The global macroeconomic burden of road injuries: estimates and projections for 166 countries

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Summary

Background Road injuries are among the ten leading causes of death worldwide and also impede economic wellbeing and macroeconomic performance. Beyond medical data on the incidence of road injuries and their resulting morbidity and mortality, a detailed understanding of their economic implications is a prerequisite for sound, evidence-based policy making. We aimed to determine global macroeconomic costs of road traffic injuries and their cross-country distribution.

Methods We calculated the economic burden of all road traffic-related injuries for 166 countries by use of a macroeconomic model that accounts for the effect of fatal and non-fatal injuries on labour supply, age-specific differences in education and experience of those who are affected by road accidents, and the diversion of injury-related treatment expenses from savings, which results in lower investment.

Findings We estimated that road injuries will cost the world economy US$1.8 trillion (constant 2010 US$) in 2015–30, which is equivalent to an annual tax of 0.12% on global gross domestic product. Although low-income and middle-income countries have the largest health burden, their share of the economic burden of road injuries is only 46.4% of the global loss, reflecting in part higher productivity (and earnings) in high-income countries, but also prominently higher treatment costs. Our results also indicate that treatment costs account for a greater proportion of the economic burden in high-income countries than in low-income countries.

Interpretation The macroeconomic burden of road injuries is sizeable and distributed unequally across countries and world regions. This finding suggests a case for nuanced policy making. Our framework should provide a good starting point for the more detailed analysis of policies both at country level and across different countries.

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Introduction

Road traffic injuries are among the ten leading causes of death worldwide, and they are the leading cause of death among young adults aged 15–29 years.1 Such accidents also lead to 20–50 million non-fatal injuries, and many people incur a disability as a result of their injury.2 According to WHO, 1.25 million people worldwide died in road traffic accidents in 2013.3 To provide some context, this figure is more than five times the death toll of the 2004 Indian Ocean tsunami,4 one of the deadliest natural disasters ever recorded. The worldwide prevalence, incidence, and mortality of road injuries are shown in detail in the appendix (pp 1–2).

Although the human burden in terms of pain and suffering of those affected by road accidents—the victims, their families, and their friends—is beyond quantification, these accidents also inflict a large economic toll. Understanding the macroeconomic burden of road injuries and how they are distributed among world regions and countries is essential for policy making.

The published literature on the consequences of road injuries broadly comprises two strands. One strand deals with the effectiveness (in terms of saving lives) of global interventions in reducing road injuries.5 Although some studies derive measures of cost-effectiveness,6 they focus on the cost of the intervention but do not assign a monetary value to the loss arising from road injuries. Establishing such a value (ie, the economic burden of road injuries) is the focus of the second strand. Although a few studies7–11 have estimated the economic burden of road injuries for one or a small number of countries, most of these approaches are based on aggregating the direct and indirect costs of road traffic accidents in different countries (the cost of illness approach) or on multiplying the cases of injuries and deaths due to road traffic accidents by the willingness of individuals to pay to avoid risks (the value of statistical life approach). However, in real economies, jobs do not remain vacant indefinitely, because companies substitute lost labour with new workers or machines (physical capital). Furthermore, approaches to date have been static and have, therefore, failed to account for the dynamics of morbidity-related and mortality-related changes in the population and the implications of treatment costs for savings (and, thus, the accumulation of capital).
A World Bank study\(^5\) infers growth effects from the coefficient estimate of mortality in growth regressions. The advantage of this approach is that, when the regression is appropriately specified, the estimated growth effect is clear from the final result, which already incorporates economic adjustment mechanisms. Because they use panel data, these growth regressions are naturally dynamic. Consequently, this method overcomes some of the crucial shortcomings of the cost of illness and value of statistical life approaches. However, this approach only allows for assessment of severe diseases that affect many people (such as cardiovascular diseases). Detecting a significant growth effect for less impactful diseases is difficult, given the small sample sizes that typically underly growth regressions.\(^6\) Thus, the World Bank study\(^5\) does not include road traffic mortality directly but instead includes overall mortality in the regressions and infers from this number the effect of road traffic-related mortality. Furthermore, growth regressions are susceptible to imprecise parameter estimation and to various biases.
when sparse data on important control variables (eg, fertility and trade openness) are available.16 This World Bank study17 also focused on the macroeconomic effects of road injuries for five countries; therefore, a comprehensive global estimate of the macroeconomic burden of road injuries, based on the simulation of an economy’s productive capacity at the aggregate level and the extent to which road injuries affect the productive capacity, is still needed.

To fill this gap, we aimed to use a theory-based simulation model that describes how the sum of workers, weighted by their human capital in terms of education and experience combines with physical capital in producing goods and services18 to estimate the macroeconomic burden of road injuries.

**Methods**

**Model description**

We simulated the projected effect of road injuries on the underlying economy’s production potential (ie, measuring the cost of injuries in terms of gross domestic product (GDP)). In doing so, we accounted for (1) economic adjustments in response to road injury casualties; (2) more inclusive measures of economic loss than earnings, which constitute only a part of GDP; (3) the effect on human capital differentiated by age-specific experience and education; and (4) the effect on physical capital caused by reduced savings from those injured individuals, because a proportion of the costs of treating road accident-related injuries could have gone into savings if no road injury had occurred.19 This approach has previously been used to assess the macroeconomic burden of non-communicable diseases in east Asian countries and the USA.19,20

We estimated road injuries’ effect on economic output for 166 countries. The definition of a road injury follows the Global Burden of Diseases, Injuries, and Risk Factors Study’s (GBD’s) injury codes and categories.21 Of these 166 countries, 138 countries have all data inputs necessary for our projections (appendix pp 5–6). We directly calculated the macroeconomic burden of road injuries for these 138 countries using the health macroeconomic model described in detail in Bloom et al22 and in the appendix (pp 2–5). In applying the model, we first recognised that injuries from road accidents affect the economy through the loss of effective labour supply due to mortality and morbidity. Higher injury-induced mortality rates reduce the population, and therefore the number of working-age individuals, and non-fatal injuries reduce productivity and increase absenteeism. Additionally, a certain share of household resources is diverted from savings to finance out-of-pocket treatment costs. At the same time, insurance-funded coverage of road injury treatment costs translates into higher private health insurance premia and public health insurance taxes. Both channels lead to a loss of aggregate savings or investment across the population and hamper

![Table 1](Table 1 continues on next page)
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| Country                  | Economic burden, millions of constant 2010 US$ (lower and upper bound) | Percentage of total gross domestic product in 2015-30 (lower and upper bound) | Per capita loss, constant 2010 US$ (lower and upper bound) |
|--------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------|
| Romania                  | 4533 (3907–5252)                                                        | 0·106% (0·091–0·122)                                                          | 237 (204–274)                                            |
| Russia                   | 59 547 (47 746–54 386)                                                   | 0·172% (0·166–0·185)                                                          | 354 (341–381)                                            |
| Serbia                   | 832 (685–1011)                                                          | 0·010% (0·087–0·122)                                                          | 97 (80–118)                                              |
| Slovakia                 | 2557 (2112–3123)                                                        | 0·119% (0·099–0·146)                                                          | 472 (390–576)                                            |
| Slovenia                 | 1207 (1017–1453)                                                        | 0·117% (0·099–0·141)                                                          | 585 (493–704)                                            |
| Spain                    | 18 200 (15 919–20 832)                                                   | 0·067% (0·058–0·076)                                                          | 393 (344–450)                                            |
| Sweden                   | 69 888 (62 222–79 311)                                                  | 0·068% (0·060–0·077)                                                          | 682 (607–774)                                            |
| Switzerland              | 85 300 (74 383–95 914)                                                   | 0·074% (0·064–0·086)                                                          | 971 (847–1129)                                           |
| Tajikistan               | 124 (95–160)                                                            | 0·064% (0·049–0·082)                                                          | 13 (10–16)                                               |
| Turkey                   | 18 195 (14 069–22 502)                                                   | 0·070% (0·061–0·089)                                                          | 215 (167–266)                                            |
| Ukraine                  | 3 804 (2 938–4 658)                                                     | 0·157% (0·121–0·192)                                                          | 89 (68–108)                                              |
| UK                       | 24 048 (21 002–25 103)                                                   | 0·049% (0·047–0·051)                                                          | 353 (338–368)                                            |
| **Latin America and Caribbean** |                                                                         |                                                                                |                                                          |
| Argentina                | 7342 (5879–9183)                                                        | 0·093% (0·075–0·117)                                                          | 158 (127–198)                                            |
| The Bahamas              | 217 (161–288)                                                           | 0·117% (0·087–0·155)                                                          | 542 (400–717)                                            |
| Barbados                 | 62 (46–82)                                                              | 0·080% (0·059–0·105)                                                          | 227 (169–298)                                            |
| Beleze                   | 54 (41–68)                                                              | 0·190% (0·146–0·239)                                                          | 134 (103–168)                                            |
| Bolivia                  | 6 588 (5 048–7 931)                                                     | 0·048% (0·049–0·186)                                                          | 55 (23–88)                                               |
| Brazil                   | 56 988 (52 347–60 648)                                                  | 0·140% (0·128–0·149)                                                          | 263 (242–280)                                            |
| Chile                    | 42 412 (34 222–52 521)                                                  | 0·082% (0·066–0·102)                                                          | 226 (183–280)                                            |
| Colombia                 | 7 765 (6 906–9 984)                                                     | 0·108% (0·082–0·139)                                                          | 152 (116–196)                                            |
| Costa Rica               | 1 161 (838–1 448)                                                       | 0·125% (0·096–0·155)                                                          | 227 (175–283)                                            |
| Dominican Republic       | 49 473 (40 606–57 614)                                                  | 0·151% (0·108–0·207)                                                          | 130 (105–158)                                            |
| Ecuador                  | 2 322 (1 884–2 833)                                                     | 0·135% (0·110–0·203)                                                          | 96 (62–142)                                              |
| El Salvador              | 629 (409–928)                                                           | 0·156% (0·101–0·230)                                                          | 96 (62–142)                                              |
| Guatemala                | 1 178 (862–1 559)                                                       | 0·115% (0·084–0·152)                                                          | 63 (46–83)                                               |
| Honduras                 | 399 (238–603)                                                           | 0·098% (0·058–0·148)                                                          | 40 (24–60)                                               |
| Jamaica                  | 173 (106–254)                                                           | 0·070% (0·044–0·105)                                                          | 60 (36–87)                                               |
| Mexico                   | 21 026 (19 903–22 202)                                                  | 0·089% (0·084–0·094)                                                          | 353 (345–362)                                            |
| Panama                   | 826 (667–1 006)                                                         | 0·079% (0·063–0·096)                                                          | 187 (151–227)                                            |
| Paraguay                 | 921 (634–1 296)                                                         | 0·169% (0·116–0·238)                                                          | 127 (87–179)                                             |
| Peru                     | 2298 (1669–3 086)                                                       | 0·058% (0·042–0·078)                                                          | 67 (49–90)                                               |
| Suriname                 | 118 (87–155)                                                            | 0·142% (0·104–0·187)                                                          | 206 (151–271)                                            |
| Uruguay                  | 1011 (796–1262)                                                         | 0·108% (0·085–0·134)                                                          | 288 (227–360)                                            |
| **Middle East and north Africa** |                                                                         |                                                                                |                                                          |
| Bahrain                  | 295 (240–365)                                                           | 0·047% (0·039–0·059)                                                          | 170 (138–210)                                            |
| Egypt                    | 10 674 (8 584–15 169)                                                   | 0·177% (0·109–0·252)                                                          | 100 (62–142)                                             |
| Iraq                     | 20 600 (16 464–25 314)                                                  | 0·053% (0·043–0·066)                                                          | 46 (37–57)                                               |
| Israel                   | 40 890 (34 699–44 844)                                                  | 0·071% (0·060–0·085)                                                          | 454 (384–537)                                            |
| Jordan                   | 544 (405–708)                                                           | 0·093% (0·069–0·122)                                                          | 53 (39–69)                                               |
| Kuwait                   | 1833 (1 590–2 086)                                                      | 0·072% (0·062–0·082)                                                          | 414 (359–471)                                            |
| Lebanon                  | 846 (434–1 253)                                                         | 0·108% (0·056–0·161)                                                          | 147 (76–218)                                             |
| Malta                    | 204 (177–236)                                                           | 0·078% (0·067–0·090)                                                          | 483 (419–559)                                            |
| Morocco                  | 3 890 (2 468–5 622)                                                     | 0·163% (0·101–0·273)                                                          | 102 (65–172)                                             |
| Oman                     | 4 304 (3 180–5 581)                                                     | 0·321% (0·237–0·416)                                                          | 819 (605–1063)                                           |
| Qatar                    | 2 397 (2 002–2 786)                                                     | 0·078% (0·063–0·096)                                                          | 866 (700–1066)                                           |
| Saudi Arabia             | 24 328 (14 997–31 711)                                                  | 0·202% (0·136–0·275)                                                          | 679 (418–925)                                            |
| Tunisia                  | 1681 (1165–2267)                                                        | 0·170% (0·122–0·238)                                                          | 139 (96–187)                                             |

(Table 1 continues on next page)
Our result implies that the burden of road injuries is $1.460 trillion if discounted at 2% or 3% (appendix pp 10–11). Our result implies that the burden of road injuries is $1.797 trillion over 2015–30 (table 2). This number is $1.460 trillion if discounted at 2% or $1.317 trillion if discounted at 3% (appendix pp 10–11). Our result implies that the burden of road injuries is

| Economic burden, millions of constant 2010 US$ (lower and upper bound) | Percentage of total gross domestic product in 2015–30 (lower and upper bound) | Per capita loss, constant 2010 US$ (lower and upper bound) |
|---|---|---|
| Yemen | 880 (591–1373) | 0.328% (0.220–0.512) | 28 (19–43) |
| Canada | 27,573 (22,790–33,318) | 0.082% (0.067–0.099) | 719 (504–869) |
| USA | 48,717 (45,139–51,388) | 0.157% (0.146–0.165) | 1444 (1344–1523) |
| Nepal | 778 (312–1342) | 0.167% (0.069–0.288) | 25 (10–43) |
| Pakistan | 13,426 (6,349–20,087) | 0.274% (0.130–0.421) | 62 (29–95) |
| Sri Lanka | 2035 (1301–2062) | 0.120% (0.077–0.180) | 96 (61–146) |

### Sensitivity analysis

We also did sensitivity analyses (for the 138 countries that had all the data necessary to compute the costs directly on the basis of our model; appendix p 7) by varying the mortality and morbidity rates. The baseline estimates were calculated with the mean mortality and morbidity data from GBD. In the sensitivity analysis, best-case and worst-case estimates were calculated on the basis of the lower and upper bounds of GBD mortality and morbidity data. In the main analyses, we provided the undiscounted economic burden attributable to road injuries for these countries (appendix pp 6–7).

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### Results

We calculated the macroeconomic burden of road injuries as the difference in total GDP in 2015–30 between the status quo scenario and the counterfactual scenario (in which all road accidents are eliminated) for the 138 countries with complete data, representing more than 90% of the world’s population (table 1). We also calculated the indirect estimates for the 28 countries for which we did not have full data (appendix p 7) and the discounted estimates (appendix pp 7–10). Among all countries, the USA has the largest economic burden of road injuries of $487 billion, followed by China ($364 billion) and India ($101 billion; figure 1). In terms of percentage of GDP, Yemen (0.317%) and Oman (0.32%) have the largest burden (figure 2), whereas the per capita figures are highest in Luxembourg with $1465, the USA with $1444, Ireland with $1081, and Norway with $1052.

Globally, we estimated the macroeconomic loss of road injuries to be $1.797 trillion over 2015–30 (table 2). This number is $1.460 trillion if discounted at 2% or $1.317 trillion if discounted at 3% (appendix pp 10–11). Our result implies that the burden of road injuries is

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equivalent to an annual tax of 0.12% on global output, with an average per capita burden of $231.

By World Bank region, the aggregate macroeconomic burden of road injuries is highest in east Asia and the Pacific with a total economic loss of $560 billion (table 2). North America has the second largest aggregate total economic loss of $515 billion, but the highest per capita loss of $1370 (table 2). This loss corresponds to an annual tax of 0.15% on the region's aggregate output. The economic burden of road injuries increases as the income group escalates: high-income countries bear the greatest burden with a total economic loss of $963 billion and a per capita loss of $779 (table 2). By contrast, road injuries cost low-income countries $11 billion in total and $14 per person (table 2). In terms of percentage loss of (cumulative) GDP, all countries have a relatively similar burden: 0.106% of GDP for high-income countries, 0.120% for low-income countries, and 0.138–0.144% for middle-income countries (table 2). Discounted estimates by World Bank region and World Bank income group are shown in the appendix (pp 10–11).

Road injuries resulted in 70 million disability-adjusted life-years (DALYs) worldwide in 2015.21 The economic burden is not distributed in proportion with population size and DALYs (table 3). For example, south Asia accounts for 23.8% of the DALYs, but only 6.7% of the economic loss, whereas North America accounts for only 3.9% of the DALYs, but 28.6% of the economic loss (table 3). Notably, despite the relatively low economic burden of road injuries in low-income and middle-income countries (46.4% of the global economic loss), the disease burden, as measured in DALYs, is very large (89% of global DALYs; table 3).

We also explored the importance of treatment costs in the economic burden of road injuries. A previous empirical analysis35 produced a bell curve when plotting traffic fatalities against GDP. Given that accident and
injury rates are not declining with income, the downward segment of this curve seems to be mostly due to better life-saving treatments in high-income countries. This disparity might also be evident in treatment costs, where countries with a higher income conceivably face a higher burden. Our results show that treatment costs account for a greater proportion of the total economic burden in high-income countries than in low-income countries. In high-income countries, physical capital loss (because a proportion of the costs of treating road injuries could have gone into savings if no road injury had occurred) accounts for 31·5% of the total economic burden due to road injuries, but this number decreases to 13·9% for upper-middle-income countries, 6·2% for low-middle-income countries, and 3·9% for low-income countries (appendix p 11).

**Discussion**

This study estimates the macroeconomic burden of road injuries for 166 countries and shows that between 2015 and 2030, road injuries will cost the world economy $1·8 trillion through a combination of diversion—healthcare expenditures that would otherwise have been used for savings or investment—and losses in employment due to mortality and morbidity. This figure is more than the aggregate GDP of Canada (the world’s tenth largest economy) in 2017.23 The economic burden of road injuries is equivalent to an annual tax of 0·12% on global GDP during this period.

The health and economic burdens of road injuries are distributed unequally across countries and regions. Of the 70 million DALYs lost to road injuries worldwide in 2015, nearly 90% occurred in low-income and middle-income countries. This distribution might be due to a higher proportion of vulnerable road users (including pedestrians, cyclists, and riders of motorised two-wheelers and their passengers) in lower-income countries. Moreover, low-income countries are more likely to lack good-quality prehospital care, the mandatory use of seatbelts for drivers and helmets for motorcyclists, appropriate speed limits, and effective laws against drunk driving.24 Responsive policy strategies for low-income and middle-income countries could include improving road conditions, lighting, traffic lights, and signage, building paved and level roads with more clearly demarcated traffic lanes, installing dedicated bike lanes, pedestrian crossings, and raised and protected pavements, enforcing the mandatory use of seatbelts in cars and helmets for motorcyclists, establishing laws against drunk driving, vehicle inspection laws, and specific speed limits appropriate to the type of road, and strengthening traffic law enforcement overall.

Despite the large burden in terms of DALYs, the economic burden of road injuries in low-income and middle-income countries only accounts for 46·4% of the global economic cost. The disparity relates to differences in economic development. First, the workforce in high-income countries is typically better educated, which implies that, for the same loss of DALYs due to road injuries, the loss of human capital will be larger. Second, high-income countries have advanced healthcare systems (eg, in terms of ambulance response times and accident and emergency departments), implying a smaller loss of DALYs due to lower morbidity and mortality associated with road injuries, but also much greater treatment costs. Our results show that physical capital loss due to diversion of savings to pay for treatment has a more important role in high-income countries than in low-income countries. More than 30% of the total economic burden due to road injuries

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### Table 2: Economic cost attributable to road injury mortality and morbidity, by World Bank region and World Bank country income group

| World Bank Region | By World Bank region | Population in 2015, million (global %) | Gross domestic product in 2015, billions of constant 2010 US$ (global %) | Economic loss in 2015–30, billions of constant 2010 US$ (global %) | Disability-adjusted life-years in 2015, million (global %) |
|-------------------|----------------------|--------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------|
| East Asia and Pacific | 2217 (31·3%) | 20 247 (27·3%) | 560 (31·1%) | 21 5 (32·2%) |
| Europe and central Asia | 906 (12·6%) | 22 466 (30·3%) | 345 (39·2%) | 5 8 (8·2%) |
| Latin America and Caribbean | 584 (8·1%) | 5339 (7·2%) | 115 (6·4%) | 5 8 (8·2%) |
| Middle East and north Africa | 404 (5·6%) | 3146 (4·2%) | 103 (5·8%) | 5 8 (8·6%) |
| North America | 356 (4·9%) | 18 500 (25·0%) | 555 (28·6%) | 6 6 (3·9%) |
| South Asia | 1744 (24·2%) | 2796 (3·8%) | 121 (6·7%) | 5 9 (23·8%) |
| Sub-Saharan Africa | 950 (13·2%) | 1621 (2·2%) | 58 (2·1%) | 5 5 (14·1%) |

| By World Bank country income group | Population in 2015, million (global %) | Gross domestic product in 2015, billions of constant 2010 US$ (global %) | Economic loss in 2015–30, billions of constant 2010 US$ (global %) | Disability-adjusted life-years in 2015, million (global %) |
|-----------------------------------|--------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------|
| Low income | 621 (8·6%) | 374 (0·5%) | 11 (0·6%) | 6 6 (10·2%) |
| Lower-middle income | 2856 (39·7%) | 5822 (7·8%) | 202 (11·2%) | 6 6 (40·1%) |
| Upper-middle income | 2521 (35·0%) | 18 952 (25·6%) | 621 (34·6%) | 6 6 (38·9%) |
| High income | 1196 (16·6%) | 48 966 (66·1%) | 963 (53·6%) | 7 3 (10·9%) |
| Global (166 countries) | 7195 (100%) | 74 103 (100%) | 1797 (100%) | 70 0 (100%) |
comes from physical capital loss in high-income countries, whereas physical capital loss accounts for less than 5% of the total economic burden in low-income countries. Although the economic burden of road injuries on low-income countries is relatively light at present, it is likely to rise in the course of economic development if growth in motorisation and traffic density outpaces development of infrastructure and law enforcement levels.10–13

Promotion of the use of self-driving cars might be a potential solution for reducing road accidents and lowering the burden of road injuries. Articles in *The Economist*41–43 and findings by the Boston Consulting Group44 argue that 90–94% of all accidents are due to human error and are, therefore, preventable through the use of self-driving cars. We calculated the potential cost savings from the adoption of autonomous cars by considering a conservative scenario of a 50% reduction in accidents and an optimistic scenario of a 90% reduction in accidents (as determined by *The Economist* and by the Boston Consulting Group). In the conservative scenario, autonomous cars could save $0.9 trillion at a global level, whereas savings of $1.6 trillion were produced in the optimistic scenario. However, because a country’s infrastructure must be well developed to use self-driving vehicles successfully, promotion of their use might only be possible in high-income countries in the near future. The scientific research on autonomous cars and accident prevention is in its infancy; autonomous cars, for example, might lead to greater traffic density such that the number of accidents could increase.

Our model has several limitations (appendix pp 11–13). First, we had to rely on imputations to calculate road injury-related health expenditures. This could either underestimate or overestimate the country-specific treatment cost of road injuries. However, this technique is a widely used approach to deal with lack of data and has also been adopted in other studies calculating the economic burden of other health outcomes.13,14 Second, owing to missing data, we had to impute the economic burden of road injuries for a subset of 28 of 166 countries. However, this does not substantially compromise our results, given that the 138 countries for which we had complete data cover more than 90% of the world population. Third, we did not account for the behavioural changes of family members, including their participation in the labour force when traffic accidents happen. Nevertheless, our analysis has many strengths and is a first step in understanding the global macroeconomic burden of road injuries using a simulation model rigorously grounded in dynamic macroeconomic theory.

This study shows that high-income countries have the largest macroeconomic costs of road injuries, whereas low-income and middle-income countries bear sizeable health burdens. The fact that low-income and middle-income countries bear the majority of the human toll underscores the need for improvements on multiple fronts, including infrastructure, law enforcement, public awareness, and emergency response systems. Otherwise, as these countries develop, the human cost they already bear will be accompanied by economic hardship.

**Contributors**

SC, KP, MK, and DEB contributed to the study concept and design. SC did data analysis and wrote the first draft of the manuscript. SC, KP, MK, and DEB contributed to the writing of the data. KP, MK, and DEB critically reviewed the manuscript for important intellectual content. All authors approved the final version.

**Declaration of interests**

We declare no competing interests.

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