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REVIEW ARTICLE

Road traffic injuries in Poland: magnitude and risk factors

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Abstract

Introduction The article presents the epidemiology of road traffic injuries and fatalities in Poland in the years 2004–2014. In Poland, every fourth death caused by external reasons is the result of a road traffic crash and Poland has one of the highest road fatality rates in relation to vehicle ownership in Europe, with an average 23 deaths per million residents. This rate is two times higher than most other European Union countries.

Materials and methods The research is based on a secondary analysis of data contained in multiple Polish governmental reports, including those of the Prevention and Analysis Office of Road Traffic Headquarters of Police, National Road Safety Program—GAMBIT 2005, National Road Safety Program 2013 to 2020, and Strategy for Efficient State in 2020, plus previous publications describing road safety in Poland. Data were analysed in two steps. First, the data were described using means and frequencies, and tabulated according to variables. Second, we considered the time frame (day, month, and year of the occurrence), the place and the circumstances of fatal road crashes, the kind of event, and types of road crashes.

Results Between 2004 and 2014, there were 475,591 traffic crashes on Polish roads. 52,217 people were killed and 597,191 people were injured. Traffic-related injuries represent the leading cause of death for Polish men up to 44 years of age. The most common cause of road crashes in Poland was failure to comply with the rules of the road traffic, such as through excessive speeding. We also found drivers poorly assessed road situations, faced a lack of adequate road infrastructure, and maintained many vehicles in poor condition.

Discussion Despite the variety of measures undertaken to improve safety on Polish roads, including modifications of the law as well as improving road quality, the number of fatalities and injuries resulting from motor vehicle crashes is still considerable, and the losses incurred by Polish society are still substantial.

Conclusions The number of fatalities and injuries as a result of road crashes in Poland remains very high. Multifaceted action to improve safety on the roads in Poland should continue.

Keywords Road traffic safety · Mortality rates · Injury rates · Vehicle speeding · Traffic violations

Introduction

Road traffic injuries are a significant public health and social problem globally. According to the World Health Organization (WHO), 1.3 million people are killed annually on the roads worldwide, and 20–50 million people

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suffer severe injuries that require long-term and expensive treatment. Without efforts to improve road safety, the number of people killed and injured as a result of motor vehicle crashes (MVC) will increase by about 65% over the next 20 years. In fact, WHO projects that by 2030, MVC will become the fifth leading cause of death, causing 3.6% of all deaths worldwide [1, 2].

Poland has one of the highest road fatality rates in relation to vehicle ownership in Europe, with an average 23 deaths per million residents, a rate two times higher than the rate in most other European Union (EU) countries [3]. Road traffic crashes are the fourth leading cause of death in Poland, presenting a major public health problem in terms of morbidity, disability and associated health care costs [4]. Road safety measures currently in place are ineffective [3, 5]. Specifically, the Polish government has taken measures to improve safety on Polish roads, including attempts to educate road users about safety, enforce and punish drivers for breaking laws of the road, implement new regulations concerning the technical condition of vehicles, and update the roads for safety [6]. Despite this, the number of injuries and fatalities, and casualties that occur as a result of MVC in Poland remains considerable.

The most comprehensive published reports on motor vehicle crashes in Poland are from two sources, three of them published in Polish [6, 7] and the other, more recent report, published in both Polish and English in a minor Polish journal [8]. Between 1980 and 2014, the number of road crashes in Poland has oscillated substantially. Notable changes occurred at a few time points. Between 1988 and 1991, a period of significant political change in Poland, crash rates grew substantially. In 1990, the number of crashes exceeded 50,000 for the first time, reaching a 1991 peak of 54,000 [7]. After a slight decline, a second peak occurred in 1997, when the rate exceeded 66,000. From 1998 to 2015, crash rates decreased (with a slight retreat in 2007 and 2008), likely a result of Poland's admittance into the European Union and the policies put in place as a result of that membership.

Road traffic injuries also pose significant financial burdens to Polish society. World Bank experts estimate that the annual cost of fatal traffic crashes in Poland is nearly 11 billion Polish zloty ($3 billion US dollars) and that the cost of all the consequences of motor vehicle crashes in Poland crashes is between 27 and 34 billion zloty ($7.3–9.2 billion US dollars).

The present paper presents a situational analysis of the problem and highlights some impediments to intervention. The aim of this study was to analyse patterns in recorded fatalities from MVC over the period from 2004 to 2014, as well as factors within the Polish traffic context connected to the environment that may lead to crashes.

Materials and methods

Sources of data

This study was conducted in Poland, an Eastern European country with 38 479 k inhabitants in 2014. To conduct our research, we merged secondary data and information from the following five sources, all of which were prepared by official government sources. The first two sources provided raw data and the last three provided tables, information, and ideas relevant to our research:

1. Annual reports from the Prevention and Analysis Office of the Road Traffic Headquarters of Police, 2004–2014 (http://www.policja.pl). These reports outline the problems related to road safety in Poland. They list general data on MVC in Poland, including risk factors, and the rate of road crashes in particular months of the year, days of the week, times of the day and the types of areas where crashes took place (urban or non-urban). Crashes were included if they were handled by police in any Polish jurisdiction.
2. Data from the Central Statistical Office of Poland (http://www.stat.gov.pl) These data came from hospitals nationwide and were used to corroborate and supplement reports from the Police reports. All injuries severe enough to require inpatient treatment (hospitalization) in a Polish hospital were included in the database. Some injuries that were severe but did not require hospitalization (e.g., were treated on an outpatient basis) were also included.
3. National Road Safety Program—GAMBIT 2005 (http://www.krbrd.gov.pl), which includes lists of safety solutions that were implemented in Poland and those that need to be implemented, solutions that succeeded and solutions that failed, plus offers advice on how to overcome failures. European requirements are enumerated in the document and address the situation on Polish roadways.
4. National Road Safety Program 2013–2020 (http://www.krbrd.gov.pl), which focuses on the general diagnosis of road safety on Polish roads. This document considers international perspectives and offers data on safety limitations present on Polish roadways.
5. Strategy for Efficient State in 2020 (http://www.administracja.mswia.gov.pl), which includes data and information concerning how to increase the efficiency of transport to facilitate traffic efficiency in urban areas. According to the document, the system of fund management for transport in Poland is in need of modification; the document offers data on potential modifications to

the funding system and how those modifications might improve the Polish transportation infrastructure.

We used the five data sources in conjunction with each other for two reasons. First, the data did not overlap entirely, so we merged data sources to obtain the most complete data possible about traffic crashes, injuries and mortalities in Poland. Second, the information was released at different time points by different agencies and we used the first (or sometimes only) available data to answer our questions of interest. In cases when information to answer our study hypotheses was available from two data sources (e.g., raw data from the annual police reports and the hospital/medical data) and did not match, we consulted with the primary statistical office in the Polish government, which collected the evidence and offered an official decision to resolve discrepancies. Because all information sources were secondary and the researchers did not have access to identifying data, the research was exempted from review by our university's ethical committee.

Method of analysis

Data were analysed in two steps. First, the data were described using means and frequencies and tabulated according to variables. Second, we considered the time frame (day, month, and year of the occurrence); the place and the circumstances of crashes, the kind of event, and types of road crashes.

Results

The number of road traffic crashes in Poland, 2004–2014

Between 2004 and 2014, there were 475,591 road crashes on Polish roads. 50,217 people were killed and 597,191 people were injured in those crashes [7]. In 2010, the last year of the implementation of the European Road Safety Programme, the number of road fatalities in Poland for the first time fell below 4000. It also represented the third year in a row with a downward trend concerning both the number of crashes and the people injured or killed (Table 1).

There also have been substantial decreases in the number of fatalities per crash over time, and in the number of fatalities among those who were injured (Table 1). Both figures consistently decreased between 2004 and 2014. Despite these promising data, the number of fatal road crashes remains high in Poland compared to other European countries. Polish mortality rates are almost three times higher than in the Netherlands and 2.5 higher than in Sweden and Great Britain. The rate of traffic fatalities and injuries in Poland also is decreasing more slowly than in other European countries. From 2001 to 2010, the number of road fatalities decreased by 29% in Poland and the number of injuries decreased by 28%. These were among the smallest declines among the Member States of the European Union [4, 9–11].

Table 1 Road crashes and their consequences in Poland in the years 2004–2014

Year	Crashes	Deaths	Injuries	Fatalities/100 crashes	Fatalities/100 injuries
2004	51,069	5712	64,661	15	11
2005	48,100	5444	61,191	14	11
2006	46,876	5243	59,123	14	11
2007	49,536	5583	63,224	15	11
2008	49,054	5437	62,097	14	11
2009	44,196	4572	56,046	12	10
2010	38,832	3907	48,952	10	10
2011	40,065	4189	49,501	10	11
2012	37,046	3571	45,792	9	9
2013	35,847	3357	44,059	9	8
2014	34,970	3202	42,545	9	8
Total	475,591	50,217	597,191		

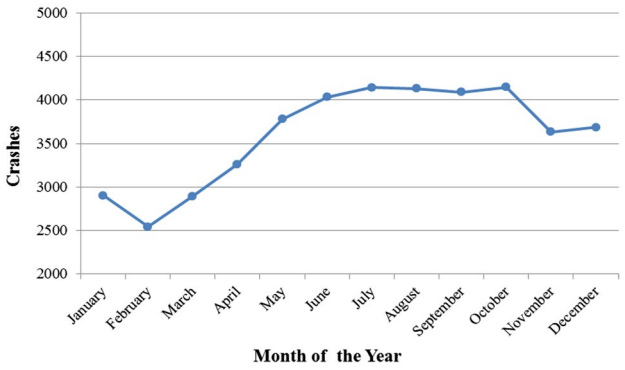

Fig. 1 Road crashes in Poland by month (2004–2014)

The months and days road crashes occur

Between 2004 and 2014, Polish road crashes occurred most often in October, July and August (Fig. 1), and least often in January and February [4]. The large number of crashes in summer and autumn coincide with increased traffic during holidays and the deterioration of road conditions with poor weather in autumn. These months also have the highest number of fatalities and injuries (Supplementary Appendix Table 1).

There was a trend for declining motor vehicle crashes over the study period. The positive change is also present, although somewhat less as distinct, when considering the

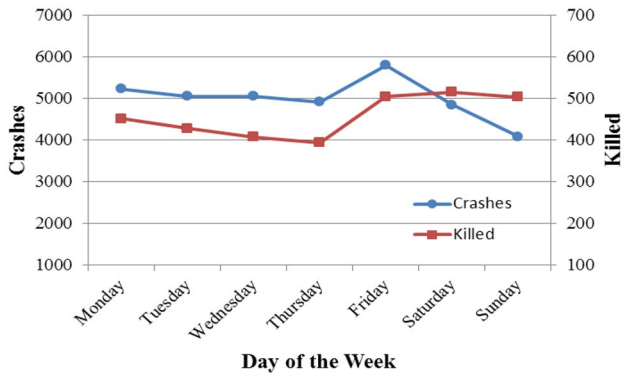

Fig. 2 Road crashes and fatality by day of the week (2014)

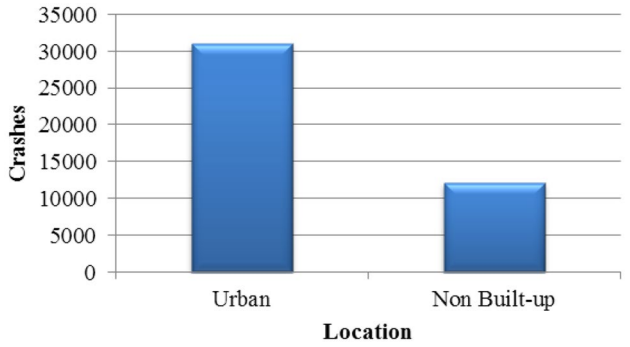

Fig. 3 Road crashes between urban and non-built-up areas (2004–2014)

number of crashes on particular days of the week (Supplementary Appendix Table 2). There was a drop of about 1000 crashes on each day between year 2004 and 2014.

More broadly, analysing the incidence of road crashes by the day of the week (Fig. 2), we found that crashes were most common on Fridays and most fatal on Saturdays. Supplementary Appendix Table 2 provides additional data on the number of road injuries across the days of the week.

Between 2004 and 2014, the highest number of traffic crashes occurred between 2 p.m. and 7 p.m., and especially between 4 p.m. and 6 p.m. This coincides with the period of heaviest traffic as people return home after work. The fewest crashes occurred between 12 midnight and 5 a.m.

Location of road crashes

As shown in Fig. 3, the majority of road crashes occurred in urban areas (72%; see also Supplementary Appendix Table 3). Crashes were most common on straight roads (60%); crashes on straight roads also resulted in the largest number of fatalities and injuries. Other dangerous locations were intersections (20% of crashes), and sharp curves and bends (10% of crashes).

Types of road crashes

The dominant type of road crashes in Poland since the 1990s has been "collisions between vehicles in motion", which includes frontal impact, side impact, and rear-end crashes. They accounted for 51% of the total number of crashes. The next most common type of crash was "hitting a pedestrian" (26%). The most fatalities, resulting in over 30% of those killed, were a result of "hitting a pedestrian" [7, 12]. Compared to other EU countries, the proportion of pedestrian crashes and fatalities in Poland is very high [2].

Casualties by road user type

The majority of road crashes in Poland between 2004 and 2014 occurred due to fault of the driver (79%), with the remaining crashes attributed to the fault of pedestrians (15%), passengers (0.2%) complicity of road traffic participants, (0.9%) and other reasons (5.1%) [5, 7].

The main causes of crashes caused by drivers were inappropriate speed for the traffic conditions, failure to comply with the right of way, improper conduct toward pedestrians (improper maneuvering through pedestrian crossings and not giving way to pedestrians), failure to keep a safe distance between vehicles, incorrect overtaking, improper turning, driving on the wrong side of the road, improper circumvention, improper reversing, improper lane changes, fatigue and falling asleep [7, 13].

The frequency of drivers disregarding existing speed limits in Poland is supported by previous research, which shows that on average 45% of drivers have a tendency to exceed legal speeds, especially on national roads. Crashes resulting from speeding were severe and resulted in numerous fatalities (approximately 30% of all deaths) [7].

We also considered the gender and age of drivers involved in crashes. Between 2004 and 2014, the most common perpetrators of road crashes in Poland (82%) were men [4, 5]. From 2006 to 2014, around 20 million people living in Poland had a driving license, with women constituting 44% of those individuals. Thus, men were disproportionately involved in crashes compared to women, although there is some evidence that female licensed drivers in Poland drive less often compared to male drivers [6–8]. Previous research also suggests that men are more prone to excess speed, risky behaviour, alcohol-impaired driving, and less regard for the traffic rules [7, 14].

In the years 2004–2014, the largest number of vehicle drivers causing crashes in Poland was in the 25–39-year-old group. Young drivers aged 18–24 caused a high rate of crashes also, including about 25% of crashes resulting from the fault of drivers [6, 7, 13, 15].

The threat to vulnerable road users (pedestrians, cyclists, motorcyclists) occurs in all countries. In Poland, this

phenomenon is particularly troublesome. On Polish roads, on average every 24 min a pedestrian loses his/her life or suffers a bodily injury. Crashes involving pedestrians represent almost 40% of all traffic crashes in Poland, a sharp contrast to data from other European Union countries where pedestrian crashes account for between 8% and 19% of total crashes [4, 6, 10, 16, 17].

Discussion

Worldwide, traffic crashes claim more deaths than war, and millions of survivors are handicapped from them [9–12]. Social and economic impacts of traffic crashes and their consequences are severe. Additionally, the costs of traffic crashes have a significant impact on global economies, particularly in low- and middle-income countries that struggle also with other development needs. In Poland, the costs of road traffic crashes equal 2.1% of gross domestic product [9, 10, 17–19].

Our results indicate motor vehicle crashes in Poland decreased between 2004 and 2014: the total number of traffic crashes dropped by more than 15,000 and the number of fatalities decreased nearly in 50% over the 10-year period. The reasons behind the drop might be attributed to two primary factors: (a) technical improvements in the roads, the result of major investments made with EU funds; and (b) traffic laws that were implemented to punish reckless drivers.

In July 2010, the European Commission adopted a plan aiming to reduce the number of fatalities on Europe's roads by half over the subsequent 10 years [20, 21]. Poland's progress on this plan between 2004 and 2014 is mixed. There was a clear decline in the number of crashes, injuries and mortality rates over the time period, a promising sign. However, Poland greatly lags EU endeavors to limit MVC fatalities. In the time period of our study, the number of fatalities on Polish roads decreased by only 29%, a decline that trailed all European nations except Romania, Malta and Bulgaria. In 2011, 109 fatalities per 1 million residents of Poland were recorded, the highest rate in the EU. Thus, driving on Polish roads continues to represent risk that is higher than most other European countries [22, 23].

There are several possible reasons for the risks that remain in Poland [2, 7]. First, infrastructure development issues place a strain on Polish roads. The poor condition of the Polish road network was recognised as having a detrimental effect on Poland's high rate of MVC [15–17], and there are currently many projects to build motorways underway, including construction of A1 (318.6 km out of 565.1 km to be completed as of 2021), A2 (469.9 km out of 622.6 km currently completed), and A4 (512 km out of 670 km planned) [16, 17].

Second, Poland has an extremely high rate of pedestrian injuries. More than 1/3 of pedestrians killed in Poland were struck at night on unlit roads. Poland has one of the lower urbanization coefficients in the EU, a factor that could explain high casualty rates on unlit roads as well as greater pedestrian mortality in general. A related concern is the location of pedestrian crossings in Poland. In many cases, crossings are placed just around the corner from turns, diminishing the ability for drivers to notice and respond to pedestrians on the roadway [7]. Legal protection of pedestrians in Poland begins only after pedestrians enter the roadway, whereas in most European countries legal protection initiates when pedestrians are in the proximity of the roadway. Finally, some have argued the Polish Police do not investigate details of crashes involving pedestrian fatalities adequately [4]. Polish Police statistics from 2008, 2009, and 2010 suggest 33% of crashes with pedestrian casualties were the fault of the surviving pedestrian, whereas 54% of crashes with pedestrian fatalities were the fault of the pedestrian. The noticeable difference has been questioned. A third factor in the high rate of MVC in Poland is the careless and risky driving displayed in the country. Efforts to change these culturally-based habits may be difficult but worthwhile [4].

Implications for prevention

To improve road safety in Poland, we must consistently implement tasks designed to educate and motivate society toward the desired behavioural change, thus improving traffic safety. We must strengthen social awareness of punishments for failure to comply with road traffic regulations, including excessive speeding and intoxicated road use, and enforce those policies [6, 13, 15]. Moreover, we should improve road infrastructure, eliminate hazardous locations, and properly design the road system to protect all road users, including vulnerable road users such as pedestrians who suffer injury and mortality at elevated rates in Poland. We should also remove vehicles in poor condition from the roadways, organise first aid training to the public, and improve emergency response to serious crashes [24].

The cold and wet climate in Poland introduces challenges that are not present in many other countries. Measures recommended to reduce crashes caused by wet, muddy or icy roads include improved winter maintenance, communication systems to inform drivers about road-related weather and conditions, driver education, road surveillance and traffic control. Snow removal and de-icing measures are also critical, and often insufficient or delayed currently in Poland [9].

We recognize and applaud current initiatives being implemented in Poland, which include reduction of the number of faulty, old cars on the roads by increasing automobile tax

and insurance rates for older cars in Poland. We also support ongoing efforts to improve road infrastructure in Poland.

Limitations of the present study

The present study has several strengths, including presentation of analytic results on road traffic injuries in Poland that have not been previously published, exploration of risk factors for road traffic injuries in Poland, and identification of substantial disparities in traffic injury risk in Poland. The findings of the study offer implications that can contribute to future development of traffic safety in Poland.

Despite these strengths, there are also limitations. First, this is a retrospective study, relying on publically available secondary databases and sources. As with all retrospective studies, our analyses were restricted to variables that were collected for purposes that may differ from the primary goals of the present paper. Second, findings of this study are based on data provided by selected Poland government datasets, and may not accurately capture all aspects of road traffic injuries occurring in Poland. In particular, some injuries may go unreported by authorities. This is most likely for less severe injuries, which may be treated on an outpatient basis and not recorded in hospitals or medical centers. There is also some possibility that motorists fail to report a crash to the police out of fear for negative consequences. Third, the findings and implications of the present study may not be applicable to road injuries in countries beyond Poland. Although the human behavioural factors in traffic injuries might be shared with other populations, caution should be taken in generalising the findings of the study to other cultures where road infrastructure and regulations might differ.

Author contributions Conceived and designed the experiments: WP, KG; analysed the data: KG, MG; contributed materials/analysis tools: MG; wrote and critically edited the paper: WP, KG, MG, DCS, JS.

Compliance with ethical standards

Conflict of interest Witold Pawłowski, Krzysztof Goniewicz, David C. Schwebel, Jiabin Shen, and Mariusz Goniewicz declare that they have no conflict of interest.

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