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Mortality from arterial hypertension in the regions of the Russian Federation in the period from 2013 to 2019

Aim	To analyze the dynamics of mortality from arterial hypertension (AH) between 2013 and 2019.
Material and methods	Arterial hypertension (AH) is one of the most common diseases. At the same time, there are no unified international criteria for establishing the primary cause of death from AH. Data were studied for the period between the end of the program for modernization of health care and the start of the Federal Project "Program for combatting cardiovascular diseases". Data for 2013-2019 by AH-related codes were provided by the Federal Service of State Statistics on request via the C15 form, "Mortality by gender and one-year age groups". A standardized mortality ratio, its mean value, standard deviation, and a coefficient of variation were determined for each "cause". The standardized mortality ratio was calculated using the European standard.
Results	In Russia during the studied period, the standardized mortality ratio for the death from AH yearly decreased (1.7 times for 6 years; the standardized mortality ratio decreased 1.15 times). However, only in 7 regions, the standardized mortality ratio yearly decreased while in the other regions of the Russian Federation, the standardized mortality ratio changed wavily. In 17 regions of the Russian Federation, the standardized mortality ratio increased in 2019 compared to 2013, including the 31.7 time increase in the Republic of North Ossetia-Alania. In the Penza Region and the Republic of Kalmykia in 2018, there were no cases of death related with AH. The highest value of the standardized mortality ratio was observed in the Chukotka Autonomous District in 2019 (85.13 per 100,000 population) and the lowest value was observed in the Penza Region (0.14 per 100,000 population). The ratio of maximal to minimal values of the standardized mortality ratio was 622. The coefficient of variation for regional standardized mortality ratios increased by 42.3% (from 86.8 to 123.5%).
Conclusion	Although the standardized mortality ratio for death from AH, in general, decreased in the Russian Federation, Russian regions showed variable dynamics and a high variability of the standardized mortality ratio. The study results together with results of international studies showed that differences in standardized mortality ratios for death from AH are largely due to different approaches to determining the primary cause of death. An international consensus on the terminology and criteria for determining the primary cause of death is required.

Keywords	Arterial hypertension; essential hypertension; mortality; primary cause of death
For citations	Samorodskaya I.V., Semenov V.Yu. Mortality from arterial hypertension in the regions of the Russian Federation in the period from 2013 to 2019. Kardiologiia. 2021;61(12):59–65. [Russian: Самородская И.В., Семенов В.Ю. Смертность от артериальной гипертензии в регионах Российской Федерации в период с 2013 г. по 2019 г. Кардиология. 2021;61(12):59–65]

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Introduction

Arterial hypertension (AH) is a recognized risk factor for cardiovascular death. In 2017, the analysis of data from 195 countries showed that the age-standardized prevalence of hypertension was 217.9 (95% uncertainty interval (UI) 184.1–254.1) per 100,000 people, which was 7.4% higher than in 1990. Age-standardized mortality rate was 12.3 (95% CI 9.0–13.2) per 100,000 people and decreased by 19.3% (95% CI –29.7 – –8.1) as compared with 1990 [1]. The prevalence of AH in different countries varies significantly depending on many reasons, including examination methods [2, 3]. AH mortality rates also vary significantly between different countries and regions of the Russian Federation.

The level of economic development of a country or a region, affecting the population's income level, is a significant factor. Standardized AH mortality rates in low-income countries are higher than in developed economies [4]. The prevalence of AH in middle-income European countries was 23.8% compared with 15.7% in high-income countries [5], higher in the Central and Eastern European countries than Southern and Northern Europe [6]. This situation is also typical of the Russian Federation, where AH is more common in the northern regions than in the south [7].

Objective

To analyze trends and regional differences in AH mortality (2013–2019).

Material and Methods

The study included data between the end of the most recent modernization of the healthcare system and the start of the federal project «Combating Cardiovascular Diseases» (2013–2019).

No data on deaths based on all four-digit codes of the International Classification of Diseases (ICD) are available to the public. The Russian Statistics Agency (Rosstat) generates statistics based on the primary cause of death stipulated in the medical certificate of death. It provides data upon request according to the Rosstat brief nomenclature of causes of death, in which some ICD codes are combined into one line. While the ICD-10 (and, thus, the Rosstat brief nomenclature of causes of death) does not include the term «arterial hypertension», it uses the term «hypertensive disease» Therefore, this (official) term was used in Table 1, while the clinical term «arterial hypertension» is used in the text of this article (to describe the results and discuss). The calculation was done using the Rosstat data on the mean annual population of the regions of the Russian Federation by annual age groups by sex and age and the number of deaths as in the C51 form «Deaths by sex and one-year age groups» in 2013–2019. The Rosstat brief nomenclature of causes of death contains the following terms and only three-digit ICD-10 codes related to AH (Table 1).

It is worth noting that the Rosstat brief nomenclature of causes of death does not include ICD- 10 code I15. 9 for Secondary hypertension. Since this code is not used as the primary cause of death, it is not used in the Rosstat brief nomenclature of causes of death.

The standardized mortality rate, its regional means, standard deviations, and coefficients of variation (CV) were determined for each «cause». The European Standard Population was used to calculate the standardized mortality rate. Calculations were made using the software suite «Calculation and analysis of mortality rates and years of life lost due to premature death in the Federal Subjects of the Russian Federation» developed at the Russian National Medical Research Center for Therapy and Preventive Medicine (state registration certificate No. 201666114 dated September 30, 2016).

Results

Table 2 shows the mean values and coefficients of variation of the standardized AH mortality rate for the period of interest.

As seen in Table 2, there was a significant decrease in the standardized AH mortality rate throughout the entire period of interest, which decreased 1.7-fold over six years. The total standardized mortality decreased only 1.15-fold in the Russian Federation in the same period. Thus, the contribution of AH to the total mortality of the population became even less significant (less than 1% of all-cause mortality). Moreover, attention is drawn not only to the significant coefficient of variation but also to its 1.4-fold growth in 2019 versus 2013, which was due to differences in the changes in the standardized AH mortality rate between Federal Subjects of the Russian Federation and throughout the study period in the same Subject of the Russian Federation (Table 3).

As shown in Table 3, unlike the Russian mean rates, the standardized AH mortality rate in most Federal Subjects of Russia changed in a wave-like manner during the period of interest. The most significant decrease in the standardized mortality rate in 2019 compared to 2013 was observed in Irkutsk Oblast, Orenburg Oblast, Kursk Oblast, Vladimir

Table 1. ICD codes used in the Rosstat brief nomenclature of causes of death

Designation	ICD code
Hypertensive heart disease	I11
Hypertensive renal disease	I12
Hypertensive heart and renal disease	I13
Essential (primary) hypertension	I10
Hypertensive encephalopathy	I67.4

ICD, international classification of diseases.

Table 2. Standardized AH mortality rate in 2013-2019

Parameter	2013	2014	2015	2016	2017	2018	2019
AH SMR	15.11	13.00	11.90	11.09	9.80	9.15	8.76
Coefficient of variation,%	86.8	105.5	105.3	126.8	108.1	108.8	123.5
% of all causes	1.41	1.25	1.14	1.10	1.03	0.96	0.94
SMR, all causes	1068.03	1041.29	1040.59	1012.59	952.25	952.82	928.33

SMR, standardized mortality rate.

ISSN 0022-9040. Kardiologiia. 2021;61(12). DOI: 10.18087/cardio.2021.12.n1643

Table 3. Trends of standardized AH mortality rates in the Federal Subjects of the Russian Federation

Federal subject	2013	2014	2015	2016	2017	2018	2019	2014 / 13	2015 / 14	2016 / 15	2017 / 16	2018 / 17	2019 / 18	2019 / 2013
Chuvash Republic	57.64	18.82	15.38	10.4	6.62	7.19	4.53	–38.83	–3.44	–4.98	–3.78	0.56	–2.66	–53.12
Republic of Chechnya	79.35	92.97	99.03	142.03	49.93	48.85	29.05	13.62	6.06	43	–92.1	–1.08	–19.8	–50.3
Republic of Mari El	50.55	16.49	13.32	9.74	9.83	3.13	3.45	–34.06	–3.17	–3.58	0.09	–6.7	0.32	–47.1
Republic of Mordovia	49.48	8.29	5.62	5.77	4.58	5.13	7.06	–41.19	–2.67	0.16	–1.2	0.56	1.92	–42.42
Magadan Oblast	56.25	13.55	14.1	8.79	19.47	24.84	14.6	–42.7	0.55	–5.3	10.67	5.38	–10.25	–41.66
Republic of Karelia	57.47	60.02	45.12	29.92	27.85	25.29	24.68	2.55	–14.9	–15.19	–2.07	–2.55	–0.62	–32.79
Stavropol Krai	34.74	26.6	16.15	10.4	7.33	6.62	3.37	–8.14	–10.45	–5.75	–3.07	–0.71	–3.25	–31.37
Kabardino-Balkarian Republic	51.94	37.83	23.42	14.52	11.27	11.95	24.53	–14.11	–14.41	–8.89	–3.25	0.68	12.57	–27.41
Vladimir Oblast	32.62	23.87	17.85	13.64	13.09	9.39	6.24	–8.75	–6.02	–4.21	–0.55	–3.7	–3.14	–26.37
Kursk Oblast	33.59	29.43	25.7	19.44	12.25	12.1	8.23	–4.16	–3.73	–6.26	–7.18	–0.15	–3.87	–25.36
Republic of Kalmykia	26.84	14.16	1.79	1.04	0.81	0	1.73	–12.68	–12.37	–0.75	–0.24	–0.81	1.73	–25.11
Orenburg Oblast	38.35	23.15	19.43	16.47	16.57	15.94	13.73	–15.2	–3.72	–2.97	0.1	–0.62	–2.22	–24.62
Irkutsk Oblast	30.26	19.75	19.17	18.39	12.21	7.65	7.25	–10.51	–0.57	–0.79	–6.18	–4.56	–0.4	–23
Kamchatka Oblast	58.85	72.42	59.36	43.83	29.05	38.11	41.84	13.58	–13.06	–15.53	–14.78	9.06	3.73	–17.01
Altai Republic	33.44	14.92	19.82	18.67	15.77	24.5	16.52	–18.52	4.9	–1.15	–2.9	8.73	–7.98	–16.93
Udmurt Republic	19.14	23.25	22.21	18.76	17.64	6.42	4.12	4.11	–1.05	–3.45	–1.12	–11.22	–2.3	–15.02
Krasnodar Krai	18.8	15.05	11.07	11.94	7.83	5.77	3.86	–3.75	–3.98	0.87	–4.11	–2.06	–1.91	–14.95
Republic of Tatarstan	37	34.48	30.46	28.5	25.79	25	22.15	–2.52	–4.02	–1.95	–2.71	–0.79	–2.84	–14.85
Perm Oblast	17.66	9.33	5.95	6.39	7.05	4.7	3.01	–8.32	–3.38	0.44	0.66	–2.34	–1.7	–14.65
Yaroslavl Oblast	29.04	23.99	20.19	18.13	14.19	15.76	14.53	–5.05	–3.8	–2.05	–3.95	1.57	–1.23	–14.51
Jewish Autonomous Okrug	28.2	33.18	44.57	30.47	20.99	22.79	14.13	4.99	11.38	–14.1	–9.48	1.8	–8.66	–14.06
Khabarovsk Krai	20.68	15.19	17.92	17.7	12.96	7.81	8.22	–5.49	2.73	–0.22	–4.74	–5.14	0.41	–12.45
Tyumen Oblast	19.45	17.47	19.55	22.29	19.72	12.77	7.77	–1.99	2.09	2.73	–2.57	–6.94	–5.01	–11.69
Pskov Oblast	16.32	9.78	7.5	6.27	5.52	6.13	4.76	–6.53	–2.29	–1.23	–0.74	0.61	–1.38	–11.56
Kemerovo Oblast	22.37	21.69	19.71	14.32	14.67	17.2	12.24	–0.67	–1.99	–5.39	0.35	2.54	–4.96	–10.12
Voronezh Oblast	12.39	18.51	11.04	5.92	7.58	5.32	2.5	6.12	–7.47	–5.12	1.66	–2.26	–2.82	–9.89
Murmansk Oblast	13.84	3.3	9.05	9.29	5.94	5.16	4.76	–10.54	5.75	0.24	–3.35	–0.77	–0.41	–9.08
Moscow Oblast	14.67	10.94	10.4	11.45	10.21	6.63	5.94	–3.73	–0.54	1.05	–1.24	–3.58	–0.69	–8.73
Tver Oblast	19.41	15.84	11.32	13.34	15.05	13.12	10.78	–3.57	–4.52	2.02	1.7	–1.92	–2.34	–8.63
Arkhangelsk Oblast	13.98	12.35	11.08	11.75	7.88	6.18	5.55	–1.62	–1.28	0.68	–3.88	–1.7	–0.63	–8.43
Nizhniy Novgorod Oblast	26.67	28.61	31.83	30.8	28.25	22.17	18.81	1.94	3.22	–1.03	–2.55	–6.07	–3.36	–7.87
Sverdlovsk Oblast	8.04	5.35	3.78	3.47	2.37	1.41	1.39	–2.68	–1.57	–0.31	–1.1	–0.96	–0.02	–6.64
Samara Oblast	7.4	5.21	4.31	1.98	1.23	1.11	1.1	–2.19	–0.9	–2.33	–0.75	–0.12	–0.02	–6.3
Novgorod Oblast	15.59	10.26	6.93	7.62	8.74	7.17	9.38	–5.33	–3.33	0.69	1.12	–1.57	2.21	–6.21
Kostroma Oblast	21.44	21.17	20.12	15.47	15.27	18.82	15.37	–0.27	–1.06	–4.65	–0.19	3.54	–3.45	–6.07
Omsk Oblast	13.94	16.65	19.58	17.93	10.07	10.74	8.3	2.7	2.93	–1.65	–7.86	0.67	–2.44	–5.64
Republic of Tuva	8.93	8	4.12	5.89	2.99	2.43	3.48	–0.93	–3.88	1.76	–2.89	–0.56	1.05	–5.45
Astrakhan Oblast	5.48	3.24	1.04	1.26	0.82	0.5	0.54	–2.24	–2.19	0.22	–0.44	–0.31	0.04	–4.93
Lipetsk Oblast	8.84	9.29	5.92	6.64	2.74	5.67	4.04	0.45	–3.37	0.72	–3.9	2.93	–1.63	–4.79
Kaliningrad Oblast	8.62	6.64	8.23	7.08	4.8	5.94	3.85	–1.98	1.59	–1.14	–2.28	1.14	–2.1	–4.77
Republic of Bashkortostan	10.62	9.09	7.92	8.2	8.39	7.95	6.14	–1.53	–1.16	0.28	0.19	–0.45	–1.81	–4.48

Table 3 (continuation). Trends of standardized AH mortality rates in the Federal Subjects of the Russian Federation

Federal subject	2013	2014	2015	2016	2017	2018	2019	2014 / 13	2015 / 14	2016 / 15	2017 / 16	2018 / 17	2019 / 18	2019 / 2013
Volgograd Oblast	5.57	4.74	1.66	1.77	1.38	0.94	1.18	-0.83	-3.08	0.1	-0.38	-0.44	0.23	-4.4
Tambov Oblast	7.79	7.58	5.64	5.89	5.22	3.6	3.56	-0.22	-1.94	0.25	-0.67	-1.62	-0.04	-4.24
Tomsk Oblast	8.03	4.14	7.54	4.69	3.89	2.85	3.95	-3.89	3.4	-2.85	-0.8	-1.05	1.11	-4.08
Novosibirsk Oblast	7.63	8.81	6.13	4.09	3.2	3.31	3.61	1.19	-2.68	-2.04	-0.9	0.11	0.3	-4.02
Ryazan Oblast	4.94	3.38	2.24	1.29	0.96	1.5	1.09	-1.56	-1.14	-0.94	-0.34	0.54	-0.41	-3.86
Altai Krai	10.63	11.4	9.42	9.34	4.6	5.19	7.01	0.77	-1.98	-0.08	-4.74	0.59	1.82	-3.62
Amur Oblast	6.78	6.37	5.71	3.29	3.09	7.94	3.17	-0.4	-0.66	-2.42	-0.2	4.85	-4.77	-3.6
Sakhalin Oblast	7.78	9.64	6.21	7.38	2.81	2.69	4.46	1.86	-3.43	1.17	-4.57	-0.12	1.76	-3.32
Komi Republic	18.55	18.37	18.55	17.34	17.1	14.25	15.37	-0.19	0.19	-1.22	-0.23	-2.86	1.12	-3.18
Republic of Dagestan	8.76	7.56	8.02	6.1	4.3	3.81	6.25	-1.2	0.46	-1.91	-1.81	-0.49	2.45	-2.5
Republic of Buryatia	3.07	2.86	0.58	0.8	0.84	0.49	0.87	-0.21	-2.28	0.22	0.05	-0.36	0.38	-2.2
Zabaykalsky Krai	10.78	8.33	14.26	18.59	16.2	8.8	8.67	-2.44	5.93	4.32	-2.38	-7.4	-0.14	-2.11
Belgorod Oblast	5.05	3.84	4.19	3.19	2.7	2.73	3.21	-1.22	0.35	-1	-0.49	0.03	0.47	-1.85
Republic of Khakassia	20.1	11.56	16.96	18.24	26.85	22.71	18.26	-8.54	5.41	1.27	8.61	-4.15	-4.45	-1.84
Ulyanovsk Oblast	5.87	3.8	6.9	17.43	11.51	7.6	4.32	-2.08	3.11	10.52	-5.91	-3.91	-3.28	-1.55
Kirov Oblast	1.73	2.99	1.44	1.34	1.57	1.7	1.09	1.25	-1.55	-0.1	0.23	0.13	-0.61	-0.64
Tula Oblast	1.03	0.42	0.57	0.48	0.52	0.24	0.54	-0.61	0.15	-0.09	0.04	-0.29	0.3	-0.49
Republic of Adygea	28.51	21.76	23.49	19.01	21.86	23.32	28.02	-6.74	1.73	-4.48	2.85	1.46	4.7	-0.48
Penza Oblast	0.5	0.37	0.23	0	0.11	0	0.14	-0.13	-0.14	-0.23	0.11	-0.11	0.14	-0.36
Smolensk Oblast	2.47	2.85	2.58	3.57	4.97	1.9	2.22	0.38	-0.27	0.99	1.4	-3.07	0.32	-0.26
Saratov Oblast	1.23	2.06	1.47	1.33	2.09	1.88	1.06	0.83	-0.59	-0.14	0.76	-0.21	-0.82	-0.17
Ivanovo Oblast	1.7	1.56	1.56	1.16	2.61	2.98	1.68	-0.14	0	-0.4	1.45	0.37	-1.3	-0.01
Bryansk Oblast	17.4	23.32	21.06	18.04	17.67	20.53	17.86	5.92	-2.26	-3.02	-0.37	2.86	-2.67	0.46
Leningrad Oblast	12.52	12.94	11.09	8.73	8.72	12.38	12.99	0.42	-1.85	-2.37	-0.01	3.66	0.61	0.47
Saint Petersburg	2.16	2.24	2.1	1.65	1.6	2.36	2.66	0.09	-0.15	-0.45	-0.04	0.75	0.31	0.51
Primorsky Krai	16.29	18.05	14.64	16.12	13.26	13.24	16.9	1.75	-3.41	1.49	-2.86	-0.02	3.66	0.61
Moscow	8.14	8.48	7.91	6.68	8	6.91	8.87	0.35	-0.57	-1.23	1.32	-1.09	1.96	0.74
Republic of Crimea	–	–	1.79	2.9	2.07	1.65	1.67	0	1.79	1.1	-0.83	-0.42	0.02	1.67
Kaluga Oblast	2.67	2.52	3.85	6.3	4.79	5.54	4.63	-0.15	1.34	2.45	-1.51	0.75	-0.91	1.96
Kurgan Oblast	29.39	27.71	28.11	36.13	30.63	33.67	32.22	-1.68	0.4	8.03	-5.5	3.04	-1.45	2.83
Rostov Oblast	15.31	15.17	16.89	16.12	15.35	15.77	18.38	-0.13	1.72	-0.77	-0.77	0.42	2.61	3.08
Krasnoyarsk Krai	5.99	9.67	6.66	10.05	13.93	12.05	10.3	3.68	-3.01	3.39	3.88	-1.88	-1.75	4.31
Vologda Oblast	3.48	4.3	2.93	2.87	2.93	4.14	8.95	0.82	-1.37	-0.06	0.06	1.22	4.81	5.47
Republic of Ingushetia	14.43	36.81	31.88	29.23	27.9	24.97	22.82	22.38	-4.93	-2.65	-1.33	-2.93	-2.14	8.4
Chelyabinsk Oblast	15.72	19.82	29.77	22.98	21.89	25.29	24.57	4.1	9.96	-6.79	-1.09	3.4	-0.73	8.85
Republic of Sakha (Yakutia)	14.05	11.32	23.06	23.09	15.65	22.72	24.12	-2.73	11.74	0.04	-7.44	7.07	1.4	10.07
Orel Oblast	15.4	16.39	20.55	23.94	31.18	39.06	31.54	0.99	4.17	3.39	7.24	7.88	-7.52	16.14
Sevastopol	–	–	1.75	0.59	0.31	1.41	30.89	0	1.75	-1.16	-0.28	1.1	29.48	30.89
Karachaevo-Cherkess Republic	33.51	68.51	57.93	47.6	54.86	66.7	71.96	35	-10.57	-10.34	7.26	11.84	5.26	38.45
Republic of North Ossetia-Alania	1.97	1.93	3.69	4.82	14.07	47.04	62.38	-0.03	1.75	1.13	9.25	32.98	15.34	60.41
Chukotka Autonomous Okrug	12.42	84.98	12.9	19.6	86.57	57.85	85.13	72.56	-72.08	6.7	66.97	-28.72	27.28	72.7

ISSN 0022-9040. Kardiologiia. 2021;61(12). DOI: 10.18087/cardio.2021.12.n1643

Oblast, Magadan Oblast, the Republic of Kalmykia, the Kabardino-Balkarian Republic, the Republic of Karelia, the Republic of Mordovia, the Republic of Mari El, the Chechen Republic, the Chuvash Republic, and Stavropol Krai. The annual decrease in the standardized mortality rate was achieved in only seven regions (Samara Oblast, Sverdlovsk Oblast, Irkutsk Oblast, Kursk Oblast, Vladimir Oblast, the Republic of Tatarstan, Stavropol Krai).

The standardized AH mortality rate increased in 2019 compared to 2013 in 17 subjects of the Russian Federation (Bryansk Oblast, Vologda Oblast, Kaluga Oblast, Kurgan Oblast, Leningrad Oblast, Orlov Oblast, Rostov Oblast, Chelyabinsk Oblast, the Republic of Ingushetia, the Karachaevo-Cherkess Republic, the Republic of North Ossetia-Alania, the Republic of Sakha (Yakutia), Krasnoyarsk Krai, Primorsky Krai, Moscow, St. Petersburg, the Chukotka Autonomous Okrug), including a more than 2-fold increase in Vologda Oblast, Orel Oblast, Chukotka Autonomous Okrug, and a 31.7-fold in the Republic of North Ossetia-Alania. In Sevastopol, the standardized mortality rate increased by 17.7 times compared to 2015 (the first year of official reporting).

The changes were also significant in terms of absolute values. For example, 17 people died of AH in the Republic of North Ossetia-Alania in 2013, while 611 people died in 2019. This was in complete contrast to corresponding figures for the Republic of Mari El, which were 428 and 31, respectively. It is noteworthy that there were no deaths related to AH in Penza Oblast or the Republic of Kalmykia in 2018.

In 2019, the maximum standardized mortality rates were registered in the Chukotka Autonomous Okrug (85.13 per 100,000 people), the Karachaevo-Cherkess Republic (71.96 per 100,000 people), and the Republic of North Ossetia-Alania (62.38 per 100,000 people). The minimum standardized mortality rates were reported in Astrakhan Oblast (0.54 per 100,000 people), Tula Oblast (0.53 per 100,000 people) and Penza Oblast (0.14 per 100,000 people). Thus, the ratio of the maximum standardized five-cause mortality rate to the minimum rate was 622.

Discussion

Although AH is a known risk factor for cardiovascular death [8, 9], little is known about how often AH is the primary cause of death. The presented findings show significant interregional and intraregional differences in indicating AH as the primary cause of death over time: the year-to-year changes cannot be explained in terms of AH prevention and treatment measures. AH is not an acute infectious disease in which significant mortality fluctuations are possible due to epidemics. Moreover, the role of AH as a cause of death is minimal in the Russian Federation. However, according to the WHO, hypertensive heart disease (AH) was the seventh leading cause of death in above-average income countries and the ninth leading cause in high per capita income countries in 2019 (it was the eighteenth leading cause of death in these countries in 2000) [10]. It remains unclear what method was used to determine the leading causes of death and whether the term «leading cause of death» is synonymous with the term «primary cause of death».

According to the Centers for Disease Control and Prevention (CDC), based on death certificates for 1999–2016, AH mortality increased in the United States by 36.4%, with a mean annual change of 1.8% in ≥35-year-old people; between 2011 and 2016, there was a marked acceleration of 2.7% per year [11]. In the CDC statistics, the ICD code I11 is listed not simply as hypertensive heart disease, as in the Rosstat brief nomenclature of causes of death, but as hypertensive disease with congestive heart failure; these account for 50% of mortality under codes associated with AH (as the primary cause of death). Interestingly, atrial fibrillation, heart failure, diabetes mellitus, obesity, vascular dementia, chronic obstructive pulmonary disease, Alzheimer's disease, and Parkinson's disease are reported as contributing causes of death. In 2019, according to the CDC, the analyzed five-cause mortality was 3.9% of all deaths or 31.1 per 100,000 people (non-standardized indicator) [12], which is three times higher than in the Russian Federation. The combined standardized mortality rate under the five codes of interest (as the primary cause of death) ranged from 9.8 to 15.7 per 100,000 people or 0.9–1.6% of the standardized all-cause mortality rate in different regions of Great Britain in 2019 [13]. Thus, a proper analysis of AH mortality is hindered by the varying approaches to selecting the primary cause of death and ICD-10 code [9].

It should be noted that this situation has been ongoing on for decades not only in the Russian Federation. Analyzing AH mortality in Taiwan, T-H. Lu (2001) noted a clear imbalance between AH prevalence and mortality [14]. The author pointed to differences in the procedure of data collecting on causes of death in different countries, differences in the approaches to determining the cause of death and interpreting causal relationship, as well as the imprecise and ambiguous rules for selecting the primary cause of death based on the ICD rules.

Postmortem examinations are currently not used in many countries as standard procedures to clarify the cause of death. Moreover, there are no worldwide agreed criteria for establishing AH as the primary cause of death in postmortem examinations. For example, the guideline on selecting and coding causes of death of the Moscow Department of Health states that differential postmortem diagnosis of «Other forms of chronic ischemic heart disease» (I25.8) and «Hypertensive heart disease» (I11. – I13.) is very challenging [15]. This is confirmed by the Brazilian trial. Researchers performed autopsies of 356 people at the age of >50 years who died of natural causes according to medical records and had a history of AH, as well as interviewing physicians and relatives of the deceased. According to autopsies, AH was the primary cause of death in 25.6% of cases. The article does not describe the criteria for establishing AH as the primary cause of death in postmortem examinations. According to the data presented in the article, virtually all patients with AH had a combined pathology; thus, it is unclear why AH was established as the primary cause of death [16].

It should be noted that there is still no common approach between different professional medical communities and academic schools to the role of AH as the cause of death, i.e., when AH is a risk factor or a factor contributing to death, and when it is the primary cause of death.

Conclusion

The standardized mortality rate associated with hypertensive disease and listed as the original cause according to ICD-10 codes is generally decreasing in the Russian Federation. However, a consistent annual decrease in the standardized mortality rate for these causes is observed in only seven regions, while wave-like trends in the standardized mortality rate are seen in other regions; moreover, the coefficient of variation of the regional standardized mortality rates increased significantly in 2019 compared to 2013. Our findings and the data of foreign trials showed that differences in the standardized arterial hypertension mortality rates are due mainly to different approaches to determining the primary cause of death. Thus, it remains impossible to determine in which cases AH (ICD-10 uses the term «hypertensive disease») is the primary cause of death and in which cases competing diseases such variability is likely to be due to different approaches to determining the primary cause of death rather than differences in AH mortality rates. In order to be able to do this, international harmonization of terminology and criteria for determining the primary cause of death due to AH is required.

No conflict of interest is reported.

The article was received on 30/03/2021

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