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Accessibility and regional features of the emergency medical system in Kazakhstan

Adenova Gulzhan[1], Kausova Galina[1], Brukhanov Alexander[2], Juvashev Almaz[3], Utaganov Bakyt[3], Lyazzat Ayaganova[3], Zhanna Dyusembayeva[4], Sabina Medukhanova[5], Konstantin Bulygin[6], Tazhiyeva Aigul[6]*

1. Kazakhstan Medical University "KSPH", Almaty, Kazakhstan.
2. Diagnostic Center of the Altai Territory, Kazakhstan.
3. Almaty City Emergency First Aid Hospital, Almaty, Kazakhstan.
4. Stroke Unit at City Clinical Hospital No. 7, Almaty, Kazakhstan.
5. Republican Coordination Center for Stroke in the Republic of Kazakhstan, Kazakhstan.
6. Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan.

***Corresponding author:** Tazhiyeva Aigul; **Email:**a.tazhieva@kaznmu.kz

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Abstract: **Objective:** The study aimed to evaluate the accessibility and performance of emergency medical service (EMS) in Kazakhstan, with a focus on regional disparities and implications for health system development.
Methods: A retrospective study on ambulance services in Kazakhstan for 2024 used data from the medical information system. The study found that the ambulance service has 100% automated call management in cities like Astana, Almaty, Shymkent, and 17 regions. The dispatcher processes calls within 5 minutes, categorizing challenges into four types: direct threats to life, potential threats, potential health threats, and acute conditions without danger. The time of arrival for ambulances varies between 10 minutes and 60 minutes.
Results: The ambulance service has 20 stations, 96 urban substations, and 195 district offices. 1,499 mobile EMS teams operate in one shift, with a ratio of 18/82. In 2024, 914 city and 585 district brigades operate consultations without team departure, accounting for 10.27% of calls. Kazakhstan has a high proportion of urgent category one calls, accounting for 86% of the total number. This raises concerns about the accuracy of the assessment of urgency, as it may indicate system errors in triage or overloading ambulances with tasks not within their competence. The Ulytau region, North Kazakhstan, East Kazakhstan, Mangystau, Kyzylorda, and Karaganda regions have the highest percentages of urgent calls (94-96%). The study recorded 8,531,652 calls, with 70.8% coming from urban areas and 29.2% of rural regions. The highest urbanization rates were found in republican significance towns like Almaty, Shymkent, and Astana. In all regions, the distribution of calls between urban and rural areas differs significantly from the overall structure for the country (X^2 = 3,210,171.3, P< 0.001).
Conclusion: The study shows that Kazakhstan's EMS system has fully automated call management, but regional disparities persist. Urgent category one calls are predominant, with urban areas like Almaty, Astana, and Shymkent generating the majority. This highlights structural imbalances in EMS utilization and calls need improvement in triage protocols, resource allocation, and health system capacity.

Keywords: Emergency Medical Services (EMS); Kazakhstan; Nosology; Rural; Urban

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1. Introduction

World health assembly (WHA) 76.2 calls for strengthening health systems to provide high-quality emergency, critical, and operative care for universal health coverage. Respiratory and cardiovascular diseases lead EMS calls, indicating a need for better primary care. Disease prevention should focus on all ages, especially women and the elderly, and resources must be allocated effectively (1).

The world health organization emergency care systems framework (WHO ECSF) guides the creation of effective emergency medical services (EMS). The Copenhagen EMS provides integrated patient-centered care, which involves community involvement and individual treatment regimens related to primary and off-duty services and complements the existing structure of WHO emergency medical systems. Specialized mobile units provide enhanced coverage, while technology enhances early sorting, dispatch, research, and security through data (2).

According to official statistical data, the comprehensive per capita standard for the EMS remains insufficient to date, which makes it challenging to ensure the service's full functioning. In the regions of Kazakhstan, there is an urgent need

to build new stations and substations of the EMS, since the existing buildings are not standard and do not meet minimum sanitary standards. A significant part of the facilities was built a long time ago. Formation of additional ambulance teams to increase the availability and quality of services. Amendments and additions to the order of the minister of finance of the Republic of Kazakhstan dated August 3, 2010, No. 393 "on approval of accounting rules in state institutions" with a revision of the wear standards for sanitary vehicles: 4 years for urban and 5 years for rural cars. Decentralizing the financing of ambulance stations by transferring budgetary powers to local executive bodies can lead to more efficient resource allocation.

Future initiatives should balance individual needs to ensure the best possible care for patients (3). The EMS comprises paramedics, nurses, doctors, and researchers, working together to provide comprehensive care, including patient triage systems, policies, and the development of community paramedicine (4). Patients raised concerns due to a task-oriented sorting system, causing communication disruptions, especially when transitioning from sorting to counseling (5). The effects of using machine learning to improve EMS response times, based on over a million calls in Stockholm. It highlights how factors like weather, call priority, and availability of resources influence how fast EMS can get to patients. The research shows that smart, data-driven strategies can help EMS teams allocate resources better to improve response times and fairness across different emergencies (6). A study in Denmark analyzed 1.2 million emergency and out-of-hours primary care calls for urgent health issues. Results showed primary care was the primary care service, while emergency services handled fewer calls but had higher hospital admission rates (7).

Medical dispatchers in Copenhagen correctly identify acute strokes in emergency calls, with daytime calls and transient ischemic attack cases more likely to be identified using a criteria-based system (8). Germany's emergency teams have demonstrated improved accuracy over the past decade, with common emergencies such as heart attacks, strokes, and breathing troubles becoming more frequent. However, elderly diagnosis remains challenging, with calls to emergency teams doubling from 2004 to 2014 (9).

The present study aimed to evaluate the accessibility and performance of EMS in Kazakhstan, with a focus on regional disparities and implications for health system development.

2. Methods

2.1. Study design

A retrospective study was conducted using data from the ambulance service of the Republic of Kazakhstan for 2024, based on the medical information system, which automates the work of medical institutions of any profile. Population data for the studied period were obtained from the statistical yearbook "Health of the population of the Republic of Kazakhstan and activities of healthcare organizations", published by the committee on statistics, Astana, Kazakhstan, for the year 2024. The automated call management system has been implemented by 100% in the cities of Astana, Almaty, Shymkent, and 17 regions. To call an ambulance, citizens use the number 103 or mobile applications with geolocation. According to the order of the ministry of health of the Republic of Kazakhstan dated 11/30/2020 № RK MHC-225/2020, the dispatcher processes the call within 5 minutes, determining its urgency. The challenges are divided into four categories: category 1 – direct threat to life, assistance is required immediately; category 2 – potential threat to life; category 3 – potential health threat; category 4 is an acute condition without danger to life and health. Time of arrival of the brigade: category 1 — up to 10 minutes; category 2 — up to 15 minutes; category 3 — up to 30 minutes; category 4 and primary health care — up to 60 minutes.

2.2. Statistical analysis

Based on the statistical collection "Healthcare of the Republic of Kazakhstan and the activities of healthcare organizations in 2024" (https://stat.gov.kz/), the indicators of the number of nosology calls and the number of transported patients were calculated in terms of the average annual urban and rural population. Maps using the service were created to visually display data on the work of the ambulance service, datawrapper.de/maps. SPSS version 25 was used for all calculations and illustrations. Quantitative variables are presented as mean ± standard deviation (Mean±SD), and categories are presented as numbers with percentages: total number of calls handled by category/total number of calls, including calls to 103*100; Call category*100/total number of calls dealt with by urgency category; number of refusals per 103*100/total number of calls, including calls to 103; urban/total number of calls*100; rural/total number of calls*100; nosology *100/number of calls handled; number of successful resuscitations performed by EMS teams*100/total number of resuscitations performed by EMS teams; number of pre-hospital deaths/total number of calls dealt with by urgency category*100. OR (odds ratio)=1 – the likelihood of calling is the same in the city and in the rural; OR >1 – the chances of calling in the city are higher than in the town; OR<1 – the chances of calling in the village are higher than in the city. A comparison between urban and rural areas in terms of emergency medical service calls was performed using the chi-square (X^2) test, with significant differences between groups noted at $P<0.05$.

3. Results

The ambulance service is represented by 20 independent stations, 96 urban substations, and 195 district offices. 1 499 mobile EMS operate in regional and urban EMS stations in one shift, of which 269 (17.9%) are specialized (medical) and 1 230 (82.1%) are paramedic teams. The ratio of medical and paramedic teams at EMS stations is 18/82. In 2024, 914

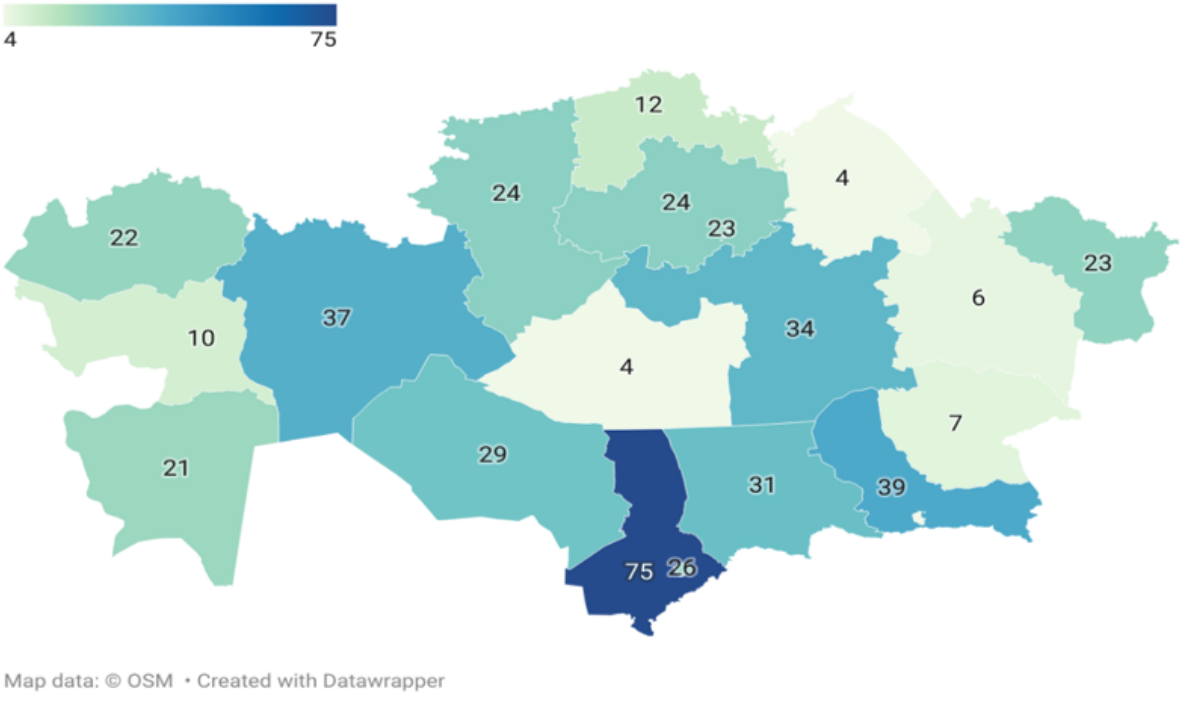

Figure 1 The number of teams of emergency medical departments in the organization of Primary health care (PHC)

brigades are operating in the city offices and 585 brigades in the district ones. To service calls of the 4th category of urgency in the republic, 454 brigades operate in the EMS offices of the primary healthcare organization, of which 259 brigades operate in city offices, and 195 brigades operate in district offices. A detailed description of the location of the number of NSR department teams in the organization of primary health care (PHC) is shown in figure 1.

The largest cities Almaty (1 392 573), Astana (952 963), and Shymkent (682 571), have the most significant number of requests in absolute numbers. At the same time, the number of calls per 1,000 population varies: the maximum values are in the regions of Kyzylorda (576.6), West Kazakhstan (502.0), and Atyrau (486.2), indicating a high burden on ambulances in these regions. Denial of service accounts for an average of less than 1% of the total number of calls nationwide (0.67%). The highest failure rates were recorded in Turkestan (3.20%) and Pavlodar (2.17%) regions, as well as in Karaganda (0.82%) and Almaty (0.24%). In some areas, there are no failures or their number is not specified, which may indicate either the absence of failures or insufficient completeness of data. The calls to EMS by patients on the call "103" are presented in table 1.

In general, there is a very high proportion of urgent category 1 (one) calls in the Republic of Kazakhstan — about 86% of the total number. This means that the vast majority of requests are classified as emergency, which raises doubts about the correctness of the assessment of urgency on the ground. Such a distribution may indicate system errors in triage (call selection) or an overload of the ambulance with tasks that do not fall within its competence. There is also a significant proportion of calls in categories 3 (three) and 4 (four), which, in theory, could be handled by an emergency or outpatient service rather than an emergency ambulance. This further confirms that some of the calls are received unreasonably, either due to a lack of other medical care or due to the lack of a clear filtration system.

The EMS call by category is shown in table 2.

Table 3 shows the distribution of EMS calls by region in Kazakhstan, broken down into urban and rural areas. A total of 8,531,652 calls were recorded, of which 70.8% (6,044,064 calls) were from urban areas and 29.2% (2,487,588 calls) were from rural areas. The data obtained demonstrate a clear predominance of calls from cities, which is confirmed by a significant level of difference ($P<0.001$). The highest urbanization rates for calls are observed in the towns of republican significance: Almaty – 100% of calls (1,102,273), Shymkent – 100% (605,257), Astana – 100% (612,266). There are no calls from rural areas in these regions. A high proportion of calls in cities is noted in Pavlodar (89.6%), Ulytau (88.0%), Karaganda (86.5%), and Kostanay (84.5%) regions. These regions show the highest OR values >1 (e.g., Pavlodar – OR=1.52; Karaganda – OR=1.27; Kostanay – OR=1.15; Ulytau – OR=1.51), indicating a statistically significantly higher probability of calls in cities. Regional differences with a shift in favour of rural areas: Turkestan region – 68.1% of calls in villages (OR=0.17; 95% CI: 0.17–0.18), Zhetysu region – 56.8% (OR=0.40), Mangistau Region – 42.4% (OR=0.67), Kyzylorda Region – 39.1% (OR=0.59), Zhambyl region – 37.8% (OR=0.64). These regions are characterized by a predom-

Table 1 Contacting an ambulance on the call "103" in 2024

Name of the region	Number of people served	Total requests calls to 103	Challenges per 1,000 population	The number of failures is 103					
				Absolute number	%	Absolute number	%	Absolute number	%
Abai	624 150	284 395	401,5	33	0,01	28132	9,89		
Akmola	788 396	287 849	331,6			17146	5,96	932	0,32
Aktobe	937 955	370 122	364,8			7751	2,09	969,0	0,26
Almaty	1 620 520	730 039	390,4	1721	0,24	61730	8,46	13706	1,88
Atyrau	698313	377 226	486,2	133	0,04	24309	6,44	5581	1,48
East Kazakhstan region	732 161	270	426	355,5			3369	1,25	
Zhambyl	1 220 500	576 921	450,6	105	0,02	12056	2,09	91	0,02
Zhetisu	667 107	507 400	0,0	3329		144745		92	0,02
West Kazakhstan region	695593	365 434	502,0			2282	0,62		
Karaganda	1 206 746	466 509	366,0	3824	0,82	9372	2,01	2709	0,58
Kostanay	792 318	402 059	424,4	5212	1,30	43319	10,77		
Kyzylorda	843383	514 703	576,6			17114	3,33		
Mangystau	815 269	325 475	382,2	2622	0,81	23	0,01	3347	1,03
Pavlodar	766 885	345 308	368,2	7500	2,17	46091	13,35		
North Kazakhstan region	536 783	169 193	307,2						
Turkestan	2 142 005	826 930	354,2	26426	3,20	7884	0,95	1259	0,15
Ulytau	221 000	95 332	429,4			37		102	0,01
Shymkent city	1 246 583	682 571	485,5	8220	1,20	48543	7,11	20	0,003
Almaty city	2 342 398	1 392 573	470,6	7963	0,57	246710	17,72	7735	0,56
Astana city	1566883	952 963	390,8			300145	31,50		
Republic of Kazakhstan	20 464 948	9 943 428	416,9	67088	0,67	1020758	10,27	36543	0,37

inance of rural calls, with the Turkestan region leading in terms of the number of rural calls (516,572 cases). A moderately balanced distribution between urban and rural areas is observed in Atyrau region (71.1% vs. 28.9%), East Kazakhstan (77.1% vs. 22.9%), West Kazakhstan (77.4% vs. 22.6%), and Akmola (77.3% vs. 22.7%) regions. Although urban calls predominate, their ratio is closer to the national level. OR values < 1 (e.g., Turkestan, Zhetysu, Zhambyl, Kyzylorda regions) indicate a significantly higher probability of calling an ambulance in rural areas. OR values>1 (e.g., Pavlodar, Karaganda, Kostanay, and Ulytau regions) demonstrate a significant predominance of urban calls. Confidence intervals (95% CI) are narrow and do not include 1, confirming the statistical stability of the results. In all regions, the distribution of calls between urban and rural areas differs significantly from the overall structure for the country (X^2=3,210,171.3, P<0.001). The most significant differences are recorded in the Almaty region, the Turkestan region, and the large metropolitan areas of Almaty, Astana, and Shymkent, where the ratio of urban to rural areas differs radically from the national average. In the regions of the Republic of Kazakhstan, EMS are most often called for the following reasons: Respiratory diseases, about 23.6% of all calls. Cardiovascular diseases (CVD) - 18.4%. Injuries and poisoning account for about 9.5%. Neurological diseases are also about 9.5%. This is followed by calls for diseases of the gastrointestinal tract (7.0%), obstetric and gynecological diseases (5.2%), infectious diseases (4.8%), and acute surgical diseases of the abdominal cavity (2.4%). Respiratory diseases account for a significant proportion in all regions and range from 13.3% (East Kazakhstan region) to 28.4% (West Kazakhstan region The Emergency medical calls by nosologies are presented in table 4.

The structure of calls varies significantly between regions of Kazakhstan for each category of respiratory diseases (23.1%, Min–Max 13.3–28.4). The variability is significant (a spread of almost 2.2 times). For example, the minimum values are observed in Eastern Kazakhstan (13.3%), and the maximum values in Western Kazakhstan (28.4%). This may reflect climatic characteristics, the prevalence of chronic obstructive pulmonary disease and asthma, as well as the availability of outpatient pulmonological care—cardiovascular diseases (19.0%, Min–Max 9.9–23.6). Despite the high average level, the spread across regions is also significant: 9.9% in Mangistau and 23.6% in the North Kazakhstan region. This indi-

Table 2 Emergency medical service call by category

Name of the region	Number of calls serviced by urgency category		Category 1		Category 2		Category 3		Category 4	
	Absolute number	%	Absolute number	%	Absolute number	%	Absolute number	%	Absolute number	%
Abai	250592	88,1	12237	4,88	77278	30,8	81597	32,6	79480	31,7
Akmola	261466	90,8	17475	6,68	90238	34,5	56414	21,6	97339	37,2
Aktobe	342199	92,5	7103	2,08	78002	22,8	68093	19,9	189001	55,2
Almaty	632605	86,7	30877	4,88	191678	30,3	192223	30,4	217827	34,4
Atyrau	339485	90,0	13463	3,97	142543	42,0	99103	29,2	84376	24,9
East Kazakhstan region	260272	96,2	11191	4,30	100833	38,7	48588	18,7	99660	38,3
Zhambyl	549977	95,3	33740	6,13	188705	34,3	124101	22,6	203431	37,0
Zhetisu	349283	68,8	13490	3,86	125246	35,9	94629	27,1	115918	33,2
West Kazakhstan region	349185	95,6	13737	3,93	82037	23,5	60153	17,2	193258	55,3
Karaganda	441653	94,7	20984	4,75	153180	34,7	87630	19,8	179859	40,7
Kostanay	336287	83,6	5342	1,59	60945	18,1	135710	40,4	134290	39,9
Kyzylorda	486333	94,5	9508	1,96	172120	35,4	98643	20,3	206062	42,4
Mangystau	311569	95,7	19698	6,32	105846	34,0	87798	28,2	98227	31,5
Pavlodar	282371	81,8	7083	2,51	94708	33,5	134779	47,7	45801	16,2
North Kazakhstan region	164907	97,5	4513	2,74	48191	29,2	38895	23,6	73308	44,5
Turkestan	758767	91,8	34231	4,51	147853	19,5	165877	21,9	410806	54,1
Ulytau	94905	99,6	5066	5,34	34692	36,6	22264	23,5	32883	34,6
Shymkent city	605257	88,7	32383	5,35	194723	32,2	180508	29,8	197643	32,7
Almaty city	1102273	79,2	110766	10,0	334835	30,4	415147	37,7	241525	21,9
Astana city	612266	64,2	15992	2,61	113411	18,5	275192	44,9	207671	33,9
Republic of Kazakhstan	8 531 652	85,8	418 879	4,91	2 537 064	29,7	2 467 344	28,9	3 108 365	36,4

Table 3 The number of calls in urban and rural areas in Kazakhstan

Name of the region	Total number of calls	Urban	%	Rural	%	OR	95% CI	P-value
Abai	250 592	187 476	74,8	63116	25,2	0,87	0,86-0,88	<0,001
Akmola	261 466	202 023	77,3	59 443	22,7	0,95	0,94-0,96	<0,001
Aktobe	342 199	264 207	77,2	77 992	22,8	0,96	0,95-0,97	<0,001
Almaty	632 605	31 283	4,9	601 322	95,1	0,01	0,01-0,01	<0,001
Atyrau	339 485	241 494	71,1	97 991	28,9	0,98	0,97-0,99	<0,001
East Kazakhstan region	260 272	200 556	77,1	59 716	22,9	0,95	0,94-0,96	<0,001
Zhambyl	549 977	342 129	62,2	207 848	37,8	0,64	0,64-0,65	<0,001
Zhetisu	349 283	151 001	43,2	198 282	56,8	0,40	0,39-0,40	<0,001
West Kazakhstan region	349 185	270 411	77,4	78 774	22,6	0,96	0,95-0,97	<0,001
Karaganda	441 653	381 866	86,5	59 787	13,5	1,27	1,25-1,28	<0,001
Kostanay	336 287	284 149	84,5	52138	15,5	1,15	1,13-1,16	<0,001
Kyzylorda	486 333	296 224	60,9	190 109	39,1	0,59	0,58-0,60	<0,001
Mangystau	311 569	179 474	57,6	132 095	42,4	0,67	0,66-0,68	<0,001
Pavlodar	282 371	252 933	89,6	29 438	10,4	1,52	1,49-1,54	<0,001
North Kazakhstan region	164 907	113 308	68,7	51 599	31,3	0,88	0,87-0,90	<0,001
Turkestan	758 767	242 195	31,9	516 572	68,1	0,17	0,17-0,18	<0,001
Ulytau	94 905	83 539	88,0	11 366	12,0	1,51	1,47-1,55	<0,001
Shymkent city	605 257	605 257	100,0	-	-	-	-	<0,001
Almaty city	1 102 273	1 102 273	100,0	-	-	-	-	<0,001
Astana city	612 266	612 266	100,0	-	-	-	-	<0,001
Republic of Kazakhstan	8 531 652	6 044 064	70,8	2 487 588	29,2			<0,001

Data are presented as a number (%) of cases.
OR: Odds ratio; CI: 95% Confidence interval; P value significant at < 0.05

cates regional differences in risk factors (hypertension, ischaemic heart disease) and, possibly, in the population's use of healthcare services. The differences between regions for all nosologies are statistically significant (X^2 (18), P<0.001), obstetric and gynecological cases (4.7%, Min–Max 2.5–9.4). Despite the small proportion, the spread is more than 3.5 times (2.5% in Kostanay and 9.4% in Shymkent). These differences can be explained by the level of migration, sanitary and epidemiological factors, and population density. Respiratory, cardiovascular, infectious, and obstetric-gynecological cases showed the most significant variability. The results confirm that the structure of emergency medical care in Kazakhstan

Table 4 The Emergency medical calls by nosologies

Name of the region	Number of calls served	Respiratory diseases	Cardiovascular diseases	Injuries and poisoning	Neurological diseases	Gastrointestinal disorders	Obstetric and gynaecological diseases	Infectious diseases	Acute surgical diseases of the abdominal cavity
	Absolute number	%	%	%	%	%	%	%	%
Abai	250592	19,3	18,1	10,1	5,29	6,04	4,35	3,53	3,36
Akmola	261466	27,3	22,5	9,05	12,2	7,19	2,47	2,42	1,86
Aktobe	342199	25,3	17,9	8,85	8,80	5,27	7,54	4,58	5,61
Almaty	632605	24,4	20,0	10,9	7,46	8,68	4,91	0,86	1,88
Atyrau	339485	24,9	15,1	7,23	9,86	8,25	6,22	5,22	3,09
East Kazakhstan region	260272	13,3	16,2	9,36	4,53	3,30	3,99	3,04	4,44
Zhambyl	549977	23,3	20,9	6,82	11,0	6,64	3,31	5,66	2,17
Zhetisu	349283	23,8	22,0	9,57	8,75	10,8	3,45	2,52	1,76
West Kazakhstan region	349185	28,4	22,1	7,16	10,2	4,65	2,89	5,44	3,52
Karaganda	441653	26,9	23,2	12,3	11,5	5,69	3,67	4,93	2,48
Kostanay	336287	22,4	21,4	7,28	7,25	10,09	2,84	2,51	1,76
Kyzylorda	486333	25,9	20,8	6,53	10,7	3,62	5,05	5,65	2,89
Mangystau	311569	21,4	9,9	7,37	3,48	9,73	5,08	3,62	1,72
Pavlodar	282371	25,1	22,6	9,60	10,3	5,25	3,32	4,73	2,89
North Kazakhstan region	164907	23,0	23,6	7,12	6,46	7,62	3,32	4,20	1,82
Turkestan	758767	24,1	23,0	7,53	11,1	9,47	6,35	1,63	0,86
Ulytau	94905	25,2	19,0	8,87	10,5	7,30	4,25	4,56	2,02
Shymkent city	605257	20,5	13,6	10,3	12,0	4,77	9,42	5,40	2,00
Almaty city	1102273	20,7	14,8	12,5	10,6	7,17	5,55	9,33	2,40
Astana city	612266	27,5	11,7	13,0	9,07	6,18	8,03	8,08	2,82
Republic of Kazakhstan	8 531652	23,6	18,4	9,49	9,52	6,95	5,23	4,83	2,44

Table 5 Variation in the structure of emergency medical calls by nosology across regions (X^2 test, P<0.001)

Nosologies	Mean ± SD	Min–Max	X^2 (df=18)	P-value
Respiratory diseases	23.1 (3.7)	13.3–28.4	2 450.3	<0.001
Cardiovascular diseases	19.0 (3.8)	9.9–23.6	2 720.6	<0.001
Injuries and poisoning	9.0 (2.0)	6.5–13.0	1 640.2	<0.001
Neurological diseases	9.1 (2.6)	3.5–12.2	2 210.7	<0.001
Gastrointestinal disorders	7.0 (2.1)	3.3–10.8	1 870.5	<0.001
Obstetric & gynecological	4.7 (1.9)	2.5–9.4	1 920.8	<0.001
Infectious diseases	4.4 (2.2)	0.9–9.3	2 110.1	<0.001
Acute abdominal surgical cases	2.6 (1.0)	0.9–5.6	1 560.9	<0.001

SD: Standard deviation

is highly dependent on regional factors, including demographic, climatic, socio-economic factors, and the level of accessibility of specialized services. These data are presented in table 5 and are essential for optimizing resource allocation and developing specialized patient pathways.

Overall, in Kazakhstan, the success rate of resuscitation performed by ambulance crews is just over half of all cases, at around 53%. However, this figure varies significantly from region to region. For example, in the Mangistau region, the success rate of resuscitation reaches 100%. However, there are only two cases there, and in Pavlodar and Shymkent, it is about 77%, which can be considered an excellent result. The analysis on resuscitation and pre-hospital mortality is presented in table 6.

Table 6 Resuscitation performed by emergency medical teams and pre-hospital mortality

Name of the region	Number of resuscitations performed by emergency medical teams	Number of successful resuscitations performed by emergency medical teams		Total number of pre-hospital deaths		Number of cases of pre-hospital mortality before the arrival of emergency medical teams		Number of cases of pre-hospital mortality in the presence of emergency medical teams	
	Absolute number	Absolute number	%	Absolute number	%	Absolute number	%	Absolute number	%
Abai	30	26	86,7	467	0,19	467	100,0		
Akmola	50	25	50,0	1298	0,50	1268	97,7	30	2,3
Aktobe	58	43	74,1	1076	0,31	1061	98,6	15	1,4
Almaty	84	27	32,1	5534	0,87	5482	99,1	52	0,9
Atyrau	63	21	33,3	1432	0,42	1382	96,5	50	3,5
East Kazakhstan region	48	33	68,8	480	0,18	465	96,9	15	3,1
Zhambyl	46	34	73,9	2731	0,50	2717	99,5	14	0,5
Zhetisu	97	43	44,3	1706	0,49	1652	96,8	54	3,2
West Kazakhstan region	54	29	53,7	1316	0,38	1291	98,1	25	1,9
Karaganda	178	58	32,6	787	0,18	667	84,8	120	15,2
Kostanay	121	43	35,5	2468	0,73	2377	96,3	91	3,7
Kyzylorda	20	14	70,0	1982	0,41	1976	99,7	0,3	6
Mangystau	2	2	100,0	1300	0,42	1280	98,5	20	1,5
Pavlodar	13	10	76,9	1637	0,58	1634	99,8	3	0,2
North Kazakhstan region	33	22	66,7	948	0,57	937	98,8	11	1,2
Turkestan	58	40	69,0	4732	0,62	4714	99,6	18	0,4
Ulytau	14	8	57,1	199	0,21	187	94,0	12	6,0
Shymkent city	70	54	77,1	3568	0,59	3552	99,6	16	0,4
Almaty city	299	172	57,5	4459	0,40	4332	97,2	127	2,8
Astana city	83	51	61,4	2152	0,35	2120	98,5	32	1,5
Republic of Kazakhstan	1421	755	53,1	40 272	0,47	39 561	98,2	711	1,8

4. Discussion

Most of the calls across the country come from cities, but there are regions where rural areas dominate, especially in the south and southeast of the country. Regions with a high proportion of rural challenges require special attention, necessitating the provision of sufficient vehicles, staging points, and routes for the rapid delivery of patients. To optimize the work of the ambulance service, it is advisable to consider these regional features when planning resources and preventive programs. A systemic problem with the classification of calls in most regions is an overestimation of urgency, which leads to an overload of ambulances. Our results show that despite the overall improvement in access to emergency medical services, persistent and clinically significant differences remain between urban and rural regions. Similar inequalities between urban and rural areas in pre-hospital care have been noted in other low- and middle-income countries. A systematic review showed that urban EMS consistently outperform rural ones in response time, pre-hospital care time, and transportation time, leading to higher survival rates for patients with cardiac arrest and injuries (10). These differences are particularly noticeable in low- and middle-income countries, where 88% of stroke deaths occur, and delays are caused by limited public awareness, socio-demographic factors, and insufficient healthcare infrastructure (11). Lack of transportation and trained staff are the main obstacles to community-based emergency care in low- and middle-income countries (12).

High-income countries usually use official level 2 EMS systems with professional rescuers, special vehicles, and modern equipment. As a first step towards developing an official EMS in these circumstances, WHO recommends tier 1 systems involving residents and non-professional rescuers.

High-income countries demonstrate advanced systems across multiple domains, with income level directly influencing implementation capabilities. In pharmacovigilance, all high-income countries are WHO PIDM members with robust drug safety systems, led by regulatory bodies like the food

and drug administration (FDA) and European medicines agency (EMA) (13). Mobile technologies offer promising solutions for coordinating the actions of non-professional rescuers and improving the development of emergency medical care in resource-limited settings (14,15). In addition, the analysis shows that in most regions of Kazakhstan, it is necessary to improve efforts to reduce mortality before the arrival of an ambulance and increase the success of intensive care. Regional differences in mortality require an analysis of logistics, equipment, and response times of ambulance stations. Community-acquired cardiac arrest is a significant public health concern, with survival rates in most communities typically ranging from 5 to 10%. However, they can reach 20% where the chain of survival is strong (16,17). Research shows that both the response time of emergency medical services and the quality of initial cardiopulmonary resuscitation significantly affect outcomes. In Croatia, the ambulance arrival time was shorter for survivors, and the results were better when primary care was performed by trained specialists rather than untrained witnesses (mortality rate 66.8% versus 83.8%) (18). The experience of England shows that, although ambulance services attempt to perform resuscitation in about 28,000 cases annually, the survival rate before discharge remains at only 7-8%, which underscores the need for systematic improvements throughout the survival chain (19). Globally, diseases caused by medical emergencies account for 50.7% of deaths and 41.5% of the disease burden. In contrast, in low-income countries, the burden of urgent diseases is 4.4 times higher than in high-income countries (20).

False calls represent another burden, with Iranian data showing unnecessary conversations comprising 52.4% of false requests, primarily attributed to insufficient public knowledge about EMS sensitivity (21). However, technological solutions show promise, with trauma dispatch algorithm software successfully reducing unnecessary EMS missions by 16% in Tehran (22), suggesting that systematic approaches can help mitigate inappropriate EMS utilization.

For antimicrobial resistance surveillance, only 7 out of 72 high-income countries have established national early warning systems (EWS), including Australia, Japan, France, Sweden, the UK, the US, and Canada, with systems established recently and varying widely in characteristics (23).

Thus, Kazakhstan's experience reflects both global trends and problems typical of post-Soviet healthcare systems in the region. Several measures at the system level can reduce these disparities. Strengthening emergency medical infrastructure in rural areas, investing in workforce redistribution, and improving paramedic training are critical steps. In addition, the introduction of technological innovations, such as triage using telemedicine and pilot mobile stroke units, can help bridge geographical gaps. These strategies are in line with international best practices and can be adapted to the conditions in Kazakhstan.

5. Limitations

A key strength of this study is its use of a comprehensive nationwide registry, which provides a rare opportunity to analyze emergency medical services at the population level in Central Asia. However, several limitations must be acknowledged.

6. Conclusion

The study results show significant regional differences in the burden on emergency medical services, the level of refusals, and false calls. The high intensity of calls in some regions requires increased resources and optimization of the service. At the same time, the development of remote consultation support without dispatching a team is a positive trend that helps to relieve the burden on emergency services.

7. Declarations

7.1. Acknowledgement

None.

7.2. Authors' contribution

GA and GK conceptualized the study. AB, AJ, and BU supervised and provided valuable insights into the conceptualization of the study and the manuscript. LA, ZD, and SM developed the manuscripts. GA and TA analyzed the data and presented results for the study. All authors approved the final manuscripts.

7.3. Conflict of interest

The authors declare no conflicts of interest.

7.4. Funding

None.

7.5. Ethics approval and consent to participate

The Bioethics Committee of the Kazakh Medical University 'KSPH' approved this study (IRB -A161 24.03.2022).

7.6. Availability of data and material

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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