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Long Term, Pre, and Post Impacts of SARS-CoV-2 Pandemic on Road Traffic Crashes in the Case of Budapest, Hungary

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Abstract

SARS-CoV-2 is a pandemic that affects road traffic flaw and crashes globally. This study attempted to compare the situation of road traffic crashes in the city of Budapest before and after the SARS-CoV-2 pandemic to better understand its long-term percussive effects. The study considers 12208 road traffic crashes that registered between 20 May 2018 – 31 December 2021. The rate and severity of road traffic crashes during the SARS-CoV-2 pandemic examined by using a percentage frequency distribution and a severity index. This study depicted that most crashes reported during the normal daytime between15:01-18:00 (peak hour). The study indicated that during the SARS-CoV-2 pandemic the road traffic crashes were reduced by 20.15%. A rear-end collision was one of the most common type of catastrophes highly registered. Road users, particularly drivers, heavily endorsed crashes. Even though the proportion of road traffic crashes caused by alcohol consumption was modest (6%), the rate of alcohol consumption and its concentration increased slightly during the SARS-CoV-2 pandemic. At the same time the number of crashes caused by high-speed traffic maneuvers reduced. Improper interpretation of road traffic signs, road pavement condition and failure to respect proper sight distance were influential reasons of road traffic crashes among the top. Meanwhile, the distributional impact of careless driving in the aftermath of the SARS-CoV-2 pandemic causes a shift in rank. Therefore, this study proved that during SARS-CoV-2 pandemics road traffic crashes reduced, the rate and concentration of alcohol consumption increased, and careless driving was encouraged.

Keywords

alcohol consumption, road traffic crash, SARS-CoV-2 pandemic, severity index, speed limit

1 Introduction

SARS-CoV-2 is a pandemic that changes overall human activity by hindering urban mobility. The interruption of human mobility has its own reflection on road traffic crashes. Budapest is a city where vehicles and humans maneuver on a large scale. Due to the SARS-CoV-2 pandemic, Budapest was in a "state of emergency" between 11 March – 18 June 2020, which is a form of special legal order (Laribi et al., 2021). Even though lockdown and stay-at-home orders were issued in Budapest due to the pandemic, there was an exception for freight traffic crossing the border and passenger travel for business and economic reasons (Nieuwsbericht, 2021). This would ensure the continuity of road traffic crashes during the SARS-CoV-2 pandemic.

Different studies showed that the spread of the pandemic and the lockdown of transportation in urban areas had a positive outcome on the reduction of road traffic crashes. Concomitantly, studies also showed that road traffic crashes and their severity levels varied before and after the SARS-CoV-2 pandemic. The study by Yasin et al. (2021a) on the global effects of SARS-CoV-2 on road traffic crashes and its outcome indicated that traffic volume dropped sharply during the SARS-CoV-2 pandemic, which was associated with a significant drop in road traffic crashes globally and a reduction of road deaths in 32 out of 36 countries in April 2020 compared with April 2019 (Wegman and Katrakazas, 2021; Yasin et al., 2021a). The findings in USA, Alabama State revealed that even if traffic volumes and vehicle miles traveled had significantly dropped during the lockdown, there was an increase in the total number of crashes (Adanu et al., 2021). A study in the United Arab Emirates indicated that the incidence of hospitalized road traffic crash trauma patients significantly reduced by 33.5% during COVID-19 compared with the pre pandemic period (Yasin et al.,

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2021b). A steep generalized decrease in the number of road traffic accidents observed in March and April 2020 (Italian lockdown) as compared with the corresponding months of 2019 (more than 70% change) (Valent, 2022).

During the SARS-CoV-2 pandemic in Southern Florida, significant reductions observed in morning peak-hour (33.3%), alcohol/drug (58.0%), and pedestrian crashes (38.3%) were the leading causes of road traffic crashes (Lee and Abdel-Aty, 2021). Toronto data from January to June 2020 showed a decrease in road transportation, and a simultaneous decrease in road traffic collisions. However, reduced traffic volumes resulted in increased vehicle speeds, which can lead to an increase in the severity of pedestrian and cyclist injuries (Amberber et al., 2021). During the lockdown in Spain from March 16–April 26, 2020, the number of accidents per day fell by 74.3% in comparison with those in February 14–20 (reference week) and 76% in respect to the equivalent period in 2018–2019 (Saladié et al., 2020). In Saudi Arabia, there was a significant reduction in motor vehicle crashes with a significant increase in serious injuries during the lockdown period compared to 2019 (Hakeem et al., 2021). The study indicated that average speed increased by 11.3% during the SARS-CoV-2 period. However, the increase in average speed during the SARS-CoV-2 period has an insignificant relationship with crash severity. During the SARS-CoV-2 period, fatal crashes increased while total crashes decreased; severe crashes decreased with the total crashes (Islam et al., 2022).

In addition to that, different studies showed that the situation of road traffic crashes varied due to the presence of the SARS-CoV-2 pandemic. It showed that there was a reduction in road traffic crashes, while others indicated that there was still an augmentation of road traffic crashes and their outcomes during the SARS-CoV-2 pandemic. As a result, to have a clear understanding of the situation of road traffic crashes and their outcomes in Budapest city, this study tried to analyze the effect of the SARS-CoV-2 pandemic on road traffic crashes and its long-term effect.

Of the total motorized vehicles registered in Hungary that accounted for around 4.5 million; it expected that around 30% (1.4 million) of them found in Budapest city (CEIC DATA, 2020). Simultaneously, it was expected that around 2 million inhabitants lived in Budapest city (Worldometer, 2022; Yezhova, 2018). Since the number of people and vehicles was high in this city, the rate of road traffic crashes and SARS-CoV-2 pandemic effects were higher than in other cities in Hungary. For analysis purposes, this study considers a total of 3 years and 10 months of (20 May 2018 – 31 December 2021) road traffic crash data before and after the SARS-CoV-2 pandemic, collected by Hungary's government transport authority. In a specified period, around 12208 road traffic crashes registered in the city. To have clarity, the study considers road traffic crashes before the pandemic from 20 May 2018 to 10 March 2020 and during the pandemic from 11 March 2020 to 31 December 2021.

These studies used percentage frequency distribution to analyze the long-term effects of the SARS-CoV-2 pandemic. It is a display of data that indicates the percentage of observations for each data point. It is a commonly used method for expressing the relative frequency of variables (JOVE, 2022). For further visualization of the level of severity of road traffic crashes and their outcomes before and after the SARS-CoV-2 pandemic, the study used a severity index (SI). The accident severity index is the proportion of road traffic accidents that result from the road traffic crash (Iyanda, 2019; Li and Bai, 2008). This study used the Statistical Package for the Social Sciences (SPSS-20) tool, which used by various kinds of researchers for complex statistical data analysis (Alchemer, 2021). For data organization, the study used MS-excel.

Even though a different study undertaken on the SARS-CoV-2 pandemic and its impact on road traffic crashes, which shows reduction in numbers during lockdown. Still, the severity of the road traffic crashes, and the continuous tragedy of the situation is alarming. Most research done in this area did not consider the effect of the SARS-CoV-2 pandemic over a long-time interval but rather over a limited period like a lockdown, stay at home, etc. This study undertaken to understand the SARS-CoV-2 pandemic's long-term effects and future impact on road transportation and its percussive effects on road traffic crashes. In addition to the aforementioned research gap, no study was conducted to examine the effects of the SARS-CoV-2 pandemic on road traffic crashes in the city of Budapest. The aim of these studies was to analyze the long-term effects of the SARS-CoV-2 pandemic on road traffic crashes and the situation of road traffic crashes before and after the SARS-CoV-2 pandemic in the city of Budapest. At the end, this study would clearly define the situation of road traffic crashes in Budapest before and after the outbreak of the SARS-CoV-2 pandemic and its long-term effects.

2 Material and method

2.1 Data type, source and method of collection

This study used road traffic crash data collected by the Hungary government's Budapest Transportation Authorities as a secondary data source. To achieve significant re-

sults, the study used 3-year and 10-month road traffic crash data from 20 May 2018 – 31 December 2021). To indicate the effect of SARS-CoV-2 on road traffic crashes, the study tried to compare the conditions before and after the SARS-CoV-2 pandemic. The study used 12208 road traffic crash data. For clarity, the study considers 1-year and 11-month road traffic crash data before and after the occurrence of the SARS-CoV-2 pandemic. As a result, Budapest city road traffic crash data used to analyze the long-term effects of the SARS-CoV-2 pandemic on road traffic crashes and the situation of road traffic crashes before and after the SARS-CoV-2 pandemic. The study area selected because of the nature of the data, availability, and convenience of the data. In addition to that, no study conducted to examine the effects of the SARS-CoV-2 pandemic on road traffic crashes in the study area. For data management and analysis, the study used tools like Ms. Excel for data organization and a statistical package for social science (SPSS-20) for data analysis. Each variable and parameter coded according to data type and priority.

2.2 Variables definition

This study used different variables to analyze the frequency of road traffic crashes and their comparative effects before and after SARS-CoV-2. Although the study includes a road traffic accident (outcome) as a dependent variable. The independent variables were hourly distribution, collision type, light condition, crash causes, geometric formation, pavement surface, number of lanes, speed limit, weather condition, alcohol consumption, responsible body, and so on.

2.3 Method of analysis

The study used percentage frequency distribution to further investigate the occurrences and rates of road traffic crashes before and after SARS-CoV-2 pandemic. This study also used the severity index (SI) to analyze the severity level of road traffic crashes. For a detailed explanation and interpretation of the output, the study used inferential statistics. It also used descriptive statistics to summarize sample or data set characteristics such as frequency, because it helps to understand the features of a specific data set by giving short summaries of the sample and measures of the data.

2.3.1 Severity index

To analyze the severity level of road geometric formation that caused road traffic crashes and their outcomes, the study used the Severity Index (SI). Empirically, the crash severity index expressed as shown in Eq. (1) (Republic of Turkey, 2001):

$$\text{Severity Index (SI)} = \frac{\text{Number of injuries}}{\text{Total number of crash}} \text{ or } \frac{\text{Number of death}}{\text{Total number of crash}}. \quad (1)$$

3 Result and discussion

In this part of the study, this paper tried to discuss the output of the analysis in detail. It contains the road crash distribution and its frequency, as well as the comparative situation of road traffic crashes before and after the SARS-CoV-2 pandemic. At all, it brings a clear finding and its implication that shows the effects of the SARS-CoV-2 pandemic on road traffic crashes.

3.1 Road traffic crash frequency before and after SARS-CoV-2 pandemic in the city of Budapest

This part of the study deals with the frequency of road traffic crashes before and after the SARS-CoV-2 pandemic. Studies have found that the SARS-CoV-2 pandemic has an impact on the number of road traffic accidents. Table 1 shown below indicates how road traffic crashes varied before and after SARS-CoV-2 in the city of Budapest.

The negative sign in Table 1 above indicates the reduction in number (percent), while comparing before and after the impacts of the SARS-CoV-2 pandemic on road traffic crashes in the city of Budapest. It shows that during the SARS-CoV-2 pandemic, road traffic crashes intensely reduced. The comparative approach showed that road traffic crashes reduced by 20.15%, which accounted for 1368 road traffic crashes during SARS-CoV-2 from (20 May 2018 – 10 March 2020) at the time after SARS-CoV-2 from (11 March 2020 – 31 December 2021). This finding supports the study on the global impact of the COVID-19 pandemic on road traffic collisions done by Yasin et al. (2021b). Even though the conclusion of this study contradicts the finding of a study in the USA, Alabama State (Adanu et al., 2021).

3.2 Road traffic crashes and their outcome distribution before and after SARS-CoV-2 in the city of Budapest

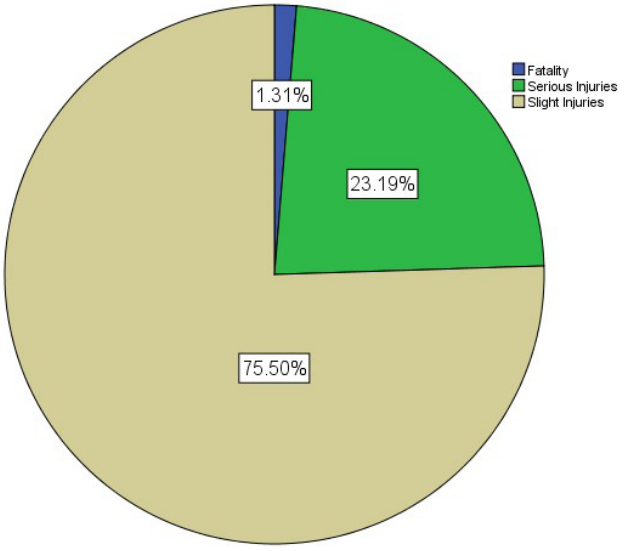
This part of the study deals with the distribution of road traffic crashes and their outcomes before and after

Table 1 Road traffic crash frequency before and after SARS-CoV-2 pandemic in the city of Budapest

Crash outcome	Before	After	Variation in number	Variation in percent
Fatalities	89	62	−27	−30.34
Serious injuries	1574	1259	−315	−20.01
Slight injuries	5125	4099	−1026	−20.02
Total	6788	5420	−1368	−20.15

SARS-CoV-2. Fig. 1 shown below indicates how road traffic crashes and their outcomes varied before and after SARS-CoV-2. Even if; there was a reduction in road traffic crashes due to SARS-CoV-2 pandemic in the city of Budapest; Fig. 1 below indicated that the distributional variation was small (insignificant). It indicated that SARS-CoV-2 pandemic has no as such significant effect on road traffic crash outcome distribution before and after SARS-CoV-2 pandemic in the city of Budapest.

The result in Fig. 1 indicated that even if the traffic flow and number of road traffic crashes reduced comparatively during the SARS-CoV-2 pandemic, the distribution of the outcomes was the same before and after the SARS-CoV-2 pandemic in in the city of Budapest. This demonstrates that reducing traffic flow and the number of road traffic accidents has no effect on the distribution of road traffic accidents in Budapest.



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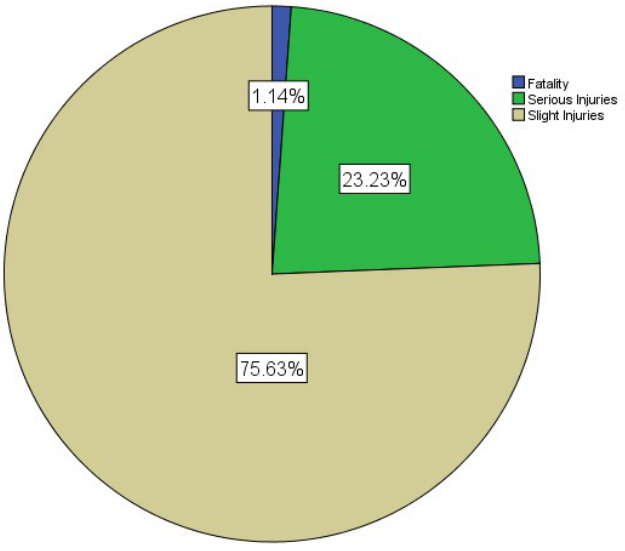

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Fig. 1 Road traffic crash distribution before and after SARS-CoV-2 pandemic in the city of Budapest; (a) between 20 May 2018 and 10 March 2020; (b) between 11 March 2020 and 31 December 2021)

3.3 Severity level of road traffic crashes and their outcome before and after SARS-CoV-2 pandemic in the city of Budapest

Unlike accident frequency, crash severity index provides the severity of each crash outcome registered during a specific time. Empirically, the crash severity index expressed in Eq. (1) above. Based on Eq. (1), this study tried to analyze the severity level of the road traffic crashes and their outcomes.

In Table 2 SIB is the Severity Index Before, SIA is the Severity Index After.

Table 2 indicates that, even if the number of road traffic crash outcomes reduced during SARS-CoV-2, comparatively before the pandemic, the severity level of road traffic crashes and their outcomes were the same as during the SARS-CoV-2 pandemic. In an unusual way, the severity level of road traffic crashes, fatality outcomes in the city of Budapest prior to SARS-CoV-2 was slightly higher than the occurrences after the SARS-CoV-2 pandemic. These findings show that reducing traffic flow and road traffic crashes had no effect on the severity level of road traffic crashes outcomes in the city of Budapest before and after the SARS-CoV-2 pandemic.

3.4 Collision type and road traffic crash outcome before and after SARS-CoV-2 in the city of Budapest

The collision of vehicles, vehicles with objects, vehicles with pedestrians etc. in transportation plays a significant role in the occurrence of road traffic accidents. Road traffic crashes are probable causes of death and injury for road users. As shown in Table 3, collisions between vehicles and pedestrians resulted in a high number of road traffic fatalities in Budapest following the SARS-CoV-2 pandemic. Furthermore, when compared to other types of collisions; collisions with vehicles, particularly rear-end collisions, played a significant role in the occurrences of road traffic crashes before and after the SARS-CoV-2 pandemic.

Even if the number of road traffic crashes and their causality reduced during SARS-CoV-2 in the city of Budapest, a high number of fatalities registered after the pandemic due to collisions with pedestrians compared with before SARS-CoV-2. The finding of this study contradicts to study done in Southern Florida that found pedestrian road crashes reduced during the SARS-CoV-2 pandemic (Lee and Abdel-Aty, 2021).

Table 2 Road traffic crash and its outcome before and after SARS-CoV-2 pandemic and its severity level in the city of Budapest

Road traffic crash outcome	Before	After	SIB-SARS-CoV-2	SIA-SARS-CoV-2 @ A
Fatalities	89	62	0.013	0.011
Serious injuries	1574	1259	0.232	0.232
Slight injuries	5125	4099	0.755	0.756
Total crash	6788	5420		

Table 3 Cross tabulation between collision type and road traffic crash outcome before and after SARS-CoV-2 pandemic in the city of Budapest

Road traffic crash outcome		Collision types								Total
		Rear end collision	Side impact collision	Side swipe collision	Head on collision	Collision with object	Pileup collision	Collision with pedestrian	Collision with animal	
Before SARS-CoV-2	Fatality	35	8	1	13	4	8	20	0	89
	Serious injury	671	130	5	163	35	136	434	0	1574
	Slight injury	2232	449	19	539	118	527	1237	4	5125
Total		2938	587	25	715	157	671	1691	4	6788
After SARS-CoV-2	Fatality	23	1	0	8	2	3	25	0	62
	Serious injury	563	102	4	131	36	51	369	3	1259
	Slight injury	1951	390	19	515	100	438	682	4	4099
Total		2537	493	23	654	138	492	1076	7	5420

3.5 Road traffic crash frequency based on visibility before and after SARS-CoV-2 pandemic in the city of Budapest

Road traffic crashes can be affected by the visibility and sight condition of the area. For further analysis, this study tried to consider the distribution of road traffic crashes before and after SARS-CoV-2 in the city of Budapest according to the visibility of the area. In both cases, high number of road traffic crashes registered during day light. Meanwhile, road traffic crashes reduced during nighttime comparatively after SARS-CoV-2 pandemic (Fig. 2). This shows road traffic crashes were highly prevalent during the SARS-CoV-2 pandemic at daytime. This could be due to a variety of factors such as alcohol consumption, for example.

3.6 Road traffic crash contributor rate before and after SARS-CoV-2 pandemic in the city of Budapest

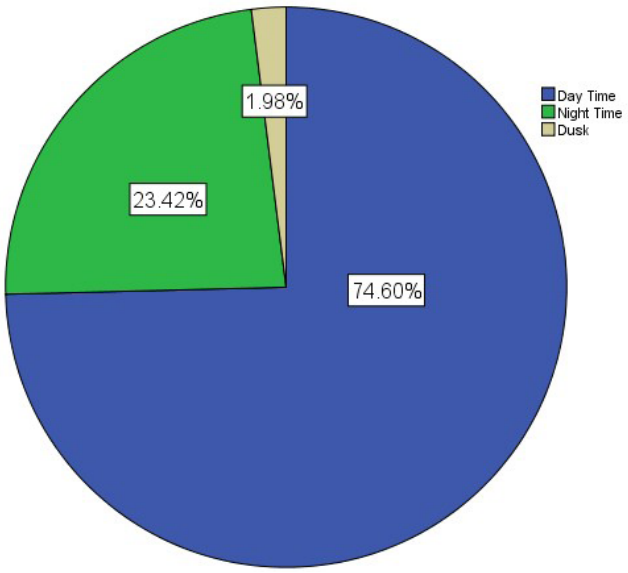
Fig. 3 shown below indicates how road, road users, vehicles, and the road environment affect the overall road transportation that causes road traffic crashes. Drivers were a major contributor to road traffic accidents during the SARS-CoV-2 Pandemic. Furthermore, other road users also played a significant role in the occurrences of road traffic crashes in Budapest during the SARS-CoV-2 Pandemic. As shown in Fig. 3, the contribution of drivers and pedestrians was high during the SARS-CoV-2 pandemic compared to before the pandemic. Even if there was a reduction in pedestrian contribution, more than 94% of road traffic crashes and their outcomes contributed by road users during the SARS-CoV-2 Pandemic in the city of Budapest. This result supports the finding in southern Florida made in 2021 (Lee and Abdel-Aty, 2021).

Even though road traffic crashes and traffic flow reduced during the pandemic, road users, particularly drivers, played a significant role in the situation. Compared to the level of contribution by road users before the SARS-CoV-2 pandemic in Budapest city, the level of contribution by road users was high during the pandemic.

3.7 Road traffic crash three-hr distribution before and after SARS-CoV-2 pandemic in the city of Budapest

Fig. 4 shown below indicates how road traffic crashes affected by the SARS-CoV-2 pandemic in the city of Budapest. As shown in Fig. 4, the maximum number of road traffic crashes registered between 15:01–18:00 (peak hour) both before and after the SARS-CoV-2 pandemic in the city. Based on the distribution of road traffic crashes at the peak hour, the percentage of road traffic crashes during the SARS-CoV-2 pandemic increased relatively. Moderately, the study shows there was a certain reduction in road traffic crashes during the morning session after the SARS-CoV-2 pandemic.

As a result, the occurrences of the SARS-CoV-2 pandemic have their own contribution to the hourly distribution of road traffic crashes. Even though there was some variation in the distribution of road traffic crashes, Fig. 4



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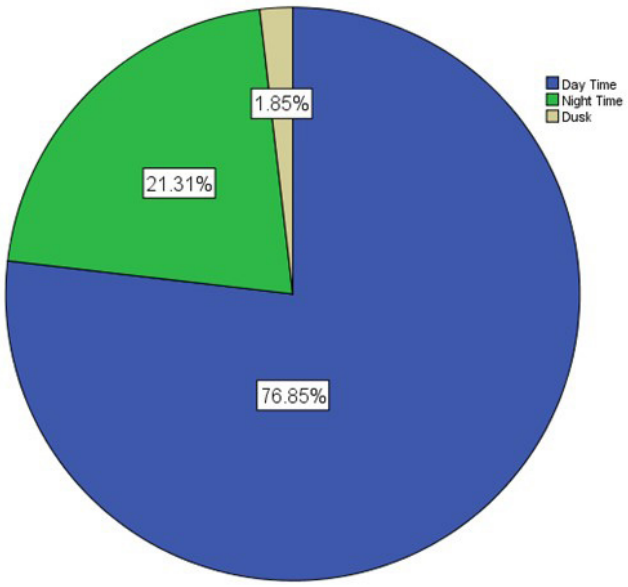


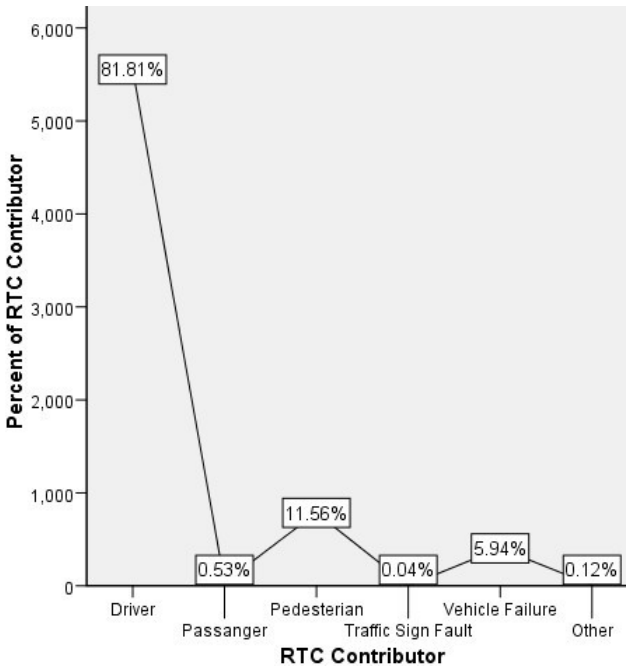
(b)

Fig. 2 Road traffic crash distribution and visibility; (a) before SARS-CoV-2 pandemic; (b) after SARS-CoV-2 pandemic in the city of Budapest

showed that the presence of the SARS-CoV-2 pandemic had no significant effect on generating a significant difference in hourly variation.

3.8 Road traffic crash and level of alcohol consumption before and after SARS-CoV-2 pandemic in the city of Budapest

Fig.5 indicated that the level of alcohol consumption before and after the SARS-CoV-2 pandemic in the city of Budapest city. Even if the proportion of road traffic crashes happening due to alcohol consumption was small



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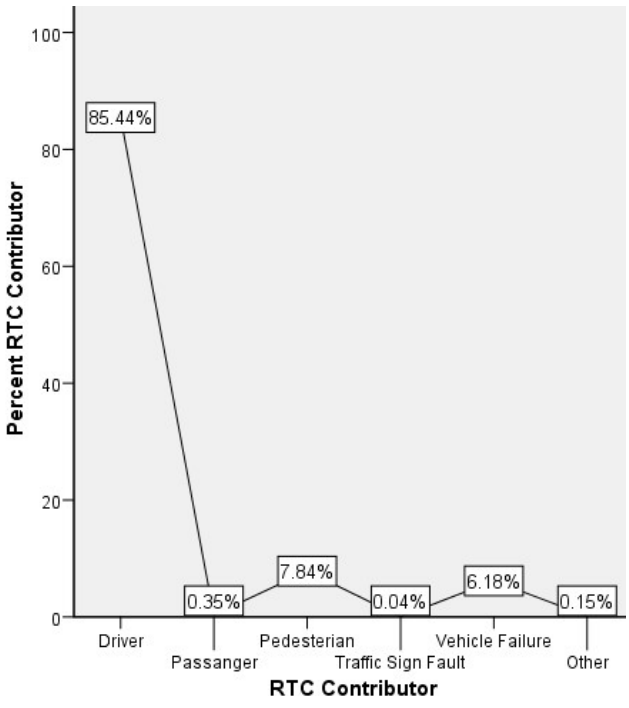
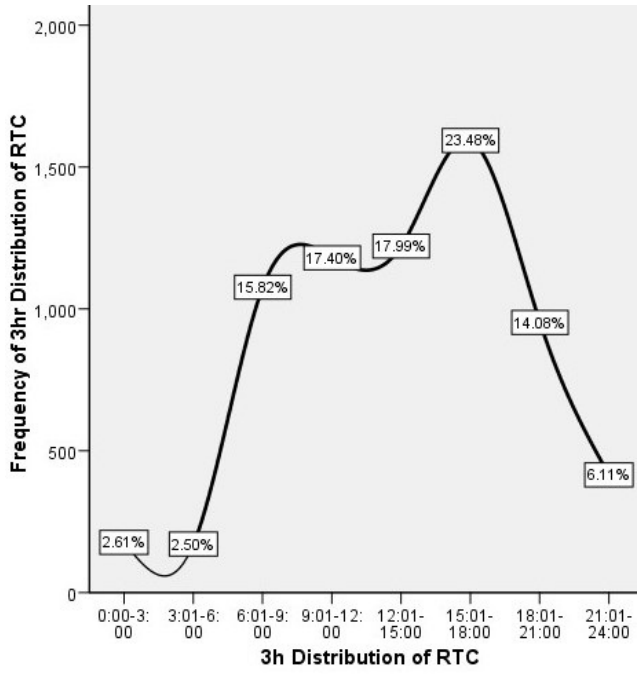


(b)

Fig. 3 Road traffic crash contributors; (a) before SARS-CoV-2 pandemic; (b) after SARS-CoV-2 pandemic in the city of Budapest

and accounted for less than 6% of total road crashes, the rate of alcohol consumption during the SARS-CoV-2 pandemic increased relative to road traffic crash causality before the SARS-CoV-2 pandemic in the city of Budapest. Fig. 5 depicts the total road traffic crash causality caused by alcohol consumption in the city of Budapest following



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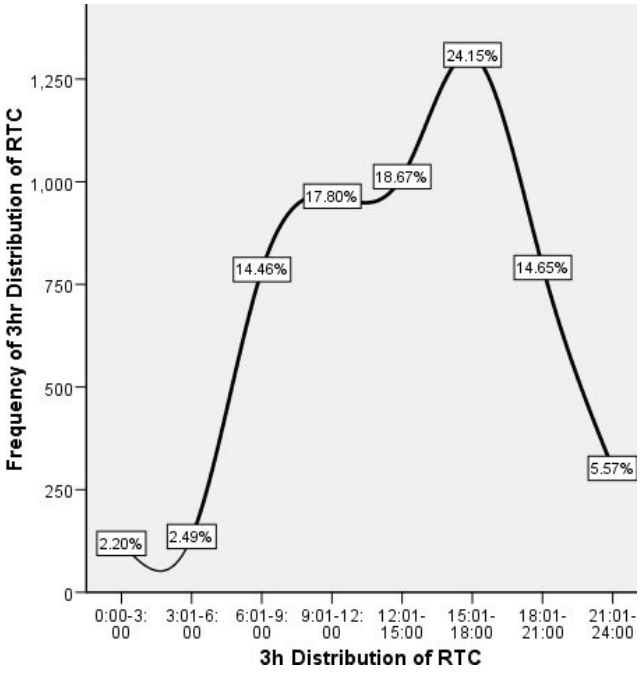

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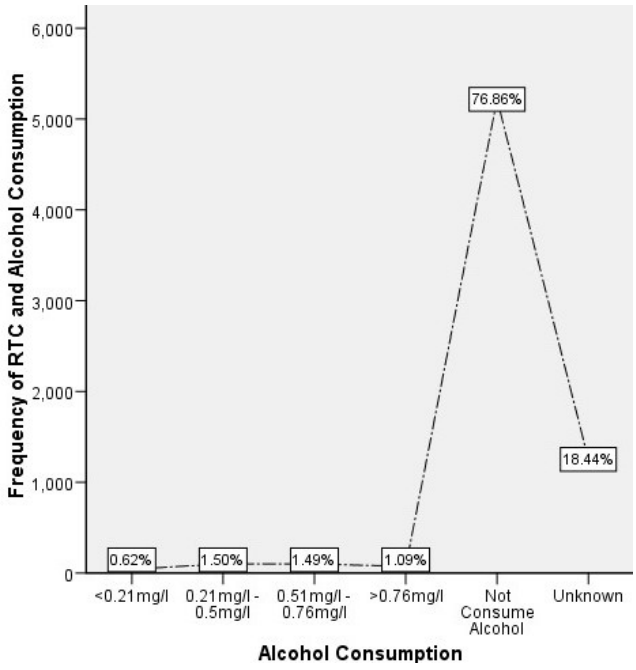
Fig. 4 Three-hour distribution of road traffic crash; (a) before SARS-CoV-2 pandemic; (b) after SARS-CoV-2 pandemic in the city of Budapest



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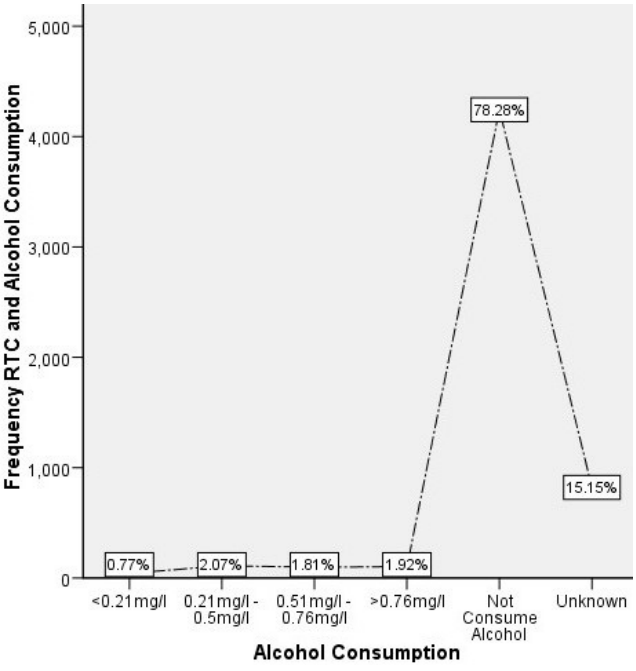


(b)

Fig. 5 Road traffic crash and alcohol consumption; (a) before SARS-CoV-2 pandemic; (b) after SARS-CoV-2 pandemic in the city of Budapest

the SARS-CoV-2 pandemic outbreak. According to this study, the level of road traffic crash causality due to alcohol consumption increased by 40% during the SARS-CoV-2 pandemic when compared to before the pandemic. This finding contradicts with a study done in Southern Florida that depicts alcohol/drug consumption that caused a road traffic crash reduced by 58% during the SARS-CoV-2 pandemic (Lee and Abdel-Aty, 2021).

As a result, the consumption of alcohol has its own contribution to the occurrence of road traffic crashes. This study also agreed that the outbreak of the SARS-CoV-2 pandemic forces the road user to drink alcohol, which

causes road traffic crashes. Even though there was variation in alcohol consumption, the high number of road traffic crashes both before and after the SARS-CoV-2 pandemic registered by none of the alcohol-consuming road users in the study area.

3.9 Visibility and alcohol consumption effect on road traffic crash before and after SARS-CoV-2 pandemic in the city of Budapest

Road users consume alcohol at any time of day or night for entertainment, medical purposes, or for other related purposes. Table 4 indicated how alcohol consumption and light conditions influenced the occurrences of road traffic crashes before and after the SARS-CoV-2 pandemic in the city of Budapest. It indicated that the situation of alcohol consumption and amounts were high during the SARS-CoV-2 pandemic comparatively. The impressive thing was that in both cases, high alcohol consumption that causes road traffic crashes registered during normal daytime light conditions.

As a result, the outbreak of the SARS-CoV-2 pandemic influences road traffic crashes by upsetting the consumption of alcohol and its amount when compared to before the SARS-CoV-2 pandemic in the city of Budapest. The disturbing issue was that people were consuming alcohol heavily during normal daylight conditions after the SARS-CoV-2 pandemic. This has its own implications for the occurrence of road traffic crashes during normal daylight hours with normal traffic flow.

3.10 Speed limit and road traffic crash before and after SARS-CoV-2 pandemic in the city of Budapest

Speed defines the level and severity of a road traffic crashes. A study indicated that speed is the deadliest cause of road traffic crashes (Transport Department of Government of Jharkhand, 2022; U.S. Department of Transportation, 2016; Pines, 2022). Fig. 6 shown indicates clearly how speed affected the situation of road traffic crashes before and after the SARS-CoV-2 pandemic. Even if different studies indicated that road traffic crashes and their outcomes were high during the SARS-CoV-2 pandemic due to the high speed (Islam et al., 2022), this study contradicts, road traffic crashes slightly decreases due to high-speed maneuvers of vehicles when compared before the SARS-CoV-2 pandemic in the city of Budapest. Even though, in both cases, before and after the SARS-CoV-2 pandemic in the city of Budapest, high number of road traffic crashes resulted with a normal speed that ranges from 25 km/h – 50 km/h allowed for vehicular maneuvers in urban traffic.

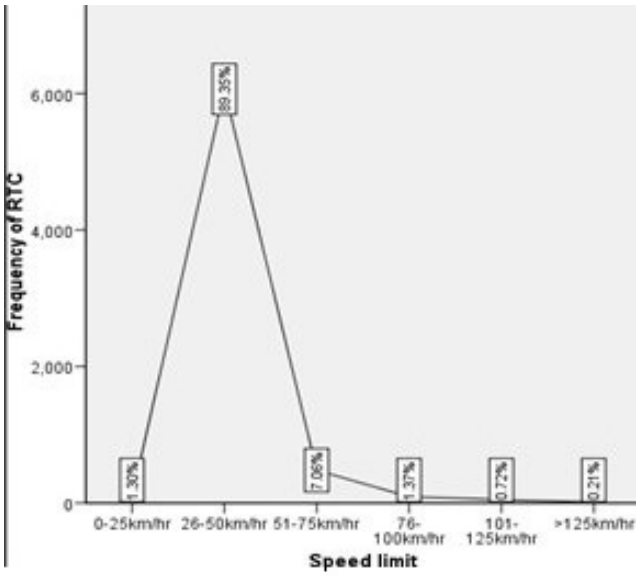
As a result, during the SARS-CoV-2 pandemic, the rate of road traffic crashes and their outcomes reduced with high-speed traffic maneuvers comparatively in the city of Budapest. This shows that even if road traffic flow was reduced due to lockdown and stay at home, that brought free flow of traffic, the situation in the city of Budapest was quite different from other studies that showed the rate of road traffic crashes happening due to high-speed traffic maneuvers was slightly decreased during the SARS-CoV-2 pandemic.

3.11 Primary reason of road traffic crashes before and after SARS-CoV-2 pandemic in the city of Budapest

From total road traffic crashes registered before and after the SARS-CoV-2 pandemic in the city of Budapest, the following top ten factors causing road traffic crashes discussed in Table 5. As indicated below, a high number of road traffic crashes resulted due to improper use of road traffic signs in both cases. Even if the rate of individual factors plays a key role in the occurrences of road traffic crashes in the city of Budapest, the distribution of those factors indicated

Table 4 Cross tabulation of light condition and alcohol consumption before and after SARS-CoV-2 pandemic on road traffic crashes in the city of Budapest

Visibility	Alcohol consumption before SARS-CoV-2 in the city of Budapest						Total
	< 0.21mg/l	0.21mg/l – 0.5 mg/l	0.51mg/l – 0.76 mg/l	> 0.76 mg/l	No alcohol consumption	Unknown	
Daytime	15	47	36	35	4028	847	5008
Nighttime	26	55	64	38	1081	381	1645
Dusk	1	0	1	1	108	24	135
Total	42	102	101	74	5217	1252	6788
Visibility	Alcohol consumption after SARS-CoV-2 in the city of Budapest						Total
	< 0.21mg/l	0.21mg/l – 0.5 mg/l	0.51mg/l – 0.76 mg/l	> 0.76 mg/l	No alcohol consumption	Unknown	
Daytime	24	46	37	54	3429	575	4165
Nighttime	17	64	59	48	741	226	1155
Dusk	1	2	2	2	73	20	100
Total	42	112	98	104	4243	821	5420



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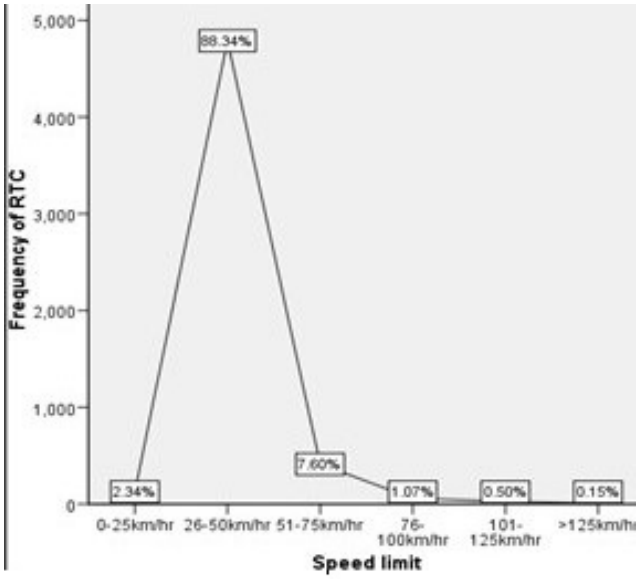

(b)

Fig. 6 Road traffic crash and speed limit; (a) before SARS-CoV-2 pandemic; (b) after SARS-CoV-2 pandemic in the city of Budapest

that there was reduction. Meanwhile, the distribution and impact of careless driving after the SARS-CoV-2 pandemic brings a change in rank when compared to the cause before the SARS-CoV-2 pandemic. Not only has the rank changed, the contribution of careless driving to road traffic crashes after the SARS-CoV-2 pandemic has slightly increased. This shows that during the SARS-CoV-2 pandemic, the level of careless driving contributed to road traffic crashes was high when compared to irregular lane change.

As a result, road traffic crashes in the city of Budapest, both before and after the SARS-CoV-2 pandemic were primarily caused by improper use of road traffic signs, road pavement condition, failure to respect proper sight distance, etc.

4 Conclusion and recommendation

SARS-CoV-2 is a pandemic that resulted an enormous loss of life since March 2018. Due to this pandemic, road traffic crashes frequency altered. This study tried to visualize the long-term impact of this pandemic on road traffic crashes in the city of Budapest. In this study, the rate of road traffic crashes reduced during this pandemic. Even though in terms of collusion type, visibility, hourly distribution, contributor, alcohol consumption, speed limit, and primary cause, the distribution of road traffic crashes in the study area was comparable before and after the SARS-CoV-2 pandemic. High number of road traffic crashes mostly reported during the daytime between 15:01–18:00 (peak hour) in both cases. Road users, particularly drivers, play a significant role in the occurrence of traffic accidents. Due to maximum speed, the rate of road traffic crashes and their outcomes were less during the SARS-CoV-2 pandemic in the city of Budapest. In line with the above justification, the rate of distribution of careless driving brings a rank change from the top ten reasons for road traffic crashes that happened during the pandemic comparatively. The rate of alcohol consumption and its level of concentration were high during the pandemic that preceded to the occurrence of road traffic crashes. Surprisingly, most crashes associated with alcohol consumption during the SARS-CoV-2 pandemic observed during normal daytime light condition. Finally, the findings of this study support and contradicted other studies related to road traffic crashes and the SARS-CoV-2 pandemic. As a result, this study recommends that it needs further investigation to recognize the long-term effect of the SARS-CoV-2 pandemic effects on road traffic crashes and their outcome.

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Table 5 Factors that caused road traffic crashes before and after SARS-CoV-2 pandemic in the city of Budapest

Before SARS-CoV-2 pandemic			After SARS-CoV-2 pandemic		
Primary reason	Frequency	Percentage (%)	Primary reason	Frequency	Percentage (%)
Overloading	179	2.6	Overloading	181	3.3
Violation of right turn Rule	281	4.1	Violation of right turn rule	223	4.1
Careless driving	321	4.7	Irregular lane change	242	4.5
Irregular lane change	339	5.0	Careless driving	268	4.9
Traffic signal negligence	384	5.7	Traffic signal negligence	323	6.0
Violation of left turn rule	522	7.7	Violation of left Turn Rule	444	8.2
Non-priority for pedestrian	647	9.5	Non-priority for pedestrian	462	8.5
Stopping sight distance	763	11.2	Stopping sight distance	586	10.8
Road pavement condition	767	11.3	Road pavement condition	659	12.2
Improper use of road sign	1158	17.1	Improper use of road sign	872	16.1

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