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Abstract

COVID-19 pandemic has quickly propagated all around the world and exerted significant effect on cities and traffic mobility. In this article, traffic data from various sources are analyzed to determine the changes of traffic mobility during lockdown in Moscow. The data of State Road Safety Inspectorate (GIBDD) were analyzed reflecting road traffic injuries on Moscow roads during lockdown. Despite the fact that in April 2020 there were significantly fewer vehicles and people on the roads than in 2019, the number of people killed on roadways was 33% higher than in the previous year. Moreover, in April 2020, the traffic-related mortality rate was 10%, which was by 7.2 p.p. higher than in 2019.

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Peer-review under responsibility of the scientific committee of the Living and Walking in Cities

Keywords: Road traffic accidents; Road traffic injuries; Road traffic safety; Traffic mobility; COVID-19

1. Introduction

Introduction of restrictions for movements and social distancing are an important tool to prevent propagation of COVID-19. In this work, the authors studied the data of traffic complex, determined the decrease in the number of vehicles on the roads and the increase in speeds. The data of road traffic injuries reflected the influence of the number of vehicles and their speed on the number of road traffic accidents, the number of people injured and killed.

As a result of the introduced measures of social distancing, the demand for trips decreased, many countries had already witnessed obvious drop of road traffic (significant decrease in loads and air pollution), as well as passenger traffic in public transport (often resulting in less frequent transportations) (Carrington, 2020). One of the consequences of social distancing, i.e. decreased interactions between people aiming at hindering of the virus propagation, was...
significant decrease in the number of city trips. For instance, restrictions of public transport in Great Britain resulted in decrease in the number of trips by subway in London by 95%. In addition, people can avoid public transport, since it is considered as a center of viruses and a place, where contact with other passengers can hardly be avoided. Even after removal of the restrictions people will use public transport less frequently (De Vos, 2020).

2. Main text

Decrease in the number of vehicles on the roads, the number of traffic jams, and simultaneous increase in the speeds during lockdown resulted in the fact that the number of road traffic accidents and people injured in the road traffic accidents in Moscow decreased, and, at the same time, the number of people killed on the roads and the mortality rate increased.

There have been initial evidences that the COVID-19 pandemic could be suppressed by isolation and social distancing (Atalan, 2020). In Moscow the lockdown was announced, which lasted from March 30 to June

On March 30, the first day of lockdown in Moscow, the number of vehicles on the roads decreased by 31%; in Tuesday, March 31, the decrease was already 46% in comparison with the same day in 2019 (Center of Traffic Organization at the Moscow Government, 2020). Average decrease in the number of vehicles in weekdays of April was 40%. Starting from May 12, the number of vehicles on the roads of Moscow started to increase in comparison with April–early May 2020. On May 12, the introduced restrictions were relaxed in Moscow. In the second half of May, the average decrease was 26% in comparison with the similar period of the previous year (Fig.1).

![Fig. 1. Dynamics of daily number of vehicles on the roads of Moscow in 2019 and 2020](image_url)

In June, the number of vehicles on the roads of Moscow gradually returned to the level of 2019. On June 9, the lockdown in Moscow was cancelled. And already on June 10, the number of vehicles exceeded the level of the previous year by 3%.

Let us consider average daily speed on the roads of Moscow in 2019 and 2020, that is, the average speed from 6:00 to 23:59. Due to decrease in the number of vehicles on the roads and absence of traffic jams, peculiar for Moscow, starting from March 20, the speeds were increasing. On March 20, it was 10% higher in comparison with the similar day in 2019. Starting from March 21, 2020, all colleges and institutions of supplemental education were closed.
Sharp increase of average daily speed took place on Saturday, March 28, the first nonworking day, it was 32%. On March 30, the first lockdown day in Moscow, the speeds on the roads increased by 48% in comparison with the similar day of the previous year (Fig.2).

Let us consider the indicators of road traffic injuries in Moscow before and during the lockdown. According to the data of the Russian Road Inspectorate, the number of road traffic accidents decreased in 2016 and 2017 (Russian Road Inspectorate, 2020). In 2016, the number of road traffic accidents was by 13% lower than in 2015, in 2017– by 2% lower than in 2016. Starting from 2018, the number of road traffic accidents started to increase. In 2018, the number of road traffic accidents was by 3% higher than in 2017, and in 2019, the increase in the number of road traffic accidents with regard to the year 2018 was 2% (Fig.3).

From 2015 to 2019, the number of people killed on the roads gradually decreased. In 2016, the number of people killed on the roads of Moscow was by 17% lower than in the previous year, this was the most significant decrease for overall considered period. In 2017, the number of people killed on the roads decreased by 12% in comparison with 2016. In 2018, the decrease was 6%, in 2019 – 5% (Fig.4).
A sharp increase of average daily speed took place on Saturday, March 28, the first non-working day; it was 32%. On March 30, the first lockdown day in Moscow, the speeds on the roads increased by 48% in comparison with the similar day of the previous year (Fig. 2).

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From 2015 to 2019, the mortality rate, i.e. the number of people killed in road traffic accidents with regard to all victims, was decreasing. In 2016, the mortality rate decreased by 0.2 p.p. in comparison with 2015. In 2017, the decrease was by 0.6 p.p.; in 2018 and 2019, the mortality rate decreased by 0.3 p.p. (Fig. 6).

Social risk is the number of people killed in road traffic accidents per 100,000 inhabitants. From 2015 to 2019, the social risk in Moscow was decreasing. The most significant decrease was recorded in 2016, the social risk decreased by 18% in comparison with 2015. In 2017, the decrease was 12%, in 2018 and 2019 – 7 and 6%, respectively (Fig. 7).
On March 30, 2020 (Monday), the lockdown was introduced in Moscow, which was active to June 9 (Tuesday), i.e., it lasted for ten complete weeks. For 2019, the comparable dates were from April 1 (Monday) to June 11 (Tuesday).

In 2019, there occurred 9,296 road traffic accidents in Moscow, in which 443 people were killed, 10,723 people were injured, the mortality rate was 4.0%. For the first half-year of 2019, there occurred 4,137 road traffic accidents, 189 people were killed, 4,810 people were injured, the mortality rate was 3.8%; and from April 1 (Monday) to June 11 (Tuesday), 2019, there occurred 1,690 road traffic accidents, 67 people were killed, 1,920 people were injured, the mortality rate was 3.4% (Fig.8).

In Moscow from January to June 2020, there occurred 3,299 road traffic accidents, 159 people were killed, 3,743 people were injured, the mortality rate was 4.1%. In the first half-year period of 2020, there occurred by 838 road traffic accidents less than for the similar period of 2019, the number of people killed was lower by 30 people, the number of people injured was lower by 1,067 people, the mortality rate increased from 3.8% to 4.1%. During the lockdown from March 30 (Monday) to June 9 (Tuesday), there occurred 716 road traffic accidents, 64 people were killed, 786 people were injured, the mortality rate was 7.5%. During the lockdown, there occurred by 974 road traffic accidents less than for the similar period of 2019, the number of people killed was by three people lower, the number...
of injured - by 1,134 people, the mortality rate increased more than twice from 3.4% to 7.5% (Fig.9).

Therefore, during the lockdown there was significant decrease in the number of road traffic accidents (by 58%) and the number of people injured (by 59%), the number of people killed decreased insignificantly (by 4%), and the mortality rate increased more than two times, from 3.4% to 7.5%. Hence, during the pandemic the severity of consequences of road traffic accidents in Moscow increased more than twice. The number of people killed and the mortality rate can be even higher, since a person is included in the statistics of killed for June 2020, if he dies in 30 days after the accident.

Let us consider the monthly statistics of road traffic accidents for the first half-year periods of 2019 and 2020 (Fig. 10).

In January 2020, the number of road traffic accidents was by 23% higher than in 2019 (642 road traffic accidents in 2019 against 787 in 2020). In February 2020, the number of road traffic accidents was higher by 15% (644 road traffic accidents in 2019 against 740 in 2020). From March 2020, the number of road traffic accidents was lower than in the previous year. The most significant drop was detected from April to June. In April, the decrease in the number of road traffic accidents was 64% (647 road traffic accidents in 2019 against 234 in 2020). In May, the number of road traffic accidents in comparison with the previous year decreased by 58% (751 road traffic accidents in 2019 against 316 in 2020). In June 2020, the number of road traffic accidents decreased by 29% (776 road traffic accidents in 2019 against 552 in 2020). The decrease in the number of road traffic accidents was stipulated by the lockdown, the decrease in the number of vehicles on the roads. In 2019, gradual increase in the number of road traffic accidents was observed from April to June. In 2020, this trend remained.
In January 2020, on the roads of Moscow the number of people killed was by ten people lower than in the previous year (34 people killed in 2019 against 24 people killed in 2020). In February 2020, the number of people killed remained nearly the same (31 people killed in 2019 against 32 people killed in 2020). In March, the decrease was 31% (36 people killed in 2019 against 25 people killed in 2020) (Fig. 11).

The trends of changes of the number of people injured differ significantly from those of the number of road traffic accidents. If during the lockdown the number of road traffic accidents radically decreased, then the number of people killed decreased not so significantly, and in April 2020, it even increased.

In April 2020, the number of vehicles on the roads of Moscow was nearly two times less than in 2019, in May — by 26% less. The average speed increase on the roads on weekdays of April was 64%. According to the data of lockdown index by Yandex, from March 29 to May 12, 2020 the number of people in the streets was significantly lower than in February and March of the same year. Despite this fact, on the roads of Moscow in April 2020, the number of people killed was by seven people more (33%) than in the previous year (21 people killed in 2019 against 28 people killed in 2020). In May, the decrease in comparison with the previous year was 16%, the number of people killed was by five people less than in 2019 (31 people killed in 2019 against 26 people killed in 2020). In June, there was a record decrease in the number of people killed on the roads, the decrease was 33%, the number of people killed was by twelve people less than in June 2019 (36 people killed in 2019 against 24 people killed in 2020).

The trends of the number of people injured coincide with those of the number of road traffic accidents. In January and February, the number of people injured was higher than in the previous year (by 25% and 10%, respectively). Starting from March, the number of people injured began to decrease: by 6% in March. In April 2020, the number of people injured was by 66% lower than in the previous year (732 people killed in 2019 against 251 people injured in 2020). In May, the decrease was 58% (840 people injured in 2019 against 357 people injured in 2020). In June 2020, on the roads of Moscow the number of people injured was by 35% lower than in the previous year (924 people injured in 2019 against 601 people injured in 2020).

The trends of the number of people killed in road traffic accidents differ significantly from the trends of the number of people injured. If during the lockdown the number of road traffic accidents radically decreased, then the number of people killed decreased not so significantly, and in April 2020, it even increased.

In April 2020, the number of vehicles on the roads of Moscow was nearly two times less than in 2019, in May — by 26% less. The average speed increase on the roads on weekdays of April was 64%. According to the data of lockdown index by Yandex, from March 29 to May 12, 2020 the number of people in the streets was significantly lower than in February and March of the same year. Despite this fact, on the roads of Moscow in April 2020, the number of people killed was by seven people more (33%) than in the previous year (21 people killed in 2019 against 28 people killed in 2020). In May, the decrease in comparison with the previous year was 16%, the number of people killed was by five people less than in 2019 (31 people killed in 2019 against 26 people killed in 2020). In June, there was a record decrease in the number of people killed on the roads, the decrease was 33%, the number of people killed was by twelve people less than in June 2019 (36 people killed in 2019 against 24 people killed in 2020).
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As in the case with the number of road traffic accidents in 2019, the gradual increase in the number of people injured was observed from April to June. In 2020, this trend remained.

If from January to March the mortality rate was lower than in 2019 (by 1.9 p.p. in January, by 0.3 p.p. in February, and by 1.0 p.p. in March), then from April the mortality rate was sharply increasing. In April 2020, the mortality rate was 10%, which was by 7.2 p.p. higher than in 2019. In May, the mortality rate increased from 3.6% in 2019 to 6.8% in 2020. In June 2020, the mortality rate was 3.9%, in 2019, it was 3.8%. (Fig. 13).

Conclusion

In the paper the descriptive analysis of the traffic and Road Traffic Injuries data is presented. During the lockdown in Moscow (from March 30 to June 9, 2020), the most noticeable changes of traffic mobility and city activity were observed in April. The number of vehicles on the roads decreased significantly and the speed sharply increased. The number of trips by public transport decreased; even at the end of June it was by 32% lower than usual. During the lockdown, especially in April, there were few people in the Moscow streets. Nevertheless, mortality in the fourth week of April reached 14.3%, i.e. it was by 8.4 times higher than in 2019. In April 2020, seven people more were killed on the roads of Moscow than a year earlier.

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