DIFFERENTIAL IMPACT OF SICKLE CELL TRAIT ON
SYMPTOMATIC AND ASYMPTOMATIC MALARIA

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Abstract. Individuals who carry the sickle cell trait (S-gene) have a greatly reduced risk of experiencing symptomatic malaria infections. However, previous studies suggest that the sickle cell trait does not protect against acquiring asymptomatic malaria infections, although the proportion of symptomatic infections is up to 50% in areas where malaria is endemic. To examine the differential impact of the sickle cell trait on symptomatic and asymptomatic malaria, we developed a mathematical model of malaria transmission that incorporates the evolutionary dynamics of S-gene frequency. Our model indicates that the fitness of sickle cell trait is likely to increase with the proportion of symptomatic malaria infections. Our model also shows that control efforts aimed at diminishing the burden of symptomatic malaria are not likely to eradicate malaria in endemic areas, due to the increase in the relative prevalence of asymptomatic infection, the reservoir of malaria. Furthermore, when the prevalence of symptomatic malaria is reduced, both the fitness and frequency of the S-gene may decrease. In turn, a decreased frequency of the S-gene may eventually increase the overall prevalence of both symptomatic and asymptomatic malaria. Therefore, the control of symptomatic malaria might result in evolutionary repercussions, despite short-term epidemiological benefits.

1. Introduction. Malaria is one of the worlds devastating and persistent diseases. Although the use of artemisinin has made a great progress in controlling malaria with deaths down 30% over the past decade ([41]), the annual incidence of malaria is approximately 300 to 500 million worldwide, resulting in 700,000 to 2.7 million malaria-associated deaths each year [31]. The majority of malaria infections are caused by either Plasmodium falciparum or Plasmodium vivax [35].