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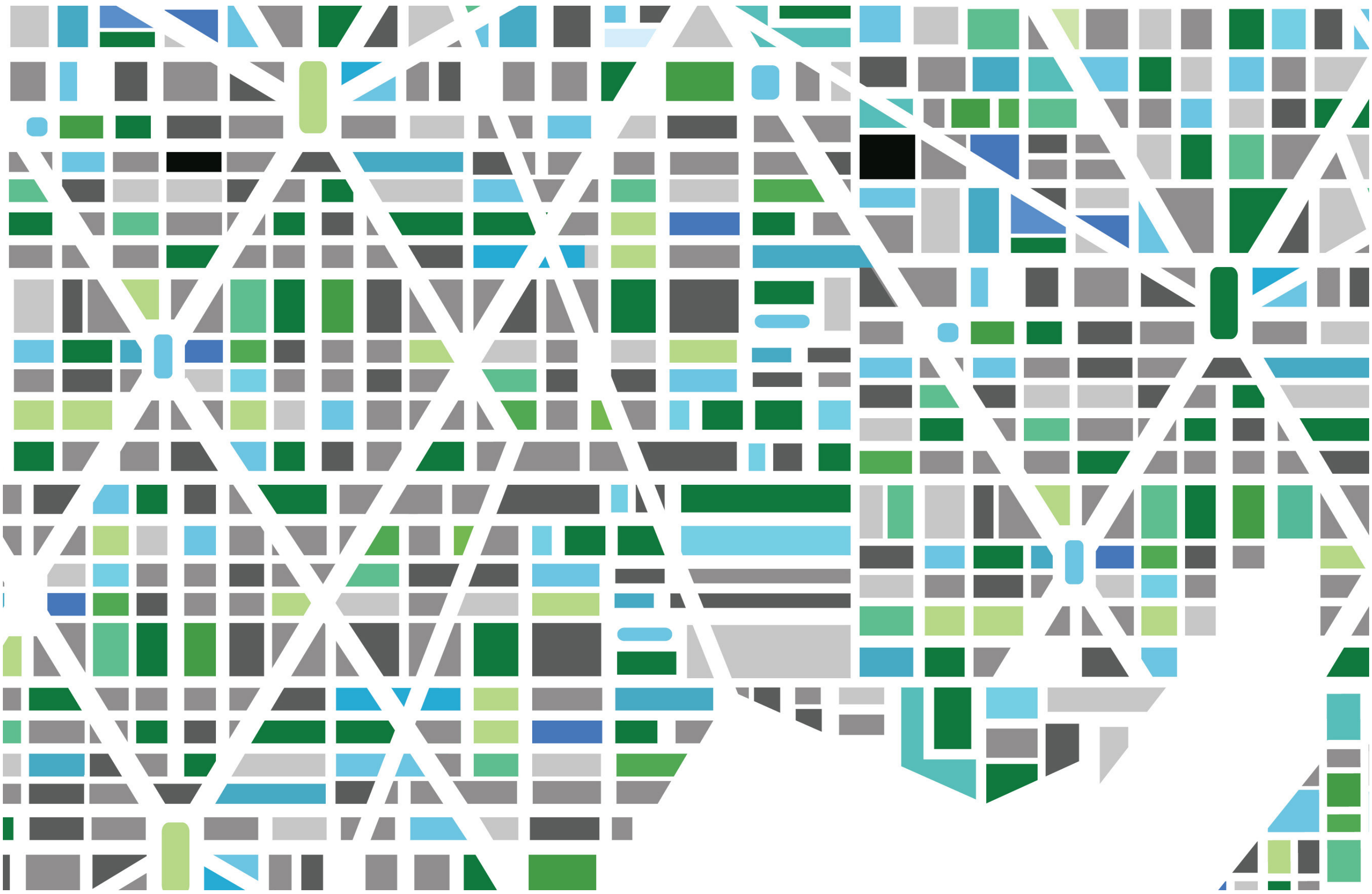

Safer City Streets

Global Benchmarking for Urban Road Safety

Working Document

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The International Transport Forum

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This work also benefits from the guidance and support of the ITF's International Traffic Safety Data and Analysis Group (IRTAD). The IRTAD group organised the pilot stage and commissioned the piece of research which serves as a methodological framework.

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Our thanks also go to the people working in cities, from Vancouver to Auckland, who have dedicated their time to collect and share their local road safety figures.

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Executive Summary

What we did

The International Transport Forum collected mobility and road safety data from 31 cities, the majority of which in Europe, 10 in the Americas and 2 in Oceania. Indicators were developed to evaluate, monitor and benchmark road safety outcomes.

A network of road safety experts was developed in parallel to support data collection and to exchange experiences with road safety analysis and policy making. Members of this network met in Paris on 20-21 April 2017, in Brussels on 7-8 December 2017 and in Rome on 11-12 April 2018.

Together, the global city-level road safety database and the network of road safety experts make up the Safer City Streets initiative. It is delivered by the International Transport Forum in partnership with the International Automobile Federation (FIA), and with support from the International Traffic Safety Data and Analysis group (IRTAD).

What we found

Our analysis reveals considerable differences in road safety performance between cities, suggesting cities should do more to share best practice and learn from their peers.

Pedestrians, cyclists and motorcyclists, together called vulnerable road users, make up about eight out of ten road users killed in city traffic. Almost half of road fatalities in cities are pedestrians, a user group which experiences a risk of fatality ten times higher than the risk experienced by car occupants. This analysis has yet to control for potentially confounding factors and to examine the number of third-party casualties but clearly makes the case for a greater focus on pedestrians in cities.

Injury data are not (yet) comparable across cities. This is due to a combination of inconsistent definitions and reporting rates and the absence of data from hospital admissions. When city-level road safety performance analysis is limited to fatalities, much insight and statistical significance are lost, reducing the relevance of monitoring efforts. Developing reliable data on injuries is therefore important.

What we recommend

Develop mobility observatories in cities

More local governments should establish a framework for the collection and reporting of relevant urban mobility data. This would include both mobility and casualty figures, thus facilitating the interpretation of road safety trends. This would also include data on behaviours, attitudes and enforcement. Such observatories are best developed as part of a sustainable urban mobility plan (SUMP).

Collect traffic casualty data from hospitals, not only from police records

All stakeholders should seek to establish protocols for the collection of injury data from the health and emergency services. Their goal should be to complement police records, often the only source of information on casualty numbers in spite of the notorious underreporting of casualties in police records. The categorisation of injury severity using an international medical standard called MAIS3+ is recommended to enable the monitoring of progress over time and to make meaningful comparisons across cities. Population surveys, with all their challenges and potential biases, shouldn't be regarded as a substitute for hospital data but could nonetheless help estimate and monitor the actual number of people injured in traffic.

Adopt ambitious targets to reduce the number of casualties

Cities should adopt ambitious targets to reduce fatalities and serious injuries, in line with the Safe System approach. The Safer City Streets benchmarking effort reveals large performance gaps between cities. Drawing attention to these gaps could help secure political support for rapid casualty reduction targets. Targets should also be set to improve the most critical behaviour indicators, most importantly speeding.

Focus on protecting vulnerable road users

Cities should intensify their efforts on improving the safety of vulnerable road users, who make up the vast majority of urban traffic fatalities and who experience a greater level of risk. Cities should enhance streets so that people walk and cycle more in safe conditions. Riders of powered-2-wheelers should also be the focus of road safety policies, such as speed enforcement, since they are associated with the greatest risk of fatality, by far, in comparison to other modes, not only risking their own life but also the life of other road users.

Use appropriate indicators to measure the safety of vulnerable road users in cities

The absolute number of road traffic fatalities and injuries are important indicators for monitoring road safety trends and setting road safety targets. However, to measure, monitor and benchmark the level of risks experienced by a specific road user group, the volume of travel should be controlled for. For this reason, the number and length of trips in each mode should be estimated and monitored. Household travel surveys or other solutions could be used. Where funding is an issue, we recommend working in partnership with metropolitan authorities, national authorities, and authorities in charge of public health or using simplified, innovative, standardised survey methods.

Estimate daytime population to improve the comparability of traffic safety statistics

Cities should estimate a daytime population figure, accounting for the contribution of commuters, and visitors. This is to improve the comparability and relevance of mortality rates, especially in central urban zones where the resident population doesn't always reflect the true daytime activity.

Prioritise research on urban road crashes

Research questions will require data collection from a larger set of cities, something which can be envisaged as the Safer City Streets network grows and welcomes new cities. In particular, the relationships between urban shape, density, speeds, mode share and road user risk will require further investigation. Gender, age and social aspects of road safety should also be investigated. This will require not only good casualty data sources, but also good data on trips, most likely from household surveys. Another area of focus should be the collection of crash participant matrices so as to better understand the impact of each user group on casualty numbers in other groups.

Cities participating in the road safety benchmark

The International Transport Forum (ITF) collected road safety data from 31 cities, 18 of which are in Europe, 10 in the Americas, 2 in Oceania (Figure 1). In this report, the term Europe includes the 28 EU member countries along with Norway and Switzerland.

Figure 1. Map of cities contributing to the Safer City Streets database

Before we examine road safety figures, we must keep in mind the differences between the 31 areas examined:

- Land area varies from 86 km^2 (Copenhagen) to 8 800 km^2 (Melbourne).
- Population varies from 400 000 (Zürich) to almost 9 million (Mexico City, the core of a conurbation of 21 million people).
- Population density varies from 300 (Auckland) to 21 000 (Paris City) inhabitants per km^2.

Distinct groups of cities could be defined in order to make cities more comparable in the future. In this document we are seeking to compute indicators that are normalised and which facilitate comparison between areas of various sizes.

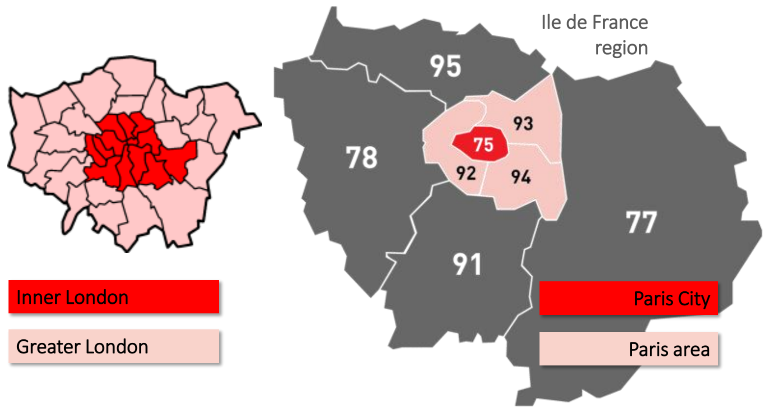
Table 1. Population and density statistics, 2015

Country	Code	City	land area (km²)	population	population density (/km²)
Argentina	ARG01	Buenos Aires	203	3 054 000	15 000
Australia	AUS02	Melbourne	8 825	4 462 000	500
Belgium	BEL01	Brussels (a)	161	1 175 000	7 300
Brazil	BRA03	Fortaleza	313	2 591 000	8 300
Canada	CAN01	Montreal (b)	365	2 000 000	5 500
Canada	CAN03	Calgary	825	1 231 000	1 500
Canada	CAN04	Edmonton	685	928 000	1 400
Canada	CAN02	Vancouver	115	666 000	5 800
Colombia	COL01	Bogotá D.C.	1 587	7 879 000	5 000
Denmark	DNK01	Copenhagen	86	580 000	6 700
France	FRA02	Paris area (c)	762	6 779 000	8 900
France	FRA01	Paris City	105	2 230 000	21 300
Germany	DEU01	Berlin	892	3 562 000	4 000
Ireland	IRL01	Dublin City	115	551 000	4 800
Italy	ITA01	Rome	1 285	2 865 000	2 200
Italy	ITA02	Milan	182	1 360 000	7 500
Latvia	LVA01	Riga	304	697 000	2 300
Mexico	MEX01	Mexico City	1 485	8 721 000	5 900
Mexico	MEX03	Guadalajara	151	1 460 000	9 700
Netherlands	NLD03	The Hague	80	516 000	6 400
New Zealand	NZL01	Auckland (d)	4 894	1 570 000	300
Poland	POL01	Warsaw	517	1 744 000	3 400
Portugal	PRT01	Lisbon	84	507 000	6 000
Serbia	SRB01	Belgrade District (e)	3 234	1 675 000	500
Spain	ESP02	Madrid	608	3 142 000	5 200
Spain	ESP01	Barcelona	101	1 605 000	15 900
Sweden	SWE01	Stockholm	187	924 000	4 900
Switzerland	CHE01	Zürich	88	410 000	4 700
United Kingdom	GBR02	Greater London (f)	1 572	8 674 000	5 500
United Kingdom	GBR01	Inner London (g)	319	3 472 000	10 900
USA	USA01	New York City	792	8 550 000	10 800

Notes: (a) Brussels Capital Region, made of 19 municipalities (b) Urban agglomeration of Montreal, also known as Montreal Island, made of 16 municipalities (c) City of Paris and three surrounding administrative units: Hauts-de-Seine, Seine St-Denis, Val de Marne (d) Auckland council, amalgamated council since 2010 (e) Belgrade District, also called Belgrade City or Belgrade, is made of 17 municipalities (f) Greater London, also known as London, is made of 33 local government districts (g) Inner London in its statutory definition is made of 13 local government districts.

In two areas, namely London and Paris, data was collected at two geographic levels: the inner and greater urban areas, which are analysed separately. The situation is illustrated on Figure 2. The collection of data at multiple geographic scales is encouraged: it helps not only compare cities of different administrative perimeters, but also understand how the road safety picture changes with urban form.

Figure 2. Concentric urban perimeters in London and Paris (to-scale)



Notes: Greater London includes Inner London. Paris area includes Paris City. Numbers are French administrative unit identifiers. London and Paris are drawn to the same scale. Adapted from Morwen (Creative Common).

Data Quality

This document reports on data collected directly from cities. The International Transport Forum (ITF) doesn't commission independent data audit in each of the participating cities, and couldn't fully assess the level of accuracy of each data contribution. The ITF however runs a number of quality control procedures. This involves internal consistency checks, comparison with alternative sources, and comparison with known values in comparable regions. In addition, the ITF collects relevant information on the data sources and survey methods, so as to elaborate correction factors where needed.

Where a data gap persists, the ITF undertakes a simple interpolation. Such interpolations are essential to support the computation of a 5-year average denominator (e.g. population, traffic, trips, etc.) as survey data can be missing between survey years.

In spite of the heterogeneous quality of the data presented in this document, the publication of road safety and mobility figures at city-level should be seen as a positive step forward: with the circulation of this document among the Safer City Streets network, we hope to maximise the level of scrutiny given to the data and correct any inaccuracy.

The Safer City Streets network involves not only local governments, but also national and international organisations, academia, road user groups, multilateral development banks and philanthropies, together committed to improve the use of robust evidence in the elaboration of road safety policies.

For any question or feedback on data quality, please contact the International Transport Forum on contact@itf-oecd.org

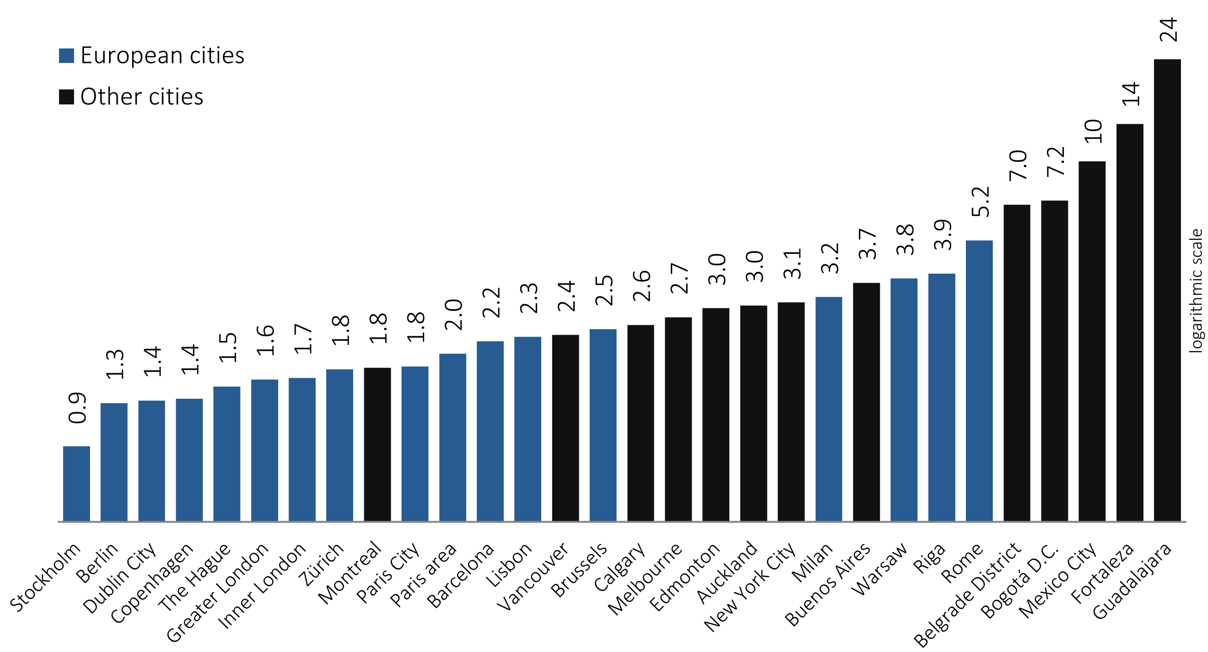
Traffic fatalities in cities

The indicator which is the most frequently used to measure road safety is the number of road fatalities per unit population, also called road mortality. This indicator was available in 17 urban areas in Europe and in 13 areas outside of Europe. In this report, the term Europe includes the 28 EU member countries along with Norway and Switzerland.

Unless otherwise specified, all indicators in this report represent a five-year average from 2011 to 2015. This is to mitigate the natural random fluctuations affecting the number of fatalities each year in a given city, a number which is typically small in statistical terms.

Results in Figure 3 reflect a wide range of situations, with a median of 2.5 fatalities per 100 000 population per year, with a highest value nearly ten times this amount. Such figures suggest that much progress can be made in most cities.

Figure 3. Fatalities per 100 000 resident population, 2011-2015



Notes: Fatality numbers in Madrid are pending validation and were not plotted.

Some cities have provided information on commuter trips, which enables the calculation of daytime population. The daytime population is defined as the sum of the resident population and the net flow of commuters towards a given area. The daytime population can be much greater than the residential population and is an important metric to better capture the level of activity within the city.

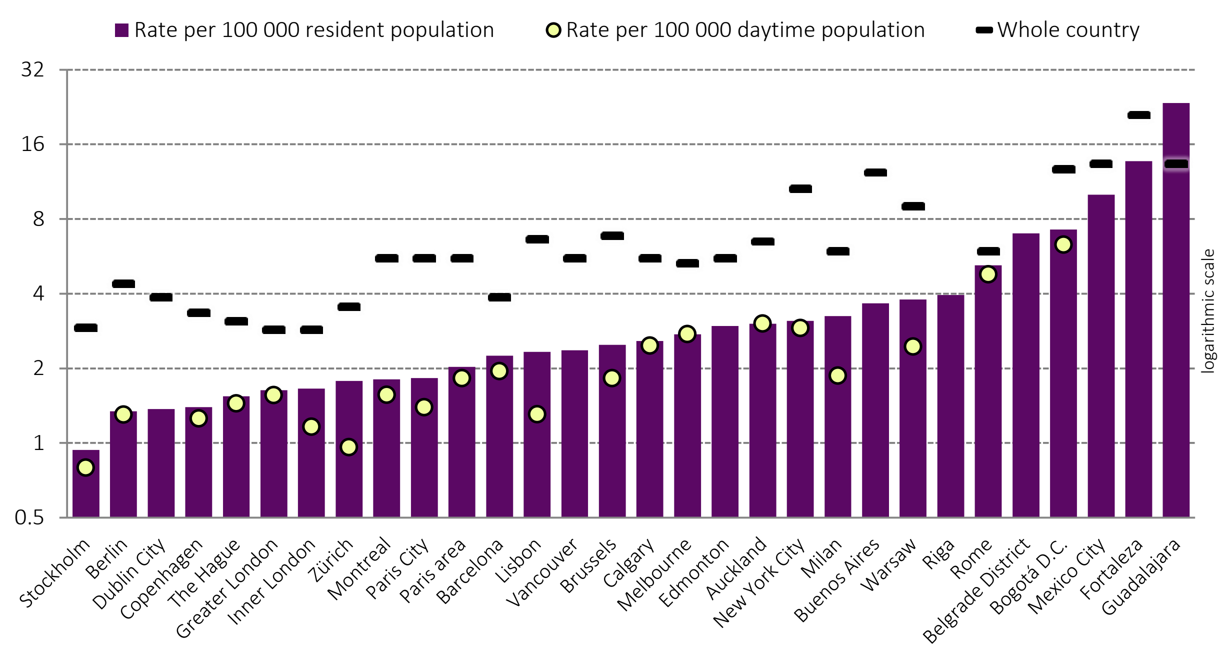
The number of fatalities per daytime population is represented in Figure 4. It makes Inner London stand out as much safer than Greater London as a whole. Similarly, the mortality in Paris City is lower than in the whole Paris area. As can be seen also in Zürich, Lisbon, Milan and Warsaw, the use of daytime population significantly affects the benchmarking results. All cities are encouraged to estimate their daytime population, for a more accurate estimation of risk exposure, and for a more robust benchmarking result.

The influence of city size and population density is worth investigating. However in this analysis, we wouldn't have enough cities to draw significant conclusions. Not only would more cities improve the analysis, but also more cities from the same countries. This question will be further examined in a forthcoming OECD/ITF report for the European Commission, in which more data will be used, at the level of functional urban areas.

In further research, we will investigate why denser cities tend to have lower mortality rates, and why cities in general tend to be safer than the whole country where they are located. Several hypotheses can be made to explain the phenomenon:

- Denser cities tend to have a higher proportion of trips using public transport, thus reducing the amount of private motor vehicle traffic per unit population.
- Denser cities tend to constrain the speed of motor vehicles.
- Denser cities give access to a vast choice of jobs and services within a relatively short distance, which can reduce the total distance travelled per person per day, and therefore exposure to risk.

Figure 4. Fatalities per 100 000 population, 2011-2015



Notes: Argentina, Brazil and Colombia: 2013 data from ITF 2017. Other countries: ITF IRTAD database (2011-2015).
At country level, the assumption is made that *resident* and *daytime* populations are equal.

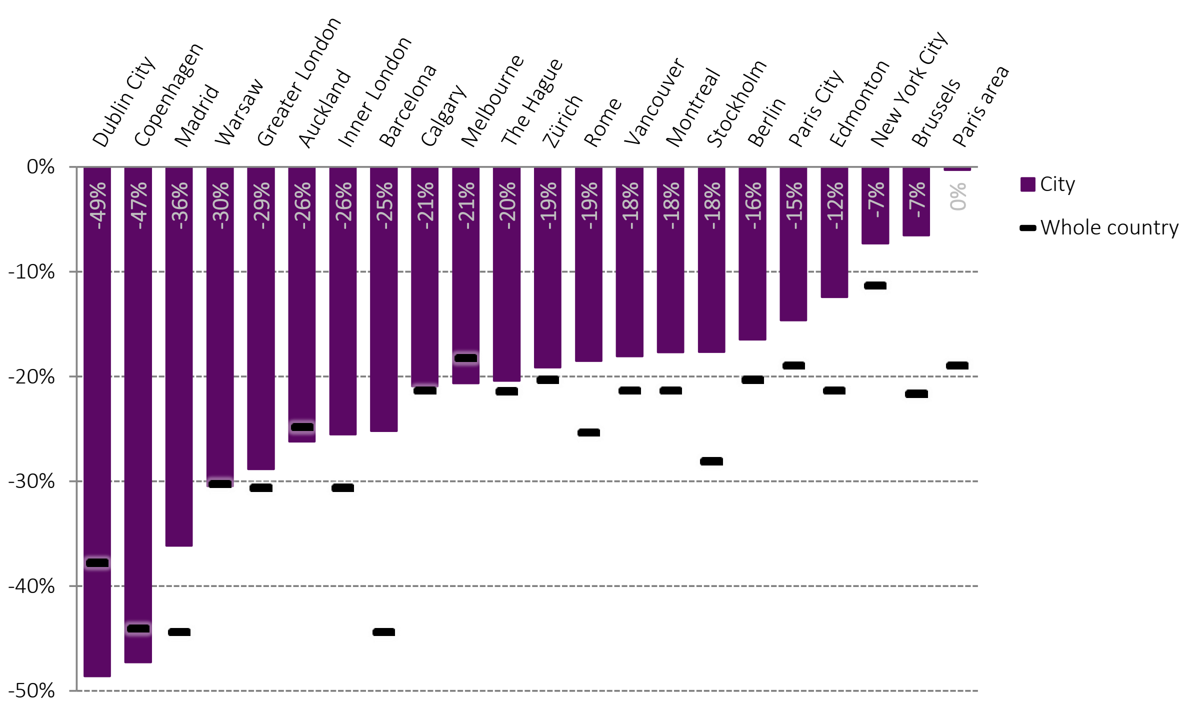
Monitoring changes in fatalities at city and country-levels

The number of fatalities recorded in cities was lower in 2011-2015 compared to the previous five year total. However, Figure 5 indicates that fatalities in cities decreased more slowly than the corresponding national level. In Barcelona for instance, the number of fatalities fell by 25%, whereas the Spanish total fell by 44%. In the Paris Area, the number of fatalities remained stable whereas the French total fell by 20%. In other cities, the gap is statistically less significant. The overall picture is clear nonetheless: fatalities fell more rapidly outside of cities.

The causes of this lag are yet to be thoroughly investigated. A faster population growth in cities may be one of the factors involved. Another factor could be the high share of vulnerable road users (VRUs) in cities, a group which didn't benefit from the development of air-bags and other safety features protecting car occupants. Some cities indeed report a rapid fall in car occupant fatalities, which they explain by the safety features integrated into new cars.

To put it simply, in cities where fatalities are disaggregated by mode, we observe a typical (median) 20% reduction in VRU fatalities, but a typical 25% reduction in car occupant fatalities.

Figure 5. Road fatalities, changes from 2006-10 to 2011-15



Source for country-level data: ITF IRTAD database

Urban traffic casualties by user groups

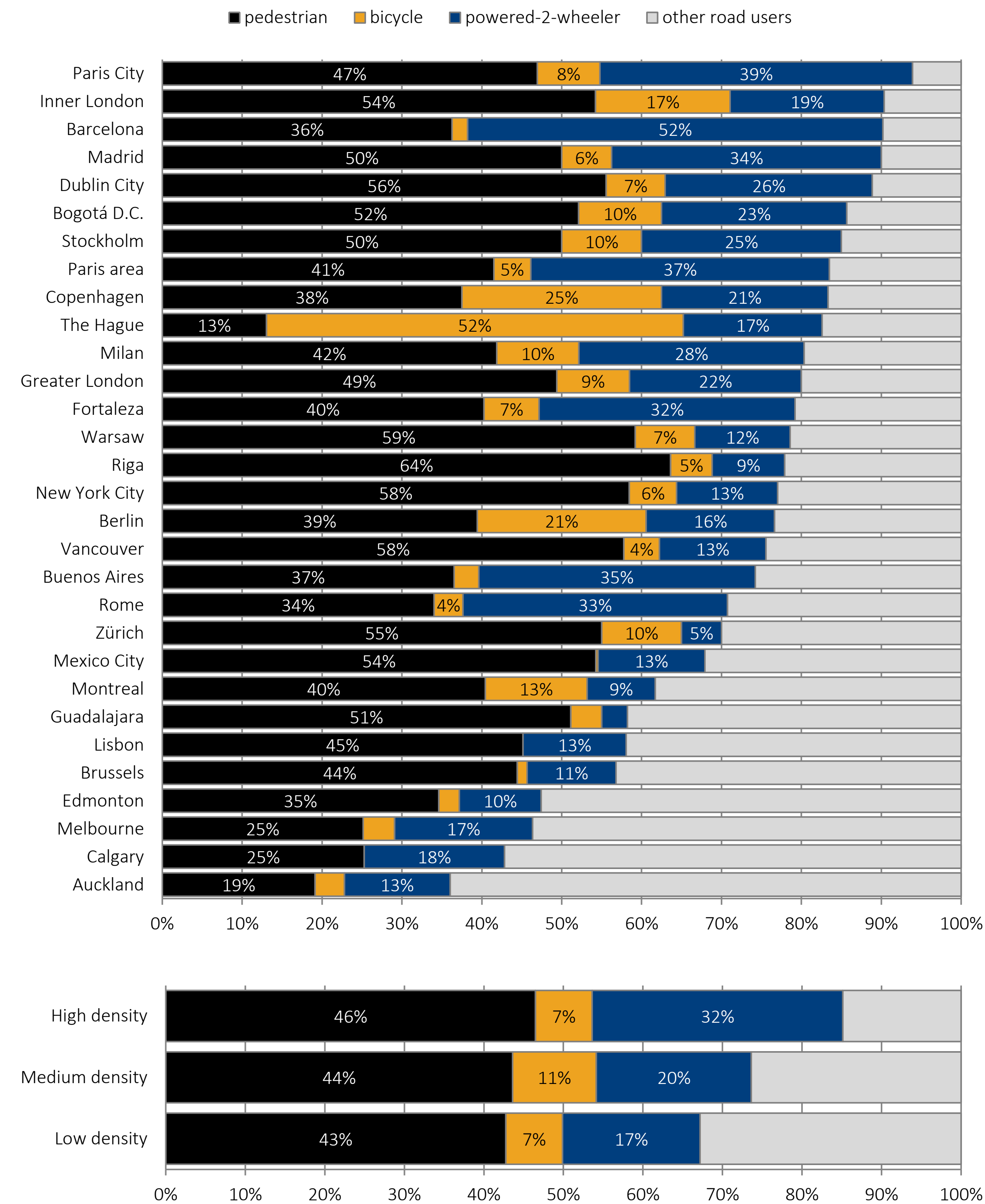
In most cities, the proportion of vulnerable road users (VRUs) in the total number of fatalities is high (Figure 6). The median is close to 80% and figures range from 36% to more than 90%. In Paris for instance, of the 41 road users killed annually on average during 2011-2015, 93% were VRU fatalities.

Across the 16 areas with figures available at both local and national level, the median share of vulnerable road users is 78% in cities, against 43% in the country as a whole. This is a considerable difference which explains the high level of interest for VRUs in the Safer City Streets network.

Vulnerable road users make up 85% of fatalities in high-density cities, those with over 10 000 inhabitants per square kilometre. In cities where the population density is lower than 5 000 inhabitants per square kilometre, VRUs still make up two thirds of road fatalities. It is remarkable that much of the difference can be attributed to the lower share of powered-2-wheeler fatalities in low-density cities. Pedestrians and cyclists together still make up 50% of fatalities in low density-cities.

Whilst Berlin, Copenhagen and The Hague have the highest shares of bicycle fatalities, further examination of the level of risk indicates that these are among the safest cities for cycling. The corollary is that one should be cautious when making an interpretation of this graph. Above all, it shows the importance of protecting VRUs in cities.

Figure 6. Modal shares of road fatalities, by city and by population density group, 2013-2015



Note: low population density (n=12) is less than 5 000 inhabitants per square kilometre, medium (n=13) is less than 10 000, high (n=5) is 10 000 and above. Where cities are grouped, we represent the unweighted average across n cities in the group

Fatality risk by transport mode

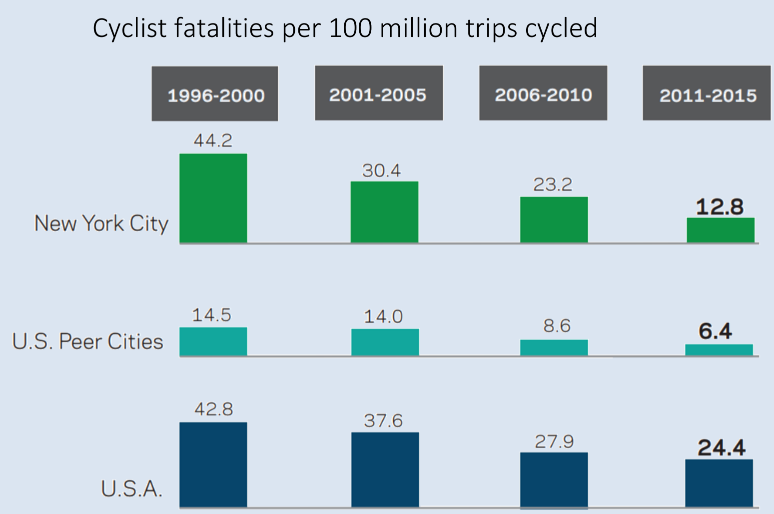
In this section, we examine the number of fatalities among a road user group, divided by the total distance travelled by the same group over the same period of time. This is a measure of the level of risk experienced by each road user group: a probability of being killed in a collision, for each unit of distance travelled.

Risk of fatality per unit distance travelled

Why distance? Some would argue that time is a more appropriate denominator. Some, constrained by the lack of available data, choose to use trips as a denominator (Box 1). The ITF proposes to work primarily on distance, the most commonly used metric. This follows the recommendation found in the methodological framework for the Safer City Streets initiative (ITF, 2016a).

Box 1. New York City cycling safety statistics

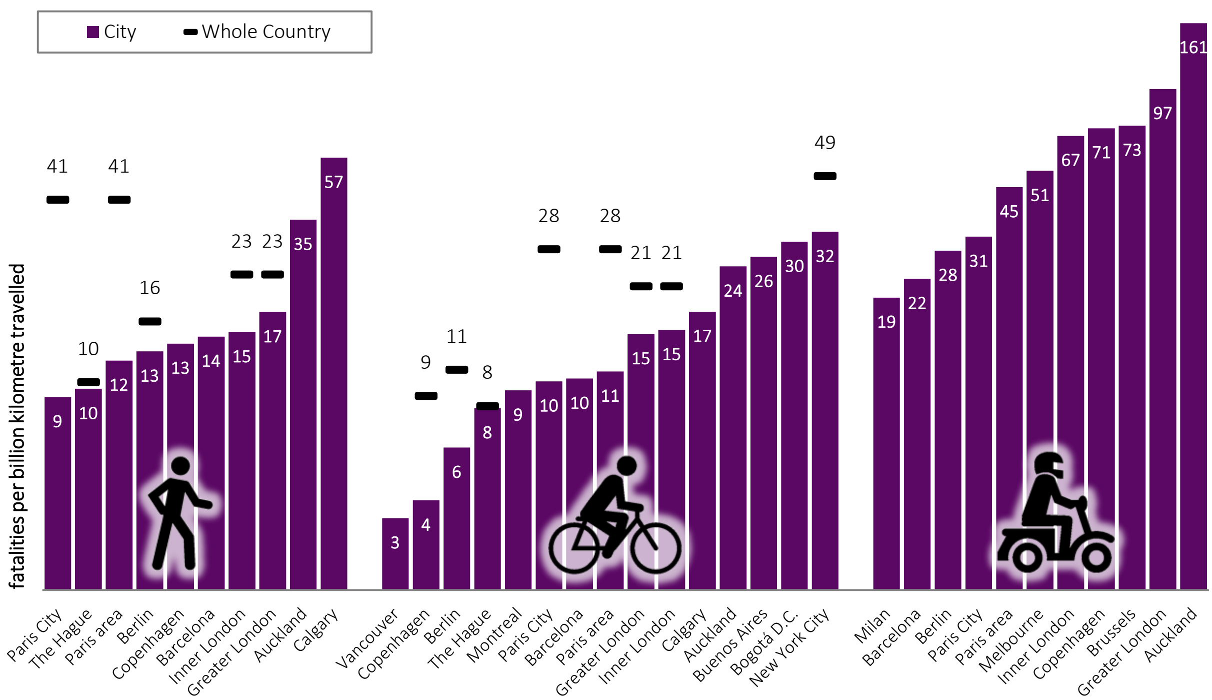
Cycling risk statistics can be presented by unit distance travelled, by unit time spent, or by the number of trips cycled. The latter is what New York City Department of Transportation (NYC DOT) has estimated and published in their 2017 Safer Cycling report. It shows a level of risk falling by more than 50% since 2001 in NYC, whereas a 35% reduction was observed at national level. It also shows an absolute risk level which is higher in NYC than in peer cities, which is giving the city administration the evidence to support an ambitious cycling safety plan.



Source: New York City Department of Transportation (2017)

Large variations in risk can be observed across cities (Figure 7). The risk experienced by pedestrians varies six-fold. The risk of being killed on a bicycle varies ten-fold. This again can be interpreted as room for progress, and could help cities learn from their peers. To some extent, differences observed across cities reflect the differences already observed across countries where the ITF (2018a) found cycling risk values between 8 and 51 fatalities per billion kilometres cycled (Table 2).

Figure 7. Risk of fatality per unit distance travelled, by mode, in cities and at country level, 2011-2015



Notes: Country-level risk figures from Castro et al. (2018). Country-level motorbike risk figures not available.

Table 2. Cycling exposure and risk by country, 2011-2015

Country	Distance cycled per year per inhabitant (km)		Cycling fatalities per year per million inhabitant		Cycling fatalities per billion km cycled
Austria	223	(2014)	5.4	(2011-2015)	24
Belgium	279	(2009)	6.5	(2011-2015)	24
Denmark	547	(2013)	5.0	(2011-2015)	9
Finland	267	(2011)	4.2	(2011-2015)	16
France	88	(2008)	2.4	(2011-2015)	28
Germany	439	(2011-2014)	4.8	(2011-2015)	11
Ireland	103	(2012-2014)	1.9	(2011-2015)	18
Italy	89	(2011-2015)	4.5	(2011-2015)	51
Netherlands	891	(2011-2015)	7.4	(2011-2015)	8
Norway	255	(2014)	2.0	(2011-2015)	8
Sweden	199	(2014)	2.3	(2011-2015)	12
Switzerland	262	(2011-2015)	4.1	(2011-2015)	16
United Kingdom	83	(2011-2015)	1.8	(2011-2015)	21
USA	48	(2009)	2.4	(2011-2015)	49

A particularly remarkable finding is that both walking and cycling fatality risks are typically lower in the city than in the country as a whole. This is most visible in Paris City, where the walking and cycling fatality risks are less than half the national average. This may support one of the hypotheses made in the previous section, which is that dense urban fabrics result in lower motor vehicle speeds. This being said, more research could be dedicated to refining this analysis and controlling for a number of potentially confounding factors, such as age, gender, time of day, etc.

Results also highlight that cycling is not as dangerous as people often think it is. In a majority of cities, it seems to be safer to travel one kilometre on a bicycle than on foot. The main caveat here would be the acknowledgement of confounding factors: in particular, if the two user groups (cyclists and pedestrians) have different age distributions and different fitness levels, their physical resilience may contribute to the difference observed here.

One solution to address some confounding factors has been developed by Transport for London (2013), where risk figures are cross-tabulated by user group *and* age group. In London, controlling for age and distance travelled, it indicates that cycling attracts a higher risk of death and serious injury than walking (Box 3).

To compare the fatality risk across modes of transport, we assembled a comprehensive dataset covering five modes of transport in five cities: Auckland, Barcelona, Berlin, London and Paris. Figures for each city and each mode are provided in Table 3, along with the median risk across all five cities. The risk of fatality is four times higher when riding a powered-two-wheeler than when riding a pedal cycle over the same distance. The risk of fatality is ten times higher on foot than in a passenger car travelling the same distance. Travelling on board a bus is an order of magnitude safer than all other modes of travel.

What interpretation could be made of such results by policy makers? Certainly that developing public transport is one of the keys to reducing road fatalities. Would there be a case to promote the use of private cars in cities, replacing some walkable or cyclable trips by car trips, on road safety grounds? This would be overlooking the risk imposed by motorised road users on other user groups, something which is not reflected in Table 3, but discussed in the next section.

Table 3. Number of fatalities per billion passenger-kilometres, 2011-2015

City	Bus	Passenger car	Pedal cycle	Pedestrian	Powered-2-wheeler
Auckland	0.4	1.9	24	35	161
Barcelona	0.0	0.7	10	14	22
Berlin	0.0	0.5	6	13	28
Greater London	0.2	1.4	15	17	97
Paris area	NA	1.4	11	12	45
Median	0.1	1.4	11	14	45

Fatality risk imposed on third-parties

Occupants of private cars are remarkably well protected from the risk of being killed in traffic. On the other hand, they contribute to a significant risk for vulnerable road users, such as pedestrians, to be killed in collisions with cars.

Box 2. Fatalities imposed on third parties

At the third Safer City Streets meeting, the City of Bogota reported on their efforts to consolidate information on road casualties across the different sources of information: Police, National Institute for Legal Medicine and Public Health Secretary. Consolidated 2017 figures in Bogota suggest that, whilst 19 private car occupants were killed in traffic crashes, 133 vulnerable road users (seven times more) were killed in crashes involving a private car. On the other hand, in a year when 59 cyclists were killed, only 3 pedestrians were killed in collisions with pedal cycles. This illustrates the significant impact of one road user group on others, relatively modest in the case of pedal cycles, yet overwhelming in the case of private cars.

Bogota pays particular attention to monitoring and improving the safety record of the taxi trade. Taxis are clearly separated in the collisions statistics, which is something other governments could learn from. The matrix below gives a complete picture of the number of fatalities resulting from each crash configuration in Bogota in 2017.

	Pedestrians	Pedal cycles	Motorcycles	Private cars	Buses	Taxis	Goods vehicles	Other vehicles	No third party	More than two parties
						TAXI		O	*	+2
	0	3	74	86	49	21	23	0	0	16
	1	0	2	11	16	3	10	0	12	4
	4	1	6	32	19	7	31	0	35	17
	1	0	0	4	8	3	5	0	4	5
Bus driver	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	1	0	5	0
Taxi driver	0	0	0	3	1	0	0	0	0	0
Taxi passenger	0	0	0	0	1	0	0	0	0	1
	0	0	0	2	4	0	2	0	11	0
	0	0	0	0	0	0	0	0	1	0

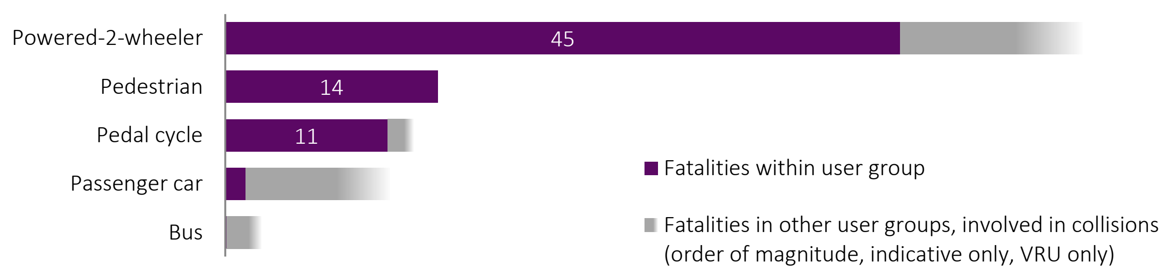
Note: each row is road user casualty group and each column is a third party vehicle involved in a collision.
Sources: minutes of the 3rd Safer City Streets meeting, presentation by Juan Pablo Bocarejo and Claudia Diaz.

The goal is not to attribute responsibilities or blame a particular user group, but to give an indication of the road safety benefits in the event of mode shift. Such calculations of "third party risk" could reveal the high impact of motor vehicles on the overall number of casualties, and strengthen the case for mode shift towards walking and cycling (ITF 2018).

Simulating the impact of mode shift would however benefit from computing fatality rates per unit travel time. Controlling for distances in this situation is questionable because mode shift often coincides with a shift in travel distances: people change destinations or home, due to limited travel time budgets, as they shift to a slower mean of transport. To illustrate how distance and time lead to different risk estimations, let's assume that urban trips on powered-two-wheelers (P2W) are twice as fast as cycling. Then the risk of riding a powered-2-wheeler, previously described as four times higher than cycling for a set distance in Table 3, would be presented as eight times higher than cycling for a set duration. When collecting more data from cities, the ITF will propose collecting travel durations in addition to distances.

Using data from Bogota (Box 2) as well as from Paris City and Inner London, a first estimation can be made of the number of third party fatalities among VRUs. As can be seen in Figure 8, for a given user group, it is possible to visualise the risk of being killed in traffic combined with the risk of causing fatalities among vulnerable road users. In these two components of risk, the latter has yet to be investigated in a greater number of cities and is therefore pictured as blurred.

Figure 8. Number of fatalities per billion passenger-kilometres, 2011-2015, median value across Auckland, Barcelona, Berlin, Greater London and Paris Area



Alternative road safety indicators

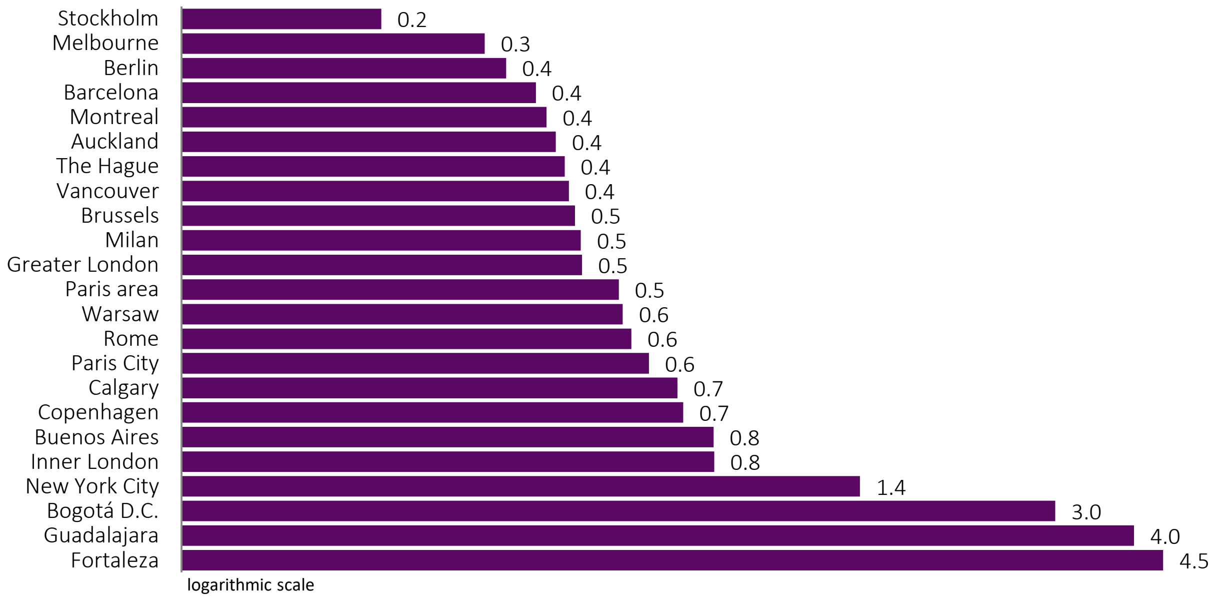
In this section, we examine several alternative but frequently used indicators, for the complementary insights they provide. These indicators share a common focus on the number of road traffic fatalities, that is the total number of fatalities across all modes, but differ in the choice of denominator: the value which is used to normalise the absolute number of fatalities and make it comparable across cities. One is controlling for the size of the vehicle fleet, one for the volume of traffic, and another for the length of the road network.

Traffic fatalities per unit of fleet size

Controlling for the size of the vehicle fleet, the number of fatalities ranges from 0.2 to 4.5 per year and per 10 000 vehicles registered. Here, the denominator includes all types of road motor vehicles subject to registration. That excludes pedal cycles but includes mopeds, motorcycles, cars, goods vehicles and buses. One should bear in mind that professional fleets (e.g. delivery or construction vehicles) often operate outside the municipality where they are registered. This may lead to a certain disconnect, relatively modest at country-level but more significant at city-level, between the number of vehicles registered in an area and the number of vehicles operating in an area.

With this indicator, the inner cores of Paris and London appear more dangerous than their wider urban area (Figure 9). This could be due to relatively low car ownership levels in core urban areas, where a significant traffic volume involves vehicles registered elsewhere (professional delivery fleets, suburban residents, taxis, etc.). If this is the case, and if car-sharing and ride-hailing services develop, a growing gap will form between vehicle ownership and traffic volumes in urban cores. The interpretation of this indicator is difficult for this reason. The high value observed in New York City is at least partly explained by this gap.

Figure 9. Number of fatalities per year per 10 000 vehicles registered, 2011-2015

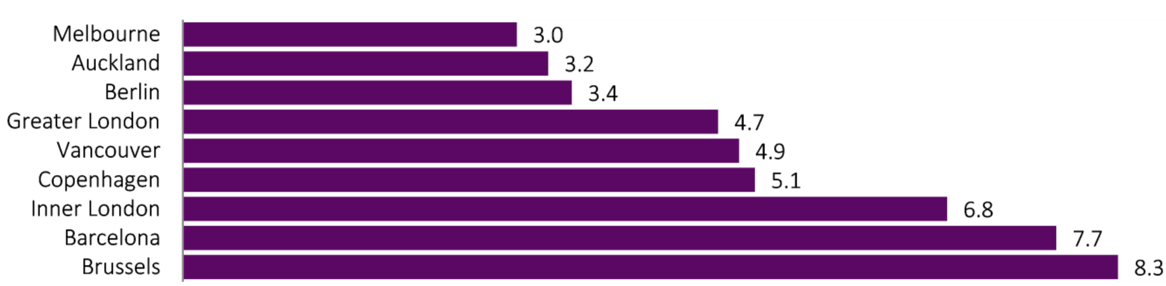


Fatalities per unit of traffic volume

Controlling for the volume of motor vehicle traffic, the number of fatalities ranges from 3 to 10 per billion vehicle-kilometres. For the reasons explained above, this is seen as a more relevant indicator, although fewer cities were able to estimate the vehicle traffic which is required as the denominator. Here again, the denominator includes all types of road motor vehicles subject to registration. That excludes pedal cycles but includes mopeds, motorcycles, cars, goods vehicles and buses.

This indicator reveals higher fatality rates in areas that are the most densely populated (Figure 10). One could speculate this is due to the high number of vulnerable road users (VRUs) and the high likelihood of conflict between VRUs and motor vehicles. Further analysis in this area would ultimately require the collection of statistics on crash matrices showing the number of road users killed in a particular user group in crashes involving another particular user group (Box 2).

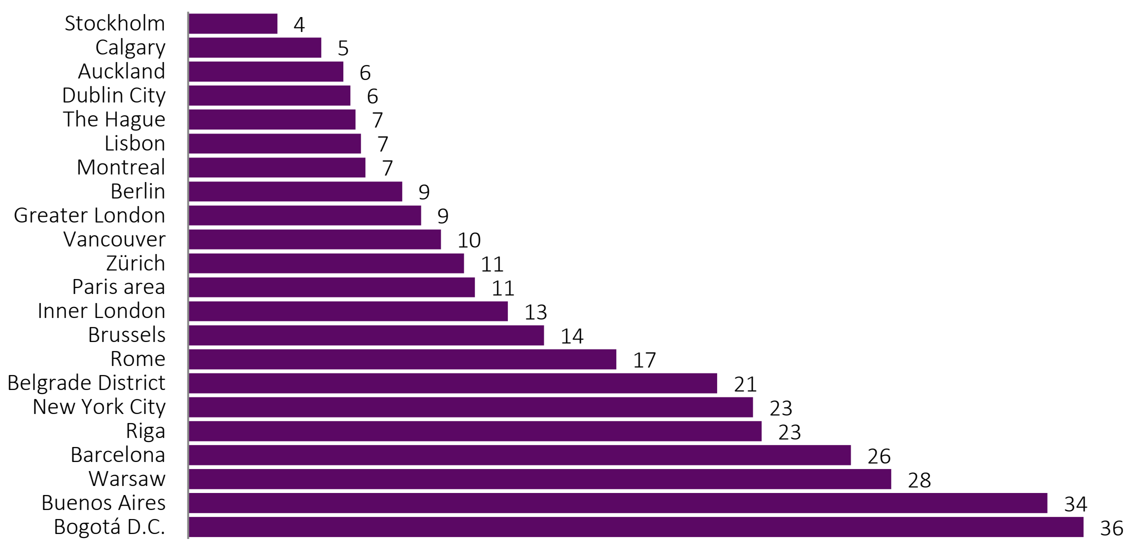
Figure 10. Number of fatalities per billion vehicle-kilometres, 2011-2015



Fatalities per unit of road network length

Controlling for the length of the road network, the number of fatalities ranges from 4 to 36 per year and per 1 000 kilometres. Figure 11 shows remarkable differences in comparison with the simple mortality rates presented in Figure 3 earlier. Rome had a significantly higher mortality rate than Warsaw but now appears safer (controlling for the length of the network) than Warsaw. This is a reflection of different urban fabrics. Rome has a dense road network, amounting to 3 000 kilometres of road per million inhabitants, including a number of residential roads. Warsaw has a lower road network density, with 1 400 kilometres per million inhabitants, which naturally leads to a higher concentration of both activity and crashes on a limited set of roads.

Figure 11. Number of fatalities per year per 1 000 kilometres of road network length, 2011-2015

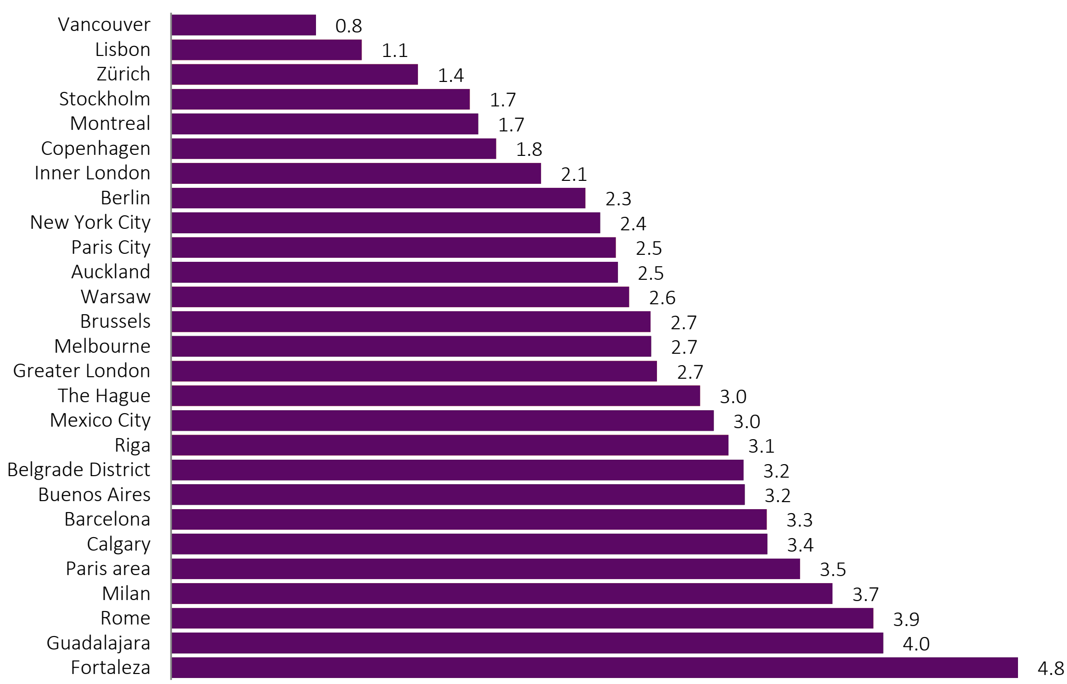


All three indicators used in this section are often seen in road safety literature, yet their interpretation is difficult. In the previous section, we saw that VRUs do not experience a higher risk of fatality in Inner London than in Greater London. Yet all three indicators in this section suggest a higher road risk in Inner London: they seem to be correlated with population density more than with the level of road danger experienced by individual members of the population. One should be cautious when using such indicators in benchmarks. This being said, they could prove useful in the policy making process: for instance, they could be used to identify cities and perimeters where speed limits and traffic demand management could bring most value.

Gender and age as traffic safety factors

Men are at least twice as likely as women to be killed in traffic. This is observed in the vast majority of cities (21 out of 27) where data is provided by gender. Figure 12 shows for each city the ratio of men and women fatality rates per unit population. A ratio of 1 indicates an equal risk for men and women. This ratio varies significantly across cities, from values close to 1 to values greater than 4 as observed in Rome and Fortaleza. Whilst high ratio values are likely to reflect behavioural gender differences, in particular different approaches to risk taking, it must be noted that high values can also be due to an increased exposure among men in places where they make more trips and/or travel longer distances.

Figure 12. Ratio between male and female fatalities per unit population, 2011-2015



The data reveals that urban cores tend to have lower ratios than wider urban areas. This is observed in both Paris and London where the greater urban areas show higher ratio values. Interpretation remains difficult however due to the need to separate the behavioural aspects from the mobility (i.e. exposure) aspects.

Nevertheless, some research does exist where road user risk is analysed by gender whilst controlling for the amount of travel and the mode choice. Transport for London (2014) merged their casualty dataset with their household travel survey and found that male pedestrians, cyclists and powered two-wheeler (P2W) riders had a significantly higher likelihood of being killed or seriously injured, controlling for the distance travelled in each mode. In England, Feleke et al. (2018) used the National Travel Survey to reveal that fatality rates for walking, cycling and driving are higher for males than females at almost every age and vary more by age than by travel mode.

Cities are encouraged to conduct travel surveys to measure differences in travel activity and mode choice between men and women, so this can be controlled for when conducting road safety research.

Figure 13. Fatalities per 100 000 population, 2011-2015, by gender and city

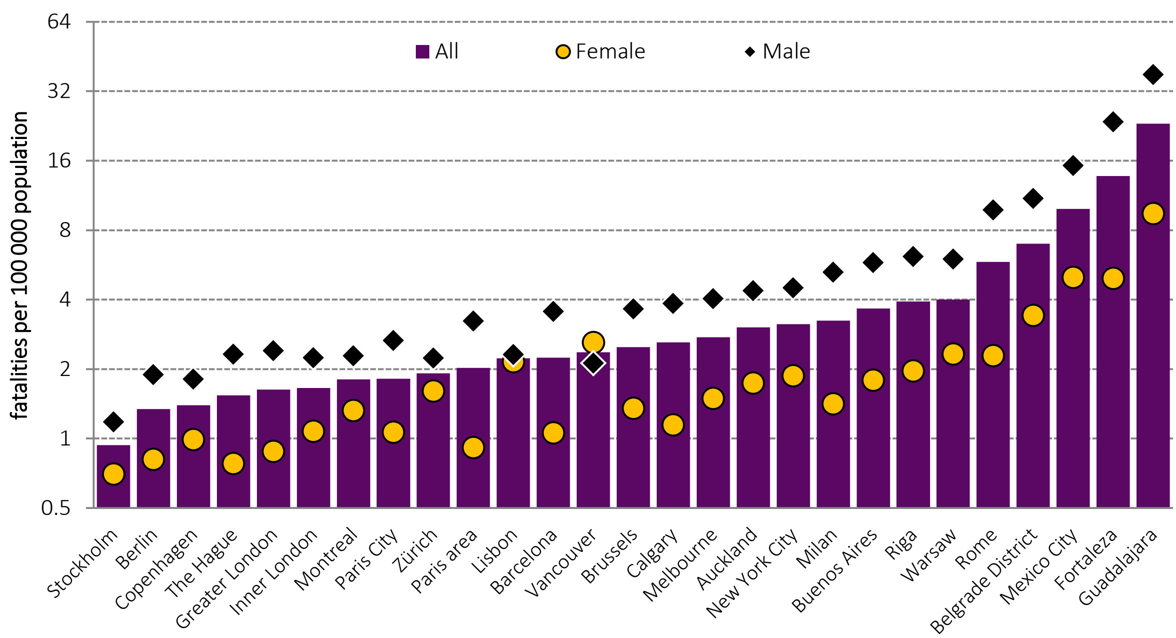
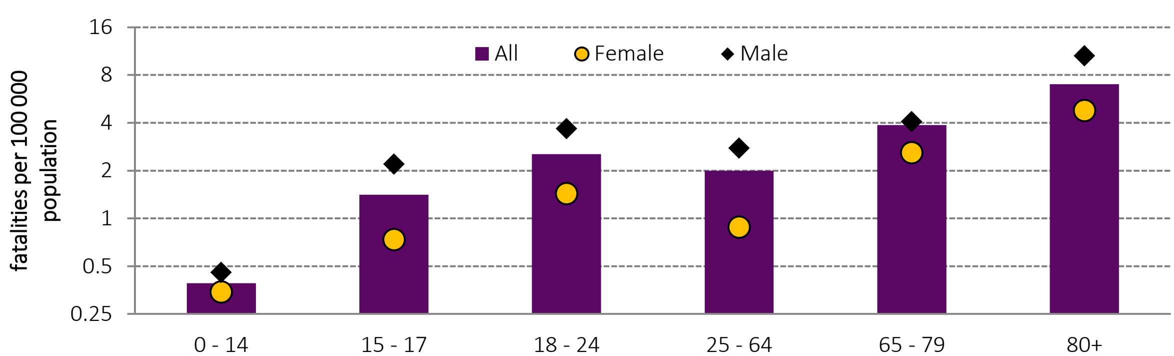


Figure 14. Mortality rates by gender and age, 2011-2015



Note: median values across 17 cities (Barcelona, Belgrade District, Brussels, Copenhagen, Greater London, Inner London, Melbourne, Milan, Montreal, New York City, Paris area, Paris City, Stockholm, The Hague, Vancouver, Warsaw, Zürich)

Reducing the mortality gap between men and women could be one of the keys to reducing road mortality. Indeed, the nine cities with the lowest mortality rates all display a gender ratio below three, whilst the five cities with the highest mortality rates all display a gender ratio above three (Figure 13).

Since age has a very significant impact on mortality and risk, it is recommended to control for this factor. With Figure 14, we learn that the most significant gender differences are observed in populations aged 18-64. Also, as people get older, their mortality rate increases. It is multiplied by two between the age bands of 25-64 and 65-79, and again between the age bands of 65-79 and 80+.

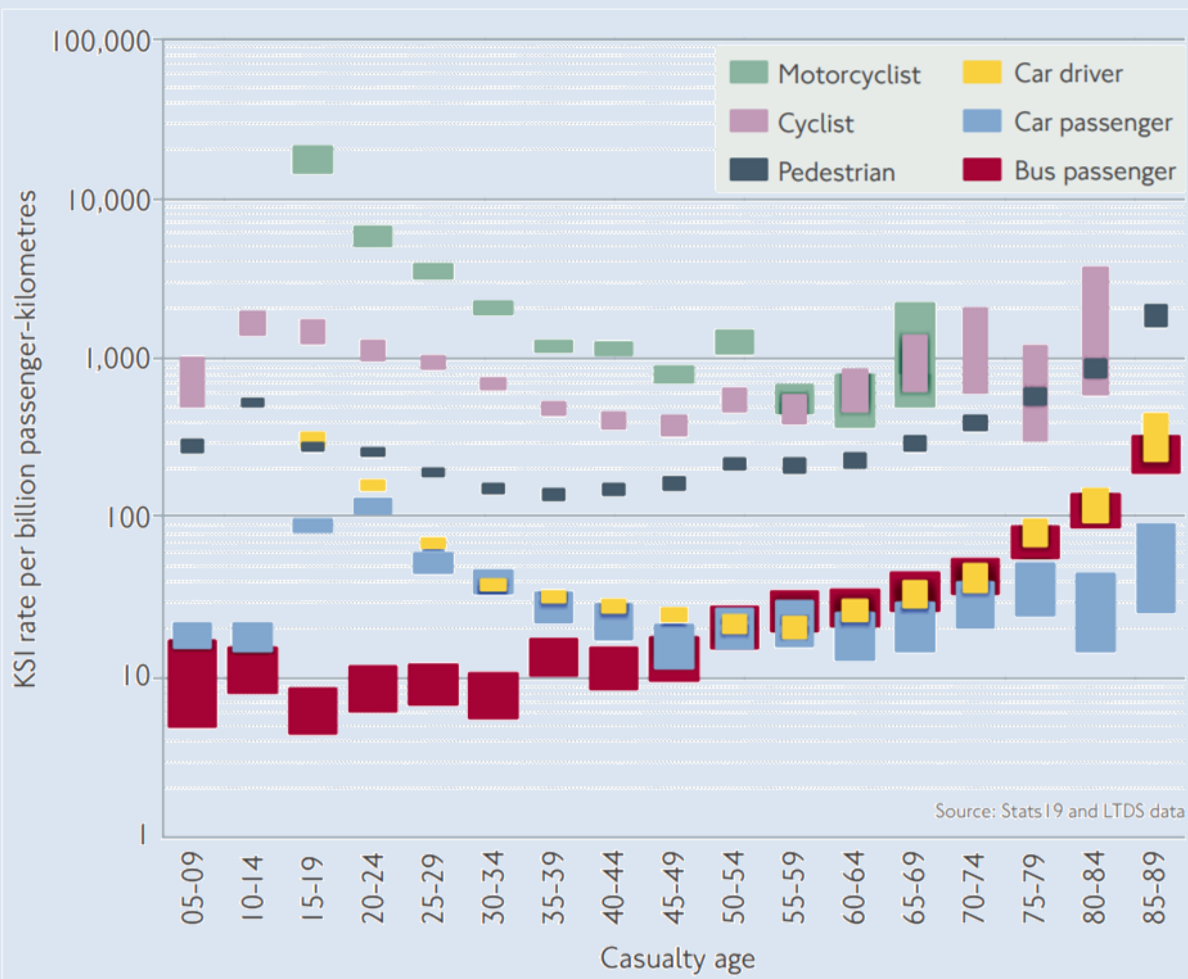
Box 3. Risk by age and mode

Revealing and monitoring casualty risk in different user groups is of great value to cities but requires significant data collection efforts, in particular to control for the amount of travel. Transport for London (TfL) undertook this exercise in 2013 to reveal that the risk of being killed or seriously injured (KSI) per unit distance travelled varies not only by mode but also by age in a very significant manner.

The risk falls by a factor a 10 for motorcyclists between the ages of 20-24 and 55-59. Likewise, between the same age bands, the risk experienced by car drivers falls with age by a factor of 10. This phenomenon is most likely due to behaviour and experience. It is also noticeable among people walking and cycling, to a lower extent. Risk however goes up again in old age, following a U-shaped pattern. For pedestrians, car drivers and bus occupants, the risk is multiplied by 10 between the ages of 45-49 and 85-89.

In the figure below, bars are used to express confidence interval, which are higher where the sample size is smaller.

Casualty rate per billion kilometres travelled by age and by mode



Source: Transport for London (2013)

Serious traffic injuries

Unlike fatalities which are standardised to the 30 day convention and which are assumed to be relatively well reported in police statistics, serious injuries are a source of concern. Different definitions are used across the world, reporting rates are low and they vary across countries.

To reveal the scale of the problem, the ratio of serious injuries to fatalities is calculated. This ratio varies from 2 to 43, a range which clearly points to inconsistent definitions (Figure 15). The median is of about 18 serious injuries per fatality.

In many countries, a "serious injury" in a road crash is defined by the police as an injury requiring at least 24 hours hospitalisation, and recorded as such in their reports. This definition, however, invariably includes a wide range of cases, from minor injuries requiring a period of hospital observation to the most serious injuries leaving the victims incapacitated for the rest of their lives.

Figure 15. Ratio between serious injuries and fatalities, 2011-2015

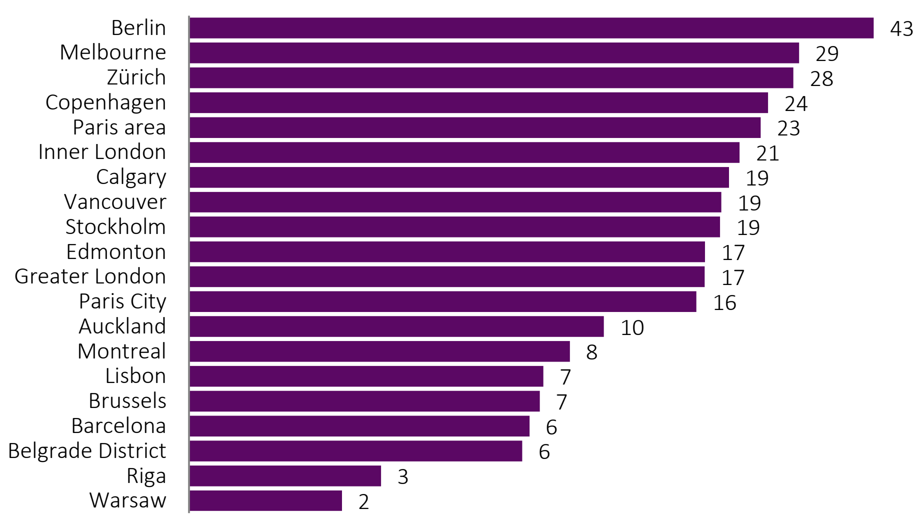


Figure 16. Ratio between MAIS3+ injuries and fatalities, 2011-2015

Hospitals in many countries are applying a medical definition of injury based on the amount and severity of the injuries sustained. These definitions are contained in the widely used the Injury Severity Scale (ISS), the Abbreviated Injury Scale (AIS) and the Maximum Abbreviated Injury Scale (MAIS). They reflect the threat to life associated with the injury, rather than a comprehensive assessment of the severity of the injury. Following the recommendation made by the ITF (2011), a level of injury of MAIS3+ has become the accepted cut-off for a serious injury, with anything below falling in the category of minor injury. A recent European Commission (EC) document adopted the MAIS3+ definition and states that in

Europe in 2014 there were 135 000 serious injuries according to the MAIS3+ definition (European Commission, 2016).

The MAIS3+ definition can therefore facilitate the consistent monitoring of progress across time and a meaningful comparison of figures across cities. Yet across the three cities where MAIS3+ injuries were monitored, the ratio of MAIS3+ injuries over fatalities ranges from 4 to 16 (Figure 16). Such a range of variation is unexpected and requires further investigation: are consistent methods being used for the estimation of MAIS3+ injuries across different cities?

Due to a combination of inconsistent definitions and reporting rates, in the absence of hospital data, injury data are not yet comparable across cities. This is why city-level road safety performance analysis is limited to fatalities. This choice affects the quality of the analysis in two ways:

- Much could be learned from injuries, as they don't necessarily follow the same pattern as fatalities.
- With a dataset limited to fatalities alone, much statistical significance is lost in the variability of small numbers.

The second point has severe consequences when working on data from a single city: with the inevitable variability of small numbers, the monitoring of single-city and single-year fatality numbers is rarely insightful. A change in the number of fatalities from one year to the next can rarely lead to a statistically significant conclusion on whether the trend is up or down. This explains our key recommendation for cities to further engage in the collection of robust and comparable injury data. Several methods exist; many are documented in ITF 2011, FERSI 2016 and SafetyCube 2016. One is illustrated in Box 4. Where hospital data is not available, a survey of the population can produce an estimate of the true number of injuries, whether or not they are reported to the police. As it is the case in England, such a survey could be integrated to a permanent travel survey (Aldred 2018).

Box 4. The Rhône Road Trauma Registry

The Rhône Trauma registry is a population-based registry which collects data on all new cases of injuries occurring in the French "département du Rhône", following a road crash, whether the victim is hospitalised or not. The Rhône administrative area contains about 1.6 million inhabitants, which significantly overlaps with the Lyon metropolitan boundaries. Injuries are coded on the Abbreviated Injury Scale (AIS). The register has existed since 1996 and involves 50 hospitals. It links with police records when available and uses common information (no common ID). A statistical model is trained on the Rhône data in order to estimate national injury figures from national police data. Under-reporting in police data is mostly influenced by severity, third-party involvement, and type of police force.

Thanks to the local household travel survey, serious injury rates were computed, by unit distance, by unit time in traffic and by unit trip. The register is a precious resource for the analysis of crashes often under-reported: single-party crashes, walking and cycling injuries, etc.

In the Rhône area, 95% of people with MAIS3+ are hospitalised, which makes it possible to use hospital data alone for the estimation of a simple total. Yet if the goal is to examine both crash circumstances and trauma outcomes, the linkage with police data is essential.

Risk of serious injury per unit distance travelled, by mode, in Rhône, 2005-2006

Type of user	Incidence MAIS3+ per million km travelled	Incidence Ratio
Car occupants	0.02	1
Pedestrians	0.17	8.5
Cyclists	0.73	36.5
Motorized two-wheelers	1.36	68

Source: Blaizot et al 2013, minutes of the 1st Safer City Streets meeting

Road user behaviour in cities

Following clear methodological guidance (ITF 2016a) and the example of the IRTAD database, road user behaviour data was collected for inclusion in the Safer City Streets database. The data reveals that the use of seat belts remains far from universal in cities. On rear seats in particular, the use of seat belts is much lower than it is on front seats. In Belgrade, the 2015 survey indicates wearing rates of 6% on rear seats, compared to 75% on the driver seat (Table 4).

Remarkably, the city with the lowest bicycle fatality rate, Copenhagen, also has one of the lowest percentages of people wearing helmets as they cycle. It shows the potential disconnect between behaviour indicators and the actual performance of the transport system, which must be kept in mind.

It must be noted that survey methods vary across countries which is why such figures must be interpreted with care. In addition, more behaviours and attitudes would be worth monitoring and comparing across cities. Speed is of course a key factor in the occurrence and severity of crashes (ITF 2018b). The monitoring of speed and of attitudes towards speeding has yet to be developed in a consistent manner before being integrated into the Safer City Streets database.

Table 4. Protective equipment wearing rate by city, 2015

City	Helmet		Seat belt in passenger cars			
	bicycle	powered 2-wheeler	child restraint	driver	front seats	rear seats
Auckland	89%		91%		97%	86%
Belgrade District		95%	53%	75%	64%	6%
Bogotá D.C.		88%	22%	89%	74%	6%
Brussels	41%	99%	92%	95%	94%	
Buenos Aires	19%	84%	37%	61%	46%	16%
Copenhagen	28%	91%		96%		85%
Fortaleza		83%	26%	72%	67%	27%
Montreal	45%			98%	98%	
Stockholm	79%			98%	97%	89%
The Hague			68%	97%	97%	82%
Warsaw		99%	95%	95%	97%	60%

Auckland: 2014 and 2015 data; Bogota: estimates; Brussels: 2013 P2W helmet wearing rate; Buenos Aires: 2016 data, with provisional bicycle helmet wearing rate; Copenhagen: 2014 and 2015 data; Montreal: estimates, 2014 and 2015; The Hague: 2010 data

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Safer City Streets
Global Benchmarking for Urban Road Safety

This document aims to support cities in setting road safety targets and to monitor progress in improving urban road safety. Pedestrians, cyclists and motorcyclists account for nearly 80% of urban traffic fatalities. Cities should thus intensify efforts to improve the safety of vulnerable road users. This document presents traffic safety indicators for different road user groups collected in 31 cities to facilitate the evaluation, monitoring and benchmarking of road safety outcomes. It places a particular attention on measuring the risk of fatality per unit distance travelled.

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