Evaluation of the Transmission Rate, the Mortality Rate, and the Level of Endemicity Due to Visceral Leishmaniasis at Marsabit County Referral Hospital

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***Abstract* — The disease Visceral leishmaniasis is a tropical infection spread by female sandflies. This leishmaniasis affects the spleen, the liver, and bone marrow. Globally, between 0.7 million and 1 million cases of visceral leishmaniasis arise yearly. In Kenya, 4000 cases are reported yearly, while 5 million individuals are at risk of infection. If untreated, the visceral leishmaniasis death rate is more than 95%. The study aims to evaluate the mortality and the transmission rate among visceral leishmaniasis patients referred to the Marsabit County referral hospital. The study adopted a retrospective cohort design. The study used secondary data obtained from the Marsabit County referral hospital. The Susceptible, Infected, and Recovered (S.I.R) Model, was incorporated to evaluate the mortality rate, the transmission rate, and the level of endemicity. The findings revealed that the mortality rate, the transmission rate, and the level of endemicity were estimated at 13.19%, 13.67%, and 0.0141, respectively. In conclusion, the mortality rate increases as the transmission rate increase and there is a need for urgent responses from health personnel to reduce the transmission rate to reduce subsequent morbidity and mortality. The study recommended adopting the following measures; the mortality rate was 13.19%, and the prevalence of the disease was higher in males than among females which subsequently increases mortality among males therefore, there is a need to put more attention to males when creating awareness. The transmission rate was 13.67%, this rate can be reduced by reducing risk factors that are responsible for the transmission of visceral leishmaniasis. Creating awareness at the community level and seeking medication on time to reduce mortality from visceral leishmaniasis in Marsabit County.**

***Keywords* — The Transmission rate, The Mortality rate, The level of endemicity.**

I. Introduction

Visceral Leishmaniasis is fatal if untreated and very little attention is given to this disease. Globally, the cases of visceral Leishmaniasis have declined by at least 30% since 2016 [1]. East Africa is as of now the most impacted region, comprising 45% of all cases of Visceral leishmaniasis reported to the World Health Organization in 2018 [2]. Visceral Leishmaniasis is prevalent in 78 countries, however, it mostly affects impoverished individuals in East Africa, Southeast Asia, and Brazil. Southeast Asia has historically had the highest cases of visceral Leishmaniasis, with approximately 270,900 cases in 2007 [3]. Approximately 90% of the worldwide burden of V.L. is located in seven countries, four are in Eastern Africa (Sudan, South Sudan, Ethiopia, and Kenya), two in Southeast Asia (India and Bangladesh), and Brazil, which accounts for most cases in South America [4]. Research conducted in Baringo and Pokot areas showed that there had been high endemicity of visceral Leishmaniasis since 1980, which affects the indigent tribal nomadic population [5]. According to a study conducted in Marsabit County. Although leishmaniasis is curable, it continues to cause considerable morbidity and mortality in humans due to a low index of suspicion among healthcare practitioners, late diagnosis, and inadequate case management. If left untreated, it has a significant fatality rate in Marsabit County [6].

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II. LITERATURE REVIEW

This section offers a comprehensive summary of the development of the S.I.R. model used in modeling visceral Leishmaniasis.There have been few investigations of elements of V.L. utilizing numerical models. In 1988, Christopher Dye and Daniel M. Wolpert acquainted the first anthroponotic V.L. deterministic model for capturing temporal dynamics [7]. Their model was utilized to clarify the noticed V.L. between scourge periods from 1875 to 1950 in Assam, India. They surveyed the effect of control measures in endemic regions utilizing properly modified models. They presumed that the sensational rise in V.L. cases might be ascribed to "characteristic" (host and vector birth and demise rates) factors. In 1996 Dye presented a four-condition O.D.E. susceptible-latent-infectious-resistant model to portray the susceptible, latent, infectious, and resistant populations of Visceral Leishmaniasis. This model thought about changes among these populaces. Nonetheless, Dye should have considered the practices of canine and vector in the model. They further developed Dye's model using a canine populace integrated into the S.L.I.R. model. [8] constructed an O.D.E. model for Visceral Leishmaniasis transmissions among people, canines, and vectors. Their model used (11) O.D.E. conditions, which included susceptible (canine, sandfly, and human), Latent (canine, vector, and human populace), infected (canine, vector, and human populace), and resistant (canine and human) populaces. Although the model they used was introduced with no information reenactment, it was a principal model to depict practices for all species engaged with Visceral Leishmaniasis. Since WHO assigned Visceral Leishmaniasis as a Neglected Tropical Disease (N.T.D.) in 2015, a plenitude of studies has zeroed in on creating numerical models of Visceral Leishmaniasis. [9] fostered a (12) condition ODE showing an instinctive leishmaniasis scourge. They refined their model by including a hospitalized populace; this populace had a greater chance of endurance because of efficient medication. Their findings revealed that the equilibrium of visceral Leishmaniasis is significantly connected to a crucial model parameter 〖(R〗_c), which is also known as the pandemic threshold value. 〖(R〗_0) is the number of cases caused by a single case in a population where people in compartments are susceptible to infection. Similarly, [10] developed a compartment-based O.D.E. of Visceral Leishmaniasis to clarify disease transmission in symptomatic Visceral Leishmaniasis, asymptomatic Visceral Leishmaniasis, and P.K.D.L-disease classes. [11] worked on a 12-condition O.D.E. from [9] to an 8-condition O.D.E. by partitioning canine and vector into the susceptible and infected populace. This model effectively recreated the 2011 Visceral Leishmaniasis pandemic in Southern Sudan. [12] moved the O.D.E. in [8] by considering the canine populace as a primary reservoir for visceral Leishmaniasis. Subsequently, their numerical model included eight variables comparing the susceptible, latent, infectious, and recovered populace of the canine and human populace. [13] analyzed three O.D.E. and compared results, and taught about indoor spraying. The contrast between the models was how connections between P.K.D.L. and the recuperation populace were displayed. Their examination anticipated that by utilizing 60%–80% Indoor Residual Spraying (I.R.S.) inclusion, Visceral Leishmaniasis could be eradicated in three years in Bihar, India. Likewise, scientists have made gradual commitments utilizing different O.D.E. Visceral Leishmaniasis pandemic models. [11] presented a two-dimensional P.D.E. dependent on an O.D.E. model. Their study used human age and time as two measurements because authentic data showed that instinctive leishmaniasis infection rates were strongly linked to human age. After all, children and teenagers (aged 0 to 20) are more likely to become infected than people of other ages.

III. METHODOLOGY

A. Study Area

The study was conducted in Marsabit County, and secondary data was obtained from the Marsabit County referral hospital.

B. Modeling the Mortality from Visceral Leishmaniasis

Let m Let be a disease-induced mortality rate for infected individuals. Let the probability of an individual in the infectious group dying from visceral Leishmaniasis be ρ.

S.I.R. equation for the mortality is given by

$$m = \frac{\rho}{I-\rho}(\gamma_h + \mu_h).\frac{I_h}{N_H} \quad (1)$$

The ρ represents the probability of an individual being in infectious compartments, γ_h represents the recovery rates, μ_h represents the rate at which an individual exists the compartments due to mortality, I_h represents the infected human population, and N_H represents the entire human population of Marsabit

County.

C. The Transmission Rate

The transmission rate is given as;

$$b\beta_{hv}\left(\frac{S_h}{N_h}+\frac{I_h}{N_h}\right)S_v \tag{2}$$

The b is the biting rate, β_{hv} is the transmission from human to vector, S_h is the susceptible vector, N_H is the total population of Marsabit county, I_h is the infected human, and s_v is the susceptible vector.

D. The Level of Endemicity

The Control reproductive number was used to estimate the level of endemicity.

$$R_C(\phi_h)=\sqrt{\left(\frac{\phi_h}{(\mu_h+\theta_h)}\times\frac{\beta_{vh}\ell}{(\mu_h+\theta_h)}\right)\times\left(\frac{b\beta_{hv}}{\mu_v}\right)} \tag{3}$$

Where ℓ is the landing rate on humans, b is the biting rate of sandfly, β_{vh} is the transmission from vector to human, ϕ_h recovery rate, θ_h treatment rate, β_{hv} transmission from human to vector, μ_h the rate at which human exit compartment due to mortality and μ_v rate at which vector dies off.

IV. RESULTS AND DISCUSSION

This section indicates the output after analysis, the study findings, and recommendations based on this study.

A. Study Participants

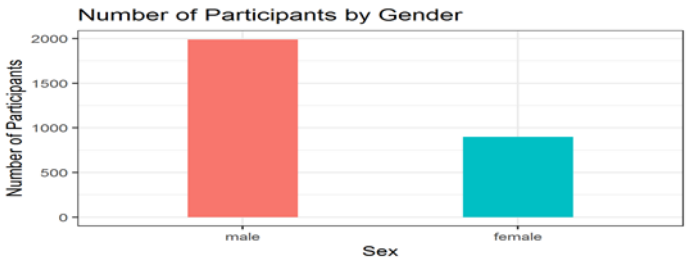

Fig. 1. Number of participants according to their sex.

From the study, more males were infected as compared to females.

B. The Mortality Rate

Using S.I.R model

$$M=\frac{\rho}{1-\rho}.(\gamma_h+\mu_h).\frac{I_h}{N_H} \tag{4}$$

$$M=\frac{0.9581}{1-0.9581}\,(0.8754+0.0863)\times\frac{2769}{459785}$$

$$M = \frac{0.9581}{0.0419}\ (0.9617) \times 0.0060$$

$$M = (22.8663)(0.9617)(0.0060)$$

M = 0.1319

M =13.19%

The mortality rate from Visceral Leishmaniasis at the Marsabit County referral hospital was 13.19%, indicating that the mortality incidence was 131 deaths per year in 1000 people.

C. The Transmission Rate

$$\text{Transmission rate} = b\beta_{hv}\left(\frac{S_h}{N_h} + \frac{I_h}{N_h}\right) S_v \tag{5}$$

$$0.0061 \times 0.6595 \times 5646 \times \frac{2769}{459{,}785},$$

$$0.0061 \times 0.6595 \times 5646 \times 0.0060$$

$$= 0.1367 \qquad = 13.67\%$$

Representing the number of new infections from visceral Leishmaniasis per unit of time generated by an infected sandfly.

D. The Level of Endemicity

$$\mathcal{R}_C(\phi_h) = \sqrt{\left(\frac{\phi_h}{(\mu_h+\theta_h)} \times \frac{\beta_{vh}\ell}{(\mu_h+\theta_h)}\right) \times \left(\frac{b\beta_{hv}}{\mu_v}\right)} \tag{6}$$

$$\mathcal{R}_c = \sqrt{\frac{0.0111}{(0.0863 + 0.9581)} \times \frac{0.6595 \times 0.8}{(0.0863 + 0.9581)} \times \frac{0.0061 \times 0.3405}{0.0714}}$$

$$\mathcal{R}_C = \sqrt{\frac{0.0111}{1.0444} \times \frac{0.5276}{1.0444} \times \frac{0.0021}{0.0714}}$$

$$\mathcal{R}_c = \sqrt{0.0106 \times 0.5052 \times 0.0294}$$

$$\mathcal{R}_c = \sqrt{0.0002} \quad = 0.0141.$$

This means a single case caused by a sandfly bite generates 0.0141 other cases of visceral Leishmaniasis; hence a disease-free equilibrium exists since $\mathcal{R}_c < 1$ at the Marsabit County referral hospital.

V. Conclusion

Most of the research in Marsabit County did not put into consideration an appropriate model to estimate the transmission and mortality incidence. From this research, the transmission rate was 13.67% and the mortality rate was 13.19%; this suggests that visceral leishmaniasis remains a public health concern. The spike in death rates is concerning and necessitates an immediate reaction from the health system. The large number of cases and deaths in this location indicates environmental and socioeconomic vulnerability, which favors disease propagation. Male populations in Marsabit had the largest number of illnesses and fatalities owing to frequent interaction with risk factors when compared to female counterparts. The level of endemicity was 0.041, which was low, and the disease could be managed if proper attention was given to minimize mortality incidence.

RECOMMENDATIONS

1) The mortality rate was 13.19%, and the prevalence of the disease was higher in males than among females which subsequently increases mortality among males therefore, there is a need to put more attention to males when creating awareness, to reduce mortality from visceral leishmaniasis in Marsabit County.
2) The transmission rate was 13.67%, this rate can be reduced by reducing risk factors that are responsible for transmitting visceral leishmaniasis.
3) Focusing on visceral Leishmaniasis is necessary to achieve specific Sustainable development goals, including the 2030 aim of universal healthcare coverage and there is a need for further financial initiatives primarily to support Marsabit County.
4) Seeking medication on time.
5) Creating awareness at the community level.

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Conflict of Interest

The authors have not declared any conflict of interest.

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