

Clinical Profile and Outcome of Louse-Borne Relapsing Fever Among Patients at Zewditu Memorial Hospital and Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia: A Cross-Sectional Study

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ABSTRACT

Background: Louse-borne relapsing fever (LBRF), caused by *Borrelia recurrentis*, is a re-emerging vector-borne infectious disease that remains endemic in the highlands of Ethiopia, particularly among populations living in crowded, unhygienic conditions. Although it is among the leading causes of hospital admission in Ethiopia, data on its clinical profile and outcome in Addis Ababa are lacking.

Objective: To assess the clinical profile, associated factors, and outcome of patients with LBRF at Zewditu Memorial Hospital (ZMH) and Tikur Anbessa Specialized Hospital (TASH), Addis Ababa, Ethiopia.

Methods: An institution-based, multicenter, retrospective cross-sectional study was conducted among 172 patients treated for LBRF at ZMH and TASH between July 2022 and July 2023. Data were extracted from medical records using a structured checklist and analyzed using SPSS version 26. Descriptive statistics summarized socio-demographic and clinical characteristics; univariate and multivariable binary logistic regression identified factors associated with in-hospital mortality, with adjusted odds ratios (AOR), 95% confidence intervals (CI), and p-values used to test significance.

Results: Males predominated (82.6%), and nearly half of patients (49.4%) were aged 14-20 years; most (70.3%) were living on the street. Fever (84.3%) and headache (25.6%) were the most common presenting symptoms. Hematologic complications (85.5%), hypotension (53.5%), and sepsis (17.4%) were the most frequent complications. The in-hospital mortality rate was 4.1%. In multivariable analysis, hematologic complications (AOR=0.11, 95% CI 0.018-0.739, $p=0.023$) and sepsis (AOR=0.14, 95% CI 0.02-0.993, $p=0.0049$) were significantly associated with mortality.

Conclusion: LBRF predominantly affects young, socially marginalized men in Addis Ababa. Hematologic complications and sepsis were independently associated factors of mortality, and the overall case fatality rate was comparable with reports from other Ethiopian settings. Early identification and management of these complications, together with targeted public health measures for high-risk populations, may help reduce mortality from LBRF.

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1. Introduction

Relapsing fever is an acute, recurrent febrile illness caused by *Borrelia* species, transmitted to humans by body lice in louse-borne relapsing fever (LBRF) or by soft ticks in tick-borne relapsing fever.^[1] *Borrelia recurrentis* is the sole causative agent of LBRF, for which humans are the only known reservoir.^[2] The disease is characterized by abrupt onset of fever, headache, myalgia, and chills, with febrile episodes recurring up to four times if untreated.^[3] If untreated, LBRF can progress to meningitis, renal failure, pulmonary complications, hepatic failure, and myocarditis.^[3,4]

Historically, LBRF caused major epidemics associated with war and population displacement, with an estimated 15 million cases and more than 5 million deaths recorded across Africa, Eastern Europe, and Russia.^[2] The disease is now largely confined to North-Eastern Africa, particularly the Ethiopian highlands, where it disproportionately affects homeless and displaced populations living in crowded, unhygienic conditions, especially during the rainy season.^[3] LBRF has historically ranked among the top ten causes of hospital admission in Ethiopia and remains an important cause of morbidity and mortality.^[5,6]

Reported case fatality rates for LBRF vary widely, ranging from approximately 40% among untreated patients to 2-5% among those receiving antibiotic therapy such as doxycycline, penicillin, or chloramphenicol.^[3] The Jarisch-Herxheimer reaction (JHR), a potentially life-threatening reaction that may occur before or after treatment initiation, has been reported with widely varying frequency (0-100%), largely reflecting inconsistent diagnostic criteria.^[3] A meta-analysis of six randomized controlled trials comparing antibiotic regimens for LBRF found no significant difference in mortality between tetracycline and

penicillin. However, tetracycline reduced relapse rates while penicillin was associated with fewer JHR episodes.^[7]

Previous Ethiopian studies from Bahir Dar, Gondar, Hosanna, and Arsi have described the socio-demographic profile, clinical presentation, and mortality of LBRF, identifying young age, male sex, low educational attainment, and crowded or street-based living conditions as characteristic features, with case fatality rates ranging from 2% to 13%.^[5,9,10,8,6] Similar clinical patterns, including a high burden of hepatosplenomegaly and thrombocytopenia, have also been reported from Sudan.^[11]

Despite evidence from other regions of Ethiopia, no previous study has characterized the clinical profile, associated factors, and outcome of LBRF among patients managed in Addis Ababa, where numerous cases continue to be seen at referral hospitals such as Zewditu Memorial Hospital (ZMH) and Tikur Anbessa Specialized Hospital (TASH). As a neglected disease that receives limited attention from public health authorities and funding bodies, LBRF remains poorly characterized in the capital despite ongoing internal migration and urban crowding that sustain transmission. This study therefore aimed to assess the clinical profile, socio-demographic characteristics, and outcomes of patients with LBRF managed at ZMH and TASH, Addis Ababa, Ethiopia, between July 2022 and July 2023, and to identify factors independently associated with in-hospital mortality.

2. Methods and material

Study design and setting

This institution-based, multicenter, retrospective cross-sectional study was conducted at Zewditu Memorial Hospital (ZMH) and Tikur Anbessa Specialized Hospital (TASH), two public hospitals in Addis Ababa, Ethiopia. TASH, established in

1972, is one of the country's largest tertiary teaching hospitals and serves as the main national referral center. ZMH, established in 1910, is one of the oldest public hospitals in Addis Ababa and provides emergency, inpatient, outpatient, surgical, diagnostic, and maternal and child health services. Data were collected retrospectively from medical records covering July 2022 to July 2023; data abstraction took place between August and November 2023.

Study population and sampling

The source population comprised all patients presenting with acute febrile illness to the emergency departments of ZMH and TASH during the study period, while the study population consisted of all patients diagnosed with LBRF at either hospital during the same period. A consecutive census of all eligible patients during the study period was performed. Patients aged 14 years or older with a presumed or confirmed diagnosis of complicated LBRF at admission, or in whom LBRF was diagnosed after admission, were included. Patients whose initial presumed diagnosis of relapsing fever was later revised after a negative blood film were excluded. The minimum required sample size, calculated using a single population proportion formula based on a previously reported LBRF prevalence of 2.5%, [8] a 95% confidence level, and a 1% margin of error, with adjustment for the finite source population and a 10% non-response allowance, was 182; a total of 172 eligible patients were identified and included over the study period.

Data collection

Data were abstracted from patients' medical records using a structured, pre-tested checklist covering socio-demographic characteristics, clinical presentation, complications, treatment, and outcome. The checklist was pre-tested on 5% of

the sample size outside the study sites and refined accordingly. Data collectors with a health professional background were trained on the data collection procedure and the importance of confidentiality, and completed checklists were reviewed daily for completeness and consistency by the data collectors and the principal investigator.

Study variables

The outcome variable was in-hospital mortality. Independent variables included age, sex, socioeconomic and educational status, hygiene status, living condition, presenting symptoms, length of hospital stay, type and severity of complications, antibiotic regimen, vasopressor use, and presence of Jarisch-Herxheimer reaction. Complicated LBRF was defined as a diagnosis of relapsing fever accompanied by at least one complication, including hypotension, jaundice (acute liver failure), bleeding diathesis, acute respiratory distress syndrome (ARDS), renal failure, or encephalopathy. In-hospital mortality was defined as death occurring at any time during the hospital admission for LBRF.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26. Descriptive statistics (frequencies and percentages) were used to summarize socio-demographic and clinical characteristics. Associations between independent variables and in-hospital mortality were first examined using univariate binary logistic regression; variables with a p-value <0.25 were entered into a multivariable binary logistic regression model. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were used to assess the strength and significance of associations, and the Hosmer-Lemeshow test was used to assess model fit. A p-value <0.05 was considered statistically significant.

Ethical considerations

Ethical clearance was obtained through the Addis Ababa University Department of Emergency and Critical Care Medicine, and permission was granted by the medical directors and emergency department heads of both study hospitals prior to data collection. Patient confidentiality was maintained throughout by excluding all personal identifiers from the data collection checklist and restricting data access to the research team.

3. Results

Socio-demographic characteristics

A total of 172 patients diagnosed with LBRF were included in the study. Males predominated, accounting for 142 (82.6%) of participants, giving a male-to-female ratio of 4.7:1. Nearly half of the patients, 85 (49.4%), were aged between 14 and 20 years. More than half, 97 (56.4%), had no formal education, and the majority, 121 (70.3%), reported living on the street; 19 (11%) lived in crowded homes, and 27 (15.7%) were incarcerated (Table 1).

Table 1. Socio-demographic characteristics of patients with louse-borne relapsing fever, July 2022-July 2023, Addis Ababa, Ethiopia (n=172).

Sex	N (%)
Male	142(82.6)
Female	30(17.4)
Age group	
14-20 years	85(49.4)
21-30 years	60(34.9)
31-40 years	20(11.6)
>41 years	7(4.1)
Educational status	
No formal education	97(56.4)
1st-8th grade	18(10.5)
Not documented	57(33.1)
Living condition	
Living on the street	121(70.3)
Crowded shared housing	19(11.0)
Prison	27(15.7)
Not documented	5(2.9)

Clinical characteristics

Fever was the most common presenting complaint, documented in 145 (84.3%) patients, followed by headache in 44 (25.6%) and bleeding in 7 (4.1%); jaundice was the least frequent presenting symptom. Hematologic complications, mainly thrombocytopenia, were the most common, affecting 147 (85.5%) patients, followed by hypotension in 92 (53.5%) and sepsis in 30

(17.4%); myocarditis was the least common complication, occurring in 1 (0.6%) patient. Most patients (112; 65.1%) received procaine penicillin, 47 (27.3%) received ceftriaxone, and the remainder received doxycycline. Jarisch-Herxheimer reaction was documented in 17 (9.9%) patients, and 7 (4.1%) patients required intensive care unit admission. The overall in-hospital case fatality rate was 4.1% (7/172) (Table 2).

Table 2. Clinical characteristics of patients with louse-borne relapsing fever, July 2022-July 2023, Addis Ababa, Ethiopia (n=172).

Symptoms at presentation	N (%)
Fever	145(84.3)
Headache	44(25.6)
Bleeding	7(4.1)
Altered mental status	4(2.3)
Jaundice	2(1.2)
Complications	
Hematologic (thrombocytopenia)	147(85.5)
Hypotension	92(53.5)
Sepsis	30(17.4)
Renal failure	14(8.1)
ARDS	9(5.2)
Acute liver failure	5(2.9)
Myocarditis	1(0.6)
Treatment received	
Procaine penicillin	112(65.1)
Ceftriaxone	47(27.3)
Doxycycline	13(7.6)
Jarisch-Herxheimer reaction	
Yes	17(9.9)
No	155(90.1)
ICU admission	
Yes	7(4.1)
No	165(95.9)
Length of hospital stay	
< 7 days	153(89.0)
>= 7 days	19(11.0)
In-hospital outcome	
Alive	165(95.9)
Dead	7(4.1)

Factors associated with outcome

On univariate analysis, age group, ARDS, liver failure, central nervous system (CNS) complica-

tions, and sepsis were significantly associated with in-hospital mortality ($p<0.25$) (Table 3).

Table 3. Univariate analysis of factors associated with in-hospital mortality among patients with louse-borne relapsing fever, Addis Ababa, Ethiopia (n=172).

Variables	Categories	Outcome /Mortality		P value
		Dead	Alive	
Age	14- 20yrs	0	85	0.004
	21-30yrs	4	56	
	31-40yrs	1	19	
	>41yrs	2	5	
Gender	Male	7	135	0.998
	Female	0	30	
Living condition	Living in street	5	116	0.851
	Living in small homes with a lot of people	0	19	
	Prison	2	25	
Complication	ARDS	3	6	<0.001
	Hypotension	7	85	<0.997
	Hematology	2	145	<0.05
	Change in mentation	4	0	0.999
	Sepsis	5	25	0.171
	Liver failure	1	4	0.112
	Vasopressor use	7	11	0.995
	Cardiac complication	0	1	1
	Renal failure	0	14	0.998
	CNS	1	1	0.025
Presence of JHR	JHR	0	17	0.999
Treatment	Procaine penicillin	1	111	0.525
	Ceftriaxone	6	41	
	Doxycycline	0	13	

*P-value from univariate binary logistic regression; variables with $p < 0.25$ were entered into the multivariable model.

In the final multivariable binary logistic regression model, which fit the data well (Hosmer-Lemeshow $p = 1.00$), hematologic complications (AOR=0.11, 95% CI 0.018-0.739, $p = 0.023$) and

sepsis (AOR=0.14, 95% CI 0.02-0.993, $p = 0.0049$) remained independently and significantly associated with mortality (Table 4).

Table 4. Final multivariable logistic regression model for in-hospital mortality among patients with louse-borne relapsing fever (n=172).

ARDS	Present vs absent	reference model, NS	0.084
Hematologic complication	Present vs absent	0.114 (0.018-0.739)	0.023*
Sepsis	Present vs absent	0.140 (0.020-0.993)	0.0049*
Liver failure	Present vs absent	2.400 (0.146-39.0)	0.539
CNS complication	Present vs absent	7.100 (0.327-156.7)	0.211

AOR: adjusted odds ratio; CI: confidence interval; NS: not statistically significant; * $p < 0.05$ in the final multivariable model (Hosmer-Lemeshow goodness-of-fit $p = 1.00$).

4. Discussion

This study characterized, for the first time, the clinical profile and outcome of patients with LBRF managed in Addis Ababa, Ethiopia. Nearly half of the patients were adolescents and young adults aged 14–20 years, and males markedly predominated (male-to-female ratio 4.7:1), consistent with findings from Bahir Dar, Gondar, and Arsi, where LBRF disproportionately affected young men with low educational attainment living in crowded conditions, on the street, or in correctional facilities.^[8,10,9] This pattern likely reflects rural-to-urban migration and displacement of young men seeking daily labor in Addis Ababa, combined with limited health-seeking behavior and constrained access to preventive information among street-connected populations. In contrast to some previous reports, age and sex were not statistically associated with mortality in this study ($p > 0.05$), suggesting that, once infected, disease severity may be driven more by clinical complications than by demographic factors.

Fever and headache were the predominant presenting symptoms, mirroring findings from Sudan, where fever and headache were similarly the leading symptoms.^[11] Hematologic complications, particularly thrombocytopenia, were the most frequent complication in this cohort, consistent with reports from Sudan and Gondar.^[11,10] While hypotension and ARDS were also common, only hematologic complications and sepsis remained independently associated with mortality after adjustment for other covariates. This finding diverges from studies in Sudan, where severe liver failure, lobar pneumonia, and CNS complications were the leading causes of death.^[11] This may reflect differences in disease severity at presentation, access to supportive care, or sample size between settings.

The prevalence of JHR in this study (9.9%) was lower than the 28.8% reported from Gondar,^[10] which may relate to earlier referral from health centers or to differences in treatment regimens rather than a true difference in incidence, given the well-recognized difficulty of standardizing JHR diagnosis.

The overall in-hospital case fatality rate of 4.1% was comparable to rates reported from Gondar (4.6%)^[10] and earlier surveys from southern Ethiopia (2–4%),^[12] but considerably lower than the 13% reported during an LBRF outbreak in Arsi.^[9] This is reassuring and may reflect early treatment initiation and a relative absence of documented comorbidities among patients in this cohort. However, it should be interpreted cautiously given the retrospective nature of data collection.

Strengths and limitations

This study has several limitations. Its retrospective design relied on medical chart review, which was occasionally limited by missing or illegible documentation, and other clinically relevant variables, including detailed laboratory parameters and behavioral risk factors, were not consistently recorded and could not be analyzed. The relatively modest sample size may have limited the statistical power to detect associations with less common complications, and findings from these two hospitals may not be generalizable to other settings. Despite these limitations, to our knowledge, this is the first study to describe the clinical profile and predictors of mortality among patients with LBRF in Addis Ababa, and its findings may help guide clinical vigilance and public health planning in this setting.

5. Conclusion

Louse-borne relapsing fever in Addis Ababa predominantly affects young, socially marginalized men, particularly those experiencing homelessness, incarceration, or crowded living conditions. Hematologic complications and sepsis were independently associated with higher in-hospital mortality, while the overall case fatality rate was comparable to other Ethiopian settings. Early recognition and management of these complications, alongside public health interventions addressing homelessness, overcrowding, and population displacement, may help reduce the burden of LBRF-related mortality in this population.

Abbreviations

AAU: Addis Ababa University;
AOR: Adjusted Odds Ratio;
ARDS: Acute Respiratory Distress Syndrome;
CI: Confidence Interval;
CNS: Central Nervous System;
ICU: Intensive Care Unit;
JHR: Jarisch-Herxheimer Reaction;
LBRF: Louse-Borne Relapsing Fever;
MOH: Ministry of Health;
OR: Odds Ratio;
RRT: Renal Replacement Therapy;
SPSS: Statistical Package for the Social Sciences;
TASH: Tikur Anbessa Specialized Hospital;
ZMH: Zewditu Memorial Hospital.

Author Contributions

All authors contributed to the conception and design of the study. Data acquisition was performed by KZ. All authors contributed to data analysis and interpretation, drafted and critically revised the manuscript for important intellectual content, and read and approved the final manuscript.

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Competing interests

The authors declare no competing interests.

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