Journal of civil engineering and transport **transEngin**

2025, Volume **7** Number **2** **ISSN 2658-1698, e-ISSN 2658-2120**

DOI: 10.24136/tren.2025.008

INFLUENCE OF ALCOHOL ON ROAD SAFETY IN POLAND 2007-2023

Andrzej **Rogowski** [1]

[1] Casimir Pulaski Radom University, Faculty of Transport, Electrical Engineering and Computer Science, Malczewskiego 29, 26-600 Radom, Poland, e-mail: a.rogowski@urad.edu.pl, https://orcid.org/0000-0002-9988-3805

Reviewed positively: 18.05.2025

Information about quoting an article:
Rogowski A. (2025). Influence of alcohol on road safety in Poland 2007-2023. *Journal of civil engineering and transport*. 7(2), 107-131, ISSN 2658-1698, e-ISSN 2658-2120, DOI: 10.24136/tren.2025.008

Abstract – The article analyzes changes in the number of accidents, injuries, and fatalities in different groups of traffic participants, especially those involving and caused by intoxicated traffic participants, drivers, and passenger car drivers. The rates of victims, injuries, and fatalities of accidents per 100 accidents were used. The number of accidents fell by nearly 58%, fatalities by 66%, injuries and victims by 62%. The number of accidents caused by intoxicated traffic participants, injuries, and victims is falling faster than the number of all accidents. In the case of fatalities, the number of fatalities per 100 accidents is increasing. Drivers are the dominant, growing, group of traffic participants causing accidents. Statistically, the number of victims in accidents caused by drivers is higher than victims in other accidents. The percentage of accidents and injuries caused by intoxicated drivers is falling, but the number of fatalities per 100 accidents has risen dramatically. Of the road safety indicators considered, in principle, only for the indicators of the number of casualties per 100 accidents can a linear trend be considered. For 50 linear trend models of various indicators, the R^2 fit is at least good (>0.8), but for 36 of them other criteria are not met.

Key words – road safety, road accident, road accident victim, alcohol in traffic

JEL Classification – R41, O18, L99

INTRODUCTION

The problem of participating in road traffic after drinking alcohol (or drugs) and its consequences arises every time in the public space after a road accident caused by an intoxicated driver is made public. An accident in which several people who were moving properly were killed. As yet, we do not have methods to eliminate traffic accidents altogether, or at least to avoid fatalities from these accidents[1]. However, the vast majority of these accidents and victims could be avoided if the participants, and especially the perpetrators of the accidents, did not participate in traffic after drinking alcohol. This problem does not only affect Poland. According to the European Road Safety Observatory [1], around 25% of all fatal road accidents in Europe are alcohol-related, while only 1% of all kilometers traveled in Europe are driven by drivers with 0.5 g/l of alcohol in their blood or more. With a BAC of 1.5 g/l, the fatal accident rate is approximately 200 times higher than for sober drivers [2]. In [3], the effect of BAC on accident and injury risk and perpetration was found to be stronger at higher BAC levels. It is greater than the effect of antianxiety and sleep medication. The relationship between BAC level and risk is approximately exponential. Similar estimates can be found in [4-5]. Results from the DRUID study [6] on the prevalence of alcohol and other psychoactive substances in injured and killed drivers show that in Finland, Norway, Portugal, and Sweden the prevalence of fatalities of drivers positive for alcohol of 0.5 g/l and above ranged between around 16% and 35%. Among injured drivers in Belgium, Denmark, Finland, Italy, Lithuania, and the Netherlands the prevalence of alcohol of 0.5 g/l and above varied between 16% and 38%. For Poland, between 2007 and 2023, the percentage of fatalities in accidents involving intoxicated participants ranged from 11% to 16.5%, and the total victims in accidents caused by intoxicated participants ranged from 8% to 13%.

A certain difficulty in the comparative analysis of the effects of drink-driving in different countries is the legislation – different blood alcohol content limit levels. Extensive analyses related to different aspects of

[1] Apart from the fact that traffic has been completely eliminated.

alcohol consumption in the context of road safety can be found in DaCoTA 2012 [2, 5-7]. In Polish journals, e.g. [8-9]. However, the primary source of information is the reports of the Police Headquarters [10].

The response to accidents caused by drink-driving has been to lower the permitted blood alcohol limits, changes in public attitudes to drink-driving, and increased penalties [11]. These methods are not always effective, e.g. lowering the blood alcohol limit in Scotland had no impact on road safety [11]. It would seem to be more effective to use interlocks to prevent intoxicated people from starting the vehicle. Large-scale quantitative studies on the use of alcohol interlocks have shown that alcohol interlocks are between 40% and 95% more effective in preventing drink-driving recidivism than traditional measures such as license revocation or fines [2]. In the case of Poland, regulations have been tightened by introducing higher fines [12], higher penalty points [13] and car confiscation [14].

1. RESEARCH OBJECT

The object of the analysis is the impact of alcohol consumption on road safety. The analysis is based on the annual road accident reports made by the National Police Headquarters [10]. The analysis covers the years 2007-2023, which is conditioned by the availability of statistical data. Although detailed data on road accidents reported by the National Police Headquarters, their causes, perpetrators, and consequences (allowing for the assumed analysis) have been available since 2001, the data from 2006 is contradictory. In addition, the manner and scope of the data reported were changed. Changes were analyzed in specific groups of road users:

- number of road accidents,
- number of injured and fatal victims and the number of victims (injured and fatal combined),
- accident severity – number of victims, injured victims and fatalities per 100 accidents.
- the percentages of accidents and victims caused by the distinguished user groups in the total number of accidents and victims and as a distinguished subgroup of a given group.

The following groups and subgroups of road traffic users/accidents were distinguished:

- accidents involving intoxicated road users,
- accidents caused by intoxicated road users,
- accidents caused by drivers,
- accidents caused by intoxicated drivers,
- accidents caused by drivers of passenger cars,
- accidents caused by intoxicated passenger car drivers.

A detailed list of the quantities (variables) analyzed and their designations is provided in Table 1, the values of the variables are provided in Tables 2 – 13 and Figures 1 – 12.

Table 1. List of designations

Designation	Variable	*
i1	number of injured per 100 accidents	Table 8 Figure 7
i2	number of injured per 100 accidents involving intoxicated persons	
i3	number of injured per 100 accidents excluding accidents involving intoxicated persons	
i4	number of injured per 100 accidents caused by intoxicated persons	
i5	number of injured per 100 accidents caused by drivers	
i6	number of injured per 100 accidents caused by intoxicated drivers	
i7	number of injured per 100 accidents caused by drivers excluding accidents caused by intoxicated drivers	
i8	number of injured per 100 accidents caused by drivers of passenger cars	
i9	number of injured per 100 accidents caused by intoxicated drivers of passenger cars	
i10	number of injured per 100 accidents caused by drivers of passenger cars excluding accidents caused by intoxicated drivers of passenger cars	
k1	number of fatalities per 100 accidents	Table 7 Figure 6
k2	number of fatalities per 100 accidents involving intoxicated persons	
k3	number of fatalities per 100 accidents excluding accidents involving intoxicated persons	
k4	number of fatalities per 100 accidents caused by intoxicated persons	
k5	number of fatalities per 100 accidents caused by drivers	
k6	number of fatalities per 100 accidents caused by intoxicated drivers	

k7	number of fatalities per 100 accidents caused by drivers excluding accidents caused by intoxicated drivers	
k8	number of fatalities per 100 accidents caused by drivers of passenger cars	
k9	number of fatalities per 100 accidents caused by intoxicated drivers of passenger cars	
k10	number of fatalities per 100 accidents caused by drivers of passenger cars excluding accidents caused by intoxicated drivers of passenger cars	
la1	number of accidents	Table 2 Figure 1
la2	number of accidents involving intoxicated persons	
la3	number of accidents caused by intoxicated persons	
la4	number of accidents caused by intoxicated drivers	
la5	number of accidents caused by intoxicated drivers	
la6	number of accidents caused by drivers of passenger cars	
la7	number of accidents caused by intoxicated drivers of passenger cars	
li1	number of injured in accidents	Table 4 Figure 3
li2	number of injured in accidents involving intoxicated persons	
li3	number of injured in accidents caused by intoxicated persons	
li4	number of injured in accidents caused by drivers	
li5	number of injured in accidents caused by intoxicated drivers	
li6	number of injured in accidents caused by drivers of passenger cars	
li7	number of injured in accidents caused by intoxicated drivers of passenger cars	
lk1	number of fatalities in accidents	Table 3 Figure 2
lk2	number of fatalities in accidents involving intoxicated persons	
lk3	number of fatalities in accidents caused by intoxicated people	
lk4	number of fatalities in accidents caused by drivers	
lk5	number of fatalities in accidents caused by intoxicated drivers	
lk6	number of fatalities in accidents caused by drivers of passenger cars	
lk7	number of fatalities in accidents caused by intoxicated drivers of passenger cars	
lv1	number of victims in accidents	Table 5 Figure 4
lv2	number of victims in accidents involving intoxicated drivers	
lv3	number of victims in accidents caused by intoxicated persons	
lv4	number of victims in accidents caused by drivers	
lv5	number of victims in accidents caused by intoxicated drivers	
lv6	number of victims in accidents caused by drivers of passenger cars	
lv7	number of victims in accidents caused by intoxicated drivers of passenger cars	
pa1	percentage of accidents involving intoxicated persons in the total number of accidents	Table 10 Figure 9
pa2	percentage of accidents caused by intoxicated persons in the total number of accidents	
pa3	percentage of accidents caused by drivers in the total number of accidents	
pa4	percentage of accidents caused by intoxicated drivers in the total number of accidents	
pa5	percentage of accidents caused by intoxicated drivers in total number of accidents caused by drivers	
pa6	percentage of accidents caused by drivers of passenger cars in the total number of accidents	
pa7	percentage of accidents caused by drivers of passenger cars in the total number of accidents caused by drivers	
pa8	percentage of accidents caused by intoxicated drivers of passenger cars in total number of accidents	
pa9	percentage of accidents caused by intoxicated drivers of passenger cars in total number of accidents caused by drivers	
pa10	percentage of accidents caused by intoxicated drivers of passenger cars in the total number of accidents caused by drivers of passenger cars	
pai1	percentage of injured in accidents involving intoxicated persons in the total number of accidents	Table 12 Figure 11
pai2	percentage of injured at accidents caused by intoxicated people in the total number of injured at accidents	
pai3	percentage of injured at accidents caused by drivers in the total number of injured at accidents	

pai4	percentage of injured at accidents caused by intoxicated drivers in the total number of injured at accidents	
pai5	percentage of injured at accidents caused by intoxicated drivers in the total number of injured at accidents caused by drivers	
pai6	percentage of injured at accidents caused by drivers of passenger cars in the total number of injured at accidents	
pai7	percentage of injured at accidents caused by drivers of passenger cars in the total number of injured at accidents caused by drivers	
pai8	percentage of injured at accidents caused by intoxicated drivers of passenger cars in the total number of injured at accidents	
pai9	percentage of injured at accidents caused by intoxicated drivers to the total number of injured at accidents caused by drivers	
pai10	percentage of injured in accidents caused by intoxicated drivers of passenger cars in the total number of injured in accidents caused by drivers of passenger cars	
pak1	percentage of fatalities in accidents caused by intoxicated persons in the total number of fatalities in accidents	Table 11 Figure 10
pak2	percentage of fatalities in accidents caused by intoxicated persons in the total number of fatalities in accidents	
pak3	percentage of fatalities at accidents caused by drivers in the total number of fatalities at accidents	
pak4	percentage of fatalities at accidents caused by intoxicated drivers in the total number of fatalities at accidents	
pak5	percentage of fatalities at accidents caused by intoxicated drivers in the total number of fatalities at accidents caused by drivers	
pak6	percentage of fatalities at accidents caused by drivers of passenger cars in the total number of fatalities at accidents	
pak7	percentage of fatalities in accidents caused by drivers of passenger cars in the total number of fatalities in accidents caused by drivers	
pak8	percentage of fatalities at accidents caused by intoxicated drivers of passenger cars in the total number of fatalities at accidents	
pak9	percentage of fatalities at accidents caused by intoxicated passenger car drivers in the total number of fatalities at accidents caused by drivers	
pak10	percentage of fatalities in accidents caused by intoxicated passenger car drivers in the total number of fatalities in accidents caused by drivers of passenger cars	
pav1	percentage of victims in accidents involving intoxicated persons in the total number of accidents	Table 13 Figure 12
pav2	percentage of victims in accidents caused by intoxicated people in the total number of accidents	
pav3	percentage of victims in accidents caused by drivers in the total number of accident victims	
pav4	percentage of victims in accidents caused by intoxicated drivers in the total number of accident victims	
pav5	percentage of victims in accidents caused by intoxicated drivers in the total number of victims in accidents caused by drivers	
pav6	percentage of victims in accidents caused by drivers of passenger cars in the total number of victims in accidents	
pav7	percentage of victims in accidents caused by drivers of passenger cars in the total number of victims in accidents caused by drivers	
pav8	percentage of victims in accidents caused by intoxicated drivers of passenger cars in the total number of victims in accidents	
pav9	percentage of victims in accidents caused by intoxicated drivers of passenger cars in the total number of victims in accidents caused by drivers	
pav10	percentage of victims in accidents caused by intoxicated passenger car drivers in the total number of victims in accidents caused by drivers of passenger cars	
pk1	percentage of fatalities in the total number of victims	Table 6 Figure 5
pk2	percentage of fatalities in the total number of victims in accidents involving intoxicated persons	

pk3	percentage of fatalities in the total number of victims excluding accidents involving intoxicated persons	
pk4	percentage of fatalities in the total number of victims in accidents caused by intoxicated people	
pk5	percentage of fatalities in the total number of victims in accidents caused by drivers	
pk6	percentage of fatalities in the total number of victims in accidents caused by intoxicated drivers	
pk7	percentage of fatalities in the total number of victims in accidents caused by drivers excluding accidents caused by intoxicated drivers	
pk8	percentage of fatalities in the total number of victims in accidents caused by drivers of passenger cars	
pk9	percentage of fatalities in the total number of victims of accidents caused by intoxicated drivers of passenger cars	
pk10	percentage of fatalities in the total number of victims in accidents caused by drivers of passenger cars excluding accidents caused by intoxicated drivers of passenger cars	
v1	number of victims per 100 accidents	Table 9 Figure 8
v2	number of victims per 100 accidents involving intoxicated persons	
v3	number of victims per 100 accidents excluding accidents involving intoxicated persons	
v4	number of victims per 100 accidents caused by intoxicated drivers	
v5	number of victims per 100 accidents caused by drivers	
v6	number of victims per 100 accidents caused by intoxicated drivers	
v7	number of victims per 100 accidents caused by drink drivers excluding accidents caused by intoxicated drivers	
v8	number of victims per 100 accidents caused by drivers of passenger cars	
v9	number of victims per 100 accidents caused by intoxicated drivers of passenger cars	
v10	number of victims per 100 accidents caused by drivers of passenger cars excluding accidents caused by intoxicated drivers of passenger cars	

* – the numbers of tables and figures in which the values of the variables are given

Table 2. Number of road accidents in Poland in 2007-2023 in selected groups of traffic participants

Year	la1	la2	la3	la4	la5	la6	la7
2007	49536	6053	5053	38434	3420	29445	2719
2008	49054	6375	4979	38318	3529	29475	2785
2009	44196	5346	4139	35044	3007	27190	2428
2010	38832	4524	3486	30628	2455	23559	1890
2011	40065	4972	3893	32188	2717	24573	2075
2012	37046	4467	3407	30186	2336	23265	1742
2013	35847	4028	3001	29354	2165	22659	1617
2014	34970	3522	2579	28716	1838	22036	1311
2015	32967	3128	2211	27307	1575	21299	1119
2016	33664	2967	2295	29081	1686	22134	1138
2017	32760	2788	2163	28359	1603	21733	1097
2018	31674	2779	2134	27556	1614	20622	1050
2019	30288	2717	2089	26534	1655	19833	1092
2020	23540	2540	2015	20999	1654	15429	1075
2021	22816	2488	1920	20623	1602	15066	1066
2022	21322	2248	1729	19373	1415	13945	923
2023	20936	2074	1600	19058	1331	14013	825
A	42.26	34.26	31.66	49.59	38.92	47.59	30.34

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 3. Number of fatalities in road accidents in Poland in 2007-2023 in selected groups of traffic participants

Year	lk1	lk2	lk3	lk4	lk5	lk6	lk7
2007	5583	774	608	3753	409	2845	351
2008	5437	748	603	3659	427	2762	356
2009	4572	571	466	3139	333	2375	282
2010	3907	455	352	2633	248	1933	203
2011	4189	559	450	2841	300	2097	265
2012	3571	584	475	2511	306	1868	242
2013	3357	523	426	2269	288	1638	237
2014	3202	470	363	2189	256	1561	214
2015	2938	407	318	2010	218	1493	174
2016	3026	383	306	2284	221	1657	167
2017	2831	341	273	2091	198	1506	155
2018	2862	370	266	2177	203	1547	161
2019	2909	326	265	2226	192	1576	147
2020	2491	327	271	2020	216	1432	163
2021	2245	331	257	1909	212	1370	165
2022	1896	268	220	1621	172	1128	134
2023	1893	290	251	1622	212	1152	156
A	33.91	37.47	41.28	43.22	51.83	40.49	44.44

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1
Source: own study based on [10]

Table 4. Number of injured in road accidents in Poland in 2007-2023 in selected groups of traffic participants

Year	li1	li2	li3	li4	li5	li6	li7
2007	63224	8193	6449	52240	4928	41481	4175
2008	62097	8025	6319	51346	4976	40908	4140
2009	56046	6795	5318	46710	4243	37285	3565
2010	48952	5620	4397	40711	3419	32342	2785
2011	49501	6075	4820	41803	3753	33072	3028
2012	45791	5035	4071	39001	3125	30989	2483
2013	44059	4737	3523	37527	2791	29841	2220
2014	42545	4046	2971	36301	2313	28769	1759
2015	39778	3564	2535	34086	1973	27189	1503
2016	40766	3392	2641	36150	2100	28342	1546
2017	39466	3150	2440	35166	1936	27672	1423
2018	37359	3112	2439	33261	1965	25614	1381
2019	35477	3081	2389	31910	2015	24695	1448
2020	26463	2723	2167	24123	1845	18205	1262
2021	26415	2805	2203	24307	1917	18302	1374
2022	24743	2567	1964	22834	1690	16937	1193
2023	24125	2263	1741	22328	1506	16981	1008
A	38.16	27.62	27.00	42.74	30.56	40.94	24.14

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.
Source: own study based on [10]

Table 5. Number of victims in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants

Year	lv1	lv2	lv3	lv4	lv5	lv6	lv7
2007	68807	8967	7057	55993	5337	44326	4526
2008	67534	8773	6922	55005	5403	43670	4496
2009	60618	7366	5784	49849	4576	39660	3847
2010	52859	6075	4749	43344	3667	34275	2988
2011	53690	6634	5270	44644	4053	35169	3293
2012	49362	5619	4546	41512	3431	32857	2725
2013	47416	5260	3949	39796	3079	31479	2457
2014	45747	4516	3334	38490	2569	30330	1973
2015	42716	3971	2853	36096	2191	28682	1677
2016	43792	3775	2947	38434	2321	29999	1713
2017	42297	3491	2713	37257	2134	29178	1578
2018	40221	3482	2705	35438	2168	27161	1542
2019	38386	3407	2654	34136	2207	26271	1595
2020	28954	3050	2438	26143	2061	19637	1425
2021	28660	3136	2460	26216	2129	19672	1539
2022	26639	2835	2184	24455	1862	18065	1327
2023	26018	2553	1992	23950	1718	18133	1164
A	37.81	28.47	28.23	42.77	32.19	40.91	25.72

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 6. Percentage of fatalities in the total number of victims in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]

Year	pk1	pk2	pk3	pk4	pk5	pk6	pk7	pk8	pk9	pk10
2007	8.11	8.63	8.04	8.62	6.70	7.66	6.60	6.42	7.76	6.27
2008	8.05	8.53	7.98	8.71	6.65	7.90	6.52	6.32	7.92	6.14
2009	7.54	7.75	7.51	8.06	6.30	7.28	6.20	5.99	7.33	5.84
2010	7.39	7.49	7.38	7.41	6.07	6.76	6.01	5.64	6.79	5.53
2011	7.80	8.43	7.71	8.54	6.36	7.40	6.26	5.96	8.05	5.75
2012	7.23	10.39	6.83	10.45	6.05	8.92	5.79	5.69	8.88	5.40
2013	7.08	9.94	6.72	10.79	5.70	9.35	5.40	5.20	9.65	4.83
2014	7.00	10.41	6.63	10.89	5.69	9.96	5.38	5.15	10.85	4.75
2015	6.88	10.25	6.53	11.15	5.57	9.95	5.29	5.21	10.38	4.88
2016	6.91	10.15	6.60	10.38	5.94	9.52	5.71	5.52	9.75	5.27
2017	6.69	9.77	6.42	10.06	5.61	9.28	5.39	5.16	9.82	4.89
2018	7.12	10.63	6.78	9.83	6.14	9.36	5.93	5.70	10.44	5.41
2019	7.58	9.57	7.38	9.98	6.52	8.70	6.37	6.00	9.22	5.79
2020	8.60	10.72	8.35	11.12	7.73	10.48	7.49	7.29	11.44	6.97
2021	7.83	10.55	7.50	10.45	7.28	9.96	7.05	6.96	10.72	6.65
2022	7.12	9.45	6.84	10.07	6.63	9.24	6.41	6.24	10.10	5.94
2023	7.28	11.36	6.83	12.60	6.77	12.34	6.34	6.35	13.40	5.87
A	89.67	131.60	85.01	146.25	101.04	161.02	96.07	98.98	172.81	93.67

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 7. Number of fatalities per 100 road accidents in Poland in 2007-2023 in selected groups of traffic participants

Year	k1	k2	k3	k4	k5	k6	k7	k8	k9	k10
2007	11.27	12.79	11.06	12.03	9.76	11.96	9.55	9.66	12.91	9.33
2008	11.08	11.73	10.99	12.11	9.55	12.10	9.29	9.37	12.78	9.01
2009	10.34	10.68	10.30	11.26	8.96	11.07	8.76	8.73	11.61	8.45
2010	10.06	10.06	10.06	10.10	8.60	10.10	8.47	8.20	10.74	7.98
2011	10.46	11.24	10.34	11.56	8.83	11.04	8.62	8.53	12.77	8.14
2012	9.64	13.07	9.17	13.94	8.32	13.10	7.92	8.03	13.89	7.55
2013	9.36	12.98	8.91	14.20	7.73	13.30	7.29	7.23	14.66	6.66
2014	9.16	13.34	8.69	14.08	7.62	13.93	7.19	7.08	16.32	6.50
2015	8.91	13.01	8.48	14.38	7.36	13.84	6.96	7.01	15.55	6.54
2016	8.99	12.91	8.61	13.33	7.85	13.11	7.53	7.49	14.67	7.10
2017	8.64	12.23	8.31	12.62	7.37	12.35	7.08	6.93	14.13	6.55
2018	9.04	13.31	8.62	12.46	7.90	12.58	7.61	7.50	15.33	7.08
2019	9.60	12.00	9.37	12.69	8.39	11.60	8.18	7.95	13.46	7.62
2020	10.58	12.87	10.30	13.45	9.62	13.06	9.33	9.28	15.16	8.84
2021	9.84	13.30	9.42	13.39	9.26	13.23	8.92	9.09	15.48	8.61
2022	8.89	11.92	8.54	12.72	8.37	12.16	8.07	8.09	14.52	7.63
2023	9.04	13.98	8.50	15.69	8.51	15.93	7.95	8.22	18.91	7.55
A	80.23	109.35	76.84	130.38	87.16	133.19	83.28	85.08	146.48	80.93

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 8. Number of injured per 100 road accidents in Poland in 2007-2023 in selected groups of traffic participants

Year	i1	i2	i3	i4	i5	i6	i7	i8	i9	i10
2007	127.63	135.35	126.56	127.63	135.92	144.09	135.12	140.88	153.55	139.59
2008	126.59	125.88	126.69	126.91	134.00	141.00	133.29	138.79	148.65	137.76
2009	126.81	127.10	126.77	128.49	133.29	141.10	132.56	137.13	146.83	136.18
2010	126.06	124.23	126.30	126.13	132.92	139.27	132.37	137.28	147.35	136.40
2011	123.55	122.18	123.75	123.81	129.87	138.13	129.11	134.59	145.93	133.54
2012	123.61	112.72	125.10	119.49	129.20	133.78	128.82	133.20	142.54	132.44
2013	122.91	117.60	123.58	117.39	127.84	128.91	127.76	131.70	137.29	131.27
2014	121.66	114.88	122.42	115.20	126.41	125.84	126.45	130.55	134.17	130.33
2015	120.66	113.94	121.36	114.65	124.83	125.27	124.80	127.65	134.32	127.28
2016	121.10	114.32	121.75	115.08	124.31	124.56	124.29	128.05	135.85	127.62
2017	120.47	112.98	121.17	112.81	124.00	120.77	124.20	127.33	129.72	127.20
2018	117.95	111.98	118.52	114.29	120.70	121.75	120.64	124.21	131.52	123.81
2019	117.13	113.40	117.50	114.36	120.26	121.75	120.16	124.51	132.60	124.04
2020	112.42	107.20	113.05	107.54	114.88	111.55	115.16	117.99	117.40	118.04
2021	115.77	112.74	116.15	114.74	117.86	119.66	117.71	121.48	128.89	120.91
2022	116.04	114.19	116.26	113.59	117.87	119.43	117.74	121.46	129.25	120.90
2023	115.23	109.11	115.90	108.81	117.16	113.15	117.46	121.18	122.18	121.12
A	90.28	80.61	91.58	85.26	86.20	78.52	86.93	86.02	79.57	86.77

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 9. Number of victims per 100 road accidents in Poland in 2007-2023 in selected groups of traffic participants

Year	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10
2007	138.90	148.14	137.62	139.66	145.69	156.05	144.67	150.54	166.46	148.92
2008	137.67	137.62	137.68	139.02	143.55	153.10	142.58	148.16	161.44	146.77
2009	137.16	137.79	137.07	139.74	142.25	152.18	141.31	145.86	158.44	144.63
2010	136.12	134.28	136.36	136.23	141.52	149.37	140.83	145.49	158.10	144.39
2011	134.01	133.43	134.09	135.37	138.70	149.17	137.73	143.12	158.70	141.68
2012	133.25	125.79	134.27	133.43	137.52	146.88	136.74	141.23	156.43	140.00
2013	132.27	130.59	132.49	131.59	135.57	142.22	135.04	138.92	151.95	137.92
2014	130.82	128.22	131.11	129.27	134.04	139.77	133.64	137.64	150.50	136.83
2015	129.57	126.95	129.85	129.04	132.19	139.11	131.76	134.66	149.87	133.82
2016	130.09	127.23	130.36	128.41	132.16	137.66	131.82	135.53	150.53	134.72
2017	129.11	125.22	129.47	125.43	131.38	133.13	131.27	134.26	143.85	133.75
2018	126.98	125.30	127.15	126.76	128.60	134.32	128.25	131.71	146.86	130.90
2019	126.74	125.40	126.87	127.05	128.65	133.35	128.34	132.46	146.06	131.67
2020	123.00	120.08	123.35	120.99	124.50	124.61	124.49	127.27	132.56	126.88
2021	125.61	126.05	125.56	128.13	127.12	132.90	126.63	130.57	144.37	129.52
2022	124.94	126.11	124.80	126.32	126.23	131.59	125.81	129.54	143.77	128.54
2023	124.27	123.10	124.40	124.50	125.67	129.08	125.41	129.40	141.09	128.67
A	89.47	83.09	90.40	89.15	86.26	82.71	86.69	85.96	84.76	86.40

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 10. Percentage of road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]

Year	pa1	pa2	pa3	pa4	pa5	pa6	pa7	pa8	pa9	i10
2007	12.22	10.20	77.59	6.90	8.90	59.44	76.61	5.49	7.07	9.23
2008	13.00	10.15	78.11	7.19	9.21	60.09	76.92	5.68	7.27	9.45
2009	12.10	9.37	79.29	6.80	8.58	61.52	77.59	5.49	6.93	8.93
2010	11.65	8.98	78.87	6.32	8.02	60.67	76.92	4.87	6.17	8.02
2011	12.41	9.72	80.34	6.78	8.44	61.33	76.34	5.18	6.45	8.44
2012	12.06	9.20	81.48	6.31	7.74	62.80	77.07	4.70	5.77	7.49
2013	11.24	8.37	81.89	6.04	7.38	63.21	77.19	4.51	5.51	7.14
2014	10.07	7.37	82.12	5.26	6.40	63.01	76.74	3.75	4.57	5.95
2015	9.49	6.71	82.83	4.78	5.77	64.61	78.00	3.39	4.10	5.25
2016	8.81	6.82	86.39	5.01	5.80	65.75	76.11	3.38	3.91	5.14
2017	8.51	6.60	86.57	4.89	5.65	66.34	76.64	3.35	3.87	5.05
2018	8.77	6.74	87.00	5.10	5.86	65.11	74.84	3.32	3.81	5.09
2019	8.97	6.90	87.61	5.46	6.24	65.48	74.75	3.61	4.12	5.51
2020	10.79	8.56	89.21	7.03	7.88	65.54	73.47	4.57	5.12	6.97
2021	10.90	8.42	90.39	7.02	7.77	66.03	73.05	4.67	5.17	7.08
2022	10.54	8.11	90.86	6.64	7.30	65.40	71.98	4.33	4.76	6.62
2023	9.91	7.64	91.03	6.36	6.98	66.93	73.53	3.94	4.33	5.89
A	81.07	74.92	117.32	92.08	78.49	112.60	95.97	71.79	61.19	63.76

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [9]

Table 11. Percentage of fatalities in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]

Year	pak1	pak2	pak3	pak4	pak5	pak6	pak7	pak8	pak9	pak10
2007	13.86	10.89	67.22	7.33	10.90	50.96	75.81	6.29	9.35	12.34
2008	13.76	11.09	67.30	7.85	11.67	50.80	75.49	6.55	9.73	12.89
2009	12.49	10.19	68.66	7.28	10.61	51.95	75.66	6.17	8.98	11.87
2010	11.65	9.01	67.39	6.35	9.42	49.48	73.41	5.20	7.71	10.50
2011	13.34	10.74	67.82	7.16	10.56	50.06	73.81	6.33	9.33	12.64
2012	16.35	13.30	70.32	8.57	12.19	52.31	74.39	6.78	9.64	12.96
2013	15.58	12.69	67.59	8.58	12.69	48.79	72.19	7.06	10.45	14.47
2014	14.68	11.34	68.36	8.00	11.69	48.75	71.31	6.68	9.78	13.71
2015	13.85	10.82	68.41	7.42	10.85	50.82	74.28	5.92	8.66	11.65
2016	12.66	10.11	75.48	7.30	9.68	54.76	72.55	5.52	7.31	10.08
2017	12.05	9.64	73.86	6.99	9.47	53.20	72.02	5.48	7.41	10.29
2018	12.93	9.29	76.07	7.09	9.32	54.05	71.06	5.63	7.40	10.41
2019	11.21	9.11	76.52	6.60	8.63	54.18	70.80	5.05	6.60	9.33
2020	13.13	10.88	81.09	8.67	10.69	57.49	70.89	6.54	8.07	11.38
2021	14.74	11.45	85.03	9.44	11.11	61.02	71.77	7.35	8.64	12.04
2022	14.14	11.60	85.50	9.07	10.61	59.49	69.59	7.07	8.27	11.88
2023	15.32	13.26	85.68	11.20	13.07	60.86	71.02	8.24	9.62	13.54
A	110.50	121.76	127.46	152.87	119.93	119.42	93.69	131.08	102.84	109.76

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 12. Percentage of injured in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]

Year	pai1	pai2	pai3	pai4	pai5	pai6	pai7	pai8	pai9	pai10
2007	12.96	10.20	82.63	7.79	9.43	65.61	79.40	6.60	7.99	10.06
2008	12.92	10.18	82.69	8.01	9.69	65.88	79.67	6.67	8.06	10.12
2009	12.12	9.49	83.34	7.57	9.08	66.53	79.82	6.36	7.63	9.56
2010	11.48	8.98	83.17	6.98	8.40	66.07	79.44	5.69	6.84	8.61
2011	12.27	9.74	84.45	7.58	8.98	66.81	79.11	6.12	7.24	9.16
2012	11.00	8.89	85.17	6.82	8.01	67.67	79.46	5.42	6.37	8.01
2013	10.75	8.00	85.17	6.33	7.44	67.73	79.52	5.04	5.92	7.44
2014	9.51	6.98	85.32	5.44	6.37	67.62	79.25	4.13	4.85	6.11
2015	8.96	6.37	85.69	4.96	5.79	68.35	79.77	3.78	4.41	5.53
2016	8.32	6.48	88.68	5.15	5.81	69.52	78.40	3.79	4.28	5.45
2017	7.98	6.18	89.10	4.91	5.51	70.12	78.69	3.61	4.05	5.14
2018	8.33	6.53	89.03	5.26	5.91	68.56	77.01	3.70	4.15	5.39
2019	8.68	6.73	89.95	5.68	6.31	69.61	77.39	4.08	4.54	5.86
2020	10.29	8.19	91.16	6.97	7.65	68.79	75.47	4.77	5.23	6.93
2021	10.62	8.34	92.02	7.26	7.89	69.29	75.30	5.20	5.65	7.51
2022	10.37	7.94	92.28	6.83	7.40	68.45	74.17	4.82	5.22	7.04
2023	9.38	7.22	92.55	6.24	6.74	70.39	76.05	4.18	4.51	5.94
A	72.39	70.75	112.01	80.09	71.50	107.28	95.78	63.27	56.49	58.98

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.

Source: own study based on [10]

Table 13. Percentage of victims in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]

Year	pav1	pav2	pav3	pav4	pav5	pav6	pav7	pav8	pav9	pav10
2007	13.03	10.26	81.38	7.76	9.53	64.42	79.16	6.58	8.08	10.21
2008	12.99	10.25	81.45	8.00	9.82	64.66	79.39	6.66	8.17	10.30
2009	12.15	9.54	82.23	7.55	9.18	65.43	79.56	6.35	7.72	9.70
2010	11.49	8.98	82.00	6.94	8.46	64.84	79.08	5.65	6.89	8.72
2011	12.36	9.82	83.15	7.55	9.08	65.50	78.78	6.13	7.38	9.36
2012	11.38	9.21	84.10	6.95	8.27	66.56	79.15	5.52	6.56	8.29
2013	11.09	8.33	83.93	6.49	7.74	66.39	79.10	5.18	6.17	7.81
2014	9.87	7.29	84.14	5.62	6.67	66.30	78.80	4.31	5.13	6.51
2015	9.30	6.68	84.50	5.13	6.07	67.15	79.46	3.93	4.65	5.85
2016	8.62	6.73	87.76	5.30	6.04	68.50	78.05	3.91	4.46	5.71
2017	8.25	6.41	88.08	5.05	5.73	68.98	78.32	3.73	4.24	5.41
2018	8.66	6.73	88.11	5.39	6.12	67.53	76.64	3.83	4.35	5.68
2019	8.88	6.91	88.93	5.75	6.47	68.44	76.96	4.16	4.67	6.07
2020	10.53	8.42	90.29	7.12	7.88	67.82	75.11	4.92	5.45	7.26
2021	10.94	8.58	91.47	7.43	8.12	68.64	75.04	5.37	5.87	7.82
2022	10.64	8.20	91.80	6.99	7.61	67.81	73.87	4.98	5.43	7.35
2023	9.81	7.66	92.05	6.60	7.17	69.69	75.71	4.47	4.86	6.42
A	75.29	74.65	113.12	85.13	75.26	108.19	95.64	68.01	60.13	62.87

A – ratio of the 2007 value to the 2023 value in [%], other designations as in Table 1.
Source: own study based on [10]

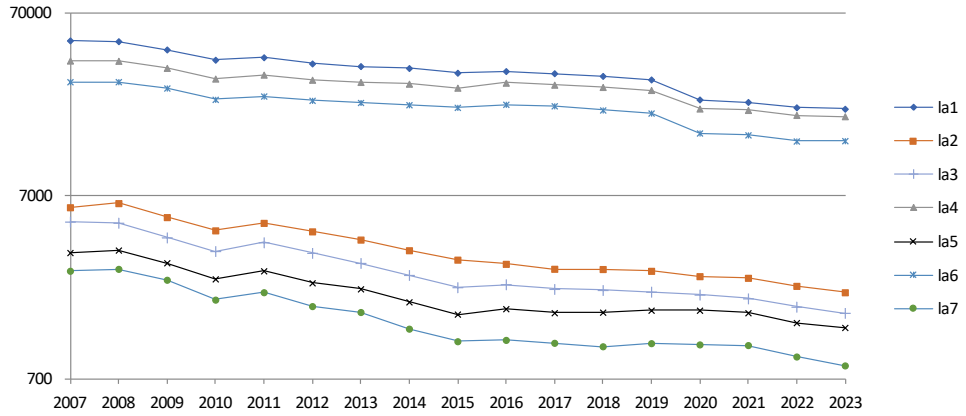

Fig. 1. Number of road accidents in Poland in 2007-2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [10]

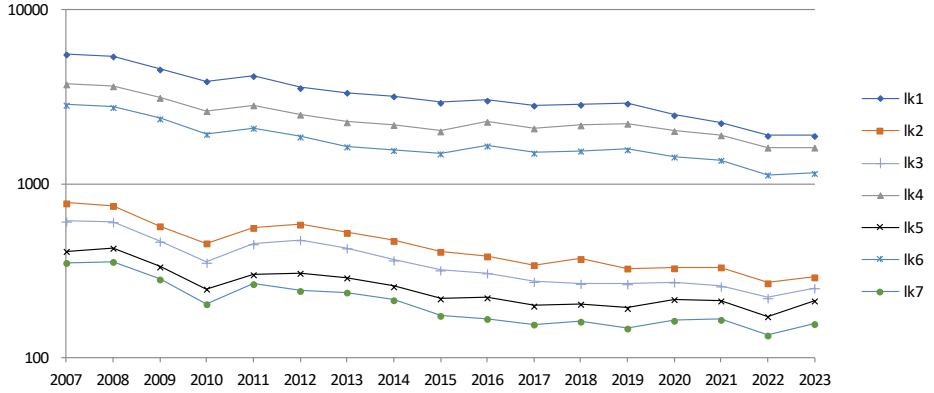

Fig. 2. Number of fatalities in road accidents in Poland in 2007-2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [9]

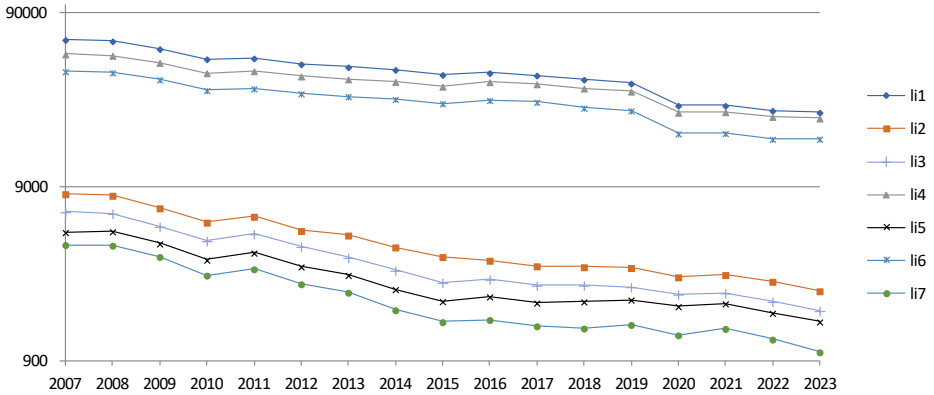

Fig. 3. Number of injured in road accidents in Poland in 2007-2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [10]

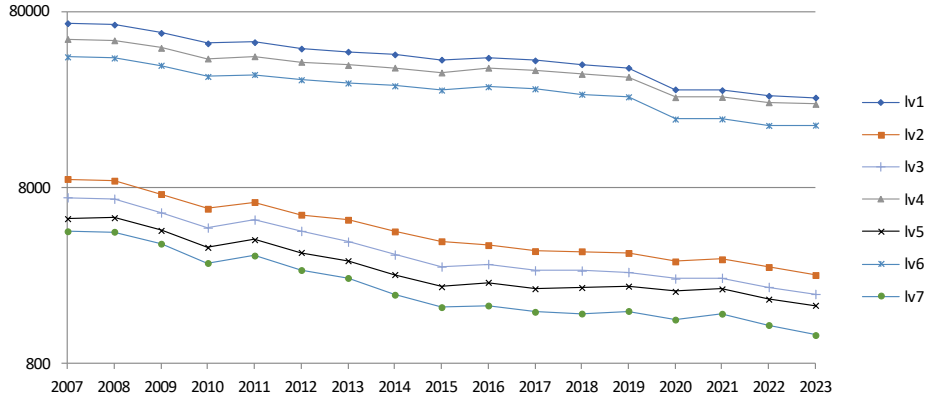

Fig. 4. Number of victims in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [10]

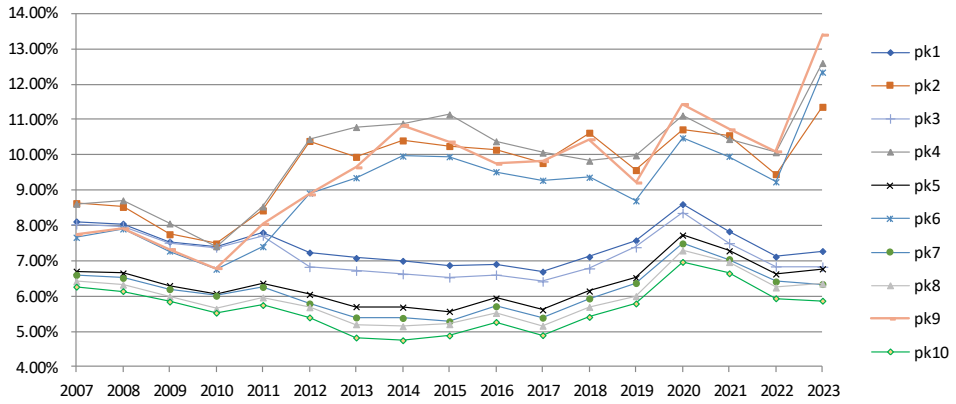

Fig. 5. Percentage of fatalities in the total number of victims in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]
Designations as in Table 1. Source: own study based on [10]

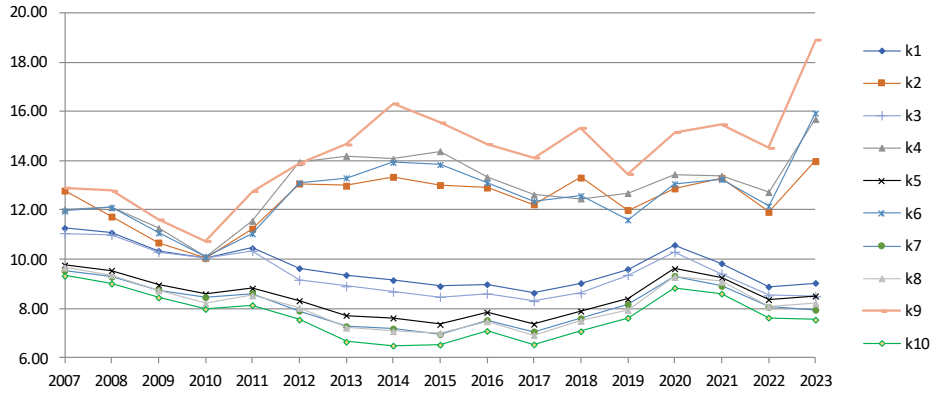

Fig. 6. Number of fatalities per 100 road accidents in Poland in 2007-2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [10]

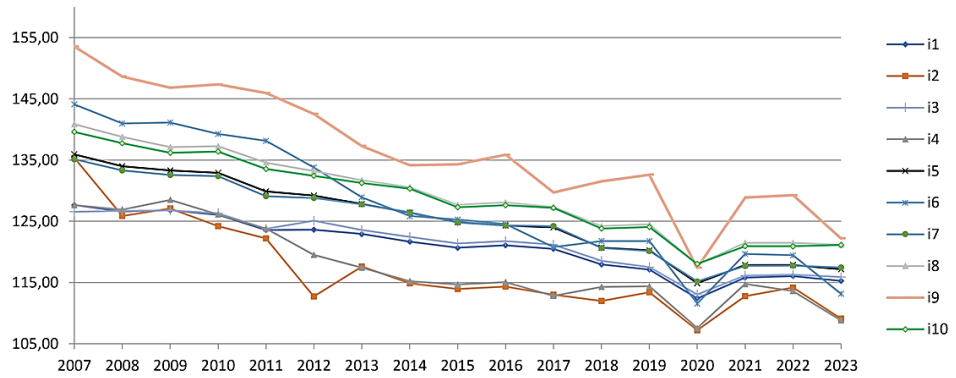

Fig. 7. Number of injured per 100 road accidents in Poland in 2007-2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [10]

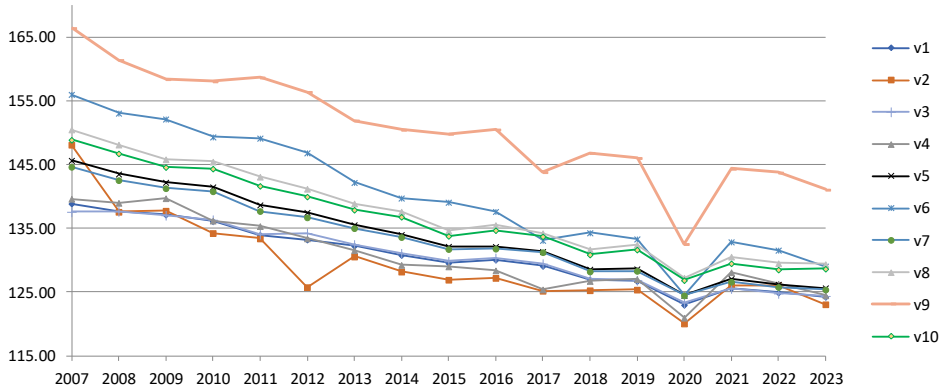

Fig. 8. Number of victims per 100 road accidents in Poland in 2007-2023 in selected groups of traffic participants
Designations as in Table 1. Source: own study based on [10]

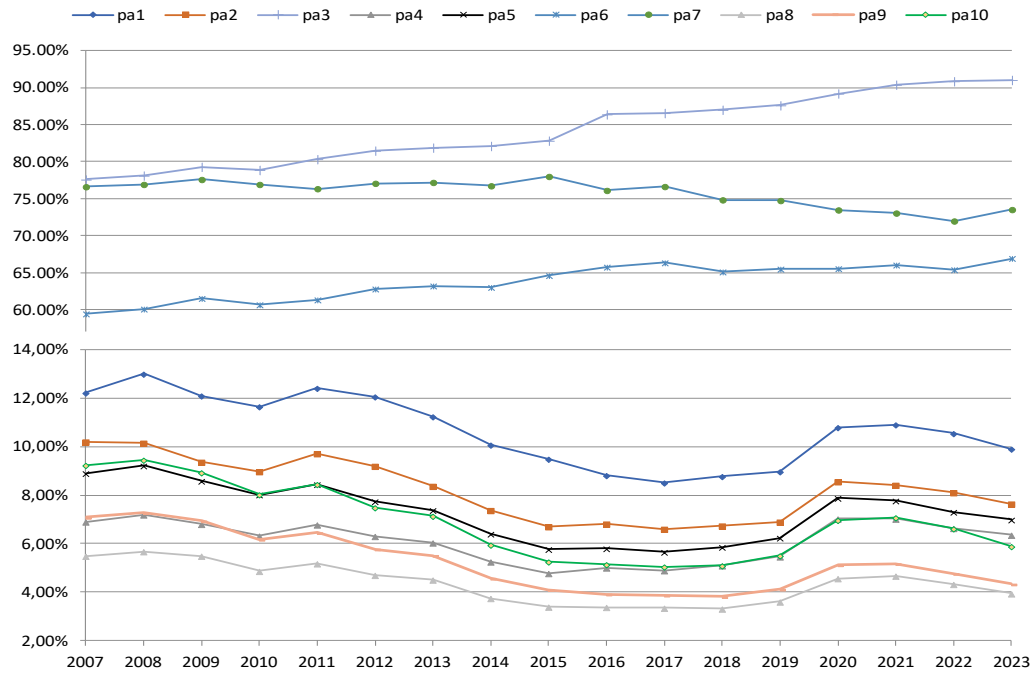

Fig. 9. Percentage of road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]
Designations as in Table 1. Source: own study based on [10]

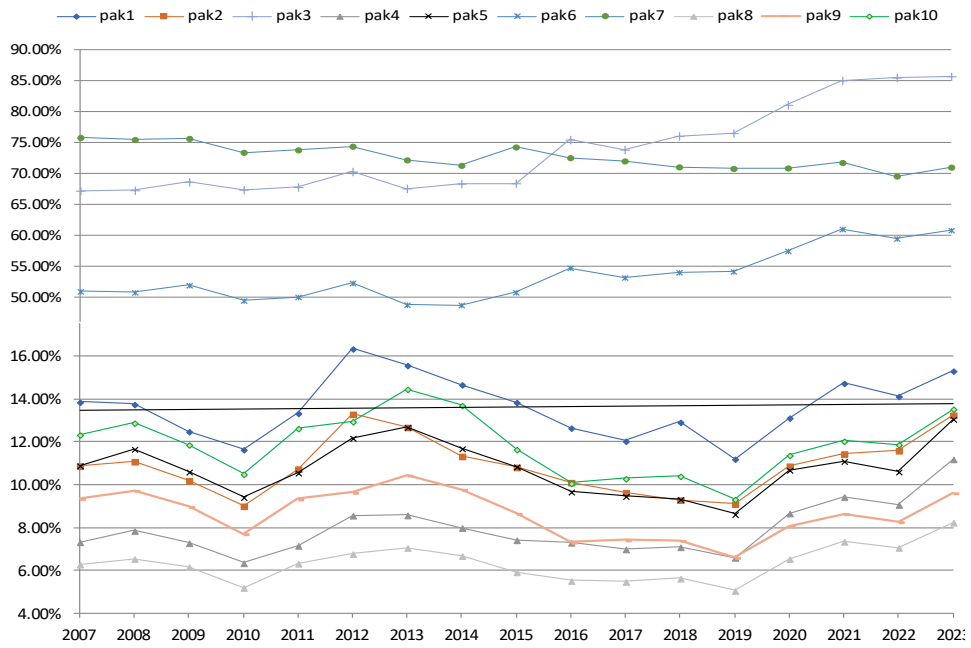

Fig. 10. Percentage of fatalities in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]. Designations as in Table 1. Source: own study based on [10]

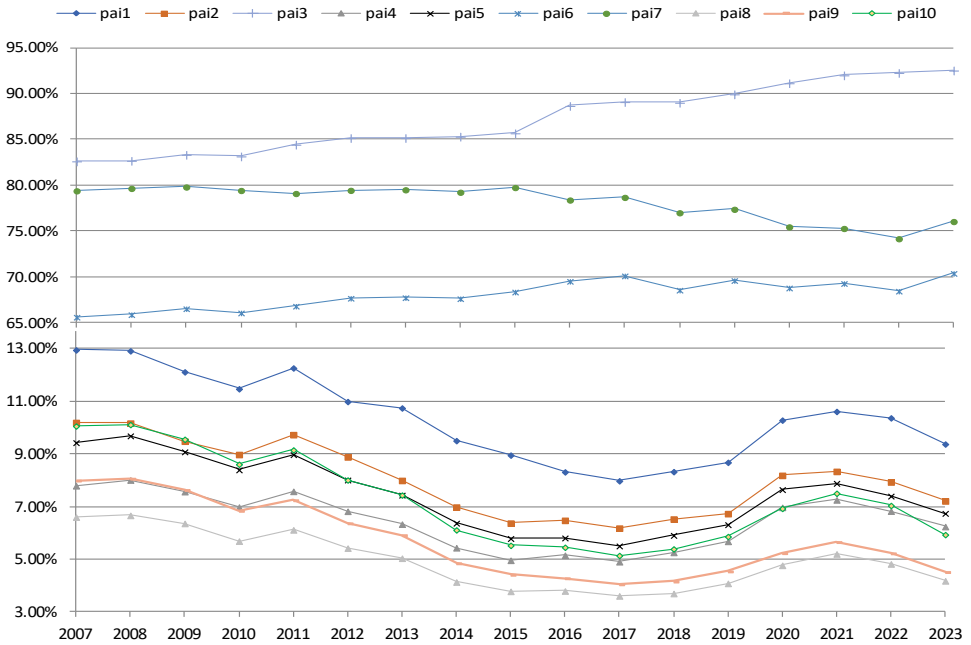

Fig. 11. Percentage of injured in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]. Designations as in Table 1. Source: own study based on [10]

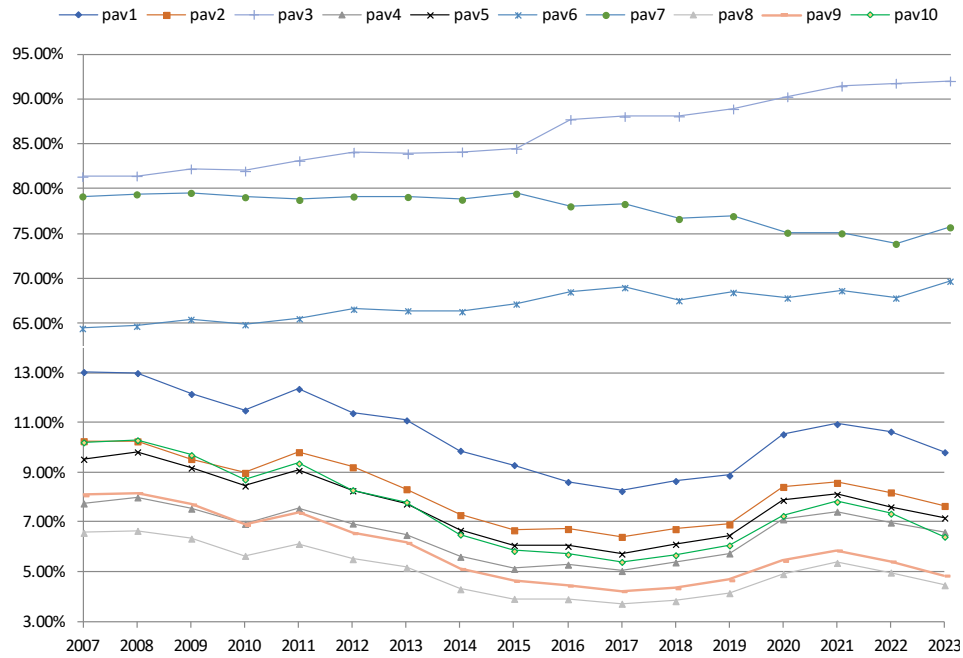

Fig. 12. Percentage of victims in road accidents in Poland between 2007 and 2023 in selected groups of traffic participants in [%]. Designations as in Table 1. Source: own study based on [10]

2. METHODOLOGY

All calculations were performed in an Excel spreadsheet. The REGLINP function was used to determine the linear trend as an array variable. This allowed a direct reading of the value of the coefficient of determination R^2 and the determination of the significance of the model and model parameters using t and F statistics (significance for these models is the same as the significance of the parameter a in the equation of the simple trend y = at + b). Parameters were assumed to be significant (reject the hypothesis that the parameter is equal to zero at the significance level α) when α is less than 0.05 (the cases α < 0.01 and α < 0.001 were also distinguished). In determining the trend, periods 1 to 17 were marked instead of the years 2007 to 2023.

In addition, the Shapiro – Wilk test for testing the hypothesis of the normality of the distribution of the residuals [15], the Durbin – Watson test for testing the autocorrelation of the residuals [16] and the:
mean absolute deviation MAD:

$$MAD = \frac{1}{n}\sum_{t=1}^{n}|y_t - \hat{y}_t| \tag{1}$$

standard deviation of the absolute deviation SMAD:

$$SMAD = \sqrt{\frac{1}{n}\sum_{n}^{1}(|y_t - \hat{y}_t| - MAD)^2} \tag{2}$$

where y_t value of the variable in period t, $\hat{y}_t$ value of the trend (regression) model in period t.

For comparisons of x_t, y_t values, the t statistic was used [15]:

$$t = \frac{\bar{Z} - m_0}{S}\sqrt{n-1} = \frac{\bar{Z} - m_0}{\hat{S}}\sqrt{n} \tag{3}$$

where $z_t = x_t - y_t$, hypothesis to be verified Ho: $EZ = \bar{Z} = 0$.

In addition, for quantities having a structure index interpretation, an equality test of structure indices was applied [15]:

$$U = \frac{\bar{p}}{\sqrt{\hat{p}(1-\hat{p})}}\sqrt{n} \tag{4}$$

where $\bar{p} = \bar{p}_1 - \bar{p}_2, n = \frac{n_1 n_2}{n_1+n_2}, \hat{p} = \frac{k_1+k_2}{n_1+n_2}$.

When testing for the non-existence of a trend, the median test, the test based on the total number of character series, the chi-square test based on the number of character series and the Wallis – Moor chi-square test were used [15]. It was assumed that there was no trend if, for at least three tests, there were no reason for rejecting the hypothesis that a trend was present (significance level 0.05).

3. RESULTS AND DISCUSSION

ROAD ACCIDENTS AND THEIR VICTIMS IN POLAND 2007-2023

The number of road accidents and their victims in Poland is on a clear downward trend[2]. Comparing 2007 with 2023, the number of road accidents la1 fell by nearly 58% (from 49536 to 20936), fatalities lk1 by more than 66% (from 5583 to 1893), injuries li1 by nearly 62% (from 63224 to 24125) and victims lv1 (total fatalities and injuries) by more than 62% (from 68807 to 26018). The number of victims of accidents is falling faster than the number of accidents – especially for fatalities. This is confirmed by:

- percentage of fatalities in the total number of accident victims pk1 – decrease from 8.11% to 7.28% (by 10.3%),
- indicator of the number of fatalities per 100 road accidents k1 – decrease from 11.27 to 9.04 (by 19.8%),
- indicator of the number of injured per 100 road accidents l1 – decrease from 127.63 to 115.23 (by 9.7%),
- indicator of the number of victims per 100 road accidents v1 – from 138.9 to 124.27 (by 10.5).

The linear model describes well the trend of the variables v1 and la1[3]. The coefficient of determination R^2 takes values from 0.96 and 0.935.

ACCIDENTS INVOLVING INTOXICATED ROAD USERS

The number of accidents involving intoxicated traffic participants and their victims, like the overall number of accidents and victims, has a clear downward trend. The decline is more rapid. The share of accidents ranges from 8.51% to 13.00%, fatalities from 11.21% to 15.58%, and injuries from 7.98% to 12.96%. Comparing 2007 with 2023:

- the number of road accidents la2 fell by nearly 66% (from 6053 to 2074), pa1 fell by nearly 19% (from 12.22% to 9.91%),
- the number of injured li2 by more than 72% (from 8193 to 2263), pai1 decreased by more than 27.5% (from 12.96% to 9.38%) and is statistically smaller than pa1 (p-value for t-test less than 0.0012),
- i2 < i1 in most cases (in 15 cases) and decreased by nearly 20% (from 135.35 to 109.11, p-value for t-test less than 0.0011),
- the number of victims lv2 by more than 71.5% (from 8967 to 2553), pav1 decreased by nearly 25% (from 13.03% to 9.81%) and is statistically smaller than pa1 (p-value for t-test less than 0.045),
- v2 < v1 in most cases (in 13 cases) and decreased by nearly 17% (from 148.14 to 123.10, p-value for t-test less than 0.044).

However, the number of lk2 fatalities is declining more slowly - down more than 62.5% (from 774 to 290). The percentage of pk1 fatalities in the total number of lk1 fatalities increased by 10.5% (from 13.86% to 15.32%). In all years considered, the value of pk2 was greater than pk1, increasing by 31.6% (from 8.63% to 11.36%; in 14 cases, significance was less than 0.0014), t-test value = -5.63 (H0: pk1-pk2=0; p-value < 0.0002). In 16 cases, k2 > k1 (p-value for t-test less than 0.00012) and increased by more than 9% (from 12.79 to 13.98). The data show that while the number, percentage of accidents and victims in accidents involving intoxicated people are declining, the severity of accidents as measured by the number of fatalities per 100 accidents and the share of total accident fatalities is increasing.

[2] A clear downward trend can be observed starting in 1998 [10].
[3] The analysis of trend models is presented in the subsection Trend Models.
[4] p-value < 0.001 for Ho's hypothesis of equality of indicators and the one-tailed alternative hypothesis.

ACCIDENTS CAUSED BY INTOXICATED ROAD USERS

The number of accidents caused by intoxicated traffic participants la3 is falling faster than la1, more significantly, faster than la2. The decrease is more than 68% (from 5053 to 1600). The percentage of pa2 ranges from 6.6% to 10.20% and has fallen by more than 25% (from 10.20% to 7.64%). It is falling even faster:

- number of lv3 victims – a decrease of nearly 72% (from 7057 to 1992), the percentage of pav2 decreased by nearly 25.5% (from 10.26% to 7.66%), but the indicators pa2 and pav2 and v1 and v4 are statistically insignificantly different (p-value for the t-test is 0.1995 and 0.2768, respectively, two-tailed hypothesis alternative hypothesis; for tests of equality of structure indicators, p-value ranges from 0.298 to 0.970),
- the number of injured li3 – a decrease of 73% (6449 to 1741), the percentage of pai2 decreased by more than 29% (from 10.20% to 7.22%),
- i4 is statistically smaller than i1 (p-value is 0.00025) and i3 (p-value is 0.00043) although in most cases it is smaller than both indicators (13 cases) and differs non-significantly from i2 (p-value is 0.407) although in most cases it is larger (12 cases),
- pai2 tends to be smaller than pa2 (13 cases, p-value for t-test less than 0.0002),

For lk3 fatalities, the decrease is much lower, at nearly 59% (from 608 to 251). The pak2 percentage increased by nearly 22% (from 10.89% to 13.26%), the k4 indicator increased by more than 30% (from 12.03 to 15.69), the pk4 indicator increased by more than 46% (from 8.62% to 12.60%). The pak2 indicator is significantly larger (always) than pa2 (p-value for t-test less than 0.00001), similarly pk4 than pk1 (p-value for t-test less than 0.00002). The data show that while the number of victims in accidents caused by intoxicated traffic participants decreases in proportion to the number of such accidents, the structure of such accidents changes – the percentage of fatalities increases significantly. The severity of accidents caused by intoxicated people (measured by the number of fatalities per 100 accidents) is statistically significantly higher than k1 (p-value for t-test less than 0.000013), k2 (p-value for t-test less than 0.0051) and k3 p-value for t-test less than 0.000011).

ACCIDENTS CAUSED BY DRIVERS

Drivers of various types of vehicles (including cars, motorcycles, mopeds, bicycles, agricultural machinery, electric scooters, buses, and streetcars) are the dominant group of traffic participants causing road accidents. This group was responsible for 77.59% of all accidents in 2007. This share (pa3) is steadily increasing, reaching more than 91.% in 2023, an increase of more than 17%. In absolute numbers, la4 has seen a decline of more than 50% (from 38434 to 19058). Also falling in numbers are lk4 by nearly 57% (from 3753 to 1622), li4 by more than 57% (from 52240 to 22328) and lv4 victims by more than 57% (from 55993 to 23950). However, pak3, pai3 and pav3 indicators increase by about 27.5%, 12% and 13%, respectively. The increase in shares can be explained by an increase in the number of drivers, but more conclusive for assessing the situation is an analysis of the changes in the k5, i5, v5 and pk5 indicators, as well as the changes in the pak3, pai3 and pav3 indicators relative to pa3. In all the years analyzed:

- the value of the k5 indicator is significantly smaller than k1 (p-value for the t-test is less than 10-8),
- the pak3 indicator, although growing faster than pa3, is significantly smaller (p-value for the t-test is less than 10-9),
- the i5 indicator is significantly larger than i1 (p-value for the t-test is less than 10-9),
- the pai5 indicator, although growing more slowly than pa3, is significantly larger (p-value for the t-test is less than 10-9),
- the v5 indicator is significantly larger than v1 (p-value for the t-test is less than 10-7),
- the pav5 indicator, although growing more slowly than pa3, is significantly larger (p-value for the t-test is less than 10-8),
- the pk5 indicator is significantly smaller than pk1 (p-value for the t-test is less than 10-9).

The indicators show that although statistically the number of victims in an accident caused by the driver is higher than the number of victims in an accident caused by other factors, the number of fatalities decreases – the number of irreversible losses decreases. The linear trend model describes well the variables v5, pai3, pav3 ($R2 > 0.96$) and quite well pak3 ($R2 = 0.839$).

ACCIDENTS CAUSED BY INTOXICATED DRIVERS

Intoxicated drivers caused between 1,331 (year 2023) and 3,529 (year 2008) traffic accidents between 2007 and 2023. In 2023, this was more than 61% less than in 2007. This was a decrease greater than that of la4

drivers and all la1 accidents, but much less than that of accidents involving la2 intoxicated drivers and caused by la3 intoxicated drivers. The indicator pa4 of these accidents in the total number of accidents varies from 4.78% in 2015 to 7.19% in 2008 (a decrease of nearly 8% between 2007 and 2023). In all the years under consideration:

- the percentage of pak4 was greater than pa4 (the p-value for the t-test is less than 10-5) and increased by nearly 53% (from 7.33% in 2007 to 11.20% in 2023),
- the percentage of pak5 was higher than pa5 (the p-value for the t-test is less than 10-7) and increased by nearly 20% (from 10.90% in 2007 to 13.07% in 2023); over the same period, the pa5 indicator decreased by more than 21% (from 8.90% to 6.98%), the number of accidents caused by la4 drivers decreased by more than 50% and intoxicated la5 drivers by more than 60%,
- the indicator of fatalities per 100 accidents k6 increased by more than 33% (from 11.96 to 15.93) and was significantly greater than the indicator k1 (the p-value for the t-test is less than 10-4), so also the indicators k5 and k7 (k7 is significantly smaller than k5),
- the percentage of pk6 increased by more than 61% (from 7.77% to 12.34%) and was larger than both the pk5 and pk7 indicators (the differences are increasing, note that the percentage of pk6 was not always larger than pk1 – the change occurred in 2012),
- the percentage of pav4 was greater than pa4 (the p-value for the t-test is less than 10-7) and decreased by nearly 15% (from 7.76% in 2007 to 6.60% in 2023, the lowest was recorded in 2017 – 5.05%),
- the percentage of pav5 was greater than pa5 (the p-value for the t-test is less than 10-6) and decreased by nearly 25% (from 9.53% in 2007 to 7.17% in 2023, the lowest was recorded in 2017 – 5.73%),
- the indicator of v6 decreased by more than 17% (from 156.05 to 129.08) and was significantly larger than the indicators of v1, v5 and v7 (the p-value for the t-test is less than 10 -7), v7 is significantly smaller than v5),
- For those injured in accidents caused by intoxicated drivers:
- the percentage of pai4 was greater than pa4 (the p-value for the t-test is less than 10-5) and increased by nearly 53% (from 7.33% in 2007 to 11.20% in 2023;
- in 13 cases, pai5 was greater than pa5 (p-value for t-test is less than 0.005) and decreased by nearly 28.5% (from 9.43% to 6.74%),
- i6 decreased by nearly 21.5% (from 144.09 to 113.15) and in 15 cases was larger than i1 (p-value for t-test is less than 10-4) and in 13 cases than i5 and i7 (p-value for t-test is less than 0.007, i7 is significantly smaller than i5).

Statistics show that there is a clear decrease in the percentage of victims of accidents caused by intoxicated drivers in accidents caused by drivers, as well as the severity of accidents as measured by indicators i6, v6, pai4, pai5, pav4, pav5. However, the percentage of victims is higher than the percentage of accidents caused by intoxicated drivers. This means that statistically, the consequences of these accidents are more serious than those of a statistical traffic accident. This is particularly evident in the case of accident fatalities. The percentage of fatalities from these accidents in the total number of fatalities has increased significantly, as well as the k6 and pk6 indicators have risen dramatically. Note that in the same period the pk7 indicator decreased by nearly 4%, and the differences between pk6 and pk7 reach up to 6 percentage points.

ACCIDENTS CAUSED BY DRIVERS OF PASSENGER CARS

Passenger car drivers constitute the largest group of traffic participants, considering the mode of transportation they use[5]. They cause (la6) from about 14,000 (years 2022, 2023) to about 29,500 (years 2007, 2008) accidents. This accounts for 73% to 78% of all road accidents (pa7). Although the number of accidents la6 fell by more than 52% (from 29445 in 2007 to 14013 in 2023), the decline was slower than that of la1. The percentage of pa7 was only 5% lower. This is due to the increase in passenger car traffic. How did the structure and percentage of victims of accidents caused by passenger car drivers change between 2007 and 2023? In the case of fatalities:

- the number of fatalities lk6 decreased by more than 59.5% – the decrease is significantly greater than the number of accidents la6 but at the same time significantly smaller than la1,
- the percentage of fatalities pk7 is essentially unchanged – it is significantly smaller than pk1 and pk5 (the p-value for the t-test is less than 10-11),
- the percentage of pak6 increased by more than 19% – it is always significantly smaller than the proportion of accidents pa6 (p-value for the t-test is less than 10-9),
- the percentage of pak7 decreased by more than 6% – it is always significantly smaller than the share of pa7 accidents (p-value for the t-test is less than 10-7),

[5] Considering "active" traffic participants omits passengers, for example, and pedestrians are also omitted here.

- the number of fatalities per 100 accidents k8 fell by nearly 15% (from 9.66 to 8.22) – it is always significantly smaller than k1 and k5 (p-value for the t-test is less than 10-8),
- In the case of injured victims:
- the number of injured victims li6 decreased by more than 59% – the decrease is significantly larger than the number of accidents la6 but at the same time significantly smaller than la1,
- the percentage of pai6 increased by more than 7% – it is always significantly greater than the percentage of pa6 accidents (the p-value for the t-test is less than 10-12),
- the percentage of pai7 decreased by more than 4% – it is always significantly greater than the percentage of pa7 accidents (p-value for the t-test is less than 10-16),
- the number of injured per 100 accidents i8 fell by nearly 14% (from 140.88 to 121.88) – it is always significantly greater than i1 and i5 (p-value for the t-test is less than 10-10).
- In the case of accident victims:
- the number of lv6 victims by more than 59% – the decrease is significantly greater than the number of la6 accidents but at the same time significantly less than la1,
- the percentage of pav6 increased by more than 8% – it is always significantly greater than the percentage of pa6 accidents (the p-value for the t-test is less than 10-11),
- the percentage of pai7 decreased by more than 4% – it is always significantly greater than the percentage of pa7 accidents (p-value for the t-test is less than 10-15),
- the number of victims per 100 accidents i8 fell by nearly 14% (from 150.54 to 129.40) – it is always significantly greater than i1 and i5 (p-value for the t-test is less than 10-10).

Fewer people die in a statistical accident caused by a passenger car driver than in a statistical traffic accident and a statistical traffic accident caused by a driver. The opposite is true for the number of injuries and the total number of victims. However, it should be noted that it has a clear downward trend. The number of victims, injuries, and fatalities is decreasing at essentially the same rate – faster than the decrease in the number of accidents and slower than the number of driver-caused accidents.

ACCIDENTS CAUSED BY INTOXICATED DRIVERS OF PASSENGER CARS

Accidents caused by intoxicated car drivers, especially passenger cars, are media events that arouse public outrage. Do statistics support the widespread opinion that the proportion of accidents caused by an intoxicated passenger car driver is increasing, and that the number of victims of a statistical accident caused by an intoxicated passenger car driver is greater than that of a statistical accident?

Note that:

- the number of accidents caused by intoxicated car drivers la7 steadily declined (by nearly 70%, from 2719 in 2007 to 825 in 2023),
- the percentage of pa8 accidents fell by more than 28% (from 5.49% to 3.94),
- the percentage of pa9 accidents fell by nearly 39% (from 7.07% to 4.33%),
- the percentage of pa10 accidents fell by more than 36% (from 9.23% to 5.89%),
- lk7 fell by more than 55% (from 351 to 156) – so the decline was much slower than the number of accidents la7,
- the percentage of pak8 increased by more than 31% (from 6.29% to 8.24%) and was always significantly higher than pa8 (the p-value for the t-test is less than 10-5),
- the percentage of pak9 increased by less than 3% (from 9.35% to 9.62%) and was always significantly higher than pa9 (p-value for t-test is less than 10-8),
- the percentage of pak10 increased by less than 10% (from 12.34% to 13.54%) and was always significantly higher than pa10 (p-value for t-test is less than 10-8),
- the indicator of fatalities per 100 accidents k9 increased by more than 46% (from 12.91 to 18.91, at the same time the indicator k10 decreased by more than 19% from 9.33 to 7.55) and was always significantly greater than the indicators k1, k6, k8, k10 (p-value for the t-test is less than 10-5),
- the indicator pk9 increased by nearly 73% (from 7.76% to 13.40%) and since 2011 was greater than k1 (p-value for t-test is less than 0.004, in 16 cases than pk6 (p-value for t-test is less than 0.006) and always greater than pk8 and pk10 (p-value for t-test is less than 10-6),
- the number of injured li7 decreased by nearly 76% (from 4175 to 1008),
- pai8 fell by nearly 37% (from 6.60% to 4.18%),
- pai9 fell by more than 43% (7.99% to 4.51%),

- pai10 fell by more than 41% (from 10.06% to 5.94%),
- the i9 injury rate per 100 accidents fell by more than 20% (from 153.55 to 122.18, at the same time, the i10 rate fell by more than 13% from 139.59 to 121.12),
- i9 is always higher than i1 and i6 and i8 and i10 (16 times, the p-value for the t-test is less than 10-6),
- the number of victims of accidents v7 fell by nearly 75% (from 4526 to 1164),
- pav8 fell by nearly 32% (from 6.58% to 4.47%),
- pav9 fell by nearly 40% (8.08% to 4.86%),
- pai10 fell by more than 37% (from 10.21% to 6.42%),
- the number of injured per 100 accidents v9 fell by more than 15% (from 166.46 to 141.09, at the same time the i10 indicator fell by more than 13% from 148.92 to 128.67),
- v9 is always higher than the indicators v1, i6, i8 and i10 p-value for the t-test is less than 10-12).

Statistics show that the number of accidents caused by intoxicated passenger car drivers is significantly decreasing (and faster than the total number of accidents). Importantly, their share (somewhat slower than the number of la7) of the total number of accidents pa8 caused by drivers pa7 and drivers of passenger cars pa10 is falling. Thus, the number of injuries and fatalities is also falling (although in this case more slowly than the number of accidents). However, the severity of accidents as measured by fatality indicators is increasing – k9 (up 46%), pk9 (up 73%), and pak8 (up 31%). The indicator of injured people per 100 accidents (although declining) is higher than both the overall i1, i6 and (in 16 cases) i8, i10. Notable is the large difference between the number of injured in accidents caused by i6 and i9 drivers, with differences ranging from 5.7 to 11.3.

4. TREND MODELS

A linear trend was determined for the studied indicators (quantities). The models were divided according to the measure of fit R^2, the significance of the parameter a (parameter b was significant for all models, p- value less than 0.0001), autocorrelation of residuals, and the result of the Shapiro – Wilk test (Table 14). Of the quantities considered, the trend is best described by a linear model ($R^2 > 0.8$):

- number of victims per 100 accidents v,
- number of victims of accidents lv,
- number of accidents la,
- number of injured in accidents li,
- number of injured per 100 accidents i.

Unfortunately, most models are fraught with flaws:

- the distribution of the residuals is not a normal distribution (this applies mainly to the indicator i),
- there is autocorrelation of the residual component.

Table 14. Classification of trend models due to R^2 fit, significance of model parameters, autocorrelation, and normality of the distribution of residuals

R^2	SW	significance α	variable/indicator
> 08	>0,892	< 0,001	i6, i9, i4(?), v7, v3, v5(?), v1, v10(?), v8(?), v6, v4, pa3, pa6(+), pai3, pak3, pav3 (?), pav6, li1(+), li2(+), li3(+), li4(+), li5(+), li6(?), li7(+), lv1(+), lv2(+), lv3(+), lv4(+), lv5(+), lv6(+), lv7(+), la1(?), la2(+), la3(+), la4(+), la5(+), la6(+), la7(+), lk1(+), lk2(+), lk3(+), lk4(+), lk6(+)
	<0,892		i5, i7, i10, i8, i1, i3, v9
[0,6;0,8)	>0,892	< 0,001	i2(?), v2(?), pa7(+), pai6, pai7(+), pai9(+), pak7, pak6(+), pav7(+), pav9(+), pk9, pk6, lk5(+), lk7(+)
[0,4;0,6)	>0,892	< 0,001	pa9(+), pai10(+), pk2(+)
		[0,001;0,01)	k9(?), k3(+), pa10(+), pa1(+), pa2(+), pai8(+), pai1(+), pai2(+), pav10(+), pav8(+), pav1(+), pav2(+), pk4(+),
[0,15;0,4)	>0,892	[0,001;0,01)	k1(+), pa8(+), pai5(+), pav5(+)
		[0,01;0,05)	k4(+), k6(?), k2, pa5(+), pak4(+)
		> 0,05	pai4(+), pak9(+), pav4(+)
< 0,15	>0,892	> 0,05	k10(+), k7(+), k8(+), k5(+), pak8(+), pak10(+), pak2(+), pak1(+), pk3(+), pk8(+), pk7(+), pk5(+), pk1(+), pa4(+)

SW – Shapiro – Wilk test,"?"– denotes indeterminacy of autocorrelation of the residuals, "+" – denotes positive autocorrelation of the residuals, other designations as in Table 1. Source: own study based on [10]

Table 15 shows 16 models with very good R^2 fit devoid of the above disadvantages. The v indicator models dominate this list.

Among the models considered, there is a group of 17 models with very poor R^2 fit (most below 0.05) and significance of the parameter a above 0.05 (most above 0.2). In principle, it can be assumed that the value of the parameter a is 0. For these models, trend and normality tests were conducted. While for all variables (indicators) there are no reasons to reject the hypothesis of normality of distribution (SW test values above 0.94), the hypothesis of the absence of a trend must be rejected for 13 of them. The question arises about the type of trend present[6] – it is not a linear trend. There is no trend for pak9, pak8, pak1 and pk5.

Table 15. Selected linear trend models that meet the conditions: R^2 > 0.8, significance of model parameters < 0.001, no autocorrelation of residuals or indeterminate autocorrelation, residuals have normal distribution

variable/ indicator	a	b	R^2	MAD	SMAD	variable/ indicator	a	b	R^2	MAD	SMAD
v1	-0,97055	139,3533	0,960	0,750	0,609	**i4(?)**	-1,18108	128,3316	0,827	2,281	1,347
v3	-0,9486	139,2726	0,963	0,731	0,549	**i6**	-1,78215	156,3032	0,920	1,973	1,645
v4	-1,0359	139,9664	0,846	1,770	1,240	**i9**	-1,82346	152,7669	0,867	2,650	2,294
v5(?)	-1,30987	145,6313	0,962	1,032	0,741	**pai3**	0,006946	0,809489	0,964	0,005	0,004
v6	-1,78215	156,3032	0,920	1,973	1,645	**pak3**	0,012587	0,623368	0,839	0,023	0,014
v7	-1,25906	144,6459	0,965	0,976	0,656	**pav3(?)**	0,007398	0,795405	0,961	0,006	0,004
v8(?)	-1,38442	149,8936	0,945	1,332	0,954	**pav6**	0,002952	0,643242	0,839	0,005	0,004
li6(?)	-1477,4	41450,93	0,944	1565,998	794,110	**la1(?)**	-1629,55	48942,53	0,935	1905,370	905,074

"?" – denotes indeterminacy of autocorrelation of the residuals. Source: own study based on [10]

CONCLUSIONS

The assessment of the influence of alcohol consumption on road safety in Poland between 2007 and 2023 is not clear. Road traffic in Poland is growing steadily. Traffic conditions are also changing:

- modernization and expansion of road infrastructure,
- significant separation of bicycle traffic (mainly in cities),
- modernization of modes of transportation (although Poland still significantly lags behind Western European countries in this regard),
- change in traffic regulations tightening penalties for traffic offenses especially after drinking alcohol,
- the occurrence of new traffic participants (means of transport), such as electric scooters and the disappearance of others, such as horse-drawn carriages.

The number of road accidents and their victims in Poland is on a clear downward trend. Comparing 2007 with 2023, the number of road accidents la1 fell by nearly 58%, fatalities lk1 by more than 66%, injuries li1 by nearly 62% and victims lv1 (total killed and injured) by more than 62%. The number of victims of accidents is declining faster than the number of accidents, especially in the case of fatalities – the percentage of fatalities in the total number of victims of accidents pk1 fell from 8.11% to 7.28% (by 10.3%). The number of accidents involving intoxicated traffic participants and their victims is also on a clear downward trend. The decline is even faster:

- the number of road accidents la2 fell by nearly 66%
- the number of injured li2 by more than 72% (from 8193 to 2263),
- the number of lv2 victims by more than 71.5%.

However, the number of lk2 fatalities is declining more slowly – down more than 62.5%. At the same time, the percentage of pak1 fatalities in the total number of lk1 fatalities has increased by 10.5%.

The number of accidents caused by intoxicated road users la3 is falling faster than la1, more significantly faster than la2. The decrease is more than 68%. Even faster declines in the number of victims lv3 (by nearly 72%), the percentage of pav2 (by nearly 25.5%), the number of injured li3 (by 73%), the percentage of pai2 (by more than 29%). For lk3 fatalities, the decrease is much lower at nearly 59%. The percentage of pak2 increased by nearly 22%, the indicator k4 increased by more than 30%, the indicator pk4 by more than 46%.

[6] For example, the R^2 for a parabolic trend is 0.5. On the trend models of the number of accidents and casualties, see [17-18].

The data show that while the number of victims in accidents caused by intoxicated traffic participants decreases in proportion to the number of such accidents, the structure of such accidents changes – the percentage of fatalities increases significantly. The severity of accidents caused by intoxicated people (measured by the number of fatalities per 100 accidents) is statistically significantly higher than k1.

Drivers of various types of transportation vehicles are the dominant group of traffic participants causing road accidents. This percentage (pa3) is steadily increasing, reaching more than 91.% in 2023, an increase of more than 17% compared to 2007.

In absolute numbers, la4 sees a decline of more than 50% (from 38434 to 19058). Also falling in numbers are lk4, li4, and lv4 by about 57%). However, the percentages of pak3, pai3 and pav3 increase by about 27.5%, 12%, 13%, respectively. The increase in proportions can be explained by an increase in the number of drivers, however, an analysis of the changes in the indicators k5, i5, v5, and pk5, as well as the changes in the indicators pak3, pai3 and pav3 relative to pa3, is more conclusive for assessing the situation. These indicators show that although statistically the number of victims in accidents caused by drivers is higher than the number of victims in accidents caused by other factors, the number of fatalities is decreasing – the number of irreparable losses is decreasing.

Intoxicated drivers caused more than 61% fewer accidents in 2023 than in 2007. This was a decrease greater than for drivers la4 and all accidents la1, but significantly less than accidents involving la2 and caused by la3 intoxicated drivers. The percentage pa4 of these accidents in the total number of accidents fell by nearly 8%; however, the percentage of fatalities pak4 increased by nearly 53% (to 11.20%) and the indicator of fatalities per 100 accidents k6 by more than 33% (to 15.93). It was significantly higher than the indicator k1. For those injured in accidents caused by intoxicated drivers, the percentage pai4 was higher than pa4 and increased by nearly 53%.

Statistics show that there is a clear decrease in the percentage of victims of accidents caused by intoxicated drivers in accidents caused by drivers, as well as the severity of accidents as measured by indicators i6, v6, pai4, pai5, pav4, pav5. However, the percentage of victims is higher than the percentage of accidents caused by intoxicated drivers. This means that statistically, the consequences of these accidents are more serious than those of a statistical traffic accident. This is particularly evident in the case of accident fatalities. The percentage of fatalities from these accidents in the total number of fatalities has increased significantly, as well as the indicators k6 and pk6 have increased dramatically. In the same period, the pk7 indicator decreased by nearly 4%, and the differences between pk6 and pk7 reached up to 6 percentage points.

Passenger car drivers constitute the largest group of traffic participants, considering the mode of transportation they use. They cause between 73% and 78% of all traffic accidents (pa7). The number of accidents la6 fell by more than 52%. The number of lk6 fatalities fell by more than 59.5% – the decrease is significantly greater than the number of la6 accidents but at the same time significantly less than la1. The percentage of fatalities pak8 is essentially unchanged and is significantly smaller than pak1 and pak3. In the case of victims of accidents, the number of victims lv6 decreased by more than 59% – the decrease is significantly greater than the number of accidents la6 but at the same time significantly smaller than la1, and the number of victims per 100 accidents i8 decreased by nearly 14% – always significantly greater than i1 and i5.

Statistically, fewer people die in an accident caused by a passenger car driver than in a statistical traffic accident and a statistical traffic accident caused by a driver. The opposite is true for the number of injured and the total number of victims. The number of victims, injuries, and fatalities is decreasing at essentially the same rate – faster than the decrease in the number of accidents and slower than the number of accidents caused by drivers.

Accidents caused by intoxicated car drivers, especially passenger cars, are media events that arouse public outrage. The number of accidents caused by intoxicated car drivers la7 has been steadily declining (by nearly 70%), and the percentages of pa8, pa9, pa10 in the total number of accidents, accidents caused by drivers and car drivers have fallen by 28%, 39%, and 36%, respectively. The number of fatalities lk7 fell by more than 55% (from 351 to 156) – so the decline was much slower than the number of accidents la7 and the indicator of fatalities per 100 accidents k9 increased by more than 46% (from 12.91 to 18.91) and was always significantly higher than the indicators k1, k6, k8, k10. The pk9 indicator increased by nearly 73% (from 7.76% to 13.40). The number of injured li7 decreased by nearly 76%. The indicator of injured per 100 accidents v9 decreased by more than 15%.

Statistics show that the number of accidents caused by intoxicated passenger car drivers is significantly decreasing (and faster than the total number of accidents). Importantly, their percentage (somewhat slower

than the number of la7) of the total number of accidents pa8 caused by drivers pa7 and passenger car drivers pa10 is falling. Thus, the number of injuries and fatalities is also falling (although in this case more slowly than the number of accidents). However, the severity of accidents as measured by fatality indicators is increasing – k9 (up 46%), pk9 (up 73%) and pak8 (up 31%). The indicator of injured people per 100 accidents (although declining) is higher than both the overall i1, i6 and (in 16 cases) i8, i10. Noteworthy is the large difference between the number of injured in accidents caused by intoxicated drivers i6 and intoxicated car drivers i9, with differences ranging from 5.7 to 11.3 (i9 > i6).

Of the road safety indicators considered, in principle, only for the indicators v number of victims per 100 accidents can a linear trend be considered for this indicator. Although for 50 linear trend models the fit R^2 is at least good (> 0.8), other criteria (e.g., parameter significance, lack of autocorrelation of residuals) are not met for 36 of them.

WPŁYW ALKOHOLU NA BEZPIECZEŃSTWO RUCHU DROGOWEGO W POLSCE W LATACH 2007-2023

W artykule przeanalizowano zmiany liczby wypadków oraz ofiar rannych i śmiertelnych wypadków w różnych grupach uczestników ruchu drogowego, w szczególności z udziałem i spowodowanych przez nietrzeźwych uczestników ruchu, kierujących i kierujących samochodem osobowym. Wykorzystano wskaźniki liczby ofiar, rannych i ofiar śmiertelnych wypadków na 100 wypadków. W latach 2007-2024 liczba wypadków spadła o blisko 58%, ofiar śmiertelnych o 66%, rannych i ofiar łącznie o 62%. Liczba wypadków spowodowanych przez nietrzeźwych uczestników ruchu, rannych i ofiar spada szybciej niż liczba wszystkich wypadków. W przypadku ofiar śmiertelnych spadek jest znacznie niższy a jednocześnie rośnie liczba ofiar śmiertelnych na 100 wypadków. Kierujący stanowią dominującą, rosnącą, grupę uczestników ruchu powodujących wypadki. Statystycznie liczba ofiar wypadków spowodowanym przez kierujących jest większa niż ofiar w innych wypadkach. Maleje udział wypadków i rannych w wypadkach spowodowanych przez nietrzeźwych kierowców. Znacznie wzrósł udział ofiar śmiertelnych tych wypadków, drastycznie wzrosła liczba ofiar śmiertelnych na 100 wypadków. Spośród rozpatrywanych wskaźników bezpieczeństwa ruchu drogowego zasadniczo jedynie dla wskaźników liczby ofiar na 100 wypadków można uznać, że występuje trend liniowy. Dla 50 modeli trendu liniowego różnych wskaźników dopasowanie R^2 jest co najmniej dobre (>0,8), jednak dla 36 z nich nie są spełnione inne kryteria.

Słowa kluczowe: bezpieczeństwo ruchu drogowego, wypadek drogowy, ofiara wypadku drogowego, alkohol w ruchu drogowym.

REFERENCES

[1] https://road-safety.transport.ec.europa.eu/european-road-safety-observatory/statistics-and-analysis-archive/hazardous-behaviourpost-impact-care_en.
[2] https://road-safety.transport.ec.europa.eu/european-road-safety-observatory/statistics-and-analysis-archive/esafety/alcohol-interlocks_en.
[3] Høye A.K., Hesjevoll I.S. (2023). Alcohol and driving-How bad is the combination? A meta-analysis. Traffic Inj Prev. 24(5):373-378. DOI: 10.1080/15389588.2023.2204984. Epub 2023 May 15.
[4] Alsop R. (2020). Drink Driving as the Commonest Drug Driving - A Perspective from Europe. IJERPH 17(24), 9521; DOI: https://doi.org/10.3390/ijerph17249521.
[5] Compton R.P., Blomberg R.D., Moskowitz H., et al. (2002). Crash rate of alcohol impaired driving. Proceedings of the sixteenth International Conference on Alcohol. Drugs and Traffic Safety ICADTS, Montreal.
[6] Isalberti C., Van der Linden T., Legrand S.-A., et al. (2011). Prevalence of alcohol and other psychoactive substances in injured and killed drivers. DRUID Driving under the Influence of Drugs, Alcohol and Medicines.
[7] Compton, R.P., Blomberg, R.D. (2015) Drug and Alcohol Crash Risk. HTSA'S Office of Behavioral Safety Research. https://www.researchgate.net/publication/240629941_Crash_Risk_of_Alcohol_Impaired_Driving.
[8] Głąbicka-Auleytner K. (2023). Road safety and alcohol consumption by drivers. Journal of civil engineering and transport. 5(4), 9-14, ISSN 2658-1698, e-ISSN 2658-2120, DOI: 10.24136/tren. 2023.013.
[9] Zgierski J. (2020). Wypadki spowodowane przez nietrzeźwych użytkowników dróg (Accidents caused by intoxicated road users). Kwartalnik policyjny, 4. https://kwartalnik.csp.edu.pl/download/21/33010/Wypadkispowodowaneprzez nietrzeźwych.pdf
[10] https://statystyka.policja.pl/st/ruch-drogowy/76562,wypadki-drogowe-raporty-roczne.html.
[11] Francesconi M., James J. (2021). None for the Road? Stricter Drink Driving Laws and Road Accidents, Journal of Health Economics. Volume 79, September, 102487. DOI: https://doi.org/10.1016/j.jhealeco.2021.102487
[12] Rozporządzenie Prezesa Rady Ministrów z dnia 30 grudnia 2021 r. zmieniające rozporządzenie w sprawie wysokości grzywien nakładanych w drodze mandatów karnych za wybrane rodzaje wykroczeń (Prime Minister's Decree of December 30, 2021 amending the Decree on the amount of fines imposed by way of criminal fines for selected types of offenses). Dz.U. z 2021 poz. 2484.

[13] Rozporządzenie Ministra Spraw Wewnętrznych i Administracji z dnia 15 września 2022 r. w sprawie ewidencji kierujących pojazdami naruszających przepisy ruchu drogowego (Decree of the Minister of Internal Affairs and Administration of September 15, 2022, on records of vehicle drivers violating traffic regulations). Dz.U. z 2022 r., poz. 1951.
[14] Ustawa z dnia 7 lipca 2022 r. o zmianie ustawy – Kodeks karny oraz niektórych innych ustaw (Law of July 7, 2022, amending the Criminal Code and certain other laws). Dz.U. 2022 poz. 2600.
[15] Rogowski A. (2012). Podstawy metod probabilistycznych w transporcie (The Basics of Probabilistic Methods in Transport), Monographs series, No. 175, Publishing House of the University of Technology and Humanities, Radom. ISSN 1642-5278.
[16] Savin N.E., White K.J. (1977). The Durbin-Watson Test for Serial Correlation with Extreme Sample Sizes or Many Regressors. Econometrica, 45, 1989-1996.
[17] Rogowski A. (2007). Analiza przydatności klasycznych modeli trendu do prognozowania liczby wypadków, rannych i zabitych w ruchu drogowym w Polsce (Analysis of the usefulness of classical trend models for forecasting the number of accidents, injuries and fatalities in road traffic in Poland). Logistyka, 3.
[18] Rogowski A. (2009). Prognozowanie bezpieczeństwa w ruchu drogowym w Polsce (Road traffic safety forecasting in Poland), Logistyka, 3.