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VARIABILITY OF MORTALITY RISK DUE TO CEREBROVASCULAR DISEASES BY DAYS OF THE WEEK AND SEASONS IN AZERBAIJAN

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Information has been retrospectively collected on all medical death certificates in Azerbaijan for 2022, where the initial cause was indicated as cerebrovascular diseases (7052), which were distributed according to the days of death. All the characteristics of descriptive statistics were determined (average daily number of deaths, average error, mode, median, variance, standard deviation, kurtosis, asymmetry, minimum and maximum number of daily deaths, etc.). Attention is drawn to the complete coincidence of the mode and median (19), as well as their similarity to the average (19.4). At the same time, the interval between the maximum (48) and minimum (7) number of deaths was wide (41). The average daily number of deaths by day of the week ranged from 19.8 ± 0.88 (Wednesday) to 21.1 ± 0.88 (Monday). The difference between these values was statistically significant ($P=0.05$). In Azerbaijan, the average daily number of deaths directly from cerebrovascular diseases is 19.4 ± 0.34 , and it varies by day of the week, month, and season. The ranges of fluctuations in daily deaths (7–48), average daily deaths by week ($13.0 \pm 1.52 - 39.7 \pm 2.83$) and by month ($16.1 \pm 0.89 - 32.0 \pm 1.46$) are relatively wide, and by days of the week ($18.8 \pm 0.88 - 21.1 \pm 0.88$) and seasons ($17.4 \pm 0.42 - 24.8 \pm 0.91$) are relatively narrow.

Key words: mortality risk, season, week, variability, cerebrovascular disease.

Хатамзаде Е.М.

ВАРІАБІЛЬНІСТЬ РИЗИКУ СМЕРТНОСТІ ВІД ЦЕРЕБРОВАСКУЛЯРНИХ ЗАХВОРЮВАНЬ ЗАЛЕЖНО ВІД ДНЯ ТИЖНЯ ТА ПОРИ РОКУ В АЗЕРБАЙДЖАНІ

Ретроспективно зібрано інформацію про всі медичні свідоцтва про смерть в Азербайджані за 2022 рік, у яких як первинну причину вказано цереброваскулярні захворювання (7052), і розподілено її за днями констатації летального результату. Було визначено всі характеристики описової статистики (середньодобова кількість випадків смерті, середня похибка, мода, медіана, дисперсія, стандартне відхилення, ексцес, асиметрія, мінімальна та максимальна кількість добових випадків смерті тощо). Привертає увагу повний збіг моди та медіани (19), а також їхня схожість із середнім показником (19,4). При цьому інтервал між максимальною (48) та мінімальною (7) кількістю випадків смерті був широким (41). Середньодобова кількість смертей за днями тижня коливалася в діапазоні $19,8 \pm 0,88$ (середа) – $21,1 \pm 0,88$ (понеділок). Різниця між цими значеннями була статистично значущою ($P=0,05$). В Азербайджані середньодобова кількість смертей безпосередньо від цереброваскулярних захворювань становить $19,4 \pm 0,34$; вона змінюється залежно від дня тижня, місяця та пори року. Межі коливань щоденних випадків смерті (7–48), середньодобових випадків смерті за тижнями ($13,0 \pm 1,52 - 39,7 \pm 2,83$) та за місяцями ($16,1 \pm 0,89 - 32,0 \pm 1,46$) порівняно широкі, а за днями тижня ($18,8 \pm 0,88 - 21,1 \pm 0,88$) та сезонами року ($17,4 \pm 0,42 - 24,8 \pm 0,91$) порівняно вузькі.

Ключові слова: ризик смертності, сезон, тиждень, варіабельність, цереброваскулярні захворювання.

Seasonal variability in morbidity and mortality associated with cardiovascular diseases has long been observed, but in recent years it has attracted attention in many countries worldwide [7, 8]. Analyzing the main patterns of seasonal cardiovascular mortality, the authors emphasize its geographic and socio-

economic characteristics [11, 12, 15]. Cardiovascular diseases (CVDs) were the leading cause of disability-adjusted life years (DALYs) and deaths estimated in the GBD. As of 2023, there were 437 million (95 % UI: 401 to 465 million) CVD DALYs globally, a 1.4-fold increase from the number in 1990 of 320 million

(292 to 344 million). Ischemic heart disease, intracerebral hemorrhage, ischemic stroke, and hypertensive heart disease were the leading cardiovascular causes of DALYs in 2023 globally. As of 2023, age-standardized CVD DALY rates were highest in low and low-middle Socio-demographic Index (SDI) settings and lowest in high SDI settings. The number of CVD deaths increased globally from 13.1 million (95 % UI: 12.2 to 14.0 million) in 1990 to 19.2 million (95 % UI: 17.4 to 20.4 million) in 2023. The number of prevalent cases of CVD more than doubled since 1990, with 311 million (95 % UI: 294 to 333 million) prevalent cases of CVD in 1990 and 626 million (95 % UI: 591 to 672 million) prevalent cases in 2023 globally. A total of 79.6 % (95 % UI: 75.7 % to 82.5 %) of CVD burden is attributable to modifiable risk factors 347 million [95 % UI: 318 to 373 million] DALYs in 2023). Globally, high systolic blood pressure, dietary risks, high low-density lipoprotein cholesterol, and air pollution were the modifiable risks responsible for most attributable CVD burden in 2023 [8].

Researchers have revealed a tendency toward increased mortality from stroke during the winter-spring months of the year in urban settings [4, 13]. In Kinshasa, prolonged observation failed to demonstrate a significant effect of traditional seasons (dry and rainy seasons) and temperature on stroke incidence; however, a positive association was found between decreased precipitation and stroke incidence [9]. In large cities of China, it was found that a 1°C increase in temperature over 7 days was associated with a 0.6 % increase in mortality [14, 16]. In northern Spain, day-of-week variability in stroke mortality was identified, characterized by an increased risk on Sundays [16].

A multicenter cohort study showed that the proportion of stroke patients, when distributed by season of onset, was higher in summer and lower in winter [12]. In southern Poland, stroke was more frequently observed in winter and less frequently in summer [10]. Similar results were obtained in the USA [3, 7].

CVDs remain the leading cause of morbidity and mortality worldwide, with the greatest burden falling on regions with low and lower-middle income levels. Substantial differences between countries, even at similar levels of development, are largely explained by insufficient control of known risk factors [8].

By 2050, CVD mortality will reach 35.6 million deaths annually, while prevalence will be at 1.14 billion cases globally. Metabolic, environmental and behavioral determinants will be key drivers, varying across regions according to sociodemographic index. Age-standardized mortality rates will decline, but absolute numbers of people living with CVD will rise due to population growth, aging, and possibly also

improved access to care, especially in low-middle income countries. Prevention strategies, early detection and treatment, and better implementation of what is already known are necessary to address this burden [11].

In 2050, ischaemic heart disease will remain the leading cause of cardiovascular deaths (20 million deaths) while high systolic blood pressure will be the main cardiovascular risk factor driving mortality (18.9 million deaths). Central Europe, Eastern Europe, and Central Asia super-region is set to incur the highest age-standardized cardiovascular mortality rate in 2050 (305 deaths per 100 000 population) [2].

The pattern of variation in cerebrovascular disease mortality risk by day of the week, month, and season of the year is insufficiently covered in the literature.

The purpose of the study was to assess the variability of mortality risk due to cerebrovascular diseases by days of the week, months and seasons of the year in the conditions of the Republic of Azerbaijan.

Materials and methods. Information has been retrospectively collected on all medical death certificates in Azerbaijan for 2022, where the initial cause was indicated as cerebrovascular diseases (7052), which were distributed according to the days of death. All the characteristics of descriptive statistics were determined (average daily number of deaths, average error, mode, median, variance, standard deviation, kurtosis, asymmetry, minimum and maximum number of daily deaths, etc.). Such characteristics were determined for the average daily number of deaths by day of the week and by week for the whole year (52 weeks), months and seasons. The distribution of deaths by season took into account the spring, summer, autumn and winter equinoxes. Deaths from March 20 to June 20, from June 21 to September 22, from September 23 to December 20, and from December 21 to March 19 (inclusive) were included in the spring, summer, autumn, and winter periods of the year, respectively. The comparison of average daily deaths by day, week, month, and season was carried out using both paired and single-factor analysis of variance using the "data analysis" package of the Excel program. The critical value of the statistical significance of the difference was $P < 0.5$ [5].

Results of the study. Descriptive statistics of the average daily number of deaths due to cerebrovascular diseases in Azerbaijan during 2022 are presented as follows: the average daily number of deaths is 19.4, the kurtosis is 2.8, the average error is 0.34, the asymmetry is 1.03, the median is 19, the interval is 41, the mode is 19, the minimum number of cases is 7, the standard deviation is 6.39, the maximum The number of cases is 48, the variance is 40.83, and the annual number of deaths is 7052.

Attention is drawn to the complete coincidence of the mode and median (19), as well as their similarity to the average (19.4). At the same time, the interval between the maximum (48) and minimum (7) number of deaths was wide (41).

The average daily number of deaths due to cerebrovascular diseases by day of the week: Monday – 21.1 ± 0.88 ($p=0.05$), Tuesday – 19.4 ± 0.89 , Wednesday – 18.8 ± 0.88 ($p=0.05$), Thursday – 19.3 ± 1.02 , Friday – 18.9 ± 0.89 , Saturday – 19.1 ± 0.85 , Sunday – 19.0 ± 0.77 .

The average daily number of deaths by day of the week ranged from 19.8 ± 0.88 (Wednesday) to 21.1 ± 0.88 (Monday). The difference between these values was statistically significant ($P=0.05$).

A paired comparison of the indicators for the

remaining days of the week did not reveal a significant difference ($P>0.05$). The maximum average daily number of deaths was observed during the third week of February (February 14–20), which was 39.7 ± 2.83 and more than twice the daily average for the year (19.4 ± 0.34). The minimum average daily number of deaths (13.0 ± 1.52) was recorded in the first week (October 3–9) of October.

From the data in table 1, the randomness of the change in the average daily number of deaths is noteworthy. The average daily number of deaths in the 4 weeks of January fluctuated in a narrow range (22.3 ± 1.65 – 24.6 ± 1.65) and was significantly higher than the annual average daily number of deaths (19.4 ± 0.34).

Table 1

Average daily number of deaths due to cerebrovascular diseases by week in 2022

Date	Average daily number of deaths	Date	Average daily number of deaths
03.01–09.01	23.4 ± 1.02	04.07–10.07	17.4 ± 0.48
10.01–16.01	24.6 ± 1.81	11.07–17.07	19.6 ± 2.03
17.01–23.01	22.3 ± 1.65	18.07–24.07	21.6 ± 1.52
24.01–30.01	24.3 ± 1.12	25.07–31.07	16.3 ± 1.01
31.01–06.02	25.0 ± 2.67	01.08–07.08	17.0 ± 1.67
07.02–13.02	28.4 ± 1.28	08.08–14.08	13.9 ± 1.40
14.02–20.02	39.7 ± 2.83	15.08–21.08	17.4 ± 2.16
21.02–27.02	33.1 ± 0.93	22.08–28.08	17.9 ± 2.21
28.02–06.03	26.9 ± 2.72	29.08–04.09	16.7 ± 1.96
07.03–13.03	19.1 ± 1.84	05.09–11.09	14.9 ± 1.24
14.03–20.03	23.4 ± 1.06	12.09–18.09	17.3 ± 1.51
21.03–27.03	18.7 ± 1.64	19.09–25.09	19.0 ± 1.13
28.03–03.04	19.1 ± 0.96	26.09–02.10	17.3 ± 1.14
04.04–10.04	16.7 ± 1.51	03.10–09.10	13.0 ± 1.52
11.04–17.04	15.9 ± 2.77	10.10–16.10	18.0 ± 1.48
18.04–24.04	17.1 ± 1.20	17.10–23.10	17.0 ± 2.83
25.04–01.05	17.9 ± 0.91	24.10–30.10	16.1 ± 1.50
02.05–08.05	16.6 ± 1.37	31.10–06.11	16.0 ± 0.81
09.05–15.05	19.1 ± 1.22	07.11–13.11	18.7 ± 1.01
16.05–22.05	16.6 ± 1.90	14.11–20.11	20.6 ± 1.52
23.05–29.05	20.3 ± 0.84	21.11–27.11	18.4 ± 1.36
30.05–05.06	18.3 ± 1.79	28.11–04.12	15.9 ± 1.59
06.06–12.06	18.7 ± 1.30	05.12–11.12	17.4 ± 1.47
13.06–19.06	17.4 ± 1.41	12.12–18.12	19.0 ± 0.87
20.06–26.06	17.9 ± 1.29	19.12–25.12	15.9 ± 1.50
27.06–03.07	18.3 ± 2.18	26.12–01.01	18.1 ± 2.51

Since the first week of February, the indicator is expected to increase, which reaches its peak in the third week of February. In the future, the indicator decreases from March 21 (the first week of spring), until the end of the year, the average daily number of deaths is usually less than the average daily annual figure. During this period, the indicator mostly

changes chaotically, periodically its decrease becomes statistically significant (July 25–31, August 8–14, October 3–9).

The average daily number of deaths was the highest in February (32.0 ± 1.46). A significant decrease was observed in March (20.9 ± 0.88) and April (17.4 ± 0.82). The indicators in April – July

months fluctuate in a narrow range (17.4 ± 0.82 – 18.5 ± 0.73) and do not differ significantly from each other. A significant decrease in the average daily number of deaths was observed in August (16.2 ± 0.91). The indicator during the months of August and September does not differ significantly from each other (Table 2).

The average daily number of deaths in spring

(17.9 ± 0.41), summer (17.5 ± 0.47) and autumn (17.4 ± 0.42) is almost the same, only in winter the figure (24.8 ± 0.91) is significantly high. Thus, the daily number of deaths varies in a wide range (7–48), by days of the week the interval (18.8 ± 0.88 – 21.1 ± 0.88) of the average daily number of deaths narrows, and by weeks (13.0 ± 1.52 – 39.7 ± 2.83) and months (16.1 ± 0.89 – 32.0 ± 1.46) is significantly expanded.

Table 2

Average daily number of deaths due to cerebrovascular diseases in Azerbaijan by month and season

Periods of the year	Average	Standard error	Minimal	Maximum	Mode
January	24.5	0.81	15	38	23
February	32.0	1.46	16	48	29
March	20.9	0.88	13	35	19
April	17.4	0.82	3	24	18
May	18.0	0.66	9	25	15
June	18.4	0.76	11	28	18
July	18.5	0.73	11	28	18
August	16.2	0.91	9	29	19
September	17.6	0.63	9	23	16
October	16.1	0.89	7	27	13
November	18.5	0.67	12	29	19
December	16.3	0.75	7	25	16
Winter	24.8	0.91	3	28	23
Spring	17.9	0.41	3	25	18
Summer	17.5	0.47	9	29	19
Autumn	17.4	0.42	7	29	21

Discussion. The variability of mortality risk from cerebrovascular pathologies, described in the literature in various aspects [1, 15], is mainly confirmed in our study. However, there are differences on certain key issues. Firstly, our data do not confirm the winter and spring mortality increases noted by the authors [6]. In Azerbaijan, the risk of mortality from cerebrovascular diseases increases only in winter.

Secondly, the risk of mortality by day of the week in Azerbaijan (high risk on Tuesdays, the same risk on other days) differs from that in Spain [14], where the risk is high on Sundays.

Thirdly, the methodology of studying the variability of mortality risk from cerebrovascular diseases in our work allows us to obtain new data. It has been established that studying the variability of deaths by day, week, month, and season of the year makes it possible to identify patterns and trends in mortality dynamics. The indicator varies by day and month in a relatively wide range, and by days of the week, weeks and seasons in a relatively narrow range. The use of descriptive statistics to characterize the variability of mortality risk makes it possible to prove the significance of its fluctuations by days of the week, weeks of the month, weeks and months of the year.

Conclusions

1. In Azerbaijan, the average daily number of deaths directly from cerebrovascular diseases is 19.4 ± 0.34 , and it varies by day of the week, month, and season.

2. The ranges of fluctuations in daily deaths (7–48), average daily deaths by week (13.0 ± 1.52 – 39.7 ± 2.83) and by month (16.1 ± 0.89 – 32.0 ± 1.46) are relatively wide, and by days of the week (18.8 ± 0.88 – 21.1 ± 0.88) and seasons (17.4 ± 0.42 – 24.8 ± 0.91) are relatively narrow.

3. The state of the cardiovascular system can be improved by focusing on reducing differences in rates of cardiovascular diseases. Identifying patterns helps in the planning of the health system, for example, to optimize the work of the ambulance, planning preventive programs and resource allocation.

Prospects for further research. Future research will focus on developing practical and innovative health strategies to accelerate progress in the prevention and control of cardiovascular diseases at the national and global levels.

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