Prevalence of fever in Children in Regions of Mali

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I.Objective

The objective of this analysis is to predict the odds that a child has a fever in the last two weeks given the mother and child's characteristics. The predictors of interest are Child's age, Mother's age, Mother's education, Child's birth order, number of children in the household, living in an urban or rural area, problems with distance to a health facility and the geographic region of the household.

Introduction

Mali, is one of the world's poorest nations. It is greatly afflicted by poverty, malnutrition, epidemics and inadequate hygiene and sanitation. Mali's health and development indicators rank among the worst in the world with very little improvement over the last 20 years. Progress is impeded by Mali's poverty and by a lack of physicians[3]. Prevalence of fever is often linked to malaria in Mali, as it remains a principal cause of morbidity and mortality in sub-Saharan Africa[2]. Unfortunately, malaria is difficult to define in areas where it is endemic. In medical practice, the diagnosis is mainly based on presence of fever. In the event that a child has a case of fever, it is primordial for the child to have adequate medical attention. In this analysis, we will evaluate all the characteristics of the child and the mother that contribute to the risk of a child having a fever.

II.Methods

Exploratory Data Analysis:

First we plot each variable of interest against the indicator of child having a fever or not. Let Y_i be child having a fever indicator for each i subject. We observe that children who are approximately 15-20 months old (26%) have a higher probability of having a fever, the probability decreases significantly as the child gets older. The probability of having a fever is higher during the first 20 months of a life of a child whose mother is younger than 18 years old, but later on after those 20 months, it changes and the probability becomes the lowest out of all the other mother's age groups. The probability of a child having a fever based on wealth and education varied significantly across children's age. In addition children who are first and second born have higher probability of having a fever. There is evidence as well that a child who is more than 20 months old and is in a household of more than 10 children has a higher probability of having a fever. Furthermore, there is a higher probability of a child having a fever if living in rural areas, while being close to a health facility increases the probability of a child having a fever(this was a surprise and woud be discussed later). The region of Sikasso appears to have the highest probability of a child having a fever. Number of children in the household: <5: "1", 5-10: "2" and >10: "3". Wealth categories into three: Poorest, Poorer: "1"; Middle: "2" and Richer,Richest: "3". Sample sizes represented: 81% (women with no education), 9% with primary education, 8% with secondary education and less than 1% with higher education, of which respectively 11%,9%,7% and 9% reported their child having a fever. There were 24.5% living in Urban areas and 75.5% in rural areas, of which respectively 7% had a fever. Almost half of fever cases were in Sikasso region(40%). In addition, the number of fever cases were respectively 37%(household with 5-10 children), 47%(household with less than 5 children) and 14% (household with more than 10 children). In the original dataset, there are 6723 women reporting the information for 10326 children, of which some will be removed for incomplete information

Figure 1: Presence of Fever vs Age of Child w/ interactions :Sikasso & Birth Order

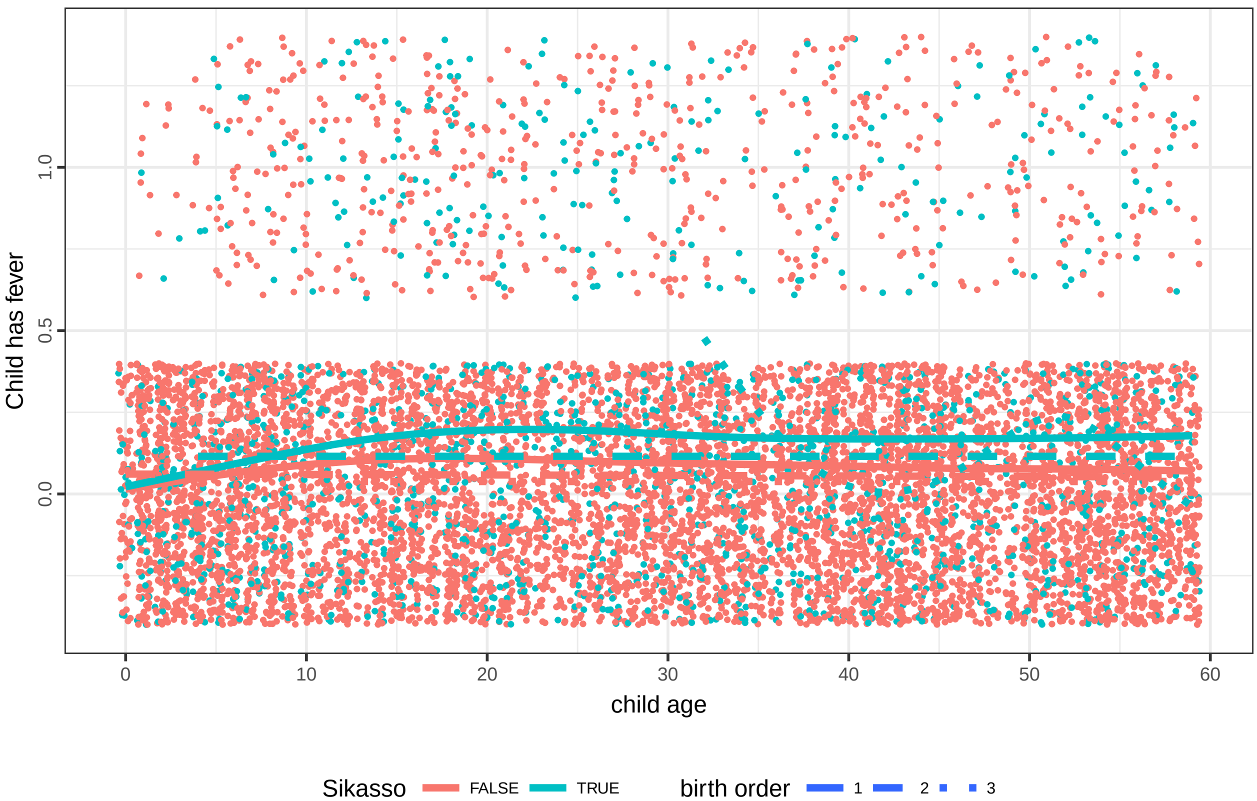
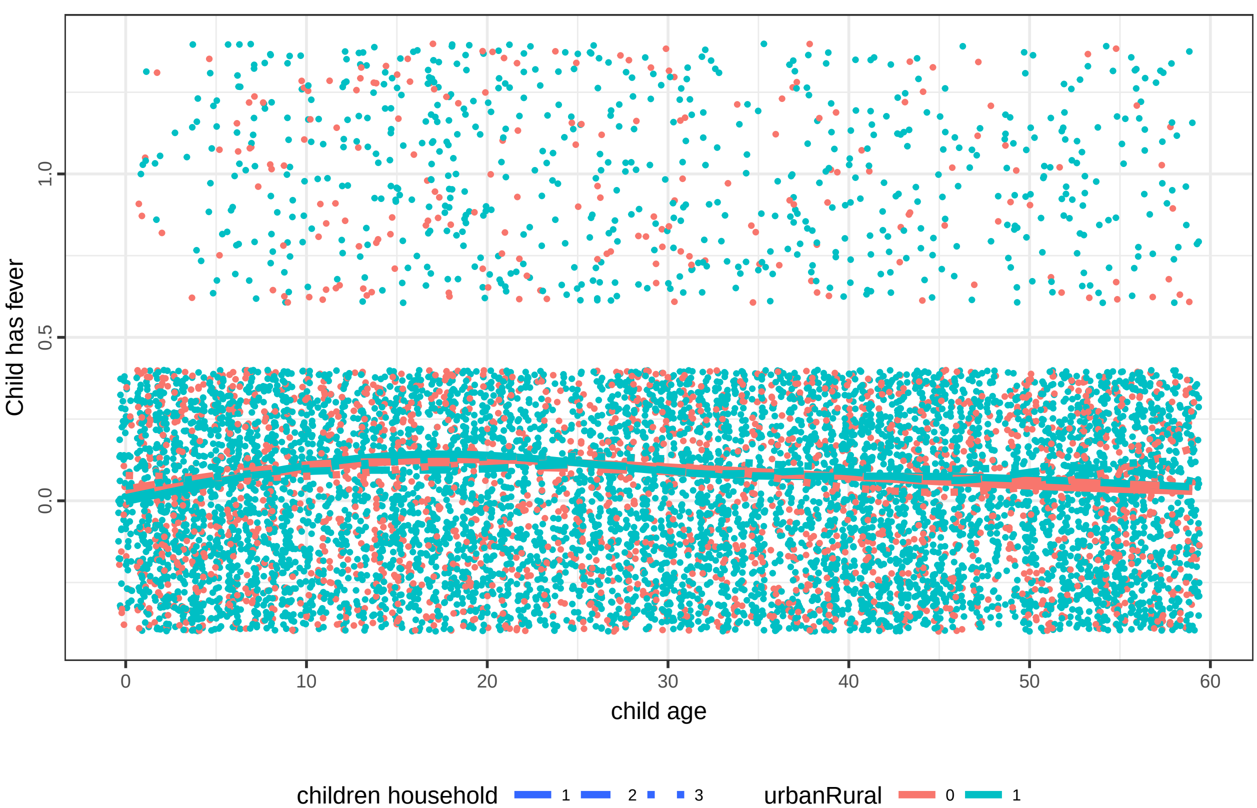


Figure 2: Presence of Fever vs Child Age w/ interactions: Rural region & Number of Childrer



Model Fitting:

Logistic regression was used since we had a binary outcome 1-Yes Fever 0-No Fever. We removed participants who did not have the information on the child fever status(0.6%). There was 744 missing values in the outcome which is less than 10% of the total sample size. Even though we do not have any background knowledge of data collection, we assume that this is missingness completely at random, as we are hoping that the missing information might have been due to poor data collection and subsequently we removed these observations from our study. Using the VIM package, we visually analyzed the missing patterns of the dataset and saw that there was some randomness. We also utilize classification trees to visualize the splits of the covariates, this is not a necessary step but it was just used as an exploratory analysis tool.

Using series of likelihood ratio tests, we tested for significance of interaction terms and spline terms by comparing full and reduced models. A spline term at 20 months was found significant (p = 0), the mother's age and child age interaction was found significant as well (p = 0.0052); number of children and spline term of child age at 20 months of age interaction was also significant (p = 0.0073). However the interaction of Sikasso and birthorder as well as Sikasso and number of children in the household was insignificant.

Model Validation:

In order to assess robustness to extreme values, the most influential points were 7902 and 4309 were removed and the model was refit, yielding results very similar to the model with all the data. The science behind the question at hand suggests that the observations would be independent, since a fever case of one child would be independent of another child, but there are external factor: children leaving together, malaria outbreak in a region,etc. The fit of the model was analyzed by examining observed and predicted values. Also, we analyze a plot of Pearson Residuals accross predicted values which checks specification of the mean model by looking for evidence of systematic differences between the model's predicted probabilities and the observed frequency of positive outcomes overall and in sub-groups and by evaluating ROC curves. The predictive power was 0.60.

Thus, our final model is: $\text{logit}Pr(Y_i = 0) = \beta_0 + \beta_1 Childage_i + \beta_2 MothersAgeCategory_i * Childage_i + \beta_3 NumberofChildren_i * (Childage_i - 20)_+ + \beta_4 Educationlevel_i + \beta_5 BirthOrder_i + \beta_6 Urban_i * (Childage_i - 20)_+ + \beta_7 Sikasso_i + \beta_8 FacilityDistance_i + \beta_9 Wealth_i$

III. Results

Table of Predictors Odds and Their Confidence Intervals

	Odds	Lower:CI	Upper:CI
Sikasso	1.47	1.13	1.88
Mother's age-Category3	1.27	0.39	4.79
Education: Primary	1.25	0.87	1.75
FacilityDistance	1.10	0.88	1.39
Mother's age-Category2	1.07	0.36	3.82
More than 10 children	1.05	0.64	1.69
ChildAge:Mother's age-Category2	1.04	0.98	1.10
ChildAgeInMonths:Mother's age-Category3	1.03	0.97	1.10
ChildAge	1.02	0.96	1.08
age spline 20:urban	1.02	1.00	1.04
Children 5-10:age spline 20	1.02	1.00	1.04
More than 10 children: age spline 20	1.01	0.98	1.03
wealth	0.95	0.82	1.10
Education: Secondary	0.93	0.59	1.43
Age spline at 20	0.91	0.88	0.95
Rural	0.81	0.55	1.20

	Odds	Lower:CI	Upper:CI
5 to 10 children at home	0.79	0.55	1.11
Birthorder:2	0.70	0.52	0.95
Birthorder:3	0.24	0.07	0.59
Baseline	0.05	0.01	0.18
Education: Higher	0.00	0.00	0.94

Based on the table above, we can observe that the estimated odds ratio of a child having a fever comparing children living in Sikasso and those who do not, holding other variables constant is1.47 with (95% CI: 1.13, 1.88). That is to say, a child living in Sikasso has an estimated odds of having a fever that is almost 2 times higher than the odds of a child not living in Sikasso, given the other predictors are held constant. Facility distance was also a big indicator of the probability of a child having a fever, since the difference in odds of a child having a fever given distance was not a big problem was 1.1 higher than when distance was a problem.

While, the difference in odds of a child having a fever given they live in a household of less than 5 children versus of more than 10 children is 1.05 with (95% CI: 0.636, 1.69). So having a household with more than 10 children increases the odds of a child having a fever by 1.05times.

For each additional month of age of the child, there is an increase odd of having a fever of 1.02 with (95% CI: 0.958, 1.08) given all the other predictors are held constant. This changes with a spline term at 20 which generates an odd risk of 0.88

For the mother's characteristics, we observe that the odds of a child having a fever given a mother is highly educated is very insignificant (close to 0) while it is 0.85 for Primary Education and 0.57 For secondary education. So the odds of a child having a fever decreases with the education of the mother. We observe as well that socio economic status of the mother.

IV. Discussion

The characteristics of the mother that best predicted the outcome were: education, region, number of children and age. While the child's age was also a contributor in indicating the risk of having a fever. Based on our results, the region of Sikusso increases the odds of children having fevers. It is a fact that in this region malaria is holoendemic, and one of the main cause of morbidity with an entomological inoculation rate of 0.032 infected bites per person per night.[1]. In this region, families tend to not take their children to the hospital, but rather use both traditional and modern techniques at home. The sensitivity and specificity of mother's diagnosis is often poor which lead to inappropriate admission of medication that can be harmful to the child. In our analysis, we observed that even if mothers have no problems with the distance to a health facility, the odds of child having a fever did not decrease. This is a contradiction to what we would hope to see in the analysis, maybe this is to emphasize the fact that families are still unable to go see a doctor due to the cost of health care and maybe to their trust of traditional remedies.

Using an application that calculates the prediction chances of a child having a fever or not, given all his characteristics as well as his mothers, would be a great form of intervention technique when health workers are doing routine visits. Sikusso could be a targetted region of intervention as the probability of fever cases in children is highest. Encouraging women to visit health centers, reducing the cost of medication and educating the population on health measures to take: sleeping under ITN(Insecticide-treated bed nets), cutting grasses and closing door/windows could prevent malaria, would be part of a greater plan to eradicate fevers, and potentially malaria.

V. Limitations

Education years covariates had zero values, therefore was not used in the analysis, but given we had the education level, it was instead utilized and there was no need to manually create education levels. Here we see that proximity to a health facility is not an issue, it could be due to the fact that the covariate was coded wrongly in the codebook or maybe just due to the fact that women are treating their children at home with traditional or modern medecine. Which is a big issue in many regions of Mali resulting in chilren morbidity.

We did not get a chance to calculate the prediction interval which would have taken into account uncertainty due to sampling. Prediction intervals could have told us where we could expect to see the next data point sampled. Furthermore, the prediction interval would have informed us about the distribution of values, not the uncertainty in determining the population mean. Given lack of much information on the dataset, calculating prediction intervals would have given us a wider standard error taking into account the true error term. This is the next step in future analysis of this data.

Works Cited

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