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Trends in amenable mortality rate in the Mongolian population, 2007–2014

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ABSTRACT

Amenable mortality (AM) is an indicator of medical care quality. This study aimed to assess the trend and magnitude of AM in Mongolia, with the purpose of providing evidence for decisions on resource allocation. This is the first study on AM trends in Mongolia. Retrospective analysis was done on mortality statistics for the period 2007–2014. Causes of death were coded according to the 10th revision of the International Classification of Diseases (ICD-10). Nolte & McKee's classification of AM was used for the estimation of amenable mortality rates (AMRs) in Mongolia. During the study period, a total of 130,402 deaths were registered in Mongolia, of which 44,800 (34.4%) deaths were classified as being amenable. The age-standardized AMR per 100,000 population was highest in 2007 (226.6), and declined continuously until the level of 169.2 in 2014. The rate remained consistently higher in males than in females. Cerebrovascular diseases, ischemic heart diseases, perinatal deaths, influenza/pneumonia/asthma and tuberculosis were the leading causes of AM in the past eight years in Mongolia. The AMR was higher in remote western provinces with harsh weather conditions, high poverty rates, lack of human resources for health, and poor infrastructure. In addition, the provinces where Mongolia's ethnic minorities live tended to have a higher AMR. The government of Mongolia needs to critically look at the regional differences in AM in order to allocate health resources, including human resources, effectively. Further studies are needed to look into the causes of regional disparities in AM, individual-level risk factors to amenable deaths, and validity of death coding in health sector.

Key Words: amenable mortality, non-communicable diseases, perinatal deaths, tuberculosis, Mongolia

INTRODUCTION

Amenable mortality (AM) is mortality that can be avoided if effective healthcare is provided in a timely manner. The concept of AM finds its origin in the evolution of the concept of avoidable mortality, developed in the 1960s. Avoidable mortality was developed as an indicator of the quality of medical care by a group of researchers from Harvard University.[1)] It has two dimensions: preventable mortality, which can be avoided through primary prevention of its causes (i.e. preventing lung cancer deaths through tobacco control measures), and AM, which can be avoided through the provision of effective and timely medical care (i.e. preventing cervical cancer

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deaths through early detection and effective treatment). However, at that time the concept did not receive much attention, and had been abandoned until the work of Nolte and McKee,[2] and Tobias and Yeh.[3] They developed lists of causes of deaths amenable to healthcare, which could be adopted for international comparison of results. Since then, the research methodology on AM has greatly advanced, and currently studies of time-trends as well as of geographical and socioeconomic variation in mortality within and between countries are becoming increasingly available in both industrialized and developing countries.[4-6]

AM is also an indicator for measuring the performance of healthcare providers. Since the overwhelming share of healthcare money is spent on medical services, the interest in developing reliable indicators for the assessment of the quality of medical care is understandable. Therefore, the concept of AM is increasingly catching the attention of researchers and healthcare policymakers.[7] Much of the work on AM has been done in developed countries. Its use in developed countries has demonstrated that the potential of AM as an indicator of healthcare system effectiveness is high, especially for the purposes of cross-country or within country comparisons.[4] According to a study of AM in the 31 countries of the Organization for Economic Cooperation and Development (OECD), age-standardized AMRs in 2007 ranged from 60 to 200 deaths per 100,000 population. Japan, France, Italy, Sweden and Iceland had the lowest rate (60–70 per 100,000), while the United States had a higher rate (above 124 per 100,000) than the other developed nations.[4]

Mongolia is located in the heart of Central Asia covering a territory of 1,566,500 square kilometres, land locked between China and the Russian Federation. The country's total population was estimated to be 3.0 million in 2015. Mongolia is the least densely populated country in the world with an overall population density of 1.7 persons per square kilometer. The sparse distribution of the population makes it challenging to deliver social services, including healthcare and education, to rural and remote areas, especially to herders who lead nomadic lifestyles. The distribution also makes it difficult and inefficient to maintain the quality of specialist care facilities and qualified human resources in the countryside. The situation is further aggravated by reduced income-generating opportunities in the countryside, which hinders the achievement of Mongolian national health targets. Mongolia has been undergoing drastic changes in the health sector for the past two and a half decades. The healthcare sector is struggling to improve the effectiveness of health services while ensuring the efficient use of scarce resources.[8] The struggle is ever more challenging with the demographic and epidemiological transition the country is currently experiencing. Non-communicable diseases (NCDs) depending on lifestyle and behaviours, such as injuries, diseases of circulatory system, digestive system, respiratory system, and cancers, have become the leading causes of mortality, with about 90% of deaths in adults. The crude death rate in Mongolia was 556.7 per 100,000 population in 2014.[9] Effective medical care has even been shown to reduce the well-known gap between male and female premature mortality, as demonstrated by the fact that the differences in gender-specific mortality rates are much higher in countries with high versus low AMRs.[4]

The current study has been formulated to assess the trend and magnitude of AM in Mongolia with the purpose of providing evidence for decisions on resource allocation. This is the first study on AM trends in Mongolia, aimed at (1) calculating age-standardized AMRs per 100,000 population, (2) identifying leading causes of AM, (3) comparing geographical distribution of age-standardized AMRs throughout the country, and (4) assessing factors that could potentially influence the magnitude of AM.

MATERIALS AND METHODS

Data Source

National population and mortality statistics for the period 2007–2014 from the Health Statistics Office of the Ministry of Health of Mongolia were utilized in this study. Causes of death were coded according to the 10th revision of the International Classification of Diseases (ICD-10). Population and mortality data were classified by age, gender and place of residence.

Selection of causes of death

Nolte and McKee's classification of AM was used for the estimation of AMRs in Mongolia.[2] The upper age limit for causes of AM was selected as 74 years in accordance with the international classification of AM causes. We had data on 32 of 33 causes of death considered as amenable to health care due to Nolte and McKee's classification (Table 1). Misadventures to patients during surgical and medical care were not coded in the national mortality database, and therefore, were not included in the analysis.

Table 1 Causes of death considered amenable by Nolte and McKee's classification during 2007–2014 in Mongolia

Cause of death	Age limits	ICD-10*	Number of deaths (%)
Intestinal infectious diseases	0–14	A00–A09	11 (0.0)
Tuberculosis	0–74	A15–A19, B90	2,086 (4.7)
Other infections (diphtheria, tetanus, poliomyelitis)	0–74	A35–A36, A80	0 (0.0)
Whooping cough	0–14	A37	0 (0.0)
Septicemia (streptococcal septicemia, other septicemia)	0–74	A40–A41	35 (0.1)
Measles	1–14	B05	0 (0.0)
Colorectal cancer	0–74	C18–C21	557 (1.2)
Nonmelanotic skin cancer	0–74	C44	17 (0.0)
Breast cancer	0–74	C50	295 (0.7)
Cervical cancer	0–74	C53	725 (1.6)
Uterine cancer	0–44	C54–C55	34 (0.1)
Neoplasm of testis	0–74	C62	34 (0.1)
Hodgkin's disease	0–74	C81	35 (0.1)
Leukemia	0–44	C91–C95	293 (0.7)
Thyroid disorders	0–74	E00–E07	118 (0.3)
Diabetes mellitus	0–49	E10–E14	231 (0.5)
Epilepsy	0–74	G40–G41	435 (1.0)
Rheumatic heart diseases	0–74	I05–I09	426 (1.0)
Hypertensive diseases	0–74	I10–I15	1,808 (4.0)
Ischemic heart diseases	0–74	I20–I25	11,234 (25.1)
Cerebrovascular diseases	0–74	I60–I69	14,781 (33.0)

Influenza, pneumonia, asthma	0–74	J10–J18, J45–J46	3,218 (7.2)
Other respiratory diseases	1–14	J00–J09, J20–J44, J47–J99	181 (0.4)
Peptic ulcer disease	0–74	K25–K27	645 (1.4)
Appendicitis	0–74	K35–K38	46 (0.1)
Hernia	0–74	K40–K46	14 (0.0)
Cholecystitis andcholelithiasis	0–74	K80–K81	140 (0.3)
Nephritis and nephrosis	0–74	N00–N07,N17–N19, N25–N27	1,280 (2.9)
Prostatic hyperplasia	0–74	N40	24 (0.1)
Diseases of pregnancy, labor and post-partum periods	0–74	O00–O99	296 (0.7)
Congenital cardiovascular anomalies	0–74	Q20–Q28	846 (1.9)
Perinatal deaths (all causes, excluding stillbirths)	0–74	P00–P96, P33	4,955 (11.1)
Total			44,800 (100)

*The 10th revision of the International Classification of Diseases: I60–I69 cerebrovascular diseases (I60 subarachnoid haemorrhage, I61 intracerebral haemorrhage, I62 other nontraumatic intracranial haemorrhage, I63 cerebral infarction, I64 stroke, not specified as haemorrhage or infarction, I65 occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction, I66 occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction, I67 other cerebrovascular diseases, I68 cerebrovascular disorders in diseases classified elsewhere, I69 sequelae of cerebrovascular diseases), I20–I25 ischemic heart diseases (I20 angina pectoralis, I21 acute myocardial infarction, I22 subsequent myocardial infarction, I23 certain current complications following acute myocardial infarction, I24 other acute ischaemic heart diseases, I25 chronic ischaemic heart diseases), P00–P96, A33 perinatal deaths (P00–P04 fetus and newborn affected by maternal factors and by complications of pregnancy, labour and delivery, P05–P08 disorders related to length of gestation and fetal growth, P10–P15 birth trauma, P20–P29 respiratory and cardiovascular disorders specific to the perinatal period, P35–P39 infections specific to the perinatal period, P50–P61 haemorrhagic and haematological disorders of fetus and newborn, P70–P74 transitory andocrine and metabolic disorders specific to fetus and newborn, P75–P78 digestive system disorders of fetus and newborn, P80–P83 conditions involving the integument and temperature regulation of fetus and newborn, P90–P96 other disorders originating in the perinatal period, A33 tetanus neonatorum), J10–J18, J45–J46 influenza, pneumonia, asthma (J10 influenza, due to other identified influenza virus, J11 influenza, virus not identified, J12 viral pneumonia, not elsewhere classified, J13 pneumonia due to *Streptococcus pneumonia*, J14 pneumonia due to *Haemophilus influenzae*, J15 bacterial pneumonia, not elsewhere classified, J16 pneumonia due to other infectious organisms, not elsewhere classified, J17 pneumonia in diseases classified elsewhere, J18 pneumonia, organism unspecified, J45 asthma, J46 status asthmaticus), A15–A19, B90 Tuberculosis (A15 respiratory tuberculosis, bacteriologically and histologically confirmed, A16 respiratory tuberculosis, not confirmed bacteriologically or histologically, A17 tuberculosis of nervous system, A18 tuberculosis of other organs, A19 miliary tuberculosis, B90 sequelae of tuberculosis).

Data Analysis

The age-standardized mortality rates in 2007–2014 were calculated by amenable causes and by place of residence, using the direct standardization method with the Mongolian census population of 2010 as a standard population.[10,11] Place of residence included all administratively divided 21 rural provinces (aimags) and the capital city Ulaanbaatar. Age groups were categorized according to the WHO standard guideline to allow the comparisons with other countries. A national mortality database was used to extract all deaths due to amenable causes as shown in Table 1.

Statistical Package for Social Sciences (SPSS) version 16.0 software was used for the data analysis. Nonparametric Spearman's rank correlation was used to examine associations between dependent variables (crude overall and age-specific AM) and four independent variables (percent of poor households, population density, number of medical doctors per 10,000 population, and health spending per capita). For dichotomous independent variables (urban/rural and with/without access to medical schools) t-tests were used. All statistical tests were two-tailed and P-value <0.05 was considered as statistically significant.

RESULTS

Demographic characteristics

During the study period (2007–2014) a total of 130,402 deaths were registered in Mongolia, of which 44,800 (34.4%) deaths were amenable. Out of total AM cases aged 0–74 years, 26,764 (59.7%) were males and 18,036 (40.3%) were females; 17,862 males and 11,734 females were from urban areas. Age-specific AMRs were higher in males than in females in all age groups. The gender difference was lowest (1.1–1.3 times) in those aged below 30 years, and highest (1.9–2.1 times) in those aged 55–64 years. In the other age groups, the difference was 1.6–1.8 times (Table 2).

Table 2 Crude amenable mortality rates per 100,000 population by age and gender during 2007–2014 in Mongolia

Age	Gender		Total
	Male	Female	
0–4	396.2	312.4	354.3
5–9	11.6	9.6	10.6
10–14	8.6	7.4	8.0
15–19	18.6	15.9	17.3
20–24	30.7	25.6	28.2
25–29	42.6	36.8	39.7
30–34	80.3	52.8	66.6
35–39	137.8	81.8	109.8
40–44	245.4	133.6	189.5
45–49	425.4	227.0	326.2
50–54	665.0	364.5	514.8
55–59	953.3	454.4	703.9
60–64	1,373.6	707.1	1,040.4
65–69	1,893.9	1,127.2	1,510.6
70–74	2,803.6	1,751.5	2,277.6
0–74	605.8	353.8	479.8

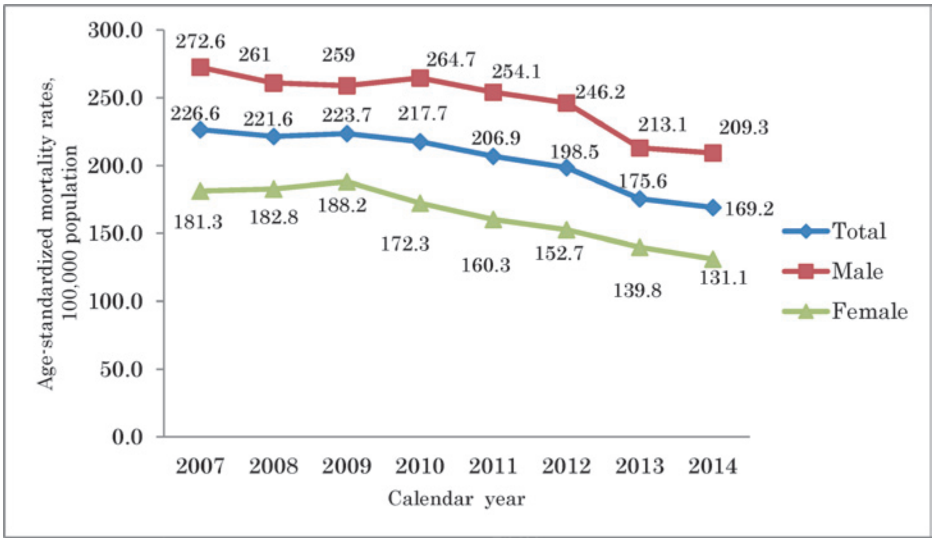

Fig. 1 Decreasing trends in age-standardized amenable mortality rate per 100,000 population according to gender, during 2007–2014 in Mongolia

Age-standardized AMRs

Trends in age-standardized AMR per 100,000 population between 2007 and 2014 are shown in Fig.1. The rate was highest in 2007 (226.6) and afterward declined continuously until the level of 169.2 in 2014. Age-standardized AMR in the past 8 years was consistently higher among men than among women by 40–60 percent. The rate decreased between 2007 and 2014 by 23% among men (from 272.6 to 209.3) and by 28% among women (from 181.3 to 131.1).

Leading causes of amenable deaths

Cerebrovascular diseases (68.0 per 100,000 population), ishemic heart diseases (51.6 per 100,000 population), perinatal deaths (all causes, excluding stillbirths) (22.7 per 100,000 population), influenza/pneumonia/asthma (14.8 per 100,000 population) and tuberculosis (9.6 per 100,000 population) were the five leading causes of AM in the past 8 years in Mongolia. The time trends of highly prevalent causes of AM among Mongolians are shown in Fig. 2. The rates of crude AM due to cerebrovascular diseases (CVD) and ischemic heart diseases (IHD) have declined since 2012. The age-specific mortality rates of the leading causes of AM by gender are shown in Table 3. The highest age-specific rates of AM due to CVD and IHD were in 70–74 year age group in both genders. Perinatal deaths and deaths due to influenza, pneumonia and asthma were highest in under-five children. The death rate of tuberculosis was highest in those aged 65–69 years in males and those aged 70–74 years in females.

Geographical distribution

We found that the overall crude AMR was highest in Khusvgul province (274.7 per 100,000 population) and lowest in Dundgovi province (153.7 per 100,000 population). In males the AM was highest in Khuvsgul (321.8 per 100,000 population), Uvurkhangai (307.2 per 100,000 population) and Bayan-Ulgii (285.9 per 100,000 population) provinces, and the corresponding rate in females was high in Bayan-Ulgii (243.5 per 100,000 population), Khuvsgul (227.6 per 100,000 population) and Uvs (207.5 per 100,000 population) (Fig.3.1 and 3.2).

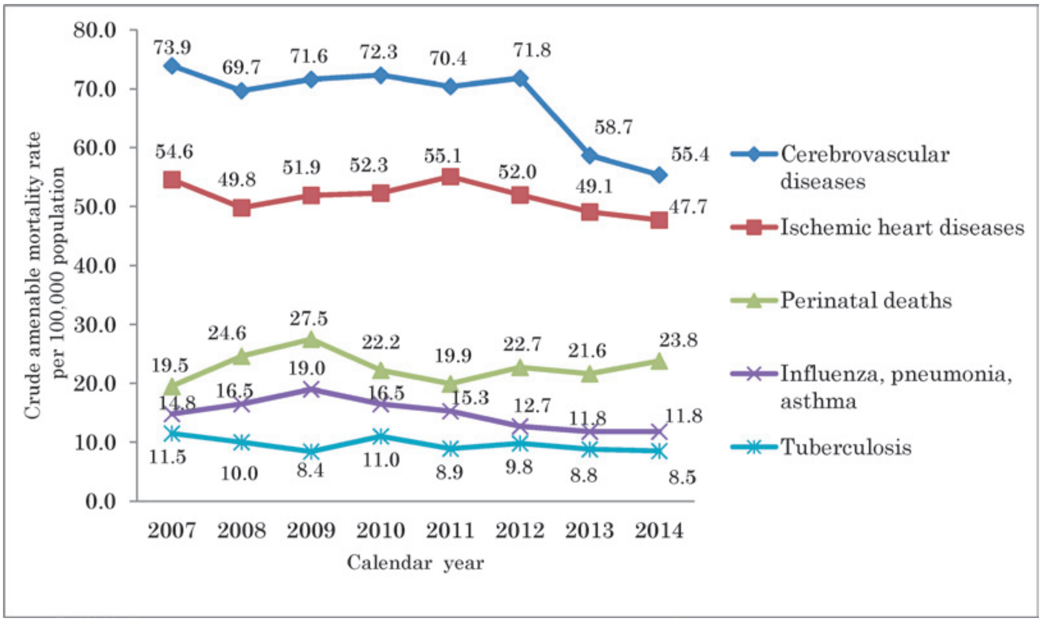

Fig. 2 Trends in leading causes of crude amenable mortality rate per 100,000 population during 2007–2014 in Mongolia

Table 3 Leading causes of amenable deaths per 100,000 population by gender and age

Age	Cerebrovascular diseases, I60–I69*		Ischemic heart diseases, I20–I25*		Perinatal deaths, P00–P96, A33*		Influenza, pneumonia, asthma, J10–J18, J45–J46*		Tuberculosis, A15–A19, B90*	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0–4	3.5	4.3	0.0	1.4	2,002.8	1,478.0	788.2	665.3	12.5	16.5
5–9	4.1	2.5	0.8	0.0	0.0	0.0	40.4	40.6	2.5	2.5
10–14	4.8	4.1	4.0	1.6	0.0	0.0	22.6	9.1	3.2	4.1
15–19	8.2	4.4	16.4	10.4	0.0	0.0	25.3	8.9	21.6	25.2
20–24	27.8	15.0	39.2	21.1	0.0	0.0	10.7	18.4	71.9	38.9
25–29	48.7	24.5	74.6	37.1	0.0	0.0	18.8	18.6	81.6	59.4
30–34	123.3	73.4	170.0	56.7	0.0	0.0	41.4	15.8	111.9	56.7
35–39	271.1	144.1	362.7	110.4	0.0	0.0	46.8	26.5	179.4	74.8
40–44	663.0	363.4	607.4	186.8	0.0	0.0	71.1	30.6	238.8	73.5
45–49	1,306.3	857.9	1,169.8	322.1	0.0	0.0	89.3	33.5	275.5	72.7
50–54	2,258.7	1,525.0	1,954.8	494.5	0.0	0.0	127.9	57.7	265.7	93.3
55–59	3,337.7	1,793.4	2,834.5	825.7	0.0	0.0	177.2	55.5	246.5	79.9
60–64	4,925.8	2,780.0	4,250.4	1,428.1	0.0	0.0	271.0	86.1	266.9	99.4
65–69	6,671.9	4,433.0	5,954.1	2,433.8	0.0	0.0	332.5	169.5	279.8	134.7
70–74	9,446.5	5,931.6	8,981.7	4,956.4	0.0	0.0	593.5	309.8	250.3	160.6
0–74	646.4	440.9	593.5	237.3	216.4	148.1	140.4	96.3	105.7	48.4

*The 10th revision of the International Classification of Diseases. See the footnote of Table 1.

There were great discrepancies in age-specific AMRs among provinces, especially in younger age groups. Bayan-Ulgii province had 4.3 times higher AMR (574.2 per 100,000 population) of children aged 0–4 years compared to Selenge province with the lowest rate of 134.4 per 100,000

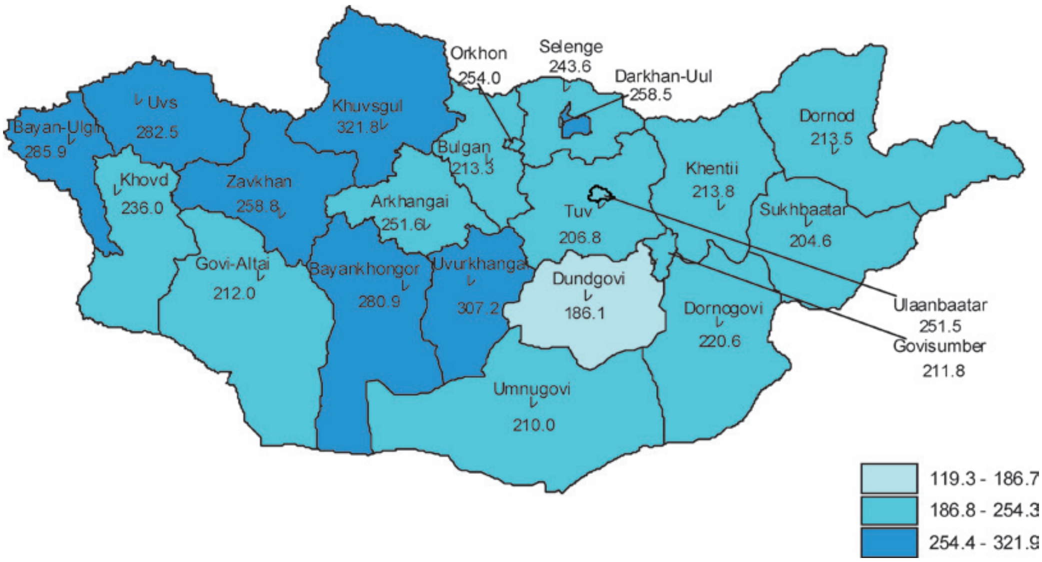

Fig. 3.1 Crude amenable mortality rate in males per 100,000 population by provinces during 2007–2014 in Mongolia

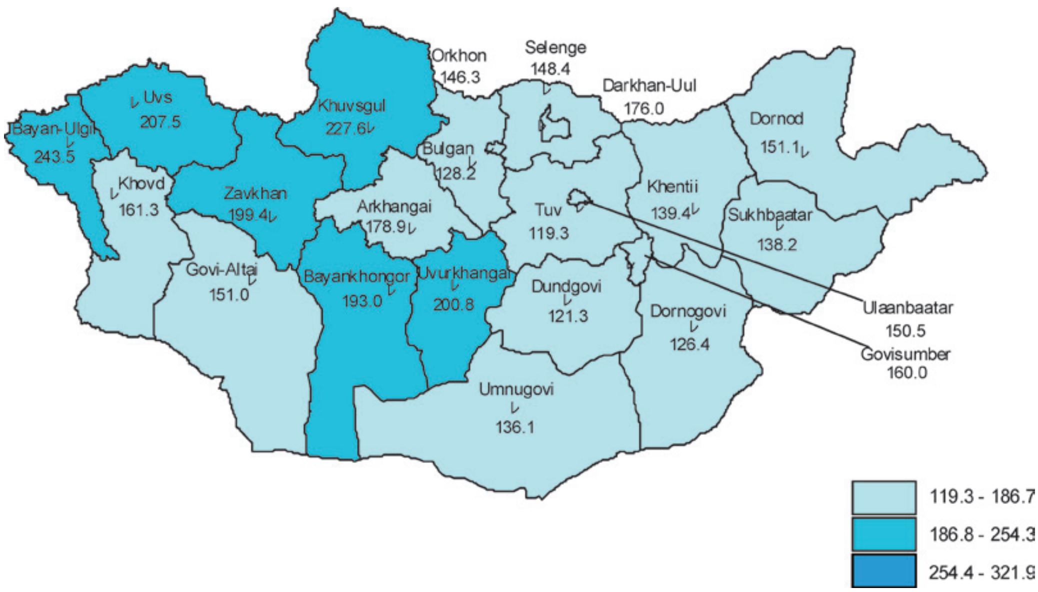

Fig. 3.2 Crude amenable mortality rates in females per 100,000 population by provinces during 2007–2014 in Mongolia

population. Similarly, the former had a 20.6 times higher amenable mortality rate of children aged 5–9 years compared to Tuv province, which had the lowest rate at 1.6 per 100,000 population. On the whole, the western-most Bayan-Ulgii province had the highest age-specific AMRs in 9 of 15 age groups (Table 4).

Table 4 Crude amenable mortality rates per 100,000 population by age and provinces during 2007–2014 in Mongolia

Province	Age															
	0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	0–74
Arkhangai	332.3	3.1	5.2	8.6	16.2	36.2	54.6	119.9	172.2	300.6	635.3	771.7	1,169.7	1,874.4	2,548.9	536.6
Bayan–Ulgii	574.2	33.0	22.2	36.5	42.3	75.8	143.9	179.4	293.4	395.6	566.7	840.2	1,365.2	2,359.7	2,804.6	648.8
Bayankhongor	384.9	3.2	9.5	17.9	36.7	64.6	60.8	127.6	204.6	389.9	670.9	845.2	1,294.7	2,086.3	3,196.5	626.2
Bulgan	201.0	7.1	6.6	13.9	12.4	33.6	41.2	75.5	174.8	272.2	431.1	503.0	1,003.7	1,301.0	1,814.7	392.8
Govi–Altai	474.4	16.9	16.7	19.0	39.3	55.9	51.3	86.1	134.0	229.6	482.1	622.3	861.2	1,228.9	1,244.2	370.8
Govisumber	283.7	10.0	0.0	16.4	16.0	45.6	71.9	100.6	154.5	370.6	427.7	742.9	1,031.0	1,519.5	2,321.6	474.1
Darkhan-Uul	208.2	3.1	1.9	11.6	24.9	22.5	63.7	112.0	223.2	421.0	565.1	801.5	1,089.8	1,698.1	2,355.4	506.8
Dornogovi	373.4	9.1	4.6	14.9	13.7	22.7	71.6	105.6	178.4	310.5	488.2	602.9	838.0	1,395.5	1,813.9	416.2
Dornod	306.9	12.5	4.1	7.8	17.0	39.6	42.9	65.4	196.0	237.3	430.5	646.5	999.7	1,492.4	2,666.9	477.7
Dundgovi	253.6	11.5	2.5	15.1	9.1	27.6	58.1	88.6	166.5	198.8	296.0	443.5	642.3	1,437.6	1,910.7	370.8
Zavkhan	337.9	12.9	1.8	6.2	23.9	35.8	68.3	75.2	208.3	333.0	509.1	956.2	1,398.5	1,849.1	2,645.3	564.1
Orkhon	321.0	3.2	3.3	12.1	21.5	40.8	55.1	78.9	174.5	304.0	487.4	815.5	1,097.5	1,586.4	2,370.7	491.5
Uvurkhangai	462.3	7.2	14.8	18.5	22.1	42.8	70.3	117.1	206.7	391.8	618.6	977.8	1,310.1	1,944.2	3,013.4	614.5
Umnugovi	316.8	5.4	2.4	18.7	34.1	33.0	52.8	133.1	148.0	268.6	409.2	508.5	1,066.1	1,342.3	2,176.4	434.4
Sukhbaatar	327.5	5.2	4.7	12.6	12.7	31.7	78.3	93.1	197.4	287.7	445.1	663.1	892.5	1,101.2	1,609.4	384.1
Selenge	134.4	4.6	5.9	12.0	23.7	41.5	58.3	118.4	190.1	354.7	541.0	694.0	1,084.6	1,642.0	2,578.6	498.9
Tuv	145.8	1.6	1.9	7.8	19.9	35.1	43.1	72.8	119.1	213.0	394.2	626.4	912.0	1,294.7	1,904.3	386.1
Uvs	436.8	17.9	6.5	16.0	26.6	31.0	47.5	119.7	176.9	401.3	684.1	939.5	1,190.3	2,124.9	3,174.3	626.2
Khovd	410.5	10.3	15.2	14.6	30.7	31.1	80.4	79.0	160.6	314.0	432.7	639.9	1,165.9	1,557.4	2,898.4	522.7
Khuvsgul	504.6	7.6	9.7	21.0	43.7	35.2	75.3	132.9	239.0	500.8	739.1	996.4	1,402.2	2,030.1	3,235.4	664.9
Khentii	340.4	13.0	9.2	8.6	23.0	47.8	48.4	96.8	153.3	259.4	353.2	624.7	724.8	1,204.2	2,181.5	405.9
Ulaanbaatar	356.4	12.2	7.4	20.9	31.4	39.8	68.0	112.8	184.2	305.9	485.0	612.3	896.1	1,223.9	1,859.2	414.4
Whole country	340.3	9.6	7.1	15.0	24.6	39.5	63.9	104.1	184.4	320.9	504.2	721.5	1,065.3	1,604.3	2,378.4	492.2

Geographical differences in age–sex-standardized AMRs were similar to the differences in crude rates during 2007–2014 in Mongolia (Fig.4). The age-sex-standardized AMRs were highest in Khuvsgul province (289.8 per 100,000 population), followed by Bayan-Ulgii (276.1 per 100,000 population) and Uvurkhangai (267.6 per 100,000 population) provinces. The lowest age-standardized AMR was observed in Dundgovi province (163.8 per 100,000 population).

Determinants of AM

Bivariate analysis was carried out to examine associations of crude overall AM and age-specific AM with six independent variables (percent of poor households, population density, number of medical doctors per 10,000 population, health expenditure per capita, urban/rural, and with/without access to medical schools). Bivariate analysis did not reveal any significant associations between crude overall AM and selected explanatory variables. In terms of age-specific AMRs, there was a strong inverse correlation between the number of medical doctors per 10,000 population and AM in 35–39, 60–64, 65–69, and 70–74 age groups (Table 5).

A similar bivariate analysis was carried out to test the associations of crude AM from these selected causes of death (the five leading causes, as well as hypertensive diseases and diabetes) with the independent variables above (Table 6). The number of medical doctors per 10,000 population had a strong inverse correlation with mortality due to CVD and IHD, and a strong direct correlation with tuberculosis mortality. Health spending per capita had a strong direct correlation with mortality from hypertensive diseases, and population density had a strong direct correlation with CVD mortality. Living in an urban area was significantly associated with mortality due to

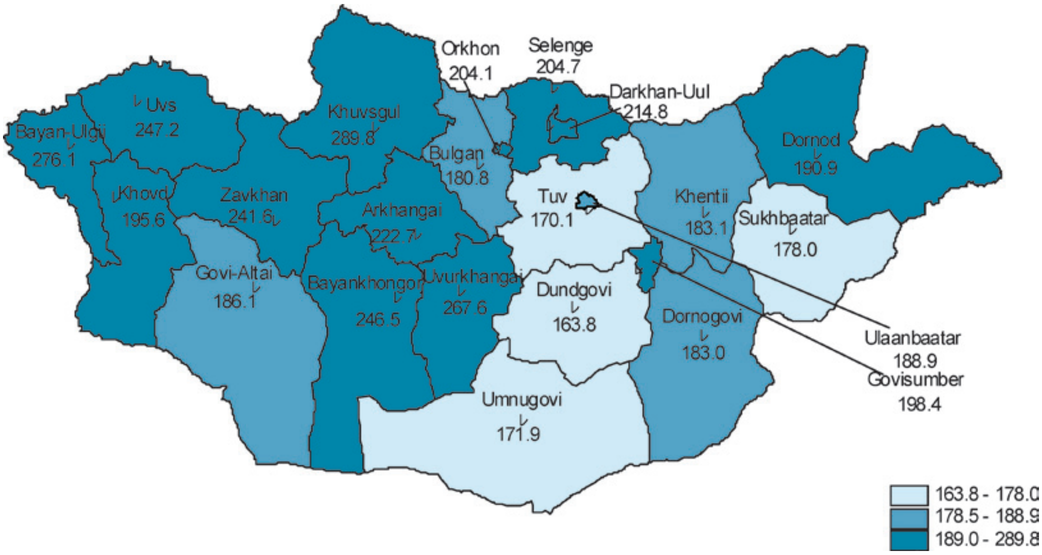

Fig. 4 Geographical distribution of age-sex-standardized amenable mortality rate per 100,000 population during 2007–2014 in Mongolia

Table 5 Spearman's rank correlation coefficient (ρ) and p-value between age-specific amenable mortality rates and number of medical doctors (all specialities) per 10,000 population in Mongolia

Age	ρ	p-value
0–4	–0.15	0.503
5–9	0.18	0.411
10–14	–0.41	0.055
15–19	–0.03	0.893
20–24	–0.28	0.215
25–29	–0.14	0.536
30–34	0.04	0.867
35–39	–0.45*	0.037*
40–44	–0.29	0.193
45–49	–0.33	0.140
50–54	–0.40	0.064
55–59	–0.40	0.068
60–64	–0.57*	0.006*
65–69	–0.53*	0.010*
70–74	–0.54*	0.009*
0–74	–0.35	0.109

*P-value <0.05

Table 6 Spearman's rank correlation coefficient (ρ), t-test and p-value for selected causes of crude amenable mortality in Mongolia, calculated from 22 provinces/capital

Causes	Health spending per capita		Number of medical doctors per 10,000 population		Population density		Urban/rural	
	ρ	p-value	ρ	p-value	ρ	p-value	t	p-value
Cerebrovascular diseases	–0.11	0.633	–0.50*	0.019*	0.50*	0.019*	–0.31	0.760
Ischemic heart diseases	0.03	0.887	–0.58*	0.005*	0.41	0.059	0.42	0.682
Influenza, pneumonia, asthma	–0.19	0.408	–0.23	0.311	–0.29	0.191	1.62	0.121
Perinatal deaths	0.06	0.789	0.09	0.682	–0.31	0.164	0.366	0.718
Tuberculosis	0.38	0.079	0.46*	0.031*	0.41	0.060	–3.86*	0.001*
Hypertensive diseases	0.43*	0.048*	–0.03	0.909	0.20	0.384	–0.78	0.448
Diabetes	0.27	0.231	0.33	0.137	0.18	0.422	–2.99*	0.007*

*P-value <0.05

tuberculosis and diabetes mellitus. Since there were no significant associations between percent of poor households and access to medical schools, the results are not listed in Table 6.

DISCUSSION

Our study showed that the Mongolian age-standardized AMR per 100,000 population declined from 226.6 in 2007 to 169.2 in 2014. Nonetheless, the rates were still high compared to other countries.[12)] Declines in AMRs contributed to overall improvements in life expectancy at birth of population. Life expectancy at birth for both genders in Mongolia increased by 2.5 years from 66.5 years in 2007 to 69.5 years in 2014.[9)]

The average AMRs in 31 industrialized OECD countries was 95.1 per 100,000 population in 2007. The highest death rates were in the USA at 95.5 deaths per 100,000 population, followed by the United Kingdom (82.5) and Denmark (80.1). The lowest AMRs were in France at 55.0 per 100,000 population, followed by Australia (56.9) and Italy (59.8).[13)] In Russia, AMR reached a peak of 240 deaths per 100,000 population in 1994.[14)] In a study in 2007, the estimated AMRs were highest in the former socialist countries, such as Estonia (199.4), Hungary (196.8), Slovak Republic (187.7), Poland (137.8) and Czech Republic (125.0).[4)]

Age-standardized AMR in Mongolia remained consistently higher in males than in females. In Hungary, the rates per 100,000 population were 238.1 for males and 139.1 for females between 2004–2008.[15)] In Israel, the rate decreased from 110.0 to 76.3 per 100,000 in males, and from 93.3 to 67.9 per 100,000 in females between 1998 and 2009.[12)] The decline was greater for males (–31%) than for females (–27%). The risk of amenable deaths increased with age; the crude AMR was highest for those aged 70–74 years (2,803.6 in males and 1,751.5 in females). The findings were similar to those studies of other countries.[5)]

In terms of geographical distribution both crude and age-sex-standardized AMRs were highest in the geographically remote mountainous western provinces of the country with harsh weather conditions, higher poverty rates, lack of human resources for health, and poor infrastructure. The sparse distribution of the rural population makes it challenging to deliver healthcare services to rural and remote areas, especially to herders who lead nomadic lives.

Further, provinces where ethnic minorities live tended to have higher AMRs. The westernmost Bayan-Ulgii province, home to the Kazakhs, Mongolia's only Muslim ethnic minority,[16)] had the highest age-specific AMRs in 9 of 15 age groups in the country. Similarly, Khuvsgul province, home for many ethnic minority groups, had the highest crude overall AMR of 289.8 per 100,000 population. Khuvsgul province, with the highest rates of AM, had a life expectancy at birth of 65 years, the lowest compared with other regions.[16] These findings highlight the importance of geographical, structural and cultural barriers to healthcare access on population health, and the importance of addressing regional differences in policies and plans for the prevention and control of leading causes of AM.

The leading causes of AM during 2007–2014 in Mongolia were cerebrovascular diseases (CVD), ischemic heart diseases (IHD), perinatal deaths, influenza/pneumonia/asthma and tuberculosis. Diseases of the cardiovascular system have grown into the leading cause of mortality of the Mongolian population over the past ten years due to common risk factors associated with unhealthy lifestyle, such as smoking, harmful use of alcohol, unhealthy diets and physical inactivity, having become highly prevalent. The results of a comparative study of the NCD risk factors indicated that the percentage of adults aged 15 to 64 years with three or more NCD risk factors increased from 26.4% in 2009 to 36.8% in 2013.[17]

According to the findings of our study, AM from CVD and IHD has been declining since 2012 in Mongolia, but still remains higher compared to other European and Asian countries.[5,18-20] The decline could be attributed to the implementation of a nationwide Non-communicable Diseases and Injuries Health Project funded by the Millennium Challenge Corporation of USA. The project was implemented in 2008–2013, and has introduced a comprehensive package for prevention, early detection and treatment of hypertension, stroke, heart attacks, type II diabetes, breast and cervical cancer and road traffic injuries. Within the framework of the project, centers for excellence in stroke and acute myocardial infarctions care have been established in the capital Ulaanbaatar.

Perinatal deaths were the third largest cause of AM. Reducing infant and under-five mortality has been a major concern for the government of Mongolia. Such a high rate of perinatal death in a country like Mongolia with very high rates of antenatal care (98.7%) and skilled attendance at birth (99.6%)[9] is indicative of poor quality emergency obstetric and essential newborn care, as highlighted in the Needs Assessment of Emergency Obstetric and Essential Newborn Care in Mongolia,[21] which disclosed that the clinical guidelines and standards were not performed accordingly.

Pneumonia is one of the leading infectious causes of death in the world, and is the fourth leading cause of AM in Mongolia.[9] In 2013, an estimated 935,000 children under the age of five years died due to pneumonia, accounting for 15% of all under-five mortality worldwide.[22] High rates of mortality due to influenza, pneumonia and asthma in Mongolia might be influenced by poor quality of medical care due to severe shortage of respiratory care equipment and drugs, and a lack of skilled health professionals, particularly in rural settings. In addition, low levels of parental knowledge and recognition of pneumonia symptoms potentially caused delays in seeking medical attention.

The fifth leading cause of AM in the country was tuberculosis. Mongolia is one of seven countries in the Western Pacific region with a high burden of tuberculosis.[23] Tuberculosis is the third most common communicable disease and the leading cause of mortality among all communicable diseases in Mongolia.[9] Mortality rate due to tuberculosis was highest in the most populated city, the capital Ulaanbaatar. Recently, the country has embarked on an ambitious initiative to conduct a tuberculosis prevalence survey, which will shed more light on social determinants of tuberculosis, prevalence of exposure to specific tuberculosis risk factors in the population, and the determinants of health seeking behaviour.

Correlation analysis indicated that number of medical doctors per 10,000 population was slightly protective against AM overall and in age groups above 50 years when controlled for the effect of other factors. The number of medical doctors was lowest in Khuvsgul (14.8 per 10,000 population) and Bayan-Ulgii (15.0) provinces while the country average was 28.6.[9] In other words, the number of medical doctors was lowest in provinces with the highest AMRs. Further, the number of medical doctors per 10,000 population was protective against AM due to IHD, while urban residence was protective against AM from influenza/pneumonia/asthma when controlled for the effect of other factors. In contrast, urban residence was a significant risk factor for the AM due to tuberculosis and diabetes.

The major limitation of the current study was the lack of individual level data, as this study was based on aggregated mortality data from 22 provinces/capital. Therefore, the analysis did not allow for the assessment of individual risk factors, in particular socio-economic factors that could potentially influence the magnitude of AM. The fact that "misadventures to patients during surgical and medical care" were not coded in the national mortality database points to another potential limitation of the current study, namely the quality of coding of causes of death.

CONCLUSION

Age-standardized AMRs declined between 2007 and 2014 in Mongolia. The government of Mongolia needs to seriously consider the regional differences in AM in order to allocate health resources, including human resources, effectively. Further studies are needed to look into the causes of regional disparities in AM, individual-level risk factors to amenable deaths, and the validity of death coding in health sector.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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