World Health Organization

EuroMed Transport SUPPORT PROJECT

UNDERSTANDING AND BRIDGING THE DIFFERENCES BETWEEN COUNTRY-REPORTED AND WHO-ESTIMATED ROAD TRAFFIC FATALITY DATA



Understanding and bridging the differences between country-reported and WHO-estimated road traffic fatality data

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World Health Organization

EuroMed Transport SUPPORT PROJECT

This booklet is a joint work of the European Union-funded EuroMed Transport Support Project (EuroMed TSP) and the World Health Organisation (WHO). It is addressed to authorities in the EuroMed Partner Countries, as well as in all WHO Member States. It aims to explain the disparity between WHO estimates and country-reported data on road traffic fatality and provide suggestions on what steps countries can take to bridge the differences and strengthen their data systems.

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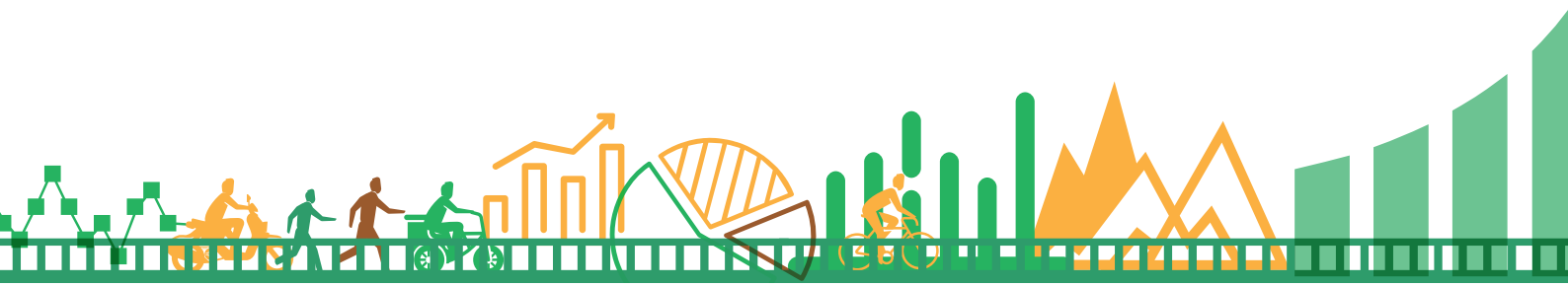
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INTRODUCTION

International commitments to Sustainable Development Goals and specifically target 3.6 – to halve the number of deaths and injuries from road traffic accidents – means countries are increasingly required to report accurate national road traffic fatality data.

However, all countries face considerable challenges in collecting complete, accurate and reliable road traffic fatality data. Among the challenges, often data are gathered across many sectors (including police, health, civil registration, insurance, and transport) whose systems are seldom linked and lack any systematic cooperation or exchange of knowledge. This often results in different sectors reporting different road traffic fatality statistics.

Other challenges include:

- **data accuracy**: there is often inadequate coverage of fatalities and injuries (known as "underreporting");
- **data comparability**: different definitions may be used by different sectors, and these definitions may not align with international standards;
- **data completeness**: there is often a lack of several key data elements required to support policy-making and the most useful data are often the least available (e.g. crash location, injury type, alcohol or drug impairment, use of seat-belt or helmet);
- **level of disaggregation**: it is often not possible to analyse data according to different road, vehicle or road-user characteristics;
- **data access**: information may be inaccessible or lacking the necessary meta-data (e.g. description of definitions and protocols used).

Despite these challenges there is very often complementarity in the data collected by different sectors. Overcoming these challenges is worthwhile, as combined assessment of different sectors' data can present a much more complete and accurate picture of the scale of the road safety problem. To this end, World Health Organization (WHO) recommendations on the development of national crash data systems[1] and EuroMed Transport Support Project recommendations on 'Setting up road safety reliable, harmonized and comparable data systems and sharing at regional level'[2] underline the importance of cooperation and the exchange of knowledge and experiences between different sectors.

Countries wishing to strengthen existing road crash data systems, or to design and implement new ones, can draw on the following strategies:

- improving the quality of police data and the performance of police road-crash systems;
- improving health facility-based data on road fatalities and injuries;
- improving vital registration data (VRD) systems, in particular the registration of deaths;
- combining existing data sources to obtain more accurate figures on the magnitude and effects of road crashes.

This booklet attempts to explain the disparity between WHO estimates and country-reported data on road traffic fatality and provide suggestions on what steps countries can take to strengthen their data systems. It advocates that improving vital registration data (VRD) is a major factor in achieving more accurate and reliable road fatality data, while acknowledging that this process is a big and long-term challenge. An immediate starting point for improving data quality is generating closer collaboration between the different sectors concerned, with the aim of creating multisectoral, integrated road safety data.

1 World Health Organization. Data systems. A road safety data manual for decision-makers and practitioners. Geneva: World Health Organization; 2010 (http://whqlibdoc.who.int/publications/2010/9789241598965_eng.pdf, accessed 12 March 2019).

2 EuroMed TSP: Final Report 'On existing best practices, methods and tools for collection and processing of reliable data, Diagnosis of the current situation in EuroMed Partner counties and Recommendations on the way forward.' European Commission, Brussels, 2018.

SECTION 1

Data discrepancies resulting from different definitions and sources

Country-reported fatalities and WHO estimated fatalities in the EuroMed region display differences ranging between 13% and 207% (see Table 1).

The use of different definitions of a road traffic crash fatality is one reason for such discrepancies. While police data are based on the international definition of "fatalities occurring within 30 days of the crash", data from other sectors (such as transport, insurance, health) may include fatalities occurring beyond that period.

Particularly, health sector data can give rise to differing definitions and data. The health sector itself is made up of three sources: hospital records, emergency services records, and vital registration data (VRD) based on death certificates issued by hospitals or private doctors. VRD for example do not take into account a time limit for when death occurs from a road traffic injury. Although the health sector is not formally responsible for collecting complete crash statistics, the need to collect VRD at the country level for all causes of death makes VRD very important for recording traffic fatalities. Moreover, VRD are the source of WHO-estimated road crash fatalities.

Table 1: Comparison of country-reported fatality statistics and WHO-estimated fatality statistics, EuroMed partner countries

Country	Country-reported fatalities*	WHO-estimated fatalities	Difference	Difference in %
Egypt	8211	9287	1076	13%
Lebanon	576	1090	514	89%
Tunisia	1443	2595	1152	80%
Morocco	3785	6917	3132	83%
Algeria**	4540	9337	4797	106%
Jordan	750	2306	1556	207%

* All countries use the definition of fatalities occurring within 30 days of the crash, except Egypt (killed at the accident scene) and Lebanon (fatality in an unlimited period following the crash)

** Data not available for 2016 in Global Status Report on Road Safety 2018 (GSRRS4). The latest data available are for 2013 from Global Status Report on Road Safety 2015 (GSRRS3)

Even countries with good data systems may encounter discrepancies between their reported fatalities and WHO estimates because WHO estimates rely on VRD alone. Table 2 shows the difference between country-reported fatalities and WHO estimates for several countries with good quality VRD (see Box 1 for an example of data flow and fatality estimates by different sectors in Greece).

Where police-based, country-reported data and/or country-registered VRD are of poor quality, a larger difference is expected. Moreover, in several cases, poor-quality or absent VRD leads to the use of statistical methods for WHO-estimated fatalities (see Section 2).



Table 2: Comparison of country-reported fatalities and WHO estimates for countries with good-quality VRD

Country	Country-reported fatalities*	WHO-estimated fatalities**	Difference in %
Kuwait	424	715	68.6
Turkey	7300	9782	34
Greece	824	1026	24.5
Chile	1675	2245	34
Canada	1858	2118	14
Guatemala	2058	2758	34
Portugal	563	768	36.4
United Kingdom	1804	2019	11.9
Japan	4682	5224	11.6

* Based on police data

** Based on VRD

Source: World Health Organization. Global status report on road safety 2018. Geneva: World Health Organization; 2018 (http://www.who.int/violence_injury_prevention/road_safety_status/2018/en/, accessed 12 March 2019).

Box 1. Data flow and fatality estimates by sector, Greece

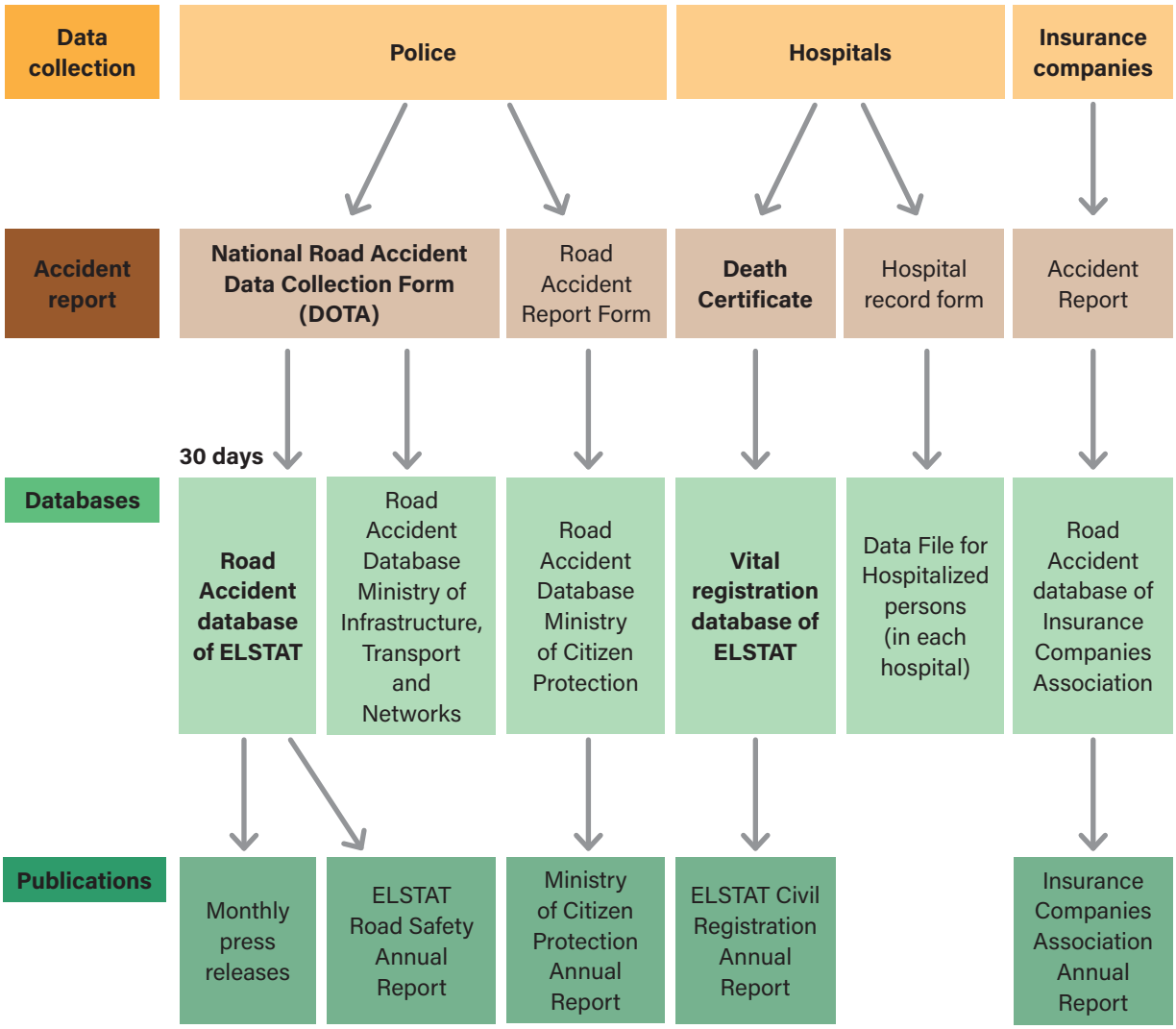
Greece has a range of sectors involved in collecting road fatality data – the police, health, and insurance sectors. The data flow (collection, transmission, storage and publication) of road crash data is shown in Figure 1. The agency responsible for the national road crash database and the national data collection form is the Greek Statistical Authority (ESTAT)[3].

Police are responsible for collecting road crash data at the scene and following-up on all fatalities that occur within 30 days, after which the national data collection form is submitted to ELSTAT for processing; a copy is submitted to the Ministry of Infrastructure, Transport and Networks, which maintains its own crash database. The police also has its own crash database.

Crash casualty data are collected in each hospital, through records of hospitalized persons, mostly in paper form and without a central database facility. Death certificates issued for all crash fatalities are forwarded from hospitals to regional and local civil registration agencies, and eventually to the VRD database operated by ELSTAT.

The insurance sector also collects road crash data (including property-damage only crashes) and maintains a crash database.

Figure 1: Road crash data flow, Greece



Source: Based on Yannis G. Road accident statistics: The Greek experience. At the Athens regional workshop on setting up a reliable, harmonized and comparable road safety data collection system and sharing at the regional level of the EuroMed Transport Support Project; 2018 (https://www.nrso.ntua.gr/geyannis/wp-content/uploads/geyannis-cp309.pdf, accessed 20 June 2019).

3 Hellenic Statistical Authority (ELSTAT) (https://www.statistics.gr/en/home/ accessed 20 June 2019)

Although the various databases are not linked, the role of ELSTAT is to consolidate police data and VRD and produce monthly statistics on road traffic deaths that are published in a press release.

Moreover, detailed final annual results are disseminated within 10 months of the end of the reporting period.

Table 3 shows the data differences between the ELSTAT fatality estimates and VRD-based fatality estimates. The police reporting rate for deaths represents around 82–84% of death certificates (VRD), placing Greece in Group 1 of countries according to WHO classification (see Section 2). A large part of these discrepancies results from the different definitions applied. However, despite the good quality of both data systems, a degree of underreporting is involved in both sectors, as has been estimated in recent studies.[4,5]

Table 3: Comparison of police data and VRD, Greece, 2000–2015

	Source		Difference	
	ELSTAT (police)*	VRD (hospitals)**	VRD/ELSTAT	Average
2000	2037	2288	1.12	1.16
2001	1880	2035	1.08	
2002	1634	1865	1.14	
2003	1605	1794	1.12	
2004	1670	1984	1.19	
2005	1658	1971	1.19	
2006	1657	1851	1.12	
2007	1612	1793	1.11	
2008	1553	1722	1.11	
2009	1456	1647	1.13	
2010	1258	1430	1.14	
2011	1141	1339	1.17	
2012	988	1191	1.21	
2013	879	1096	1.25	
2014	795	1025	1.29	
2015	793	956	1.21	

* Fatality within 30 days

** Fatality within an unlimited time period

Challenges in data accuracy

Underreporting of road traffic fatalities represents a real challenge to data collection in all countries, and there are several known causes:

Police reported data:

- Non-use of the 30-day definition of fatality.
- Insufficient follow-up of traffic casualties up to 30 days.
- Some road crashes not being reported to the police ("real" underreporting).
- Police not attending reported crashes due to inadequate human resources.
- Police not properly registering a crash because they are not sufficiently trained.

Vital registration data:

- Non-use of international protocols for the classification of causes of death.
- Lack of knowledge of health sector practitioners in properly assigning cause of death.
- Lack of skills in drafting death certificates that meet WHO standards.
- Poor coordination between central and local authorities in the collection and processing of VRD.

4 Petridou E, Yannis G, Terzidis A, Dessypris N, Germeni E, Evgenikos P, et al. Linking emergency medical department and road traffic police casualty data: a tool in assessing the burden of injuries in less resourced countries. Traffic Injury Prevention. 2009;10(1):37–43.

5 Broughton J, Keigan M, Yannis G, Evgenikos P, Chaziris A, Papadimitriou E, et al. Estimation of the real number of road casualties in Europe. Safety Science. 2010;48(3):365–371.

SECTION 2
Understanding the WHO Global status report on road safety methodology

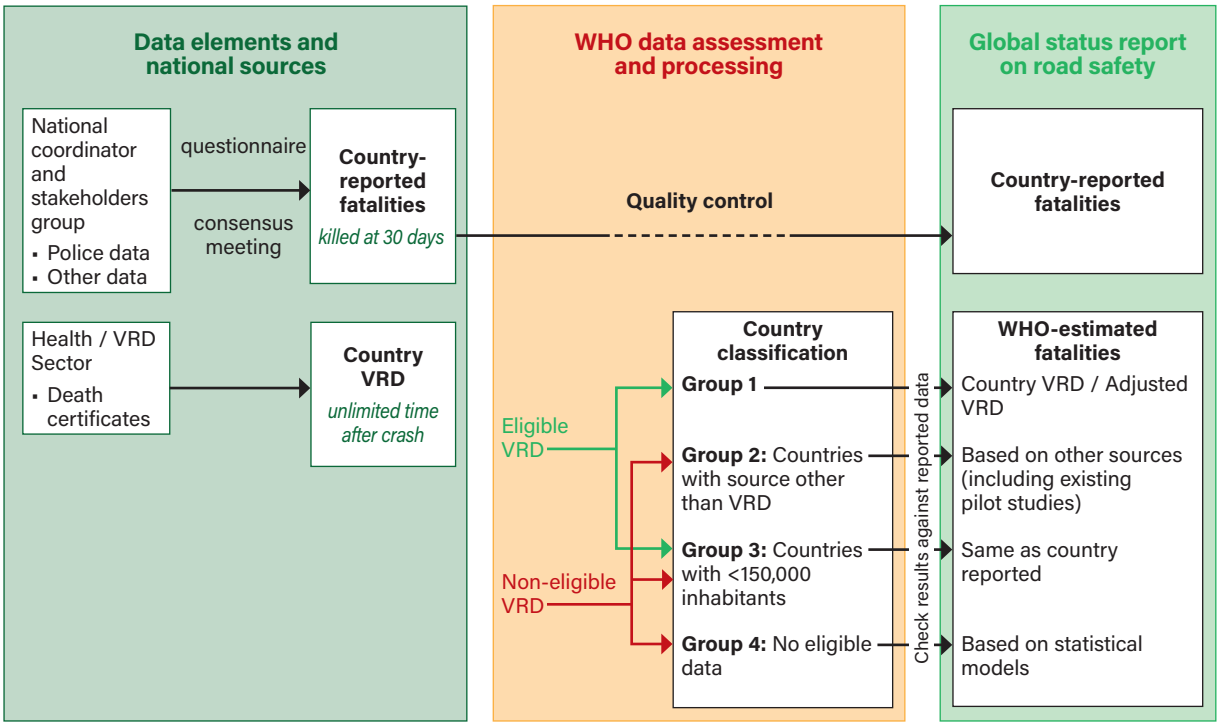
WHO Global Status Report on Road Safety statistics

In its *Global status report on road safety*, WHO publishes integrated police data and VRD (and data from other sectors where relevant) for each country. An overview of WHO data sources, data flow and final estimates in the *Global status report on road safety* is shown in Figure 2.

Each country profile in the *Global status report on road safety* contains two statistics (see Table 4):

- The national road traffic fatalities figure as reported by the country (in most cases based on police data sources) using the 30-day definition of fatality.
- WHO-estimated road traffic fatalities: these estimates are calibrated depending on the quality of the country's VRD system (see next subsection for country groupings). WHO uses the reported VRD for road traffic fatalities for countries with good quality VRD. For those with lower quality VRD a model is developed, and the final data are based on several variables (see "WHO statistical model" section).

Figure 2: WHO data sources, data flow and final estimates





WHO criteria for VRD quality and country classification

Countries are assigned to one of four WHO groups depending on the quality of their reported VRD:

- **Group 1**: Countries with good VRD statistics (completeness for the year estimated at 80% or more, average completeness for the decade including the last year at 80% or more).
- **Group 2**: Countries with other sources of information on causes of death (including recent studies submitted to WHO).
- **Group 3**: Countries with a population of less than 150 000.
- **Group 4**: Countries without eligible VRD.

A detailed list of countries by group is provided in Appendix 1 of this booklet. For countries in Group 4, WHO estimates traffic fatalities based on the statistical model explored in the next subsection.

The WHO statistical model

The WHO statistical model is applied for Group 4 countries to estimate traffic fatalities based on variables such as gross domestic product (GDP), road network density, vehicle ownership, health system characteristics, and other sociodemographic and transport indicators. WHO-estimated road traffic fatalities are provided together with their confidence interval (denoted as CI) – i.e. the range within which the estimated value lies, expressing the reliability of the statistical estimation. The details of the formulation of the statistical model and variables are provided in Appendix 2 of this booklet.

Understanding differences in reported data in the EuroMed region

Table 4 shows EuroMed country-reported data and the VRD on road traffic fatalities received by WHO, as well as the respective country classification. **Of the six EuroMed partner countries engaged in this exercise, only Egypt's VRD meets WHO's quality criteria, with all other countries in the group classified as Group 4 (this means that the WHO statistical model is used to estimate their fatalities)**.

It is worth highlighting, however, that there is no single reason for the observed discrepancies between country-reported fatalities and WHO estimates. While the difference is largely due to the poor VRD quality, there are also considerable gaps and limitations in the country-reported fatalities. For example, Egypt and Lebanon do not use the 30-day definition of fatality, while Tunisia has flagged that it has difficulties in reporting its fatalities completely. Further country-specific analysis is presented in Box 2.

Table 4: Comparison of country-reported fatalities, VRD-based fatalities and model-based WHO-estimated fatalities, six EuroMed partner countries

	Global status report on road safety statistics		VRD statistics**			
	Country-reported fatalities*	WHO-estimated fatalities	Reported VRD	Year	Completeness	Country classification group
Egypt	8211	9287	8211	2015	94%	1
Lebanon	576	1090	–	–	–	4
Tunisia	1443	2595	298	2013	29%	4
Morocco	3785	6917	887	2014	29%	4
Algeria**	4540	9337	–	–	–	4
Jordan	750	2306	669	2012	59%	4

* All countries use the 30-day definition except Egypt (killed at the accident scene) and Lebanon (fatality within an unlimited period following the crash)

** Figures of latest year available

Box 2: Analysis of discrepancies in EuroMed countries

Egypt is the only Group 1 EuroMed partner country engaged in this exercise. The WHO-estimated number of fatalities for Egypt is based on actual VRD reported, but there is a challenging situation for road fatality data collection in the country as the various data sources are not linked between the following sources:

- police record fatalities occurring at the scene of the crash;
- emergency medical services record fatalities occurring during the transfer;
- hospitals record fatalities occurring while in the hospital.

Moreover, the 30-day follow-up of crash casualties to complete police data files is not carried out in all cases. Therefore, country-reported fatalities, based on police data, are clearly an underestimation of actual fatalities.

Morocco has several good practice elements in its road safety data collection, including:

- engagement and systematic cooperation among key stakeholders;
- compliance with international definitions and standards; and
- several steps of data cross-checking and validation before publication of country-reported fatalities.

However, VRD-based fatalities in Morocco are five times lower than those reported by the country, leading to the classification of the country in Group 4.

In **Jordan** the difference between country-reported fatalities and WHO estimates is the largest in the region (207%), but nevertheless there seems to be potential for improvement, as the VRD reported is relatively close to the required level of completeness. Moreover, there are known reasons for VRD underreporting of road fatalities, such as non-inclusion of foreigners and the misclassification of cause of death for some road traffic victims.

SECTION 3
Improving data quality

Benefits of improving data quality

The benefits of improving the quality of country-reported data and VRD are considerable, since credible data may play an important role for all in-country agencies in cross-checking the accuracy of their statistics. Moreover, a smaller difference between WHO estimates (VRD) and country-reported data demonstrates the accuracy of national data systems, enhances their credibility and reflects the important efforts of all agencies involved.

Sustainable Development Goal target 3.6.1 calls for a halving of road traffic fatalities and injuries by 2020 and countries will need to report accurately on road fatality data in the near future in order to show their efforts in this area.

Improving the quality of national data and reducing data discrepancies

It is important to note that perfectly matched country-reported data and WHO estimates are by no means the ultimate objective, and a small difference is acceptable, as there is a known difference in the definition of fatality.

The EuroMed Transport Support Project and WHO are helping countries to understand WHO's methodology and its related estimates and are also providing technical assistance to countries wishing to improve their data systems. Recent experiences confirm that countries that have worked closely with WHO have improved their understanding of the discrepancies and eventually their data quality (see Box 3 on the case of Thailand).

WHO recognizes the limitations of a model-based estimate for countries in Group 4, as it has uncertainties like any model estimate. WHO strongly encourages countries to strengthen cooperation among stakeholders to improve their data so eventually they can move from Group 4 to Group 1. Ways to do this include the following activities and objectives.

1. Mobilizing and establishing intersectoral cooperation

The first step **is to identify the problem and establish cooperation between the police, transport, and the health/VRD sector.** The mobilization of all relevant authorities is an important prerequisite for ensuring the engagement of all agencies working to improve road fatality data. At the same time, **countries are strongly encouraged to establish cooperation with the WHO Violence and Injury Prevention Department for the identification of country-specific challenges, and to request tailored advice and assistance.**

2. An intermediate objective: shifting to Group 2

The improvement of a country's VRD system requires time and resources, and not all countries have the immediate human and financial resources available to meet the WHO criteria to shift to Group 1. Therefore, an intermediate and perhaps more realistic objective would be a shift to Group 2.



As Group 2 requires other sources of information on causes of death, countries may carry out research studies aimed **at estimating the level of underreporting of road traffic fatalities** with the cooperation of the police and the health sector. Such studies are based on linking and matching records in police and hospital databases in a given area, with coverage by specific police departments and hospitals. There are different ways to achieve this but describing them is beyond the scope of this booklet. Such studies can be implemented with a lower level of resources, and cooperation with universities or research institutes may provide opportunities.

There are numerous relevant examples of this from European countries[6] (e.g. France[7], Greece[8], the Netherlands[9] and United Kingdom[10]). The added value of such studies, contributing indirectly to the improvement of VRD, is that they allow a better understanding of the degree and the sources of road fatality underreporting in a given country, and the identification of specific gaps and issues that warrant further attention (e.g. geographic areas, specific populations etc.). For a detailed list of relevant studies from across the world see: http://erso.swov.nl/data/content/studies_about_underreporting.htm

The results of such studies allow the estimation of correction coefficients for the number of fatalities found in each data file. **The results may be examined by WHO to determine whether they replace the model-based WHO estimate, and shift the country from Group 4 to Group 2.**

3. The eventual objective: shifting to Group 1

A prerequisite for a country's VRD to be considered eligible is the adoption and use of the 7th-11th revision of the International Classification of Diseases (ICD). Moreover, the adoption and use of the WHO death certificate model is an important step in the improvement of VRD. **Acknowledging that this death certificate model is often found to be complicated, especially for private medical practitioners, WHO offers the option of a "simplified" death certificate model.[11]**

6 Broughton J, Keigan M, Yannis G, Evgenikos P, Chaziris A, Papadimitriou E, et al. Estimation of the real number of road casualties in Europe. Safety Science. 2010;48(3):365–371.

7 Amoros E, Martin L, Laumon B. Underreporting of road crash casualties in France. Accident Analysis and Prevention. 2006;38:627–635.

8 Petridou E, Yannis G, Terzidis A, Dessypris N, Germeni E, Evgenikos P, et al. Linking emergency medical department and road traffic police casualty data: a tool in assessing the burden of injuries in less resourced countries. Traffic Injury Prevention. 2009;10(1):37–43.

9 Bos N, Derriks H, Reunings M, Correction for underreporting of road traffic casualties in the Netherlands (https://www.itf-oecd.org/sites/default/files/docs/4-bos2.pdf accessed 12 March 2019).

10 Cryer PC, Westrup S, Cook AC, Ashwell V, Bridger P and Clarke C (2001). Investigation of bias after data linkage of hospital admissions data to police road traffic crash reports. Injury Prevention, Vol. 7, pp. 234-241.

11 World Health Organization: WHO Application of ICD-10 for low-resource settings initial cause of death collection; 2018 (https://www.who.int/healthinfo/civil_registration/ICD_10_SMoL.pdf?ua=1, accessed 12 March 2019).

Countries may wish to explore how best to incorporate the simplified death certificate in their country. One concrete project could be the application of the WHO SMoL (Start-Up Mortality List) which contains an electronic version of the simplified death certificate model. The application is available online and for mobile devices. It allows death certificate data to be filled-in online and directly submitted to a central database. The project requires a formal adoption process by the Ministry of Health, and the engagement of police, hospitals and private doctors. It can be initially implemented in one small region or in a single hospital to test acceptability and feasibility. Formal adoption and full-scale implementation can then be undertaken, monitored and evaluated.

Some countries such as Kenya already use such a system for other causes of death, with remarkable results. For these countries, the adjustment of the application to include VRD for road injuries could be done with minimal effort.

4. Strengthening efforts to improve police data quality

Countries should continue working to improve national statistics on fatalities based on police data. Even if a country is shifted to Group 2 or Group 1, incomplete and inaccurate police data will result in a persistently large discrepancy.

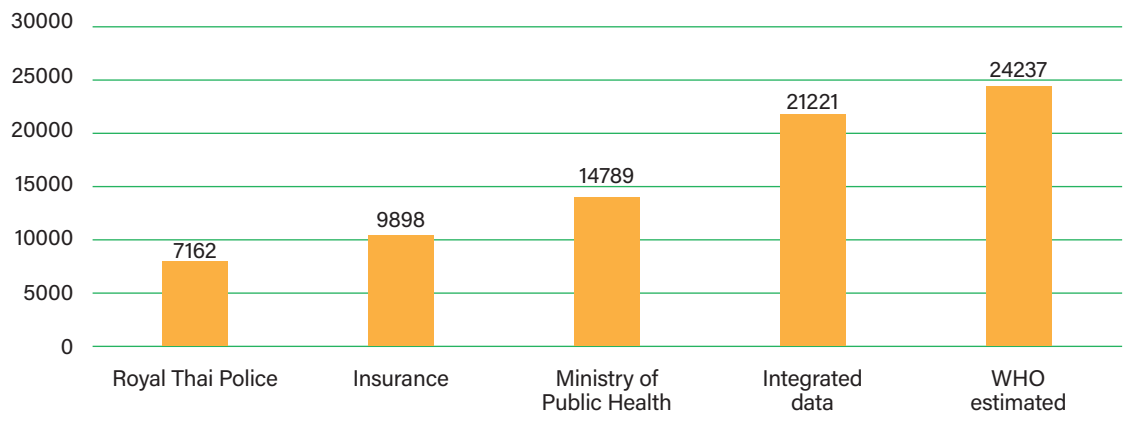
Countries should adopt and properly implement international definitions and protocols regarding road crash statistics, the follow-up of casualties for 30 days after the crash, the cross-checking of police data with health (and other) sector data, and the strengthening of cooperation among all agencies involved in the collection, processing and publication of road crash statistics.

Box 3. Bridging the gap, Thailand

Following the publication of the *Global status report on road safety* in 2015, the Thai government expressed major concern over the discrepancy between the country-reported statistic of 14789 deaths for 2013 and the WHO estimate of 24237 deaths (a difference of 9448). With support from WHO, the government implemented a mapping study that identified all potential sources of data (including insurance data), definitions used, coding systems, and existing links between these sources (see Figure 3). Through this exercise the government arrived at a revised count of 21221 deaths.

Following this, the government implemented changes in the reporting of road traffic deaths and rather than relying on only one data source as had previously been done, a combination of data from the Ministry of Public Health, the Royal Thai Police and the insurance sector was used to generate the official count. An enhanced data management system was then developed with the support of WHO to integrate the main data sources. Because of these changes, in 2016 Thailand reported 21745 deaths while WHO estimated the number of deaths at 22491 – a reduction in the discrepancy to 746.

Figure 3: Road traffic fatality data collection 2013, Thailand



Frequently Asked Questions

Q1. Why does WHO publish an estimate in addition to the country reports?

As a global public health organization WHO has a mandate to publish health sector VRD on all causes of mortality, without a time limit on the occurrence of the fatality following the crash. Given the underreporting road traffic fatalities and other challenges, and in acknowledgment of the key role of the police and other sectors in the collection of data on road crashes, WHO publishes both country-reported figures and its own estimate for each country.

Q2. My country's national reported data is very accurate. How did WHO obtain its estimate for my country? Why is there this large discrepancy?

WHO-estimated fatalities are based on the quality of VRD if available and eligible, and in cases where they are not, a statistical model is applied. In many countries VRD quality is very poor. Moreover, despite the important efforts made, there are persistent limitations in country-reported data collection (e.g. definitions, follow-up for 30 days, geographical coverage, etc.), which also contribute to this large discrepancy.

Q3. Why is a model estimate used for my country?

WHO uses a model estimate for countries that do not report eligible VRD. To correct the underreporting of the registration of deaths, a statistical model is used.

Q4. Why is my country classified in Group 4?

Group 4 includes countries with VRD of insufficiently good quality. To be considered to have good-quality VRD, a country needs (i) to use ICD 7–11 codes for cause of death classification, and (ii) to have achieved a coverage of 80% of the population. See WHO, health statistics and information systems,[12] WHO mortality database[13] for more details on VRD country classification methodology.

Q5. Why are the discrepancies in some countries much smaller?

Countries with a small discrepancy are those that have solid VRD (Group 1 countries). A small difference is considered normal and is usually due to the definition of road traffic fatality used. VRD typically do not use the 30-day fatality definition, and every country's VRD, if eligible, will naturally be somewhat higher than police data.

12 World Health Organization. Classifications and indicators (https://www.who.int/healthinfo/indicators/en/, accessed 12 March 2019).

13 World Health Organization. WHO Mortality Database (https://www.who.int/healthinfo/mortality_data/en/, accessed 12 March 2019).

Q6. How is it that some countries have identical figures for national data and the WHO estimate?

The few countries that have the same exact figure for national data and the WHO estimate (e.g. France) are those with eligible VRD that did not report VRD in the prior couple of years, and for which an extrapolation of past VRD was made. When this extrapolation results in a smaller number of fatalities than the country reported, the WHO estimated fatalities are considered to be equal to the country-reported estimate.

Q7. How should my country get started in bridging the differences between the two figures?

The first step to reduce the difference is establishing close cooperation between all sectors involved in gathering road fatality statistics – especially the police and health sectors – in order to cross-check and validate statistics.

Q8. How can a country improve the quality of VRD?

A prerequisite for a country's VRD to be considered eligible is the adoption and use of the ICD 7–11 protocol for classification of diseases, as well as the use of WHO's death certificate model. WHO and partners has prepared many tools to help countries to improve their civil registration and vital statistics (CRVS)[14]. For example ANACoD, CoDEditt, SMoL[15]

Q9. It seems difficult to reach the required quality in VRD. Is there another option?

An intermediate option is the implementation of studies to estimate underreporting of road fatalities, based on linking and matching records in police and hospital databases in a given area. This will allow the estimation of correction coefficients for the number of fatalities found in each data file. The results may be examined by WHO to determine whether they can be used to replace the model-based WHO estimate, and shift the country from Group 4 to Group 2.

Q10. How can a country improve the quality of police data?

Adopting the international definition of a road fatality and the 30-day post-crash follow-up are the first steps in achieving a higher level of completeness of police-recorded data. The cross-checking of police data with health and other sector data – and the strengthening of cooperation among all agencies involved in the collection, processing and publication of road crash statistics – will enhance the accuracy of country-reported estimates. At the same time, additional resources for data systems integration, improved training etc., will contribute to all systems' sustainability and reliability.

14 World Health Organization: Health statistics and information systems / Civil Registration and Vital Statistics (CRVS) (https://www.who.int/healthinfo/civil_registration/en/ accessed 12 March 2019)

15 World Health Organization. WHO Application of ICD-10 for low-resource settings initial cause of death collection; 2018 (https://www.who.int/healthinfo/civil_registration/ICD_10_SMoL.pdf?ua=1, accessed 12 March 2019).

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Appendices

Appendix 1: WHO classification of countries

Estimation method	Country
Group 1 Countries/areas with good death registration data	Argentina, Australia, Austria, Azerbaijan, Barbados, Belarus, Belgium, Belize, Brazil, Bulgaria, Canada, Chile, China (14, 15), Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Fiji, Finland, France, Georgia, Germany, Greece, Guatemala, Guyana, Hungary, Iceland, Iran (Islamic Republic of), Ireland, Israel, Italy, Jamaica, Japan, Kazakhstan, Kuwait, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Maldives, Malta, Mauritius, Mexico, Montenegro, Netherlands, New Zealand, Norway, Oman, Panama, Paraguay, Philippines, Poland, Portugal, Qatar, Republic of Korea, Republic of Moldova, Romania, Russian Federation, Saint Lucia, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Suriname, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Trinidad and Tobago, Turkey, Ukraine, United Kingdom, United States of America, Uruguay, Uzbekistan, Venezuela (Bolivarian Republic of), West Bank and Gaza Strip
Group 2 Countries with other sources of cause of death information	India (16, 17, 18), Thailand, Viet Nam
Group 3 Countries with populations less than 150000	Antigua and Barbuda, Cook Islands, Dominica, Grenada, Kiribati, Micronesia (Federated States of), San Marino, Seychelles, Tonga
Group 4 Countries without eligible death registration data	Afghanistan, Albania, Angola, Armenia, Bangladesh, Benin, Bhutan, Bolivia (Plurinational State of), Bosnia and Herzegovina, Botswana, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Honduras, Indonesia, Iraq, Jordan, Kenya, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Niger, Nigeria, Pakistan, Papua New Guinea, Peru, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Solomon Islands, Somalia, South Sudan, Sri Lanka, Sudan, Swaziland, Syrian Arab Republic, Tajikistan, Timor-Leste, Togo, Tunisia, Turkmenistan, Uganda, United Arab Emirates, United Republic of Tanzania, Vanuatu, Zimbabwe

Appendix 2: WHO statistical model

A negative binomial regression model formulated as follows:

$$\ln N = C + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \ln Pop + \varepsilon$$

Where N is the total road traffic deaths (for a country-year), C is a constant term, X_i are a set of explanatory covariates, Pop is the population for the country-year, and ε is the negative binomial error term.

Three models (Models A, B and C) that had good in-sample and out-of-sample fit, and for which all the covariates were statistically significant, were chosen for each country. The final estimates were derived as the average of the predictions from these three models.

The table below describes the covariates used for the three models:

Covariates used in the models

Independent variables	Description	Source of information	Included in models
ln (GDP)	World Development Indicators 2017) and WHO estimates of Gross Domestic Product (GDP) per capita (international dollars or purchasing power parity dollars, 2011 base)	World bank and WHO database	Models A, B, C
ln (vehicles per capita)	Total vehicles per 1000 persons	GSRRS surveys and WHO database	Models A, B, C
Road density	Total roads (km) per 1000 hectares	International Futures database	Models A, B, C
National speed limits on rural roads	The maximum national speed limits on rural roads (km/h) from WHO questionnaire	GSRRS survey	Models A, B, C
National speed limits on urban roads	The maximum national speed limits on urban roads (km/h) from WHO questionnaire	GSRRS survey	Models A, B, C
Health system access	Health system access variable (principal component score based on a set of coverage indicators for each country)	Institute for Health Metrics and Evaluation dataset	Models A, B, C
Alcohol apparent consumption	Liters of alcohol (recorded plus unrecorded) per adult aged 15+	WHO database	Models A, B, C
Population working	Proportion of population aged 15-64 years	World Population Prospects 2017 revision	Models A, B, C
Percentage motorbikes	Per cent of total vehicles that are motorbikes	GSRRS survey	Model B
Corruption index	Control of corruption index (units range from about -2.5 to +2.5 with higher values corresponding to better control of corruption	World Bank (Kaufmann et al 2009), International Futures database	Model B
National policies for walking / cycling	Existence of national policies that encourage walking and / or cycling	GSRRS survey	Model C
Population	Total population (used as offset in negative binomial regression	World Population Prospects 2017 revision (UNDESA)	Models A, B, C

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