Application of grouped outlier and spatial statistics to identify villages having unusual health seeking behaviour for childhood Malaria in Malawi

Gracious A. Hamuza[1*] Tsirizani M. Kaombe[2] Emmanuel Singogo[3]

1. National Statistical Office of Malawi, Zomba, Malawi. *Corresponding author email: gahamuza@gmail.com
2. Department of Mathematical Sciences, School of Natural and Applied Sciences, University of Malawi, Zomba, Malawi.
3. University of Northern Caroline, Lilongwe, Malawi.

Abstract

Healthcare seeking behaviour (HSB) is one of the health service utilization (HSU) indicators for at-risk-populations. Fever is a symptom of malaria, which is also associated with other childhood illnesses, that contributes to high levels of morbidity and mortality in young children in Malawi. Early diagnosis and prompt treatment of malaria, within 24 hours of onset of symptoms, is regarded as an essential element for malaria control worldwide, according to World Health Organization (WHO). Blanket rollout of malaria interventions is no longer an option in the 2023-2030 Malawi Malaria Strategic Plan (MSP), due to limited resources and the heterogeneous nature of transmission. Therefore, more targeted interventions for malaria will have to be advocated. The available data from literature only indicate high risk districts to childhood malaria in Malawi, which might also be too wide geographic area to focus a cost-effective intervention. In this article, multivariate logistic regression diagnostic statistics, as well as spatial logistic model are applied to the 2014, 2017 and 2021 Malawi Malaria Indicator Surveys data to identify Traditional Authorities (TAs) in Malawi with very low or high HSB for childhood malaria. The analyses were carried out using R software version 3.6.3 and Stata version 14.0. The results show that 69.6%, 56.7% and 53.6% of caregivers for the under-five children sought healthcare advice within 24 hours of the onset of fever in 2014, 2017 and 2021 respectively. Among other findings, sex of household head, age of caregiver/mother, tribe, net use, exposure to malaria messages, and religions were significantly associated with caregiver HSB. The study recommends that spatial statistical analyses, combined with multivariate model grouped outlier methods could be intertwined in locating villages with disadvantaged access to HSU, so as to help in rolling out right tailored interventions.

Keywords: Childhood Malaria, Health Seeking Behaviour, MMIS data, Mixed-effects logistic regression diagnostics, Spatial statistics.

1. Introduction

The 2022 World Malaria Report indicates low rates of treatment seeking in sub-Saharan Africa (SSA) with only 67% of children reportedly sick sought treatment for their recent fever [1]. Fever is a symptom of malaria but also associated with other childhood illnesses that may contribute to higher levels of malnutrition, morbidity and mortality in young children [2]. The only way to paralyze the progression of the disease to a worse scenario, caregiver of children with fever should seek appropriate care to rule out malaria or other causes of febrile illness. World Health Organization (WHO) emphasizes that one essential element of malaria control is early diagnosis and prompt treatment within 24 hours of onset of symptoms. Ending preventable child deaths and global child survival goals are part of the Sustainable Development Goal (SDG) 3 that aims at ensuring a reduction in deaths of children under-five to 25 deaths per 1,000 live births and deaths of newborns to 12 deaths per 1,000 live births throughout the world by 2030 [12]. Blanket rollout of malaria interventions is no longer an option in the 2023-2030 Malaria Strategic Plan (MSP) due to limited resources and the heterogeneous nature of transmission [14]. Therefore, more targeted malaria interventions need to be advocated. The available data from literature only indicate high risk districts to childhood malaria in Malawi, which might also be too wide geographic area to focus a cost-effective intervention. Rigorous approach for sub-national tailoring of interventions that consist of appropriately selecting intervention mixes for specific risk communities, which remains a challenge and requires a good understanding of the local context.

Healthcare seeking behaviour (HSB) is one of health service utilization (HSU) indicators among at risk population that can be used to assess either individual, family or community health. Globally, there were 247 million malaria cases in 2021 of which 95% were in SSA including Malawi and 76% of malaria related deaths were in children under five years [1]. Several studies, including those of [1 – 7] have concluded that factors such as age, sex, marital status, education levels, religion, ethnicity, occupation, cost of services, proximity of services, quality of services, access to information and availability of services are the major determinants of HSB. However, none of them have gone further in quantifying the effects of each factor on the outcome (HSB) and this creates a vacuum in the empirical analysis of the effects of individual determinant to the outcome variable. HSB classified as 1 for seeking treatment within 24 hours and 0 for seeking treatment after 24 hours, is a binary outcome variable that can be modelled using a binary logistic regression to assess risk factors associated with delayed treatment seeking. Quantifying the effects of each determinant would help in identifying unusual communities extremely affected by these factors and aid in the designing of a well-informed community based intervention strategy, that takes into account both the context in which the behaviour takes place and the relative weight of the various factors that trigger actions within that context.

HSB at community level is preceded by a decision-making process that is further governed by individual and/or household behaviour, community norms, beliefs, culture and expectations as guided by community leaders as well as provider related characteristics and behavior. It is heterogeneous as it depends on several factors that call for a careful contextual analysis. Given the important role of timely use of primary healthcare services by individuals for opportune diagnosis and control of disease and, eventually, the progression of recovery, knowing about individuals' behaviors at the first step of HSB can be of great help to managers and healthcare providers for decision making. The success of the malaria control programme in Malawi is dependent on the malaria prevention practices of people in the community, which are hampered by HSB among others. This study aims at assessing factors that affect HSB of caregivers of under-five malaria children and spatial distribution of unusual communities extremely affected by these factors using three episodes (2014, 2017 and 2021) of Malawi Malaria Indicator Surveys (MMISs) so that tailored community-based interventions can be formulated to optimize HSU in Malawi.

2. Results

2.1 Impact of socio-demographic characteristics of under-five caregivers on their HSB

Socio-demographic characteristics of under-five caregivers were analyzed to determine their effect on health seeking behaviour. Table 1 gives the distribution of the weighted characteristics of the caregivers of the under-five children who had fever two weeks prior to 2021 Malaria Indicator Survey. There were 1,708 under-five children out of which, 583 tested positive of malaria, representing 34 percent. As the goal of this analysis was to analyze health seeking behavior of guardians of these malaria positive under-five children. Below half (47 percent = 272/583) of the guardians managed to seek medical attention within the WHO recommended time-line of within 24 hours upon the onset of symptoms of malaria.

Table 1: Distribution of HSB by socio-demographic characteristics of under-five caregivers

Characteristics		**2021 MMIS**			
		HCSB		**Total**	***p*-value**
		Over 24 hrs	**Within 24 hrs**		
		N = 311	**N = 272**	**N = 583**	
Household head Sex					0.031*
	Female	265 (85.2%)	213 (78.3%)	478 (82.0%)	
	Male	46 (14.8%)	59 (21.7%)	105 (18.0%)	
Age of woman/guardian					0.280
	15-24	124 (39.9%)	107 (39.3%)	231 (39.6%)	
	25-34	125 (40.2%)	123 (45.2%)	248 (42.5%)	
	35-49	62 (19.9%)	42 (15.4%)	104 (17.8%)	
Residence					0.190

	Rural	71 (22.8%)	75 (27.6%)	146 (25.0%)	
	Urban	240 (77.2%)	197 (72.4%)	437 (75.0%)	
Region					0.060
	Northern	88 (28.3%)	67 (24.6%)	155 (26.6%)	
	Central	120 (38.6%)	89 (32.7%)	209 (35.8%)	
	Southern	103 (33.1%)	116 (42.6%)	219 (37.6%)	
Religion					0.078
	Christians	228 (73.3%)	203 (74.6%)	431 (73.9%)	
	Muslim	59 (19.0%)	35 (12.9%)	94 (16.1%)	
	No Religion	1 (0.3%)	2 (0.7%)	3 (0.5%)	
	Others	23 (7.4%)	32 (11.8%)	55 (9.4%)	
Tribe					0.520
	Chewa	112 (36.0%)	84 (30.9%)	196 (33.6%)	
	Tumbuka	49 (15.8%)	40 (14.7%)	89 (15.3%)	
	Lomwe	42 (13.5%)	52 (19.1%)	94 (16.1%)	
	Yao	40 (12.9%)	37 (13.6%)	77 (13.2%)	
	Ngoni	26 (8.4%)	21 (7.7%)	47 (8.1%)	
	Others	42 (13.5%)	38 (14.0%)	80 (13.7%)	
Education levels of mothers/guardian					0.002*
	No School	32 (10.3%)	11 (4.0%)	43 (7.4%)	
	Primary School	217 (69.8%)	183 (67.3%)	400 (68.6%)	
	Secondary and above	62 (19.9%)	78 (28.7%)	140 (24.0%)	
Wealth status of household					0.035*
	Poor families	187 (60.1%)	137 (50.4%)	324 (55.6%)	
	Middle Families	65 (20.9%)	62 (22.8%)	127 (21.8%)	
	Rich Families	59 (19.0%)	73 (26.8%)	132 (22.6%)	
Knowledge of Malaria					0.250
	No	12 (3.9%)	6 (2.2%)	18 (3.1%)	
	Yes	299 (96.1%)	266 (97.8%)	565 (96.9%)	
Slept_under_net night before survey					0.056
	No	163 (52.4%)	121 (44.5%)	284 (48.7%)	
	Yes	148 (47.6%)	151 (55.5%)	299 (51.3%)	

The results show that gender of the household head, education status of the caregivers and economic status of the household has an impact on the health seeking behavior of guardians of under-five malaria children.

2.2 Model estimates

Mixed-effects logistic model results show that there was a group (TA) effect on the health seeking behavior of these under-five malarious children as witnessed by the distribution of TA variations i.e sd(TAs) having a significant chibar2. These effects were seen in the gender, region, religion and education levels of the guardians.

Table 2: The effects of caregiver's characteristics on HSB outcomes upon fitting the model

Effects		**Log-Odds**	**Std Error**	***p*-value**
Constant		0.095	0.082	0.006**
Household head Sex				
	Female*			
	Male	1.936	0.489	0.009**
Age of woman/guardian				
	15-24*			
	25-34	1.230	0.259	0.325
	35-49	0,864	0.242	0.603
Residence				
	Rural*			
	Urban	0.835	0.256	0.558
Region				
	Northern*			
	Central	1.671	0.754	0.256
	Southern	3.045	1.366	0.013*
Religion				
	Christians*			
	Muslim	0.356	0.140	0.009**
	Others	1.912	0.666	0.063
	No Religion	2.516	3.463	0.503
Tribe				
	Chewa*			
	Tumbuka	1.334	0.623	0.537
	Lomwe	0.807	0.327	0.597
	Yao	1.319	0.615	0.553
	Ngoni	0.656	0.267	0.301
	Others	0.906	0.383	0.816
Education levels of mothers/guardian				
	No educarion*			
	Primary School	2.306	0.968	0.047*
	Secondary and above	3.117	1.479	0.017*
Wealth status of household				
	Poor Families*			
	Middle Familes	1.502	0.382	0.110
	Rich Families	1.803	0.575	0.064
Knowledge of Malaria				
	No*			
	Yes	1.420	0.869	0.566
Slept_under_net night before survey				
	No*			
	Yes	1.320	0.257	0.153
Random-effects Parameter		**Estimate**	**Std Error**	**95% CI**
	sd(TAs)	0.754	0.174	(0.47,1.19)
		LR test vs. logistic model: chibar2(01) = 10.82 Prob >= chibar2 = 0.001		

Though most fixed effects are not significant but the random effects are significant suggesting that indeed grouping respondents through their respective TAs has a significant effect on the outcome variable as shown by chibar-squared (10.82) with a corresponding p-value of 0.001.