

Out-of-hospital deaths in Mongolia: a nationwide cohort study on the proportion, causes, and potential impact of emergency and critical care services

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Summary

Background Little is known about the proportion and causes of out-of-hospital deaths in Mongolia. In this study, we aimed to determine the proportion and causes of out-of-hospital deaths in Mongolia during a six-month observation period before the COVID-19 pandemic.

Methods In a retrospective study, the Mongolian National Death Registry was screened for all deaths occurring from 01 to 06/2020. The proportion and causes of out-of-hospital deaths, causes of out-of-hospital deaths likely treatable by emergency/critical care interventions, as well as sex, regional and seasonal differences in the proportion and causes of out-of-hospital deaths were determined. The primary endpoint was the proportion and causes of out-of-hospital death in children and adults. Descriptive statistical methods, the Fisher's Exact, multirow Chi²-or Mann-Whitney-U-rank sum tests were used for data analysis.

Findings Five-thousand-five-hundred-fifty-three of 7762 deaths (71.5%) occurred outside of a hospital. The proportion of out-of-hospital deaths was lower in children than adults (39.3% vs. 74.8%, $p < 0.001$). Trauma, chronic neurological diseases, lower respiratory tract infections, congenital birth defects, and neonatal disorders were the causes of out-of-hospital deaths resulting in most years of life lost in children. In adults, chronic heart diseases, trauma, liver cancer, poisonings, and self-harm caused the highest burden of premature mortality. The proportion of out-of-hospital deaths did not differ between females and males (70.5% vs. 72.2%, $p = 0.09$). The proportion (all, $p < 0.001$; adults, $p < 0.001$; children, $p < 0.001$) and causes (adults, $p < 0.001$; children, $p < 0.001$) of out-of-hospital deaths differed between Mongolian regions and Ulaanbaatar. The proportion of out-of-hospital deaths was higher during winter than spring/summer months (72.3% vs. 69.9%, $p = 0.03$). An expert panel estimated that 49.3% of out-of-hospital deaths were likely treatable by emergency/critical care interventions.

Interpretation With regional and seasonal variations, about 75% of Mongolian adults and 40% of Mongolian children died outside of a hospital. Heart diseases, trauma, cancer, and poisonings resulted in most years of life lost. About half of the causes of out-of-hospital deaths could be treated by emergency/critical care interventions.

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Keywords: Mongolia; Out-of-hospital death; Home death; Proportion; Cause; Regions; Emergency care; Critical care medicine

Introduction

Mongolia is a lower middle-income country located in East Asia. With 3.3 million inhabitants and an area of

1.56 Mio square kilometres it is the least densely populated and second largest landlocked country in the world.¹ One third of the Mongolian population lives in



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Research in context

Evidence before this study

We searched the PubMed database using the following medical subject headings terms: ((Mongolia) AND (out-of-hospital death OR home death) and (rate)). In addition, another search with the terms ((Mongolia) AND (out-of-hospital deaths OR home death) and (cause)) was conducted. Hand searches of the reference lists of all identified publications were performed in order to find further evidence. So far, only one multinational study had included the rate of home deaths in Mongolia. This study found that 60.9% of Mongolians die outside of a hospital. No study has so far evaluated causes and treatability of deaths occurring outside of hospitals in Mongolia.

Added value of this study

In this retrospective analysis of the Mongolian National Death Registry, we determined the proportion and causes of, as well as sex, seasonal and regional variations in out-of-hospital deaths during the first six months of 2020. In addition, we evaluated the percentage of causes of out-of-hospital deaths which could likely be treated by emergency and critical care interventions. The study results revealed that 71.5% of Mongolians die outside of a hospital. This proportion was

lower in children than adults. Trauma, chronic neurological diseases, lower respiratory tract infections, congenital birth defects, and neonatal disorders were the causes of out-of-hospital deaths resulting in most years of life lost in children. In adults, chronic heart diseases, trauma, liver cancer, poisonings, and self-harm caused the highest burden of premature mortality. The proportion of out-of-hospital deaths did not differ between females and males, but between winter and spring/summer months as well as between Mongolian regions and the capital city of Ulaanbaatar. An expert panel estimated that 49.3% of out-of-hospital deaths were likely treatable by emergency and critical care interventions.

Implications of all the available evidence

Although further research is needed to define causes of limited access to emergency and critical care services in Mongolia, the currently available evidence suggests that the majority of Mongolians die outside of a hospital and that a substantial amount of these deaths could be treated by emergency and critical care services. These data may inform policy makers to plan and set-up nationwide emergency and critical care services in Mongolia.

rural areas following a traditional semi-nomadic lifestyle.¹ Over the last decades, Mongolia's health care system has seen significant improvements resulting in a respectable increase in the average life expectancy at birth to 68.1 years in 2019.² Mongolia has a national health care system which is organised in two tiers including primary care, specialized care, and a referral system. By 2019, social health insurance covered 90.2% of Mongolians providing free health care to the vast majority of the population.^{2,3} Certain health challenges, however, remain.

One of them is unrestricted access to emergency and critical care medicine, particularly in regions outside of the capital city of Ulaanbaatar. A prospective, observational, multicentre study reported that an emergency department or a resuscitation room to manage emergency patients was available in only 62.2% of 74 Mongolian primary level hospitals.⁴ Other reports indicated that although the intensive care unit bed availability per 100,000 inhabitants was comparatively high in Mongolia, only half of these beds were equipped with mechanical ventilators and that a substantial amount of young patients suffering from acute reversible conditions die in Mongolian hospitals without prior admission to intensive care.^{5,6} Mongolian acute services face significant shortages in resource availability to care for critically ill patients such as patients with sepsis.⁷

A comprehensive analysis of the disease burden in Mongolia based on the Global Burden of Disease study 2019 revealed that ischaemic heart disease and stroke

were the most frequent causes of death in males and females. Further prevalent causes of death among both sexes were liver and stomach cancer, as well as chronic liver diseases including cirrhosis.³ The highest age-standardised rates of disability adjusted life years were attributable to arterial hypertension and dietary risks.³ In a multinational study, it was reported that 60.9% of Mongolians die at home.⁸ While patient and family preferences are likely to explain a certain percentage of home deaths, a relevant number of deaths occurring outside of Mongolian hospitals might result from limited access to healthcare facilities including emergency and critical care services.

In this study, we sought to determine the proportion and causes of out-of-hospital deaths in Mongolia during a six months observation period before the COVID-19 pandemic. Furthermore, we estimated the percentage of causes of out-of-hospital deaths likely treatable by emergency and critical care interventions, as well as sex, regional and seasonal differences in the proportion and causes of out-of-hospital deaths.

Methods

This analysis was designed as a retrospective cohort study. Data were extracted from the National Death Registry of the Mongolian Centre for Health Development for the period between January 1 and June 30, 2020. During this time, no domestic COVID-19 cases had been reported in Mongolia.⁹ The study protocol was

evaluated and approved by the Ethics Committee of the Mongolian National University of Medical Sciences (2021/3-11). In view of the retrospective study design written informed consent was waived. The manuscript was prepared according to the updated STROBE checklist for reporting cohort studies.¹⁰

Inclusion and exclusion criteria

The National Death Registry was screened for all death cases occurring in Mongolia during the observation period ($n = 7762$). All out-of-hospital death cases were included into the analysis. Participants dying in a hospital were excluded. Out-of-hospital death cases were defined as deaths occurring outside of a public or private health care facility with an in-patient unit, as registered with the Mongolian Ministry of Health.

The National Death Registry

The National Death Registry is hosted by the Mongolian Centre for Health Development located in Ulaanbaatar. This registry aggregates data on all death cases occurring in Mongolia which includes the 21 Mongolian provinces and the capital city of Ulaanbaatar with its nine districts. In each province and in Ulaanbaatar, out-of-hospital deaths are registered, and patient data, including the cause of death as per the International Classification of Disease (ICD) 10 code, are entered into the database through one electronic platform by different official bodies. These bodies include soum (sub-province) and district hospitals, family clinics, general practitioners, as well as institutes of forensic medicine. The Mongolian Centre for Health Development updates the national registry every work day and assures completeness of the datasets by retrieving missing data from submitting bodies at monthly intervals. By Mongolian law, autopsies are required for all out-of-hospital deaths following trauma, self-harm, or homicide, as well as in case of sudden deaths and deaths occurring under unclear circumstances. In the remaining death cases, the causes of death are determined by general practitioners or district doctors using screening of health records, medical history taking, and/or verbal autopsy. So far, no study has been performed to validate the content of the National Death Registry.

Data collection and processing

The following data were extracted from the National Death Registry for all study participants: age, sex, place of residence, date, and location of death (categorized as out-of-hospital or in-hospital), and cause of death as per the ICD 10 code.

An independent expert panel consisting of one public health expert as well as five internal medicine, emergency and critical care specialists determined which causes of death (as per ICD 10 code) would have been treatable by emergency and critical care interventions. The expert panel assumed timely and

unrestricted access to emergency and critical care services. Unrestricted access was defined as unrestricted access in terms of time (24 h/7 days) and without monetary limits. Emergency and critical care services were considered to include countrywide pre-hospital services, emergency departments and critical care units at standards currently provided in high-income countries. Decisions were made for each cause of death as per ICD-10 code. In a first round, each expert independently documented the likelihood that treatment resulted in short-term survival as either high (likely treatable) or low (unlikely treatable). The experts were asked to base their decisions on previous publications on amenable mortality,^{11,12} the OECD/Eurostat lists of preventable and treatable causes of death,¹³ as well as on their expertise and experience working in the acute health care sector in Mongolia. In accordance with other studies,^{11,12} an upper age limit (70 years for chronic conditions and 80 years for acute conditions) informed the expert panel's decision whether the causes of out-of-hospital deaths were treatable by emergency and critical care interventions. In case of agreement, the likelihood with which the cause of death was treatable by emergency and critical care interventions was then entered into the database for each participant who died from the respective cause. In case of disagreement, a second round was performed. If disagreement persisted, consensus was achieved by discussion.

Cause-specific years of life lost due to premature out-of-hospital death (YLLs) were calculated using the standard formula as suggested by the World Health Organization assuming a global life expectancy of 90 years.¹⁴ ICD 10 codes were further grouped into categories as suggested before¹⁵ and appropriate to evaluate whether the cause of death could have been treated by emergency and critical care interventions. Based on the age of study participants at the time of death, the study population was dichotomized into children (age <18 years) and adults (age ≥18 years). Since over half of the Mongolian population resides in Ulaanbaatar,¹⁶ the place of residence was categorized into Mongolian regions and the capital city. In addition, regions were further subdivided into the four official regions of Mongolia (West, Khangai, Central, East). The months January until April were classified as winter season, while May and June were summarized as spring/summer months.

Study endpoints

The primary endpoint of this study was the proportion and causes of out-of-hospital death in Mongolian children and adults. Secondary study endpoints were: 1) the difference in the proportion of out-of-hospital deaths between sex, regions, and season; 2) the percentage of causes of out-of-hospital deaths likely treatable by emergency and critical care interventions; 3) the difference in the causes of out-of-hospital deaths between Mongolian regions and the capital city of Ulaanbaatar.

All secondary study endpoints were evaluated separately for children and adults.

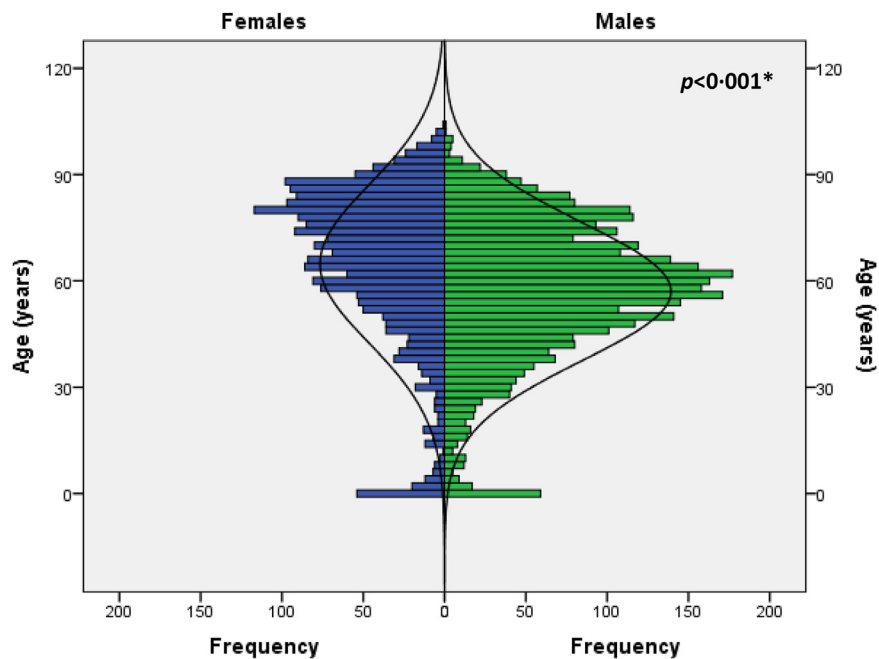
Statistical analysis

Following plausibility control of extracted datasets, statistical analyses were performed using the PASW statistical software package (IBM SPSS Statistics 20; IBM, Vienna, Austria). As all datasets were complete, no statistical methods were used to compensate for missing values. Descriptive statistical methods were applied to report primary and secondary study endpoints. Comparisons between groups were conducted using the Fisher’s Exact (e.g., for group comparisons of the proportion of out-of-hospital deaths), multirow Chi² (e.g., for group comparisons of the causes of out-of-hospital deaths) or Mann–Whitney U-rank sum test

(e.g., for group comparisons of continuous variables), as appropriate. Continuous variables are presented as median values with interquartile ranges. Categorical variables are given as absolute numbers with percentages. Two-sided *p*-values <0.05 were considered to indicate statistical significance. In case multiple comparisons were performed, Bonferroni corrections were applied.

Role of the funding source

This study was supported by institutional funds only. The Mongolian National University of Medical Sciences had no influence on the study design, data collection, data analysis, interpretation of the results, writing of the manuscript, and in the decision to submit the paper for publication.



Proportion of out-of-hospital Deaths			
	Females	Males	<i>p</i> -value
<i>n</i>	2,146	3,407	
Age groups			
neonates	19 (15.4%)	18 (10.5%)	0.22
under 5 years	26 (49.1%)	27 (45%)	0.71
5-12 years	58 (55.2%)	75 (63%)	0.28
13-17 years	27 (65.9%)	31 (72.1%)	0.64
18-65 years	798 (65.2%)	2,122 (71.9%)	<0.001*
>65 years	1,218 (81.2%)	1,134 (82.7%)	0.31

Fig. 1: Age distribution among female and male study patients. *, significant difference between females and males. Data are given as absolute values with percentages.

Results

During the observation period, 7762 deaths were recorded in Mongolia. Out of these, 2209 death cases occurred in hospitals and were therefore excluded. Five-thousand-five-hundred-fifty-three death cases occurred outside of a hospital and were included into the statistical analysis. An autopsy was performed in 1060 of 5553 (19.1%) out-of-hospital deaths. Female study participants died at an older age than males (Fig. 1).

Proportion and causes of out-of-hospital death

The proportion of out-of-hospital deaths in the entire population was 71.5%. The proportion of out-of-hospital deaths differed between adults and children (Table 1). The causes of out-of-hospital deaths and the associated YLLs for children and adults are presented in Table 2. In adults, the three causes of out-of-hospital death resulting in most YLL were chronic heart diseases, trauma, and liver cancer. Trauma, chronic neurological diseases, and lower respiratory tract infections made up the three causes of out-of-hospital death causing most YLL in children. The causes of out-of-hospital death differed between children and adults both in type and frequency ($p < 0.001$, Chi²-test).

Differences in the proportion of out-of-hospital deaths

The proportion of out-of-hospital deaths did not differ between females and males (Table 1). This was the same among all age groups except for the age group 18–65 years in which the proportion of out-of-hospital deaths was higher in males than females (Fig. 1). The proportion of out-of-hospital deaths was higher in Mongolian regions than in the capital city of Ulaanbaatar (Table 1). This difference was observed both in adults (83.7% vs.

65.6%, $p < 0.001$) and children (52% vs. 22.8%, $p < 0.001$) (Fig. 2). The proportion of out-of-hospital deaths between the four Mongolian regions (excluding Ulaanbaatar) did not differ in the entire population ($p = 0.13$), adults ($p = 0.41$), and children ($p = 0.22$). The proportion of out-of-hospital deaths differed between winter and spring/summer months (Table 1). There was no seasonal difference in the proportion of out-of-hospital deaths in adults, children, and Mongolian regions, but a significant difference between winter and spring/summer months was observed for out-of-hospital deaths occurring in Ulaanbaatar (Fig. 3).

Percentage of causes of out-of-hospital deaths treatable by emergency and critical care interventions

The expert panel estimated that the causes of 2740 of the 5553 out-of-hospital deaths (49.3%) were likely treatable by emergency and critical care interventions. This percentage was higher in children than adults and higher in Ulaanbaatar than in Mongolian regions (Fig. 4). The frequency of out-of-hospital deaths due to causes likely and unlikely treatable by emergency and critical care interventions across different ages is shown in Fig. 4.

Differences in the causes of out-of-hospital death

The causes of out-of-hospital deaths differed between Mongolian regions and Ulaanbaatar both for adults ($p < 0.001$) and children ($p < 0.001$) (Table 3). While chronic heart diseases, liver cancer, and trauma were the three most common causes of out-of-hospital deaths in Mongolian regions, it was poisonings, chronic heart diseases, and trauma in Ulaanbaatar. The causes of out-of-hospital deaths in Ulaanbaatar varied between winter and spring/summer months ($p = 0.001$). The largest difference was found for the incidence of poisonings including alcohol intoxication as a cause of out-of-hospital death during winter compared to spring/summer months [202/1671 (12.1%) vs. 46/665 (6.9%), $p < 0.001$].

Discussion

During a six month-period in 2020, 71.5% of deaths in Mongolia occurred outside of a hospital. With no differences between males and females, the proportion of out-of-hospital deaths was lower in children than adults. While trauma, chronic neurological diseases including neonatal encephalopathy, lower respiratory tract infections, congenital birth defects, and neonatal disorders were the causes of out-of-hospital deaths resulting in most YLL in children, chronic heart diseases, trauma, liver cancer, poisonings including alcohol intoxication, and self-harm caused the highest burden of premature mortality in the out-of-hospital setting in adults. Both the proportion and causes of out-of-hospital deaths differed between Mongolian regions and the capital city. In Ulaanbaatar, the proportion of out-of-hospital deaths

	n	Proportion of out-of-hospital deaths	p-value
Age groups			
Adults	5272 (94.9%)	74.8%	<0.001 ^a
Children	281 (5.1%)	39.3%	
Sex			
Females	2146 (38.6%)	70.5%	0.09
Males	3407 (61.4%)	72.2%	
Residence			
Mongolian regions	3217 (57.9%)	80.5%	<0.001 ^a
Ulaanbaatar	2336 (42.1%)	62.1%	
Season			
Winter	3834 (69%)	72.3%	0.03 ^a
Spring/Summer	1719 (31%)	69.9%	

COPD, chronic obstructive pulmonary disease; excl., excluding; incl., including; YLL, years of life lost. Data are given as median values with interquartile ranges, if not otherwise indicated. ^aSignificant difference between groups.

Table 1: Characteristics of the study population.

Adults				
	Cause of Death	YLL sum (% of total)	YLL per individual (yrs)	n (%)
1	Chronic heart diseases	20,021 (13.9)	20 (7–34)	940 (17.8)
2	Trauma (incl. falls, drowning, burns & interpersonal violence)	14,806 (10.3)	46 (37–57)	320 (6.1)
3	Liver cancer	13,956 (9.7)	25 (16–33)	570 (10.8)
4	Poisonings (incl. alcohol intoxication)	12,619 (8.8)	43 (35–51)	293 (5.6)
5	Self-harm	9830 (6.8)	55 (48–62)	184 (3.5)
6	Nontraumatic intracranial haemorrhage	7316 (5.1)	26 (15–34)	290 (5.5)
7	Ischaemic heart disease (incl. acute coronary syndromes)	6936 (4.8)	26 (13–39)	270 (5.1)
8	Stomach cancer	5908 (4.1)	26 (15–35)	229 (4.3)
9	Cerebrovascular disease (incl. ischaemic stroke)	5044 (3.5)	17 (10–27)	264 (5)
10	Cirrhosis	4802 (3.3)	32 (21–40)	160 (3)
11	Chronic lung diseases (incl. COPD)	4505 (3.1)	22 (10–33)	201 (3.8)
12	Lung cancer	4059 (2.8)	26 (16–33)	164 (3.1)
13	Hypothermia	3310 (2.3)	43 (33–51)	78 (1.5)
14	Chronic digestive & liver diseases (excl. cirrhosis)	2758 (1.9)	25 (11–35)	112 (2.1)
15	Chronic kidney disease	2165 (1.5)	22 (9–30)	106 (2)
16	Diabetes	2043 (1.4)	26 (14–36)	78 (1.5)
17	Chronic neurological diseases	1956 (1.4)	33 (16–55)	57 (1.1)
18	Oesophagus cancer	1743 (1.2)	17 (10–25)	96 (1.8)
19	Pancreas cancer	1276 (0.9)	23 (14–34)	53 (1)
20	Lower respiratory infections	1257 (0.9)	30 (12–43)	45 (0.9)
Children				
	Cause of Death	YLL sum (% of total)	YLL per individual (yrs)	n (%)
1	Trauma (incl. falls, drowning, burns & interpersonal violence)	8557 (35.9)	87 (82–90)	100 (35.6)
2	Chronic neurological diseases (incl. neonatal encephalopathy)	2468 (10.3)	88 (81–90)	29 (10.3)
3	Lower respiratory infections	2272 (9.5)	90 (88–90)	26 (9.3)
4	Congenital birth defects	2207 (9.2)	90 (90–90)	25 (8.5)
5	Neonatal disorders	2160 (9.1)	90 (90–90)	24 (8.5)
6	Self-harm	1881 (7.9)	74 (73–77)	25 (8.5)
7	Poisonings (incl. alcoholic intoxication)	888 (3.7)	80 (74–87)	11 (3.9)
8	Chronic heart diseases	480 (2)	77 (75–89)	6 (2.1)
9	Benign neoplasm	256 (1.1)	83	3 (1.1)
10	Chronic lung diseases	241 (1)	77	3 (1.1)

COPD, chronic obstructive pulmonary disease; excl., excluding; incl., including; YLL, years of life lost. Data are given as median values with interquartile ranges, if not otherwise indicated.

Table 2: Causes of out-of-hospital deaths resulting in most years of life lost in Mongolian adults and children.

was higher during winter than spring/summer months. An expert panel judged that 49.3% of out-of-hospital deaths were likely treatable by emergency and critical care interventions.

The observed proportion of out-of-hospital deaths of 71.5% in Mongolia in this study is high compared to other countries. Adair reported home death rates of 59%, 56% and 27% in lower middle-, upper middle- and high-income countries, respectively.⁸ Although we did not assess reasons why deaths occurred outside of hospitals, it is probable that the low population density and low density of healthcare facilities in Mongolian regions together with cultural preferences may have contributed to the high proportion of out-of-hospital deaths. Furthermore, the widespread lack of pre-hospital emergency and acute care services, particularly in Mongolian regions,^{4–7,17,18} likely contributed to

the high burden of out-of-hospital deaths from acute conditions such as trauma, poisonings, self-harm, ischaemic heart disease, stroke, and hypothermia. While the lower proportion of out-of-hospital deaths in children compared to adults was expected and is in line with findings of a previous study,¹⁹ it was surprising that the proportion of out-of-hospital deaths in the capital city was higher during winter than during spring/summer months but not in Mongolian regions. Poisonings including alcohol intoxication with or without consecutive hypothermia could partly explain this unexpected finding.

Except for a higher burden of acute conditions such as trauma, poisonings, and self-harm in patients dying outside of a hospital, the causes of out-of-hospital death identified in this study were comparable to the most common causes of mortality in

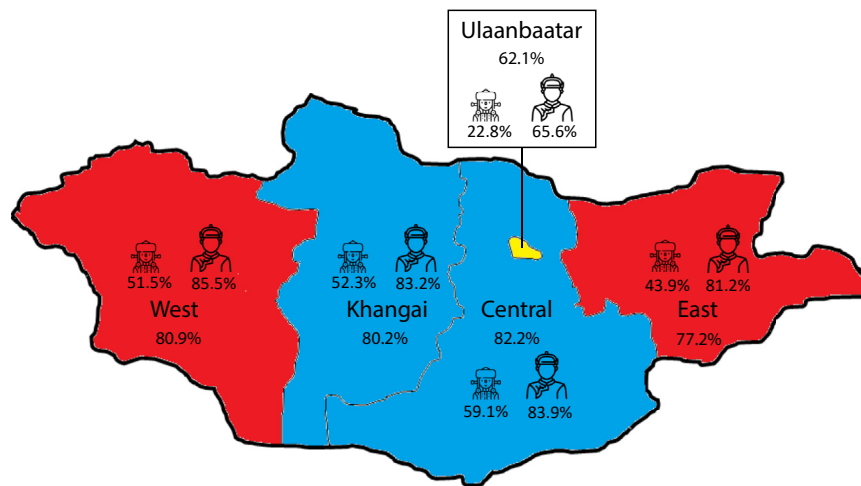


Fig. 2: Proportion of out-of-hospital deaths in the entire population, adults, and children in the four Mongolian regions and the capital city of Mongolia.

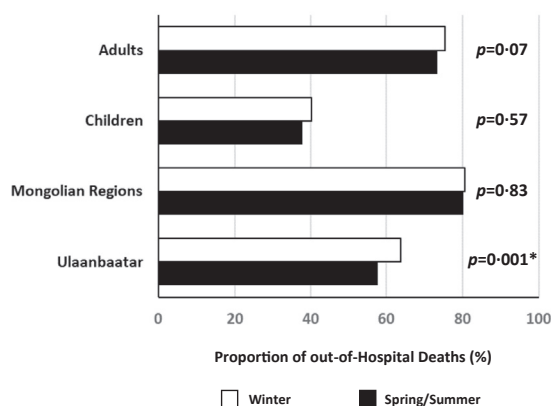


Fig. 3: Differences in the proportion of out-of-hospital deaths between winter and spring/summer months in adults, children, Mongolian regions, and the capital city of Ulaanbaatar. *, significant difference between winter and spring/summer months (level of significance adjusted to $p < 0.125$ due to multiple testing).

Mongolia as reported by the 2019 Global Burden of Disease Study.³ Only few studies have so far specifically assessed causes of out-of-hospital mortality in low- and middle-income countries. Reports from China,²⁰ Bangladesh,²¹ and Sri Lanka²² similarly indicated a high rate of non-communicable diseases, particularly ischaemic heart disease, stroke, as well as chronic respiratory and kidney conditions. Compared to Mongolia, however, out-of-hospital fatalities due to trauma, poisoning including alcohol intoxication, and cancer were substantially less common in these reports.^{20–22} The burden of alcohol use disorders and certain cancers (e.g., liver, stomach, and oesophageal cancer) in Mongolia is known to be among the highest worldwide.³

An expert panel estimated that approximately half of the causes of out-of-hospital deaths in this study would have been likely treatable by emergency and critical care interventions. According to the experts' judgement, the potential benefit of emergency and critical care services to decrease out-of-hospital mortality appears especially pronounced in children and non-geriatric adults. So far, only one study has evaluated how many deaths could be avoided by effective and timely healthcare in Mongolia. Over an 8 years period, 34.4% of all deaths occurring in Mongolia were considered avoidable.²³ The latter study, however, evaluated all deaths occurring in- and outside of hospitals which could explain the lower rate of potentially treatable causes of death reported.²³ When interpreting the estimations of the expert panel in our study, it is important to remember that many emergency conditions carry a high risk of death irrespective of timely and appropriate emergency and critical care. This implies that although half of the causes of out-of-hospital death in this population might have been treatable by emergency and critical care interventions, a certain percentage of death cases may still not have been avoidable. Long distances, harsh weather conditions, the nomadic life style, and the low population density in rural Mongolian regions represent key challenges when planning and setting up country-wide emergency and critical care services in Mongolia. High-income countries with a comparably low population density such as Australia or Iceland may serve as valid blueprints to improve these acute care services in Mongolia.

An important strength of our study is that it included the entire population of Mongolia and overlooked a meaningful observation period. Nonetheless, certain limitations need to be considered when interpreting its results. First, although ICD 10 codes were available for each study participant, the modes to

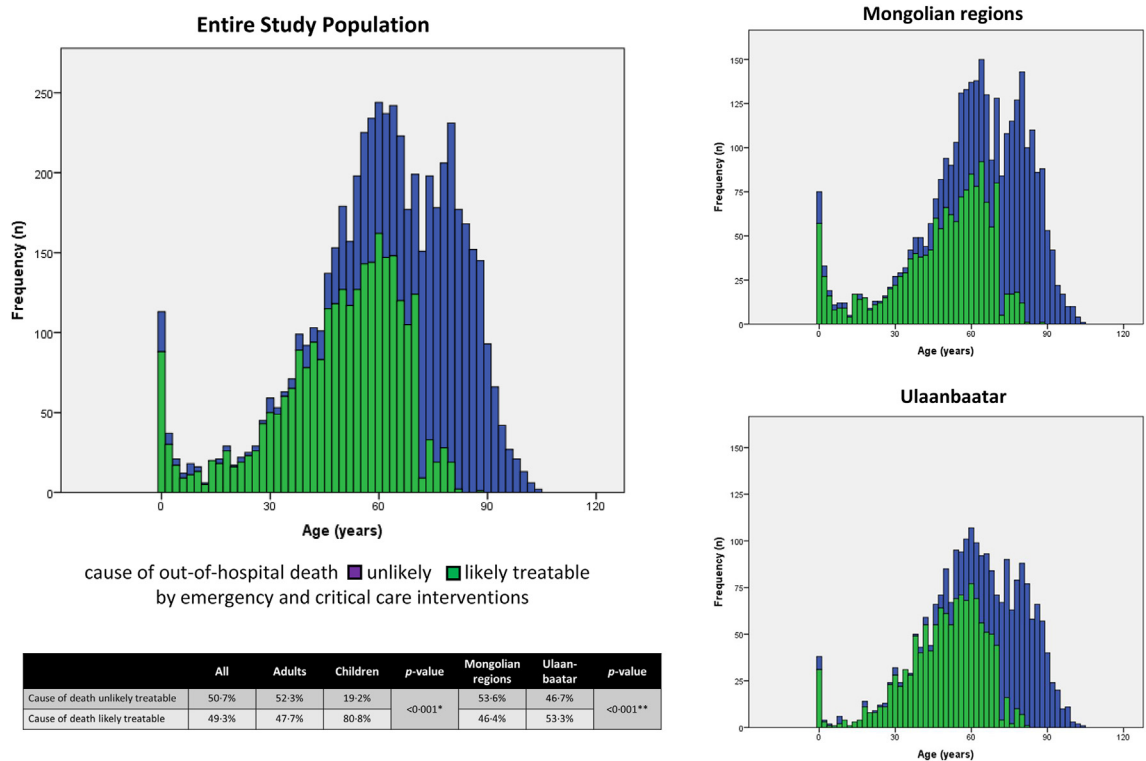


Fig. 4: Frequency of out-of-hospital deaths due to causes likely and unlikely treatable by emergency and critical care interventions across different ages in the entire study population, Mongolian regions, and the capital city of Ulaanbaatar. *, significant difference in the frequency of causes of out-of-hospital deaths likely and unlikely treatable between adults and children; **, significant difference in the frequency of causes of out-of-hospital deaths likely and unlikely treatable between Mongolian regions and Ulaanbaatar.

determine the causes of death were not homogeneous and only relied on autopsy results in one fifth of the study population. It is likely that this fact has introduced a risk of uncertainty to the results on the causes of death in our study. Second, the result whether causes of death were treatable by emergency and critical care interventions could not be objectively measured but was based on consensual judgement by an expert group. Third, the observation period of this study spanned the first six months of 2020. Since the first domestic cases of COVID-19 were reported in Mongolia only in November 2020,⁹ it is unlikely that unrecognized COVID-19 cases have relevantly biased the results of this study. In addition, analysing only six months instead of a longer interval (e.g., one year) might have been too short an observation period to assess seasonal variations in both the proportion and causes of out-of-hospital deaths. Finally, this was a retrospective study thus providing an inferior level of scientific evidence compared with a prospective study. Although our dataset was complete, it might have still been confounded by recall or misclassification bias.

In conclusion, with regional and seasonal variations, about 75% of Mongolian adults and 40% of Mongolian

children died outside of a hospital. Heart diseases, trauma, cancer, and poisonings resulted in most YLLs. About half of the causes of out-of-hospital deaths could be treated by emergency and critical care interventions.

Contributors

AS designed the study, directly accessed and verified the data, collected data, interpreted results, and drafted the manuscript. DG designed the study, directly accessed and verified the data, collected data, interpreted the results, and revised the manuscript for important intellectual content. GL designed the study, directly accessed and verified the data, collected data, interpreted the results, and revised the manuscript for important intellectual content. BB designed the study, directly accessed and verified the data, collected data, interpreted the results, and revised the manuscript for important intellectual content. JM directly accessed and verified the data, conducted the statistical analysis, interpreted the results, and revised the manuscript for important intellectual content. MWD directly accessed and verified the data, conducted the statistical analysis, interpreted the results, and drafted the manuscript. NM designed the study, directly accessed and verified the data, collected data, interpreted the results, and revised the manuscript for important intellectual content.

All authors have accessed and verified the data, and were responsible for the decision to submit the manuscript.

Data sharing statement

The deidentified dataset and related study documents will be made available to individual researchers upon reasonable request (e.g.,

Adults					
Mongolian Regions			Ulaanbaatar		
Cause of Death	YLL sum (% of total)	n (%)	Cause of Death	YLL sum (% of total)	n (%)
1 Chronic heart diseases	9957 (12.6)	500 (16.6)	1 Poisonings (incl. alcohol intoxication)	10,217 (15.9)	241 (10.6)
2 Liver cancer	8387 (10.6)	335 (11.1)	2 Chronic heart diseases	10,064 (15.6)	440 (19.4)
3 Trauma (incl. falls, drowning, burns & interpersonal violence)	8294 (10.5)	171 (5.7)	3 Trauma (incl. falls, drowning, burns & interpersonal violence)	6512 (10.1)	149 (6.6)
4 Ischaemic heart disease (incl. acute coronary syndromes)	5434 (6.9)	196 (6.5)	4 Liver cancer	5569 (8.7)	235 (10.4)
5 Nontraumatic intracranial haemorrhage	5008 (6.3)	204 (6.8)	5 Self-harm	4973 (7.7)	93 (4.1)
6 Self-harm	4857 (6.1)	91 (3)	6 Cerebrovascular disease (incl. ischaemic stroke)	2661 (4.1)	146 (6.4)
7 Stomach cancer	4061 (5.1)	150 (5)	7 Cirrhosis	2539 (3.9)	78 (3.4)
8 Chronic lung diseases (incl. COPD)	3693 (4.7)	153 (5.1)	8 Nontraumatic intracranial haemorrhage	2308 (3.6)	86 (3.8)
9 Lung cancer	2703 (3.4)	104 (3.5)	9 Hypothermia	2111 (3.3)	51 (2.3)
10 Chronic digestive & liver diseases (excl. cirrhosis)	2420 (3.1)	94 (3.1)	10 Stomach cancer	1847 (2.9)	79 (3.5)

Children					
Mongolian Regions			Ulaanbaatar		
Cause of Death	YLL sum (% of total)	n (%)	Cause of Death	YLL sum (% of total)	n (%)
1 Trauma (incl. falls, drowning, burns & interpersonal violence)	7289 (40.9)	85 (40.5)	1 Trauma (incl. falls, drowning, burns & interpersonal violence)	1268 (21)	15 (21.1)
2 Chronic neurological diseases (incl. neonatal encephalopathy)	2037 (11.4)	24 (11.4)	2 Neonatal disorders	810 (13.4)	9 (12.7)
3 Congenital birth defects	1667 (9.4)	19 (9)	3 Lower respiratory infections	719 (11.9)	8 (11.3)
4 Lower respiratory infections	1553 (8.7)	18 (8.6)	4 Self-harm	600 (9.9)	8 (11.3)
5 Neonatal disorders	1350 (7.6)	15 (7.1)	5 Poisonings (incl. alcohol intoxication)	568 (9.4)	7 (9.9)

Table 3: Differences between Mongolian regions and the capital city Ulaanbaatar in causes of out-of-hospital deaths resulting in most years of life lost in adults and children.

detailed research plan) and following signing a data access agreement with the Mongolian Centre for Health Development.

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

None of the authors has a financial or other conflict of interest in regards of data discussed in this manuscript.

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