NOTES

Underlying cause of death at medical facilities in Xaiyabouli Province, Lao People's Democratic Republic

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ABSTRACT

In Lao PDR, Ministry of Health introduced District Health Information Software 2 (DHIS2) in 2013. Although DHIS2 includes cause of death, Lao government did not request to report cause of death through DHIS2, resulting in no information on frequency of underlying cause of death even for the deaths at medical facility. This study aimed to collect the information on the underlying cause of death at all medical facilities in Xaiyabouli province, a rural area in Lao PDR. As well as the point estimate of the proportion, a 95% confidence interval (CI) based on a binomial distribution was calculated for each cause of death. According to the local government request, 226 deaths (128 males and 98 females) in 2019 were reported from all medical facilities in the province. Among them, infectious diseases were the most frequent (33.6%, 95% CI 27.5–40.2%); sepsis (16.8%, 95% CI 12.2–22.3%), pneumonia (8.8%, 95% CI 5.5–13.3%), and meningitis (4.9%, 95% CI 2.5–8.5%). Heart diseases were 15.9% (95% CI 11.4–21.4%) including heart failure and myocardial infarction. Injury was 10.2% (95% CI 6.2–14.4%) including brain injury. Neonatal death was 10.6% (95% CI 6.9–15.4%). Among those, preterm death was common (8.8%, 95% CI 5.3–13.3%). Renal failure was 8.0% (95% CI 4.8–12.3%). According to civil registration covering all deaths both at facilities and outside facilities, deaths at facilities were 16.8% of the whole deaths (1,372 deaths) in Xaiyabouli province. Although deaths outside facilities were not included, this is the first report demonstrating cause of death in one province in Lao PDR.

Keywords: deaths at health facilities, underlying cause of death, Xaiyabouli Province, Lao PDR

Abbreviations:
CI: confidence interval
Lao PDR: Lao People's Democratic Republic
DHIS2: District Health Information Software 2
ICD-10: International Classification of Diseases 10
SPSS: Statistical Package for the Social Sciences
COPD: chronic obstructive pulmonary disease
ECG: electrocardiogram

INTRODUCTION

Information on the underlying cause of death is an essential guide for policy makers, planners, and managers to plan, implement, monitor, and evaluate public health strategies.[1-4] In several countries, the health statistics are summarized at each facility, reported to a local government, and sent to the central government.[5] Each country must develop its own systems to fit in its infrastructure in an inexpensive and reasonably accurate manner that is linkable to the current policy making.

In Lao People's Democratic Republic (PDR), death at home is reported verbally to village office by a family member (household representative). When a person dies at a medical/health facility, the facility issues a death notification and a family member submit it to village office. However, underlying cause of death is not tabulated nor reported to central government. The Ministry of Health of Lao PDR decided to switch their health management information system from Excel-based to web-based District Health Information Software 2 (DHIS2) at the end of 2013.[6] Although DHIS2 covers the causes of death, the Lao government did not request reporting of the causes of death through DHIS2. Notably, there is no process to report the possible cause of death for deaths occurring outside medical facilities.

Lao PDR is a landlocked country with a population of 6.4 million; 32.0% of the population is aged 0–14 years, 63.7% are aged 15–64 years, and 4.2% are aged ≥65 years according to the Population Census in 2015.[7] The life expectancy at birth in 2010 was 65.7 years for men and 68.5 years for women.[8] The maternal mortality ratio decrease from 530 per 100,000 live births in 2000 to 357 per 100,000 live births in 2012. However, undernutrition is high in children, with 44.2% children aged <5 years having low height for their age (stunting) and 26.6% having low weight for their age in 2012.[8]

Although the data source has not been clearly described, the World Health Organization stated that the mortality rate among individuals aged 15–59 years in 2017 was 159 per 1,000 in females and 197 per 1,000 in males.[9] The most prevalent causes of death in Laos were influenza and pneumonia (13%), coronary heart diseases (11%), stroke (10%), and dengue (9%).[9] There was no information about the underlying causes of death in Lao PDR, except that from a tertiary hospital in Vientiane capital from 2013 to 2015.[10] This study aimed to report the underlying causes of death at all hospitals in Xaiyabouli province.

MATERIALS AND METHODS

Subjects and characteristics of health facilities in Xaiyabouli province

The subjects were Xaiyabouli individuals who died at hospitals from January to December 2019 in Xaiyabouli province, Lao PDR. Xaiyabouli province is located in the northwest of the country.[11] It covers an area of 16,389 km^2 and had a population of 381,000 people (194,000 females and 187,000 males) according to the Population and Housing Census in 2015. The province is located on the west of Mekong River, which borders Thailand to the west. According to the Xaiyabouli Provincial Governor Office, the main industries are Xayaburi dam in Xaiyabouli district and Hongsa powerplant in Hongsa district. Health services are provided at 88 public health facilities; 1 provincial hospital, 10 district hospitals, and 77 health centers (Fig. 1).
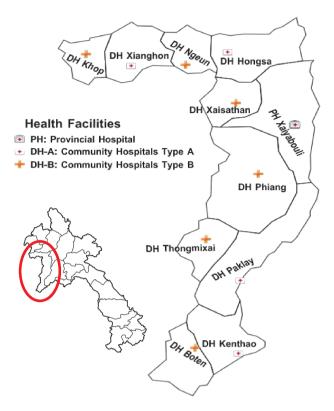
Fig. 1 Map of Xaiyabouli province showing district hospital

Xaiyabouli Provincial Hospital is the largest hospital in Xaiyabouli province, with 120 beds for inpatient services and an emergency room. In 2019, the bed utilization rate was 106.9%. The total number of staff was 146 (28 physicians, 51 nurses, 13 pharmacists, 3 dentists, and 51 others). This hospital provides general surgeries, including hysterectomy, myomectomy, cholecystectomy, laminectomy, resection/reconstructive surgery of the digestive tract (level 3 surgery),[12] caesarian section, and laparoscopic surgery. Hemodialysis machines were introduced in 2018.

According to the rule of the Ministry of Health of Lao PDR, district hospitals should have 20 beds for inpatient services. In Xaiyabouli province, the actual number of beds was 18.5 (range, 10–20) beds on average per district hospital in 2019. Among the 10 district hospitals, there are four type A district hospitals and six type B district hospitals. Type A hospitals can provide major surgeries, while type B hospitals cannot. Overall, the district hospitals had 259 employees, including 70 physicians (range, 2–18 per hospital) and 103 nurses (range, 3–28 per hospital) in 2019.

Health centers are also classified into types A and B. Type A health centers have ≥5 beds for inpatient services and 5–7 medical professionals, including doctors and nurses. Type B health centers have <5 beds for inpatient services and 3–5 health workers. Among the 77 health centers in Xaiyabouli province, 12 health centers were classified as type A, and the other 65 health centers were classified as type B. Type A health centers had 5–10 health workers per center, while type B health centers had 1–4 workers per center. Among them, 73 (94.8%) health centers could provide childbirth services. In total, 341 employees, including 206 nurses (1–3 per health

center) and 14 physicians worked at 77 health centers.

Data collection

Data collection was conducted from August to October 2020 by staff in the statistical section of the provincial hospital and 10 district hospitals in Xaiyabouli province. The data were collected from the record system, such as a log book/computer at each hospital or health center. After confirmation by the head of the facilities, the information was sent to the main researcher at the Xaiyabouli Provincial Health Office.

The total number of deaths in 2019 was obtained from the Plaining and Cooperate Unit of the Xaiyabouli Provincial Health Office. The data were reported from village health volunteers through health centers and district health offices to the Xaiyabouli Provincial Health Office.

Classification of cause

The underlying cause of death was classified based on International Classification of Diseases 10 (ICD-10).[13] The injuries were categorized into poly shock, brain injury or other injuries. Poisoning was categorized into food toxicity, food allergy, and others. When ≥2 diseases were described, the more serious condition or an origin of disease was considered the main underlying cause of death.[10,14] For example, hypertension, diabetes mellitus, heart failure, cerebral hemorrhage/infarction, myocardial infarction, liver cirrhosis, chronic kidney disease, anemia, diarrhea, or pneumonia was not considered the main cause of death when dengue hemorrhagic fever (DHF), cancer, sepsis, tetanus, meningitis, or Japanese encephalitis was described. Among individuals with cancer, sepsis, or Japanese encephalitis, and DHF, DHF was selected as the main cause. Among individuals with cancer or sepsis and tetanus, tetanus was selected as the main cause.

Statistical analysis

The data were entered to Statistical Package for the Social Sciences (SPSS) for Windows. A 95% confidence interval (CI) of percentage were calculated based on a binomial distribution. Descriptive statistics were used to describe characteristics of subjects and variables. A chi-square test was performed to examine the difference in the proportion. A p-value less than 0.05 was considered as statistically significance.

Ethical issues

This data was collected from an internal document at health offices for management purposes. The head of the Xaiyabouli Provincial Health Office permitted the reporting of anonymized results in an academic journal.

RESULTS

Sex and age distribution of deaths

The total deaths and age-specific rates in Xaiyabouli province in 2019 according to the Planning and Cooperate Unit of Xaiyabouli Provincial Health Office are shown in Table 1. In total, 1,372 deaths (677 females and 695 males) were reported. The death rate was 3.5 per 1,000; 3.5 per 1,000 females and 3.4 per 1,000 males. Although there were significant differences in the death rate between females and males among several 5-year age groups, no difference in the rate between females and males was observed as a whole.

Table 1 Sex and age distributions of deaths and mortality rate per 1,000 in Xaiyabouli province, 2019

Age	Females		Males		Total	
	N	Rate	N	Rate	N	Rate
0–4	150	7.1	176	7.6	326	7.4
5–9	27	1.1	25	1.2	52	1.2
10–14	13	0.5	11	0.5	24	0.5
15–19	28	1.1	32	1.4	60	1.3
20–24	43	2.3	42	2.1	85	2.2
25–29	28	1.9	58	3.7**	86	2.8
30–34	50	4.2***	11	0.8	61	2.4
35–39	21	1.9	37	3.2	58	2.6
40–44	28	2.7	21	2.1	49	2.4
45–49	50	6.0*	26	3.3	76	4.7
50–54	14	2.6	32	5.5*	46	4.1
55–59	58	13.4***	26	5.3	84	9.1
60–64	14	3.4	53	13.3***	67	8.2
65–69	50	10.6	48	12.6	98	11.5
70–74	50	12.1	32	7.9	82	10.0
75–79	43	11.0**	21	5.2	64	8.1
≥ 80	28	9.8	26	8.1	54	8.9
Total	695	3.5	677	3.4	1,372	3.5

* p<0.05, ** p<0.01, and *** p<0.001 for the difference in rate between males and females.

Table 2 shows the number of deaths in health facilities and total number of deaths according to the district. There were 226 deaths (98 females and 128 males) in health facilities. Their mean ± standard deviation of age were 35.6 ± 28.0 years. Those among the whole 1,372 deaths were 36.7 ± 27.8 years. Deaths in health facilities accounted for 16.5% of the total deaths in Xaiyabouli province. The percentage varied from 2.6% of Boten district to 49.3% of Hongsa district, and was significantly higher in males (18.9%) than in females (14.1%) (p=0.016). Deaths in health facilities were the most frequent in Xaiyabouli district (44.2%, 100/226), follow by Phiang district (16.4%, 37/226), Hongsa district (15.9%, 36/226) and Paklay district (8.0%, 18/226).

Table 2 Deaths in health facilities and total deaths according to district of Xaiyabouli province in 2019

District	Population	Females		Males		Total	
		In/Total	%	In/Total	%	In/Total	%
Xaiyabouli	76,929	43/165	26.1	57/158	36.1	100/323	31.0
Khop	20,668	2/ 35	5.7	0/ 34	0.0	2/ 69	2.9
Xianghon	33,374	4/ 42	9.5	7/ 41	17.1	11/ 83	13.3
Gneun	18,432	2/ 46	4.3	3/ 45	6.7	5/ 91	5.5
Hongsa	28,721	16/ 37	43.2	20/ 36	55.6	36/ 73	49.3
Phiang	60,192	20/109	18.3	17/107	15.9	37/216	17.1
Paklay	71,514	6/ 33	18.2	12/ 31	38.7	18/ 64	28.1

Kenthao	42,494	1/108	0.9	6/103	5.8	7/211	3.3
Boten	18,775	0/ 38	0.0	2/ 38	2.0	2/ 76	2.6
Thongmixai	9,213	0/ 26	0.0	2/ 26	7.7	2/ 52	3.8
Xaisathan	15,775	4/ 56	7.1	2/ 58	3.4	6/114	5.3
Total	396,087	98/695	14.1	128/677	18.9	226/1,372	16.5

In/Total: deaths in health facilities over total deaths

Most deaths in health facilities were reported from Xaiyabouli Provincial Hospital (80 females and 89 males). Ten district hospitals reported 53 deaths (17 females and 36 males). The remaining 4 deaths were reported from 2 health centers. There were no deaths in Boten District Hospital, Thongmixai District Hospital, and Xaisathan District Hospital in 2019 (Table 3).

Table 3   Reported number of deaths according to medical facility in Xaiyabouli province in 2019

Place of death	Females	Males	Total
	N (%)	N (%)	N (%)
Xaiyabouli Provincial Hospital	80 (81.6)	89 (96.5)	169 (74.8)
Health center, Xaiyabouli district	1 (1.0)	1 (0.8)	2 (0.9)
Health center, Xaisathan district	0 (0.0)	2 (1.6)	2 (0.9)
Khop Disctrict Hospital	2 (2.0)	0 (0.0)	2 (0.9)
Xienghon District Hospital	3 (3.1)	7 (5.5)	10 (4.4)
Gneun District Hospital	1 (1.0)	1 (0.8)	2 (0.9)
Hongsa District Hospital	8 (8.2)	17 (13.3)	25 (11.1)
Phiang District Hospital	1 (1.0)	1 (0.8)	2 (0.9)
Paklay District Hospital	1 (1.0)	4 (3.1)	5 (2.2)
Kenthao District Hospital	1 (1.0)	6 (4.7)	7 (3.1)
Boten District Hospital	0 (0.0)	0 (0.0)	0 (0.0)
Thongmixai District Hospital	0 (0.0)	0 (0.0)	0 (0.0)
Xaisathan District Hospital	0 (0.0)	0 (0.0)	0 (0.0)
Total	98 (100)	128 (100)	226 (100)

Underlying cause of death

Table 4 demonstrates the underlying cause of death among 226 deaths in health facilities. Infection diseases (33.6%, 95% CI 27.5–40.2%) were the major cause of death in Xaiyabouli province; 29.6% (95% CI 20.6–39.9%) in females and 36.7% (95% CI 27.5–44.5%) in males. Among them, sepsis was the most frequent (16.8%, 95% CI 12.2–22.3%); 16.3% (95% CI 9.7–25.0%) in females and 17.2% (95% CI 9.9–22.9%) in males, followed by pneumonia (8.8%, 95% CI 5.5–13.3%); 5.1% (95% CI 0.7–9.5%) in females and 11.5% (95% CI 6.0–17.1%) in males, and meningitis (4.9%, 95% CI 2.5–8.5%); 3.1% (95% CI 0.4–6.5%) in females and 6.3% (95% CI 2.0–10.5%) in males.

Table 4 Underlying cause of death in health facilities of Xaiyabouli province in 2019

Diagnosis	Females N (%)	Males N (%)	Total N (%)	ICD-10
Infectious diseases	29 (29.6)	47 (36.7)	76 (33.6)	A00-B99
Sepsis	16 (16.3)	22 (17.2)	38 (16.8)	A41. 9
Severe pneumonia	5 (5.1)	15 (11.5)	20 (8.8)	J18. 9
Meningitis	3 (3.1)	8 (6.3)	11 (4.9)	G03.9
Dengue hemorrhagic fever	1 (1.0)	0 (0.0)	1 (0.4)	A91
Diarrhea	0 (0.0)	1 (0.8)	1 (0.4)	R19.7
Diarrhea with blood	1 (1.0)	0 (0.0)	1 (0.4)	K92.1
Jaundice syndrome	1 (1.0)	0 (0.0)	1 (0.4)	R17
Peritonitis	1 (1.0)	1 (0.8)	2 (0.9)	K65.9
Pulmonary tuberculosis	1 (1.0)	0 (0.0)	1 (0.4)	A15.0
Heart diseases	16 (16.3)	20 (15.6)	36 (15.9)	I00-I99
Heart failure	12 (12.2)	14 (10.9)	26 (11.5)	I50.9
Myocardial infarction	3 (3.1)	6 (4.7)	9 (4.0)	I21-I22
Congenital heart disease	1 (1.0)	0 (0.0)	1 (0.4)	Q24.9
Injury	8 (8.2)	15 (11.7)	23 (10.2)	S00-T88
Brain injury	6 (6.1)	11 (8.6)	17 (7.5)	S09.90XA
Other site	1 (1.0)	2 (1.6)	3 (1.3)	T14.8
Bite	0 (0.0)	1 (0.8)	1 (0.4)	W57.XXXA
Burn stage II	1 (1.0)	1 (0.8)	2 (0.9)	T30.0
Neonatal death	13 (13.3)	11 (8.6)	24 (10.6)	P00-P04
Preterm	12 (12.2)	8 (6.3)	20 (8.8)	P07.38
Birth asphyxia	1 (1.0)	2 (1.6)	3 (1.3)	P21
Stillbirth	0 (0.0)	1 (0.8)	1 (0.4)	Z37.1
Renal disease	11 (11.2)	7 (5.5)	18 (8.0)	N17-N19
Renal failure	11 (11.2)	7 (5.5)	18 (8.0)	N17-N18
Cerebrovascular disease	7 (7.1)	4 (3.1)	11 (4.9)	I60-I69
Hemorrhagic stroke	7 (7.1)	4 (3.1)	11 (4.9)	I67.9
Malignant neoplasm	3 (3.1)	4 (3.1)	7 (3.1)	C00-C97
Leukemia	0 (0.0)	1 (0.8)	1 (0.4)	C95.90
Lung cancer	1 (1.0)	0 (0.0)	1 (0.4)	C34.90
Thalassemia	1 (1.0)	0 (0.0)	1 (0.4)	D56.9
Brain tumor	1 (1.0)	1 (0.8)	2 (0.9)	C71. 9
Stomach cancer	0 (0.0)	1 (0.8)	1 (0.4)	C16. 9
Scleroderma	0 (0.0)	1 (0.8)	1 (0.4)	L94.0
Respiratory disease	4 (4.1)	4 (3.1)	8 (3.5)	J00-J99
Respiratory failure	4 (4.1)	2 (1.6)	6 (2.7)	J96.00
COPD	0 (0.0)	1 (0.8)	1 (0.4)	J44.9
Pulmonary edema acute	0 (0.0)	1 (0.8)	1 (0.4)	J81.0
Malnutrition	0 (0.0)	6 (4.7)	6 (2.7)	E40-E46
Beriberi	0 (0.0)	1 (0.8)	1 (0.4)	E51.1
Malnutrition	0 (0.0)	3 (2.3)	3 (1.3)	E46

Anemia	0 (0.0)	2 (1.6)	2 (0.9)	D64.9
Liver cirrhosis	1 (1.0)	4 (3.1)	5 (2.2)	K70-K77
Digestive system disease	1 (1.0)	3 (2.3)	4 (1.8)	K00-K95
Gastric perforation	0 (0.0)	2 (1.6)	2 (0.9)	K25.1
Hemorrhagic digestive	1 (1.0)	2 (1.6)	3 (1.3)	K92.2
Maternal death	3 (3.1)	-	3 (1.3)	O00-O94
Eclampsia	1 (1.0)	-	1 (0.4)	O15.9
Ectopic pregnancy	1 (1.0)	-	1 (0.4)	O00.9
Post-partum hemorrhage	1 (1.0)	-	1 (0.4)	O72.1
Hypoglycemia	0 (0.0)	1 (0.8)	1 (0.4)	E00-E89
Arterial thromboembolism	0 (0.0)	1 (0.8)	1 (0.4)	T80-T88
Hyperthyroidism	1 (1.0)	0 (0.0)	1 (0.4)	E00-E89
Irreversible shock	1 (1.0)	1 (0.8)	2 (0.9)	R00-R99
Total	98 (100)	128 (100)	226 (100)	

COPD: chronic obstructive pulmonary disease
ICD-10: International Classification of Diseases 10

Heart diseases (15.9%, 95% CI 11.4–21.4%) were the second most prevalent cause of death; 16.3% (95% CI 8.9–23.8%) in females and 15.6% (95% CI 9.2–22.0%) in males. Among them, heart failure (11.5%, 95% CI 7.7–16.4%) was more frequent; 12.2% (95% CI 5.3–18.6%) in females and 10.9% (95% CI 5.5–16.4%) in males, followed by myocardial infarction (4.0%, 95% CI 1.8–7.4%); 3.1% (95% CI 0.4–6.5%) in females and 4.7% (95% CI 1.0–8.4%) in males.

Injuries including brain injury, injury to other sites, insect bites, and burn, were the third common cause (10.2%, 95% CI 6.2–14.4%); 8.2% (95% CI 2.4–10.7%) in females and 11.7% (95% CI 6.1–18.2%) in males. Among them, brain injury (7.5%, 95% CI 4.4–11.8%) was the main cause; 6.1% (95% CI 0.8–10.1%) in females and 8.7% (95% CI 3.7–12.8%) in males, and two cases with burns were classified as stage II with co-infection.

Preterm births, birth asphyxia, and stillbirths together accounted for 10.6% (95% CI 6.9–15.4%); 13.3% (95% CI 6.4–20.1%) in females and 8.6% (95% CI 3.7–13.5%) in males. Among them, preterm deaths were the most common (8.8%, 95% CI 5.3–13.3%); 12.2% (95% CI 5.6–18.8%) in females and 6.3% (95% CI 2.0–10.5%) in males.

The underlying cause of death according to age groups were tabulated in Appendix 1. Among individuals aged <20 years, infectious diseases were the most common (44.7%, 95% CI 33.3–56.1%), follow by neonatal death (31.5%, 95% CI 20.9–42.3%). Among individuals aged 20–59 years, the most frequent causes of death were infectious diseases (26.0%, 95% CI 16.7–35.5%), injuries (18.1%, 95% CI 9.0–25.0%), heart disease (17.0%, 95% CI 9.0–25.1%), and renal failure (17.0%, 95% CI 9.0–25.1%). Among individuals aged ≥60 years, infectious diseases (30.6%, CI 18.8–42.4%) and heart disease (27.5%, 95% CI 16.0–38.8%) were the most prevalent causes of death.

Modern diagnosis tests provided

Due to the capacity of the hospital and the short duration of stay in the hospital, modern diagnostic tests were provided in a limited manner. Usually, diseases are diagnosed based on the symptoms and signs obtained through physical checkups. Blood tests were performed in 101 cases, including 50 cases of infectious disease and 12 cases of renal failure. Heart diseases were

confirmed by electrocardiogram (ECG) in only 7 of 36 cases. Plain radiography was used in 31 cases, including 11 cases of infectious disease and 10 cases of injury, while ultrasound was used in 12 cases of renal failure and 10 cases of infectious disease (Table 5).

Table 5 Provided diagnosis tests according to underlying cause of death

Underlying cause of death	Diagnosis test			
	Blood*	ECG	X-ray	Ultrasound
Injury (n=23)	7	0	10	0
Infection diseases (n=76)	50	1	11	10
Heart disease (n=36)	6	7	1	1
Renal failure (n=18)	12	1	1	12
Live cirrhosis (n=5)	5	0	0	5
Other (n=68)	21	7	8	9
Total (n=226)	101	16	31	37

* Blood tests include white blood cell, hemoglobin, red blood cell, hematocrit test, platelet count test, mean corpuscular volume, mean corpuscular hemoglobin, cholesterols, triglycerides, fasting blood sugar test, aspartate transaminase, alanine transaminase, creatinine, blood urea nitrogen.
ECG: electronic cardiogram

DISCUSSION

This was the first study to report the cause of death at health facilities in a rural area in Lao PDR. Infectious diseases (33.8%) including sepsis, pneumonia, and meningitis were the most frequent cause of deaths. Heart diseases including heart failure and myocardial infarction were observed in 15.9% patients. Neonatal mortality accounted for 10.6% deaths. Injuries including brain injuries accounted for 10.2% deaths and renal failure accounted for 8.0% deaths. Among individuals aged <20 years, the common causes of death were infectious diseases (44.7%) and neonatal mortality (31.5%). Among individuals aged 20–59 years, the predominant causes of death were infectious diseases (26.0%), injuries (18.1%), heart diseases (17.0%), and renal failure (17.0%). Among individuals aged ≥60 years, the predominant causes of death were infectious diseases (30.6%) and heart diseases (27.5%).

The above finding showed that infection diseases including sepsis, pneumonia and meningitis were the major underlying causes of death. The proportion was higher than that at a tertiary hospital in Vientiane and that reported in previous studies.[7,10,15] This higher proportion in a rural province seemed plausible despite the recent improvements in sanitation.

Heart diseases were the second most common cause of death at health facilities in Xaiyabouli. Since most deaths were recorded as heart failure, the actual cause was unknown. ECG was used in only 7 cases. The routine application of ECG and training for ECG diagnosis are necessary to improve diagnosis accuracy. Since these are cheap and easy to use, they should be strongly recommended.

The proportion of injury-related deaths was similar to that reported in a study in Luangprabang province,[16] but smaller than that reported in a tertiary hospital in Vientiane.[10] Death due to injury is caused mainly by serious head injuries in motorcycle riders due to traffic accidents. In addition, as the tertiary hospital is an acute hospital, the heavier traffic in Vientiane may reflect a higher proportion. Although data on the cause of injury in Xaiyabouli were not collected in

this study, injury-related deaths could be reduced by relaying strong instructions for motorcycle riders to use a helmet in Xaiyabouli.

Renal failure was observed most frequently among individuals aged 20–59 years. This finding was similar to that reported by a study conducted at a tertiary hospital in Vientiane.[10] Although kidney disease was 10th most common cause of death in Lao PDR according to the World Health Ranking,[17] its ranking has decreased after the introduction of hemodialysis machines in Xaiyabouli Provincial Hospital in 2018.

Xaiyabouli Provincial Hospital, located in the Xaiyabouli district, shares borders with Hongsa district to the north, Xaisathan district to the west, and Phiang district to the south. Since these districts are near Xaiyabouli Provincial Hospital, individuals living in these districts could also use the healthcare services at Xaiyabouli Provincial Hospital. In case of emergency or serious conditions, people living in the other seven districts could also use the healthcare service at the nearest type A hospital or Xaiyabouli Provincial Hospital.

This study has several limitations. First, information on the deaths of inhabitants who died in a hospital in another province was not available. Although the number might be small, the percentage of death in facilities could be underestimated and may influence the percentages of the underlying causes of death. Second, the use of modern equipment for diagnosis was limited, resulting in the misdiagnosis of the cause of death. Finally, most data on causes of death were collected from handwritten medical charts. This could cause errors due to an unreadable diagnosis. In addition, the selection of one cause of death among several conditions at death was based on the staff of each facility, not controlled by researchers. When two or more causes were sent to the researchers, the selection of one serious disease became arbitrarily because there was no information on the severity of the diseases.

In conclusion, the study showed the underlying cause of death in health facilities in Xaiyabouli province, Lao PDR. The most frequent cause of death was infection diseases, follow by heart diseases, injury and neonatal mortality. Although this was the first report on underlying cause of death based on medical chart, the collected deaths were a part of the whole deaths in Xaiyabouli province. A system to collect information on underlying cause of death including deaths outside health facilities should be established for the priority setting of health services. The obtained information on disease frequency could also allow the studies to examine the risk factors in Lao PDR.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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Appendix

Appendix 1 Underlying cause of death according to age

Diagnosis	Females N (%)	Males N (%)	Total N (%)	ICD-10
0–19 years				
Infectious diseases	10 (31.9)	24 (52.1)	34 (44.7)	A00-B99
Sepsis	4 (13.3)	11 (23.9)	15 (19.7)	A41. 9
Severe pneumonia	2 (6.7)	6 (13.0)	8 (10.5)	J18. 9
Meningitis	1 (3.3)	6 (13.0)	7 (9.2)	G03.9
Dengue hemorrhagic fever	1 (3.3)	0 (0.0)	1 (3.3)	A91
Diarrhea with blood	1 (3.3)	0 (0.0)	1 (3.3)	K92.1
Diarrhea	0 (0.0)	1 (2.2)	1 (3.3)	R19.7
Jaundice syndrome	1 (3.3)	0 (0.0)	1 (3.3)	R17
Neonatal death	13 (43.3)	11 (23.8)	24 (31.5)	P00-P04
preterm	12 (40.0)	8 (17.3)	20 (6.3)	P07.38
Birth asphyxia	1 (3.3)	2 (4.3)	3 (3.9)	P21
Stillbirth	0 (0.0)	1 (2.2)	1 (1.3)	Z37.1
Injury	2 (6.6)	2 (4.3)	4 (5.2)	S00-T88
Brain injury	1 (3.3)	2 (4.3)	3 (3.9)	S09.90XA
Other site injury	1 (3.3)	0 (0.0)	1 (1.3)	T14.8
Heart diseases	2 (6.6)	2 (4.3)	4 (5.2)	I00-I99
Heart failure	1 (3.3)	2 (4.3)	3 (3.9)	I50.9
Congenital heart disease	1 (3.3)	0 (0.0)	1 (1.3)	K92.1
Respiratory failure	1 (3.3)	1 (2.2)	2 (2.6)	J96.00
Malnutrition	0 (0.0)	2 (4.3)	2 (2.6)	E46
Eclampsia	1 (3.3)	0 (0.0)	1 (3.3)	O15.9
Renal failure	0 (0.0)	1 (2.2)	1 (3.3)	N17-N18
Thalassemia	1 (3.3)	0 (0.0)	1 (3.3)	D56.9
Beriberi	0 (0.0)	1 (2.2)	1 (3.3)	E51.1
Irreversible shock	0 (0.0)	1 (2.2)	1 (3.3)	R57.1
Brain tumor	0 (0.0)	1 (2.2)	1 (3.3)	C71. 9
Total	30 (100)	46 (100)	76 (100)	
20–59 years				
Infectious diseases	9 (20.0)	14 (29.2)	23 (26.0)	A00-B99
Sepsis	7 (5.0)	5 (10.4)	12 (13.6)	A41. 9
Severe pneumonia	1 (2.5)	6 (12.5)	7 (8.0)	J18. 9
Meningitis	1 (2.5)	2 (4.2)	3 (3.4)	G03.9
Peritonitis	0 (0.0)	1 (2.1)	1 (1.1)	K65.9
Injury	5 (12.5)	11 (22.9)	16 (18.1)	S00-T88
Brain injury	4 (10.0)	8 (16.7)	12 (13.6)	S09.90XA
Other site injury	0 (0.0)	2 (4.2)	1 (1.1)	T14.8
Burn stage II	1 (2.5)	0 (0.0)	1 (1.1)	T30.0
Bite	0 (0.0)	1 (2.1)	1 (1.1)	W57.XXXA

Renal diseases	11 (30.0)	4 (8.3)	15 (17.0)	N17-N19
Renal failure	11 (27.5)	4 (8.3)	15 (17.0)	N17-N18
Heart diseases	5 (12.5)	10 (20.9)	15 (17.0)	I00-I99
Heart failure	4 (10.0)	7 (14.6)	11 (12.5)	I50.9
Myocardial infarction	1 (2.5)	3 (6.3)	4 (4.5)	I21-I22
Hemorrhagic stroke	3 (7.5)	2 (4.2)	5 (5.7)	I67.9
Anemia	0 (0.0)	2 (4.2)	2 (2.3)	D64.9
Ectopic pregnancy	1 (2.5)	0 (0.0)	1 (1.1)	O00.9
Hyperthyroidism	1 (2.5)	0 (0.0)	1 (1.1)	E05
COPD	0 (0.0)	1 (2.2)	1 (1.1)	J44.9
Lung cancer	1 (2.5)	0 (0.0)	1 (1.1)	C34.90
Postpartum hemorrhage	1 (2.5)	0 (0.0)	1 (1.1)	O72.1
Irreversible shock	1 (2.5)	0 (0.0)	1 (1.1)	R57.1
Brain tumor	1 (2.5)	0 (0.0)	1 (1.1)	C71. 9
Severe hypoglycemia	0 (0.0)	1 (2.1)	1 (1.1)	E16.2
Respiratory failure	1 (2.5)	0 (0.0)	1 (1.1)	J96.00
Hemorrhagic digestive	0 (0.0)	1 (2.1)	1 (1.1)	K92.2
Liver cirrhosis	0 (0.0)	1 (2.1)	1 (1.1)	K74.60
Scleroderma	0 (0.0)	1 (2.1)	1 (1.1)	L94.0
Total	40 (100)	48 (100)	88 (100)	
60 years or older				
Infectious diseases	11 (39.3)	8 (23.5)	19 (30.6)	A00-B99
Sepsis	6 (21.4)	5 (14.7)	11 (17.7)	A41. 9
Severe pneumonia	2 (7.1)	3 (8.8)	5 (8.1)	J18. 9
Meningitis	1 (3.6)	0 (0.0)	1 (1.6)	G03.9
Peritonitis	1 (3.6)	0 (0.0)	1 (1.6)	K65.9
pulmonary tuberculosis	1 (3.6)	0 (0.0)	1 (1.6)	A15.0
Heart diseases	9 (32.1)	8 (23.5)	17 (27.5)	I00-I99
Heart failure	7 (25.0)	5 (14.7)	12 (19.4)	I50.9
Myocardial infarction	2 (7.1)	3 (8.8)	5 (8.1)	I21-I22
Hemorrhagic stroke	4 (14.3)	2 (5.9)	6 (9.7)	I67.9
Brain injury	0 (0.0)	2 (5.9)	2 (3.2)	S09.90XA
Respiratory failure	2 (7.1)	1 (2.9)	3 (4.8)	J96.00
Liver cirrhosis	1 (3.6)	3 (8.8)	4 (6.5)	K74.60
Hemorrhagic digestive	1 (3.6)	1 (2.9)	2 (3.2)	K92.2
Renal failure	0 (0.0)	2 (5.9)	2 (3.2)	N17-N18
Arterial thromboembolism	0 (0.0)	1 (2.9)	1 (1.6)	I74.3
Burn stage II	0 (0.0)	1 (2.9)	1 (1.6)	T30.0
Stomach cancer	0 (0.0)	1 (2.9)	1 (1.6)	C16. 9
Gastric perforation	0 (0.0)	1 (2.9)	1 (1.6)	K25.1
Leukemia	0 (0.0)	1 (2.9)	1 (1.6)	C95.90
Malnutrition	0 (0.0)	1 (2.9)	1 (1.6)	E46
Pulmonary edema acute	0 (0.0)	1 (2.9)	1 (1.6)	A15.0
Total	28 (100)	34 (100)	62 (100)	

COPD: chronic obstructive pulmonary disease