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Medical and epidemiological features of road traffic injuries in the Khorezm region of the Republic of Uzbekistan

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Abstrak. Road traffic injuries remain one of the leading causes of premature mortality and disability, and human factors retain a key role in the structure of road accidents. One of the most significant, yet understudied, components of the human factor is driver training, which reflects their level of practical preparedness, discipline, and ability to act safely in challenging traffic conditions.
To study the factors affecting driver training and assess their role in the development of road accidents and the severity of their consequences.
A comparative study was conducted using official statistical data on road accidents for 2024–2025. Indicators characterizing driver age, driving experience, the presence or absence of a driver's license, the main causes of road accidents, and the distribution of accidents by type of road user were analyzed. Descriptive and comparative statistical methods were used to calculate absolute and relative indicators, rates of change, fatality rates, injury rates, and overall accident severity. The statistical significance of differences was assessed using the χ^2 test at a significance level of $p<0.05$.
It was established that the statistical structure of road accidents reflects the significant role of driver training factors in shaping accident rates and the severity of their consequences. The highest accident rate remained among young drivers, indicating a lack of practical experience and consistent safe driving skills. At the same time, a significant increase in mortality was observed in a number of middle- and older-age groups, indicating a more complex risk structure extending beyond the initial stages of a driver's career. The most unfavorable situation was observed among unlicensed drivers, for whom both the frequency of accidents and the severity of their consequences increased. Among the immediate causes of accidents, the leading roles were played by speeding, dangerous overtaking, violations of road signs and signals, and other disciplinary errors reflecting a lack of safe behavioral skills. It has been shown that driver errors pose a risk not only to the driver but also to passengers, pedestrians, and other road users.
training factors are an important determinant of road traffic injuries and largely determine the structure of serious and fatal road accidents. The obtained results substantiate the need to improve the driver certification system, strengthen practice-oriented training, and develop sustainable safe behavior skills as one of the key areas of road injury prevention.

Keywords: road accidents; driver training; driving experience; driver's license; human factor; causes of accidents; road injuries; prevention.

1. Introduction

Road traffic injuries remain one of the most serious public health problems today, combining high mortality, persistent disability, significant demographic losses, and significant economic damage.

According to the World Health Organization, approximately 1.19 million people die annually in road traffic accidents worldwide, and road injuries remain the leading cause of death among children, adolescents, and young adults aged 5–29 years [1, 2]. It is particularly important that 92% of all road deaths occur in low- and middle-income countries, although they account for only a fraction of the global vehicle fleet; more than half of those killed are vulnerable road users [1–3]. This makes the problem of road traffic accidents not just a transport issue, but a multifaceted medical and social challenge, affecting preventive medicine, hygiene, road environment management, public behavior, and occupational safety [1–4]. Current international approaches to reducing road traffic injuries are based on the recognition that a sustainable preventive effect is achieved only through a combination of engineering, legal, organizational, and behavioral measures. This is the foundation of the WHO Save LIVES package, which combines speed management, improved road infrastructure, vehicle safety, law enforcement, and improved post-crash care [3]. However, major reviews in recent years show that even with improved infrastructure and enhanced enforcement, human error remains the leading cause of most serious accidents, and driver error continues to determine the risk of both the accident itself and its adverse outcome [4–7].

Driver training occupies a special place within the human factor framework. Training in this context should be understood not only as formal training in a driving school, but also as a combination of knowledge, practical skills, consistent behavior patterns, the ability to assess a road situation, control speed, maintain distance, maneuver safely, and make decisions under time pressure. International analyses highlight that young and novice drivers typically exhibit insufficiently developed hazard recognition skills, poor risk awareness, distractibility, inadequate speed control, and an increased tendency toward risky behavior [8, 9]. Consequently, a significant portion of accidents, traditionally attributed to the "human factor," can be seen as a reflection of a driver's lack of or incomplete preparation for the real road environment [8–10].

This is particularly important for young and novice drivers. The European Road Observatory notes that young novice drivers are disproportionately involved in nighttime accidents, speeding accidents, and single severe collisions; among the reasons cited are insufficient hazard perception, weak motivation to avoid risks, and limited practical experience [8, 9]. Systematic reviews also show that the most consistently confirmed risk factors for road accidents include young age, risky driving patterns, alcohol consumption, mobile phone use, speeding, and long working hours [5, 6]. Thus, it is not just a question of age per se, but a combination of age, behavioral immaturity, and insufficiently developed safe driving skills [5, 6, 8, 9].

The issue of driver experience deserves special attention. International literature emphasizes that driving experience alone is not a simple, linear protective factor: in the early stages after admission to independent driving, the risk is particularly high due to a lack of automated skills and poor preparedness for non-standard situations [8–10]. At the same time, the lack of legal driver approval or a low level of actual training is often accompanied by more pronounced behavioral indiscipline, disregard for rules, and, as a result, serious outcomes [5, 6]. For countries and regions with a heterogeneous road environment, a combination of urban, inter-settlement, and transit traffic, this problem becomes especially significant, as insufficient training more quickly manifests itself in errors in speed, overtaking, choosing a distance, and reacting to sudden danger [3, 5, 6].

From a public health perspective, the professional and hygienic aspect of driver training is also important. A number of studies show that even formally trained drivers, under long shifts, intercity routes, lack of rest, and high psycho-emotional stress, exhibit decreased attention, increased fatigue, and an increased likelihood of errors [7]. This means that driver training cannot be limited to merely obtaining a driver's license: it must incorporate elements of sustainable safe behavior, risk recognition skills, self-control, fatigue management, and the ability to make decisions in difficult driving situations [7, 10, 11]. Otherwise, the accident pattern itself begins to reflect not only rule violations but also hidden gaps in the driver training and support system during the development of practical experience [7–11].

Equally important, driver training is reflected in accident statistics indirectly, but through a combination of indirect indicators: age, experience, the presence or absence of a driver's license, the profile of accident causes, the nature of involvement in road accidents, and the severity of the consequences. This

is why research into training factors should be structured not as a formal evaluation of training programs, but as an analysis of real behavioral and socio-demographic indicators that reflect the quality of driver preparedness for road traffic. This approach allows us to move beyond abstract theories about the importance of training to an evidence-based understanding of which driver categories and which errors contribute most to accident rates [5, 6, 8–10].

This is particularly relevant in regions with a heterogeneous road environment, where city streets, inter-town and intercity roads, mixed traffic flows, and seasonal fluctuations in traffic volume are present simultaneously. In such conditions, driver inadequacy becomes particularly apparent, as the road situation demands constant attention shifting, highly accurate speed and distance assessment, maneuvering discipline, and stress tolerance. Therefore, analyzing driver training factors has not only theoretical but also clear practical significance: it allows us to identify those human factors that are potentially amenable to preventative intervention—through improved training, improved driver authorization, and subsequent support and correction of risky behavior.

Therefore, studying driver training factors in the context of road accidents represents an important area of modern preventative medicine and road safety. Such analysis allows us to determine which sociodemographic and behavioral characteristics of drivers are most closely associated with accident rates and the severity of their consequences, as well as the extent to which accident statistics reflect a deficit in safe driving skills. This is precisely what determines the relevance of this study.

Study Objective

To study driver training factors and assess their role in the incidence of road accidents and the severity of their consequences.

Materials and Methods

This study was conducted based on a comparative analysis of official statistical data on road accidents recorded in the study region for 2024–2025. The source of information was consolidated data from regional road safety service departments, including information on the number of accidents, fatalities and injuries, driver age and gender, driving experience, the presence or absence of a driver's license, the main causes of accidents, and the distribution of accidents by type of road user. The analytical sample included indicators that allow one to consider road traffic injuries through the prism of factors indirectly reflecting the level of driver training and the development of safe driving skills.

The object of the study was road accidents as a medical and social phenomenon that causes mortality, injuries, and demographic losses. The study focused on driver training factors reflected in the statistical structure of road accidents, primarily age, driving experience, the presence or absence of a driver's license, as well as accident causes related to driving errors and traffic violations. The study included the following analytical blocks: driver age structure; gender distribution; driving experience; accidents involving unlicensed drivers; the main causes of accidents, including speeding, dangerous overtaking, violation of signals and road signs, and other behavioral errors; and the distribution of accidents by type of road user.

Descriptive and comparative epidemiological statistics were used for statistical processing. Absolute values, relative indicators, growth and decline rates (Δ, Δ%), as well as fatality rates, injury rates, and overall accident severity were calculated. The fatality rate was defined as the number of fatalities per 100 road accidents, the injury rate as the number of injured per 100 road accidents, and the overall severity rate as the total number of fatalities and injuries per 100 accidents. The χ^2 test was used to assess the statistical significance of differences between compared groups and proportions; differences were considered significant at a significance level of $p < 0.05$.

Additionally, a social-hygienic approach to interpreting the results was used, allowing the identified statistical relationships to be viewed not as isolated numerical differences, but as a manifestation of varying levels of driver preparedness for road traffic situations. This approach made it possible to assess which driver groups and which types of errors are most closely associated with a lack of practical skills, behavioral discipline, and legal responsibility. Statistical processing and tabular systematization of the results were performed in Microsoft Excel 2021. The obtained data were used to subsequently analyze the role of driver training in the formation of road traffic injuries and to discuss areas for their prevention.

Results and Discussion

The study showed that driver training factors in the structure of road accidents are not directly reflected, but rather through a combination of statistically observable characteristics: age, driving experience, the presence or absence of a driver's license, the profile of accident causes, and the nature of the driver's involvement in the accident. In other words, accident statistics allow for an indirect but convincing assessment of a driver's readiness to safely participate in road traffic and which specific training deficiencies most often lead to serious consequences.

In 2025, compared to 2024, a number of groups associated with insufficient experience, unstable behavioral skills, and poor driving discipline showed either a persistently high accident rate or a significantly worsened accident outcome. This allows driver training to be viewed not as a formal stage of driver authorization, but as a key factor in road injury prevention. Driver age groups, driving experience, and driver license status are particularly important in this context, as these characteristics are most closely linked to practical preparedness, road discipline, and the ability to make safe decisions.

Age and experience as indirect indicators of driver training

The analysis showed that the age structure of road accidents in 2025 remains significantly heterogeneous and reflects differences in driver training. Among drivers aged 18–22, the number of accidents remained stable at 25, but the number of fatalities increased from 10 to 12 (+20.0%), while the number of injuries decreased from 18 to 16 (-11.1%). This indicates that even without an increase in accident frequency, young drivers continue to account for a high proportion of serious accidents. In the 23-27 age group, the number of accidents remained virtually unchanged (38 versus 39 in 2024), but the number of fatalities increased from 11 to 15 (+36.4%). This trend confirms that the early stages of a driver's life remain the period of the most unstable and risky driving behavior.

At the same time, the study revealed that the lack of safe driving preparedness is not limited to young people. In the 28-32 age group, the number of accidents decreased from 33 to 23 (-30.3%), but the number of fatalities increased from 8 to 17 (+112.5%), and the number of injuries decreased from 19 to 8 (-57.9%). In the 38-42 age group, the number of fatalities increased from 7 to 12 (+71.4%), with minimal change in the overall number of accidents. Particularly unfavorable changes were noted in the 48-52 and 53-60 age groups, where the number of fatalities increased fivefold—from 2 to 10 in each category. These results suggest that at certain stages of a driver's driving experience and life cycle, not only experience but also professional overload, psychophysiological fatigue, decreased attention, and the entrenchment of risky behavioral patterns become increasingly important in the accident structure.

Thus, age in this article should be considered not simply as a passport characteristic, but as an indirect indicator of the quality and consistency of driver training. Young age is more often associated with a lack of experience and insufficient development of safety skills, whereas in older age groups, the problem may lie not in a lack of training per se, but in its insufficient adaptation to the real-life conditions of heavy and tiring road traffic.

Table 1.
Trends in road traffic accidents by driver age group

Age Group	Accidents 2024	Accidents 2025	Change, %	Fatalities 2024	Fatalities 2025	Change, %	Injured 2024	Injured 2025	Change, %
18–22 years	25	25	0,0	10	12	+20,0	18	16	–11,1
23–27 years	39	38	–2,6	11	15	+36,4	32	27	–15,6
28–32 years	33	23	–30,3	8	17	+112,5	19	8	–57,9
33–37 years	24	22	–8,3	6	7	+16,7	16	15	–6,3
38–42 years	20	21	+5,0	7	12	+71,4	14	15	+7,1
43–47 years	13	13	0,0	5	2	–60,0	10	11	+10,0
48–52 years	7	17	+142,9	2	10	+400,0	5	12	+140,0
53–60 years	9	16	+77,8	2	10	+400,0	7	12	+71,4
Over 60 years old	14	16	+14,3	9	7	–22,2	7	10	+42,9

Driving Experience and License Status

While age reflects the general stage of driver socialization, experience and license status provide a much more accurate assessment of driver training. The study found that this component is one of the most sensitive for assessing the impact of driver training on accident rates.

In 2025, the total number of road accidents in groups related to inexperienced drivers and unlicensed drivers increased from 32 to 50, an increase of 56.3%. The number of fatalities increased from 13 to 26, or doubled, and the number of injuries increased from 26 to 29 (an increase of 11.5%). Even at this level, it becomes clear that insufficient driver training not only increases the likelihood of an accident but also directly impacts its severity.

The group of drivers without a driver's license was found to be the most disadvantaged. In 2025, 28 traffic accidents were registered here compared to 18 in 2024 (+55.6%). The number of fatalities increased from 11 to 16 (+45.5%), and the number of injuries increased from 13 to 17 (+30.8%). From the perspective of the present study's logic, this is one of the most compelling results. The absence of a driver's license in this case should be considered a marker not only of a legal violation but also of a probable lack of basic training, a lack of stable driving skills, and poor road discipline. In other words, illegal driving is a concentrated expression of a lack of preparedness to safely participate in traffic.

For drivers with up to one year of experience, the situation is different: the number of accidents decreased from 17 to 10 (-41.2%), the number of fatalities decreased from 5 to 4 (-20.0%), and the number of injuries decreased from 13 to 6 (-53.8%). At first glance, this appears to be a positive development; however, even under these conditions, the severity level remains high. Consequently, novice drivers remain a vulnerable group who have not yet developed robust skills for safe behavior in challenging traffic situations. Their risk is likely primarily related to a lack of practical experience, while in the unlicensed group, this is compounded by general behavioral and legal indiscipline.

Thus, experience and the possession of a driver's license provide the most direct assessment of driver training. The data obtained show that the greatest risk is associated not simply with inexperience, but with a combination of insufficient experience and the absence of a legal, structured driver license. This makes this section central to the entire article, as it is here that accident statistics most clearly reflect gaps in driver training and supervision.

Table 2.

Temporary road traffic accidents by driving experience and driver's license status

Driver Category	Accidents 2024	Accidents 2025	Change, %	Fatalities 2024	Fatalities 2025	Change, %	Injured 2024	Injured 2025
Without a driver's license	18	28	+55,6	11	16	+45,5	13	17
Experience up to 1 year	17	10	–41,2	5	4	–20,0	13	6
Total	**32**	**50**	**+56,3**	**13**	**26**	**+100,0**	**26**	**29**

Behavioral Causes of Road Accidents as a Reflection of a Deficit of Training

The next level of analysis moves from indirect signs of training to a more direct manifestation of its deficiency—the structure of road accident causes. These causes most clearly demonstrate which skills, behavioral attitudes, and elements of road discipline are undeveloped or insufficiently stable.

In 2025, the total number of road accidents due to the main causes was 153, compared to 149 in 2024 (+2.7%). However, the number of fatalities increased from 45 to 63 (+40.0%), while the number of injuries decreased from 116 to 111 (-4.3%). This again confirms the general trend of the article: even with a relatively stable number of violations, the consequences themselves are becoming more severe.

Speeding resulted in 38 accidents, compared to 46 in 2024 (-17.4%), but the number of fatalities remained unchanged at 12 each year. This means that even with a lower number of high-speed accidents, they retain a high fatality potential. Speed in this case is a classic indicator of insufficient behavioral preparation: a driver may formally have a driver's license, but lack a strong habit of choosing a safe driving mode.

In the category of dangerous overtaking, the number of accidents decreased from 35 to 20 (-42.9%), but the number of fatalities increased from 13 to 14 (+7.7%). This result is especially significant for an article on driver training, as overtaking is one of the most complex driving situations, requiring mature judgment. Consequently, the high fatality rate during dangerous overtaking reflects a lack of safe maneuvering skills and a lack of readiness to quickly assess the traffic situation. The role of sign and signal violations has increased particularly significantly: the number of such accidents increased from 9 to 23 (+155.6%), the number of fatalities from 3 to 7 (+133.3%), and the number of injuries from 8 to 15 (+87.5%). This is no longer simply an aggressive violation, but an indicator of a general decline in discipline and the quality of everyday safe behavior on the road. In other words, driver training should

be assessed not only by driving skills but also by the ability to integrate into the regulated traffic system. Finally, the category of other causes increased from 32 to 50 cases (+56.3%), and the number of fatalities from 11 to 26 (+136.4%). This block is particularly valuable for interpretation, as it reflects the accumulation of mixed errors: incorrect situational assessment, distraction, violation of distance, imprecise maneuvering, fatigue, and other behavioral deficiencies. From the article's point of view, this is one of the strongest arguments in favor of the fact that the problem of driver training lies not only in the lack of knowledge, but also in the insufficient formation of stable, safe behavioral stereotypes.

Table 3.
Dynamics of road accidents by main causes

Main Cause of Accidents	Accidents 2024	Accidents 2025	Change, %	Fatalities 2024	Fatalities 2025	Change, %	Injured 2024	Injured 2025	Change, %
Speeding	46	38	–17,4	12	12	0,0	34	26	–23,5
Dangerous Overtaking	35	20	–42,9	13	14	+7,7	24	16	–33,3
Violation of Signs and Signals	9	23	+155,6	3	7	+133,3	8	15	+87,5
Other Causes	32	50	+56,3	11	26	+136,4	23	28	+21,7
Total	**149**	**153**	**+2,7**	**45**	**63**	**+40,0**	**116**	**111**	**–4,3**

The Role of Drivers in the Overall Structure of Road Accident Participants
The study showed that, based on the type of road user, the driver remains the central figure in the formation of accident situations. In 2025, the number of accidents involving drivers increased from 34 to 39 (+14.7%), the number of fatalities from 23 to 30 (+30.4%), and the number of injuries from 26 to 30 (+15.4%). This confirms that the driver's actions are responsible for the majority of active risk.
At the same time, an important finding was that the consequences of driver error extend far beyond the driver's own group. The number of accidents among passengers decreased, but the number of fatalities increased from 25 to 30 (+20.0%). Among pedestrians, the number of fatalities increased from 10 to 24 (+140.0%). Consequently, inadequate driver training has a broader social impact: it not only increases the risk for the driver himself, but also translates into a serious threat to other road users.

Table 4.
Dynamics of road accidents by type of road user in 2024–2025.

Type of Participant	Accident 2024	Accident 2025	Change, %	Fatalities 2024	Fatalities 2025	Change, %	Injured 2024	Injured 2025	Change, %
Driver	34	39	+14,7	23	30	+30,4	26	30	+15,4
Passenger	56	46	–17,9	25	30	+20,0	49	40	–18,4
Pedestrian	51	66	+29,4	10	24	+140,0	41	42	+2,4
Cyclist	14	9	–35,7	4	7	+75,0	10	2	–80,0
Total	**155**	**160**	**+3,2**	**62**	**91**	**+46,8**	**126**	**114**	**–9,5**

Discussion

Taken together, they obtained results allow us to consider driver training as a key controllable factor in road traffic injuries. Age, experience, driver's license, the structure of accident causes, and the driver's role in the overall accident mechanism form a unified analytical system that reflects deficiencies in practical experience, discipline, and behavioral resilience.

The most important conclusion is that inadequate training is not limited to young or novice drivers. It has a more complex structure: among young drivers, it manifests itself through inexperience and risky behavior; among those without a license, through a lack of legal and disciplined entry into the road system; and among some older groups, through a mismatch between actual skills and the conditions of modern traffic. In other words, this is not simply a matter of "driving school training," but a broader concept of driver readiness.

An analysis of accident causes clearly demonstrates that the key accident mechanisms—speed, dangerous overtaking, signal violations, and accumulated behavioral errors—are largely controllable. Therefore, they can and should be considered as an area for preventive action through improved training, early identification of vulnerable groups and the development of sustainable skills for safe participation in road traffic.

Conclusions

1. The study showed that driver training plays a central role in the formation of road accidents and the severity of their consequences. In 2025, the statistical structure of road accidents reflected not only the influence of external road conditions but also a clear dependence on the level of driver readiness, discipline, and practical skills for safe participation in traffic.
2. Driver age is an important indirect indicator of the quality of training. The highest accident rate remained among young drivers, indicating a lack of practical experience and the instability of safe behavior patterns. At the same time, a significant increase in mortality in several middle- and older age groups indicates that the issue of training is not limited to the initial stage of driving and requires a broader understanding of the ability to maintain safe behavior under prolonged traffic congestion.
3. The most unfavorable situation was observed among individuals without a driver's license. The increase in both the frequency of accidents and the severity of their consequences in this group allows illegal driving to be considered one of the most dangerous and manageable risk factors. This confirms that the lack of formal driver certification is closely linked to inadequate training for safe vehicle operation.
4. An analysis of the main causes of road accidents revealed that the leading mechanisms of accidents are primarily behavioral. Speeding, dangerous overtaking, violating road signs and signals, as well as a host of other disciplinary errors, reflect a deficit in safety skills, an insufficient ability to recognize hazards, and a weak stability of correct behavior patterns in real-life traffic situations.
5. The driver remains the central figure in the development of an accident situation, but the consequences of their errors extend far beyond their own group and affect passengers, pedestrians, and other vulnerable road users. This allows driver training to be considered not only as an individual characteristic but also as a significant factor in public safety.
6. The obtained results indicate that driver training should be considered one of the leading reserves for the prevention of road traffic injuries. Increasing the effectiveness of prevention requires strengthening controls over access to transport, improving practice-oriented training, developing sustainable safety skills, and targeting high-risk groups.

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