ABSTRACT

Introduction

Malaria disease is one of the public health challenges in Malawi, with under-five children being the most affected. It is a leading cause of morbidity, hospital admission, and mortality in children under five years of age. To achieve the "Malaria –Free Malawi" goal, there is a need to know the specific geographical areas which still have the highest burden of malaria despite the passing of time. This study aimed at determining the malaria prevalence trends, the spatial distribution and clustering of malaria, and determining the spatial-temporal effects on malaria morbidity in under-five children in Malawi for the years 2010, 2012, 2014, and 2017.

Methodology

This study used data from the cross-sectional 2010, 2012, 2014, and 2017 Malawi Malaria Indicator Surveys (MMIS). Malaria Prevalence trends, at district level, were explored by using Line graphs in Stata. Spatial distribution of Malaria was explored by using Choropleth maps in ArcGIS. Spatial autocorrelation of Malaria was explored using the Moran's I index and the Getis-Ord G_i^* statistic in ArcGIS software; while spatial clustering of malaria was explored using the Kulldorf spatial scan statistic in SatScan software. Summary statistics of continuous variables were done using survey weighted means, while categorical variables were summarized using survey weighted frequencies with the associated proportions/percentages. For each survey year, determining the factors associated with malaria was done by using Multilevel Logistic Regression in Stata, of which Odds Ratios together with 95% Confidence Intervals were used to report the results. In determining the spatial-temporal effects on malaria, seven Negative Binomial models were fit; of which the first four models only included the cluster spatial random effect, while the last three models included both the spatial and temporal random effects. The model with the lowest DIC was chosen as the best fitting model. All the Bayesian models were fit using the INLA method.

Results

1758 children (from the 2010 MMIS), 2112 children (from the 2012 MMIS), 1928 children (from the 2014 MMIS), and 2305 children (from the 2017 MMIS) were included in the analysis. There was a general declining trend in malaria prevalence at national level (43% in 2010, 27% in 2012, 33% in 2014, and 24% in 2017). Most districts in the central region still had high malaria prevalence as compared to other districts in the other regions. Significant spatial positive autocorrelation of malaria prevalence values was observed in 2010 (I=0.044, p=0.021) and in 2012 (I=0.074, p<0.001). Most high malaria values were clustered in the central region and the south-eastern parts of Malawi, as per the results from the Kulldorf scan statistic. The Bayesian spatial-temporal random effects Negative Binomial model with the interaction term was chosen as the best fitting model because it had the lowest DIC value (DIC= 1839.70). The significant factors associated with low malaria risk in under-five children were: a child living in a rich house [RR=0.52, 95%Cr.I=(0.35,0.75)], a child whose mother attained Secondary (or higher) education level [RR=0.38, 95%Cr.I=(0.20,0.71)], and a child living in clusters with higher altitude [RR=0.97, 95%Cr.I=(0.94,0.99)]. The significant factors associated with high malaria risk were: Age (in months) of a child, and a child living in a rural area [RR=1.48, 95%Cr.I=(1.10,1.99)]. Spatial and temporal effects values were greater than 0, and most spatial malaria heterogeneity was explained by the structured spatial random effects.

Conclusions

There was a general decline in under-five malaria in Malawi, although malaria burden is still high in most areas of the central region and the south-eastern areas of Malawi. The significant predictors of malaria were: Age of the child, Place of residence, Wealth Index, Mother's education, and Cluster altitude. Bayesian Spatial-temporal models provide better fitting models in modelling under-five malaria morbidity in Malawi over time.