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AGE OF A PASSENGER CAR AND ITS INFLUENCE ON ACCIDENTS WITH FATALITIES IN POLAND

Summary. The article concentrates on road safety in Poland, which is one of the countries with a high number of fatalities in European Union. As the passenger cars are the mostly involved in traffic accidents with fatalities, this type of vehicles was analyzed to check relationship between age of the vehicle and its involvement in accidents with fatalities. This type of scientific analysis was made for the first time. For carrying out this research, a method of estimating passenger car fleet in motion in Poland was designed, as the official data were not updated and provided wrong information. The updated information on passenger car fleet when compared with that on the age of vehicles involved in road accidents with fatalities showed that the age of a vehicle has influence on the occurrence of road accidents in Poland. Presented data showed that the fact that people involved in accidents are at a higher risk of loss of life depends on the age of a vehicle. The data from analysis conducted between 2014 and 2015 showed that the risk of being killed increases with the age of the vehicle. Chances of the loss of life of people involved in accident participants are three times more in the case of more than 21 year old cars compared to 5 years old cars.

1. INTRODUCTION

Road safety is a major society issue on a global scale. In 2013, more than 30,000 people died on the roads of the European Union. For every death on Europe's roads, there are estimated 4 permanently disabling injuries such as damage to the brain or spinal cord, 8 serious injuries, and 50 minor injuries [1]. The threat of road accidents in Poland has been very high for years. Fatalities per million inhabitants in Poland, despite downward trend compared to other European Union countries, are still estimated to be one of the highest. There were 79 fatalities per million inhabitants in Poland in 2016, when the average risk for European Union countries were 50, 5 fatalities per 1 million inhabitants [2].

Poland adopted strategic document, National Road Safety Programme, with assumed drop in the number of fatalities by 50% and seriously injured by 40% between 2010 and 2020. This means that in the course of the implementation of the assumptions of the National Road Safety Programme 2020 (NRSP 2020) on Polish roads, by 2020, there should not be more than 2000 fatalities and no more than 6900 serious injuries [3]. There were 33664 road accidents in which 3 026 people were killed and 40 766 were injured, in Poland, in year 2016 [4]. The comparison of data from 2010 to 2016 indicates that even seven years after the implementation of NRSP the percentage of fatalities has still not changed (7%), the rate of slightly injured has decreased by only 6 percentage points (from 71% to 65%), and the rate of seriously injured increased by 6 percentage point (from 22% to 28%) (Figure 1) [5]. From this situation, it has been observed that the goals outlined in the National Road Safety

Program 2020 were not achieved in terms of decreasing the number of fatalities and reducing the number of serious injuries.

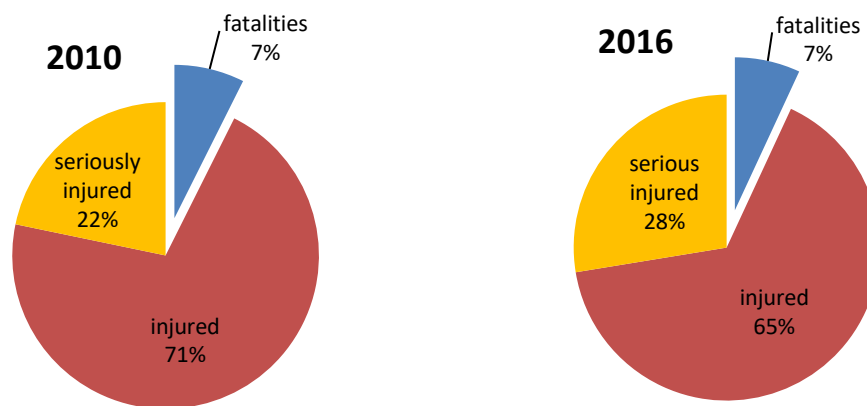


Fig. 1. Fatalities on Polish roads between 2010 and 2016 [5]

Over 10 year period, between 2006 and 2016, the number of vehicles in the Poland increased by 58% (from 18 035,0 to 28 601,0 vehicles) and the number of passenger cars increased higher by 61.9% (from 13 384,2 to 21 675,3 cars). The threats indicators between 2006 and 2016 according to the numbers of accidents, fatalities, injuries, serious injuries are shown in Table 1.

Polish Road Safety Observatory data indicates that drivers of passenger car caused most of the accidents with fatalities and they were mostly the accident's victims (46.8%).

Due to high risk of life loss in or by a passenger car, this means of transport has been chosen for analysis to find out whether the age of a vehicle influences the road safety. The analysis was carried out with data on the number of accidents and fatalities related to passenger cars between 2014 and 2015 in Poland in terms of:

1. number of passenger cars involved:
 - in accidents with fatalities,
 - in accidents with fatalities inside a passenger car, i.e., drivers and passengers.
2. number of fatalities caused by passenger cars:
 - in total,
 - inside the vehicle (drivers and passengers).

The total number of passenger cars involved in fatal accidents was divided into five different age groups, depending on the year of production, to show the age impact on the possibility of fatalities.

In order to carry out the analysis in accordance with the adopted assumptions, the number of passenger cars in Poland was also determined.

The data on the number of road accidents, fatalities and injuries were collected from the database of accident and collisions (SEWiK) from Police Headquarter for the studied years. The data were then transferred for analysis to Motor Transport Institute (MTI) for compliance with Polish Road Safety Observatory. MTI is sending to European Union an official Polish data on number of accidents, fatalities and injuries every year. Main problems related to the road safety in Poland are speeding, pedestrians, cyclists, motorcyclist, and young drivers. There is no analysis made so far to answer whether the age of a car affects the road accidents and is real danger in road traffic. The analysis that the age of a passenger car impacts the road accidents (drivers and passengers of the vehicle) was carried out in Polish Road Safety Observatory in 2016 to answer the question. Before carrying out the analysis the number of fatalities had to be compared with the number of vehicle fleet. As the number of the vehicle fleet in Poland has been questioned for years (many of these vehicles are no longer driven on roads and most of them fail to exist at all), the estimation of vehicle fleet was the first step to start analysis with. Statistics according to the fatalities based on the transport mode in Poland indicated passenger cars as the most dangerous vehicles.

Table 1

Threats indicators on Polish road between 2006 and 2016 [4]

Year	Accidents	Fatalities	Injured	Seriously injured	Fatalities per 1 million inhabitants	Seriously injured per 1 million inhabitants	Passenger cars per 1 thous. inhabitants
2006	46 875	5 243	59 121	14 659	138	385	351
2007	49 536	5 583	63 224	16 053	147	421	383
2008	49 054	5 437	62 097	16 042	143	421	422
2009	44 195	4 572	56 047	13 689	120	359	432
2010	38 832	3 908	48 953	11 491	102	301	451
2011	40 069	4 189	49 506	12 585	109	327	470
2012	37 043	3 570	45 790	12 047	93	313	487
2013	35 845	3 357	44 056	11 669	87	303	504
2014	34 970	3 202	42 545	11 696	83	304	520
2015	32 967	2 938	39 778	11 200	76	291	539
2016	33 664	3 026	40 766	12 078	79	314	539

2. PASSENGER CAR, AS THE MOST ENGAGED IN TRAFFIC ACCIDENTS WITH FATALITIES

Analysis of the influence of vehicle age on road safety was limited to passenger car***. Passenger cars are the most significant in vehicle fleet in Poland and this type of vehicles is usually involved in road accidents with fatalities. The age structure of passenger cars driven in Poland is very diverse; many of them were manufactured in the last century. Design, passive and active protection equipment in old cars against injuries and deaths during accidents do not meet today's security standards.

Analysis of road accident and fatality statistics according to the means of transport in Poland clearly indicates that passenger cars are more dangerous than truck, bus, bicycle, motor, or motorcycle. This type of mode of transport is most frequently involved in accidents with deaths inside the vehicle (drivers and passengers) and outside the vehicle (pedestrians, cyclists, and motorcyclists). Mentioned below are the numbers of people killed on road by different transport modes in Poland between 2012 and 2016. Data were compiled by Motor Transport Institute in Polish Road Safety Observatory, according to the data on road accidents collected by General Police Headquarter Database and the records of Central Register of Vehicles (Table 2 and Fig. 2) [4].

3. PASSENGER CARS' FLEET IN POLAND

The number of vehicle fleet in Poland has been questioned for many years. An official database on the number of vehicles is Central Register of Vehicles (CEP), which is not a reliable source of data, many vehicles are no longer driven on roads and most of them fail to exist at all, but still their records are in the database. Vehicles in the database have to be updated at least once in a year. Updating means updating the information on making technical approval (MOT), insurance, and change of owner. A lot of institutions have made attempts on basis of the records of the Central Register of Vehicles to estimate the real number of vehicle fleet driven on the polish roads. Motor Transport Institute using its own methodology (MTI methodology) estimated the number of vehicle fleet in Poland. For this analysis, only the number of passenger cars was important.

3.1. Method of estimating the passenger car fleet in motion

The MTI method of estimating the number of passenger cars in motion was based on the elimination from total passenger vehicle fleet in databases of the Central Register of Vehicles all vehicles that were not updated during more than past twenty years. The fact that the vehicle has insurance indicated its potential use; therefore, the information on the validity of insurance of vehicles

registered in Poland was used to estimate the number of used vehicles. Hence, we assumed that passenger cars in motion have valid insurance and if doesn't have updated insurance it can be used up to twenty years.

Table 2
Fatalities by different transport modes in Poland during 2012–2016 [4]

Transport mode	2012		2013		2014		2015		2016	
	number	%	number	%	number	%	number	%	number	%
Pedestrian	1 157	32.4%	1 140	34.0%	1 116	34.9%	915	31.1%	868	28.7%
Passenger car - drivers	1 025	28.7%	871	25.9%	869	27.1%	858	29.2%	863	28.5%
Passenger car - passengers	590	16.5%	577	17.2%	477	14.9%	484	16.5%	554	18.3%
Bicycle	300	8.4%	306	9.1%	286	8.9%	300	10.2%	271	9.0%
Motorcycle	261	7.3%	253	7.5%	237	7.4%	208	7.1%	244	8.1%
- including up to 125 ccm engine capacity	N/A		N/A		N/A		N/A		26	0.9%
Lorry*	104	2.9%	90	2.7%	92	2.9%	64	2.2%	114	3.8%
- including up to 3.5 T lorries	N/A		N/A		N/A		N/A		74	2.4%
Moped	82	2.3%	62	1.8%	71	2.2%	65	2.2%	77	2.5%
Bus	18	0.5%	18	0.5%	12	0.4%	14	0.5%	8	0.3%
Other vehicles	34	1.0%	40	1.2%	42	1.3%	30	1.0%	27	0.9%
- including four-wheelers (ATVs)	N/A		N/A		N/A		N/A		12	0.4%
All vehicles	2 414	67.6%	2 217	66.0%	2 086	65.1%	2 023	68.9%	2 158	71.3%
Total	3 571	100%	3 357	100%	3 202	100%	2 938	100%	3 026	100%

*A new category containing the lorries up to 3.5 T was introduced in 2016 (it was included in passenger cars until 2015).

It was assumed that vehicles operating in Poland:

- have valid insurance in the database of Central Register of Vehicles,
- all recorded vehicles in Central Register of Vehicles database with invalid insurance up to 20 year old (manufactured between 1995–2014 and 1996–2015 or 1995–2015),
- all recorded vehicles in Central Register of Vehicles that did not have any information about insurance, up to 20 year old (manufactured between 1995–2014 and 1996–2015 or 1995–2015).

There was presented for purpose of comparison the age structure of the passenger car fleet for both categories according to the CEP and MTI' methodology. In Table 3, in the first column, complete data on outdated vehicles in the Central Register of Vehicles are given. In the second column, updated data of passenger cars, according to adopted assumptions, are provided. Each column of data is divided into different age groups, depending on the manufacturing year of a car.

The age structure of the passenger car fleet for both categories according to the Central Register for Vehicle and Motor Transport Institute' methodology is presented below. Table 3 presents data for year 2014 and Table 4 data for 2015.

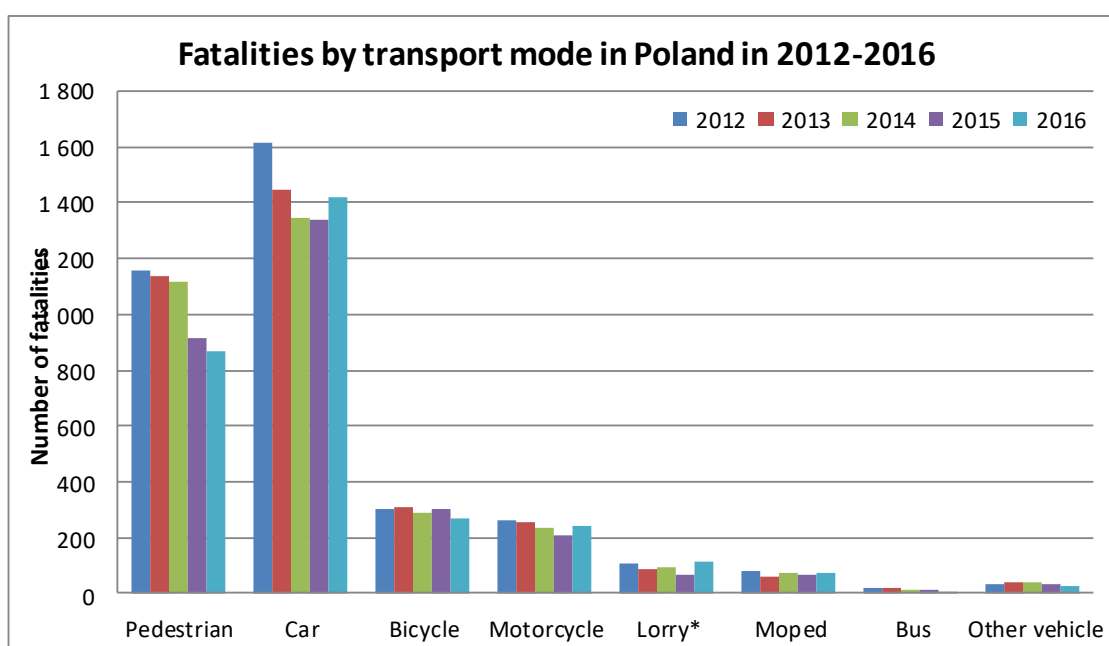


Fig. 2. Fatalities by different transport modes in Poland during 2012–2016 [4]

The comparison between the numbers of passenger car fleet in Poland indicates that in Poland in 2015 more than 20 million vehicles were registered, as per the records of CEP, but in real less than 15 million were driven. The comparison between the age structures of passenger car fleet indicates that the number of passenger cars aged 21 year old driven on the polish roads is much smaller than indicated on the records of CEP. This group of car has only 10% share in the age structure of all driven passenger cars (not 30% according to the CEP). Outdated records of CEP show the average age of passenger cars in Poland is more than 17 years. According to MTI estimation, the average age of polish passenger vehicle fleet is younger than official records and is estimated at less than 13 year old.

Table 3

The age structure of the passenger car fleet according to the CEP and MTI methodology in Poland in 2014

Age of a car	Structure of the passenger car fleet according to the Central Register for Vehicle		Structure of the passenger car fleet according to MTI' methodology	
	Number (thousand)	Share (%)	Number (thousand)	Share(%)
Up to 5 years	1 450.9	7.2	1 450.9	10.1
6–10 years	2 652.0	13.3	2 652.0	18.4
11–15 years	4 088.7	20.5	4 088.7	28.4
16–20 years	4 860.1	24.3	4 860.1	33.8
21 years and more	6 925.8	34.7	1 331.4	9.3
Total	19 977.5	100.0	14 383.1	100.0

Table 4

The age structure of the passenger car fleet according to the CEP and MTI methodology in Poland in 2015

Age of a car	Structure of the passenger car fleet according to the Central Register for Vehicle		Structure of the passenger car fleet according to MTI' methodology	
	Number (thousand)	Share (%)	Number (thousand)	Share (%)
Up to 5 years	1 562.6	7.6	1 562.6	10.6
6–10 years	2 621.8	12.7	2 621.8	17.7
11–15 years'	4 041.5	19.5	4 041.5	27.3
16–20 years	5 016.4	24.3	5 016.4	33.9
21 years and more	7 439.6	35.9	1 560.8	10.5
Total	20 681.9	100.0	14 803.1	100.0

4. AGE OF PASSENGER CARS AND ITS INVOLVEMENT IN ACCIDENTS WITH FATALITIES

The impact of vehicle age on the possibility of an accident with fatalities is an important factor for the assessment of hazards on traffic safety. The data of Polish Road Safety Observatory (POBR) at Motor Transport Institute enabled us to assess the impact of age of a vehicle on road safety. The number of passenger cars driven in Poland updated using the MTI methodology showed figures and the age structure of passenger cars causing accidents with fatalities between 2014 and 2015 (Table 5). The passenger car fleet in motion has been analyzed and divided into five different age groups, the number of passenger cars involved in accidents with fatalities as well as the number of victims of these accidents (total fatalities and fatalities inside passenger vehicles, which meant deaths involving drivers and passengers).

There were 29 186.3 passenger cars driven between 2014 and 2015 on the Polish road, out of which 5 508 vehicles were involved in accidents with fatalities. From those 5508 accidents, 2 320 passenger cars caused fatalities involving drivers and passengers. The rate of fatalities causing accident was higher in more than 20 year old passenger cars (13.4%) than those of other driven vehicles in Poland (9.9%), updated by the MTI methodology. The rate of fatalities in new (up to 5 year old) passenger cars was 10.6%, which was almost the same as the rate of passenger car fleet driven in Poland (10.3%). The highest rate of fatal accidents, total fatalities and fatalities inside the car, was for vehicles aged between 11 and 20 years. In Poland, 18 006.7 thousand cars (58.7% of total moving passenger car fleet) manufactured between 2005 and 1996 were being used in analyzed two year time. Passenger vehicles aged 11–20 years were most commonly involved in fatal accidents (64.2%). Analysis of age groups of passenger cars involved in accidents with fatalities indicated that cars aged 11–20 were mostly involved in a fatal accident. This age group of vehicles represented most passenger cars age in the fleet in Poland. There is proportion between the number of passenger cars causing fatalities and the number of passenger car fleet. The age group of vehicles aged more than 21 years indicated higher proportion of people killed in accidents. There were 2 892.2 passenger cars in Poland between 2014 and 2014 (9.9% of the updated vehicle fleet), out of which 740 were involved in accidents, in which people were killed on the road. According to the statistics from Table 5, due to the age group passenger cars causing fatalities per 100 000 passenger cars indicated age group of passenger cars aged 21 and more years had the higher value of total fatalities as well as inside the car. Generally, passenger car aged 21 years and more often caused fatalities. The most safe passenger cars

are the newest one (up to 5 year old). The probability of accident involvement with fatalities is three times higher for the passenger cars of 21 years and more (indicator 15.6) than newest (indicator 4.9).

Due to the high number of old (more than 11 up to 20 year old) passenger cars in Poland, there is a high number of road accidents with fatalities.

Table 5

Comparison of the passenger cars fleet age structure with the structure of vehicles involved in road accidents with a total fatal effect and with victims inside the vehicle during 2014–2015 [8]

Year of manufacture	Age of a car	Passenger cars causing fatalities between		Passenger cars causing fatalities inside the vehicle (drivers and passengers)		Number of passenger cars in motion updated due to the MTI' methodology		Number of passenger cars causing fatalities per 100 000 passenger cars	Number of passenger cars involved in accidents with fatalities among drivers and passenger per 100 000 vehicles
		Number	%	Number	%	Number in thousand	%		
2011–2015	0–5	584	10.6%	147	6.3%	3 013.5	10.3%	19.4	4.9
2006–2010	6–10	951	17.3%	293	12.6%	5 273.0	18.1%	18	5.6
2001–2005	11–15	1 656	30.1%	674	29.1%	8 130.2	27.9%	20.4	8.3
1996–2000	16–20	1 577	28.6%	814	35.1%	9 876.5	33.8%	16	8.2
1995 and older	21 years and older	740	13.4%	284	12.3%	2 892.2	9.9%	25.6	9.9
No data		284	4.5%	106	4.6%	-	-	-	
Total		5 508	100.0%	2 320	100.0%	29 186.3	100%	18.9	7.9

5. FATALITIES BY PASSENGER CARS BY AGE GROUP OF VEHICLES

The impact of vehicle age on the possibility of accident with fatalities is an important factor for the assessment of hazards on traffic safety. The data of Polish Road Safety Observatory (POBR) at Motor Transport Institute enabled to assess the impact of age of a vehicle on road safety. The number of passenger cars in motion in Poland updated by MTI methodology showed figures and age structure of passenger cars causing accidents with fatalities between 2014 and 2015 (Table 5)¹. The passenger car fleet in motion has been analyzed and divided into five different age groups, the number of passenger cars involved in accidents with fatalities as well as the number of victims of these accidents (total fatalities and fatalities inside passenger vehicles, which meant deaths among drivers and passengers).

¹ Own study based on the Central Register of Vehicle (Poland).

Table 6
Number of fatalities by age of passenger cars involving in accidents, including drivers and passengers between 2014 and 2015 in Poland [8]

Year of manufacturing	Age of a car	Fatalities of passenger cars due to the age of vehicles between		Fatalities of passenger cars per 100 000 vehicles in the same age groups	Fatalities (drivers and passengers) of passenger cars by age group of vehicles		Fatalities of passenger cars by age groups of 100 000 vehicles in the same age group	Fatalities of passenger cars by 100 vehicles involved in this type of accidents
		Liczba	%		Liczba	%		
2011–2015	0–5	476	9.56%	15.8	149	5.60%	4.9	87.8
2006–2010	6–10	820	16.47%	15.6	315	11.80%	6	93.1
2001–2005	11–15	1 498	30.08%	18.4	739	27.60%	9.1	95
1996–2000	16–20	1 490	29.92%	15.1	949	35.40%	9.6	101
1995 and older	21 years and more	469	9.42%	16.2	452	16.90%	15.6	136.9
No data		227	4.56%		128	4.80%		104.6
Total		4 980	100.00%	17.1	2 678	100%	9.2	100

The number of fatalities caused by passenger cars between 2014 and 2015 is shown in Table 6 according to the age group of vehicles. From the number of 5 508 passenger cars involved in accidents, 4 980 were involved in fatalities, of which in 2 678 cases drivers and passengers were killed. Data analysis indicated that 60% of fatalities were caused by passenger cars aged more than 11 up to 20 years, the fleet of which was estimated to be moving on polish roads (61.7%) between 2014 and 2015 (according to the MTI methodology). Passenger cars manufactured between 2001 and 1995 caused 63% of all fatalities inside the vehicle, which meant 63% of drivers and passengers of those cars were killed. Among five analyzed age groups of passenger cars, the least fatalities among passengers and drivers were observed in new cars. As the vehicle age increases, the number of victims inside the vehicle increases as well. Hence, the risk of being killed during car accident increases with the age of a vehicle. The risk of being killed is three times higher in old vehicles than new ones. People involved in accidents with new vehicle up to 5 year old passenger cars have more chance to survive the accident than those involved with more than 21 year old cars.

6. SUMMARY

Data analysis on the number of passenger vehicle fleet driven on polish roads and numbers of fatalities caused by this type of vehicles between 2014 and 2015 showed that the average age of passenger cars driven on polish roads is less than 13 years (not 17.5 years as shown by the records of Central Register of Vehicles). The number of vehicles in motion updated according to the Motor Transport Institute methodology showed 30% less fleet (mostly on cars more than 21-year-old) than in

official Central Register of Vehicles. Updating the number of passenger cars fleet driven in Poland showed that:

- more than 60% of passenger cars is between 11 and 20-year-old,
- rate of oldest (more than 21 years old and more) vehicles of this type is very low, estimated to be 9.9% of all passenger cars,
- rate of newest vehicle (up to 5-year-old cars) is also at low level, 10.3%.

The number of fatalities caused by passenger cars analyzed by the age of a vehicle indicated that:

- life loss of driver and passenger in a car more than 21-year-old is three times higher than of the new cars of 5 years old cars.

Due to equipped active and passive devices and protective systems in new passenger cars, when the accident occurs, users have the best chance to survive. Hence, the lowest rate of killed drivers and passengers in a road accident is found in new cars of up to 5-year-old. The age of a passenger car has an influence on accidents with fatalities in Poland. The risk of being killed increase with the age of a vehicle. The longest used passenger cars in the country for more than 21 years have no great significant impact on road safety in Poland and a high number of killed people because of their small share in the passenger vehicle fleet.

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