995). Two-tailed approach was followed for obtaining the p values and a p value of .05 or lower was considered as significant.

To understand individuals' perception level about traffic safety during the pandemic, data was collected through the two questionnaire surveys as explained earlier. The main variables were in discrete ordinal form (1 = strongly disagree, 5 = strongly agree), therefore, spearman's correlation tests were conducted to find the significant relations (Hauke & Kossowski, 2011; Khamis, 2008). In this regard, different demographic and contextual factors such as age (continuous), gender (1 = female, 0 = male), ethnicity (dummy variable: Asian, African, American, European and Australian), educational status (low to high), occupational status (dummy variable: employed, unemployed, students) family setup (with children = 1, without children = 0), number of vehicles in the household (0, 1, 2, 3, 4+), number of trips per week during COVID-19 (0, 1, 2, 3, 4, 5, 6+), gross income per month (low to high) and work-from-home (1 = yes, 0 = no) were used in the analysis of public perception. However, regarding the experts' perception data for the two factors, (i.e. gender and country of residence) was available and were used in the analysis. Spearman's correlations were estimated using IBM SPSS Statistics software (version 26) to measure the significant correlation metrics between the demographic/contextual factors and the safety perceptions.

5. Results

5.1. Road crash data

The crash data that was obtained from the National Traffic Safety Committee of the State of Qatar included total crashes, type of injuries and different types of violations. The overall data is summarized in two different tables that are presented as appendices. Appendix 1 includes the total crashes, causalities and the rate of each causality per 1000 crashes for each month that are reported for both the averaged for 2015–2019 and separately for 2020. In addition, Appendix 2 includes the different types of violations for each month that are reported separately for 2019 and 2020. For better visualization, the data is illustrated in different figures that will be discussed henceforth. It is important to highlight that exposure data such as traffic volumes or vehicle-kilometre travelled was not available and thus it could not be considered in the analysis.

Figure 3 illustrates the overall number of road crashes per month in Qatar separately for each year from 2015 to 2020 and averaged for years 2015–2019. These crashes include all types of crashes such as vehicle–pedestrian, vehicle–vehicle and vehicle–street objects crashes. It can be seen from the figure that road crashes were reduced gradually from 2015 to 2019 in general, which is the result of the successful implementation of the National Traffic Safety Strategy (2013–2022) (Timmermans et al., 2019b). In this regard, a comparable similar trend was found in the crash data from 2015 to 2019 such as peak road crashes in May and lowest road crashes from July to September. During the early stages of restrictions in the state of Qatar, a remarkable drop in the road crashes was noticed. To

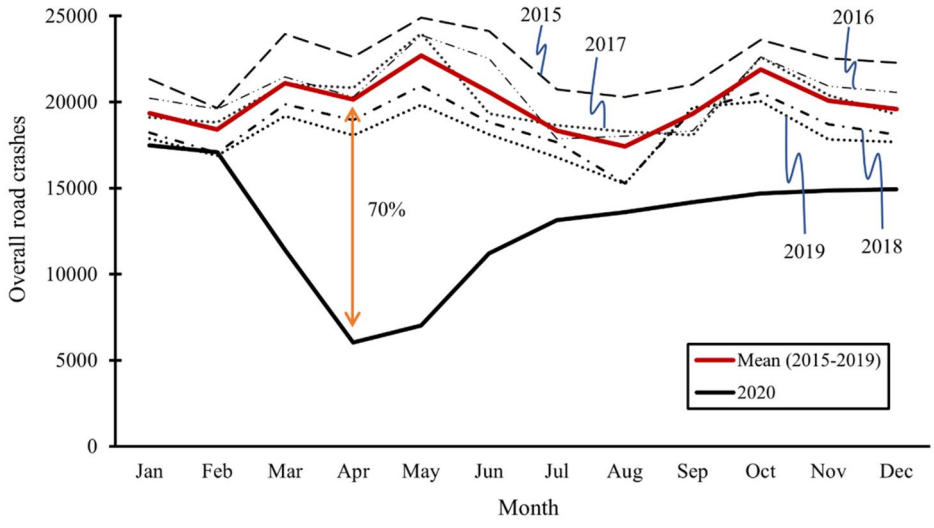
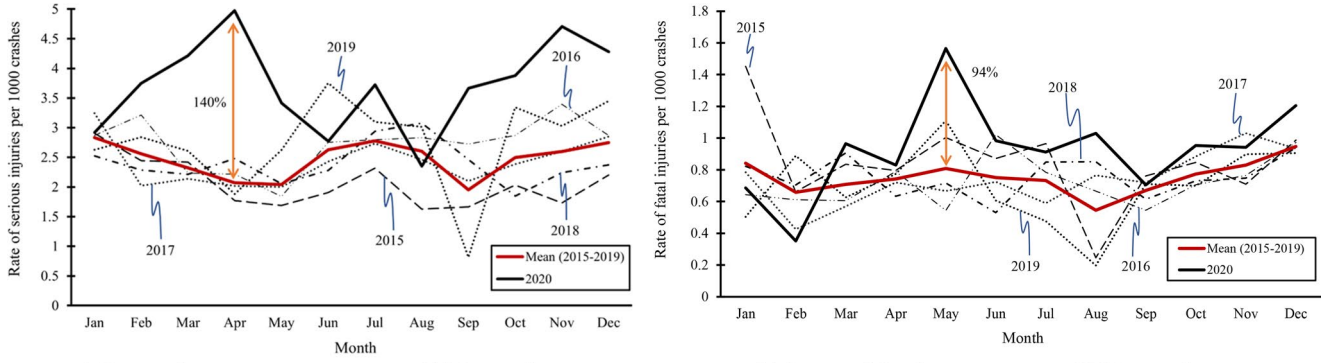


Figure 3. Number of overall road crashes from 2015 to 2020.

understand if the drop was significant, a *Z*-test was conducted. The results showed that the average of the overall road crashes from 2015 to 2019 (Mean: 20119, Standard Deviation (SD): 1495) was significantly higher than the overall road crashes in 2020 (Mean: 12108, SD: 3066) (two-tailed: $z_{(9)} = -7.427$, $p < .001$). In fact, the data used in all presented *Z*-tests in this section are for the period from March to December of each year as the COVID-19 started to spread in Qatar from March 2020 onwards. In particular, the highest reduction in road crashes reached up to 70% ($\Delta = 14{,}124$ crashes) in April, when compared with the average road crashes from 2015 to 2019 in April. However, the overall road crashes increased after April 2020 to reached ~15,000 in December 2020 since certain restrictions were lifted by the government in different phases from July 2020 onwards.

Although the state of Qatar has witnessed a dramatic reduction in the number of overall crashes due to the pandemic, it is important to investigate if a similar trend was followed by the outcomes of these crashes as well. In this regard, from the available data the rate of serious injuries per 1000 crashes (Figure 4a) and the rate of fatal injuries per 1000 crashes (Figure 4b) were plotted. The figures present the rates of injuries separately for each year from 2015 to 2020 as well as the averaged injury rate for 2015–2019. The rates were calculated as dividing the injuries (serious or fatal) by the total crashes of the same month and year. As shown in Figure 4a, the rate of serious injuries/1000 crashes steeply elevated in 2020, especially during the peak restrictions period. Since the year 2015, the highest rate of around five serious injuries/10,000 crashes was obtained in April 2020. This was around 140% increase in the rate of serious injuries/1000 crashes while comparing to the mean rate of serious injuries/1000 crashes (2015–2019) for the same month. To investigate if the overall rate of serious injuries/1000 crashes in 2020 was significantly higher than the mean rate (2015–2019), *Z*-test (two-tailed) was conducted. The results confirmed that the mean rate of serious injuries/1000 crashes in 2020 (Mean: 3.72, SD: 0.74) was significantly higher than the overall mean rate (2015–2019) (Mean: 2.45, SD: 0.29) ($z_{(11)} = 5.51$, $p < .001$). A similar trend was observed for the rate of fatal injuries/1000 crashes as shown in Figure 4b. The highest escalation was observed in the month of May in 2020 (1.56 fatalities/1000 crashes), which was around 94% higher than the mean fatalities/1000 crashes from 2015 to 2019 for the same month (Mean: 0.80 fatalities/1000 crashes). The *Z*-test results showed that the overall mean rate of



a) Rate of serious injuries per 1000 crashes

b) Rate of fatal injuries per 1000 crashes

Figure 4. Proportion of serious/fatal injuries per 1000 total crashes from 2015 to 2020.

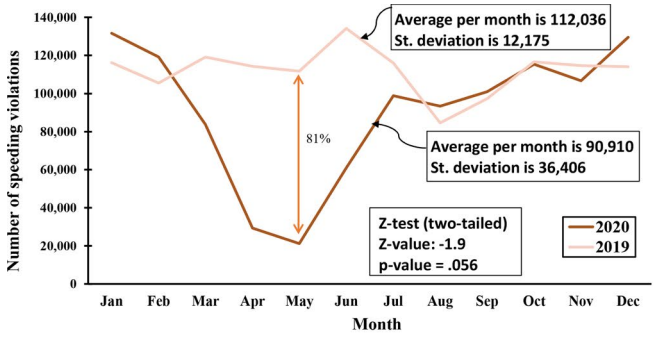
fatalities/1000 crashes in 2020 (Mean: 0.93, SD: 0.28) was significantly higher than the overall mean rate (2015–2019) (Mean: 0.75, SD: 0.09) ($z_{(11)} = 2.05$, $p = .040$).

To further analyse the situations during the pandemic, the number of reported speeding tickets, passing traffic signal violations and other violations are plotted in Figure 5. As shown in Figure 5a, the total number of speeding tickets in 2020 was higher than in 2019 before the appearance of the COVID-19 in Qatar. However, in March and April 2020, a large reduction in the number of speeding tickets was noticed (i.e. up to 81% of reduction in April 2020 compared with April 2019). To see if the difference was significant, a *Z*-test (two-tailed) was conducted between the 2 years. The results showed that the number of speeding tickets in 2020 (Mean: 90,910, SD: 36,406) was significantly different at .1 level compared with 2019 (Mean: 112,036, SD: 12,175) (two-tailed: $z_{(11)} = -1.9$, $p = .056$). As for the passing traffic signals violations [red-light running (RLR)], it was noted that in 2020, the number of violations were always higher than the same month in 2019 (Figure 5b). Although, the number of passing traffic signal violations were reduced in April 2020 compared with the previous month, it remained higher than in April 2019. However, after a slight reduction in April 2020, the violations increased to reach a steady range that is equivalent to the same month in 2019. As informed by the National Traffic Safety Committee of the State of Qatar, the sharp increase in the traffic signal violations between June and August 2019 could be due to the newly installed RLR violation cameras at many intersections during the third quarter of that year in the state of Qatar. The results from *Z*-test confirmed that the number of violations in 2020 (Mean: 4867, SD: 608) was significantly higher than the same month in 2019 (Mean: 2844, SD: 1379) (two-tailed: $z_{(10)} = 4.65$, $p < .001$). Figure 5c illustrates the number of other violations such as overtaking violations, driving license-related violations and stand and wait rules/obligations-related violations (excluding the speeding and passing traffic signal violations) for 2019 and 2020. Again, a steep reduction of around 78% was observed in the month of April in 2020 compared with the same month of 2019. The results from *Z*-test showed that the reduction in other traffic violations in 2020 was significant (two-tailed: $z_{(10)} = -3.87$, $p < .001$).

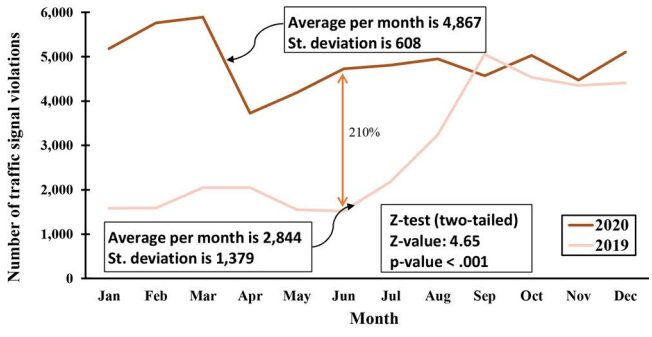
5.2. General public perceptions of traffic safety during COVID-19

Figure 6 illustrates the percentages of the public perceptions on traffic safety for the three different questions. Most of the respondents perceived that the roads have become more safer during the pandemic. Out of the total respondents, 83% and 92% reported that the roads have become more safer and the driving behaviour (i.e. less reckless or aggressive driving behaviour) has improved, respectively. Furthermore, 67% have agreed that the road congestion was also reduced during the pandemic.

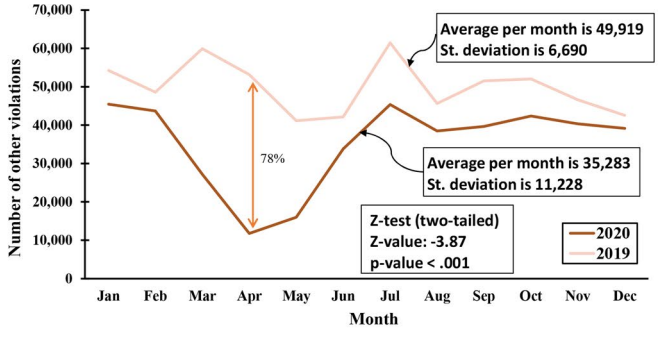
Table 2 presents the results from Spearman's correlation for the three main questions with the demographic and some other contextual factors such as age, gender, ethnicity,



a) Number of speeding violations



b) Number of traffic signal violations



c) Number of all other types of violations

Figure 5. Comparison of total number of violations between 2019 and 2020 for each month.

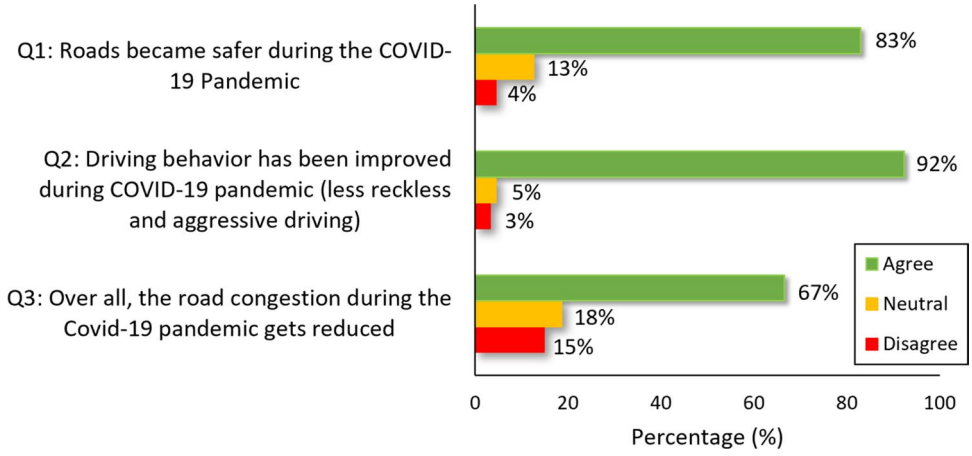


Figure 6. Results of the road safety questions from the questionnaire survey.

Table 2. Spearman's Correlations between each question from the Questionnaire.

	Q1: Roads became safer during the COVID-19 pandemic			Q2: Driving behaviour has been improved during COVID-19 pandemic (less reckless and aggressive driving)			Q3: Overall, the road congestion during the COVID-19 pandemic gets reduced		
	Coefficient	*P*	*N*	Coefficient	*P*	*N*	Coefficient	*P*	*N*
Q1: Roads became safer during the COVID-19 Pandemic	1.00	.	404	.557	**<.001****	404	.505	**<.001****	404
Q2: Driving behaviour has been improved during COVID-19 pandemic (less reckless and aggressive driving)	.557	**<.001****	404	1.00	.	404	.245	**<.001****	404
Q3: Overall, the road congestion during the COVID-19 pandemic gets reduced	.505	**<.001****	404	.245	**<.001****	404	1.00	.	404
Age (low to high)	.154	**.002****	404	.072	.147	404	.278	**<.001****	404
Gender (0 = male, 1 = female)	−.016	.747	399	−.091	**.071***	399	−.114	**.022****	399
Ethnicity									
Asian	−.099	**.047****	404	−.003	.957	404	−.167	**.001****	404
African	.093	**.063***	404	.099	**.047****	404	.061	.220	404
American	.021	.668	404	−.027	.589	404	.080	.109	404
European and Australian	.024	.628	404	−.083	**.095***	404	.111	**.025****	404
Education level (low to high)	.049	.329	404	−.014	.783	404	.226	**<.001****	404
Occupational status									
Employed	.151	**.002****	404	.086	**.085***	404	.241	**<.001****	404
Unemployed	−.075	.134	404	−.041	.412	404	−.001	.980	404
Student	−.127	**.010****	404	−.073	.145	404	−.256	**<.001****	404
Gross income (low to high)	−.007	.892	331	−.130	**.018****	331	.061	.270	331
Number of vehicles (cars/motorbikes) in the household (low to high)	−.099	**.047****	404	−.122	**.014****	404	−.121	**.015****	404

*Significant at 0.1 level; **significant at 0.05 level.

educational/occupational status, family setup (with and without children), number of vehicles in the household, number of trips during COVID-19, gross income per month and work-from-home. Results of the factors that were not significant at 90% confidence level for any of the three main questions are not reported in the table. In this regard, the factors 'family setup', 'number of trips during COVID-19' and 'work-from-home' had no significant correlations with any of the main questions. A general consensus was found in the individuals' perceptions regarding road safety (Q1), driving behaviour (Q2) and road congestion (Q3), i.e. Q1 & Q2 ($r_{(402)}$ = .557, p < .001), Q1 & Q3 ($r_{(402)}$ = .505, p < .001) and Q2 & Q3 ($r_{(402)}$ = .245, p < .001). This means that the respondents who agreed that the roads have become safer during the pandemic, have also agreed that the driving behaviour was improved while the road congestion was reduced.

Regarding age of the respondents, the results showed positive correlations with Q1 ($r_{(402)}$ = .154, p = .002) and Q3 ($r_{(402)}$ = .278, p < .001). This indicates that compared with younger people, elder people have higher perceptions that the roads became safer and less congested. Furthermore, compared with males, females showed higher disagreement on the statements that the driving behaviour ($r_{(402)}$ = −.091, p = .071) and traffic flow ($r_{(402)}$ = −.114, p = .022) improved during the pandemic. When it comes to the different ethnic groups, Africans had higher perceptions that roads became safer ($r_{(402)}$ = .093, p = .063) and driving behaviour improved during the pandemic ($r_{(402)}$ = .099, p = .047). Different from that, Asian showed a higher disagreement on road safety improvement ($r_{(402)}$ = −.099, p = .047) while Europeans and Australians showed a higher disagreement on the improvement of driving behaviour during the pandemic ($r_{(402)}$ = −.083, p = .095). Moreover, regarding the reduction in road congestion during the pandemic, Europeans and Australians showed a higher agreement ($r_{(402)}$ = .111, p = .025) while Asians showed a higher disagreement ($r_{(402)}$ = −.167, p = .001) both compared with

the other ethnic groups. Respondents with higher educational level indicated that the congestion level was reduced during the pandemic ($r_{(402)}$ = .226, p < .001). Regarding occupational status, respondents who were employed showed higher agreements with all of the statements (Q1: $r_{(402)}$ = .151, p = .002; Q2: $r_{(402)}$ = .086, p = .085; Q3: $r_{(402)}$ = .241, p < .001). In contrary, the students showed higher disagreement that the roads became safer ($r_{(402)}$ = −.127, p = .010) or less congested ($r_{(402)}$ = −.256, p < .001) compared with the other groups. This is in accordance with the impact of age where younger participants showed higher disagreement with the questioned improvements. Interestingly, respondents' gross income was negatively correlated with Q2 ($r_{(402)}$ = −.130, p = .018) indicating that respondents with higher income showed higher disagreement that driving behaviour was improved during the pandemic. Finally, the factor 'number of vehicles in the household' was negatively correlated with all of the statements (Q1: $r_{(402)}$ = −.099, p = .047; Q2: $r_{(402)}$ = −.122, p = .014; Q3: $r_{(402)}$ = −.121, p = .015). This indicates that respondents who were possessing more vehicles had higher disagreements on the improvement of traffic safety, driving behaviour and traffic flow compared with those with no or less vehicles.

5.3. Experts' perceptions of traffic safety during COVID-19 pandemic

Figure 7 presents the percentages of the experts' perceptions on traffic safety for the three different questions that were asked during the webinar. Despite the fact that 47% of the respondents mentioned that the roads became safer during the pandemic, 55% indicated that the driving behaviour was not improved. It is interesting to note that unlike the general public perceptions (Figure 6), a higher percentage of traffic safety experts disagreed with the statements on the improvement of traffic safety and driving behaviour during the pandemic (Figure 7). Moreover, 70% of the respondents agreed that the pandemic has reduced the attention on road safety.

Figure 8 illustrates the percentages of the road safety experts' perceptions on three different questions split by gender and country of residence of the experts. Females showed comparably higher disagreement for the first two statements compared with males. However, compared with males, they had higher perceptions that the COVID-19 pandemic reduced the attention on road safety. Regarding the country of residence, experts from Asia had higher perceptions (54.8% agreed) followed by experts from Africa (50% agreed) on road safety during the pandemic. However, only 23.7% of the experts from Europe shown agreement to this statement. Moreover, regarding the improvement of driving behaviour during the pandemic, experts from Africa have shown the highest disagreement (68.8% disagreed) followed by Europe and Australia (60.6% disagreed). When it comes to the third question, 97% of the experts from Europe and Australia agreed that the pandemic affected the attention given to road safety.

To investigate the significant correlations between the three main questions and the factors 'gender' and 'country of residence', a Spearman's correlation was conducted. The results showed that gender was not significant for any of the three questions. Table 3 presents the results from Spearman's correlation for the three main questions and the factor 'country of residence'. Again a general consensus was found in the experts' perceptions regarding road safety and driving behaviour (Q1 vs. Q2: $r_{(402)}$ = .385, p < .001). This means that road safety experts who agreed that the roads became safer during the pandemic, have also shown agreement that the driving behaviour was improved. However, negative correlations were found between Q1 and Q3 ($r_{(402)}$ = −.227, p = .012), and Q2 and Q3 ($r_{(402)}$ = −.199, p = .028). This shows the consistency between experts' opinions, i.e. the experts who thought that the traffic safety or driving behaviour have improved, disagreed that the attention on roads reduced due to the COVID-19 pandemic. Regarding the country of residence, experts living in Asia have shown higher agreement ($r_{(120)}$ = .160, p = .078) while experts living in Europe or Australia have shown higher disagreement ($r_{(120)}$ = −.195, p = .031) on Q1 (roads became safer during the COVID-19 pandemic), compared with the other

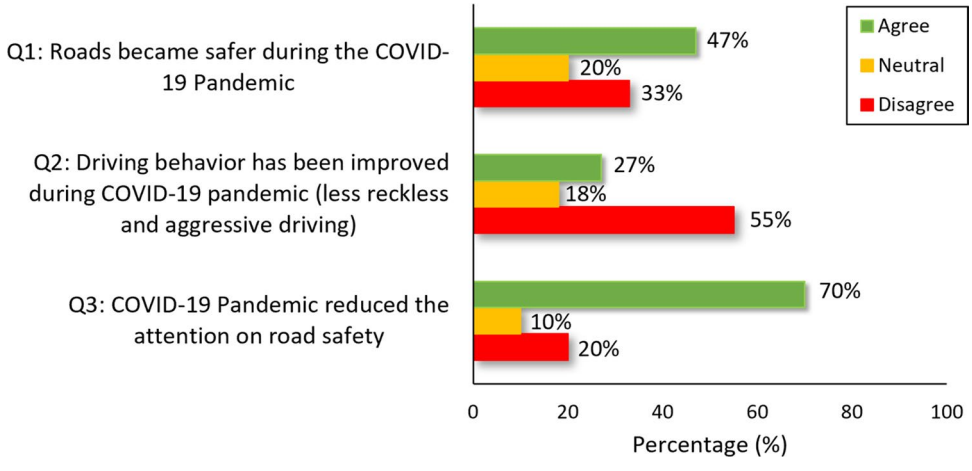
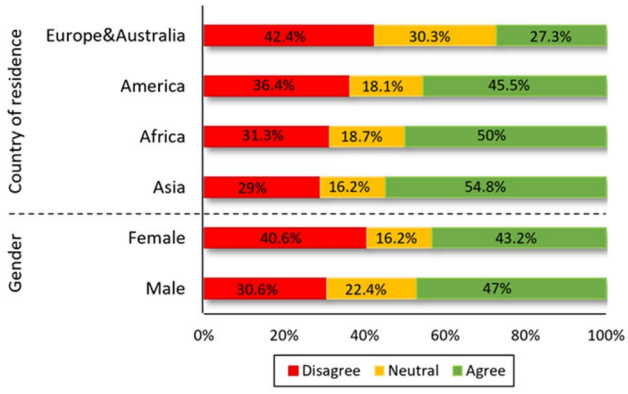
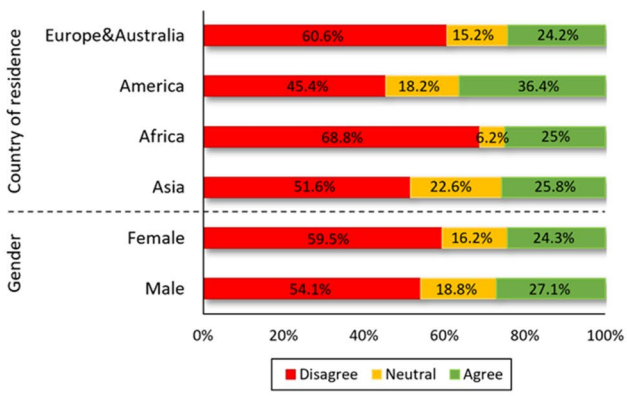


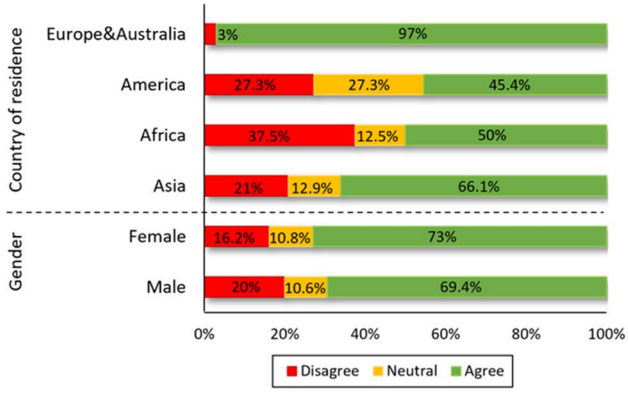
Figure 7. Percentages of the experts' perceptions on traffic safety for the three different questions.



a) Q1: Roads became safer during the COVID-19 Pandemic



b) Q2: Driving behavior has been improved during COVID-19 pandemic



c) Q3: COVID-19 pandemic reduced the attention on road safety

Figure 8. Percentages of the experts' perceptions on traffic safety by gender and country of residence.

Table 3. Spearman's Correlations between each question from the webinar questions.

	Roads became safer during the COVID-19 Pandemic			Driving behaviour has been improved during COVID-19 pandemic (less reckless and aggressive driving)			COVID-19 pandemic reduced the attention on road safety		
	Coefficient	*P*	*N*	Coefficient	*P*	*N*	Coefficient	*P*	*N*
Roads became safer during the COVID-19 pandemic	1	–	122	.385	**<.001****	122	–.227	**.012****	122
Driving behaviour has been improved during COVID-19 pandemic (less reckless and aggressive driving)	.385	**<.001****	122	1	–	122	–.199	**.028****	122
COVID-19 pandemic reduced the attention on road safety	–.227	**.012****	122	–.199	**.028****	122	1	–	122
Country of residence									
Asia	.160	**.078***	122	.056	.539	122	–.092	.316	122
Africa	.029	.751	122	–.076	.404	122	–.186	**.040****	122
America	–.011	.908	122	.073	.421	122	–.155	**.088***	122
Europe and Australia	–.195	**.031****	122	–.053	.565	122	.344	**<.001****	122

*Significant at 0.1 level; **significant at 0.05 level.

regions. Regarding the perceptions that the COVID-19 pandemic reduced the attention on road safety, the experts living in Europe and Australia had higher agreements compared with the other regions ($r_{(120)} = .344$, $p < .001$). Meanwhile, compared with the other regions, experts living in Africa ($r_{(120)} = -.186$, $p = .040$) and America ($r_{(120)} = -.155$, $p = .088$) have shown lower agreements on the statement that the pandemic reduced the attention on road safety compared with other regions. Finally, when it comes to the perceptions on driving behaviour, we did not find any significant difference between the experts from different regions which means that surveyed experts from different continents consistently agree that driving behaviour was not improved during the pandemic.

6. Discussion

The main aims of this study were to investigate the traffic safety status (RTCs, rate of injuries and violations) during

the COVID-19 pandemic and to explore the general public and road safety experts' perceptions of traffic safety during the pandemic. Three different research questions were formulated in this study to address the above objectives. In this section, the research questions will be repeated for convenience and for formulating our findings subsequently.

The first research question was 'to what extent did the COVID-19 affect the RTCs and their severities in Qatar?' Presented road crash data in section 5.1 'Road crash data' for the period from 2015 to 2020 can be linked to the first research question. In this regard, we found that in general RTCs were reduced gradually from 2015 to 2019. This reduction can be attributed to the implementation of the National Traffic Safety strategy (2013–2022) which led to overall improvements in medical emergency response and treatments, advancement in traffic enforcement technology such as the installation of speed and RLR radars, and improvements in overall road infrastructures. However, a large reduction in RTCs was observed during the pandemic especially in the months of April till July in the state of Qatar. This steep reduction in RTCs could solely be due to the fact that highest governmental restrictions were imposed during that period such as work-from-home, online education, social distancing, prohibiting social gathering and restrictions on other out-of-home activities. The reduction in overall RTCs is not only witnessed in Qatar but also in many other countries in the world as found in the literature (Aloi et al., 2020; Brodeur et al., 2021; Oguzoglu, 2020; Qureshi et al., 2020; Saladié et al., 2020).

Although, RTCs were reduced dramatically, a completely opposite trend was observed in the outcomes of these crashes. In this regard, we found that the rates of minor/major and fatal injuries per 1000 crashes climbed up during the highest restrictions period (see Appendix 1). This clearly shows that the main proportional reduction happened only in the property damage only (PDO) crashes, which commonly occur during traffic congestion periods. The steep increase in the rates of injuries could be due to the fact that roads experienced significantly low traffic volumes during the peak restrictions period, which resulted in increased aggressive and speeding behaviour (Bényei & Golarits, 2002; Doucette et al., 2021; Oskarbski et al., 2020). Therefore, increased speeding behaviour could have triggered more severe outcomes from crashes. Another reason could be the increase in social, financial and psychological stress (Robillard et al., 2020) and anxiety and depression (Hou et al., 2021) levels during the COVID-19 pandemic. In this context, according to Kontogiannis (2006), driver stress level has a strong correlation with unsafe driving behaviours as well as traffic crashes. In addition, a review study indicated that drivers with depression may encounter difficulties with divided attention, reaction time, changing speeds and changing lanes (Wickens et al., 2014). Our results also indicated that even when most of the restrictions were lifted during the last quarter of 2020, the rates of injuries were still higher compared with the same months from the previous few years (2015–2019). According to Lally et al. (2010), exposure to a repetitive travel behaviour for at least 1 month could shape individual's travel habits in the future. Concerning the violations, as it was expected, we found that the number speeding and other type of violations reduced with high margins during the peak restriction periods. However, the trend of RLR violations was completely opposite compared with the other violations, i.e. no steep reduction was observed in these violations during the peak restriction period of 2020 compared with the previous months in early 2020 and the last quarter of 2019 where new RLR cameras were already installed at many intersections. Policy makers should make use of such trends to implement temporary traffic calming measures during the expected upcoming waves of the COVID-19 or future epidemics.

The second research question was 'How did the general public and traffic experts perceive road safety status and driving behaviour during the pandemic?' Most of the general public perceived that road safety status (83%) and driving behaviour (92%) improved during the pandemic. While comparing the differences in perception levels, certain groups showed higher agreement than others. For instance, males showed higher agreements that driving behaviour was improved and roads were less congested during the pandemic compared with females. Important to mention here that males had higher exposure to the roads compared with females, i.e. higher proportion of males were not working from home (35.8%) compared with females (11%), and males performed more trips per day (2.1 trips/day) compared with females (1.6 trips/day) during the peak restrictions period. Compared with youngster drivers, older drivers have higher perceptions that the roads have become safer and less congested. Regarding ethnicity, compared with the other ethnic groups, Asians showed higher disagreement while Africans showed higher agreement that the roads became safer. Next, Africans had higher perceptions while Europeans and Australians had lower perceptions that the driving behaviour improved. When it comes to the gross income, individuals with higher income had lower perceptions that the driving behaviour improved.

Interestingly, the experts' perceptions about road safety and driving behaviour were different than the general public perceptions. For instance, one third of the experts did not agree that the road safety improved during the pandemic compared with 4% of the general public who disagreed. In addition, more than half of the experts disagreed that the driving behaviour was improved during the pandemic compared with only 3% of the general public who disagreed. A possible reason could be that general public associate traffic volume to the overall road safety in general, while the road safety experts analyse road safety in a deeper way and they are exposed to updated data and information on road safety. For instance, as found in this study that even though overall RTCs were reduced, the rates of injuries were higher during the pandemic compared with the previous years. In general, the rates of injuries could provide a significant illustration of road safety, e.g. higher rates of injuries indicate lower proportional road safety and higher

proportional unsafe driving behaviour. Therefore, the traffic experts' opinions are more in-line with the reported road safety status during the pandemic compared with the public opinions. The results from Spearman's correlation confirmed that the gender of road safety experts was not significant factor, meaning that both male and female experts had similar opinions regarding road safety and driving behaviour during the pandemic. With regard to the country of residence, the road safety experts from Asia had higher perceptions while the experts from Europe and Australia had lower perceptions that roads became safer during the pandemic compared to the experts from other regions. Such findings about evaluating the differences between individuals' perceptions regarding road safety, driving behaviour and congestion level are not yet reported in the literature and therefore, could contribute to improve policy makers' knowledge of public perceptions during the pandemic.

The third research question was 'did the COVID-19 pandemic affect the attention on road safety: based on road safety experts' opinions?'. In this regard, we found that around 70% of the experts showed agreement that the pandemic reduced the attention on road safety. This is quite logical as the government and public attention was shifted towards COVID-19-related issues. In addition, there should be high financial burdens due to the COVID-19 alleviation measures and economic crisis around the world, which could have exerted high pressures on funding at different levels including road safety. However, it is important for relevant authorities to keep balance between different issues including road safety in a more cost-effective way. In addition, this is a good time to inform the public regarding the importance of road safety to overcome the RTCs and resulted casualties. Furthermore, road traffic authorities could examine strategies that could be implemented on a temporary basis to reduce risky driving behaviours in these type of situations with lower traffic volumes. This could not only help in saving lives but also help in reducing pressure on health and other emergency services during these difficult times.

This study had some methodological limitations. The violation-related data presented in this study describes the overall violation for each category, e.g. RLR violations. It would be interesting to examine the differences in traffic violations identified by automated cameras systems vs. tickets given in person by officers separately. Furthermore, the samples of the public questionnaire and the webinar were skewed more towards male respondents, i.e. 62.9% and 69.9%, respectively. Samples containing higher proportion of female respondents may produce slightly different results. Nonetheless, the actual population in Qatar include higher percentage of males (78.1%) (Planning and Statistics Authority of Qatar, 2019a). Future studies should focus on evaluating the long-term impacts of the COVID-19 pandemic on road safety and driving behaviour. In addition, future studies with higher sample size could use more sophisticated modelling techniques to draw different linkages between public/experts' perceptions and the real-world impacts that COVID-19 has had on various travel behaviour characteristics.

7. Conclusion

The objectives of this study were to investigate the impacts of the COVID-19 pandemic on traffic safety (RTCs, rate of injuries and violations) using crash data in Qatar. In addition, the study presents results from a questionnaire survey targeting the general public in Qatar and a webinar survey targeting international road safety experts to explore their perceptions regarding traffic safety during the pandemic. In this regard, the study attempted to first investigate the trend of RTCs and rates of injuries during the pandemic and to statistically compare them with the trends 5 years prior to the pandemic using *Z*-tests. The results showed that there was a significant reduction in overall RTCs in 2020, compared with the previous years. During the peak restriction period in April 2020, a 70% reduction in overall crashes were observed. Although, there was drastic reduction in overall crashes, we found that the rate of injuries per 1000 crashes was significantly increased, especially during the peak restrictions period, i.e. the rates of serious and fatal injuries increased by 140% and 111% in April and May, respectively. This means that the main proportional reduction happened in the PDO crashes only, which usually occur during the high traffic volume situations. The results further indicated that since the roads had low traffic volumes during the peak restrictions period, this could have triggered unsafe driving behaviour such as speeding or reckless driving. Moreover, the study analysed data from questionnaire surveys and a webinar survey to investigate general public perceptions regarding road safety. The overall descriptive statistics showed that majority of the respondents from the general public sample agreed that the road safety and driving behaviour improved during the pandemic. However, unlike the general public, higher percentages of the road safety experts disagreed that the roads became safer (33%) or driving behaviour improved (55%) during the pandemic. The results form Spearman's correlation tests showed that there was no significant difference in perception levels about road safety and driving behaviour between male and female experts. However, experts from Europe and Australia showed higher disagreements, while those from Asia showed higher agreement that the road safety improved during the pandemic in comparison to the experts from other regions. Around 70% of the experts agreed that the COVID-19 pandemic affected the attention on road safety. In this regard, experts from American and African countries showed lower agreement while experts from Europe and Australia showed significantly higher agreement.

The study is important in that it presents the RTCs and their casualties as well as public/experts' perceptions regarding road safety during the pandemic. The findings of this study could help policy makers to understand the road safety status during the pandemic and the impacts that COVID-19 has had on the various aspects of road safety and driving behaviour. Policy makers could make appropriate adjustments in the traffic laws and regulations on a temporary basis to overcome risky driving behaviours during future epidemics, for instance, by re-evaluating the posted speed limits and traffic fines. This could not only help in

reducing serious/fatal injuries but also in reducing pressure on health and other emergency services.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix 1. Total crashes and injuries: averaged annual data from 2015 to 2019 vs. data from 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Violations type in 2019												
Radar	116,207	105,498	119,139	114,295	111,712	134,232	116,054	84,556	97,275	116,670	114,675	114,121
Passing traffic signal violations	1582	591	2048	2048	1552	1522	2186	3239	5057	4537	4353	4409
Overtaking violations	1830	1966	2636	1747	1835	1052	1585	1691	1589	1299	1348	775
Driving license violations	103	76	86	75	50	72	119	105	140	142	112	102
Stand and wait rules and obligations violations	14,885	14,151	19,999	18,263	9756	12,558	25,901	16,610	17,583	18,439	15,975	14,075
Others	37,405	32,387	37,206	33,065	29,526	28,460	33,872	27,251	32,219	32,170	29,126	27,606
Violations type in 2020												
Radar	131,618	119,206	83,792	29,282	21,199	60,930	98,906	93,367	100,947	115,388	106,698	129,585
Passing traffic signal violations	5181	5761	5890	3725	4189	4726	4811	4952	4568	5027	4472	5104
Overtaking violations	1092	1266	513	290	307	609	1019	753	113	104	123	124
Driving license violations	122	144	139	58	56	49	52	71	61	69	84	57
Stand and wait rules and obligations violations	16,787	15,109	8704	3015	6043	15,657	18,810	14,884	14,227	16,178	13,913	13875
Others	27,473	27,188	17,866	8418	9627	17,486	25,479	22,747	25,252	26,039	26,231	25,115

Appendix 2. Total violations: violations in 2019 vs. violations in 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Averaged annual data from 2015 to 2019												
Average annual crashes (2015–2019)	19359	18398	21100	20152	22713	20583	18340	17423	19337	21885	20078	19582
Casualties												
Fatalities												
Driver	6.2	6.6	6.4	6	7.2	5.4	5.8	5.2	6.8	7	5.2	8.8
Passenger	5	3.2	3.6	4.8	4	6.6	3.8	1.4	3	3.6	6	4.4
Pedestrian	5.4	2.2	5	4.2	7	3.8	4	2.8	3.2	6.4	5.4	5.4
Total	16.6	12	15	15	18.2	15.8	13.6	9.4	13	17	16.6	18.6
Minor injuries	474	442	470	447	475	442	398	377	411	479	483	515
Serious injuries	55	47	49	42	46	53	51	44	37	54	52	53
Rate												
Fatality/1000 crash	0.84	0.66	0.71	0.74	0.81	0.75	0.73	0.55	0.67	0.77	0.83	0.95
Major injury/1000 crash	2.84	2.57	2.32	2.06	2.02	2.58	2.76	2.55	1.93	2.49	2.58	2.73
Minor injury/1000 crash	24.48	24.02	22.26	22.16	20.90	21.49	21.72	21.63	21.24	21.91	24.05	26.29
Traffic data in 2020												
Total crashes	17474	17081	11393	6028	7030	11194	13153	13596	14182	14690	14866	14943
Casualties												
Fatalities												
Driver	6	2	5	4	6	6	6	5	7	5	8	5
Passenger	1	2	1	0	1	3	1	4	3	5	0	6
Pedestrian	5	2	5	1	4	2	5	5	0	4	6	7
Total	12	6	11	5	11	11	12	14	10	14	14	18
Minor injuries	618	531	417	290	298	322	343	359	398	467	514	540
Serious injuries	51	64	48	30	24	31	49	32	52	57	70	64
Rate												
Fatality/1000 crash	0.69	0.35	0.97	0.83	1.56	0.98	0.91	1.03	0.71	0.95	0.94	1.20
Major injury/1000 crash	2.92	3.75	4.21	4.98	3.41	2.77	3.73	2.35	3.67	3.88	4.71	4.28
Minor injury/1000 crash	35.37	31.09	36.60	48.11	42.39	28.77	26.08	26.40	28.06	31.79	34.58	36.14