

Clinical Profiles and Outcomes of rK39-Confirmed Paediatric Visceral Leishmaniasis at a General Hospital in Massawa, Eritrea: A Retrospective Study

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Background: Although timely diagnostic and treatment modalities exist worldwide for the disease Visceral leishmaniasis (VL), still a sporadic outbreak cases are reported especially in the high burden of Sub-Saharan countries.

Purpose: The purpose is to identify the characteristics, distribution of the clinical parameters and treatment outcomes of VL among affected children younger than five years old.

Patients and Methods: A retrospective cohort study design was used by involving all patients admitted with the rk-39 serology diagnosed patients in the VL treatment center from 15th December 2021 until 7th February 2023 in Massawa. It evaluated a patients' hospital stay, progressive changes and finally assessing treatment outcome as favorable and unfavorable.

Results: Our study found 97 rk-39 confirmed VL cases. Out of these, most cases were males 53.6%, median age with IQR of 32 (15–66) months, and most were from Ghelalo (62%) and Foro (35.1%) of the Northern Red Sea region of Eritrea. The mortality rate was 14.4% which is 14 out of 97 cases. The younger cases were found to have higher mortality rate. Children who recovered or those with favorable outcome were found to have better baseline hematologic parameters, without concomitant infection and few blood products given. Pre and post treatment anthropometric and hematologic comparisons showed a significant positive shift with $p < 0.001$ paired sample *T*-test. Finally, a time-to-event analysis revealed a 1729 days of follow-up period with overall mortality of 6.3 per 1000 child-days.

Conclusion: Along with the implementation of updated diagnostic and treatment guidelines, our study discovered the need for region-specific approach of the disease, a holistic treatment approach including their nutritional status and focusing on specific socio-demographic factors, which strongly affect the outcome of the patients.

Keywords: visceral leishmaniasis, kinesin-related (rk-39), Massawa, Eritrea

Introduction

Visceral Leishmaniasis (VL), also known as kala-azar, is one of the most common neglected tropical diseases, a systemic parasitic infection caused mainly by two of the species of the protozoan *Leishmania donovani* and *Leishmania infantum*.¹ *L. donovani* causes the most common VL in Southeast Asia and Eastern Africa and *Leishmania infantum* in Latin America as well as in the Mediterranean. The parasites are transmitted through the bite of female phlebotomine sandflies. They infect and multiply in different macrophage populations in the human host. Most infected patients present with fever often associated with rigour and chills, splenomegaly, pancytopenia, weight loss, and weakness, which is fatal if left untreated.^{2–4}

The most appropriate diagnostic method to detect infection and disease can vary because of the diverse epidemiology of Leishmaniasis across countries and regions. Although spleen aspiration remains the most sensitive method for parasite

detection, it is rarely used in clinical practice due to the high risk of hemorrhage, especially in resource-limited settings. Safer alternatives, such as bone marrow aspiration and serological tests, are more commonly employed. Serological tests based on the recombinant kinesin antigen of 39 kilodaltons (rK39), such as the rK39 immunochromatographic test (ICT), are widely used due to their ease of application in field settings.^{5,6}

VL is a neglected tropical disease that mainly affects the impoverished population globally. According to a 2020 WHO report, new VL occurred globally in India, Brazil, Ethiopia, South Sudan, Kenya, Sudan, Eritrea, Somalia, China, and Yemen.^{7,8} Approximately 500,000 people are affected with VL worldwide.⁹ This fatal vector-borne disease was reported in approximately 70 countries.¹⁰ However, there have been tremendous progresses regarding the treatment protocols of VL globally. Since 2010, Sodium stibogluconate (SSG) and paromomycin (PM) combination has been the standard of care for VL in Africa.⁵

In sub-Saharan Africa, Ethiopia has recorded the highest number of VL cases after Sudan, with more than 4000 people registered for treatment every year,^{11,12} where the highest burden of VL was found in the north-western lowlands bordering Sudan. This area is an important cash crop region with a very high demand for agricultural labour.¹³

In Eritrea, the exact burden and prevalence of the disease are not established yet due to the scarcity of clinical data despite the sporadic cases reported by the health information management system (HMIS). Passive case detection data collected through the HMIS indicate that there have been 680 cases reported from all health services in all six zones (regions) of Eritrea from 2012 to 2015, the highest number being in Gash Barka, Debub, and Anseba regions in their descending order.^{6,14} The three main affected zones of Eritrea bordered with North Sudan and/or Ethiopia; the borders of both of these countries are also leishmaniasis endemic area, and cross border transmission is likely to occur.^{15–17} Therefore, this study aims to identify the characteristics, distribution of the clinical parameters and treatment outcomes among children younger than five years old.

Materials and Methods

Study Design and Setting

This is a retrospective cohort study conducted in the leishmaniasis treatment centre at Massawa Zonal Referral Hospital located in the city of Massawa. Massawa, a Northern Red Sea region of Eritrea, is one of the two ports of Eritrea located 115km away from the capital on the eastern coastal lowlands, having an arid climate. Massawa Hospital serves a catchment population of approximately 575,000 people, mostly in rural areas of moderate to low-income people.

This Massawa Hospital Leishmaniasis Treatment Centre serves patients diagnosed with Leishmaniasis either on their hospital outpatient department visit or after a mass screening on a suspected population in their home areas clinics. Since its commencement, a number of patients received proper medical care from the assigned physicians along with nurses under the supervision of CDC program of the Ministry of Health of Eritrea. All patients were treated according to national VL treatment guidelines. First-line therapy included sodium stibogluconate (20 mg/kg/day IM) and paromomycin (15 mg/kg/day IM) for 17 days. Treatment adjustments were made in case of intolerance or contraindications.

Study Population

A total of 97 patients were included in this study, all diagnosed serologically with rk-39. The manufacturer is Bio-Rad. The kit's name is IT Leish. It uses serum. Patients admitted from the 15th of December 2021 up to 7th February 2023 were recruited for the study. The recruitment details are illustrated in (Figure 1).

Data Collection and Approach

The patient clinical card, including patients' diagnosis, follow-up, and discharge information forms, was used to extract the data. Then the data was collected via a suitable, well-structured and pre-formatted template. Finally, the data retrieved and collected was transferred to Microsoft Excel 2016 and then exported to SPSS version 26. Baseline data collected included sociodemographic characteristics (namely, date of birth/age at diagnosis, sex, weight and address), clinical signs and symptoms at diagnosis (fever, abdominal distention, vomiting, diarrhoea, loss of appetite, bleeding tendency, extremity swelling and organomegaly either splenomegaly and/or hepatomegaly), pre and post-

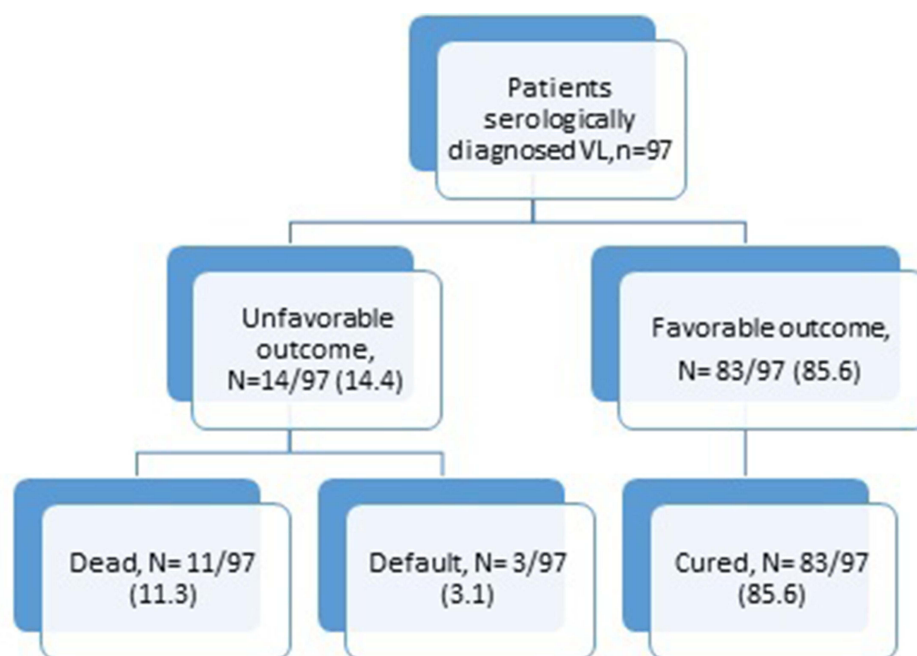


Figure 1 Flow diagram of study participant's recruitment and outcome.

treatment laboratory characteristics (complete blood count, ie WBC, hemoglobin and platelet counts) and also follow-up progress of the patient including concomitant infections, antibiotics and blood products given as well as the treatment outcome.

Operational Definitions

- Cure: A full course of drugs has been given, and the patient has clinically improved.
- Clinical criteria for cure are defined as “no fever and regression of splenomegaly and return of appetite and/or gain in body weight”.
- Death: any death, whether related to VL or not.
- Defaulter: the patient did not complete treatment.

Data Analysis

The retrieved data were exported to SPSS V.26.0 and STATA V.12.0 and processed for analysis. Descriptive statistics for categorical variables were analyzed using the chi-square or Fisher's exact test and summarized using frequency and percentage. Continuous variables were summarized using mean ($\pm$ SD) or median/IQR depending on the data distribution. Suitable parametric or non-parametric statistics were used to evaluate differences and also to compare the means for the variables with pre- and post-treatment values. Incidence of mortality was calculated per 1000 person-months with 95% CI. Furthermore, the Log rank test was used to evaluate differences in the equality of survival functions. Box plots are also used to compare the median of weight, WBC count, Hgb level and platelet count before and after treatment. All p values were two-tailed and p values of <0.05 were considered statistically significant.

Outcome of Interest

Primary outcomes were an estimate of favorable outcomes (cured/recovered) and unfavorable outcomes (death and default).

Results

Of the 97 involved children with confirmed cases of Visceral leishmaniasis, 52 (53.6%) were males. The median age with IQR of the patients was 32 (15–66) months. All the patients reside in the Northern Red Sea region of Eritrea. More than 90% of the cases were from Ghelalo (62%) and Foro (35.1%) (Table 1).

Table 1 Background, Sociodemographic and Baseline Clinical Characteristics of Visceral Leishmaniasis Patients in Massawa Hospital, Massawa, Eritrea: 2022

Variables	Total n (%)	Outcome During Follow-Up n (%)		D:C	p-value
		Recovered	Death/Unfavorable		
Total	97 (100)	83 (85.6)	14 (14.4)	1:6.9	
Age, median (IQR) in months	32 (15–66)	36 (17–72)	19 (10–40.5)	-	0.067 ^a
≤ 15	25 (25.8)	19 (22.9)	6 (42.9)	1:4.2	0.08 (6.7)
16–32	24 (24.7)	19 (22.9)	5 (35.7)	1:4.8	
33–60	24 (24.7)	24 (28.9)	0 (0)	-	
61	24 (24.7)	21 (25.3)	3 (21.4)	1:8	
Gender					
Male	52 (53.6)	44 (53)	8 (57.1)	1:6.5	0.77 (0.082)
Female	45 (46.4)	39 (47)	6 (42.9)	1:7.5	
Address					
Foro	34 (35.1)	28 (33.7)	6 (42.9)	1:5.7	0.078 (6.8)
Ghelalo	61 (62.9)	54 (65.1)	7 (50.0)	1:8.7	
Ghindae	1 (1)	1 (1.2)	1 (0)	1:1	
Massawa	1 (1)	0 (0)	1 (1.0)	1:1	
Length of stay in days, mean ±SD	17.8±5	18.9±3.8	11.7±6.9	-	<0.001 ^b
<17 days	58(59.8)	47(56.6)	36(43.4)	1:1.6	0.12(2.4)
>17 days	39(40.2)	11(78.6)	3(21.4)	1:19.5	
Baseline WAZ, mean± SD	−2.7±1.5	−2.6±1.6	−3.3±1.1	-	0.08 ^b
Baseline CBC					
WBC, median(IQR) in ×10 ³ cells/μL	4(2.7–5.9)	4.2(2.8–5.92)	3.1(2–7.9)	-	0.478 ^a
Hemoglobin, mean ± SD in g/dl	8.1±2.9	8.3±2.6	6.7±2.9	-	0.049 ^b
Platelet, median(IQR) in ×10 ³ cells/μL	144 (75.7–224.1)	159.8 (82–242.3)	61.4 (44.2–97.3)	-	0.002 ^a
Baseline number of cytopenias	2(1–2)	1.5 (1–2)	2(2–3)	-	0.049 ^a
None	17(17.5)	15(18.1)	2(14.3)	1:8.5	0.012(5.8)
One	28(28.9)	27(32.5)	1(7.1)	1:28	
Two	30(30.9)	25(30.1)	5(35.7)	1:6	
Three	22(22.7)	16(19.3)	6(42.9)	1:3.7	
Concomitant Infection					

(Continued)

Table 1 (Continued).

Variables	Total n (%)	Outcome During Follow-Up n (%)		D:C	p-value
		Recovered	Death/Unfavorable		
No	26(27.7)	26(32.5)	0(0)	-	0.012(6.3)
Yes	68(72.3)	54(67.5)	14(100)	1:4.9	
Visited traditional healers	97(100)	83(85.6)	14(14.4)	1:6.7	0.13(2.25)
No	75(77.3)	62(74.4)	13(92.9)	1:5.8	
Yes	22(22.7)	21(21.6)	1(7.1)	1:22	
Antibiotics given	97(100)	83(85.6)	14(14.4)	1:6.7	0.07(3.23)
No	16(16.5)	16(16.5)	0(0)	-	
Yes	81(83.5)	67(69.1)	14(14.4)	1:5.8	
Blood products given	97(100)	83(85.6)	14(14.4)	1:6.7	0.001(12.05)
No	61(62.9)	58(69.5)	3(21.4)	1:20.3	
Yes	36(37.1)	25(30.1)	11(78.6)	1:3.3	

Notes: NB: ^aIndependent Mann–Whitney U-Test ^bindependent sample T test, D:C= Death to Case Ratio. § Bold letters indicate statistical significant at $\alpha < 0.05$.

Abbreviations: WAZ, weight for age Z-score; CBC, complete blood cell count.

Sociodemographic Characteristics

The mortality rate of the VL-confirmed children in the outbreak was 14/97 (14.4%, 95% CI: [7.9–22.4]) making death/unfavorable outcome-to-case ratio $\approx$ 1:7. Age wise, the median age of the children who suffered from death/unfavorable outcomes was 19 [IQR: 10–40.5] months vs median age of children who recovered was 36 [IQR: 17–72] months – Mann–Whitney U-test $p = 0.07$. The death(D):cure(C) was highest among those whose age is less than 15 months (Table 1).

Males died more frequently than females, 8 (57.1) vs 6 (42.9), with Chi-square test $p = 0.77$. Patients admitted from relatively urban regions of the zone were only two, and both died. Most of the cases were from Ghelalo 62.9%, and half of the mortality was from this district, making the D:C = 1:8.7. Individuals who died had a significantly higher 75th quartile length of stay than those who recovered, 1(1–2) days vs 1(1–1.25) days – Mann–Whitney U-test $p < 0.001$. The mean hospital stay duration was 17.8 days with an SD $\pm$ 5 days. Those who suffered from unfavorable outcomes stayed shorter by a week than those who recovered, $p < 0.001$ -Independent Sample T-test. The mean z-score of weight for the age of the study participants was -2.7 ± 1.5 (Table 1).

Children who recovered had better hematological parameters (fewer anemic and thrombocytopenic) at baseline than those who passed away. The mean $\pm$ SD hemoglobin count was significantly higher among those who had negative outcomes as compared to those recovered (6.7 ± 2.9 g/dL vs 8.3 ± 2.6 g/dL). On the other hand, median (Q1-Q3) of platelets count of those who had negative outcomes was higher as compared to those recovered (61.4 (44.2 - 97.3) $\times 10^3$ cells/uL). Similarly, the number of cytopenias among those groups was larger for the group with a higher number of cell-lines deficit, $p = 0.049$ Independent Mann–Whitney U-test. Additionally, all children who suffered from negative outcomes had concomitant infections, and 78.6% of those who died were given blood products (Table 1).

Pre and Post-Treatment Anthropometric and Hematologic Comparisons

The patients seemed to significantly improve hematologic conditions after treatment, while the weight for age Z-score (WAZ) remained silent (Figure 2). The mean weight for post-treatment was computed for a smaller number of children than the pre-treatment number. When compared against WHO standard curves, both standardized weights are shifted to the left, with post-treatment showing more shift (Figures 3). Hemoglobin, white cell counts and platelets revealed a significant positive shift, $p < 0.001$ paired sample T-test. (Table 2)

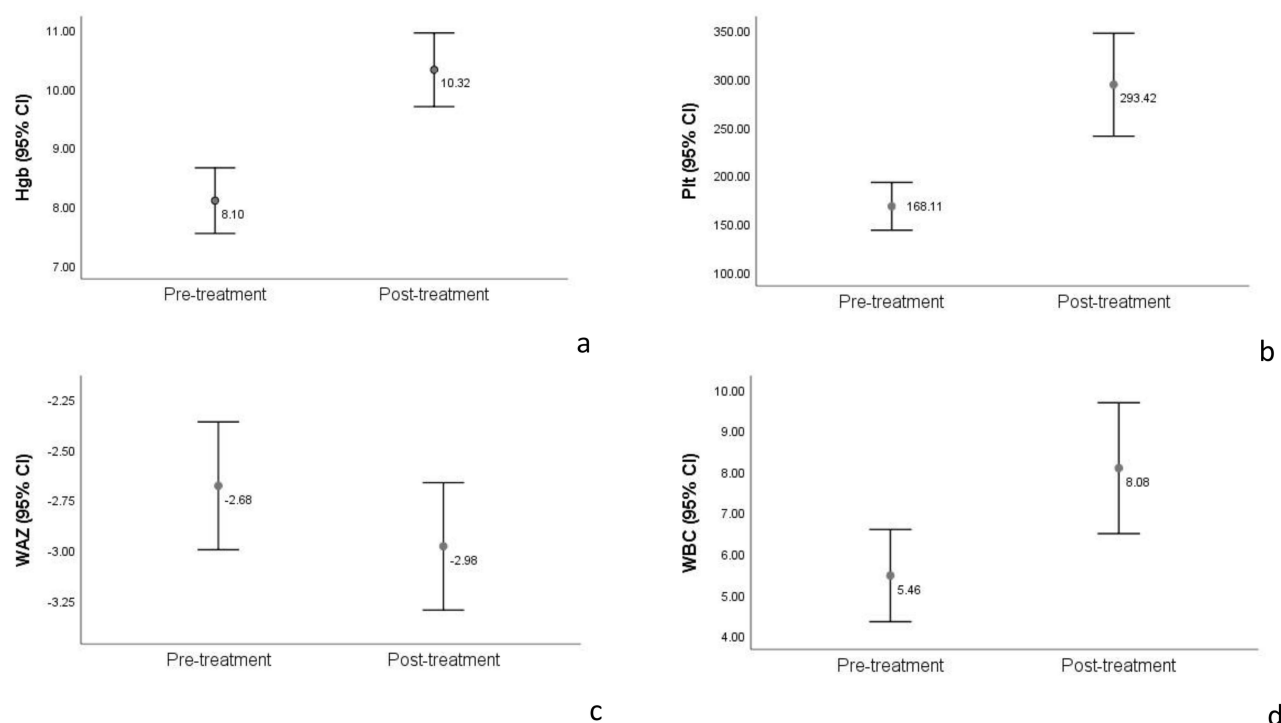


Figure 2 (a) Mean Hgb value in pre and post treatment of the participants. (b) Mean platelet value in pre and post treatment of the participants. (c) Mean WAZ value in pre and post treatment of the participants. (d) Mean WBC value in pre and post treatment of the participants.

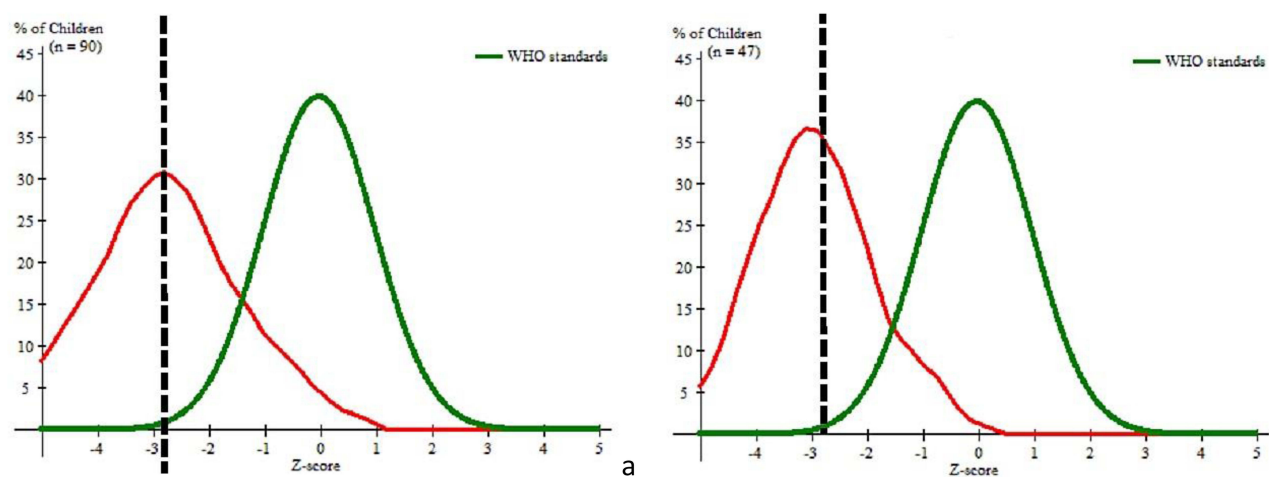


Figure 3 (a) Graphical representation of pre-treatment weight for age Z-score in comparison with WHO standard. (b) Graphical representation of post-treatment weight for age Z-score in comparison with WHO standard.

Clinical Signs and Symptoms at Diagnosis and Follow-up

The clinical findings vomiting ($p = 0.01$), bleeding ($p = 0.001$) and extremity swelling ($p = 0.02$) were found to be statistically significant (Table 3). The outcome during follow-up (recovery or death/unfavorable) was found to be significantly associated with the clinical signs and symptoms at diagnosis, namely, vomiting ($p = 0.010$), bleeding ($p = 0.001$) and extremely swelling ($p = 0.020$).

Table 2 Pre and Post Treatment Difference in Several Clinical and Laboratory Measures Among the Visceral Leishmaniasis Patients, Massawa Hospital, Massawa, Eritrea: 2022

Characteristics	Mean $\pm$ SD	Mean of Difference $\pm$ SD	95% CI of Md	p-value ^a
WA-z pre-Rx	-2.7 $\pm$ 1.5	0.03 $\pm$ 1.46	-0.4-(0.46)	0.896
WA-z Post-Rx	-2.98 $\pm$ 1.1			
Hgb pre-Rx (g/dl)	8.1 $\pm$ 2.7	3.4 $\pm$ 2.7	0.37-2.6	<0.001
Hgb post-Rx (g/dl)	10.3 $\pm$ 2.3			
WBC pre-Rx ($\times 10^3$ cells/ μ L)	5.5 $\pm$ 5.5	3.35 $\pm$ 5.6	0.8-1.8	<0.001
WBC post-Rx ($\times 10^3$ cells/ μ L)	8.1 $\pm$ 5.7			
Plt pre-Rx ($\times 10^3$ cells/ μ L)	168.1 $\pm$ 11.9	171.4 $\pm$ 187.8	119.2-223.7	<0.001
Plt post-Rx ($\times 10^3$ cells/ μ L)	293.4 $\pm$ 190.6			

Note: § Bold letters indicate statistical significant at $\alpha < 0.05$.

Table 3 Baseline Dichotomous Variables for Clinical Finding Among Visceral Leishmaniasis Patients in Massawa Hospital, Eritrea: 2022

Variables	Total n	Recovered n	Death/Unfavorable n	p-value (Chi-Square Value)
Fever	97	83	14	0.561(0.34)
Abdominal distention	37	31	6	0.690(0.15)
Cough	32	27	5	0.820(0.06)
Vomiting	39	29	10	0.010(6.60)
Diarrhea	44	36	8	0.340(0.92)
Loss of appetite	95	81	14	0.560(0.34)
Bleeding	7	3	4	0.001(11.10)
Extremity swelling	15	10	5	0.020(5.10)
Hepatomegaly	20	16	4	0.430(0.63)
Splenomegaly	63	53	10	0.580(0.30)

Note: § Bold letters indicate statistical significant at $\alpha < 0.05$.

Time to Event Analysis and Incidence Rates

The 97 patients were followed for a total of 1729 days. The mortality rate was 6.3 per 1, 000 child-days [95% CI: 3.5-11]. Gender-wise, the males have a higher mortality rate than females: 7.6 (3.6-15.9) vs 4.9 (1.9-13.2) per 1, 000 children-days, $p = 0.82$ -Log rank test. The higher mortality rate among children who received blood products may reflect more severe disease at baseline, such as profound anemia or thrombocytopenia, necessitating transfusions [14.5 (7.6-27.9) vs 1.8 (0.5-7.2)] per 1, 000 children-days, $p < 0.001$ (11.1) (Table 4).

Discussion

Demographic Characteristics

Our study on paediatric VL in the Northern Red Sea region of Eritrea aligns with findings from studies conducted in diverse geographic areas, emphasizing the need for region-specific insights.^{18,19} Similar to investigations in Brazil and

Table 4 Mortality Rate and Associated Factors

Characteristics	Person Time in Days (Events)	Mortality Rate per 1000 Child-Day (95% CI)	Mean Survival Duration in Days (95% CI)	p-value (log Rank Test)
Total	1729	6.3(3.5–11)	30.1(27.6 –32.6)	-
Gender				0.82(0.05)
Male	921	7.6(3.6–15.9)	25.3(22.9–27.7)	
Female	808	4.9(1.9–13.2)	30.4(27.7–33.2)	
Address				
Foro	603	9.9(4.5–22.2)	27.2(21.9–32.4)	0.212(1.6)
Ghelalo	1094	4.6(1.9–10.9)	30.1(28.4–31.7)	
Ghindae	17	0	-	
Massawa	15	0	-	
Blood products given				
Yes	620	14.5(7.6–27.9)	25.2(20.8–29.7)	<0.001(11.1)
No	1109	1.8(0.5–7.2)	30.6(29.1–32.2)	
CBC Pre-Rx				
Hgb				
≤ 10.5	1419	6.3(3.3–12.1)	29.5(26.9–32.2)	0.92(0.01)
>10.5	254	3.9(0.5–27)	18.1(16.9–19.3)	
WBC				
<3	476	10.5(4.3–25.2)	26.5(22.6–30.4)	0.16(1.9)
≥3	1197	4.2(1.7–10)	30.5(27.7–33.4)	
Plt				
<150	878	10.3(5.3–19.7)	27(23.6–30.5)	0.004(8.2)
≥ 150	795	1.2(0.2–8.9)	28.6(27.7–29.4)	
Baseline number of cytopenias				
None	278	7.1(1.7–18.7)	17.4(15.2–19.6)	0.17(5)
One	517	1.9(0.2–13.7)	28.5(27.5–29.5)	
Two	546	9.2(3.8–22)	28.9(24.7–33)	
Three	388	15.4(6.9–34.4)	25.5(21.1–29.9)	

India, we observed a concentration of cases in specific districts, suggesting localized endemicity.^{20,21} Not only in other parts of the continent but also Somalia and Kenya, East African countries, showed similar distribution of the disease pattern.^{22,23}

Mortality Rates

The mortality rate of approximately 14.4% in our study corresponds to rates reported in other VL-endemic regions.^{24,25} Although age-related differences were observed, other variables such as delayed presentation and prolonged illness duration often seen in younger children may also contribute to worse outcomes and should be explored in future studies.^{26,27}

Diagnosis, Clinical Parameters and Treatment Outcomes

Patients were diagnosed serologically using rk-39. The rk39 is an essential rapid diagnostic test tool with multiple advantages, including its feasibility, rapidness, equipment and cold chain free. Diagnosis of VL was established based on clinical signs combined with a positive rk39 rapid diagnostic test (ICT) in our study. Bone marrow aspiration was used in select cases where diagnostic uncertainty remained. In terms of accuracy, the sensitivity and specificity of the rk39 to diagnose VL can reach as high as 80.0% (95% CI 77.0% to 82.8%) and 97.4% (95% CI 95.0% to 98.8%) depending on specific brand.²⁸ The association between a longer length of stay and unfavorable outcomes in our study echoes findings from studies in Sudan and Brazil, highlighting the potential consequences of delayed treatment.^{29,30} The post-treatment improvement in hematologic parameters aligns with the general expectation but underscores the need for holistic care.^{31,32}

Treatment Protocol and Follow-up

During the course of time and changing medicine, research and region-based treatment protocols have been used to treat visceral Leishmaniasis. A 17 days' course of sodium stibogluconate and paromomycin combination was currently the standard of care in most East African countries like Ethiopia and Uganda.³³ Along with this evidence and the higher cure rate (>90%) of this combination,³⁴ our treatment center used the same protocol with an 85.6% cure rate.

Anthropometric and Hematologic Comparisons

The persistent impact of VL on nutritional status, as indicated by weight-for-age Z-score (WAZ) below WHO standards in our study, resonates with studies emphasizing the long-term consequences of VL on growth and development.³⁵ Pancytopenia, as a main finding in our study, is common in VL patients, same as in other studies; for example, in a study in North West Ethiopia, 27 of the 31 patients were found to have three cell lines to be low [13]. Not only as a finding, but thrombocytopenia was used as a predictor of death,⁵ as our results show 10.3 per 1000 child-days (95% CI: 5.3–19.7) mortality rate among thrombocytopenic patients. The post-treatment positive shift in hematologic parameters aligns with broader expectations.³²

Time to Event Analysis

Time-to-event analysis in our study contributes to the understanding of mortality dynamics during the follow-up period, complementing findings from studies in East Africa and India.^{26,36} Although our study found an association between blood transfusion and increased mortality, this likely reflects confounding by indication, where more severely ill children were those requiring transfusion and showed consistent findings with broader patterns reported in different regions.^{1,37}

Implications and Recommendations

The nuanced insights from our study and the consistent patterns observed compared with previous research have several implications. First, they underscore the importance of tailoring interventions based on demographic and clinical characteristics. Second, the study reinforces the need for comprehensive care, including nutritional rehabilitation, to address the long-term consequences of VL. Third, the identified associations between mortality rates and specific clinical parameters highlight potential areas for targeted interventions. Fourth, there is a need for thorough follow-up after the cure because there is a recorded relapse rate after, primarily within six months of treatment completion.

Challenges and Future Directions

Despite the valuable contributions of this study, there are still challenges that need to be taken into account. The high loss to follow-up and the retrospective nature of our analysis limits the definitive determination of long-term outcomes. Future research should prioritize prospective, multi-center studies with larger sample sizes to validate and refine the current findings. Additionally, exploring host-genetic factors and variations in parasite strains could offer deeper insights into the observed heterogeneity in VL outcomes.

Conclusion

This study contributes region-specific insights into pediatric VL, aligning with and extending findings from diverse geographic areas. The observed patterns in mortality rates, demographic variations, and clinical outcomes emphasize the complex interplay of factors influencing the course of VL. Routine screening and early case detection, especially in newborns and small children in endemic areas, may be essential to reduce disease burden and improve outcomes. These findings have implications for refining strategies in managing pediatric VL, highlighting the need for context-specific interventions and continued research to address the challenges posed by this debilitating disease.

Abbreviations

CI, Confidence Interval; Hgb, Hemoglobin; IQR, Interquartile Range; SD, Standard Deviation; SPSS, Statistical Package for Social Sciences; STATA, Statistics and Data; VL, Visceral Leishmaniasis; WAZ, weight-for-age Z-score; WBC, White Blood Cells; WHO, World Health Organization.

Data Sharing Statement

All relevant data are within the manuscript and its Supporting Information files.

Ethical Approval and Informed Consent

The study complied with the world medical association declaration of Helsinki ethical principles for medical research involving human subjects. Hence, administrative and ethical approval was granted by the Eritrean Ministry of Health (EMOH) research proposal review and ethical clearance committee. The need for consent was waived as the analyses used de-identified data collected as part of routine patient care.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that there is no conflict of interest for this work.

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