

Respiratory-related deaths and associated factors in Alichu-Weriro district, southern Ethiopia: verbal autopsy data analysis

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ABSTRACT

Background Respiratory diseases disproportionately affect people living in resource-limited settings. However, obtaining information that explains respiratory-related deaths has been difficult, mainly due to a lack of medical certification of death and the fact that most deaths occur outside of health institutions. This study aimed to determine the proportion of respiratory-related deaths and identify associated factors in Alichu-Weriro district, southern Ethiopia, using the verbal autopsy method.

Methods A community-based cross-sectional study was conducted from April to June 2022. All deceased people in the study area from January 2020 to December 2021 were included in the study. Trained physicians ascertained the cause of death from verbal autopsy data that were collected using a pre-tested and modified WHO-designed questionnaire. The binary logistic regression models were used to identify factors associated with respiratory-related deaths.

Results Respiratory-related deaths accounted for 25% of the deaths from all causes, with 20.8% of male and 29.5% of female deaths. Of which, 9.7% were from tuberculosis, 8.3% were from asthma and 6.2% were from acute lower-respiratory tract infections. Moreover, being female (adjusted OR, AOR: 3.3; 95% CI: (1.75 to 6.22)), age 50–64 years (AOR: 9.3; 95% CI: (1.16 to 73.90)), age above 64 years (AOR: 8.9; 95% CI: (1.130 to 70.79)), family size of five persons or more (AOR: 1.9; 95% CI: (1.15 to 3.29)), smoking (AOR: 3.9; 95% CI: (1.86 to 8.35)), using wood and/or animal dung for household cooking (AOR: 6.6; 95% CI: (1.92 to 22.59)) and poor house ventilation (AOR: 3.1; 95% CI: (1.75 to 5.38)) were significantly associated with increased odds of dying from respiratory-related diseases.

Conclusion This study has determined that about a quarter of deaths from all causes were due to respiratory diseases, mainly tuberculosis, asthma and acute lower respiratory tract infections. Therefore, interventions to reduce this burden should focus on supporting early case detection and treatment, promoting healthy lifestyles, exercising women's equality at the household level and improving housing conditions.

BACKGROUND

Respiratory diseases are illnesses that affect the lungs and airway systems, making gas

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Finding epidemiological evidence explaining respiratory-related mortalities has been challenging in low-income and middle-income countries, mostly because most deaths happen outside of medical facilities and there is a dearth of medical certification of death.

WHAT THIS STUDY ADDS

⇒ Respiratory diseases, mainly tuberculosis, asthma and acute lower-respiratory tract infections, accounted for about a quarter of deaths from all causes.
⇒ Being female, higher age, increased family size, smoking and poor housing conditions could increase the risk of deaths from respiratory diseases.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Epidemiological evidence on respiratory-related mortalities can be generated from community-based verbal autopsy data.
⇒ Interventions to reduce the burden of respiratory diseases should focus on strengthening primary healthcare activities and ensuring gender equality.

exchange and respiration difficult.¹ Chronic obstructive pulmonary diseases, tuberculosis, acute lower respiratory tract infections and lung cancer are the major causes of death and disability.² According to the 2020 report of the WHO, respiratory diseases were among the top 10 causes of death globally.³ Moreover, they caused significant economic impacts on patients, families and societies through direct healthcare expenses and indirect costs associated with lost productivity.⁴ People living in low- and middle-income countries were disproportionately affected by these diseases, mainly due to poverty, overcrowding, indoor air pollution and occupational exposures.⁵

The prevention and control of respiratory diseases have been areas of global health priority.^{4–6} The Forum of International



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Respiratory Societies is a major collaborative effort in this area, aiming to reduce the global burden of respiratory diseases by 2030. The forum calls for improvements in healthcare policies, systems, care delivery and research. Ethiopia has also shared this global initiative and incorporated respiratory health issues into its strategic document for health, the health sector transformation plan (2016–2025), which is adapted from the Sustainable Development Goal.^{7,8} To achieve this commitment, the government has further developed a specific national strategic plan for the prevention and control of respiratory diseases, with the overall goal of reducing the fatal and non-fatal effects of these diseases by promoting healthy lifestyles, reducing the prevalence of common risk factors, and providing integrated treatment and care services in all health facilities across the country most cost-effectively. For example, immunisation with a 10-valent pneumococcal conjugate vaccine, integrated service provision for tuberculosis and HIV, screening and treatment of tuberculosis among households with index cases, integrated community case management of pneumonia and availability of essential antibiotics can be mentioned as some of the interventions.⁹ Consequently, there has been a significant reduction in the death rates from major respiratory diseases such as pneumonia and tuberculosis.⁸

However, despite such gains, there is still a high disparity in the burden of respiratory diseases among communities in different geographical areas and socio-economic groups in Ethiopia.¹⁰ Moreover, obtaining information that explains respiratory-related deaths has been difficult, mainly due to a lack of reliable vital registration systems.¹¹ This study aimed to assess respiratory-related proportionate mortality and associated factors in Alichu-Weriro district, southern Ethiopia, by using a verbal autopsy method to ascertain the cause of death in a population-based cross-sectional study. The findings may help the local health authority and other stakeholders as a guide for planning, budgeting and resource mobilisation.

MATERIALS AND METHODS

Study design, area and period

A population-based cross-sectional study was conducted in Alichu-Weriro district, southern Ethiopia, from April to June 2022. The district has an estimated population of 130 670 people living in 28 'kebeles' (the smallest administrative units in Ethiopia). There are five health centres and 26 health posts providing curative and preventive health services.¹²

Participants and data collection

All deceased people in the study area who were registered in the community's vital events registration book from January 2020 to December 2021 were included in the study. This period was chosen in order to reduce the recall bias without much implication on the number of deaths.

Deceased people who had no close relative, neighbour or friend to witness the illness condition responsible for the death event were excluded from the study. Data were collected by interviewing a close relative, a neighbour or a friend of the deceased using a modified and pretested WHO and INDEPTH-designed verbal autopsy questionnaire.¹¹ The questionnaire included a closed section to witness specific symptoms, signs and conditions leading to death; a narrative section to record free explanations of the death circumstances; a medical history section to extract data from medical certificates and a behavioural section to assess the lifestyle of the deceased, including drinking and smoking.

Data quality control

The questionnaire was translated into Amharic, the official language and back to English to maintain consistency in meaning. The questionnaire was pretested on 20 respondents in the nearby Alichu-Weriro district to identify potential problem areas, cultural objections and unanticipated interpretations of any of the questions. Data collection was carried out by trained data collectors and supervisors. A close relative, a friend or a neighbour of the deceased person was interviewed to witness the illness condition responsible for the death event. For recent deaths, the data were collected after 1 month by considering the morning period in the study area. The collected data were reviewed for completeness and consistency on a daily basis.

Physician interpretation

Two physicians reviewed each verbal autopsy questionnaire independently and assigned a single cause of death based on the 10th revision of International Classification of Diseases.¹¹ About 2.4% of the deaths were indeterminate since no physician agreement was reached after discussion. The physician's training focused on procedures for assigning the cause of death, the study population, the disease epidemiology of the study area and common local terms used to express symptoms, causes and conditions of death. Moreover, the physician review process was closely monitored.

Data processing and analyses

Data were entered using EpiData V.3.1 and exported to SPSS V.21.0 for statistical analyses. The findings were presented in tables and graphs using frequency and percentage. First, all independent variables were fitted separately into a bivariate logistic model to estimate the degree of association with respiratory-related proportionate mortality. Then, those variables with a $p < 0.25$ were fitted into a multivariable logistic model to control confounders. The statistical significance of the variables was declared by using the OR with a 95% CI. Respiratory-related proportionate mortality was calculated by dividing the number of respiratory-related deaths by the

total number of deaths from all causes in Alichu-Weriro district from January 2020 to December 2021 and multiplying by 100.

Patient and public involvement

The study did not involve patients or members of the public in the design, conduct, reporting or dissemination of results.

RESULTS

Sociodemographic characteristics of the study participants

Physicians reviewed a total of 421 verbal autopsy interviews successfully. Nearly half, 52.5%, of them were male deaths. The median age of the deceased was 54 years, with an IQR of 29–67 years. A higher proportion of deaths, or 28.7%, were identified in the age group above 65 years old. About 69.8% of the deceased were married, and 81% were farmers. Most, 81.7%, of the deaths took place at home. Two-thirds, or 66.5%, of the deceased were unable to read or write. More than half, or 58%, of the deaths occurred among families where at least five people lived together. The majority, 94.8%, of the deceased were Muslims by religion and Silte by ethnicity (table 1).

Cause-specific proportionate mortality

The majority, 52.3%, of the deaths were caused by non-communicable diseases, followed by communicable diseases and injuries, which accounted for about 30.1% and 15%, respectively. There were not many differences in the cause of deaths among males and females (table 2). About 34% of the deaths due to non-communicable diseases and 18.8% of the deaths due to communicable diseases occurred among people who were older than 49 years. Injury-related deaths were common among the economically productive age group, 15–49 years (figure 1).

Respiratory-related proportionate mortality

Respiratory-related deaths accounted for 25% of the deaths from all causes and were the leading causes of death among both sexes (20.8% of male and 29.5% of female deaths). Of which, 9.7% were from tuberculosis, 8.3% were from asthma, 6.2% were from acute lower-respiratory tract infections, 0.5% were from COVID-19 and 0.2% were from lung cancer-related deaths. The risk of respiratory-related deaths increased as the age of the deceased increased and decreased as their educational status improved. About 26.7% of the deaths among married people were related to respiratory causes (tables 2 and 3). The proportion of respiratory-related deaths was higher in the summer months (June, July and August) (figure 2).

Factors associated with respiratory-related mortality

Age, sex, occupation, family size, smoking, fuel use and house ventilation showed associations with respiratory-related mortality in the bivariate analysis at a $p < 0.25$. being female (adjusted OR, AOR: 3.3; 95% CI: (1.75

Table 1 Sociodemographic characteristics of the deceased in Alichu-Weriro district, southern Ethiopia from January 2020 to December 2021

Variables	Frequency	Per cent
Sex		
Male	221	52.5
Female	200	47.5
Age (in years)		
<5	29	6.9
5–14	47	11.2
15–49	110	26.1
50–64	114	27.1
≥65	121	28.7
Marital status		
Married	294	69.8
Single	111	26.4
Other	16	3.8
Educational status		
Unable to read and write	280	66.5
Primary school	94	22.3
Secondary school and above	47	11.2
Religion		
Muslim	399	94.8
Christian	22	5.2
Family size		
<5 person(s)	177	42
≥5 persons	244	58
Residence		
Rural	363	86.2
Urban	58	13.8
Occupation		
Farmer	341	81
Government/NGO employer	20	4.8
Other	60	14.2
Ethnicity		
Silte	399	94.8
Other	22	5.2
Place of death		
At home	344	81.7
At health institution	54	12.8
Other	23	5.5

NGO, non-governmental organization.

to 6.22)), age 50–64 years (AOR: 9.3; 95% CI: (1.16 to 73.90)), age above 64 years (AOR: 8.9; 95% CI: (1.130 to 70.79)), family size of five persons or more (AOR: 1.9; 95% CI: (1.15 to 3.29)), smoking (AOR: 3.9; 95% CI: (1.86 to 8.35)), using wood and/or animal dung for household cooking (AOR: 6.6; 95% CI: (1.92 to 22.59)) and poor house ventilation (ie, window to floor area ratio less than

Table 2 Cause-specific proportionate mortality by sex in Alichu-Weriro district, southern Ethiopia from January 2020 to December 2021

Cause of Death	Male (no.(%))	Female (no.(%))	Total (no.(%))
Communicable diseases	60 (14.3)	67 (15.8)	127 (30.1)
Intestinal infectious diseases	9 (2.1)	9 (2.1)	18 (4.3)
Tuberculosis	24 (5.7)	17 (4.0)	41 (9.7)
HIV/AIDS	4 (1.0)	3 (0.7)	7 (1.7)
Diarrheal diseases	10 (2.4)	15 (3.6)	25 (5.9)
Meningitis	4 (1.0)	3 (0.7)	7 (1.7)
Acute lower respiratory diseases	7 (1.7)	19 (4.5)	26 (6.2)
COVID-19	2 (0.5)	0	2 (0.5)
Lung cancer	0	1 (0.2)	1 (0.2)
Non-communicable diseases	121 (28.7)	100 (23.8)	221 (52.5)
Stomach cancer	4 (1.0)	2 (0.5)	6 (1.4)
Gastric cancer	2 (0.5)	1 (0.2)	3 (0.7)
Breast cancer	0	6 (1.4)	6 (1.4)
Diabetes mellitus	13 (3.1)	11 (2.6)	24 (5.7)
Hypertension	17 (4.0)	11 (2.6)	28 (6.7)
Cardiovascular diseases	3 (0.7)	2 (0.5)	5 (1.2)
Stroke	9 (2.1)	3 (0.7)	12 (2.9)
Rheumatic heart disease	0	3 (0.7)	3 (0.7)
Asthma	13 (3.1)	22 (5.2)	35 (8.3)
Renal failure	1 (0.2)	1 (0.2)	2 (0.5)
Acute abdomen	2 (0.5)	0	2 (0.5)
Kidney disease	7 (1.7)	4 (1.0)	11 (2.6)
Congestive heart failure	9 (2.1)	6 (1.4)	15 (3.6)
Epilepsy	4 (1.0)	1 (0.2)	5 (1.2)
Urinary tract infection	3 (0.7)	1 (0.2)	4 (1.0)
Severe anaemia	4 (1.0)	2 (0.5)	6 (1.4)
Arthritis	3 (0.7)	3 (0.7)	6 (1.4)
Nerve	5 (1.2)	2 (0.5)	7 (1.7)
Tetanus	2 (0.5)	0	2 (0.5)
Liver disease	12 (2.9)	10 (2.4)	22 (5.2)
Childbearing-related haemorrhage	0	5 (1.2)	5 (1.2)
Stillbirth	3 (0.7)	0	3 (0.7)
Low birth weight	2 (0.5)	1 (0.2)	3 (0.7)
Bacterial sepsis	3 (0.7)	3 (0.7)	6 (1.4)
Injuries	34 (8.1)	29 (6.9)	63 (15.0)
Transport accident	7 (1.7)	5 (1.2)	12 (2.9)
Accidental falls	2 (0.5)	5 (1.2)	7 (1.7)
War-related deaths	6 (1.4)	0	6 (1.4)
Intentional suicide	7 (1.7)	7 (1.7)	14 (3.3)
Unintentional suicide	4 (1.0)	4 (1.0)	8 (1.9)
Accidental drowning	5 (1.2)	5 (1.2)	10 (2.4)
Electric shock	3 (0.7)	3 (0.7)	6 (1.4)
Indeterminate cause of death	6 (1.4)	4 (1.0)	10 (2.4)

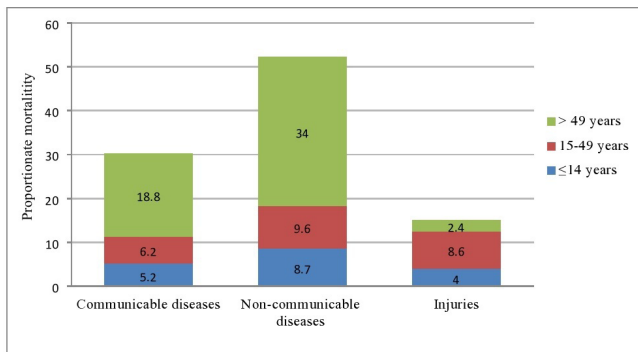


Figure 1 Cause-specific proportionate mortality by age in Alichio-Werrior district, southern Ethiopia from January 2020 to December 2021.

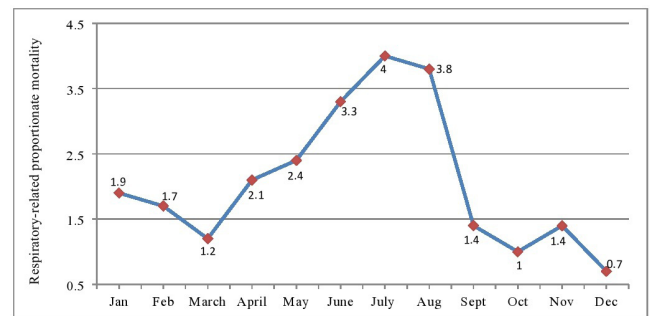


Figure 2 Seasonal pattern of respiratory-related proportionate mortality in Alichio-Werrior district, southern Ethiopia from January 2020 to December 2021.

20.0%)¹³ (AOR: 3.1; 95% CI: (1.75 to 5.38)) remained significant in the multivariable logistic model (table 4).

DISCUSSION

This study estimated respiratory-related proportionate mortality and identified the associated factors in Alichio-Weriro district, southern Ethiopia. The study

has indicated that the proportion of respiratory-related deaths accounted for about a quarter of the deaths from all causes in the district. Tuberculosis, asthma and acute lower-respiratory tract infections were the leading causes of respiratory-related deaths. Moreover, being female, age above 50 years, family size of five or more people, smoking, using wood and/or animal dung for household cooking, and poor house ventilation were significantly associated with an increased risk of deaths from respiratory-related diseases.

Table 3 Distribution of respiratory-related proportionate mortality in relation to sociodemographic characteristics of the deceased in Alichio-Weriro district, southern Ethiopia from January 2020 to December 2021

Variables	Respiratory-related death (No (%))	Non-respiratory deaths (No (%))
Sex		
Male	46 (20.8)	175 (79.2)
Female	59 (29.5)	141 (70.5)
Age		
<5	1 (3.4)	28 (96.6)
5–14	4 (8.5)	43 (91.5)
15–49	27 (24.5)	83 (75.5)
50–64	34 (29.8)	80 (70.2)
≥65	39 (32.2)	82 (67.8)
Occupation		
Farmer	87 (25.5)	254 (74.5)
Government/NGO employer	7 (35.0)	13 (65.0)
Other	11 (18.3)	49 (81.7)
Education		
Unable to read and write	76 (27.1)	204 (72.9)
Primary school	22 (23.4)	72 (76.6)
Secondary school and above	7 (14.9)	40 (85.1)
Marital status		
Married	78 (26.5)	216 (73.5)
Single	22 (19.8)	89 (80.2)
Other	5 (31.2)	11 (68.8)

NGO, non-governmental organization.

This study has revealed that respiratory diseases, mainly tuberculosis, asthma and acute lower-respiratory tract infections, accounted for about a quarter of deaths from all causes in Alichio-Weriro district, southern Ethiopia. This was consistent with previous studies from Ethiopia.^{14 15} However, it was higher than reports from Tanzania, Nigeria and South Africa.^{16–18} The observed variation could be explained by demographics, health system and cultural differences among the countries. Therefore, intervention efforts to reduce the burden of these diseases should focus on supporting early detection and treatment of respiratory problems, preventing outdoor and indoor air pollution, strengthening the national surveillance system, promoting physical activity and improving the capacity of respiratory health service delivery, especially at the primary healthcare level.

Mortality due to respiratory diseases was statistically associated with being female in this study. Low social status of females in the community, such as less access to health information, social and perceived stigma, increased susceptibility to infection with the HIV, and a lack of decision-making power to seek healthcare in times of illness, could explain this relationship.^{19–21} Hence, designing programmes that support gender equality at household levels could be important to reduce the observed difference in the risk of death.

This study has also revealed that being older than 50 could increase the odds of dying from respiratory-related diseases. Studies from Ghana, Malaysia, Spain and Japan supported the observed evidence.^{22–25} This could be due to the fact that there is a progressive decline in pulmonary function with increased age, resulting in a higher risk of developing respiratory-related diseases and

Table 4 Factors associated with respiratory-related mortality in Aicho-Weriro district, southern Ethiopia from January 2020 to December 2021

Variables	Respiratory-related deaths		Crude OR (95% CI)	Adjusted OR (95% CI)
	Yes	No		
Sex				
Male	46	175	1	1
Female	59	141	1.6 (1.02 to 2.48)	3.3 (1.75 to 6.22)
Age				
<5	1	28	1	1
5–14	4	43	2.6 (0.28 to 24.53)	2.6 (0.27 to 25.73)
15–49	27	83	9.1 (1.18 to 70.15)	5.9 (0.73 to 46.97)
50–64	34	80	11.9 (1.56 to 91.03)	9.3 (1.16 to 73.90)
≥65	39	82	13.3 (1.75 to 101.48)	8.9 (1.130 to 70.79)
Family size				
<5 person(s)	29	148	1	1
≥5 persons	76	168	2.3 (1.43 to 3.74)	1.9 (1.15 to 3.29)
Smoking				
No	75	278	1	1
Yes	30	38	2.9 (1.70 to 5.03)	3.9 (1.86 to 8.35)
Type of fuel used				
Kerosene/biogas	3	44	1	1
Wood/animal dung	96	278	5.5 (1.67 to 18.11)	6.6 (1.92 to 22.59)
House ventilation				
Good	83	177	1	1
Poor	22	139	3.0 (1.76 to 4.98)	3.1 (1.75 to 5.38)

disorders.²⁶ Thus, conducting regular exercise, reducing exposure to outdoor and indoor air pollutants, avoiding cigarette smoking and promoting better nutrition can be recommended.

In this study, larger family size was associated with increased odds of dying from respiratory-related diseases. This was in agreement with studies from Argentina, Los Angeles and Mexico.^{27–29} Overcrowded housing creates a condition of poor ventilation that increases the risk of infectious disease transmission.³⁰ Moreover, larger households often consume a high volume of biomass fuel for domestic purposes, such as cooking, heating and lighting, which would increase the concentration of harmful particulate matter in the indoor environment.^{31–32} Previous studies from Ethiopia have revealed that using firewood for cooking was responsible for about half of acute lower-respiratory tract infections and deaths from lung cancer.³³ In this study, the odds of dying from respiratory-related diseases were observed to be higher among households that used wood and/or animal dung for cooking purposes. Therefore, increased use of cleaner energy sources, such as electricity and improved housing ventilation could reduce the risk of respiratory-related deaths among larger households.

This study has revealed that the odds of dying from respiratory-related diseases were observed to be higher

among smokers. This was supported by a study from Ghana, where tobacco smoking has increased the odds of dying from respiratory-related diseases.²² The other study from Addis Ababa, Ethiopia, also indicated that the odds of dying from tuberculosis were about two times higher among tobacco users.³⁴ Besides strengthening counselling interventions, public health authorities should consider enforcing laws that discourage smoking.

This study has limitations. The verbal autopsy data were interpreted by physicians who might be influenced by their perception, clinical experience and local epidemiology. Previous studies have also suggested that the use of the physician review method to interpret verbal autopsy data should be done with caution.^{14–34–35} The respondents' ability to recall the correct symptoms and/or events that led to death could be influenced by their level of education, sex, age, marital status and occupational status.³⁶ However, the data collectors were trained to choose the appropriate person to witness the death event in each interview. Additionally, the recall bias could be higher due to the study's cross-sectional nature. Therefore, we recommend strengthening the health and demographic surveillance systems in resource-limited settings to ascertain the causes of death from verbal autopsy data.

CONCLUSION

This study has determined that about a quarter of deaths from all causes were due to respiratory diseases, mainly tuberculosis, asthma and acute lower respiratory tract infections. Therefore, interventions to reduce this burden should focus on supporting early case detection and treatment, promoting healthy lifestyles, exercising women's equality at the household level and improving housing conditions.

Contributors NB, ST and MH conceived, designed and conducted the study. ST and MH supervised and provided mentorship. NB, ST and MH were involved in the analysis and interpretation of the findings. ST wrote the manuscript. All authors have approved the final version of the manuscript. ST acted as a guarantor.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and ethical approval was received from the Institutional Review Board of Wachemo University via the School of Graduate Studies (Ref No. 884/14). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information.

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