

## **A method to estimate the number of people suffering from long-term consequences**

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### **Abstract**

Road traffic injuries remain a major public health challenge in Europe, not only because of the number of people killed each year, but also due to the substantial burden carried by survivors who sustain serious and long-lasting consequences. While fatality figures are well documented, serious non-fatal injuries and their long-term impacts remain largely undocumented. This stems from a structural limitation: national crash databases rarely include medically validated information on injury severity or long-term disability outcomes. As a result, the true burden of serious injuries and functional impairments is insufficiently captured. Thus, bridging this information gap is essential for supporting evidence-based road safety policies and monitoring progress toward EU targets for reducing serious injuries. The present paper is a first approach towards addressing this gap by developing and applying a harmonised methodology to estimate both the number of seriously injured people (defined as MAIS3+ according to the Abbreviated Injury Scale, AIS) and the number of people who suffer long-term consequences (LTC) following road traffic crashes in Europe. The work, which is part of the Horizon Europe project IMPROVA, builds on detailed in-depth crash investigation data (VOIESUR, RAIDS, GIDAS) available from project partners, combined with national police-reported crash data from Germany, Great Britain and France, and is subsequently extrapolated to the European level through the Community database on road crashes, CARE.

In-depth crash data constitute the foundation of the analysis, because they provide medically coded AIS injury descriptions that allow precise identification of MAIS3+ casualties. Importantly, these datasets also contain the predicted Functional Capacity Index (pFCI) scores included in the AIS codebook. The pFCI metric describes the 12-month functional outcome predictions associated with each AIS-coded injury. In this study, individuals with at least one injury with pFCI under 5 (pFCI<5) were classified as having sustained long-term consequences. Thus, in-depth datasets enable a medically grounded definition of long-term outcomes, which are otherwise absent from national and EU-wide crash databases.

Because in-depth datasets are limited in size, the study applies decision tree models to extrapolate medically validated information to national datasets. This is based on the methodology which has been in use in Germany for estimating the number of serious injuries (MAIS3+) for more than a decade now. The methodology is implemented twice: once for predicting MAIS3+ serious injuries, and once for predicting long-term consequences (based on pFCI). For each country, the models identify the most informative crash-, vehicle-, and user-related variables that are common to both in-depth and national databases. These shared variables serve as predictors, enabling the estimation of both serious injury outcomes and long-term impairment across all nationally recorded crashes.

The final step consists of extending these national estimates to the EU level. By selecting variables available both in national datasets and in the CARE database, the national models were translated into a form usable for European-wide extrapolation. This process produces a fully harmonised set of estimates for serious injuries (MAIS3+) and for long-term consequences (pFCI-based) across Europe.

The model from the in-depth databases considered transport mode / road user category, impact configurations and manoeuvres, road type, environment and age of the road user as relevant factors influencing the probability of a serious injury or long-term consequence. These broad patterns are largely consistent for all three countries with in-depth data. The number of people, suffering from serious injuries (MAIS3+) in the EU-27 plus Great Britain is estimated to lie between 62,000 and 105,000 people, which corresponds to 83,400 MAIS3+ people with a range of  $\pm 26\%$ . The number of people, suffering from long-term consequences (pFCI $<5$ ) in the EU-27 plus Great Britain is estimated to lie between 62,000 and 76,000 people, which corresponds to 69,883 people with a range of  $\pm 10.6\%$ .

There are various limitations which have to be considered. Some of them come from the methodology itself and are typical for real-world injury-severity models based on observational data. Those are more reliable for broad patterns and large subgroups and tend to be less reliable for more detailed results. Also, the use of pFCI under 5 as a proxy for long-term consequences needs to be discussed further. The most important limiting factor comes from the available data itself. There are differences in definitions, data quality and data availability between the countries in Europe. Neither MAIS3+ data nor pFCI data are consistently collected in national databases across the EU. Additionally, the definition of serious injuries is not harmonised and there is not much detailed information on the level of underreporting. Thus, the results provided in this paper have to be considered as a first estimate of long-term consequences from road crashes in Europe

**Keywords:** Decision tree modelling, extrapolation, long-term consequences, European data