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In-hospital mortality of acute respiratory distress syndrome and its associated factors in adult intensive care unit of specialized hospitals in Bahir Dar, Ethiopia

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BAHIR DAR UNIVERSITY COLLEGE OF MEDICINE AND
HEALTH SCIENCES, SCHOOL OF MEDICINE, DEPARTMENT
OF INTERNAL MEDICINE

IN-HOSPITAL MORTALITY OF ACUTE RESPIRATORY
DISTRESS SYNDROME AND ITS ASSOCIATED FACTORS IN
ADULT INTENSIVE CARE UNIT OF SPECIALIZED
HOSPITALS IN BAHIR DAR, ETHIOPIA

A THESIS TO BE SUBMITTED TO THE DEPARTMENT OF INTERNAL
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ABSTRACT

Background: Acute respiratory distress syndrome (ARDS) is an acute condition marked by bilateral lung infiltrates and hypoxemia within one week of an inciting event. Despite advances in critical care, ARDS continues to be associated with high mortality and prolonged hospital stays. Mortality is influenced by patient characteristics, disease severity, treatment strategies, and complications. However, data on ARDS outcomes in Ethiopia, particularly in the Amhara region, remain limited.

Objectives: This study aimed to determine in-hospital mortality of ARDS and associated factors in intensive care units of TibebeGhion and FelegeHiwot Specialized Hospitals, Bahir Dar, Ethiopia, from November 2020 to November 2025.

Methods: A retrospective cohort study was conducted using 374 medical records of adult ARDS patients. Data were collected from December 15, 2025, to January 10, 2026, using a structured data extraction tool. Data were entered into Kobo Toolbox and analyzed using SPSS version 27. Bivariate and multivariable logistic regression analyses were performed to identify factors associated with in-hospital mortality.

Results: The study demonstrated that in-hospital mortality of ARDS was 63.1% (95% CI: 58.2%–68.0%). Multivariable logistic regression analysis identified; low GCS (8–12: AOR = 2.23, 95% CI 1.16–4.30; <8: AOR = 2.83, 95% CI 1.03–7.80), moderate (AOR = 2.20, 95% CI 1.14–4.26) and severe ARDS (AOR = 3.02, 95% CI 1.49–6.10), extra-pulmonary sepsis (AOR = 2.98, 95% CI 1.13–7.91), liberal fluid management (AOR = 3.27, 95% CI 1.55–6.91), and complications such as VAP (AOR = 2.95, 95% CI 1.02–8.54) and sepsis (AOR = 4.28, 95% CI 2.04–8.98) as independent predictors of in-hospital mortality.

Conclusion: The study demonstrated that in-hospital mortality was higher than rates reported in developed countries and in most developing nations. Various factors were identified as independent predictors of in-hospital mortality. These findings emphasize the urgent need for targeted interventions to enhance the quality of critical care for patients with ARDS.

Lists of Acronyms and Abbreviations

ARDS	Acute Respiratory Distress Syndrome
BDU	Bahirdar University
CKD	Chronic kidney disease
CLD	Chronic liver disease
COPD	Chronic obstructive pulmonary disease
DM	Diabetes Mellitus
FHSH	Felegehiwot specialized hospital
FiO ₂	Fraction of Inspired Oxygen
HTN	Hypertension
ICU	Intensive care unit
LMIC	Low and middle income countries
MAP	Mean arterial pressure
PaO ₂	Partial pressure of oxygen in arterial blood
SOFA	Sequential Organ Failure Assessment
SpO ₂	Peripheral Oxygen Saturation
TGS	Tibebe Ghion Specialized hospital
TRALI	Transfusion related acute lung injury

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1. INTRODUCTION

1.1. Background of the study

Acute respiratory distress syndrome (ARDS) is an acute disorder that starts within seven days of the inciting event and is characterized by bilateral lung infiltrates and severe progressive hypoxemia in the absence of any evidence of cardiogenic pulmonary edema(1).

The clinical definition of ARDS was revised in 2024 to include both intubated and non-intubated patients as well as allow diagnosis within resource-limited settings. Diagnosis of ARDS is based on fulfilling three criteria: Acute onset (within 1 week), Bilateral opacities on chest radiography or computed tomography (CT), or bilateral B lines and/or consolidations on ultrasound not fully explained by effusions, atelectasis, or nodules/masses and $\text{PaO}_2/\text{FiO}_2$ (arterial to inspired oxygen) ratio of ≤ 300 or $\text{SpO}_2/\text{FiO}_2$ (pulse ox metric saturation to inspired oxygen) ratio of ≤ 315 (2).

Worldwide ARDS remains a condition with high in hospital mortality, ranging between 36% and 44% in most studies(3). In Africa there is limited data on outcomes of ARDS and the studies done show significant variation, from 42% to 77%(4-6). In Ethiopia there is only one published data, and the mortality of ARDS was 59%(7).

In different researches done, several factors have been identified as determinants of in hospital mortality of ARDS. Increased age, presence of comorbidities (DM, Heart failure, asthma, COPD, HIV, active neoplasm and chronic liver failure) are associated with poor outcomes. Although there are inconclusive evidences about the impact of sex on ARDS mortality, being male is associated increased mortality in some studies (4, 7, 8).

Sepsis and pneumonia as a cause of ARDS are significantly associated with poor outcome (7, 9, 10). Disease severity markers(e.g. severity of ARDS based on level of hypoxemia, low GCS, multiorgan failure) are also associated with increase mortality(4, 7, 8). Regarding patient treatment strategies; invasive ventilation, liberal fluid management are associated with higher mortality(7, 11) and patients who were given steroids had better outcome(12).

Occurrence of complications in ICU, like ventilation associated pneumonia and sepsis are poor prognostic factors(7, 13).

In Ethiopia, data on in hospital mortality of ARDS and contributing factors are limited, particularly in Amhararegion.

1.2. Statement of the problem

ARDS remains a major cause of morbidity and mortality worldwide in critical patients. Patients with ARDS place significant demands on health care systems and ICUs in particular. Hospitalization costs also are significant, reflecting the complexity and resource use required. Patients in the ICU contribute up to 10% of the total cost of inpatient care(14), with patients with ARDS accounting for a disproportionate amount of these costs(15). In the USA it contributes to an estimated annual economic burden of approximately 1.16 billion USD (16).

In hospital mortality of ARDS have been studied globally and among different countries. The Large Observational Study to Understand the Global Impact of Severe Acute Respiratory Failure (LUNG SAFE) conducted among 50 countries demonstrated the in hospital mortality ranges from 34.9% to 46.1%(8). However, there was a noticeable variation in mortality rates across different continents and subcontinents.

In Africa (Sub Saharan region) studies show higher in hospital mortality rate than global, factors like severity of ARDS, resource limitations (eg lack of MV, electrical ,piped oxygen and critical care clinicians) were considered as contributors.

In Ethiopia there is scarce data ,a study done in southern Ethiopia ICUs revealed that the cumulative incidence of in-hospital mortality among ARDS patients in ICUs was 59.1%, determinants were ,severity of ARDS, comorbidities, sepsis, respiratory causes , initial GCS at admission, mode of ventilation(invasive versus non-invasive),time of admission, and complications(VAP)(7).

For almost half a century, researches and advancements have shaped the diagnosis and treatment of ARDS. Significant developments have emerged across different periods, including those preceding the 1990s, the establishment of the American-European Consensus in 1994, the introduction of the Berlin definition in 2012, and the Kigali modification of the Berlin criteria, specifically adapted for resource-limited settings(17, 18).

In the past few decades, different strategies have been investigated for reducing mortality of ARDS(19, 20). Lung-protective ventilation is employed to reduce ventilator-induced lung injury(21, 22), while the prone position has been shown to enhance oxygenation in certain

patients(23, 24). Lung recruitment maneuvers assist in reopening collapsed lung tissue(25), and early glucocorticoid administration may help mitigate lung inflammation(26). Additionally, more advanced approaches, such as lung stem cell transplantation and extracorporeal membrane oxygenation (ECMO), are being explored for severe respiratory conditions(27, 28).

In Ethiopia, especially in Amhara region information about in hospital mortality of ARDS and associated factors is scarce and no published data exist on the region. This study aimed to identify in hospital mortality and associated factors of ARDS(including factors which were not assessed by the research done in southern Ethiopia; like steroid use and fluid management strategy) in adult ICU at Tibebe Ghion and Felegehiwot comprehensive Hospitals. The study was intended to provide insights into the burden of ARDS, identify key determinants, and to guide clinical and resource allocation strategies to improve patient care in the Amhara region.

1.3 Significance of the study

This study provides important data on in-hospital mortality of ARDS and associated factors, which can support national health policymakers and planners in improving ICU resource allocation and developing context appropriate, evidence-based ARDS management protocols.

Additionally it generates local (regional) evidence on the burden of ARDS. This can help to fill gaps in data in the Amhara region, the findings can assist regional health authorities and hospital administrators in identifying high-risk patient groups and strengthening critical care services.

By examining factors such as age, sex, ARDS etiology, comorbidities, mode of ventilation, adjunctive treatments, and complications including ventilator-associated pneumonia and sepsis, the study may help clinicians to facilitate early risk stratification, improve clinical decision-making, enhance prevention and management of complications, which ultimately contribute to improved patient outcomes and reduced ARDS related mortality.

2.LITERATURE REVIEW

2.1 In hospital mortality of ARDS

Despite improvements in supportive care and ventilation strategies, globally ARDS remains a condition with high in hospital mortality, ranging between 36% and 44% in most studies (3). A systematic review found that the worldwide mortality rate from ARDS was significant, ranging from 30–40% (29). However, the outcomes vary noticeably in different continents and countries.

Another systematic review disclosed that the mortality rate from ARDS was 41.2% in Scandinavian countries (Sweden, Denmark, and Iceland), 34% in Australia, 41% in the USA, and 55.5% in Brazil. (30-33). Among 126 eligible patients with ARDS admitted to the a tertiary hospital in Vietnam, the mortality was 57.1% (34).

In Africa there is limited data on outcomes of ARDS and the studies done show significant variation. A prospective prevalence study done in Uganda reported survival rate of 57.1% (42.9% died) (5), however in another study done in Uganda the mortality of ARDS was 77% (4). In a retrospective cohort study done among COVID ARDS cases on invasive ventilation, at Nairobi hospital ICU, 43.3 % of patients survived (6).

In Ethiopia, a multi-centre longitudinal study was conducted from January 2018 to June 2023 in southern region ICUs revealed that the cumulative incidence of in-hospital mortality among ARDS patients in ICUs is 59.1 % (95% CI: 53.8 to 64) (7).

2.2 Factors Associated within hospital mortality of ARDS

Worldwide numerous researches are done regarding the factors affecting the outcome of ARDS in ICU. In LUNG SAFE study the relation between etiologies of ARDS and its outcomes was assessed; extra-pulmonary sepsis was associated with worse outcome than ARDS due to pneumonia. Non cardiogenic shock and blood transfusion related ARDS are also associated with higher mortality (8). In a study conducted from 2006-2014 in the USA Shock, sepsis and transfusion-associated ARDS had higher mortality rates compared to

other factors(9). In Taiwan a study compared outcomes of pneumonia associated ARDS with extra-pulmonary sepsis associated ARDS showed higher mortality in sepsis associated ARDS (43% versus 67%, $p = 0.02$)(10).

In the study done in Southern Ethiopia respiratory disorders and sepsis were the major causes of mortality in patients with ARDS than other aetiologies.(7)

In addition increased age, presence of comorbidities (DM, Heart failure, asthma, COPD, HIV, active neoplasm and chronic liver failure.) was associated with poor outcomes. Regarding the impact of sex on the outcomes of ARDS there are inconclusive evidences; in a research conducted in Uganda being male is associated increased mortality. While in LUNG SAFE study though there was increased mortality in males it was not statistically significant(4, 7, 8, 35).

Severity of ARDS is also associated with the magnitude of mortality of ARDS ,LUNG SAFE study the hospital mortality was 34.9% for those with mild, 40.3% for those with moderate, and 46.1% for severe ARDS.(8) $\text{SPO}_2 / \text{FiO}_2 < 200$ is associated with 88% mortality which is significantly higher than 68% mortality for those with $\text{SPO}_2 / \text{FiO}_2 > 200$, in a study at Uganda .(4, 36) In Ethiopia a study revealed similar pattern with mortality rate of 27%, 58% and 71% for mild, moderate and severe ARDS respectively(7). In addition, in previous studies, lower pH, high SOFA score, low GCS(<12), complications (like VAP, sepsis), MAP <65 mmHg are associated with poor prognosis(4, 7, 8, 37).

Regarding to time of admission, a study showed that patients admitted at weekend and night time had a higher odds of mortality. Those patients who were admitted at night time were approximately 4 times more likely to die compared to those who were admitted at weekend days and day time. This study also showed that patients managed with invasive ventilation were more than 3 times more to be expected to die compared to patients managed by non - invasive type (AOR =3.2, 95% CI 1.56, 6.42)(7). Key aspects of ventilator management are associated with patient outcome. In LUNG SAFE study 2377 patients (those on invasive ventilation) were included in the analysis. Potentially modifiable factors associated with increased hospital mortality in multivariable analyses include lower PEEP(positive end expiratory pressure), higher peak inspiratory, plateau, driving pressures, and increased respiratory rate. The impact of tidal volume on outcome was unclear. Although there was a

lack of relationship between tidal volume and outcome of the patients the study does not imply that tidal volume is unimportant, many other prospective randomized clinical trials show that reducing tidal volume is a key component of protective lung ventilation and saves lives(38, 39).

Pertaining to fluid management, a higher cumulative fluid balance is independently associated with increased risk of death, and longer length of ICU-stay in patients with ARDS(11). Although not statistically significant a conservative fluid management approach reduces mortality and improves oxygenation compared to liberal fluid therapy(40). Regarding the impact of steroids, different systematic review and meta-analysis of randomized trials have shown systemic corticosteroids may potentially reduce mortality. For example a systematic review of 7 randomized controlled trials involving 851 patients showed that corticosteroids reduced all-cause mortality (risk ratio [RR], 0.75; 95% CI, 0.59-0.95; P = 0.02).(12)

In most studies prone positioning of patients on mechanical ventilation (particularly those with severe ARDS) is associated with mortality reduction. A meta-analysis including 15 articles; the prone position group had a statistically significant mortality benefit (risk ratio [RR], 0.48; 95% CI, 0.35 to 0.67)(41, 42).

Overall, studies done globally, in Africa (including the study in Ethiopia) and other continents demonstrated ARDS is associated higher mortality and assessed the relation between various factors (socio demographic, disease severity, ARDS etiology, comorbidities, treatment strategies, and complications) and mortality of ARDS.

The study done on in hospital mortality of ARDS and its determinants in southern Ethiopia was the first published work in the country. But it did not assess the impact of other factors (eg; fluid management and impact of steroids). So, this study will determine in hospital mortality of ARDS and it will investigate associated factors, including factors not assessed in the previous study done in Ethiopia.

3. CONCEPTUAL FRAME WORK

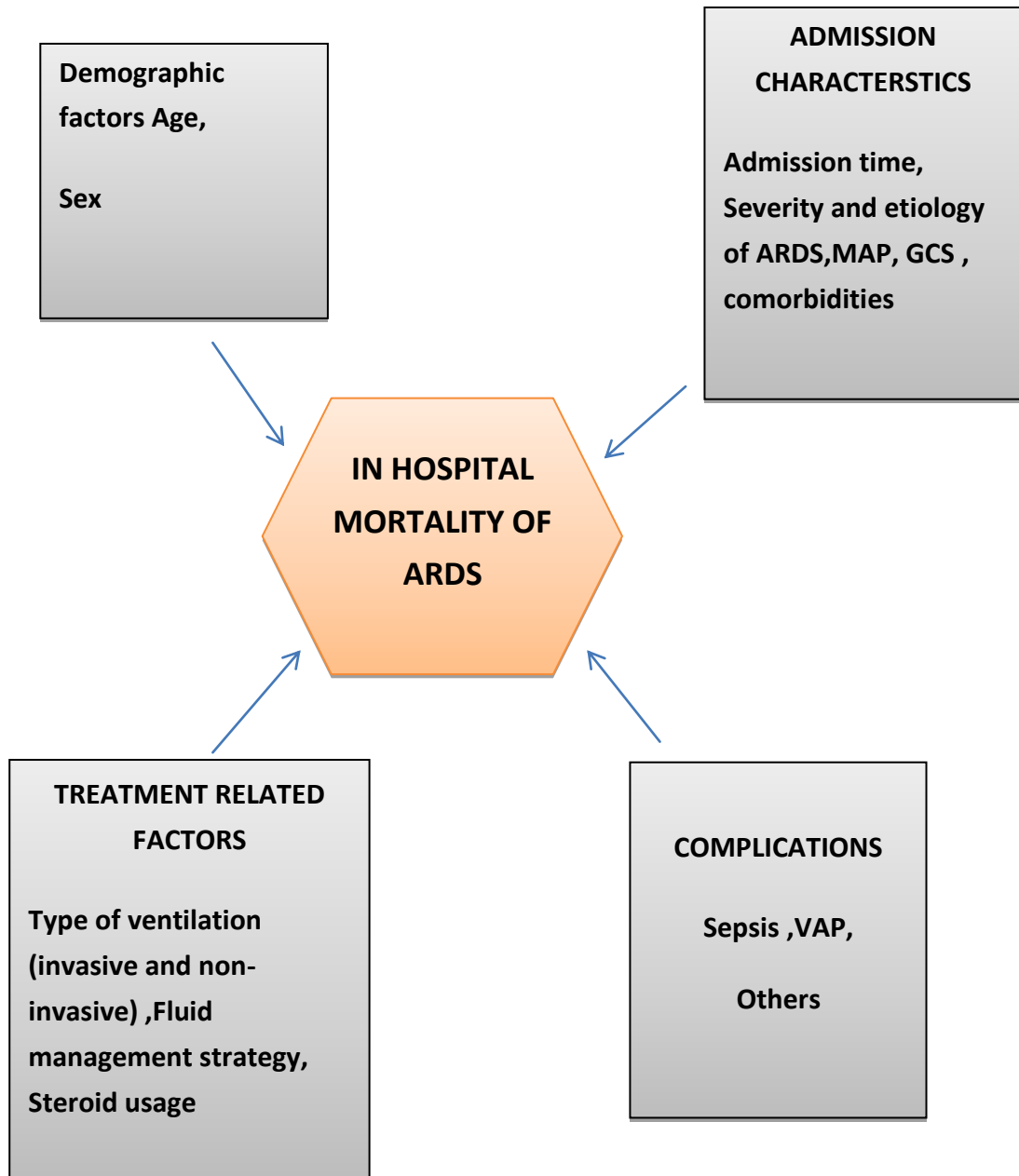


Figure 1. Conceptual framework developed after reviewing different literatures on the association between in hospital mortality of ARDS and its determinants.

4. OBJECTIVES OF THE STUDY

4.1 General Objective

- To determine in hospital mortality of ARDS and its associated factors among ARDS patients admitted to the adult ICU at TGSH and FHSB Bahirdar city, Amhara region, Ethiopia.

4.2 Specific Objectives

1. To determine in-hospital mortality of ARDS among patients admitted to ICU with the diagnosis of ARDS.
2. To identify factors associated with in hospital mortality of ARDS.

5. METHODS

5.1 Study Design

The study used a retrospective cohort study design to assess in hospital mortality and identify associated factors. Patients diagnosed with ARDS admitted to the ICUs of FHSB and TGSB from November 2020 to November 2025 GC were included.

5.2 Source population and Study population

5.2.1 Source population

All adult patients admitted to intensive care unit of FHSB and TGSB with the diagnosis of ARDS.

5.2.2 Study population

The study population consisted of adult patients who were admitted to the ICU at FHSB and TGSB with the diagnosis of ARDS between November 2020 and November 2025 G.C

5.3 Inclusion and Exclusion Criteria

Inclusion Criteria:

- Patients aged 18 or older.
- Patients admitted with the diagnosis of ARDS based on modified Kigali criteria at ICUs of FHSB and TGSB between November, 2020 and November 1, 2025 G.C.

Exclusion Criteria:

- Patients referred to other hospitals for better care
- Patients who went against medical advice
- Patients who died on arrival to ICU

5.4 Study Area and Period

The study was conducted in Bahir Dar, located on the southern shore of Lake Tana, the source of the Blue Nile (locally 'Abay'), is recognized as one of Africa's ten most beautiful cities and received the UNESCO Learning Cities Award in 2015. It is situated about 578 kilometers north-northwest of Addis Ababa, at an altitude of 1,840 meters above sea level.

TibebeGhion specialized hospital is located 10 kilometers south of the city center, is a tertiary university teaching facility with 450 beds, including 10 medical and surgical ICU beds. It serves as a major referral center for the Amhara region, offering comprehensive services across all medical specialties. FHS is a government referral hospital located in Bahirdar city is serving the community since 1963; it has 12 beds in its adult ICU. From November 2020 to November 2025 around 177 and 352 patients were admitted in adult ICU of TGS and FHS respectively. The study was conducted from November 25, 2025 to January 25, 2026 G.C,

5.5 Study Variables

The dependent variable is in hospital mortality of ARDS. Independent variables include demographic factors (age, sex), comorbidities (hypertension, diabetes, cardiac disease, CKD, CLD, Asthma, COPD, malignancy), disease severity factors (severity based on $p\text{SO}_2/\text{FiO}_2$ ratio, MAP, GCS), etiology of ARDS, management factors (mode of ventilation, use of corticosteroids and fluid management strategy) and complications (VAP, sepsis or others).

5.6 Operational Definitions

ARDS: Defined based on fulfilling three criteria: Acute onset (within 1 week), Bilateral opacities on chest radiography or computed tomography (CT), or bilateral B lines and/or consolidations on ultrasound not fully explained by effusions, atelectasis, or nodules/masses and $\text{PaO}_2/\text{FiO}_2 \leq 300$ or $\text{SpO}_2/\text{FiO}_2 \leq 315$.(2)

Time of admission;

Regular working time was defined as daytime working hours on weekdays. Duty time is defined as daytime working hours on weekends and all nighttime hours on both weekdays and weekends.

In hospital Mortality: Was defined as the proportion of ARDS patients who died during ICU stay, calculated as deaths divided by total ARDS admissions in the study period multiplied by 100.

Severity of ARDS: Classified based on $\text{SpO}_2/\text{FiO}_2$ ratio(18):

- Mild: 235-315,
- Moderate: 148-235 and
- Severe: ≤ 148

Fluid management Strategy expressed as average fluid balance(40):

- Conservative strategy: near neutral/slightly negative balance
- Liberal fluid management strategy: $>900\text{ml/day}$

Type of ventilation:

Noninvasive ventilation; respiratory support without direct tracheal intubation (Face mask oxygen, CPAP). Invasive Ventilation: Mechanical ventilation via an endotracheal tube or tracheostomy(43).

5.7 Sample size determination

By taking the study done in southern Ethiopia which revealed mortality rate of 59 % as a reference(7).

Using Single population proportion formula:

$$n = \frac{Z_{1-\alpha/2}^2 (p)(1-p)}{d^2}$$

Where:

- $Z=1.96$ (for a 95% confidence level)
- $p=0.59$ (estimated mortality rate of ARDS patients, 59%)
- $d=0.05$ (desired margin of error)
- $n = \frac{(1.96)^2 0.59 \times 0.41}{0.05^2}$
- $n=371$, by adding the 10% none response rate the sample size was 409 patients

The sample sizes in the table below were calculated using the double population proportion formula for different factors associated with ARDS mortality. The largest calculated sample size among these factors is 336, which corresponds to non-invasive ventilation and absence of complications.

For the study, a final sample size of 409 was adopted, as it was larger than all double-proportion calculations and ensured adequate power to assess both overall mortality and its associated factors.

Table 1. Assumptions used to estimate the largest possible sample size using the double population proportion formula for factors associated with ARDS mortality

Associated factor (non-exposed group)	P ₁ (%)	P ₂ (%)	Absolute difference (P ₁ – P ₂)	Calculated total sample size (n)
GCS > 12	59.1	39.8	19.3	203
Mild ARDS	59.1	26.8	32.3	66
Daytime admission	59.1	38.2	20.9	172
Non-invasive ventilation	59.1	44.0	15.1	336
No complications	59.1	44.0	15.1	336

5.8 Sampling Technique

A complete list of all ICU-admitted ARDS patients between November 2020 and November 2025 G.C were compiled. There were a total of 529 ARDS patients registered; 177 in TGSH and 352 at FHSH. From these 32 patients were excluded. From the remained 497 patients 409 were selected using a proportionate allocation to size, by dividing the number of admissions in each ICU by the total number of admissions in both ICUs, then multiplying the result by the sample size (n =409); TGSH = $n_1/N * n$ and FHSH = $n_2/N * n$. Therefore 137 and 272 patients were drawn by simple random sampling from TGSH and FHSH respectively.

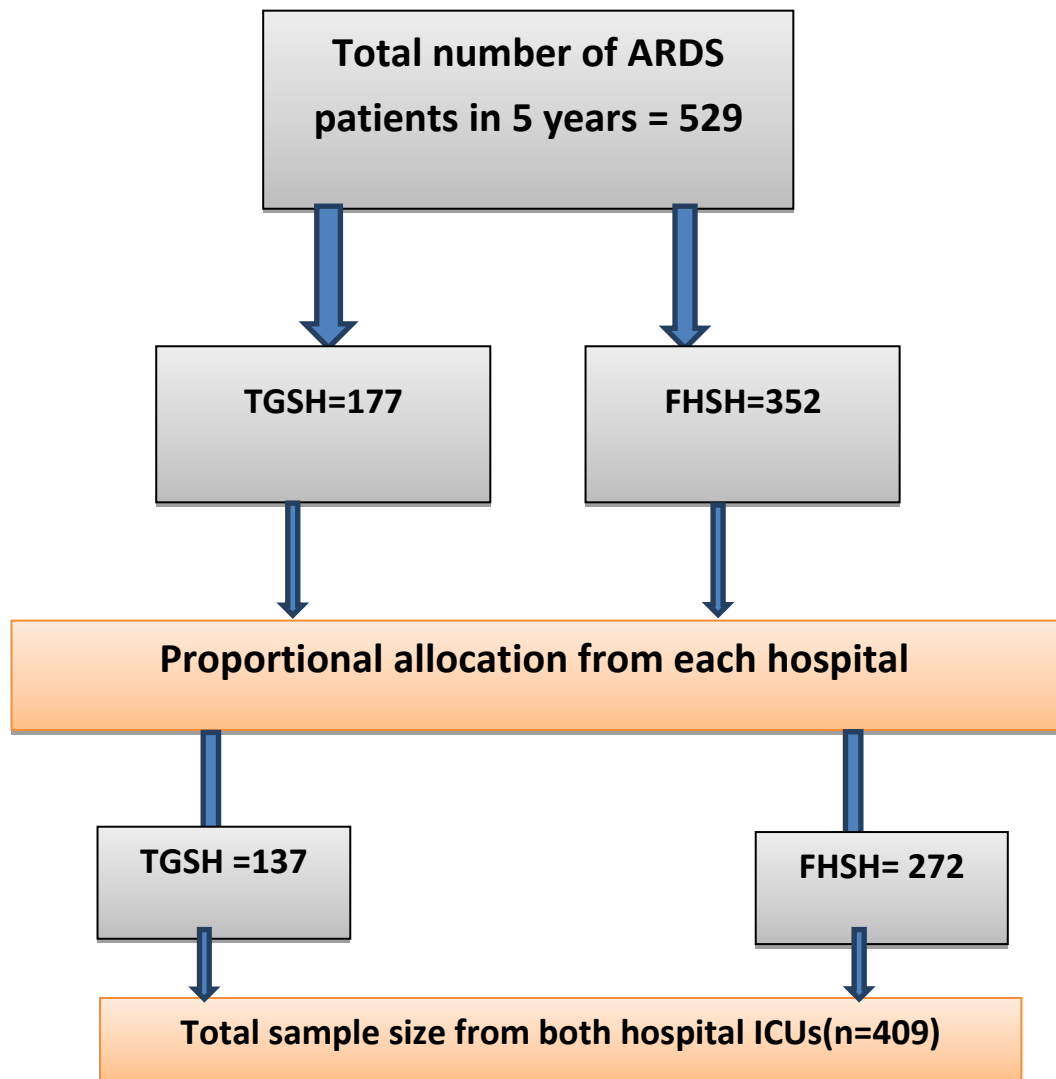


Figure 2. Schematic representation of the sampling procedure for in-hospital mortality of ARDS and its associated factors in adult ICU of FSHH and TGSH, 2020-2025

5.9 Data Collection Procedures

After reviewing different published literatures on ARDS mortality and determinant factors, a structured checklist designed in koboToolbox was used to collect demographic data, clinical characteristics (comorbidities, ARDS severity, underlying causes, GCS, MAP, admission time), treatment details and complications. In hospital mortality and discharge with improvement were also documented as the outcome measure. Data were collected from December 15, 2025, to January 10, 2026. Two BSC nurses from FHSB and two medical interns from TGSB, who have experience in data collection collected the data.

5.10 Data Quality Assurance

Data collectors were trained for one day prior to data collection process to ensure quality of data. The training was focused on the objectives of the study, data collection tool, data collection methods. The checklist was pretested on 5% of the sample in FHSB using data from a period outside the actual study timeframe, and necessary modifications were made. Data collection was supervised by the principal investigator for its completeness.

5.11. Data Processing and Analysis

The collected data was checked for completeness and entered to Microsoft Excel, then exported to SPSS version 27 for analysis. Descriptive statistics (frequencies, percentages, means, and standard deviations) summarized the data.

Bivariate logistic regression was used to assess the association between independent variables and dependent variable, and then those variables with p value < 0.25 were taken to multivariable logistic regression. Odds ratios with 95% CI was reported, with p -values < 0.05 considered significant. Results are presented in tables, graphs, and narratives.

Multicollinearity was evaluated using variance inflation factor obtained from linear regression analysis. All independent variables had variance inflation factor values ranging from 1.02 to 1.27 and tolerance values greater than 0.1, suggesting the absence of multicollinearity.

The Hosmer–Lemeshow goodness-of-fit test was used to assess the adequacy of the logistic regression model. The test showed no statistically significant difference between the observed and predicted outcomes ($\chi^2 = 11.865$, $df = 8$, $p = 0.157$), indicating that the model had an acceptable fit to the data.

5.12. Ethical Considerations

Ethical clearance was obtained from Bahir Dar University Ethics Review Committee, and a support letter was sent to TGSH and FSH. Data collection ensured confidentiality by excluding patient names, and protecting electronic files with a password. Only the research team handled the data.

5.13. Dissemination

The final finding of this study will be submitted and defended at Bahirdar University College of Health Sciences and Medicine, School of public health. Additionally, the results will be shared with BDU, TGSH, and the Amhara National Health Bureau to inform and enable them to take recommendations into consideration during their planning process. Finally, an effort will be made to publish in peer-reviewed journals.

6. RESULTS

6.1 Sociodemographic characteristics

From the total sample (409), 19 charts were lost, so the study reviewed the medical charts of 390 adult ICU patients admitted with the diagnosis of ARDS at FHSB and TGSB in the time between November 2020 to November 2025 GC. From these 16 had incomplete data, making the response rate 91.4%.

The mean (standard deviation) age of the patients was 38.5 ± 16.15 years. Majority (72.7%) of patients were in the age range of 18-49 years. Nearly half (51.9%) of patients were females. Patients from rural area accounted for nearly two third (63.1%) of total participants.

Table 2 Socio-demographic characteristics of ARDS patients admitted from 2020-2025 GC in ICU of FHSB and TGSB

Variable	Category	n (%)
Age group	18–49 years	272 (72.7)
	≥ 50 years	102 (27.3)
Sex	Female	194 (51.9)
	Male	180 (48.1)
Area of residence	Urban	138 (36.9)
	Rural	236 (63.1)

6.2 Admission characteristics

The study demonstrated that 29.9% of cases had admission mean arterial pressure <65 mmHg. With regard to the baseline GCS 12% of cases had a GCS of < 8, while 26.7% of patients have GCS 8-12 and the remaining 61.2% had GCS 13-15.

In relation to time of admission, number of patients admitted during duty time were greater than those admitted on regular working time, 52.4% and 47.6% respectively. It also showed that 42.5% of cases had moderate ARDS while mild and severe ARDS accounted for 22.2% and 35.3%. As demonstrated in Figure3; the commonest cause identified for ARDS was pneumonia(65.2%), followed by extra pulmonary sepsis(13.6%); the rest(21.1%) was due to other various causes like lung contusion, TRALI, massive aspiration, pancreatitis, toxic inhalation and drug overdose.

216 patients (57.8%) were found to have comorbidity, from these 103 patients had comorbidities like COPD, Asthma, Diabetes Mellitus, Hypertension and heart failure. While 79 patients (21.1%) had other comorbidities like CKD, CLD, HIV/AIDS, different malignancies and other less common conditions. 34 patients had more than one comorbidity (see Figure 4).

Table 3 Baseline admission characteristics of ARDS patients admitted to FHS and TGS from 2020-2025

Variable	Category	Total n (%)
Mean Arterial Pressure (MAP)	< 65 mmHg	112 (29.9%)
	≥ 65 mmHg	262 (70.1%)
Glasgow Coma Scale (GCS)	3–7	45(12%)
	8–12	100 (26.7%)
	13–15	229 (61.2%)
Time of Admission	Duty Time	196 (52.4%)
	Regular Working Time	178 (47.6%)
ARDS Severity	Mild ARDS	83 (22.2%)
	Moderate ARDS	159 (42.5%)
	Severe ARDS	132 (35.3%)
ARDS Etiology	Pneumonia	244 (65.2%)
	Sepsis / Extrapulmonary	51 (13.6%)
	Other causes	79 (21.1%)

Comorbidity Status	COPD / Asthma	34 (9.1%)
	Diabetes Mellitus	28 (7.5%)
	Hypertension	18 (4.8%)
	Chronic Heart Failure	23 (6.1%)
	Other Comorbidities	79 (21.1%)
	>1 Comorbidity	34 (9.1%)
	No known Comorbidity	158(42.2%)

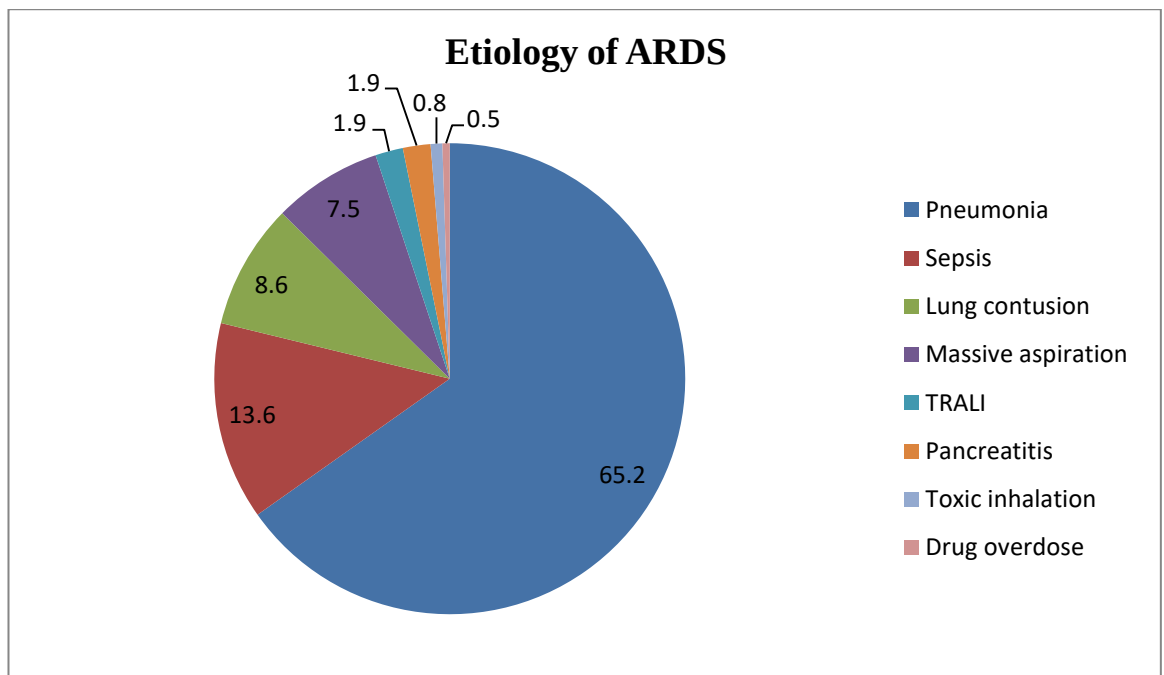


Figure 3. A pie chart demonstrating the percentages of different causes of ARDS among patients admitted to ICU of FHS and TGS from 2020 to 2025 GC.

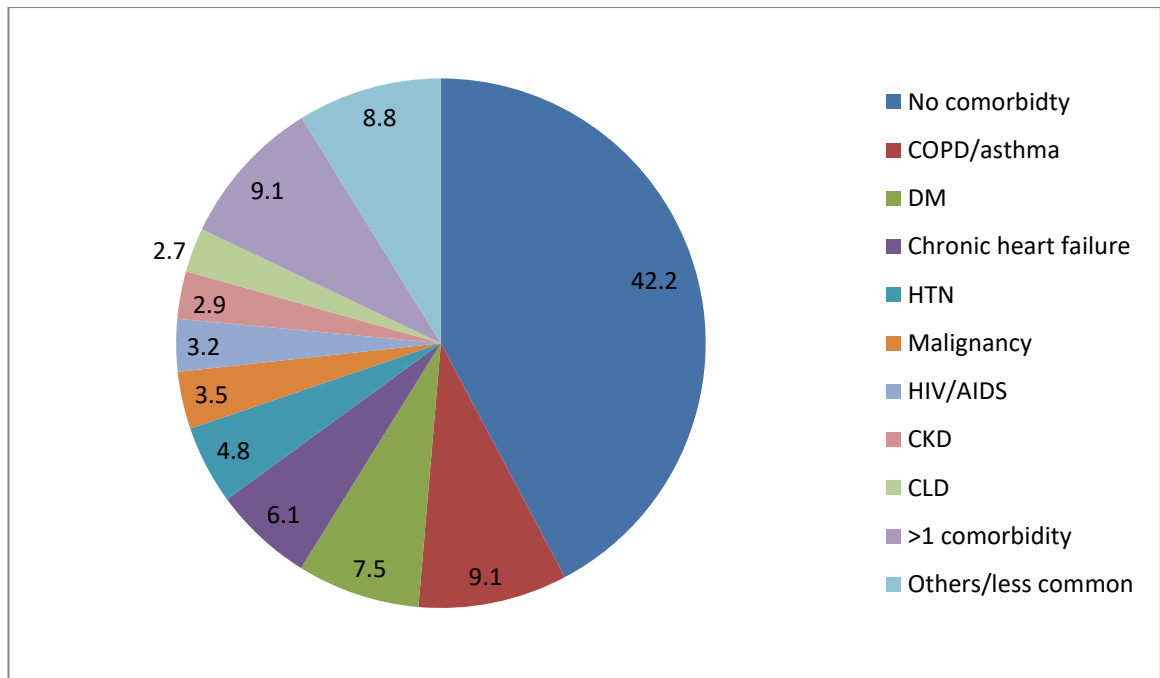


Figure4. Pie chart demonstrating the percentage of comorbidities among patients with ARDS in ICU of FHS and FHS from 2020-2025 GC.

6.3. Management related factors

All of the patients were given ventilationsupport; majority (75.9%) was invasive ventilation. It was identified that around 40.6% of patients had average fluid balance < 200ml/day and steroids were used in 38.5% of cases.

Table 4 Distribution of ventilator support and treatment related variables, in ARDS patients admitted to ICU of FHS and TGS , 2020-2025 GC.

Variable	Category	Frequency (n)	Percentage (%)
Ventilator support	Yes	374	100.0
	No	0	0.0
Mode of ventilation	Invasive	284	75.9
	Non-invasive	90	24.1
Average Fluid balance	<200mL	152	40.6

	200-900 mL	126	33.7
	>900mL	96	25.7
Steroid use	Not given	230	61.5
	Given	144	38.5

6.4. Complications and outcome of ARDS patients

Among the 374 cases most of the patients (61.2%) developed complications during their ICU stay. From those who develop complications 55.5% was ventilator associated pneumonia and sepsis. The study demonstrated that the in hospital mortality of patients with ARDS was 63.1% (95% CI: 58.2%–68.0%).

Table 5 Distribution of complications among ARDS patients admitted to ICU of FHS and FHS, 2020-2025 GC.

Variable	Category	Frequency (n)	Percentage (%)
Complication	Ventilator-associated pneumonia	30	8.0%
	Sepsis	97	25.9%
	Other complications	102	27.3%
	No identified complication	145	38.8%

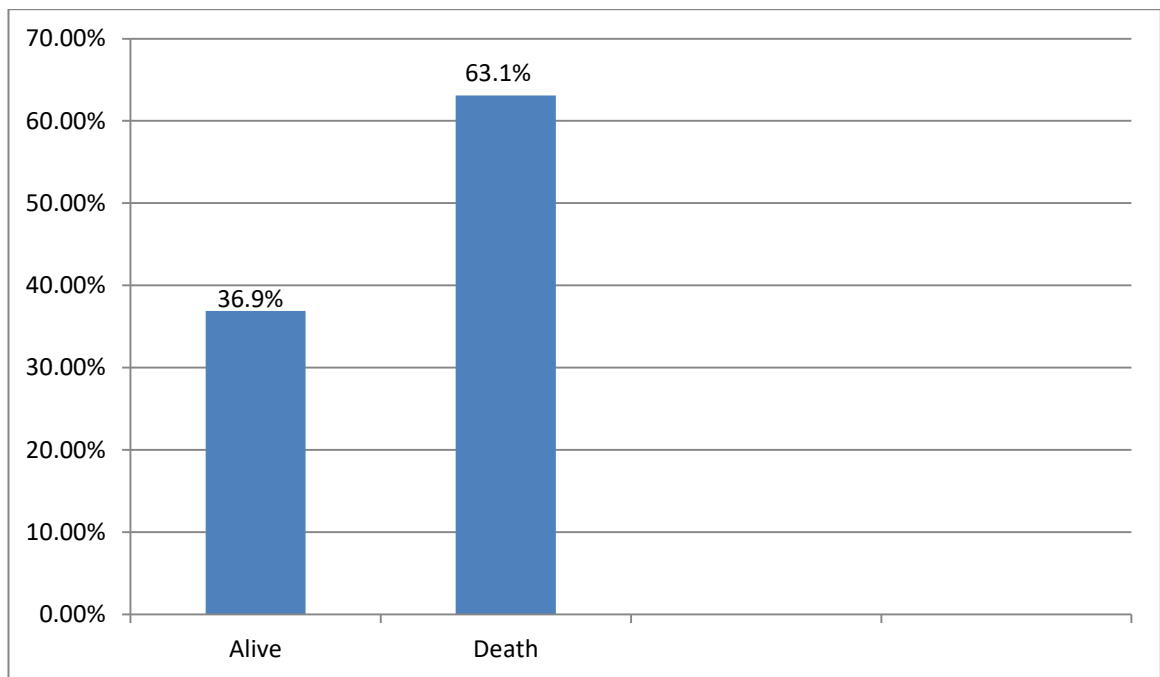


Figure 5. A bar graph illustrating the outcome of ARDS patients admitted in ICU of FHSB and TGSB, 2020-2025 G.C.

6.5 The relationship between risk factors and mortality of ARDS in ICU of FHSB and TGSB; 2020-2025 G.C.

Variables like age, sex, the mean arterial pressure, baseline GCS at admission, time of admission, etiology and severity of acute respiratory distress syndrome, comorbidities and management related factors including mode of ventilation, average fluid balance, steroid use and presence of complications in ICU were found to have P value < 0.25 in bivariate logistic regression. But area of residence was found to have P value > 0.25 .

Variables; baseline GCS at admission, severity and etiology of acute respiratory distress syndrome, Fluid management strategy, and presence of complications during ICU stay were statistically significant variables in multivariable binary logistic regression with p -value < 0.05 . While variables like age, sex, admission MAP, time at admission, mode of ventilation, presence of comorbidity, steroid usage did not have significant association.

The odds of mortality among patients who had Glasgow coma scale of 3-7 were almost 3 times higher AOR (2.83, 95% CI: 1.03-7.80; $p=0.044$) than those with GCS of 13-15 at

admission. And those patients with GCS of 8-12 were found to have 2 times higher chance of mortality AOR (2.23, 95% CI: 1.16-4.30; p=0.017) than those with GCS of 13-15.

Patients with moderate and severe Acute respiratory distress syndrome were found to have higher odds of mortality than those with mild ARDS with AOR (2.20, 95%CI: 1.14-4.26;p=0.019) and (3.02 , 95%CI;1.49-6.10;p=0.002) respectively. Regarding the cause of ARDS patients who had ARDS due to sepsis had 3 times higher odds of mortality, AOR(2.98; 95% CI;1.13-7.91; p=0.028) compared with those who develop ARDS due to other causes. Although not independently associated with mortality, pneumonia as a cause was found to have 1.5 times higher odds of mortality.

Using average daily fluid balance of <200 mL/day as the reference category, the study identified that patients with a fluid balance of 200–900 mL/day was associated with higher odds of adverse outcome, although this did not reach statistical significance (OR = 1.74; 95% CI: 0.96–3.13; p = 0.067). In contrast, patients with a daily fluid balance >900 mL/day had significantly higher odds of adverse outcome (OR = 3.27; 95% CI: 1.55–6.91; p = 0.002).

Patients who had complications during their stay in ICU were found to have higher odds of mortality when compared who did not have complication. Development of sepsis had 4 times higher odds of mortality AOR (4.28; 95% CI; 2.04-8.98: p=<0.001) and VAP and other complications had 3 times higher odds of mortality compared with those who did not have complications. The table below demonstrates the association between independent variables and in hospital mortality.

Table 6 the relationship between risk factors and mortality of ARDS with multivariable logistic regression; among patients admitted to ICU from 2020-2025 GC.

Variable	Category	Total n	Alive n (%)	Death n (%)	COR(95%CI)	AOR	(95% CI)	p-value
Age	18–49 years	272	110 (40.4)	162 (59.6)	1*	1*	—	—
	≥50 years	102	28 (27.5)	74 (72.5)	1.80(1.09-2.95)	1.13	0.59 – 2.19	0.707
Sex	Male	180	72 (40.0)	108 (60.0)	1*	1*	—	—
	Female	194	66 (34.0)	128 (66.0)	1.29(0.85-1.97)	1.09	0.65 – 1.83	0.739
Mean Arterial Pressure	≥65 mmHg	262	111 (42.4)	151 (57.6)	1*	1*	—	—
	<65 mmHg	112	27 (24.1)	85 (75.9)	2.31(1.41-3.81)	1.01	0.54 – 1.89	0.978
Glasgow Coma Scale	13–15	229	111 (48.5)	118 (51.5)	1*	1*	—	—
	3–7	45	7 (15.6)	38 (84.4)	5.11(2.19-11.91)	2.83	1.03 – 7.80	0.044**
	8–12	100	20 (20.0)	80 (80.0)	3.76(2.16-6.55)	2.23	1.16 – 4.30	0.017**
Admission Time	Regular working time	178	72 (40.4)	106 (59.6)	1*	1*	—	—
	Duty time	196	66 (33.7)	130 (66.3)	1.34(0.88-2.04)	0.89	0.52 – 1.53	0.683

1* Indicates Reference category, **Significant

Variable	Category	Total n	Alive n (%)	Death n (%)	COR	AOR	95% CI	p-value
ARDS Severity	Mild	83	47 (56.6)	36 (43.4)	1*	1*	—	—
	Moderate	159	57 (35.8)	102 (64.2)	2.34(1.36-4.02)	2.20	1.14 – 4.26	0.019**
	Severe	132	34 (25.8)	98 (74.2)	3.76(2.10-6.75)	3.02	1.49 – 6.10	0.002**
ARDS Etiology	Others	79	39 (49.4)	40 (50.6)	1*	1*	—	—
	Pneumonia	244	85 (34.8)	159 (65.2)	1.82(1.09-3.05)	1.51	0.75 – 3.05	0.250
	Sepsis/extra-pulmonary	51	14 (27.5)	37 (72.5)	2.58(1.21-5.49)	2.98	1.13 – 7.91	0.028**
Mode of Ventilation	Non-invasive	90	47 (52.2)	43 (47.8)	1*	1*	—	—
	Invasive	284	91 (32.0)	193 (68.0)	2.32(1.43-3.76)	1.02	0.54 – 1.93	0.942

Variable	Category	Total n	Alive n (%)	Death n (%)	COR(95% CI)	AOR	(95% CI)	p-value
Comorbidity	No known comorbidity	158	79 (50.0)	79 (50.0)	1*	1*	—	—
	COPD / Asthma	34	9 (26.5)	25 (73.5)	2.78(1.22-6.33)	1.56	0.57 – 4.27	0.386
	Diabetes mellitus	28	6 (21.4)	22 (78.6)	3.67(1.41-9.53)	1.13	0.36 – 3.52	0.838
	Hypertension	18	7 (38.9)	11 (61.1)	1.57(0.58-4.26)	0.51	0.15 – 1.71	0.278
	Chronic heart failure	23	8 (34.8)	15 (65.2)	1.88(0.75-4.67)	1.43	0.47 – 4.34	0.523
	Others	79	23 (29.1)	56 (70.9)	2.44(1.37-4.34)	1.20	0.58 – 2.49	0.625
	Combined (>1)	34	6 (17.6)	28 (82.4)	4.67(1.83-11.89)	1.86	0.61 – 5.64	0.274
Fluid Balance	<200 mL/day	152	80 (52.6)	72 (47.4)	1*	1*	—	—
	200–900 mL/day	126	42 (33.3)	84 (66.7)	2.22(1.36-3.62)	1.74	0.96 – 3.13	0.067
	>900 mL/day	96	16 (16.7)	80 (83.3)	5.56(2.98-10.37)	3.27	1.55 – 6.91	0.002**
Steroid Use	Yes	144	61 (42.4)	83 (57.6)	1*	1*	—	—
	No	230	77 (33.5)	153 (66.5)	1.46(0.95-2.24)	1.03	0.58 – 1.84	0.920
Complications	No complication	145	89 (61.4)	56 (38.6)	1*	1*	—	—
	VAP	30	8 (26.7)	22 (73.3)	4.37(1.82-10.49)	2.95	1.02 – 8.54	0.046**
	Sepsis	97	17 (17.5)	80 (82.5)	7.48(4.02-13.92)	4.28	2.04 – 8.98	<0.001**
	Others	102	24 (23.5)	78 (76.5)	5.17(2.93-9.1)	3.32	1.73 – 6.37	<0.001**

7. DISCUSSION

This study was designed to investigate in-hospital mortality and its determinants among ARDS patients admitted to ICU in Tibebe Ghion and Felegehiwo hospitals.

It illustrated that the in hospital mortality rate of ARDS was comparable to the multicentre study done in southern Ethiopia ; was 59.1 % (7), and higher than the global study done across 5 continents in 50 countries (8). However in another study done in Uganda the mortality of ARDS was significantly higher (4). These differences might be due to variation in ICU infrastructure, epidemiology of risk factors for ARDS in different populations, differences in management strategies, misclassification during diagnosis, and variation in methodology of studies.

This research identified factors that independently predict in hospital mortality of ARDS patients. These include GCS, severity of ARDS, etiology of ARDS, fluid management strategy and complications during stay in ICU.

Larger proportion of patients with GCS <8 and those with GCS 8-12 were dead but almost half of patients with GCS >12 survived; mortality was relatively higher when compared with the multicentre research done in southern Ethiopia for patients with GCS <8, 8-12 and >12 respectively. (7).

Regarding severity of ARDS at admission, mortality was 43.4% for mild, 64% for moderate and 74.2% for severe ARDS. This was comparable to the mortality rate of 58% for moderate and 71.1% for severe ARDS reported in the same study in our country. (7). These rates were higher than those reported in a multinational observational study, which showed hospital mortality rates of 34.9% for mild, 40.3% for moderate, and 46.1% for severe ARDS. (8) This discrepancy may be attributed to limitations in healthcare infrastructure and resource availability, delayed recognition of ARDS and delayed ICU admission.

This study also found that sepsis as a cause of Acute respiratory distress syndrome was associated three times higher odds of mortality and pneumonia had 1.5 times higher odds of mortality when compared with other etiologies. This was consistent with the multinational study which stated extra-pulmonary sepsis was associated with worse outcome than ARDS due to pneumonia(8); and the study conducted in Taiwan which compared outcomes of pneumonia associated ARDS with extra-pulmonary sepsis associated ARDS showed higher mortality in sepsis associated ARDS(10).

There was a trend towards higher odds of mortality in older patients in different studies. But age was not significant predictor of mortality in this study and many previous studies.(7, 44)

Despite patients with comorbidity had higher proportion of death compared with those without comorbidity; none of the comorbid conditions were statistically significant predictors of mortality after multivariable adjustment. This did not coincide with previous literatures done in other countries and the study done in southern Ethiopia.(4, 7, 8). This might be due to the stronger effect of acute physiological derangements(like low GCS, severity of ARDS and ICU complications) on mortality of critically ill patients(45) or due to a relatively smaller subgroup size.

Pertaining to fluid management, it identified liberal fluid management strategy was independently associated with increased death when compared with patients managed with conservative strategy. This result matched previous studies.(11, 40)

Regarding the effect of steroids on the outcome of ARDS patients, different systematic review and meta-analysis of randomized trials have shown systemic corticosteroids may potentially reduce mortality. For example a systematic review of 7 randomized controlled trials involving 851 patients showed that corticosteroids reduced all-cause mortality(12). In this study mortality was numerically lower in patients who received steroids (57.6%) compared to those who did not (66.5%) . But there was no statistically significant association between steroids and ARDS mortality. This discrepancy may be explained by the observational nature of the study and potential confounding by indication, as corticosteroids are usually administered to more severely ill patients. Additionally,

heterogeneity in timing, dosage, and indications for steroid therapy in routine clinical practice may attenuate measurable benefits observed in controlled trial settings.

In this study, ICU-acquired complications were strong independent predictors of mortality. Patients who developed ventilator-associated pneumonia had nearly threefold higher odds of death compared with those without complications. Sepsis demonstrated the strongest association with in hospital mortality (AOR 4.28; 95% CI: 2.04–8.98). Their role as a major determinant of ARDS mortality is consistent with previous studies reporting substantially increased mortality among patients who developed complications during their ICU stay.(7, 13) These findings highlight the importance of implementing effective preventive strategies to reduce ICU-acquired infections, particularly VAP and sepsis.

8. STRENGTH AND LIMITATION

8.1 Strength

This study included a relatively large number of patients with acute respiratory distress syndrome (ARDS), enrolling 374 cases, which is higher than the only previously published study on this topic in the country that involved 340 patients. It is done in homogenous population in terms of sociodemographic characteristics, and similar ICU infrastructure. In addition to evaluating commonly reported demographic and clinical variables, the study extended the scope of analysis by assessing the association of additional, clinical factors like fluid management strategy and impact of steroids with patient outcomes.

8.2 Limitations

This study is not without limitations, which includes; it is a retrospective study leading to missing data and it did not assess the impact of other disease severity factors like SOFA score, pH level and mechanical ventilator settings on mortality of ARDS, due to incomplete data. The study focused primarily on in-hospital mortality, and long-term outcomes such as functional status, quality of life, or post-ICU mortality were not assessed.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

This study concludes that the in hospital mortality rate of acute respiratory distress syndrome is significantly higher than those of developed countries, and relatively higher than some countries in Africa. In addition it concludes that factors like low GCS, severity and etiology of ARDS, fluid management strategy and complications in ICU were independent predictors of mortality.

9.2 Recommendations

9.2.1 Recommendation for healthcare professionals

Health care professionals should prioritize early identification and careful management of high-risk ARDS patients, particularly those with low Glasgow Coma Scale scores, severe ARDS, pneumonia and sepsis-related ARDS, or ICU-acquired complications.

Conservative fluid management strategies should be considered whenever possible, as liberal fluid administration may increase mortality risk. Professionals should monitor for and manage ICU-acquired complications, especially ventilator-associated pneumonia and sepsis, using established infection-prevention and antimicrobial stewardship practices.

9.2.2. Recommendation for policy makers

Preventing the occurrence of ARDS by addressing major causes like pneumonia and other infectious diseases should be considered. The regional health bureau should support strengthening ICU infrastructure, ensuring adequate availability of monitoring equipment, ventilators, and other essential resources. It should encourage the adoption of standardized ARDS management protocols across hospitals to improve patient outcomes. Continuous professional development programs for ICU staff should be promoted across the region to maintain and improve quality of care. The bureau should also advocate for infection-prevention strategies and ICU quality improvement initiatives in all hospitals.

9.2.3.Recommendation for Future Research

Future studies should consider a prospective design to minimize missing data and allow inclusion of disease severity indicators, such as SOFA score, pH level, and mechanical ventilator settings. Additionally, assessing long-term outcomes, including post-ICU mortality, functional status, and quality of life, would provide a more comprehensive understanding of ARDS prognosis.

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Annexes

Annex I: Request Form for Ethical Clearance

Date:

To BDU/CMHS Ethics Committee

Subject: To get ethical clearance for my research

I am Dr. BekaluGashaw , a third -year medical resident in Bahir Dar university college of medicine and health sciences, I would like to apply to your office to have ethical clearance to conduct a research on the prevalence of in hospital mortality of ARDS and its associated factors among patients admitted to adult ICU of TibebeGhionand Felegehiwotspecialized hospitals, Bahir Dar; as partial fulfillment for the requirement of specialty program in internal medicine. Data will be extracted using a prepared checklist; confidentiality of records will be kept. The results of this research will show in hospital mortality of ARDS patients and identify associated factors.

With regards

DrBekaluGashaw(Year III Medical Resident)

Annex II: Check list

Section	Question / Variable	Response Options / Fill-in
ARDS Eligibility	ARDS criteria met	☐ Yes ☐ No
1. Patient Demographics	Age	_____ years
	Sex	☐ Male ☐ Female
	Living area	Urban ☐ Rural
2. Admission Characteristics / Clinical Factors	Mean Arterial Pressure (MAP)	_____ mmHg
	Glasgow Coma Scale (GCS)	_____
	Admission time	☐ Day time ☐ Night time ☐ Weekend
	SpO ₂ /FiO ₂ ratio (ARDS severity)	☐ >235–≤315 (Mild) ☐ >148–≤235 (Moderate) ☐ ≤148 (Severe)
	ARDS etiology	☐ Pneumonia ☐ Aspiration ☐ Sepsis ☐ Trauma ☐ Toxic inhalation injury ☐ Drug overdose ☐ Pancreatitis ☐ TRALI ☐ Near drowning
	Presence of comorbidity	☐ Yes ☐ No
	If yes, specify	☐ COPD/Asthma ☐ DM ☐ HTN ☐ CHF ☐ CLD ☐ CKD ☐ Malignancy ☐ RVI ☐ >1 comorbidity ☐ Others

3. Patient Management	Ventilatory support used	☐ Yes ☐ No
	If yes, mode	☐ Non-invasive ☐ Invasive
	Average fluid balance	_____ ml/day
	Steroid used	☐ Yes ☐ No
4. Complications	Any complication	☐ Yes ☐ No
	If yes, specify	☐ VAP ☐ Sepsis ☐ Other: _____
5. Outcome	Patient outcome	☐ Discharged alive ☐ In-hospital death

Annex III: Declaration

I, the undersigned, declared that this is my original work, has never been presented in this university, and that all the resources and materials used for the research, have been fully acknowledged.

Principal Investigator

Name: Dr. Bekalu Gashaw (Year III medical resident)

signature: _____
Date: 29/7/18 E.C

Advisors

Name: Genet Gedamu (Assistant professor of public health)

Signature: _____

Date: 29/07/18

medicine)

Name: Dr. Awoke Teshale (Assistant professor of Internal

Signature: _____

Date: 29/07/18

