Global burden and trends of transport injuries from 1990 to 2019: an observational trend study

Rui Wan, Jun Xia, Fangfang Duan, Li Min, Tan Liu

ABSTRACT

Background: Transport injuries (TIs) are a major cause of global disability-adjusted life-years (DALYs) and mortality. In this study, we aimed to assess the global burden and trends of TIs from 1990 to 2019.

Methods: We assessed the annual age-standardised incidence rate (ASIR) and age-standardised DALY’s rate of TIs by sex, age, Social Development Index (SDI) and geographical region from 1990 to 2019 from the Global Burden of Disease Study 2019. The changing trends were described by estimated annual percentage changes (EAPCs).

Results: Globally, in 2019, the ASIR and age-standardised DALY’s rates of TIs were 134.66 (95% UI 114.26–157.55)/100 000 and 97.79 (95% UI 86.91–107.68)/100 000, respectively. From 1990 to 2019, the global ASIR of TIs presented significant upwards trends with the EAPC (0.25%, 95% CI 0.19% to 0.31%), and it was significantly increased in the age groups of 15–49 (0.37%, 95% CI 0.29% to 0.45%), 50–69 (0.40%, 95% CI 0.36% to 0.44%) and 70+ (0.22%, 95% CI 0.17% to 0.28%). Prominent increases in ASIR were detected in middle-SDI areas (0.72%, 95% CI 0.57% to 0.87%), low-middle SDI areas (0.66%, 95% CI 0.59% to 0.72%) and low-SDI areas (0.21%, 95% CI 0.17% to 0.26%). The global age-standardised DALY’s rate presented downwards trends with the EAPC (~1.27%, 95% CI ~1.35% to ~1.2%), and it was significantly decreased in all age groups and SDI areas.

Conclusion: Globally, TIs still cause a serious burden, and the incidence has significantly increased, especially in people above the age of 14 and in middle-SDI and low-SDI areas, thus necessitating more attention and health interventions.

BACKGROUND

Transport injuries (TIs), including road injuries and other TIs, are a major cause of global disability-adjusted life-years (DALYs) and mortality, accounting for more than 2.5% of all deaths worldwide,1 and they are the main cause of death among adolescents aged 10–14 years.2 In 2016, TIs were the eighth-leading cause of death for people of all ages and might become the fifth-leading cause of death worldwide in 2030,3 which would cause a serious impact and burden on global public health, the health system and the economy. In 2019, TIs caused 106 703 225 (95% uncertainty interval (UI) 90 047 092–124 852 549) incident cases and 77 639 453 (69 162 381–85 466 247) DALY cases globally.4

In low-income and middle-income countries (LMICs), the health threat caused by TIs has shown an even more prominent trend, as 90% of the global road traffic-related deaths occur and cost approximately 3% of the gross domestic product (GDP) in LMICs.5 6 Although all countries have taken various measures and enacted laws and regulations to reduce the burden caused by non-fatal and fatal TIs, the burdens are still not optimistic. For example, TIs rank first on the injury death list in China7; 2.0% of all deaths are due to TIs in Turkey8; and the economic costs of TIs in Nepal have increased by threefold since 2007 and are equivalent to 1.52% of the GDP.9 Globally, economic development and domestic and international tourism have resulted in increased transportation, thereby making TIs unavoidable and a major global health problem.

However, there is still a lack of a comprehensive picture and dynamic of the global burden of disease attributable to TIs, which is essential to provide valuable insights into the progress of TIs and to guide resource allocation, programme planning and strategy development. In this study, we report the burden and trends of TIs by age, sex, region and Social Development Index (SDI) level from 1990 to 2019.

METHODS

Data sources

Data on the burdens of TIs were obtained from the Global Health Data Exchange GBD Results Tool.10 The GBD used all available sources of epidemiological data to estimate the global burdens of diseases and followed the general framework established for comparative risk assessment used in the GBD since 2002.10 The Cause of Death Ensemble model (CODEm) and DisMod-MR were the two main standardised tools used to generate estimates of
each quantity of interest by age, sex, location and year. Among them, CODEm is a highly systematised tool to analyse cause of death data. The DisMod-MR model was used to estimate non-fatal outcomes, including incidence, prevalence, years lost due to premature death, years living with disability and DALYs for disease and injury.11,12 The Global Burden of Disease Study 2019 (GBD 2019) has provided an up-to-date estimation of prevalence, incidence, DALYs and deaths due to 369 diseases and injuries and 87 risk factors in 204 countries and territories from 1990 to 2019.12,13

TISs include road injuries and other TIs, specifically road TIs sustained by pedestrians, cyclists, motorcycle riders, motorists and non-motorised vehicle passengers in land transport accidents. Additionally, there are also transport accidents and injuries related to maritime, railway, space and aviation transport.11,14

In this study, the TI-related burdens included annual incident cases, age-standardised incidence rate (ASIR), DALYs and age-standardised DALYs rate, with 95% UIs stratified by sex, age, country, 21 GDB regions and SDI levels between 1990 and 2019. The SDI is a measure of the social and economic factors that affect health outcomes in different locations. It takes into account the total fertility rate for those under 25, the average education level for those aged 15 and above, and the lag-distributed income per capita. These indices are standardised to a range of 0–1, and their geometric mean is used to calculate the SDI.15 According to the fertility rate, education and income scores, 204 countries and territories were classified into five SDI quintiles (low, low-middle, middle, high-middle and high SDI scores).12 Age was further subdivided into four groups (0–14 years old, 15–49 years old, 50–69 years old and 70+ years old).

Statistical analysis
We calculated the estimated annual percentage changes (EAPCs) and its 95% UIs of ASIR and the age-standardised DALYs rates to assess temporal trends of burden of TIs from 1990 to 2019 at national, regional and global levels. The natural logarithm of age-standardised rates (ASR) was fitted to the model, ln(ASR) = α + βX + ε, where X referred to the calendar year. The EAPC and its 95% CI were calculated as 100 × (exp(B)−1).15 We regarded the trend as stable if the EAPC's 95% CI were <0.16

Patient and public involvement
No patient involved.

RESULTS

Overall burden of TIs
Globally, in 2019, the ASIR and age-standardised DALYs rates of TIs were 134.60/100 000 (95% UI 114.42/100 000−157.57/100 000) and 97.79/100 000 (86.91/100 000−107.68/100 000), respectively. The burden of TIs was higher among males than among females (online supplemental table 1). The ASIR of TIs was highest in the age group of 15–49 years (180.55/100 000, 95% UI 136.71/100 000−220.33/100 000), and the age-standardised DALYs rate was highest in the age group of 50–69 years (120.93/100 000, 95% UI 104.47/100 000−138.71/100 000). The burden of TIs was lowest in the high-SDI areas, while the ASIR was highest in the low-middle SDI areas (179.78/100 000, 95% UI 150.91/100 000−221.78/100 000), and the age-standardised DALYs rate was the highest in the low-SDI areas (122.71/100 000, 95% UI 104.35/100 000−138.71/100 000) (table 1).

The highest ASIRs were observed in the regions of Eastern Europe (265.37/100 000, 95% UI 216.49/100 000−319.18/100 000), South Asia (242.82/100 000, 95% UI 200.45/100 000−289.52/100 000) and Central Europe (195.37/100 000, 95% UI 168.40/100 000−224.69/100 000), whereas the lowest ASIR was found in high-income Asia Pacific (52.41/100 000, 95% UI 44.32/100 000−61.08/100 000) (table 1, figure 1A,B).

Global trends of TIs
Overall, during the past 30 years, the global ASIR presented significant upwards trends with the EAPC (0.25%, 95% CI 0.19% to 0.31%). The most prominent increases in ASIR were detected in the regions of East Asia (1.96%, 95% CI 1.64% to 2.28%), South Asia (0.77%, 95% CI 0.69% to 0.86%), Western Sub-Saharan Africa (0.34%, 95% CI 0.27% to 0.4%) and Southern Latin America (0.27%, 95% CI 0.15% to 0.39%). The global age-standardised DALYs rate presented significant downwards trends with the EAPC (−1.27%, 95% CI −1.33% to −1.2%), and the age-standardised D ALYs rate was the highest in the age group of 0–14 (−0.45%, 95% CI 0.59% to 0.72%) and low SDI (0.21%, 95% CI 0.17% to 0.26%). The age-standardised DALYs rate decreased in each SDI area (figure 2 and online supplemental table 2).

SDI-specific and age-specific trends of TIs
We found that the ASIR decreased obviously in the high and high-middle SDI areas (high SDI (−1.03%, 95% CI −1.13% to −0.93%), high-middle SDI (−0.39%, 95% CI −0.45% to −0.32%), while it increased in the middle and low-SDI areas (middle SDI (0.72%, 95% CI 0.57% to 0.87%), low-middle SDI (0.66%, 95% CI 0.59% to 0.72%) and low SDI (0.21%, 95% CI 0.17% to 0.28%)). The age-standardised DALYs rate decrease in all four age groups. In the middle-SDI and low-SDI areas, the incidence increased significantly in populations aged above 14 years old. The age-standardised DALYs rate decreased in all four age groups (figure 3 and online supplemental table 3).

Relationship between the SDI and the burden of TIs
Figure 4 shows the changes in ASIR (figure 4A) and the age-standardised DALYs rate (figure 4B) across SDI scores by the 21 GBD regions from 1990 to 2019. For ASIR, of the six regions with the highest SDI scores, all experienced decreases in the ASIR of TIs. In the regions with middle-SDI and low-SDI scores, the changes in ASIR were not consistent. In the seven regions, including Central Asia (R=0.45, p<0.05), Central Latin America (R=0.49, p<0.01), East Asia (R=0.97, p<0.01), South Asia (R=0.47, p<0.05), Southern Latin America (R=0.81, p<0.01), Tropical Latin America (R=0.41, p<0.05) and Western Sub-Saharan Africa (R=0.97, p<0.01), the ASIR of TIs increased as the SDI scores improved (figure 4A). The age-standardised DALYs rate of TIs decreased in all 21 GBD regions as the SDI scores improved (figure 4B). The associations among ASIR, SDI and TIs burden are shown in (figure 4C).
<table>
<thead>
<tr>
<th>Region</th>
<th>Incidence (95% UI)</th>
<th>DALYs (95% UI)</th>
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<tr>
<td></td>
<td>1990</td>
<td>2019</td>
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<td></td>
<td>Age-standardised rate</td>
<td>Age-standardised rate</td>
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<td>1943.92 (1627.8–2304.68)</td>
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<td>817.96 (693.79–960.44)</td>
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<td>Caribbean</td>
<td>1065.92 (938.87–1195.15)</td>
<td>921.56 (794.63–1056.61)</td>
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<td>2577.98 (2269.23–2907.83)</td>
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<td>Western Europe</td>
<td>920.63 (807.19–1034.34)</td>
<td>558.01 (478.98–650.42)</td>
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</table>

*Represents statistical significance.

DALYs, disability-adjusted life-years; EAPC, estimated annual percentage change; UI, uncertainty interval.
age-standardised DALYs rates and SDI scores across countries in 2019 are shown in online supplemental figure 1).

**DISCUSSION**

Our study reported trends in global TIs incidence and DALYs and regional differences between countries by using data from the GBD 2019 study. As a result of this study, we found that global incidence and ASIR showed a continuous increase, but DALYs and the age-standardised DALYs rate were declining. The distribution of the ASIR and age-standardised DALYs rate from TIs by age and sex has indicated that men and adults (15–49 years) are the most affected groups with TIs. The bulk of the...
The global ASIR burden of TIs is in lower-middle SDI and low-SDI regions. In 2019, the top three highest ASIRs were observed in the regions of Eastern Europe, South Asia and Central Europe. However, the most prominent increases in ASIR were detected in the regions of East Asia, South Asia, Western Sub-Saharan Africa and Southern Latin America.

The countries with the highest ASIR burden of TIs were still mainly in Eastern Europe, South Asia and Central Europe from 1990 to 2019, although the ASIR of TIs in Central Europe and Eastern Europe showed a downwards trend. In Europe, death rates caused by unintentional injuries were the second-leading cause of death in those aged 5–29 years; for example, road traffic injuries were 60% higher in Eastern and Central Europe than in Western Europe.\(^1\) In addition, Russia ranked number one in the world for road crashes, and the traffic mortality ratio was twice that of other G-8 countries.\(^1\) The rising trend in the number of deaths and persons with disabilities in Eastern European countries is thought to be due to rising unemployment, increased alcohol availability and weak regulations.\(^1\) Therefore, projects to promote road safety have been carried out in countries including Poland, the Russian Federation, Hungary and Romania, such as limiting alcohol consumption by drivers,

**Figure 3** The age-standardised incidence and DALYs rates of transport injuries among four age groups from 1990 to 2019. (A) Global. (B) High SDI areas. (C) High-middle SDI areas. (D) Middle SDI areas. (E) Low-middle SDI areas. (F) Low SDI areas. DALYs, disability-adjusted life-years; SDI, Social Development Index.

**Figure 4** The relationships between age-standardised incidence and DALYs rates and SDI scores across 21 GBD regions. (A) Age-standardised incidence rate. (B) Age-standardised DALYs rate. DALYs, disability-adjusted life-year; GBD, Global Burden of Disease; SDI, Social Development Index.
encouraging drivers and passengers to use seat belts, ensuring safe transport of children’s vehicles and improving road signals. Moreover, organisations such as the Global Road Safety Partnership provide strong financial and technical support for transportation safety. However, our results also revealed that the trends of incidence and ASIR of TIs in South Asia both rose obviously. A study of the burden of road traffic injuries in urban South Asia suggested that 27.7 HeaLY per 1000 general population were lost from traffic injuries in South Asia. The main reasons for the high burden of TIs in this region are increasing motorisation, inadequate adoption and enforcement of traffic laws, and poor roads, vehicles and public health infrastructures that have not been significantly improved.

In our study, the highest ASIR of TIs was in the 15–49 age group, and the ASIR and the age-standardised DALYs rate burden of men were higher than those of women, which is consistent with previous studies. Men tend to drive more and perform more high-risk behaviours such as unauthorised speeding, improper use of vehicles, crossing unauthorised areas and underusing safety equipment. Therefore, depending on the distribution between age and sex groups, especially males in the 15–44 age group, TIs should be considered a serious public health problem. In this setting, the priority is to develop sex-oriented interventions and increase the number of experienced drivers, if possible. It is worth noting that the age-standardised DALYs rate of TIs in the age group of 50–69 years is the highest among all age groups, although it shows a downwards trend. With the problem of global ageing, older adults make up an increasing proportion of the driving population and are more likely to be involved in traffic crashes and elderly individuals have reduced mobility and include a subset of patients with low bone density, who are more likely to suffer traffic injuries during pedestrian activities. More investments should be made in the prevention of osteoporosis to reduce the burden of traffic injuries caused by low bone density.

Although TIs occur in every country, the burden of disease from these injuries is disproportionately high in LMICs. In the low-SDI and middle-SDI regions, the ASIR in people over the age of 14 showed significantly increasing trends. In fact, LMICs accounted for approximately 85% of the TIs deaths, and the lost annual DALYs accounted for approximately 85% of the TIs deaths, and the main reason for the high burden of TIs in this region is increasing motorisation, inadequate adoption and enforcement of traffic laws, and poor roads, vehicles and public health infrastructures that have not been significantly improved.

CONCLUSION

Globally, TIs still cause a serious burden, and the incidence has significantly increased, especially in people above the age of 14 years and in middle-SDI and low-SDI areas. It is also noteworthy that in seven middle-SDI and low-SDI areas, the ASIR of TIs increased with increasing SDI scores. The implementation and enforcement of effective safety measures and interventions in vulnerable regions and populations are necessary and thus more attention is needed.

Contributors RW and TL designed the study, RW, JX, FD and LM collected and analysed the data. RW, JX and TL interpreted data and wrote the report. All the authors read and approved the final manuscript. RW is guarantor for this paper.

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Patient consent for publication Not applicable.

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