Epidemiology and Patterns of Transport-Related Fatalities in Austria 1980–2012

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Objectives: Transport-related accidents remain the largest single cause of death among people aged 15 to 29 in the European Union, and despite the decrease in number of fatalities from 1990 onwards they remain a significant public health problem. The aim of this article was to analyze the long-term trends and patterns of transport-related fatalities, identify the anatomic distribution of most significant injuries in different road users, and identify the primary populations at risk of transport-related death in Austria between 1980 and 2013.

Methods: Data on transport-related fatalities based on death certificates were obtained from Statistics Austria for the analyzed period. Crude and age-standardized mortality rates per 100,000 were calculated and broken down by age, gender, and month of death, and the anatomic distribution of most significant injuries were identified. Potential years of life lost before age 75 (PYLL-75) were used as a measure of public health impact.

Results: A total of 39,709 transport-related fatalities were identified for the studied years; 74% were males and the mean age was 42.1 years (range 0–103). A decrease in the number of fatalities (from 2018 in 1980 to 554 in 2012), mortality rates (from 26 in 1980 to 7 in 2012), and PYLL-75 (from 68,960 in 1980 to 14,931 in 2012) was observed. Introduction of major prevention milestones (compulsory use of seat belts or child restraints) may have contributed to this decrease. Men 16–24 years old were at the highest risk of transport-related death. Pedestrian victims were more likely to be women and car drivers and motorcyclists were more often men. Most fatal transport accidents occurred between the months of May and October and prevailingly in towns of fewer than 20,000 inhabitants. Injuries to the head were the most significant injuries in all user groups (>50% of cases in all road user types). Reduced mortality rates could translate into higher prevalence of long-term disabilities in survivors of transport accidents.

Conclusions: Despite the decreasing trend observed, transport-related fatalities remain a serious public health issue in Austria. An increase in the mortality of motor vehicle drivers warrants more preventive action in this group. Further research is needed on other outcomes of transport accidents such as long-term disabilities to elucidate the true public health burden of transport accidents.

Keywords: transport accidents, road traffic accidents, mortality, traumatic brain injury, epidemiology, public health

Introduction

Over 1.2 million people die each year on the world’s roads, and between 20 and 50 million suffer nonfatal injuries. Road traffic injuries are projected to become the fifth most important cause of death globally by 2030 (World Health Organization [WHO] 2009). In the European Union (EU), the traffic performance during the past decades has been rising and was closely linked to economic development. An average of 34 km was traveled daily by EU-27 passengers in 2006, 26 km of which were by passenger car, making road traffic the predominant means of transport (Eurostat 2009a, 2009b). Passenger cars accounted for about 72% and road transport in general for about 83% of all transport performance in 2006 in the EU (Eurostat 2009a). The vast majority of transport accidents and deaths in the EU occur on roads reflecting high level of road traffic (Eurostat 2009b). Transport-related accidents represent the largest single cause of death among people aged 15 to 29 in the EU, and despite the decrease in number of fatalities from 1990 onwards they remain a significant public health problem (Belanger et al. 2008; Eurostat 2009b). There were 1.3 million road accidents involving personal injuries in the EU-27 in 2006, of which 42,950 were fatal (Eurostat 2009b).

Along with tolls on lives and health, transport accidents come with major economic cost: in the United States, medical and work loss costs for deaths and emergency department–treated nonfatal injuries exceeded $90 billion in
2005 (Centers for Disease Control and Prevention 2011), and the European Commission estimates the economic damages generated by road traffic accidents in the EU-27 in 2007 as amounting to EUR 200 billion (Eurostat 2009b).

Reliable data on fatalities are needed to assess the true scope of the road traffic injury problem, target responses to it, and evaluate the effectiveness of intervention (WHO 2009). Such data include information on incidence and types of crashes as well as a detailed understanding of the circumstances of accidents. Knowledge of detailed causation of injuries, and the type as well as who the primary populations at risk are, is valuable to inform interventions and the monitoring of their effectiveness (WHO 2004).

The aim of this article was to analyze the long-term trends and patterns of transport-related fatalities, identify the anatomic distribution of most significant injuries in different road users, and identify the primary populations at risk of transport-related death in Austria between 1980 and 2013.

Materials and Methods

Data Sources

All data used for the study were provided by the central statistical office of Statistics Austria (2006). Data on all fatalities in Austria during the period of 1980 to 2012 were obtained. Accidental deaths with an external cause registered as transport related were filtered from the entire data set. In the provided database the most significant injuries were listed as the cause of death. However, because the injury was presumably not the actual cause of death per se (the cause of death in trauma patients was most often bleeding, severe sepsis, or neurological failure), we refer to it as “most significant injury” throughout the article. The most significant injuries were aggregated by affected body region into 6 major groups, including the head, spine, thorax, trunk, extremities, and multiple injuries.

For coding of external causes and underlying causes of death, International Classification of Diseases, ninth edition (ICD-9; for 1980–2001), and ICD-10 coding (for 2002–2012) were used. Guidelines on comparable ICD-9 and ICD-10 coding were used to harmonize the 2 coding systems (Anderson et al. 2001); a detailed list of the codes for external causes of mortality is presented in Table 1.

| Table 1. ICD-9 and ICD-10 external causes of death codes used to define transport accidents and motor vehicle accidents |
|---------------------------------------------------------------|
| Cause of death category | ICD-9 | ICD-10 |
|-------------------------|-------|--------|
| Transport accidents     | E810–E825 | V02–04, V09.0, V09.2, V12–V14, V19.0–V19.2, V19.4–V19.6, V20–V29, V80.3–V80.5, V81.0–V81.1, V82.0–V82.1, V83–V86, V87.0–V87.8, V88.0–V88.8, V89.0, V89.2 |
| Motor vehicle accidents  | E810–E825 | V02–04, V09.0, V09.2, V12–V14, V19.0–V19.2, V19.4–V19.6, V20–V29, V80.3–V80.5, V81.0–V81.1, V82.0–V82.1, V83–V86, V87.0–V87.8, V88.0–V88.8, V89.0, V89.2 |

Variable Definitions and Analysis

Both total number of deaths and mortality rates were used in our analysis. Mortality rates were calculated using aggregated number of deaths in age groups, gender groups, or periods of years divided by mid-year population count in the respective group or in overall. Where mortalities were calculated for periods of years, mean of the mid-year population counts for those years was used as a denominator. Seasonal mortalities were computed using the cumulative number of deaths in each month for the whole studied period divided by the mean mid-year population for the respective gender groups. All mortalities were recalculated to 100,000 population. All data on population counts were obtained from Statistics Austria (2006). Standardized mortality rates were calculated using the direct method of standardization and the WHO standard world population (Ahmad et al. 2001) to allow for international comparability of our results.

Mortality rates were compared by gender, age, month of death (seasonality), and location of death (size of town). For comparison of mortalities across the age spectrum, 7 age groups were created, as suggested in the Injury Surveillance Guidelines (Holder et al. 2004). The location of death was categorized into 4 groups based on the population size of the municipality.

Potential years of life lost before age 75 (PYLL-75) were used to evaluate public health impact. This measure was used as a surrogate because life expectancy was not available for years in the early 20th century, making it impossible to calculate real PYLL. PYLL-75 was calculated by subtracting the age at death from 75 and it represents the number of years lost if the life expectancy was 75 years. Deaths occurring at ages over 75 years were excluded; thus, the total number used for this analysis was 35,435 deaths.

The entire study is based on population data and therefore no statistical hypothesis tests were used because they were considered not relevant. For analysis of trends the Mann-Kendall trend test for time series data implemented in the Kendall package of the R statistical software (McLeod 2011) was used. Kendall’s tau coefficients of rank correlation were calculated and used where deemed appropriate.

Results

Using our criteria, 39,709 fatalities related to transport were identified for the period of 1980–2012 in Austria. The victims were prevalingly of male gender (74%) with a mean age of 42.1 years (range 0–103 years). A steady decreasing trend in number of transport-related fatalities was apparent for both males (τ = −0.924) and females (τ = −0.9); male victims remained predominant for the whole period (Figure A1, see online supplement). The total number of deaths has dropped significantly from 2018 in 1980 to 554 in 2012.
Fig. 1. Crude and age-standardized transport-related mortality rates in Austria, 1980–2012, by gender in context with major prevention milestones. *Rates age standardized using the direct method of standardization for the WHO world standard population (Ahmad et al. 2001). SBF = year of introduction of compulsory front seat belts, SB = year of introduction of compulsory seat belts in all seats, CS = year of introduction of compulsory child restraints for children below 12 years, FI = fines for not wearing a seat belt increased.

Aggregated number of deaths for entire period by age units are shown in Figure A2 (see online supplement). In total and in males the number of fatalities peaked at age 16–24, whereas in females the numbers of fatalities remained similar across the age spectrum. Most of the deaths occurred between the months of May and December, with fatality counts being slightly lower for January to April (Figure A3, see online supplement). About half of the transport fatalities during the analyzed period occurred in municipalities of 2,000 to 19,999 inhabitants, and about three quarters occurred in those with less than 20,000 inhabitants with proportions of males and females being similar (Figure A4, see online supplement).

Trends of crude and standardized mortality rates are presented in Figure 1. Age-standardized rates were in line with crude rates. In general, a steady decrease is apparent and is more apparent in males than in females. Such a phenomenon is discernible across age groups as presented in Table A1 (see online supplement). The highest mortalities were observed in the period 1980–1985 and especially in those aged 15–24. Mortality rates in all age groups were considerably higher in males, reaching values of 486 and 404 in age groups 15–19 and 20–24, respectively. Overall the crude mortality rates dropped from 26 in 1980 to 7 in 2012 (see Tables A2–A4, online supplement, for details).

The injured road user was specified in 19,600 cases (51%). Pedestrians were the most prevalent and bicycle riders comprised only 9% of all fatalities (Figure A5, see online supplement). The distribution differed by gender, with a significantly higher proportion of female pedestrians and car passengers and a higher proportion of male car drivers and motorcyclists.

The most significant injuries were aggregated to groups based on the body region injured. Figure 2 presents the anatomic distribution of most significant injuries among the different road users. In all groups, injuries to the head were the most frequent (over 50% in all groups) and were especially predominant in bicycle riders (72%). Major injuries to multiple body regions were most common in motor vehicle drivers (19% of cases). Injuries to extremities were the least common.

Overall, for the whole period the number of years potentially lost before age 75 was 1,333,796 (1,057,667 years for males and 276,129 for females) and dropped from 68,960 years (55,152 for males and 13,808 for females) in 1980 to 14,931 (11,769 for males and 3,162 for females) in 2012. Figure 3 depicts trends in PYLL-75 over the followed period. Observed patterns correspond to trends in number of fatalities and mortality rates: a steady decline is much more apparent in males.

Major prevention milestones such as introduction of compulsory seat belts, seat belts in all seats, and use of child restraint systems seem to have contributed to the decrease in both mortality and years of lost life, as Figures 1 and 3 suggest.

Fig. 2. Anatomic distribution of most significant injuries in transport-related fatalities in Austria, 1980–2012.
Transport-Related Fatalities in Austria

Fig. 3. Potential years of life lost before age 75 in transport-related fatalities in Austria, 1980–2012, in context with major prevention milestones. PYLL-75 = potential years of life lost before age 75; SBF = year of introduction of compulsory front seat belts, SB = year of introduction of compulsory seat belts in all seats, CS = year of introduction of compulsory child restraints for children below 12 years, FI = fines for not wearing a seat belt increased.

Discussion

This article looks at patterns, trends, and causes of death in transport-related fatalities in Austria during the past 33 years. There is a clear overall decrease in the number of fatalities, mortality rates, and potential years of lost life before the age of 75 years. The primary population at risk of death as a result of a transport accidents was men 16–24 years old. As to road users, pedestrians and motorized 4-wheel vehicle drivers or passengers were most often victims. Pedestrians were more likely to be women and car drivers and motorcyclists were more frequently men. Most fatal transport accidents occurred between May and October and prevalingly in towns of less than 20,000 inhabitants. Injuries to the head were the most common major injury in all user groups.

Globally, the annual number of road traffic injury deaths increased by 10% since 1990 due mainly to sharp increases in low- and middle-income countries (WHO 2004). However, the trend is reversed in high-income countries. According to projections of the World Bank, in the next 20 years, fatalities will increase by 66% globally, while at the same time they will decrease by 28% in high-income countries (Kopits and Cropper 2003). The decreasing mortality trend that has been demonstrated in this study is apparent in most high-income countries of Europe (Belanger et al. 2008). A long-term analysis of road fatalities in 8 European countries starting from 1960 revealed an increasing personal risk until a structural bend of trend from which the risk started to decrease. In Austria, this bend is apparent in the early 1970s and is not captured in our analysis. However, the decreasing trend of fatality rates starting in 1980 revealed in our analysis corresponds with the findings of this study (Yannis et al. 2011).

On the other hand the number of injuries in high-income areas remains stable (Ameratunga et al. 2006) and it is likely that prevented deaths will translate into higher prevalence of people living with severe long-term disabilities. This analysis showed that injuries to the head were the cause of death in over 50% of cases. Previous studies on patients hospitalized with traumatic brain injuries after a road traffic accident in Austria showed that they resulted in a severe disability in about 50% of cases (Majdan et al. 2011, 2013). Thus, we can assume that besides being a major cause of fatalities, traumatic brain injuries could also be a major cause of disability in survivors of transport accidents.

In general, prevention strategies have been mainly implemented for vehicle occupants, whereas little attention has been paid to more vulnerable road users such as pedestrians or cyclists (Ameratunga et al. 2006). Major interventions that were implemented in Austria over the followed period were introduction of obligatory front seat belts in 1984, obligatory seat belts in all seats in 1990, and child restraints for kids under 12 years in 1994. These interventions probably contributed to the general decrease in mortality as documented by our results. Additionally, in 2005, fines were increased for not wearing seat belts (StatisticsAustria 2006), which may have played a role as well. The effectiveness of these interventions has been shown in previous studies (Ameratunga et al. 2006; Rice and Anderson 2009) and populations and they presumably had a major impact on the observed decrease in fatalities in our population. Additionally, road safety campaigns focusing on drunk-driving have been shown to be effective, especially when accompanied by enforcement and for a short duration (Phillips et al. 2011). Other measures that could reduce the number of accidents and thus also fatalities in motor vehicle users are policies reducing the amount of motorized transport (WHO 2004), speed detection cameras, and speed enforcement detection devices (Wilson et al. 2010) or red light cameras (Aeron-Thomas and Hess 2005). Motorcycle helmets have been shown to be effective in reducing crashes and fatalities in motorcyclists (Liu et al. 2008); street lighting (Beyer et al. 2009) and visibility aids (Kwan and Mapstone 2006) have the potential to increase visibility and enable drivers to detect pedestrians and cyclists earlier and thus prevent crashes and fatalities among these road users. A study analyzing the situation in 10 countries suggested that major safety measures (e.g., speed limits mandatory seat belts) were highly effective in decreasing the number of fatalities even after adjusting for the increase in fatalities caused by the annual increase in total mileage driven (Lassarre 2001).

In our study, the most significant decreasing trend in fatalities was observed in pedestrians (tau = −0.87) and motorbike users (tau = −0.724) compared to the decrease in motor vehicle drivers and passengers (tau = −0.597) or cyclists (tau = −0.664). When considering all fatalities, aggregated motor vehicle occupants were the most common victims, which corresponds to previous findings in high-income countries (Naci et al. 2009). Analysis of the distribution of road users aggregated in 3 decades revealed that the proportion of pedestrian victims decreased by 10% (from 37% in the 1980s to 27% in 2000–2012), whereas the frequency of motor vehicle driver fatalities increased from 22% in the 1980s to 30% in the 1990s and 37% in the period 2000–2012. The proportion of cyclists, motor vehicle passengers, and motorcycle drivers remained similar.
One of the key factors that could influence the variations observed within the compared groups of victims is the different risk exposure. To take this factor into account, exposure-based denominators should be used (e.g., 100 million person-trips or 100 million kilometers traveled) instead of solely population count denominator (e.g., 100,000 population) as we did in our analysis. Traffic-related fatality rates could differ significantly when using exposure-based or non-exposure-based denominators. For example, a study from British Columbia revealed that the fatality rates of drivers and passengers were highest when using 100,000 population as a denominator, whereas when exposure-based denominators were used other road user groups such as pedestrians or bicyclists showed higher rates of fatalities (Teschke et al. 2013). Another study showed a similar pattern in Wisconsin: the highest rates of fatalities in motor vehicle users when population count was used as a denominator and higher rates in pedestrian, bicyclist, and motorcycle groups when exposure-based denominators were used (McAndrews et al. 2013). These studies show that risk exposure is of high relevance when actual risks are to be compared between various groups of road users. Different risk exposure patterns could play a role in the variations observed between months or between towns of different sizes observed in our study.

Although showing a continuous decrease over the study period of years, the large number of years potentially lost due to premature deaths underlines the public health importance of transport-related accidents. Of specific concern in the context of years of lost life worldwide are young adults (WHO 2004, 2009), and previous research has indicated that deaths due to transport accidents result in a significant number of lost years in the pediatric and adolescent populations (Majdan et al. 2014).

There are limitations to our methodology and analysis. We were not able to obtain data on risk exposure on various road users and population groups that are compared throughout the article. Thus, we were not able to apply exposure-based denominators in our analysis and, as a result, between-group variations in exposure are not reflected in our findings. Although in-depth exposure-adjusted comparisons were not the primary purpose of this article, such information could bring further valuable insights. We therefore suggest further studies that will reflect variations in risk exposure.

Despite the overall decreasing trend, transport-related fatalities remain a serious public health issue in Austria. The increase in the mortality of motor vehicle drivers warrants more preventive action toward this group. Further research is needed on other outcomes of transport accidents such as long-term disabilities to elucidate the true public health burden of transport accidents.

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Supplemental Materials

Supplemental data for this article can be accessed on the publisher’s website.

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