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MORTALITY FROM CARDIOVASCULAR PATHOLOGIES DEPENDING ON SEISMOLOGICAL ACTIVITY IN ZAGATALA REGION OF AZERBAIJAN

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Recent studies provide evidence of a link between seismological and geophysical activity and an increase in the number of cardiovascular accidents. The purpose of the work was to study the dependence of cardiovascular diseases mortality on helioseismic indicators in the Zagatala region of the Azerbaijan. In 2013, seismological information was obtained from 35 telemetry stations. To analyze the connection with diseases in the Zagatala region, 401 case histories of patients who died in 2013 from various cardiovascular diseases were examined. Results of the study showed that the largest number of deaths was: from a hypertensive crisis – at the age of 80–89 years (37.8 %), from acute cerebrovascular accident – at the same age (33.3%), from acute coronary syndrome – at the age of 70–79 years (43.4 %) and from acute heart failure – at the age of 80–89 years (40.7 %). The largest number of deaths was in all age categories due to acute coronary syndrome. The maximum number of deaths was at a magnitude of 1.1–2.0 ml (35.4 %). Thus, the study of seismic activity in various seismogenic zones will improve the prevention of morbidity and mortality from CVD.

Key words: earthquake, magnitude, acute coronary syndrome, stroke, hypertensive crisis

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СМЕРТНІСТЬ ВІД КАРДІОВАСКУЛЯРНОЇ ПАТОЛОГІЇ ЗАЛЕЖНО ВІД СЕЙСМОЛОГІЧНОЇ АКТИВНОСТІ У ЗАГАТАЛЬСЬКОМУ РАЙОНІ АЗЕРБАЙДЖАНУ

Дослідження останніх років свідчать на користь зв'язку між сейсмологічною та геофізичною активністю та збільшенням числа серцево-судинних катастроф. Метою дослідження стало вивчення залежності смертності від серцево-судинних захворювань від геліо-сейсмічних показників у Загатальському районі Азербайджану. У 2013 році з 35 телеметричних станцій було отримано сейсмологічну інформацію. Для аналізу зв'язку із захворюваннями у Загатальському районі було розглянуто 401 історію хвороби хворих, які померли у 2013 році від кардіоваскулярних захворювань. Результати показали, що найбільша кількість смертей від гіпертонічного кризу була у віці 80–89 років (37,8 %), від гострого порушення мозкового кровообігу в цьому ж віці (33,3%), від гострого коронарного синдрому у віці 70–79 років. (43,4 %) та від гострої серцевої недостатності у віці 80–89 років (40,7 %). Найбільша кількість смертей була у всіх вікових категоріях від гострого коронарного синдрому. Максимальна кількість була за величиною магнітуди 1,1–2,0 мл (35,4 %). Таким чином, вивчення сейсмічної активності у різних сейсмогенних зонах дозволить удосконалити профілактику захворюваності та смертності від ССЗ.

Ключові слова: землетрус, магнітуда, гострий коронарний синдром, інсульт, гіпертонічний криз

The results accumulated by numerous studies convincingly prove the existence of a connection between the processes occurring on the Sun, fluctuations in the Earths, magnetic field and an increase in the number of cardiovascular accidents [1, 14, 15]. Myocardial infarctions that occur during geomagnetic disturbances are more severe and can be fatal [12].

A significant increase in the frequency of cardiac arrhythmias occurs mainly in the first – third days of the development of a magnetic storm. According to Gurfinkel YUI. (2014), cardiac arrhythmias develop on the first day after the onset of a magnetic storm, and within 5–3 days, the incidence of this type of pathology is significantly higher than in a quiet period [3]. Significant changes in the functional systems of the body (nervous, blood, immune, respiratory) during the period of increased solar activity have been noted by many authors [5, 8, 13].

It should be noted that in Azerbaijan the first place among cardiovascular diseases (CVD) is occupied by arterial hypertension (AH). Arterial hypertension is not only a medical and social, but also an economic problem. AH belongs to the risk factors for coronary heart disease, it is the cause of the development of vascular-dystrophic processes of internal organs, including cerebrovascular diseases, leading to acute disorders of cerebral circulation [2, 10, 11].

So far, some isolated studies have been carried out in cardiology, which made it possible to assess the influence of the seasons of the year, and geomagnetic disturbances on the mortality rates of the population from myocardial infarction and cerebral strokes [9].

The purpose of the study was to assess the dependence of mortality from cardiovascular diseases on helioseismic indicators in the Zagatala region of Azerbaijan.

Materials and methods. In 2013, seismological information was received from 35 telemetry stations, which included an overview of the seismic regime of the republic, the distribution of seismic waves, the dynamics of seismic processes, the intensity of the earthquake, the magnitude, etc. Also, at 9 geophysical and 5 geochemical stations, the strength of the geomagnetic field and the force of attraction were studied.

To analyze the fatal outcomes of diseases in the Zagatala region, 401 case histories of patients who died in 2013 from various diseases were studied. The causes of deaths, distribution by sex and age, and a relationship between death accidents and the magnitude of earthquakes, the depth of the epicentre and seismological activity by months were established. The obtained data were statistically processed using Statistica 12.0 for the Windows application package (Statsoft Inc., USA). The Kruskal-Wallis analysis of variance was used to compare three or more samples; the results were considered significant at $p<0.05$.

Results of the study and their discussion. According to seismological information which was received from 35 telemetry stations of Azerbaijan in 2013, (60 geomorphological zones were observed) in the first half of 2013, 1394 earthquakes were registered, the maximum magnitude was 5.1ml. The peak of the amplitude was in the southeastern slope of the Greater Caucasus, mainly in the Zagatala-Belokan and Shamakhi seismically active zones. In the second half of the year, activity continued in the same zones and the maximum of magnitude was 2.5 ml.

In the course of our study, the medical history of 401 patients were studied, of which 204 (50.9%) men and 197 women (49.1%). 9.2 % of patients died from a hypertensive crisis (of these 6.9 % of men and 11.7 % of women). From acute cerebrovascular accident died 12.7% of all patients (10.8% men and 14.7 % women). From acute coronary syndrome died 48.9 % (52.5 % of men and 45.1 % of women). From heart failure 26.9 % (26.0 % of men and 27.9 % of women). In almost all age categories statistically significant men died more than women (40–49 years – 69.2 %, 50-59 years – 82.9 %, 60–69 years – 58.6 %), but in 80–89 years group vice versa more women died (56.7 %). (table 1)

Table 1

Distribution of CVD deaths by cause, age and gender

			Age groups (years)										
			0–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99	>=100
Gender	male	Abs	2	0	0	1	9	29	30	76	55	2	0
		%	100.0	0.0	0.0	50.0	69.2	82.9	58.8	50.3	43.3	11.8	0.0
	female	Abs	0	2	0	1	4	6	21	75	72	15	1
		%	0.0	100.0	0.0	50.0	30.8	17.1	41.2	49.7	56.7	88.2	100.0
Deseases	Hypertensive crisis	Abs	0	0	0	0	0	2	7	13	14	1	0
		%	0.0	0.0	0.0	0.0	0.0	5.7	13.7	8.6	11.0	5.9	0.0
	Stroke	Abs	0	0	0	0	3	6	7	16	17	2	0
		%	0.0	0.0	0.0	0.0	23.1	17.1	13.7	10.6	13.4	11.8	0.0
	Acute coronary syndrome	Abs	0	2	0	1	4	20	27	85	49	7	1
		%	0.0	100.0	0.0	50.0	30.8	57.1	52.9	56.3	38.6	41.2	100.0
	Heart failure	Abs	1	0	0	1	5	7	9	34	44	7	0
		%	50.0	0.0	0.0	50.0	38.5	20.0	17.6	22.5	34.6	41.2	0.0
	Other	Abs	1	0	0	0	1	0	1	3	3	0	0
		%	50.0	0.0	0.0	0.0	7.7	0.0	2.0	2.0	2.4	0.0	0.0

Note: Abs- absolute number of patients

A comparative analysis of gender differences and deaths showed that in a hypertensive crisis, deaths among women amounted to 62.2 %, among men 37.8 %, in acute cerebrovascular accident 56.9 % and 43.1 %, respectively, in acute heart failure 50.9 % and 49.1 %, respectively. But, on the contrary, from acute coronary syndrome the death number were 54.6 % of men and 45.4 % of women.

The largest number of deaths from a hypertensive crisis was at the age of 80–89 years (37.8 %), from acute cerebrovascular accident was at the same age (33.3 %), from acute coronary syndrome was at the age of 70–79 years (43.4 %) and from acute heart failure was at the age of 80–89 years (40.7 %). The largest number of deaths in all age categories was due to acute coronary syndrome. At the age of 50–59 years it was 57.1 %, 60–69 years 52.9 %, 70–79 years 56.3 % and at the age of 80-89 – 38.6 %.

When studying deaths depending on months of the year, it was found that the highest percentage of deaths was in May 15 %, then – in December 13.5 %, November 11.5 % and January 10.7 %. Among men, the highest number of deaths was in February (83.3 %) and in January (55.8 %). Among women the highest number of deaths registered in March (62.5 %) and in July (62.2 %). 17.1 % of patients died from a hypertensive crisis in June, a large number of deaths was in March from acute cerebrovascular accidents (25.0 %). In February, 83.3 % of patients died from acute coronary syndrome and 40.0 % – died from heart failure in October.

Deaths, depending on the age group, were distributed in the following order: 70–79 years old 37.7 %, 80–89 years old 31.7 % and 60–69 years old 12.7 %.

The largest number of deaths at the age of 50–59 years was in March (37.5 %), at the age of 60–69 years there were more deaths in August (18.4%), at the age of 70–79 years – in February (66.7 %) and at the age of 80–89 – in July (51.4 %).

A comparative study of the influence of the depth gradation of the seismic process on gender differences showed that the majority of deaths were at a depth of the seismic process of 11–20 km (18.75 %), of which 56 % were men and 44% were women. Second place – when process depth was less than 10 km (15.55 %), of which 54.8 % were men and 45.2 % were women. When the seismic process deepened, the number of deaths gradually decreased; in particular, at a depth of 21–30 km it became 9.2 %, of which 59.5 % were women and 40.5 % were men. And more than 40 km–0.7 %, of which 66.7 % were women and 33.3 % were men.

When studying influence of the depth of the seismic process on deaths number of different CVD, it was determined that the largest percentage of mortality in all deep processes was from acute coronary syndrome (at a process depth of 21–30 km (51.4 %) and at 11–20 km (48.0 %)). The second place was occupied by acute heart failure (at a process depth of less than 10 km (33.9 %) and 21–30 km (29.7 %)). (table 2)

When analyzing the depth of the seismic process and the age of the dead, it was found that for all deep processes, the age of the dead corresponded to 70–79 years, but the highest was at 11–20 km.

Study of the dependence of deaths on the magnitude of earthquakes, showed that the maximum number was at a magnitude of 1.1–2.0 ml (35.4 %), then at a magnitude of 2.1–3.0 ml (6.5 %). Among men, the maximum number of deaths was at a magnitude of 2.1–3.0 ml (65.4 %), and among women 3.1–4.0 ml (100 %).

Depending on the deaths and magnitude of earthquakes, it was found that most deaths were from acute coronary syndrome with a magnitude of 0.1–1.0 ml (36.4 %), 1.1–2.0 ml (48.6 %) and 3.1–4.0 ml (75.0 %), and at a magnitude of 2.1–3.0 ml from acute heart failure (34.6 %). The maximum number of deaths was in the age range of 70–79 years, the maximum number of deaths was at a magnitude of 3.1–4.0 ml (50.0 %), then, as it decreases, at 2.1-3.0 ml (42.3 %), 1.1–2.0 (38.7 %), 0.1-1.0 – (36.4 %).

A comparative analysis of deaths from the nosology of diseases demonstrated that more deaths were from a hypertensive crisis at the age of 80–89 years (37.8 %), then at the age of 70–79 years (35.1 %). From acute cerebrovascular accident – also at the age of 80–89 years (33.3 %) and at the age of 70–79 years (31.4 %), from acute coronary syndrome – at the age of 70–79 years (43.4 %) and from acute heart failure at the age of 80–89 years (40.7 %).

Also in the study, we studied the influence of the Earths magnetic field strength on deaths from age, gender, and nosology of the disease. The magnitude unit is in nanotesla (nT) and varied from 6.8*105nT at the poles to 3*105nT at the equator. The spatio-temporal increase in the geomagnetic field strength made it possible to determine its compliance with the law of dependence on seismic activity.

The results of our study showed that at high magnetic intensity indicators of 49507 T, more deaths were from acute coronary syndrome and acute heart failure, at a magnitude of 49506 T – from acute cerebrovascular accident, and then at a hypertensive crisis (at a magnitude of 49503 T). With regard to

gender differences in death rates, in principle, no significant differences were observed, 204 deaths among men were at a magnitude of 49506 T and 197 among women at a magnitude of 49507 T.

Table 2

Distribution of CVD deaths by cause and depth of the seismic process

			Depth of the seismic process					
			no	<=10 km	11–20 km	21–30 km	31–40 km	>40 km
Gender	male	Abs	104	34	42	15	8	1
		%	50.2	54.8	56.0	40.5	47.1	33.3
	female	Abs	103	28	33	22	9	2
		%	49.8	45.2	44.0	59.5	52.9	66.7
Deseases	Hypertensive crisis	Abs	17	6	8	3	2	1
		%	8.2	9.7	10.7	8.1	11.8	33.3
	Stroke	Abs	24	10	12	4	1	0
		%	11.6	16.1	16.0	10.8	5.9	0.0
	Acute coronary syndrome	Abs	109	23	36	19	8	1
		%	52.7	37.1	48.0	51.4	47.1	33.3
	Heart failue	Abs	53	21	17	11	5	1
		%	25.6	33.9	22.7	29.7	29.4	33.3
	Other	Abs	4	2	2	0	1	0
		%	1.9	3.2	2.7	0.0	5.9	0.0
Age (years)	0–9	Abs	1	0	0	1	0	0
		%	0.5	0.0	0.0	2.7	0.0	0.0
	10–19	Abs	2	0	0	0	0	0
		%	1.0	0.0	0.0	0.0	0.0	0.0
	20–29	Abs	0	0	0	0	0	0
		%	0.0	0.0	0.0	0.0	0.0	0.0
	30–39	Abs	1	0	1	0	0	0
		%	0.5	0.0	1.3	0.0	0.0	0.0
	40–49	Abs	7	3	2	1	0	0
		%	3.4	4.8	2.7	2.7	0.0	0.0
	50–59	Abs	18	8	5	3	1	0
		%	8.7	12.9	6.7	8.1	5.9	0.0
	60–69	Abs	32	8	7	3	0	1
		%	15.5	12.9	9.3	8.1	0.0	33.3
	70–79	Abs	75	23	32	14	7	0
		%	36.2	37.1	42.7	37.8	41.2	0.0
	80–89	Abs	63	20	25	10	8	1
		%	30.4	32.3	33.3	27.0	47.1	33.3
	90–99	Abs	8	0	3	4	1	1
		%	3.9	0.0	4.0	10.8	5.9	33.3
	>= 100	Abs	0	0	0	1	0	0
		%	0.0	0.0	0.0	2.7	0.0	0.0

Note: Abs- absolute number of patients

Depending on age, at a magnitude of 49520 T, deaths were at the age of 10–19 years, at 49518 T in 0–9 years age group, then at 49509 T at 30–39 years, and at 49507 T at three age intervals: 60–69, 70–79, 80–89.

Our study found out different forms of CVD exacerbation in patient, depending on characteristics of earthquakes in Zagatala region of Republic of Azerbaijan. So, these results are very important to understanding the mechanisms of human reaction on seismic activity. In our study the main causative pathology of death from CVD is hypertension. The same data were demonstrated in some other studies. For example, one of the studies showed that individuals indicate increase in BP within some period after earthquakes. Authors proposed that through stimulating sympathetic nerve, earthquake leads to increase in heart rate and cardiac mortality [6].

The largest number of death was noted in our patients at the age of 80–89 from the hypertensive crisis. However, in Lin LY et al. research the increase of BP as a result of stimulation of sympathetic nerve system after earthquake in the individuals over 60 years of age, was blunt [11].

Data of study, carried out in New Zealand showed, that after two earthquakes, there was no increase observed in ventricular arrhythmia as a main cause of sudden death [7]. But in this study the dependence of CVD mortality on age, magnitude of earthquake and other important factors was not studied.

Some authors indicate the increase in blood pressure on winter mornings, particularly in the elderly [6]. The same results were characteristic for our patients: the high percentage of deaths was in December (13.5 %), November (11.5 %) and January (10.7 %). But the highest death rate in our study was registered in May (15 %)

The fact that the period following the earthquakes is characterized by increased mortality is confirmed not only by our study, but also by the data of authors from other regions. So, Shchuchinov LV (2011) proposes to consider the level of premature mortality in the Altai Republic (from 5.2 to 10.1 per 100 thousand population) as a non-specific indicator accompanying aftershock periods, since it was found in his work that in the period following due to increased seismic activity, an increase in premature mortality by 94.2 % is recorded [4].

Conclusions

1. The largest number of deaths from a hypertensive crisis was at the age of 80–89 years (37.8 %), from acute cerebrovascular accident was at the same age (33.3%), from acute coronary syndrome at the age of 70–79 years (43.4 %) and from acute heart failure at the age of 80–89 years (40.7 %).

2. The largest number of deaths in all age categories was due to acute coronary syndrome.The maximum number was at a magnitude of 1.1–2.0 ml (35.4 %). Among men, the maximum number of deaths was at a magnitude of 2.1–3.0 ml (65.4 %), among women at a magnitude of 3.1–4.0 ml (100%). Depending on the age and magnitude of earthquakes, the maximum number of deaths was in the age range of 70–79 years, the maximum number of deaths was at a magnitude of 3.1–4.0 ml (50.0 %).

3. Thus, the study of seismic activity in various seismogenic zones will make it possible to program a seismic forecast for a specific local zone, including the prevention of morbidity and mortality from CVD, and work to increase the populations resistance to geophysical and seismological fluctuations.

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