

# ANALYSIS OF FACTORS INFLUENCING PEDESTRIANS' SAFETY IN THE ROAD TRAFFIC

Marek Idzior

## Summary

The article presents analysis of pedestrian safety in the national road traffic. Factors influencing the safety of pedestrians in the road traffic are discussed. In terms of the regulations governing the relations of drivers and pedestrians, we significantly differ from the countries of Western Europe or Scandinavia, where the level of road safety is much higher than in our country. The situation in this country has probably matured to change it, give it the proper rank and improve the unfavourable statistics of pedestrian safety in the road traffic.

## Keywords

pedestrian, road safety, car accidents

## The cite this article

Idzior Marek Analysis of factors influencing pedestrians' safety in the road traffic. *Motor Transport*, 64(2), 24 - 29  
DOI: 10.5604/01.3001.0015.5038

## 1. Introduction

The development of modern motorisation in recent years has resulted in a huge increase in road traffic, especially in large agglomerations. It suffices to say that the number of cars in the world already in 2010 exceeded a billion, with the world population, at that time, of 7.2 billion people. And yet in the not so distant year 1970, the number of vehicles in Poland was about 0.5 million - thus about 80 persons per 1 car. Today, there are around 7 people per vehicle in the world. Unfortunately, the expenditure on the

development of road infrastructure in this country is completely disproportionate to the increase in the number of vehicles [17].

The huge supply of cars makes car concerns outdo each other in meeting the expectations of car buyers to attract customers, who choose a model not only based on the price, make and colour as it used to be in the past, but also engine power, fuel consumption and driving comfort. Unfortunately, many aspects of road safety are often overlooked in the comfort of choice offered.

In Poland, a vast number of accidents have been occurring for many years. The statistics put our country on the edge of the European market. These figures are particularly alarming in relation to accidents involving pedestrians. In 2019, there were 7,005 accidents involving pedestrians. Despite the fact that in absolute values compared to 2018 there was a decrease in the number of such events by 8%, accidents with pedestrians still account for 23% all road incidents - as in 2018 [1, 2].

In terms of the regulations governing the relations of drivers and pedestrians, we significantly differ from the countries of Western Europe or Scandinavia, where the level of road safety is much higher than in our country. The situation in the country has probably matured to change it, give it the proper rank and improve the unfavourable statistics of pedestrian safety in road traffic.

As a result of road accidents in 2019, 793 pedestrians died and 6.4 thousand were injured (Fig. 1). Pedestrians constituted as much as 27 percent of all road fatalities (Fig. 2). This is because pedestrians are not protected by the bodywork and airbags when confronted with a car. According to the police, in 26 percent of the incidents with pedestrians, they themselves are to blame, but in as much as 68 percent drivers of vehicles are to blame. Most often they are drivers of passenger cars (3 769 accidents), light commercial vehicle drivers are in second place (217 accidents), and cyclists are in a third (151 accidents). It should be emphasized once again that pedestrians are in no way protected against the effects of road accidents!

Fig. 1. Number of accidents involving pedestrians in 2010-2019 [1]

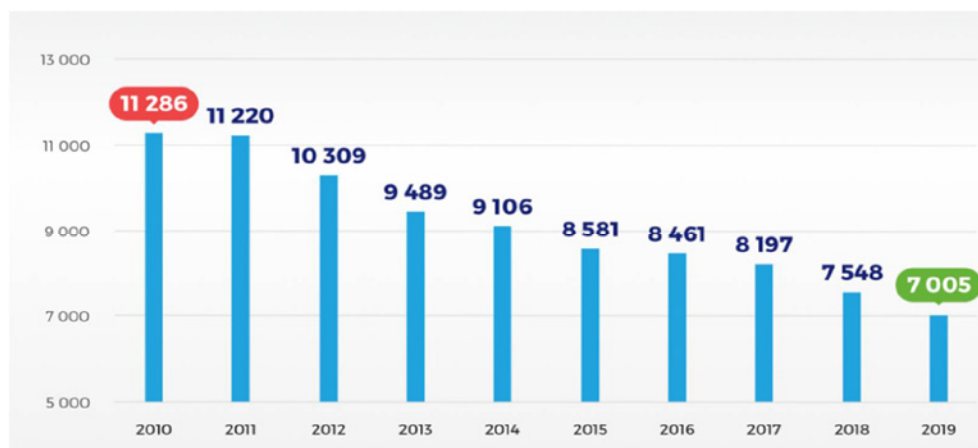
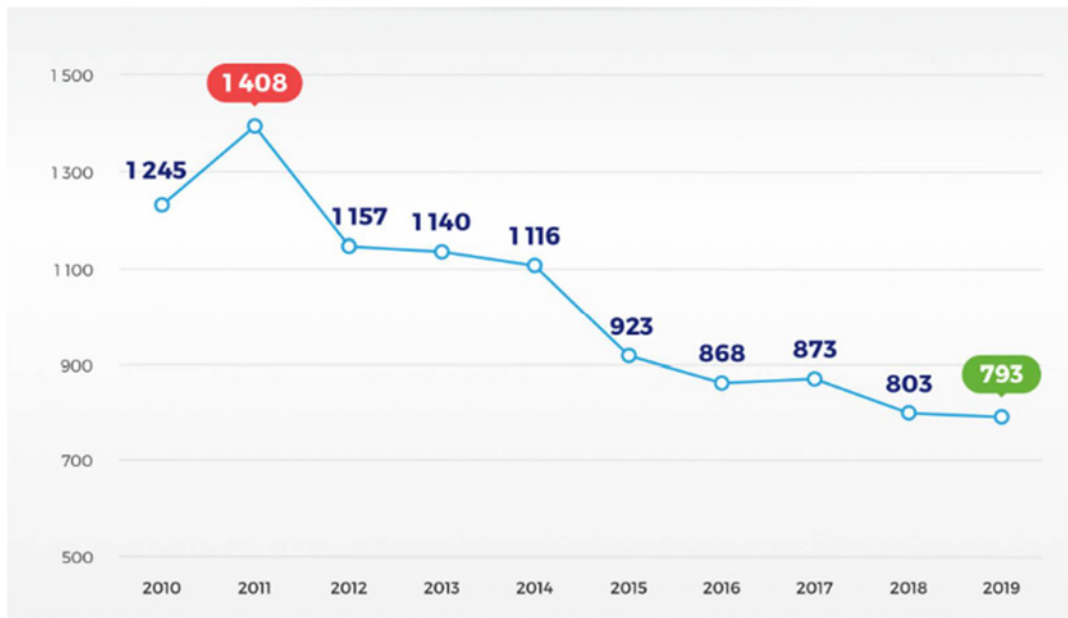


Fig. 2. Number of fatalities among pedestrians in the years 2010-2019 [1]



The systematic decline in casualties since 2010 is certainly hopeful. According to current statistics, compared to the number of pedestrian fatalities in 2019, with 7005 road accidents, it is 543 less than in 2018 (-7, 1%). However, as many as 3,466 accidents occurred at pedestrian crossings (49.5%) [14].

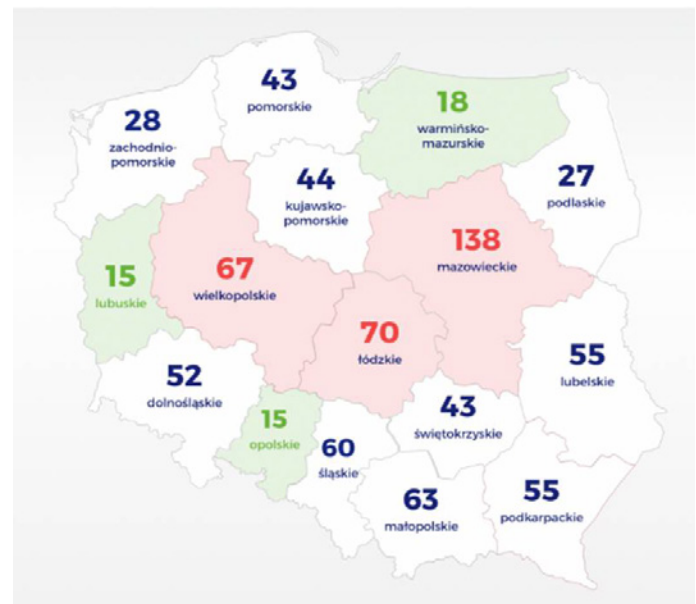
It is therefore far from what was expected. There is a certain regularity in the number of pedestrian casualties - larger agglomerations, higher de-

gree of land development, are definitely in the leaders among the statistics (Figs. 3 and 4). In 2019, the highest number of pedestrian casualties occurred in Mazowieckie voivodship (138). In the lead is also Łódź (70) and Wielkopolskie voivodship (67). On the other hand, pedestrians could feel safest on the roads of the Lubuskie and Opolskie voivodships, where only 15 fatal accidents occurred with their participation [1,3].

Fig. 3. The number of victims depending on the type of land development [1]

Perpetrators	Accidents	Killed	Injured
Built-up area	6312	510	5938
Undeveloped area	693	283	423
In total	7005	793	6361

Fig. 4. Number of pedestrian casualties in 2019, by voivodships [1]



In the quoted year 2019, pedestrians over 60 years of age prevailed among the fatal accidents victims (50.3%). Slightly fewer deaths occurred in

the range of 40-59 years old (28.4%), as well as 25-39 years old (11.9%). People under 17 (3%) could feel safest on the road, Fig. 5.

Fig. 5. Number of pedestrian casualties in 2019 depending on age [1]

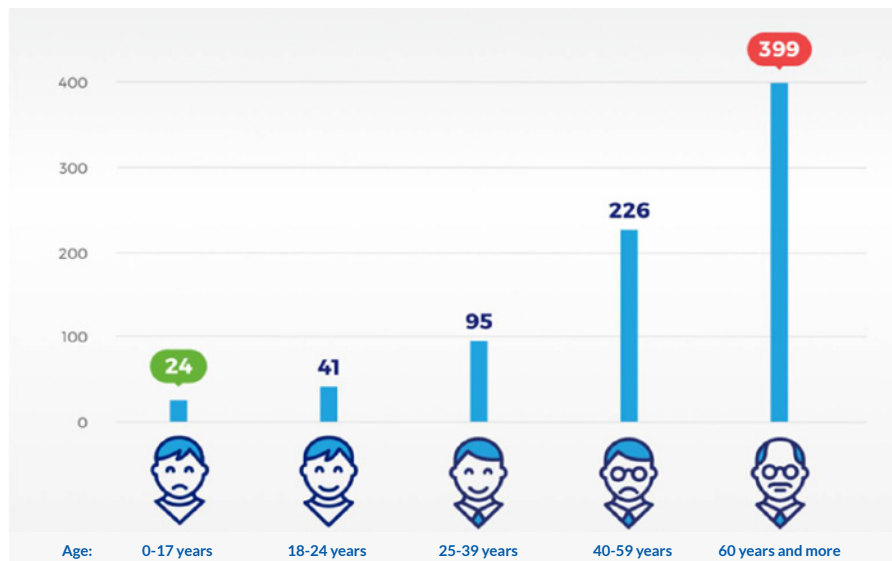


Table 1. The causes of accidents caused by drivers [4]

Causes		Accidents	Killed	Injured
		%	%	%
Speed not adjusted to traffic conditions		28,5	43,4	30,7
Right of way not respected		26,6	14,6	27,4
Incorrect overtaking		6,1	9,2	6,6
Incorrect	avoidance	1,8	2,4	1,5
	evasive action	1,6	2,1	1,6
	<b>behaviour towards a pedestrian</b>	<b>14,0</b>	<b>10,0</b>	<b>10,9</b>
	turning	3,0	2,3	2,6
	reversing	1,8	0,9	1,4
	lane change	2,1	2,0	2,2
	turning back	0,7	0,4	0,7
	crossing a cycle path	0,2	0,1	0,2
	stopping, stoppage	0,1	0,1	0,1
	Driving on the wrong side of the road		2,1	4,3
Driving without the required lighting		0,2	0,6	0,1
Red light entry		1,5	0,9	1,7
No safe distance between vehicles		6,8	2,0	6,9
Rapid braking		0,6	0,2	0,5
Fatigue, falling asleep		1,8	4,1	2,1
Failure to observe other signs and signals		0,4	0,3	0,4
<b>Total</b>		<b>100,0</b>	<b>100,0</b>	<b>100,0</b>

However, a pedestrian who committed road incursion often is not 100% responsible for the accident. The driver of the vehicle involved in the incident is often accused of:

- maladjustment of speed to traffic conditions,
- lack of due attention,
- not giving the right of way.

The worst situation for a driver is in when a pedestrian runs over the zebra crossing. In such a situation, the driver should pay particular attention, as any possible hitting of a pedestrian will always incriminate the driver to a greater or lesser extent. Here it can be mentioned that the driver should al-

ways pay particular attention in built-up areas, e.g. in the vicinity of villages where pedestrians are walking along the roadside, in the vicinity of schools and bus stops, etc.]

Table 2 presents a set of factors that may cause road accidents involving pedestrian road users.

The most common causes of accidents involving pedestrians include:

- careless entering the road - 57,6% of all incidents caused by pedestrians,
- crossing the road in a prohibited place - (12%),
- entering the road from behind the vehicle, obstacle - (11%).

Table 2. Factors influencing the occurrence of accidents involving pedestrians [4]

Object	Feature	Parameter
Road	Road classification	Road type and class. Condition and type of surface. Width of the lanes. Road geometry. Main participant in the road traffic. Traffic intensity: - during the daytime, - at night time. Road function depending on the season, e.g. transit route, holiday route. Number of access points (e.g. property access drives)
Pedestrian crossing	Geometric visibility of a pedestrian from the driver's observation point	Visibility limitation at the pedestrian crossing from the driver's side - permanent: the presence of trees, vegetation, poles, advertisements and other obstacles, - temporary: parked vehicles directly in front of the pedestrian crossing, bus stop. No parking prohibition zone in front of the crossing.
	Legibility of a pedestrian crossing	Lack or poor condition of vertical and horizontal signing. Existence of elements obscuring signs informing about a pedestrian crossing. Lack or poor condition of information infrastructure at a pedestrian crossing, including traffic lights, sound signals for the disabled.
	Accessibility of a pedestrian crossing	No separate pavement, Absence or incorrect location and levelling of the pavement in relation to the road, No hard shoulder, No awaiting zone for crossing, No restrictions separating pedestrian traffic - barriers, chains.
	Location of a pedestrian crossing	Incorrect location of a pedestrian crossing, e.g. on a curve or hill.
	Features of the road directly in front of and behind the pedestrian crossing	Incorrect traffic organisation. Incorrect lane width. No island or dividing lane. No separate road for cyclists. Hard shoulder with incorrect width. Bad technical condition of the roadside. Hard shoulder too narrow. Roadside obstacles, e.g. nearby buildings. Presence of surfaces with a low friction coefficient. No drainage near the pedestrian crossing.
	Lighting on or near the pedestrian crossing	No lighting or bad lighting at the pedestrian crossing. Incorrect levels of illuminance and luminance. The existence of adverts and devices causing glare or inappropriate visual guidance to the driver.
Pedestrian	Geometric visibility of the vehicle from the pedestrian observation point	Visibility limitation on the pedestrian crossing from the pedestrian side: - constant: trees, vegetation, poles, adverts and other obstacles, road geometry, - temporary: parked vehicles directly in front of the pedestrian crossing, bus stop,
	Main participant of the pedestrian traffic	Use of dark clothes. Incorrect perception of the road situation by, e.g. children or the elderly. Failure to comply with road traffic regulations. Psychophysical condition of a pedestrian.
Weather	Atmospheric conditions	Periodic occurrence of rain, snow and fog.

Tab. 3. The causes of accidents involving pedestrians [4]

Causes of pedestrian accidents	Accidents		Killed		Wounded	
	In total	%	In total	%	In total	%
Standing on the road, lying down	400	5,8	196	17,7	217	3,6
Walking on the wrong side of the road	335	4,8	106	9,6	238	4
Entering the road at red light	561	8,3	53	4,8	520	8,7
Careless entry in front of a moving vehicle	3 980	57,6	582	52,7	3 476	58,5
Careless entry from behind an obstacle	760	11	50	4,5	723	12,2
Stopping, backing up on the street	50	0,7	4	0,4	47	0,8
Crossing the road in a prohibited place	826	12	114	10,3	725	12,2

## 2. Consequences of a vehicle collision with a pedestrian

Despite the efforts of many institutions and entities to prevent road accidents, the level of safety in Poland has not changed significantly. Health and life is a big price we pay for too slow changes in the awareness of road users about the risks in the road traffic.

Injuries suffered by pedestrians in an accident have two sources - primary injuries - resulting from the direct contact of the pedestrian with the vehicle and secondary injuries - occurring when the thrown back victim hits the road or other obstacles or is run over.

In both cases, the speed of the car is decisive. The extent of the damage depends on it:

- spine fracture - always above 68 km/h,
- torn thoracic aorta - always above 85 km/h,
- the occurrence of torn wounds in the groin area - always above 95 km/h,
- body fragmentation - high chance over 98 km/h [4].

Accidents occur mainly when there are differences in speed and directions of the movement of road users. The severity of injuries is determined by the driving speed and the difference in weight between road users. In both cases, however, speed is decisive. A road traffic accident is a complex phenomenon and most often arises as a result of the simultaneous occurrence of many circumstances. However, most accidents are accompanied by the speeding of one or more participants. The concept of excessive driving speed includes both the speed exceeding the applicable limit and the speed which is too high in relation to the road conditions, weather conditions and the driver's individual characteristics [3].

As the speed of travel increases, the injuries to the victims of accidents become more severe, regardless of what other circumstances accompany the accident. The physical characteristics of the human body cannot withstand a collision with the vehicle moving at a speed above 30 km/h without any harm. First of all, this applies to pedestrians and cyclists who are not protected by the bodywork or seat belts. In the event of a pedestrian being

hit by a vehicle travelling at 50 km/h, the probability of death is nine times greater than in the case of a speed of 30 km/h [4].

A pedestrian collision with a car has a different course depending on: the pedestrian's initial position (standing or similar, lying, crouching, sitting, etc.) and the location of the centre of gravity of his body (and thus his height also related to age), the type of collision (frontal, corner, tangential, impact with a protruding element - e.g. a side mirror, only being run over), the shape of the front contour of the vehicle and the height of individual elements (bumper, edge of the bonnet, windshield) in relation to individual parts of the victim's body, the height of the vehicle suspension and the ground clearance (high in old type trucks and off-road vehicles), the collision speed of the vehicle and its acceleration (positive, zero, negative) and sometimes also other, largely random factors (e.g. luggage carried by a pedestrian or next to a bicycle).

## 3. Summary

Until recently, the growing requirements for cars from their users focused on constantly tightening emission standards for combustion products, pro-ecological, with reduced energy consumption, design, introduction of modern construction materials and dynamic introduction of new drives and fuels. The history of the automotive industry shows that the elements of passive and active safety of vehicles, as well as safety of broadly understood road traffic, have long been gaining their proper rank. Finally, for a number of years now, the level of safety offered by cars has a huge impact on the decision of customers to buy cars.

The primary source of information are crash tests conducted by independent organisations, primarily Euro NCAP, (European New Car Assessment Program) - an independent non-profit vehicle safety assessment organisation sponsored by various independent organisations, supported by the governments of some European countries. Euro NCAP was established in 1997 and its main objective is to test cars (bought with their own money) in terms of passive safety. The main component of this test is the crash test. The organisation contributes to the development of safety.

The crash test consists of four components:

- front impact,
- side impact,
- **pedestrian impact – mannequins acting as pedestrians are fired in a direction of various points at the front of the vehicle (on the bonnet, at the height of the headlights, on the front bumper), at speed of 40 km/h,**
- collision with a pole.

The Euro NCAP tests are one of the sources of information for buyers whether the car is safe. European safety tests include frontal, side and pole collisions, but also measurement of pedestrian safety. The cars are awarded stars not only for test results, but also for equipment that affects active or passive safety. It is worth adding that the tests are constantly evolving - for example, in 2018 the cyclist safety assessment was added. Therefore, the problem of pedestrian safety in road traffic has gained increasing importance in recent years. This publication contains an analysis of factors influencing the safety of pedestrians in road traffic, the continuation of which is the second publication on methods of reducing pedestrian accidents.

## Bibliography

1. Komenda Główna Policji: „Wypadki drogowe w Polsce w 2019 roku”, Biuro Ruchu Drogowego, Warszawa 2020.
2. Krajowa Rada Bezpieczeństwa Ruchu Drogowego - Bezpieczeństwo na drodze, wypadki drogowe w Polsce, bezpieczeństwo ruchu drogowego. - KRBRD.GOV.PL
3. Wicher J.: Bezpieczeństwo samochodów i ruchu drogowego, Warszawa 2004.
4. Szyler D.: Analiza możliwości zwiększania bezpieczeństwa pieszych w ruchu drogowym. Praca inżynierska.
5. [www.komputerswiat.pl/novosci/wydarzenia/2012/31/wifi-zapobieganie-wypadkom-drogowym.aspx](http://www.komputerswiat.pl/novosci/wydarzenia/2012/31/wifi-zapobieganie-wypadkom-drogowym.aspx)
6. <http://www.mobileye.com/all-products/mobileye-c2-series/mobileye-c2-270/>
7. [http://video-idea.ru/?type=3&cat\\_id=2782&id\\_rod=2781](http://video-idea.ru/?type=3&cat_id=2782&id_rod=2781)
8. [www.menworld.pl](http://www.menworld.pl),
9. [www.volvo-rozpoznaje-piesznych](http://www.volvo-rozpoznaje-piesznych)
10. [www.autokult.pl/naped-elektryczny-cichy-zabojca-piesznych](http://www.autokult.pl/naped-elektryczny-cichy-zabojca-piesznych)
11. [www.plastech.pl/wiadomosci/artykul\\_1695\\_1/Dzieki-tworzywom-BASF-Opel-zwieksza-bezpieczenstwo-na-drodze](http://www.plastech.pl/wiadomosci/artykul_1695_1/Dzieki-tworzywom-BASF-Opel-zwieksza-bezpieczenstwo-na-drodze)
12. <http://www.adrenalinemotorsport.pl/aktualnosci/n,poduszka-powietrzna-dla-piesznych-od-volvo>
13. <http://moto.wp.pl/kat,106078,title,Volvo-poduszka-powietrzna-rowniez-dla-pieszego,wid,14318711,wiadomosc.html?tid=1f91f>
14. [http://dlakierowcow.policja.pl/portal/dk/807/47493/Wypadki\\_drogowe\\_raporty\\_roczne.html](http://dlakierowcow.policja.pl/portal/dk/807/47493/Wypadki_drogowe_raporty_roczne.html); [www.radiopolska.pl/portal/staticpages/index.php?page=rds](http://www.radiopolska.pl/portal/staticpages/index.php?page=rds)
15. [http://motolokalizator.pl/aktualnosc/907/0/volvo\\_s60\\_t6\\_304km\\_summum\\_moc\\_kontra\\_bezpieczenstwo\\_test\\_motolokalizator\\_pl.html](http://motolokalizator.pl/aktualnosc/907/0/volvo_s60_t6_304km_summum_moc_kontra_bezpieczenstwo_test_motolokalizator_pl.html)
16. <http://www.bmwblog.com/2008/12/31/how-to-retrofit-a-night-vision-system-in-your-bmw/>
17. Materiały własne.

---

### Marek Idzior

[marek.idzior@put.poznan.pl](mailto:marek.idzior@put.poznan.pl)

Poznan University of Technology