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Original article

Regional Specifics of the Frequency of Road Accidents on the Highways of Republican Significance of Kazakhstan, Based on the Mortality Rates and the Number of Victims in 2021

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Abstract

The purpose of the study: to study the frequency of road accidents on highways of national significance for 2021, based on the mortality rates and the number of victims in the regions of Kazakhstan.

Methods. The paper analyzes the indicators of the frequency of accidents, their mortality rate and the number of victims, based on the population density. The work of the country's highway medical and rescue centers has been also evaluated, namely the number of departures and the number of hospitalizations.

Results. The number of road accidents in relation to the population density during the study period prevails in the city of Almaty and Almaty region – 33%, Zhambyl region – 11%, in the city of Nur-Sultan and Akmola region – 11%, in the city of Shymkent and Turkestan region – 7%. The proportion of accidents in the context of the regions of Kazakhstan left: the southern region – 54%, the northern region – 22%, the western region – 12%, the eastern region – 6%, central Kazakhstan – 5%. Greater number of victims per 1 exit of highway medical and rescue points can be noted in the city of Almaty and Almaty region (1211), the city of Shymkent and Turkestan regions (408), as well as in Zhambyl (412) and Karaganda (403) regions. The highest mortality rates as a result of road accidents are observed in the southern region of Kazakhstan: the city of Almaty and Almaty region (31.98 per 100 thousand population), in Shymkent and Turkestan region (16.46 per 100 thousand population) and in Zhambyl region (10.67 per 100 thousand population). The lowest indicator in the North Kazakhstan region is 2.03 per 100 thousand population.

Conclusions. There is a correlation between the cases of road accidents, the number of injured and dead as a result of road accidents and the population density, since the largest proportion of road accidents occur in the densely populated regions of Kazakhstan. There is a decrease in the number of road accidents in 2021 by 16% compared to previous years, which was reflected in a decrease in the number of visits by teams of HMRP by 12%, medical care provided by 27% and the number of hospitalized by 8%.

Keywords: road accidents, mortality, population density, highway medical rescue point.

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Introduction

According to international transport statistics, road transport is considered to be one of the most accident-prone and traumatic in the world. Road traffic injuries (road accidents) rank first in the world in terms of the number of fatalities and second in terms of the number of injured. The total mortality in road accidents is 12 times higher than in other types of injuries, disability is 6 times higher. Such victims need hospitalization 7 times more often, and hospital mortality is 4.5 times higher than the mortality of victims from other causes [1-3].

More than half of all deaths as a result of road accidents among young people aged 15 to 44 and 73% of all deaths as a result of road accidents are men. The number of fatal and disabled accidents is growing every day and is considered as a real problem for health care and all interested bodies that prevent them [4,5].

Currently, the organization of road safety, reduction of mortality and disability of victims of road accidents is an important social problem, as well as a medical problem in the field of public health in many countries of the world [6-8]. Reasonable provision and planning of the organization of medical care for victims on road routes during the pre-hospital, transportation and hospital stages, that is, at all stages of emergency medical care is one of the first and necessary factors that can significantly reduce and minimize the consequences of injuries and the overall outcome [9,10].

According to the data of the authorized body for legal statistics and special records, there is an increase in the number of accidents on highways of republican significance in Kazakhstan. So, in 2019, there is an increase in the number of deaths from 3.4% to 6.1%, compared with 2018 [8].

Materials and methods

In this study information and analytical (collection and analysis of reporting materials for 2021 on the number of road accidents in the context of the regions of Kazakhstan, taking into account the sample of the number of victims) and statistical (processing the number of road accidents, taking into account injuries and the number of deaths on highways of republican significance) methods were used. The sources of the study included:

- the data from the Disaster Medicine Service for 2021;
- reporting and statistical materials of the Committee on Legal Statistics and Special Accounts of the Prosecutor General's Office of the Republic of Kazakhstan on the number of registered accidents and the number of deaths on highways of republican significance for 2021;
- reporting and statistical materials of the Committee of administrative police of the Ministry of Internal Affairs of the Republic of Kazakhstan for 2021 on the number of car accidents on highways of republican significance;
- the information materials of the Committee of Highways of the Ministry of Industry and Infrastructural

Results

In 2021 a total of 13.903 road accidents were registered, the number of deaths as a result of an accident equaled to 2.070 people, and the number of injured as a result of an accident equaled to 16431 people. In absolute numbers, statistics of the studied year for the causes of an accident are as follows: driving a vehicle in a state of

According to the Republican Bureau of Forensic Medical Examination, there is also an increase in injuries that entail a fatal outcome, the latter is due to the high risk of injury to vehicles. More than half of the deaths (52%) in road accidents occur directly at the scene of the accident, about 39% - in hospitals, in clinics, 6% - in the emergency departments of hospitals and 3% - during the transportation of victims [11].

There are also barriers in the comparison and reliability of existing cases of non-fatal outcomes, since there is no single standard and approach in accounting for statistical data by authorized bodies in the law enforcement and healthcare fields. There is also a significant difference in the organization of emergency medical care in case of an accident in large cities and on republican highways in the medical and tactical situation and in the organizational approaches resulting from it.

At the same time, there are unresolved problems in providing medical care to victims during the "golden hour" after an accident. Introduction of a unified system for organizing medical care at highway medical and rescue points stationed on highways of international and national significance will allow timely and on schedule provision of emergency medical care to victims of road accidents, and reduce the number of fatal cases.

The purpose of the study: to analyze the frequency of road accidents on highways of national significance in 2021, taking into account mortality rates and the number of victims throughout the regions of Kazakhstan.

Development of the Republic of Kazakhstan on highways of republican significance, their length, infrastructure.

We have studied the ratio of population density and the number of accidents in the regions on highways of international and national significance. The paper also analyzes the work of the country's highway medical and rescue points (HMRPs), namely the number of departures and the number of hospitalizations. We have conducted a comparative analysis of the ratio of the number of accidents and departures of HMRP brigades, the number of victims per 1 departure of HMRP.

Statistical studies have included calculations of extensive, intensive and aligned indicators, which are calculated according to a generally accepted methodology. The death rates from road accidents are calculated per 100 thousand of the corresponding population.

The received materials have been processed using a computer (Microsoft Office 2007 software package: Excel, Word, Access; BIOSTAT; SPSS 26; STATA 16E).

alcoholic, narcotic and (or) toxic intoxication – 323; the reason for on-coming driving or over-taking – 584; non-compliance with the requirements prescribed by road signs or roadway markings – 635; speeding - 3250; other reasons - 9111.

The number of road accidents in relation to the population density during the study period prevails in the city of Almaty and Almaty region - 33%, Zhambyl region - 11%, in the city of Nur-Sultan and Akmola region - 11%, in the city of Shymkent and Turkestan region - 7%. The

largest share of accidents in the context of the regions of Kazakhstan can be observed in: the southern region -54%, the northern region - 22%, the western region - 12%, the eastern region - 6%, central Kazakhstan - 5% (Table 1).

Table 1 - The ratio of population density and the number of accidents in the regions on highways of international and national significance

Region	Population size	Territory, square km	Density of population	Number of road accidents in 2021
Nur-Sultan, Akmola region	1919683	146219	13,13	272 (11%)
Aktobe region	895967	300629	2,98	130 (5%)
Almaty, Almaty region	4028247	223911	17,99	839 (33%)
Atyrau region	659074	118631	5,56	61 (2%)
West-Kazakhstan region	661960	151339	4,37	68 (3%)
Zhambyl region	1140556	144264	7,91	285 (11%)
Karaganda region	1375680	427982	3,21	122 (5%)
Kostanay region	863566	196001	4,41	81 (3%)
Kyzylorda region	816700	226019	3,61	68 (3%)
Mangystau region	722977	165642	4,36	61 (2%)
Shymkent, Turkestan region	3153682	117249	26,90	179 (7%)
Pavloar region	750488	124725	6,02	114 (5%)
North-Kazakhstan region	542654	97993	5,54	79 (3%)
East Kazakhstan region	1362656	283226	4,81	149 (6%)

Thus, there is a relationship between road accidents and population density, since the largest proportion of accidents tend to occur in densely populated regions of the country.

We have analyzed the work of HMRPs, namely the number of visits and the number of hospitalizations.

In 2021 1,371 departures were made by HMRP teams for 2.508 road accidents on highways of international and national significance, which is 45% of the total number of road accidents.

TMSP on average react to about 50% of accidents occurring on highways of international and national significance, which is correlated to their number, the area of responsibility and the compliance with the principle of the "golden hour".

We have considered data on the number of victims in an accident, and the number of hospitalizations through HMRP, based on its response time to an incident to determine its effectiveness (Table 2).

Table 2 - Indicators of the number of victims per 1 departure of HMRP in 2021

Region	Number of HMRPs	Number of departures in 2021	Number of victims in 2021	Number of injured per 1 departure in 2021
Nur-Sultan, Akmola region	3	91	326	3,6
Aktobe region	3	55	190	3,5
Almaty, Almaty region	6	277	1211	4,3
Atyrau region	1	12	40	3,3
West-Kazakhstan region	1	58	114	2,0
Zhambyl region	3	120	412	3,4
Karaganda region	7	192	403	2,0
Kostanay region	1	31	213	6,9
Kyzylorda region	3	80	96	1,2
Mangystau region	2	56	113	2,0
Shymkent, Turkestan region	3	237	408	1,7
Pavlodar region	2	97	222	2,2
North-Kazakhstan region	1	12	83	6,9
East Kazakhstan region	4	53	272	5,1
Average		98	293	3,4

The largest number of victims is noted in the city of Almaty and Almaty region (1211), the city of Shymkent and Turkestan region (408), as well as in Zhambyl (412) and Karaganda (403) regions.

At the same time, the correlation coefficients between the number of injured and the population density

for 2021 equals to 0.37, which indicates that the population density should be taken into account when organizing the work of HMRP.

Taking into account the capacity of a reanimobile, we have considered the indicators of hospitalization by means of HMRP (Table 3).

Table 3 - Indicators of the number of hospitalized persons per 1 departure of HMRP in 2021

Region	Number of HMRPs	Number of departures in 2021	Number of hospitalized in 2021	Number of hospitalizations per 1 departure in 2021
Nur-Sultan, Akmola region	3	91	76	0,8
Aktobe region	3	55	43	0,8
Almaty, Almaty region	6	277	217	0,8
Atyrau region	1	12	16	1,3
West-Kazakhstan region	1	58	114	2,0
Zhambyl region	3	120	92	0,8
Karaganda region	7	192	219	1,1
Kostanay region	1	31	19	0,6
Kyzylorda region	3	80	51	0,6
Mangystau region	2	56	19	0,3
Shymkent, Turkestan region	3	237	226	1,0
Pavloar region	2	97	52	0,5
North-Kazakhstan region	1	12	7	0,6
East Kazakhstan region	4	53	33	0,6
Average		98	85	0,8

Thus, the number of victims in need of hospitalization per 1 departure of HMRP is about 1 person, which indicates a sufficient capacity of the reanimobile used.

The results of the assessment of the provision of emergency medical care at HMRP have revealed that the number of deaths in 2021 depends on the density of the population living near the republican highways (Table 4).

Table 4 - Mortality rates per 100 thousand people in road accidents, based on the population of the region in 2021

Region	Length of the roadway	Number of HMRP	Number of HMRP per distance	Number of HMRP per 100,000 population	Mortality rates
Nur-Sultan, Akmola region	970	3	323,3	2,5	7,31
Aktobe region	1240	3	413,3	3,0	7,91
Almaty, Almaty region	1920	6	320,0	3,5	31,98
Atyrau region	500	1	500,0	6,6	3,19
West-Kazakhstan region	330	1	330,0	6,6	4,98
Zhambyl region	822	3	274,0	3,8	10,67
Karaganda region	2100	7	300,0	2,0	9,89
Kostanay region	450	1	450,0	8,6	3,01
Kyzylorda region	1160	3	386,7	2,7	4,91
Mangystau region	947	2	473,5	3,6	3,76
Shymkent, Turkestan region	410	3	136,7	6,8	16,46
Pavloar region	550	2	275,0	3,8	4,66
North-Kazakhstan region	189	1	189,0	5,4	2,03
East Kazakhstan region	1490	4	372,5	3,4	5,99

The highest mortality rates as a result of road accidents are observed in the southern region of Kazakhstan: the city of Almaty and Almaty region (31.98 per 100 thousand population), in Shymkent and Turkestan region (16.46 per 100 thousand population) and in Zhambyl

Discussion

We have compared the obtained data with the results of our previous studies and have revealed a decrease in the number of road accidents in 2021 by 16% compared to 2019-2020, which is probably due to the outbreak of the COVID-19 pandemic and quarantine restrictions imposed, which was reflected in a decrease in the number of visits by HMRP teams by 12%, medical care provided by 27% and the number of hospitalized by 8% [12]. However, in the context of regions, the southern region prevails as the largest case of road accidents, taking into account the large number of deployed HMRPs.

According to Quistberg D. [13], population density is one of the main variables in predictive models for the prevention of accidents.

In dynamics it is noticeable that the prevailing reasons for three years (2019-2021), also contain other reasons in the same ratio (weather conditions, road condition, technical condition of vehicles, driver's health, etc.) - 63%, speeding - 27%, non-compliance with traffic signs and maneuvering while driving -5%, on-coming driving or over-taking - 3%, driving in states of intoxication - 2%.

We have considered the factors that make up the frequent causes of accidents on highways. The national operator, JSC "NC "KazAvtoZhol" – is responsible for the condition of highways, and at the time of publication we have not established reports and other documents reflecting quantitative data on the quality of the roadway on the highways of Kazakhstan, indicating the quality coefficients for each road section. At the same time, according to Tokkulov B. [14], the state of highways of republican significance for 2016 is considered as good (32%), satisfactory (45%), and unsatisfactory (23%).

It is also established that in Kazakhstan there are no official statistical data on the density of automobile traffic both in settlements and on highways, in the context of seasonality and time of day.

According to Chen Yu (2016) and T. Tsuboi [15,16], the correlation coefficient between the traffic density and

Conclusions

There is a correlation between the cases of road accidents, the number of injured and dead as a result of road accidents and the population density, since the largest proportion of road accidents occur in the densely populated regions of Kazakhstan.

There is a decrease in the number of road accidents in 2021 by 16% compared to previous years, probably due to the outbreak of the COVID-19 pandemic and the quarantine restrictions imposed, which was reflected in a decrease in the number of visits by HMRP teams by 12%, medical care provided by 27% and the number of hospitalized by 8%.

The identified regional peculiarities of the frequency of accidents and their consequences should be taken into consideration when organizing the work of emergency medical services on the highways of Kazakhstan.

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region (10.67 per 100 thousand population). The lowest indicator in the North-Kazakhstan region is 2.03 per 100 thousand population.

the number of accidents ranges from 0.68 to 0.78, which indicates a direct relationship between these factors. According to the state of the country's fleet, it has been identified that as of January 1, 2021, there are 3.76 million cars in Kazakhstan. According to a specialized analytical study, the car fleet tends to grow by an average of 8.6% per year, the average age of the car is 20 years, and it tends to age by 1% per year [17].

According to McDonald H. (1984) [18], cars manufactured before 1984 were 2.88 times more likely to have an accident with injuries than cars built after 1994. There was also a tendency of increased risk of an accident with a rise in the age of the vehicle for each year after an adjustment with potential distorting factors. According to Martín-delos Reyes L. (2019) [19], there is a positive strong connection between a traffic incident and involvement of the car with an expired inspection certificate. Since in countries with a high standard of living, there is a tendency to reduce the number of accidents [20], the poor-quality condition of roads and the deterioration of the country's fleet are additional risks to a dangerous situation on the roads, and should be taken into account when organizing the work of emergency medical services on the highways.

Limitations. In our study, it has not been possible to determine the number of deaths that occurred after hospitalization, which could also be an indicator of the effectiveness of HMRP.

There is also a lack of data on the density of automobile traffic on the highways of the Republic of Kazakhstan and on the distribution of cars by deterioration in the context of regions.

Given the limited information, it can be assumed that the approach of implementing the rules and regulations available for effective planning of emergency services is incomplete.

police of the Ministry of Internal Affairs of the Republic of Kazakhstan, as well as the Roads Committee of the Ministry of Industry and Infrastructural Development of the Republic of Kazakhstan for kindly providing reporting, statistical and information materials according to our requests within the framework of this study.

Conflict of interest. The authors declare that the conflict of interest is absent.

Contribution of the authors. Conceptualization credits – I.A.A.; writing credits – S.A.K., O.G.U.; editing credits – O.G.U.; data collection and analysis credits – S.A.K.

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2021 жылғы өлім-жітім көрсеткіштері мен зардап шеккендер санын ескере отырып, Қазақстанның республикалық маңызы бар трассаларындағы жол-көлік оқиғаларының жиілігінің өңірлік ерекшеліктерін зерттеу

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Түйіндеме

Зерттеу мақсаты. Қазақстан өңірлері бойынша өлім-жітім көрсеткіштері мен зардап шеккендер санын ескере отырып, 2021 жылғы республикалық маңызы бар автомобиль жолдарындағы жол-көлік оқиғаларының жиілігін зерделеу.

Әдістері. Жұмыста жол-көлік оқиғаларының жиілігінің көрсеткіштері, олардан болатын өлім-жітім және халықтың тығыздығын ескере отырып, зардап шеккендердің саны талданды. Сондай-ақ, еліміздің трассалық медициналық-құтқару пункттерінің жұмысы, атап айтқанда, шығу саны мен емдеуге жатқызу саны бағаланды.

Нәтижелері. Зерттеліп отырған кезеңде халықтың тығыздығына қатысты жол-көлік оқиғаларының саны Алматы қаласында және Алматы облысында - 33%, Жамбыл облысында - 11%, Нұр-Сұлтан қаласында және Ақмола облысында - 11%, Шымкент қаласында және Түркістан облысында - 7% басым болады. Қазақстан өңірлері бөлінісінде жол-көлік оқиғаларының үлес салмағы қалды: Оңтүстік өңір - 54%, Солтүстік өңір - 22%, Батыс өңір - 12%, Шығыс өңір - 6%, Орталық Қазақстан-5%. Трассалық медициналық-құтқару пункттерінің 1 шығуына зардап шеккендердің көп саны Алматы қаласы мен Алматы облысында (1211), Шымкент қаласы және Түркістан облыстарында (408), сондай-ақ Жамбыл (412) және Қарағанды (403) облыстарында байқалады. Жол-көлік оқиғаларының салдарынан болатын өлім-жітімнің ең жоғары көрсеткіштері Қазақстанның оңтүстік өңірінде байқалады: Алматы қаласы мен Алматы облысында (100 мың тұрғынға шаққанда 31,98), Шымкент қаласы мен Түркістан облысында (100 мың тұрғынға шаққанда 16,46) және Жамбыл облысында (100 мың тұрғынға шаққанда 10,67) болды. СҚО - дағы ең төменгі көрсеткіш - 100 мың тұрғынға шаққанда 2,03 құрады.

Тұжырымдама. Жол-көлік оқиғаларының жағдайлары және олардың нәтижесінде зардап шеккендер мен қаза тапқандар саны мен халықтың тығыздығы арасында тәуелділік байқалады, өйткені Қазақстанның халық тығыз орналасқан өңірлерінде жол-көлік оқиғасы жағдайларының ең көп үлес салмағы келеді. 2021 жылы жол-көлік оқиғаларының санының өткен жылдармен салыстырғанда 16% - ға төмендеуі орын алды, бұл трассалық медициналық-құтқару қызметі бригадаларының шығу санының 12%-ға, көрсетілген медициналық көмектің 27% - ға және емдеуге жатқызылғандар санының 8%-ға азаюына әкелді.

Түйін сөздер: жол-көлік оқиғалары, өлім-жітім, халықтың тығыздығы, трассалық медициналық-құтқару пункті.

Региональные особенности частоты ДТП на трассах республиканского значения Казахстана с учетом показателей смертности и числа пострадавших за 2021 год

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Резюме

Цель исследования; изучить частоту дорожно-транспортных происшествий на автомобильных трассах республиканского значения за 2021 год с учетом показателей смертности и числа пострадавших по регионам Казахстана.

Методы. В работе проанализированы показатели частоты ДТП, смертности от них и количество пострадавших с учетом плотности населения. Также оценена работа трассовых медико-спасательных пунктов страны, а именно количество выездов и количество госпитализаций.

Результаты. Количество ДТП в соотношении с плотностью населения за изучаемый период превалирует в городе Алматы и Алматинской области - 33%, Жамбылской области - 11%, в городе Нур-Султан и Акмолинской области - 11%, в городе Шымкент и Туркестанская область - 7%. Удельный вес случаев ДТП в разрезе регионов Казахстана оставил: южный регион - 54%, северный регион - 22%, западный регион - 12%, восточный регион - 6%, центральный Казахстан - 5%. Больше количество пострадавших на 1 выезд трассовых медико-спасательных пунктов отмечается в городе Алматы и Алматинской области (1211), г. Шымкент и Туркестанской области (408), а также в Жамбылской (412) и Карагандинской (403) областях. Наибольшие показатели смертности в результате ДТП наблюдается в южном регионе Казахстана: г. Алматы и Алматинской области (31,98 на 100 тыс. населения), в городе Шымкент и Туркестанской области (16,46 на 100 тыс. населения) и в Жамбылской области (10,67 на 100 тыс. населения). Самый низкий показатель в СҚО - 2,03 на 100 тыс. населения.

Выводы. Наблюдается зависимость между случаями ДТП, количеством пострадавших и погибших в результате ДТП и плотностью населения, так как именно в густонаселенных регионах Казахстана приходится наибольший удельный вес случаев ДТП. Имеет место снижение количества ДТП в 2021 году на 16% по сравнению с предыдущими годами, что и отразилось на уменьшении количества выездов бригадами ТМСП на 12%, оказанной медицинской помощи на 27% и количество госпитализированных на 8%.

Ключевые слова: дорожно-транспортные происшествия, смертность, плотность населения, трассовый медико-спасательный пункт.