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Wegman, Fred; Katrakazas, Christos

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Research Article

# Did the COVID-19 pandemic influence traffic fatalities in 2020? A presentation of first findings

Fred Wegman [a,*], Christos Katrakazas [b]

[a] Delft University of Technology, the Netherlands
[b] National Technical University of Athens, Greece

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ABSTRACT

The year 2020 was an extraordinary year due to the COVID-19 pandemic. This pandemic resulted in lockdowns and confinements globally and emptier streets and roads. Traffic patterns and traffic composition (modal split) changed considerably during the pandemic and as a consequence the number of people killed and injured in road crashes. The aim of this research is to present the number of road fatalities and the fatality rates (fatalities per kilometer driven) in 2020 and to compare these numbers and rates with the previous period (2017–2019), a baseline. An online questionnaire was distributed among the forty countries that are members of the International Safety Data and Analysis Group (IRTAD) in the International Transport Forum and 24 were in a position to submit the requested information before the 1st of June 2021. The questionnaire requested information on the monthly number of fatalities on a national level for four years, (2017–2020) and on kilometres driven. The number of fatalities in 2020 was 17.3% lower in the 24 participating countries compared with the baseline period and the reduction is almost seven times higher than annually in these countries in the period 2010–2019. The reduction took place in spring 2020 and not so much in the remainder of the year. The highest reduction were measured among young (0–17) and elderly people (75 and older), with public transport and on motorways. With the exception of one country, reductions in fatalities have been measured in all countries, however we observe major differences between countries. Regarding fatality rates (fatalities per vehicle kilometer travelled), we also observe major differences between countries and not a stable pattern over 2020 and a remarkable increase in April 2020, the month with the largest fatality reduction. Countries with severe COVID-19 restrictions do not necessarily demonstrate the greatest reductions in road fatalities. It is recommended to carry our further analysis to find explanations for the results and for the differences between the countries.

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## 1. Introduction

The COVID-19 pandemic has interrupted global everyday life since the first cases occurred in Wuhan, China in December 2019, followed by many countries since early 2020. In March 2020, the World Health Organization (WHO) declared COVID-19 a world-wide pandemic. Thenceforth, (strict) restrictions on (non-essential) movements were imposed globally to counter the rapid spread of the virus. The various strategies such as lockdowns and confinements that were taken by the majority of countries, had a great impact on mobility and road safety as well.

In order to quantify the impact of the pandemic on road safety, several factors need to be considered. The number of road casualties is the product of three dimensions [1,2]: exposure to risk, crash risk (number of crashes per exposure) and injury risk (number of people killed or injured per crash). All three dimensions may have changed during the COVID-pandemic. If only fatal crashes and fatalities are considered, we have just two dimensions: exposure to risk and fatality rate (fatalities per exposure, for example the number of kilometres travelled). In other words: the number of fatalities is the number of kilometres travelled times the number of fatalities per kilometer driven. For the pandemic impacts: is a change in the number of road fatalities a result of less kilometres travelled, or from a change in the number of fatalities per kilometer travelled (‘risk’)?

With lockdowns and confinements imposed globally, streets were significantly emptier and the question is whether the absolute number of crashes was substantially lower. However, a comparison between previous years and 2020 needs to be performed in order to identify the change in absolute numbers, but also to consider the reduction in exposure to risk and changes in crask risks and injury risks. Traffic patterns and traffic composition (modal split) changed considerably during

* Corresponding author.
*E-mail address:* f.c.m.wegman@tudelft.nl (F. Wegman).
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the pandemic. To give a few examples: school lockdowns in many countries resulted in no transportation of vulnerable schoolchildren, working at home resulted in reduced commuting, and older persons may have reduced their traffic participation due to the higher infection fatality ratio due to the corona-virus for this age group. We can also think about people having abandoned public transport (social distancing!) resulting in less walking and cycling to and from busstops and metro/train stations. Closure of shops resulted in an increase of online shopping and an increase of delivery vehicles. An economic downturn, as experienced in the COVID-19 pandemic, is often associated with fewer (long haul) heavy goods vehicles on the roads and with less driving by young drivers [3]. It is also possible that increased levels of stress (due to the pandemic and/or economic recession) may have affected driving behaviour and crash risks. Similarly, drivers were foreseen to increase speeds [4] and hence speed-related crashes due to less traffic on the roads were also expected to increase [5]. Increased levels of impaired driving (alcohol, drugs) could have resulted in more crashes and casualties. The ban on night time activities (curfews during certain hours of the day) may have impacted road travel and, consequently, road crashes.

In their 'Short Communication', Vingilis and her colleagues from Canada [5] presented three groups of interactions when describing the impact of COVID-19 on road safety: (i) economic downturn and traffic safety, (ii) high risk and/or vulnerable road users, and (iii) situation factors: fuel price, health of citizens due to transportation barriers. In order to draw conclusions on road safety, a holistic perspective taking account of safety indicator trends and exposure changes in relation with pandemic-related governmental responses needs to be established. It is crucial to understand whether and how the three dimensions (exposure, crask risk, injury risk) have changed in 2020.

The COVID-19 pandemic hit countries with a different intensity and at different moments, and it is reasonable to expect that countries responded differently to reduce the number of COVID-19 cases. We see spikes in corona graphs, also known as 'coronawaves', with a first one in March 2020, the second late 2020, et cetera. For example, countries in the south of Europe (Italy, Spain, Portugal) experienced an intense wave with severe restrictions in early spring, while in the same period the responses in Nordic countries seem to be less severe and more mild. The idea of waves implies that we cannot use mean values over the year 2020, but have to investigate by week or month to understand developments.

In order to identify the impact of COVID-19 on road safety, a literature review was conducted using databases such as Scopus and Google Scholar. The search was carried out using the Boolean terms {"COVID-19" or "Pandemic" and "driving behaviour" or "driving behaviour" or "road safety"}. The search yielded 150 documents which were screened per title and abstract.It became evident that the relationship between COVID-19 and travel behaviour and road safety has received extensive attention from the beginning of the pandemic and this has continued.

From the bulk of retrieved documents, it was observed that the majority of studies regarding the effect of COVID-19 on transportation are concerned with the changes in travel behaviour and choice of travel mode [6–10]. Only few of the retrieved studies were concerned with the road safety effects of the pandemic and these were chosen for further review. The retrieved documents can be divided in three categories: (i) focusing on epidemiological models and analysing road safety as yet another health consequence of the pandemic, (ii) providing descriptive evidence of the effect of the pandemic and (iii) studies utilizing (advanced) statistical tools to investigate crucial indicators and explain the impact of COVID-19 on injuries, road crashes and driving behaviour.

Descriptive results are presented in Saladie et al. [11] who looked at the reduction in road crashes in the province of Tarragona by comparing frequency of crashes and checking statistical significance using a chi-square test on weekdays and weekends as well as on different road types. A large reduction in crashes (74% compared with February of 2020; 76% compared with 2019) was observed and was associated with the overall reduction of traffic volumes. Likewise, Katrakazas et al. [12] provided descriptive evidence from Greece and Saudi Arabia with regards to COVID-19 and driving behaviour. More specifically, it was observed that when a lockdown was imposed, a slight increase of 6–11% in average driving speed was observed, while harsh accelerations and harsh brakings also were more frequent (up to 12%) when compared with normal situations. The results presented in the aforementioned studies were purely descriptive, without significant statistical analyses.

Shilling and Waetjen [13] reported that road collisions and especially injury and fatality collisions on state highways and rural roads in California were reduced by half as a result of the so-called shelter in place order (SIPO); leave home only for essential trips/destinations.

To date, only a few studies have conducted statistical analyses with regards to the effect of COVID-19 on driving behaviour, using both simple as well as more sophisticated models. These studies can be further distinguished between simple modelling and hypotheses testing, and time-series regression modelling of the effect of the pandemic.

Prasetijo et al. [14] for example, used a simple linear fit speed model and underlined the importance of road design to incorporate sudden changes in traffic volumes with regards to safety. On the same principle, using crowdsourced cycling data from July 2019 to March 2020, Hong & Mcarthur [15] employed a simple linear regression model, but mixed results with regards to the safety of cyclists are presented.

A more sophisticated approach is presented in [16], where two-sample *t*-test was utilized to identify differences in road crashes before and after a lockdown in the USA, as well as ARIMA modelling for auto-correlation and trend analysis. The reduction of road crashes with regards to non-serious or no injuries was found significant, but more complex analyses would shed light on the influencing factors. Similarly, between and within year *t*-tests, as well as segmented Poisson Regression was utilized by Doucette [17] for the analysis of vehicle miles travelled and road crashes. It was found that despite a reduction in mean daily crash counts, the rate of road crashes was actually higher.

Stavrinos et al. [18], using multi-level modelling, demonstrated that after COVID-19 the number of days driving a vehicle per week in Greece decreased by 37%, while vehicle miles driven dropped by 35%. Nevertheless, the data utilized was concerned with self-reported driving behaviour and consequently was subject to bias. Similar results were presented by Roe et al. [19] who used within-subjects general linear models on a sample of elderly drivers. It was demonstrated that driving days as well as frequency of speeding had reduced.

A full time-series modelling approach was employed by Inada et al. [20]. Using a seasonal ARIMA model and data from January to May 2020, the authors concluded that the lockdown was the crucial factor for speed-related traffic violations, which consequently led to an increase of fatal road crashes. It was further demonstrated that speeding had increased by 52% in March 2020 compared with March 2019. Likewise, Katrakazas et al. [21] using seasonal ARIMA models, concluded that speeds had increased by an average of 2.3 km/h compared with the forecasted evolution of 2020, and this speed increase is associated with more harsh braking. Simultaneously, road crashes in Greece were reduced by 49% during the months at the height of the COVID-19 pandemic. Finally, Gupta et al. [22] fitting generalized linear models found that stringent law enforcement and appropriate compliance from the road users could increase road safety by reducing the crash/fatality ratio by up to 1.86%.

As the above studies illustrate, studies primarily focus on the impact of the pandemic on transportation and road safety in a specific country and within a limited scope of either travel behaviour or safety. The only exception to date can be found in Barbieri et al. [23] who conducted a survey in Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa and the United States to investigate the changes in mobility and transportation due to COVID-19. However, the investigation of factors leading to these changes and an exploration of different strategies followed by many different countries is yet to be conducted.

Recently, various national reports on road safety using final or provisional data have been published and provide an insight on the impact of the pandemic on road safety. For example in France [24], final road safety data showed a 21% reduction in casualties as well as a 34% reduction in elderly road users (75+). However, the report also showed that the impact of the pandemic was not significant over the year regarding crashes and casualties. Similarly, in Austria [25] a 33% reduction in casualties was observed during the first lockdown and a total reduction of 18% was observed in casualties in all of 2020, compared with 2018 and 2019. In Luxemburg [26], road crashes had reduced by 22% compared with 2019. Finally, provisional data from the United Kingdom [27] show a decrease of 22% in the number of fatalities and seriously injured in 2020 and a 25% decrease of all severity casualties, whereas cyclist casualty rates showed the greatest decrease by 34%, compared with 2019.

Summarizing the findings of the available literature, it is demonstrated that both research papers and national reports point towards a decrease in absolute number of crashes and injuries, while, simultaneously, speeds seem to have increased only slightly. No studies to date, however, control for the change (reduction) in vehicle kilometres travelled when reporting fatalities and crashes, whereas the French national report shows that the impact of the pandemic was not statistically significant when compared with previous years.

It is a tradition in road safety to publish ‘progress’ reports on road safety trends and monitor progress, for example in the framework of a road safety target (minus 50% fatalities over a ten year period). These progress reports [28–30] are descriptive in nature. Based on the progress reports it can be assessed whether developments are on track (to reach a set road safety target) or if additional interventions should be considered. To *explain* trends, however, more detailed in-depth research is needed [31]. For example, an ex post evaluation can be carried out that looks back and attempts to estimate the safety effects of implemented programmes.

This paper is based on an ITF/IRTAD-report [32] and the data collected for this study. The ITF/IRTAD-report presents a preliminary and first overview of the impact of the COVID-19 pandemic on road safety in 2020 as reported by member countries of the International Safety Data and Analysis Group (IRTAD), the permanent working group on road safety of the International Transport Forum (ITF) at the OECD.

## 2. Methodology and data collection

As mentioned previously, the aim of this paper is to present the number of road fatalities and the fatality rates (fatalities per kilometer driven) in 2020 and to compare these numbers and rates with the previous period, a baseline. A comparison between both periods may indicate how the pandemic influenced mobility and road safety. This approach does not aim to establish causal relationships between pandemic-impacts and road fatalities, but to explore correlations in time between impacts of COVID-19 related restrictions and road safety.

Towards that aim, a questionnaire was sent to the forty countries that were IRTAD members in early 2020. This questionnaire requested information on the monthly number of fatalities on a national level for four years, (2017–2020). A monthly basis was chosen because from March 2020 onward the pandemic outbreak and the governmental restrictions changed constantly over time. We decided to make a breakdown into transport modes, age groups and road types. Furthermore we invited IRTAD-members to submit information on kilometres travelled in the four years. A three years baseline (2017–2019) for fatalities and exposure was chosen to reduce the influence of fluctuations.

We received information from 24 out of 40 IRTAD member countries: Argentina, Australia, Belgium, Canada, Chile, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Israel, Italy, Japan, Luxembourg, Mexico, The Netherlands, New Zealand, Poland, Slovenia, Sweden and Switzerland. All these countries delivered the requested information on road fatalities. Unfortunately, the other member countries were not in a position to deliver the requested information before the closing date (1 June 2021).

Eleven of the forty member countries were in a position to deliver the requested exposure data (kilometres travelled): Australia, Canada*, Denmark, Finland*, France, Great Britain*, Germany*, Japan, the Netherlands*, Slovenia and Sweden*. The countries marked with * delivered only annual data, the other countries delivered monthly data. Because of the limited number of countries able to provide monthly exposure data, it was decided to use another data source containing information on driving, walking and transit mobility [33]. The Apple mobility data describes a relative volume of direction requests per country compared with a baseline volume measured on the 13th of January 2020 (just prior to the outbreak of the pandemic in many countries). This data does not provide information on actual kilometres travelled, but may be considered a rough indication.

Finally we collected data on COVID restrictions in participating countries. Governmental countermeasures in response to the spread of COVID-19 were collected from the Oxford COVID-19 Government Response Tracker (OxCGRT) [34], an online database that contains information on governments' policies against the spread of the disease.

After the distribution of the questionnaire, the data was inserted into a Python 3.7 environment for further data analysis.This study offers a visual and descriptive in-depth comparison. It was decided not to carry out statistical analyses on the data.

## 3. COVID-19 restrictions and their impact on mobility

COVID-19, initially diagnosed in Wuhan, China in December 2019, has since continuously impacted the worldwide population until the present day. According to the COVID-19 Dashboard by the Johns Hopkins University (November 2021) the pandemic surpassed 250 million confirmed cases and more than 5 million died as a result of a corona infection, while more than 7 billion vaccine doses have been administered. The pandemic forced the majority of governments to impose lockdowns, including closures of educational institutions, working from home and staying at home requirements, sometimes via curfews, while many recreational, religious, cultural, dining and entertainment establishments were instructed to cease operations.

From a road safety perspective we are interested to learn about the impact of the restrictions on mobility. We will present information on restrictions presented in the Oxford COVID-19 Government Response Tracker [34] that collects systematic information on policy measures that governments have taken to tackle COVID-19 and that cover more than 180 countries, and on changes in mobility per country per month in the year 2020. It is to be expected that the more numerous and the more severe the restrictions, the more mobility will be reduced.

As indicated previously, we have two sources for mobility data: data from countries reported in the questionnaire, which are based on national surveys, and data collected by Apple. Apple is providing information from people asking for information how best travel from A to B. This online and open data is available for all 24 countries for three transport modes: driving, walking and using public transport. The Apple mobility data were used because they were publicly available from the beginning of the pandemic and provided an alternative to national data which were released later or were not available at the time. One of the limitations of this dataset is the use of a one day baseline (13th of January 2020). This makes it not possible to capture seasonal patterns. Furthermore, data from Apple users are only a sub-group of the national populations and may not resemble the total behaviour.

### 3.1. Stringency index and impact on apple mobility data

The Oxford COVID-19 Government Response Tracker (OxCGRT) [12], classifies governments' policies against the COVID-spread into eight indicators. Containment and closure policies are described by the following countermeasures: C1 (School and universities closure), C2 (Workplace closure), C3 (Cancelling of public events), C4 (Limits on gatherings), C5 (Closing of public transport), C6 (Orders to 'stay at home'), C7 (Restrictions on internal movements between cities and regions) and C8 (Restrictions on international travel) and one indicator on public information campaigns. These indicators are recorded on a scale from 0 to 2, 3 or 4 in relation to the strictness of the applied measures and are accompanied by a binary flag to denote the geographic scope (targeted or general). Based on the nine response indicators the strictness of governmental response is estimated in terms of a Stringency Index. The Oxford Stringency Index is a composite score: the mean of the confinement and public information campaign indices. The Index is estimated for more than 180 countries on the scale of 0 (no measures) to 100 (very strict measures).

An overview of the Stringency Index is shown in Fig. 1, together with the evolution of the mobility (index) per month and for different modes in the studied countries using the Apple mobility data.

In all countries we observe more restrictions (increase in the Stringency Index) in March/April/May 2020. The second period of the year (after spring) shows remarkable differences between countries. Sometimes the Stringency Index remains constant (e.g. Argentina, Chile, Canada, Great Britain), sometimes countries show a high volatility and a second wave (e.g. France, Poland, Slovenia) at the end of the year.

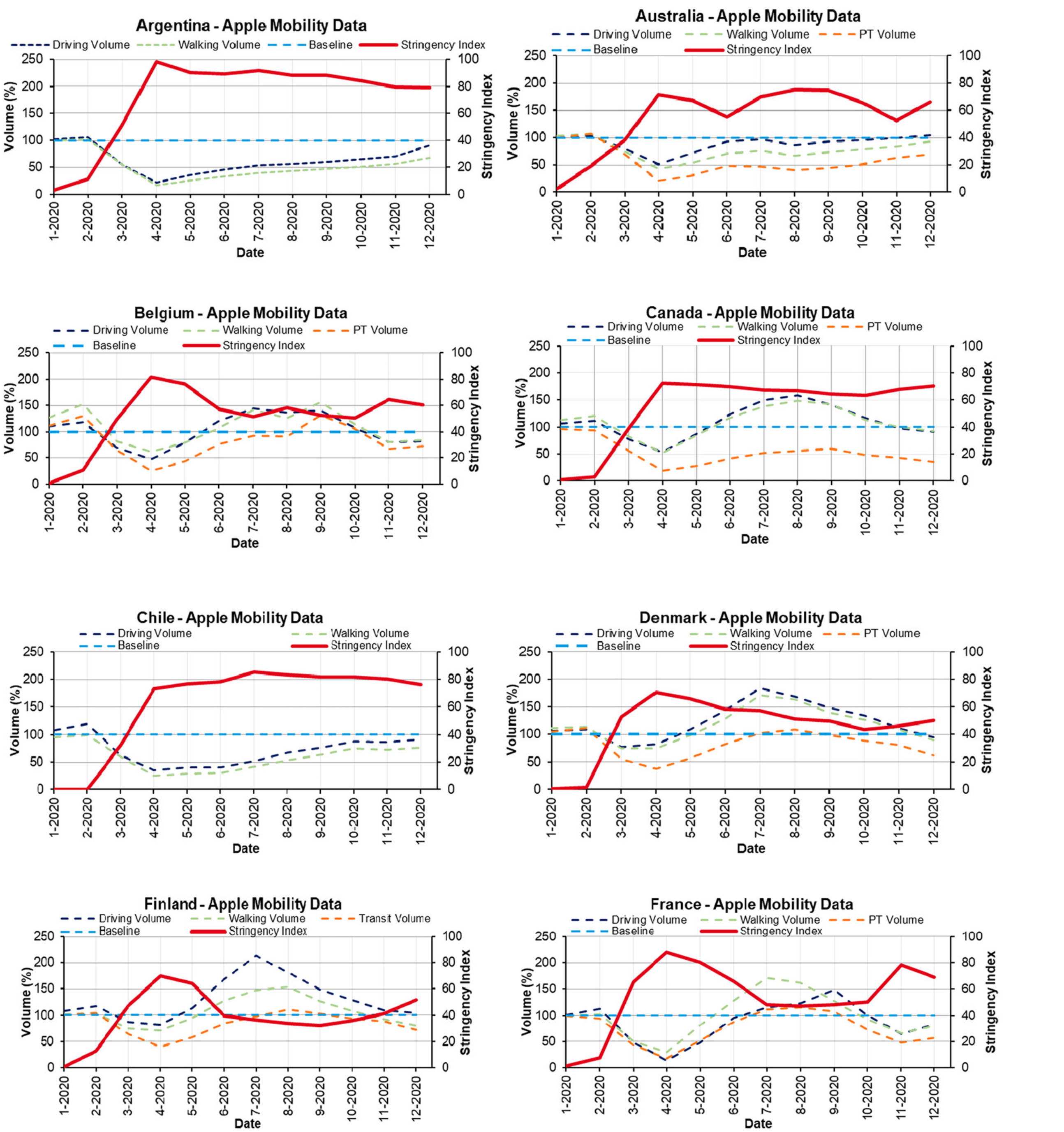
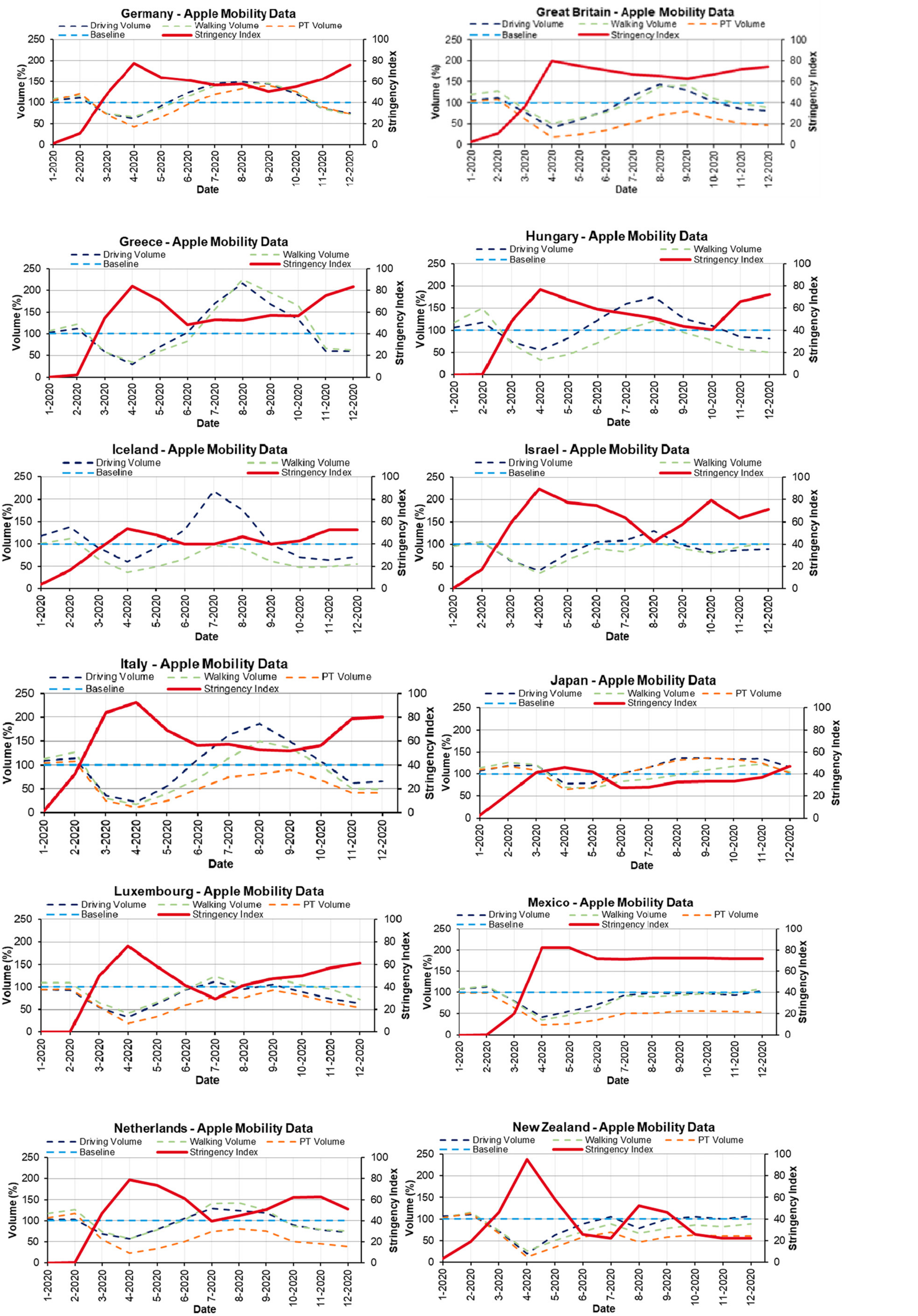



**Fig. 1.** The Oxford Stringency Index and Apple mobility data for 24 countries in 2020 per month.

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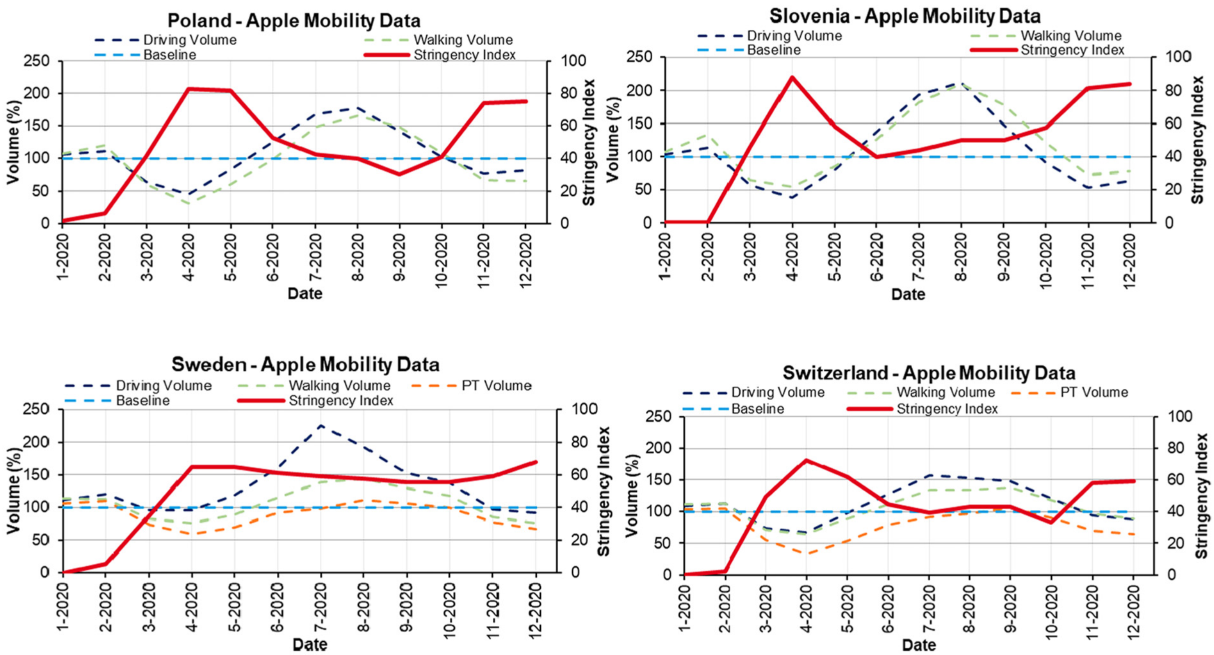


**Fig. 1** (*continued*).

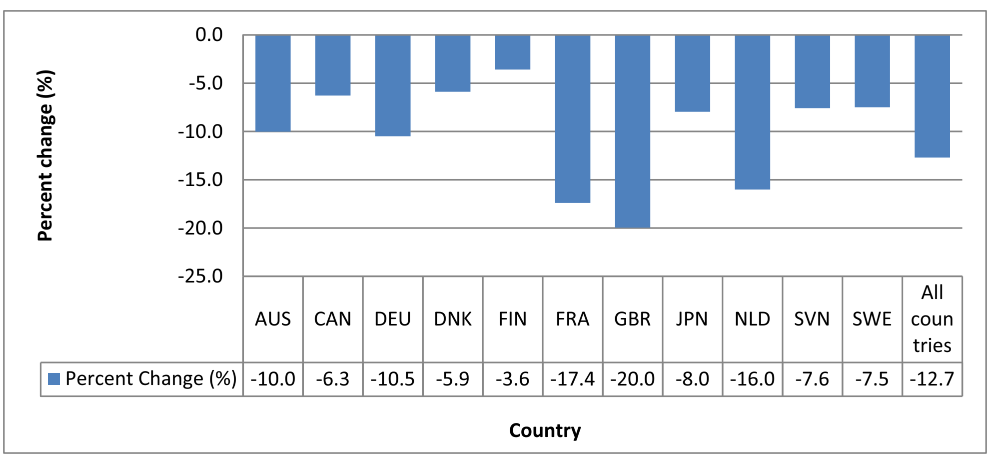


**Fig. 2.** Evolution in monthly vehicle-kilometres 2020 vs baseline (average for 2017–2019) aggregated data for Australia, Canada, Denmark, France, Japan and Slovenia.

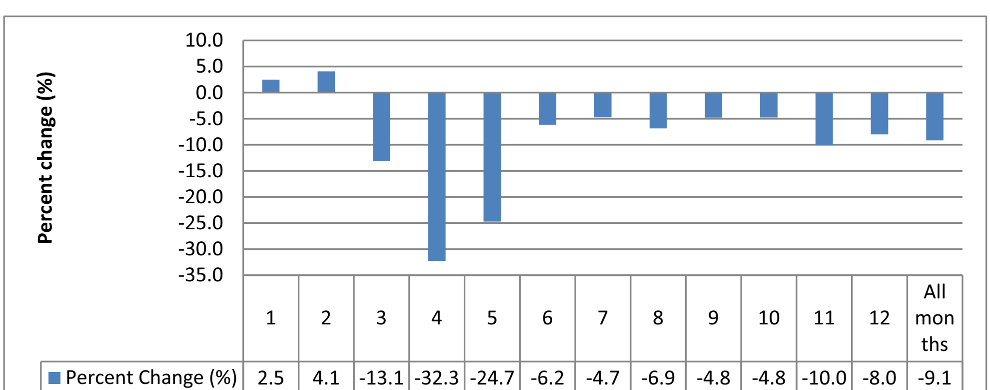


**Fig. 3.** Average difference in vehicle kilometres travelled per month between 2020 and baseline years aggregated for Australia, Canada, Denmark, France, Japan and Slovenia.

Furthermore, in some countries the level of the Stringency Index is sometimes mild and sometimes severe.

The increase of the Stringency Index in spring 2020 is associated with a decrease of mobility in the same period for all 24 countries without exception. The developments later in the year vary. For all countries with information on this issue, the decrease in public transport use is higher than that for driving and walking.

### 3.2. Vehicle kilometres travelled

In order to validate the publicly available data provided by Apple, this section provides an overview of the eleven countries that reported exposure data for 2017, 2018, 2019 and 2020: Australia, Canada, Denmark, Finland, France, Great Britain, Germany, Japan, the Netherlands, Slovenia and Sweden. As a result, annual differences were estimated for these countries (Fig. 2) and monthly data for six countries (i.e. Australia, Canada, Denmark, France, Japan and Slovenia) are presented in Fig. 3.

Total vehicle kilometres were reduced by 12.7% in average. The highest reductions are observed in France, Great Britain and the Netherlands with reductions higher than 15% and up to 20% in Great Britain, while in Finland the reduction is lower than 4%.

Fig. 3 presents changes per month in the amount of kilometres travelled for the six countries who provided monthly data. This figure clearly illustrates that we experienced a clear 'wave' in March, April and May. We observe hardly any change in the summer, and modest reductions in the last couple of months. However, these reductions are much lower than the reductions in spring. The data presented in Fig. 3

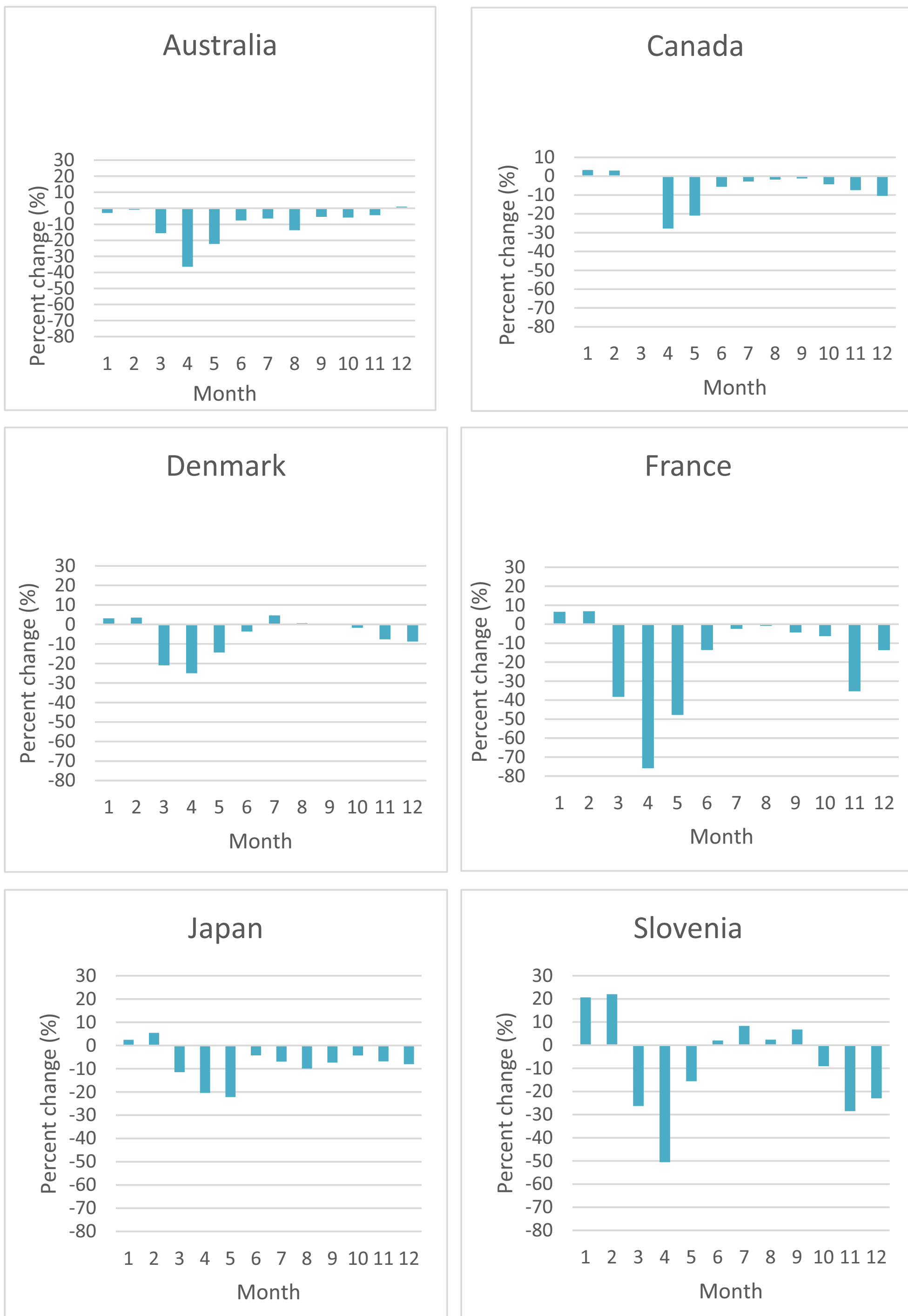


**Fig. 4.** Average difference in total vehicle kilometres for Australia, Denmark, France Japan and Slovenia per month between 2020 and baseline years.

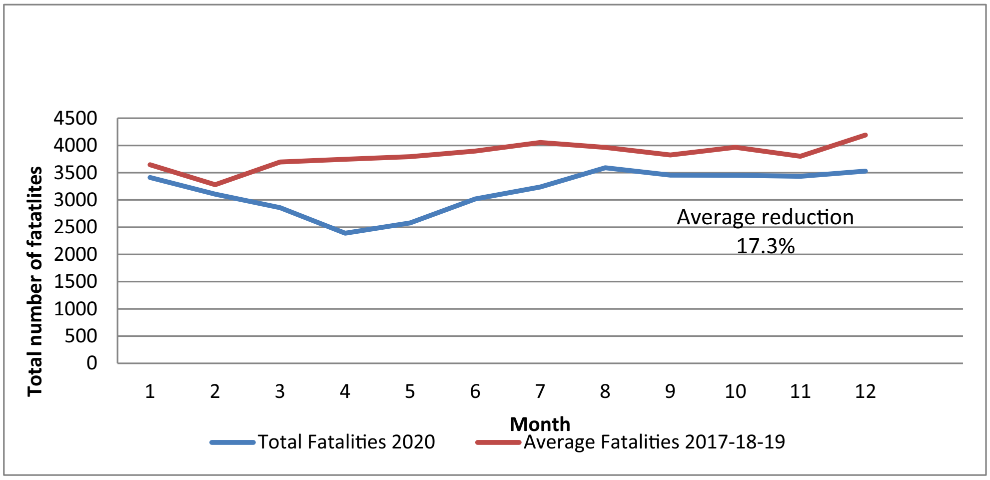


**Fig. 5.** Change in the number of road fatalities aggregated for 24 countries in 2020 compared with the baseline years (2017–2019).

show a similar pattern to the data in Fig. 1. But countries differ from each other, as is illustrated in Fig. 4.

Fig. 4 presents the comparison in vehicle kilometres travelled between the baseline years and 2020 for the six countries that provided monthly data, collected in national surveys.

All six countries follow a similar pattern: a relatively sharp initial reduction in vehicle kilometres travelled especially in April 2020, with some sort of rebound for the summer period. However, Australia and Japan don't reach the 2017–2019 level, but remain somewhat lower. We observe a 'second wave' at the end of 2020 especially in France and Slovenia, but not in the other four countries. The Australian summer period (December 2020) shows similar levels of kilometres travelled as in the previous years.

Comparing Figs. 1 and 4, it is concluded that data provided by Apple for 2020, resemble the trends collected in surveys for Australia, Canada, Denmark, France, Japan and Slovenia. However, we observe remarkable differences between survey data and Apple data, especially in the period April–July 2020: Apple data show more oscillations than survey data (higher decreases and increases). We are inclined to state that the data provided by Apple can be considered as a reasonable indicator for trends in individual countries in 2020. We don't recommend to compare countries. Further research is recommended to arrive at more firm conclusions.

## 4. Road fatalities and fatality rates in 2020

### 4.1. Comparison total number of fatalities in 2020 with baseline

When we add the results of the 24 participating countries, we have a first indication of how different 2020 is compared with the baseline-period. These results are presented in Fig. 5. The conclusion is that the numbers of fatalities were 17.3% lower than in the baseline period, with higher reductions in the first part of the year compared with the second part. The question to be answered is whether this percentage of 17.3% is relevant and significant. We answer this question in 4.2.

However, we observe major differences between countries as is illustrated in Fig. 6. A reduction of the number of fatalities took place in 23 out of 24 countries. The only exception is Switzerland. The reduction rate differs between almost no reduction (Finland) and more than 35% (Argentina). Many countries see a reduction bteween 15% and 25% (Belgium, France, Great Britain, Greece, Hungary, Mexico, New Zealand, Japan, Slovenia and Sweden).

Fig. 7 presents information for the absolute number of fatlities per month of the 24 individual countries. Obviously, the patterns between countries differ, both for the blue lines (2020), the red lines (baseline) and the differences between the two. It is beyond this

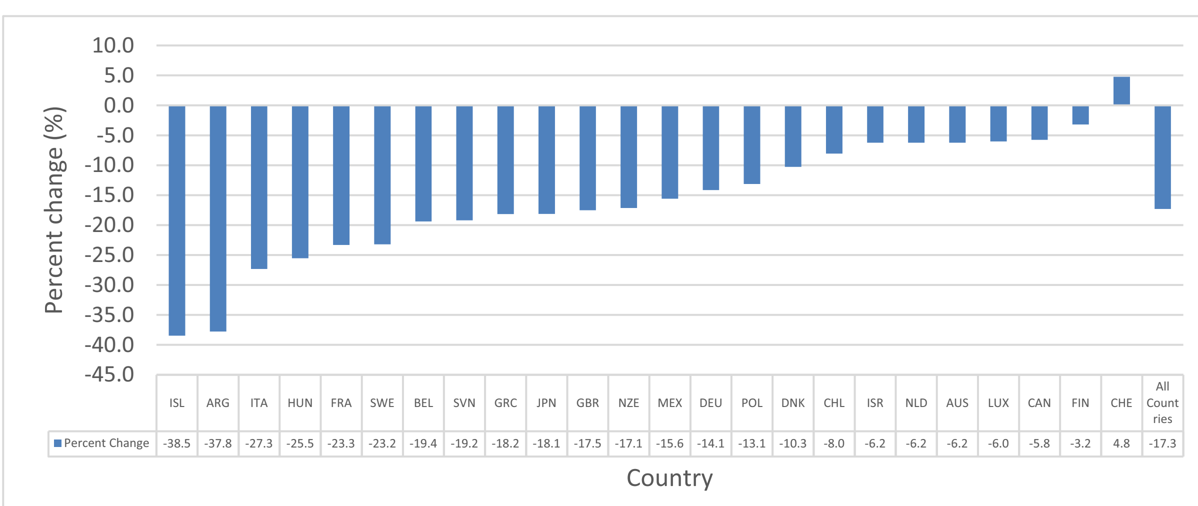


**Fig. 6.** Average percentage of change in total fatalities per country in 2020 compared with the baseline years.

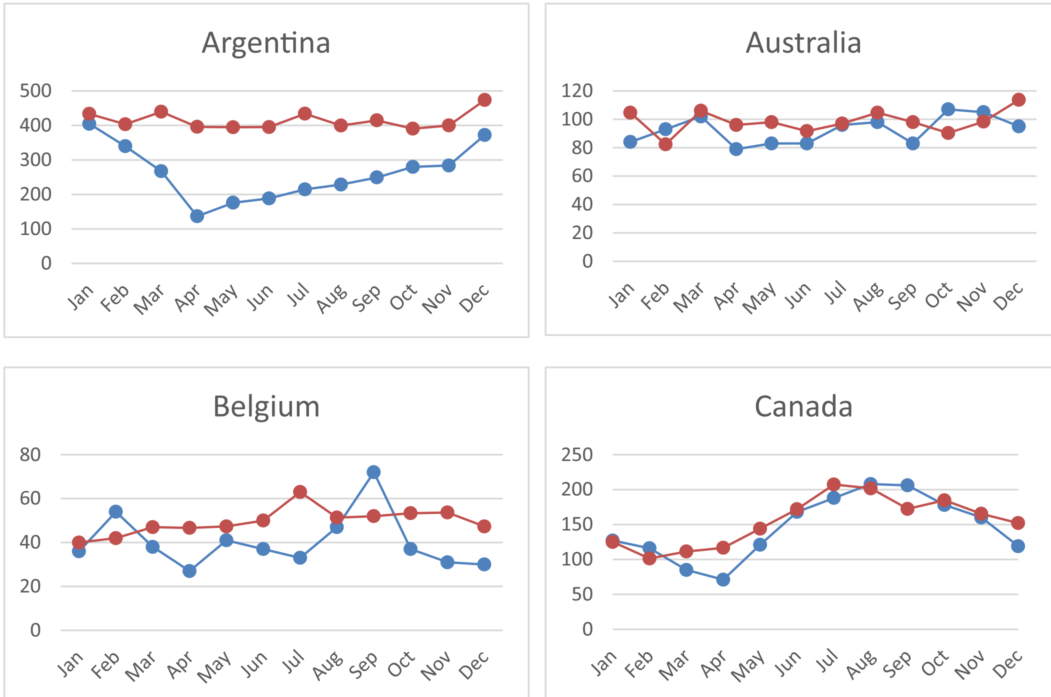


**Fig. 7.** Fatalities per month for 24 countries (blue: 2020, red: average 2017, 2018, and 2019).

paper to present plausible explanations for the differences between the countries and we recommend to make a more detailed analysis on this.

### *4.2. Trend in road fatalities 2010–2020*

It is of interest to compare the reduction percentages of the number of fatalities in 2020 with the average annual change over the period 2010–2019. We have the annual changes for 20 out of the 24 countries in this study [30], but not for Argentina, Canada, Great Britain and Mexico. The average change for these 20 countries over 2010–2019 is 2.5% per year. If we compare this percentage with the percentage presented in Fig. 5 the difference is striking (significant and relevant): the average change (17.3%) is almost seven times higher. It is even more striking if we take into account that the fatality reductions between 2010 and 2019 were measured at the beginning of that period and that from 2014 we reached a plateau in many countries [29,30]. These findings are an illustration that also from a road safety perspective, 2020 was an extraordinary year with a reduction rate rarely experienced.

### *4.3. By transport mode*

We observe for all modes reductions (Fig. 8), the highest reductions for public transport related fatalities (68%), the lowest for cyclists (6.4%). Of course it is of interest to know what happened with the number of kilometres travelled per transport mode.

### *4.4. By age group*

With regard to age, it is evident from Fig. 9 that the largest reduction of fatalities was among elderly people (75+) and for the youngest age group (0–17y), followed by people of other ages. These two age groups were significantly affected by the pandemic.

### *4.5. By road type*

Three road types have been distinguished in this study and 14 countries were in a position to present relevant data (Fig. 10). The highest reduction has been observed on motorways. We see also major differences between countries and these differences are asking for further analysis: on urban streets in Hungary we see a decrease of 35.5% and increases in Switzerland and Finland. Or on motorways: an increase in Finland of 7.1% and a decrease in Switzerland of 22.9%. Without detailed additional information the observed differences result in more questions than answers.

### *4.6. Fatality rates (fatalities per billion vehicle kilometres)*

Regarding the number of fatalities in relation with the total number of motorised vehicle kilometres travelled, Fig. 12 shows that the fatality rates dropped slightly (3.8%) in 2020. However we don't observe a stable pattern over the year (Fig. 11) or the same developments for different countries (Fig. 12). April, the first full month after the introduction of COVID-19 related restrictions, was obviously the worst month. In April 2020, 33% more fatalities per billion vehicle kilometres were reported in comparison with the average percentage of the three previous years.

Looking into individual country data, Sweden, Slovenia and Japan demonstrated the highest reductions in fatality rates. Great Britain, Australia and the Netherlands however, were found to have an increase of fatality rates. It is without further detailed information not possible to understand why countries differ that much. Further research is needed to explain these differences.

## 5. Discussion

In 2020, the COVID pandemic (COVID-19) abruptly entered the lives of citizens all around the world and has led to unprecedented changes in everyday societal life. Due to the restrictions imposed by governments

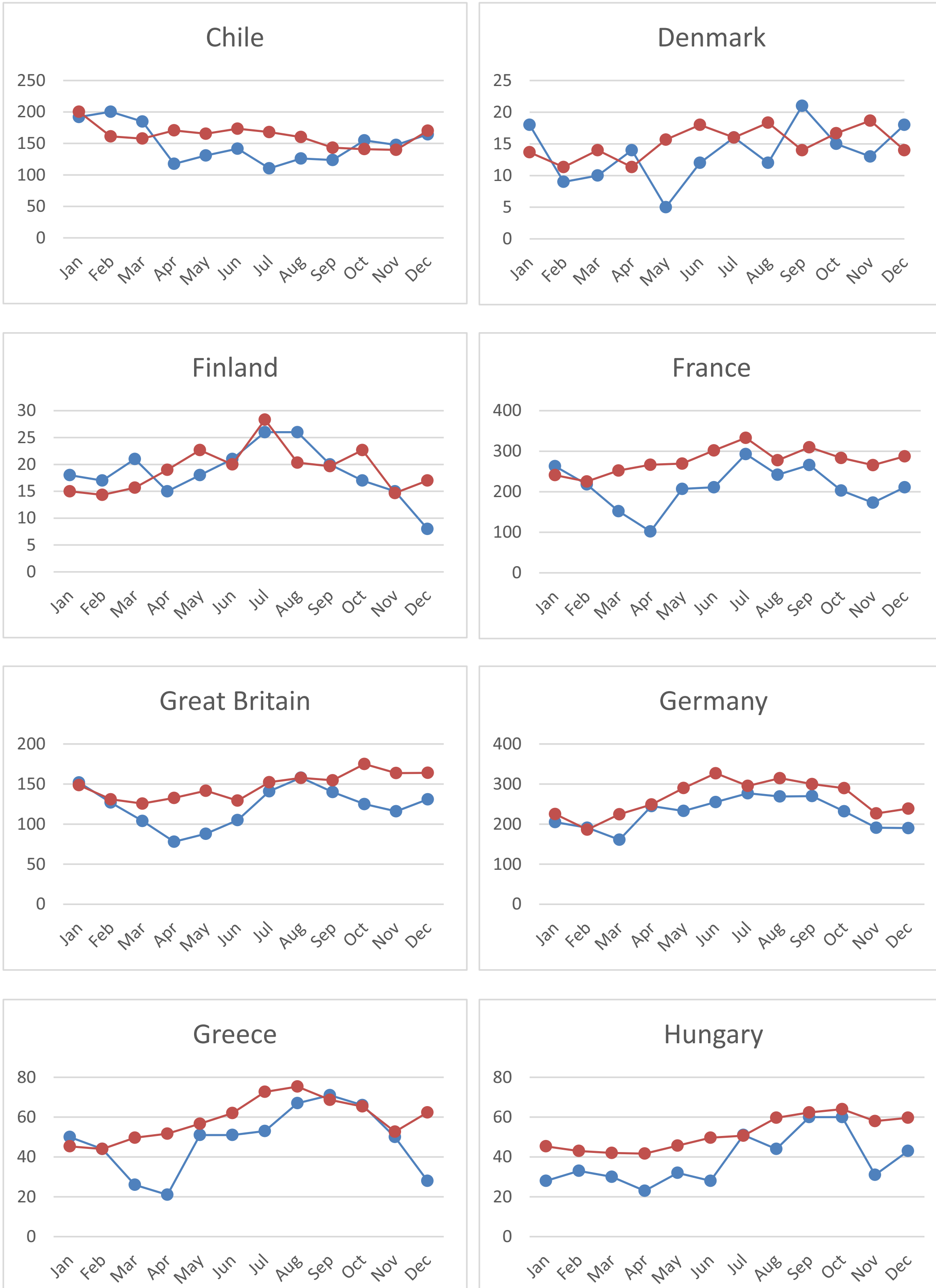


**Fig. 7** (*continued*).

in order to prevent the spread of COVID-19, mobility patterns were also immensely affected, as people were expected to stay mostly at home and go out, commute for example, only when absolutely necessary. The strictness of governmental responses were higher early in the pandemic and fluctuated according to the number of cases and casualties related with the pandemic as shown from the Stringency Index data across the studied countries.

The 'stay-at-home' policy, used by the majority of governments, led to emptier streets and to trips which were shorter both in terms of distance as well as in time [12]. As a result, empty streets were the 'new normal' in the beginning of the outbreak in March and April 2020 [35], as shown from collected mobility data. For example, France and Great Britain demonstrated a 20% decrease in vehicle kilometres travelled, when the average for all countries that provided exposure data

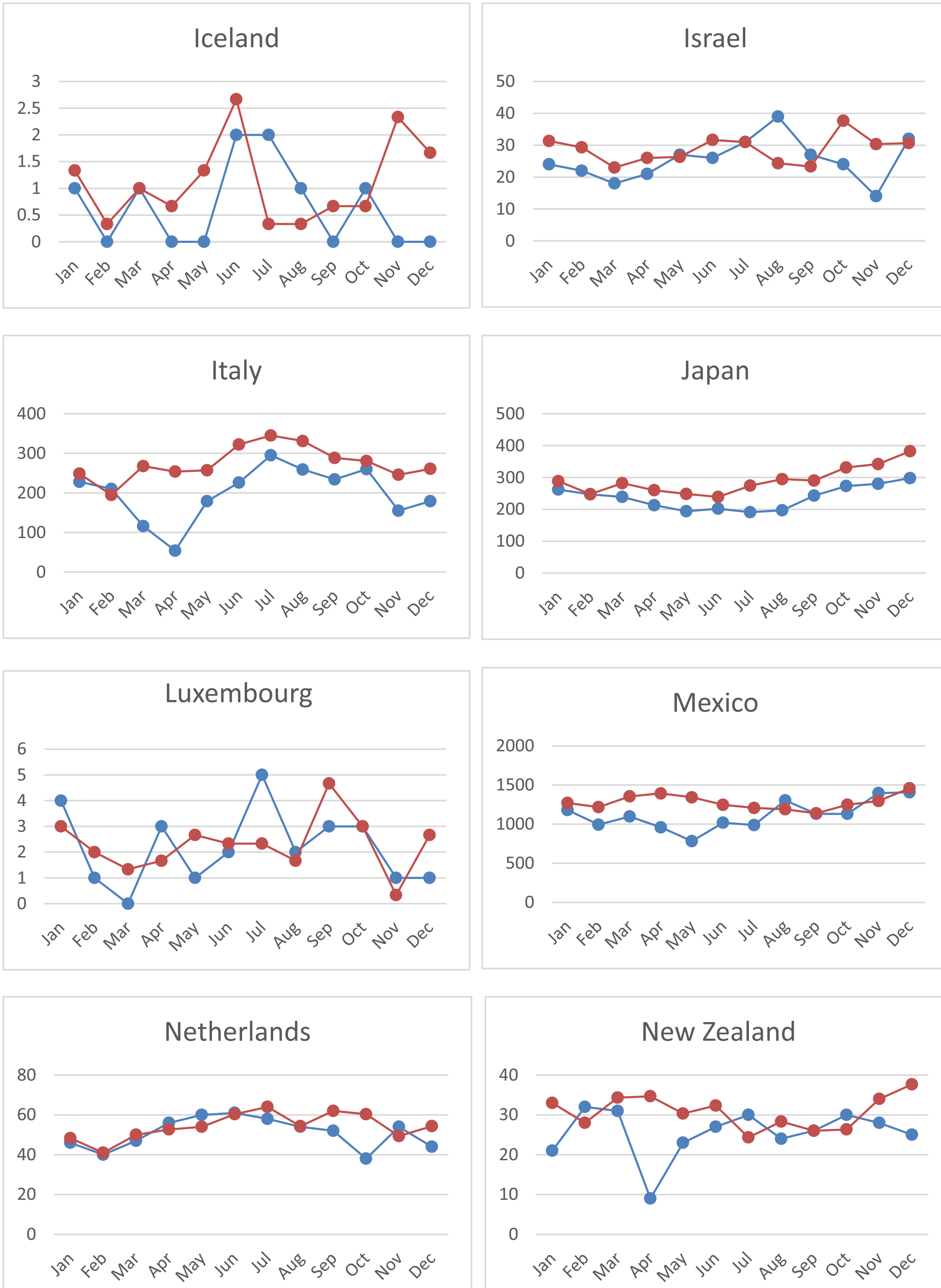


**Fig. 7** (*continued*).

was 12.7%. When governmental measures became stricter, the impact on mobility was demonstrated immediately: more restrictions, less kilometres, lifting restrictions more kilometres.

With empty streets, citizens at home, schools closed and national and international movements being prohibited, the majority of the literature on the subject suggested that a significant reduction on crashes and related injuries was to be expected in 2020 [5], especially with regards to vulnerable age groups such as people aged 75 years and older and vulnerable road users (e.g. pedestrians and cyclists). Published national reports also pointed towards the reduction in crashes and injuries, with the French report [24] however remarking that no statistical significant reduction was found.

Our findings confirm the expectation of fatality reductions in road crashes in 2020: we observe a reduction in the vast majority of countries

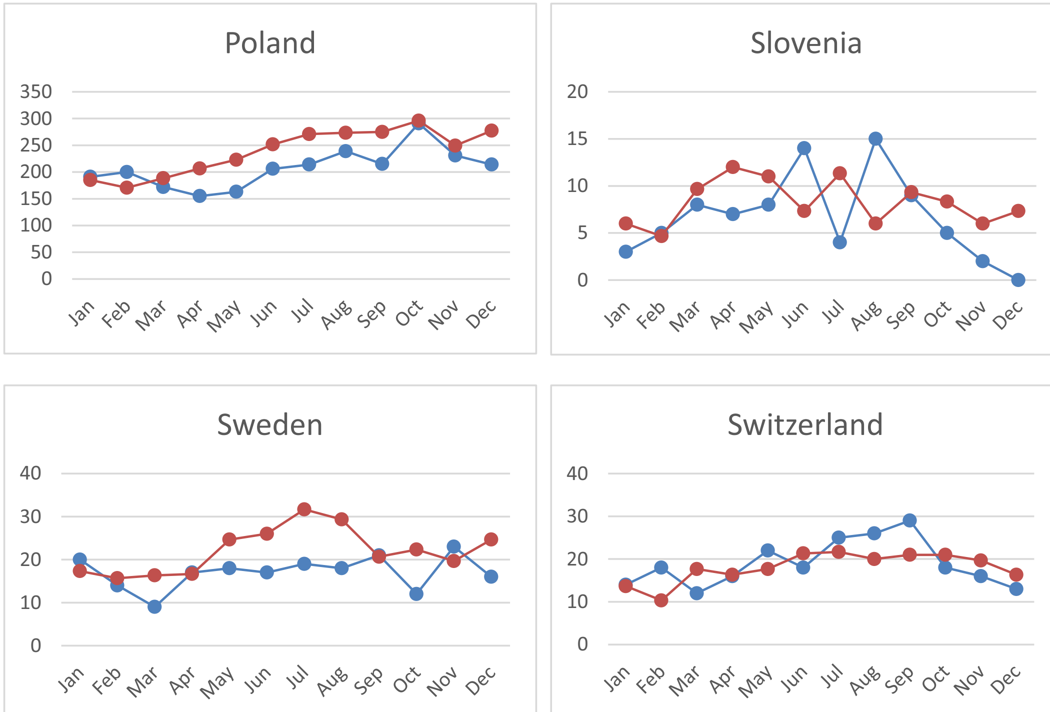


**Fig. 7** (*continued*).

(23 out of 24), with Switzerland being the exceptions. It is of relevance to note that the ITF/IRTAD-Annual Report 2021 [32], that includes data from 34 IRTAD-members, two more countries experienced an increase in the number of fatalities: Ireland and the USA. But, it certainly makes sense to perform a deeper analysis of trends in Switzerland in the past (high reduction rate of 6% annually in Switzerland 2010–2019) and to the summer period in Switzerland with a high number of fatalities compared with the numbers in the baseline period.

The measured reduction in the number of fatalities compared with the baseline (17.3%) is much higher (almost a factor of 7) than the measured reduction in the same countries over the period 2010–2019 (2.5% annual average). In other words, 2020 marks a break with the plateauing trend since 2010. However, despite the exceptional reduction in road deaths in 2020, the target of halving the number of road deaths by 2020, as declared by the United Nations and the European Union, has not been met.

When we see the developments per month in 2020, a substantial drop can be observed in mobility and in fatalities, starting in March and continuing until July. But after imposed restrictions were lifted, mobility increased and the fatality reduction almost disappeared. The second 'corona wave' at the end of 2020 resulted in a similar pattern as in springtime, but certainly not to the same extent.

With regards to the age distribution of fatalities, young (0–17) and elderly people (75+) were the group demonstrating the highest

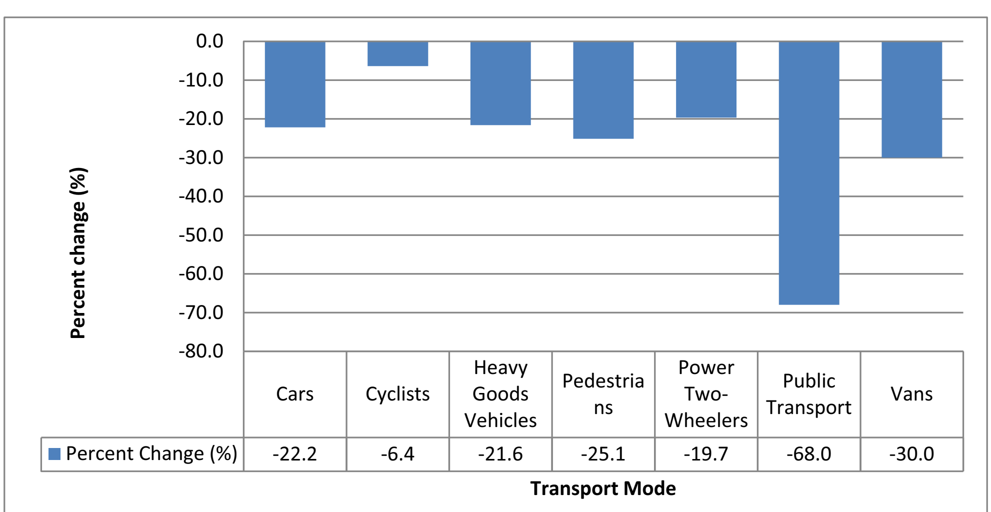


**Fig. 8.** Average difference between fatalities per transport mode in 2020 compared with the baseline years ((Argentina, Australia, Belgium, Switzerland, Chile, Denmark, Finland, France, Germany, Great Britain, Hungary, Israel, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Poland, Slovenia, and Sweden).

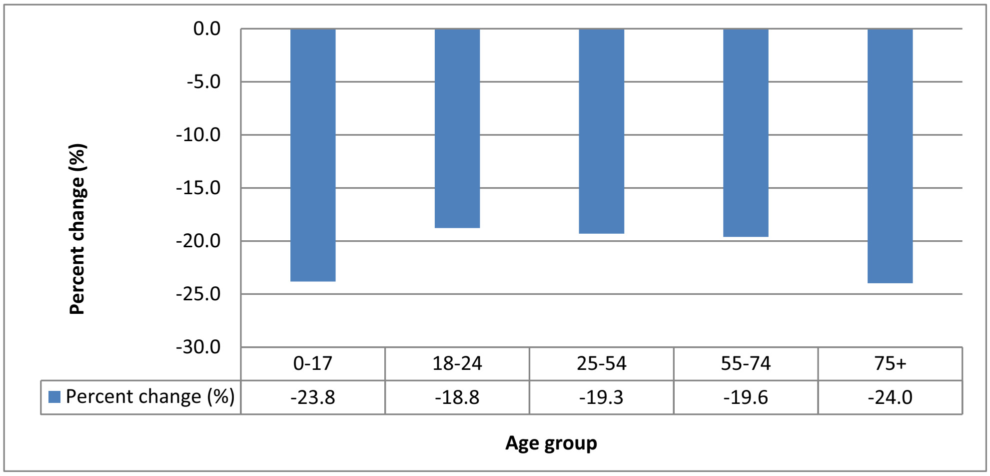


**Fig. 9.** Average difference between fatalities for age groups in 2020 compared with the baseline years (Argentina, Australia, Belgium, Switzerland, Chile, Denmark, Finland, France, Germany, Hungary, Israel, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Poland, Slovenia and Sweden).

declines. That is plausible for both age groups. Young people (and their parents!) were confronted with a closing of education institutions resulting in no trips to and from schools. For the elderly it is also plausible due to the fact that this group was considered one of the most vulnerable, if not the most vulnerable, to the COVID-19 virus and therefore it is to be expected that its mobility was significantly reduced.

Public transportation related fatalities was the one demonstrating the greatest decline and this is most probably related with the fact that the public decided hardly to use public transport, afraid of being infected. Cyclist fatalities demonstrated the lowest reduction (6.4%), a result also reported in individual countries [36], probably due to the increased cycling activity and the tendency of cyclists to use previously 'car-dominated' streets [15,37]. However, in a 'cycling country' such as the Netherlands the number of kilometres cycled reduced with 16%, due to a reduction in commuting and, more importantly, less cycling by schoolchildren and students. At the same time, however, there was an increase in leisure and sports-biking, and a countinuous increase in the use of e-bikes. Because the number of cycle fatalities increased with 8%, cycle risk increased in the Netherlands compared with previous years. It is recommend to investigate the background of the increase in cyclist fatalities, and how his relates with cyclist mobility within the current transport ecosystem.

It is interesting to know if and how restrictive measures, as presented in the Stringency Index, influenced mobility, fatalities and fatality rates. A first analysis indicates no simple (linear) relatonship. For example, Argentina and Italy had a relatively high Severity Index and observed also high reductions in the number of road deaths. But the reduction in road fatalities in another country with a high Stringency Index (Chile) is rather low. And countries that had a relatively softer approach with regards to COVID-19 and lockdown restrictions (e.g. Japan and New Zealand), observed fatality reductions very close to the mean value of 17.3%. In other words, the relationship between Stringency Index and the reduction in the number of road deaths is not a somple one.

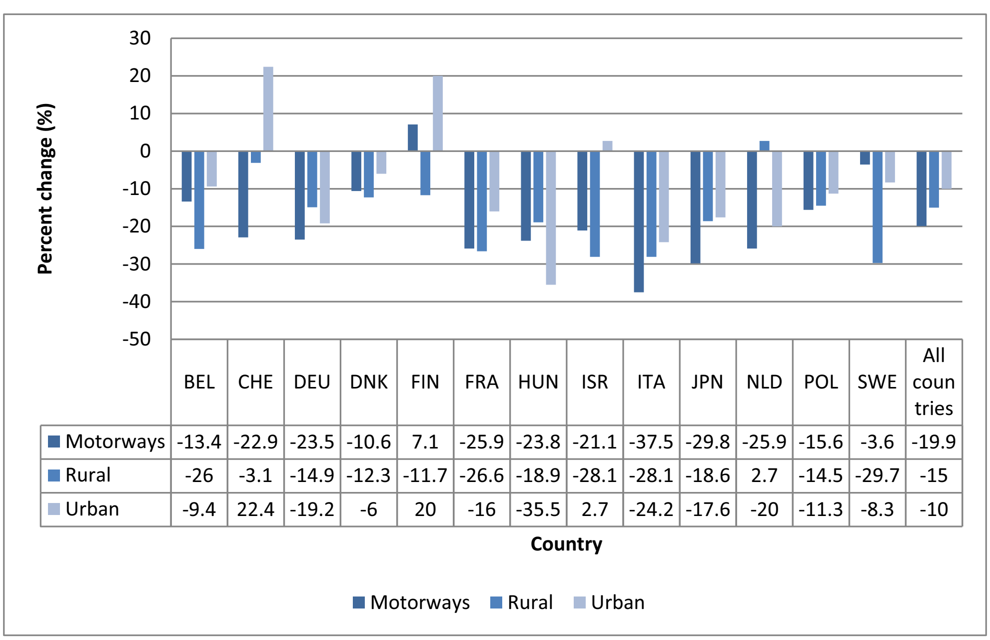


**Fig. 10.** Average difference in fatalities per road type in 2020 compared with the baseline years (Belgium, Switzerland, Denmark, Finland, France, Germany, Hungary, Israel, Italy, Japan, Luxembourg, the Netherlands, Poland, Slovenia and Sweden).

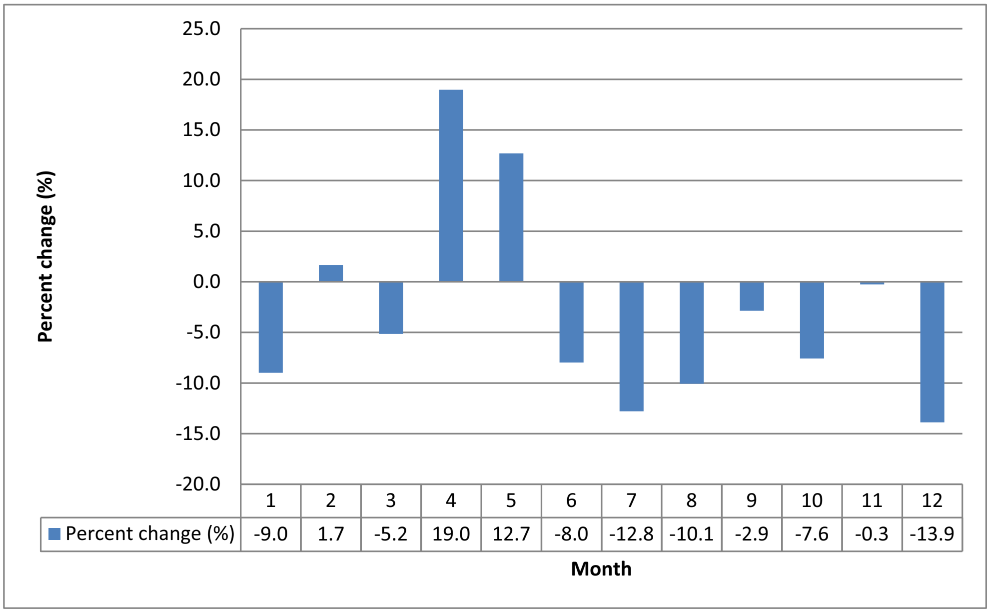


**Fig. 11.** Average difference in fatality rates (fatalities per billion vehicle kilometres) in 2020 compared with the baseline years (Australia, Canada, Denmark, France, Japan, Slovenia).

April 2020, the month when the majority of countries were in lockdown was the unsafest month, with a 33.3% increase in fatality rates (although it should be mentioned that only 11 out of the 24 countries provided both exposure and crash data). But this is an intruiging result that deserves futher research.

In this paper we describe the number of road fatalities per country and per month in 2020 and compare this data with data from a baseline period. To *explain* trends and to explain differences between countries, more infomation is required. First of all, it is of interest to know more about changed mobility patterns and to get etailed information about changes per transport mode, per age group and per risk factor (e.g. speed, impaired driving, fatique, distraction). But it is also possible that road users behaved more carefully, as was the case in other periods of economic and social hardship. In relation with risk factors, the ITF/IRTAD report [32] presents some information about increased travel speeds. Here we present the example of Great Britain (Fig. 13).

The conclusion leaves little doubt: Great Britain experienced an increase in travel speeds on all road types, especially on motorways with a stronger effect at the start of the pandemic. The observed increases in speed certainly had a negative impact on the number of fatalities on British roads. This is in line with earlier results and expectations [4 and 5]. However, the ITF/IRTAD-report [32] also presents data from Denmark and the Netherlands. These results are basically pointing into the same direction (higher speeds), but here the results are not that convincing with no higher speeds on urban Danish roads and Dutch motorways in spring 2020.

Transportation experts expect that some changes in transportation and road safety will be structural, once the pandemic is more or less under control. For example, (partly) working from home will be structural and bicycle-use will be higher than before the pandemic. It is of importance to detect structural changes as early as possible, to understand the impact on mobility and on road safety, and to identify problems that require a road safety policy response.

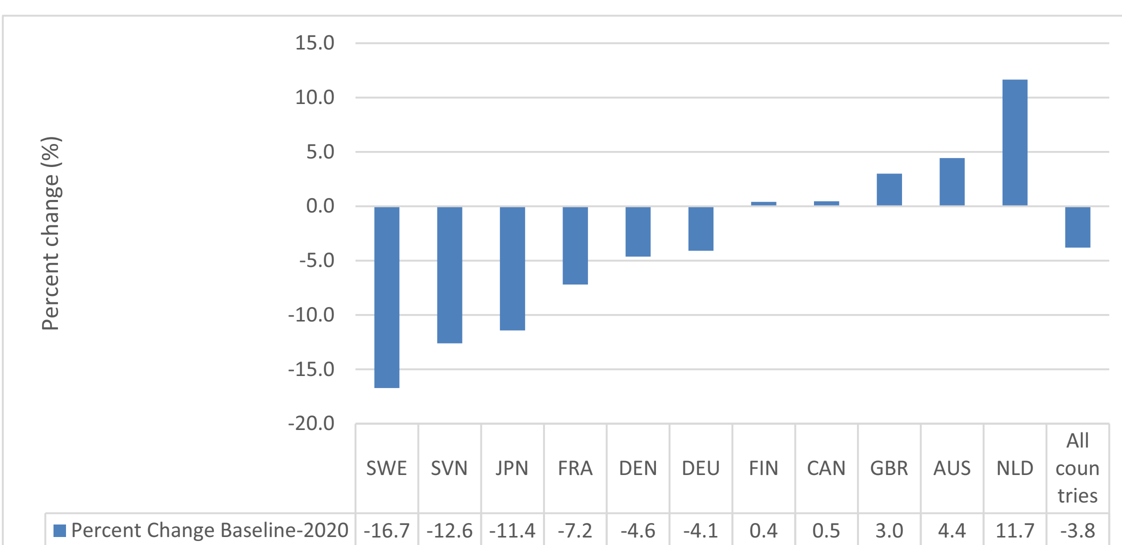


**Fig. 12.** Average percent change in fatality rates per country in 2020 compared with the baseline years.

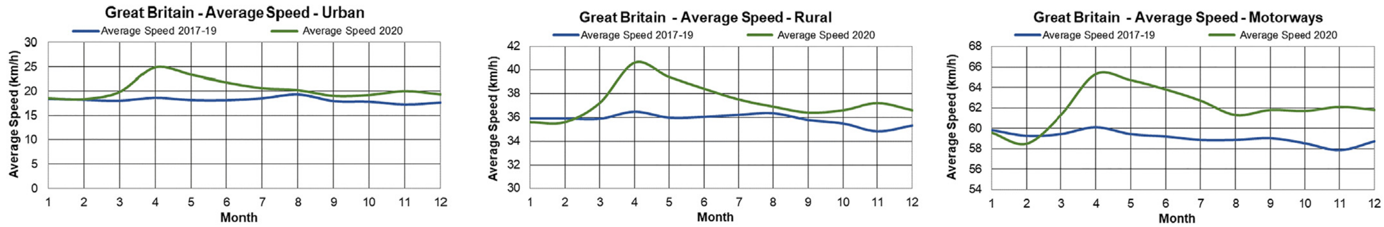


**Fig. 13.** Travel speeds (miles/h) on urban streets, rural roads and motorways in Great Britain per month in 2020, compared with the average speed 2017–2019.

Finally, the spread of COVID-19 in 2020 was anticipated to bring about major differences in mobility and road safety globally. All in all, although a reduction in the total number of kilometres occurred and fatalities in the majority of the countries dropped, the reduction is not as high as was to be expected based on the 'empty streets' image ('empty roads and streets and almost no road fatalities'). The comparisons of 2020 with the baseline years, demonstrated that the pandemic had the highest impact on both mobility and road safety during the "shock" of the first wave in March–July 2020. After loosening restrictions in the summer and re-initiating them during the second wave, which started in September 2020, the reduction in road fatalities rates was lower than in the beginning of 2020 and more or less comparable with the situation in previous years. We expect that with more data in the 24 participating countries, data from more countries, data on 'explanatory factors' and advanced statistical analyses of the data collected e.g. with time series or deep learning approaches, may further enhance our understanding of what happened in the very peculiar year 2020. The results may then be used to make further progress to reach the road safety target of 50% less fatalities in 2030 compared to 2020.

## 6. Conclusions

The main conclusions of the research presented can be summarized as follows:

1. COVID-19 had a major impact on many, if not all countries in the world because governments imposed restrictions on society in order to prevent a further spread of the virus. The various containment and closure strategies, taken by the majority of countries, reduced mobility. In this study a reduction of 12.7% of vehicle kilometres was found for 11 out of the 24 countries participating in this study.
2. Comparison of the number of fatalities in 2020 with the number in a baseline-period (2017–2019) shows a reduction of 17.3% in the number of fatalities in the 24 participating countries.
3. The reduction in the number of fatalities has mainly been measured in the beginning of 2020 (March–July), rather than in the last months of the year.
4. We find the highest reduction in fatalities among the young (0–17) and elderly (over-75 s), in crashes involving users of public transport and on motorways.
5. The fatality rates went down (3.9%). A reduction took place in several, but not in all countries. Some countries experienced an increase in fatalty rates.
6. The observed reduction in the number of fatalities is associated with less mobility and lower fatality rates with, however, major differences between countries. More research is needed to shed some light on the differences between countries. Changes in modal split, route choice, travelling speed, impaired driving, high risk users in traffic (elderly, novice drivers), driving less/more carefully, post-crash treatment et cetera, could be included in these studies.

## Declaration of competing interest

None.

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