# Investigating Differences in Nutritional Parameters in Ugandan Children with *Plasmodium falciparum* Severe Malaria

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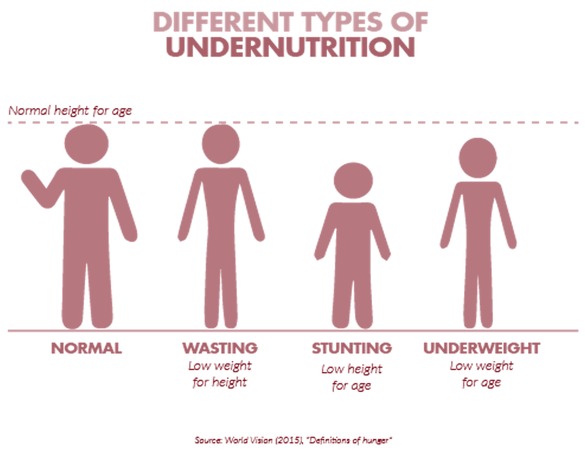
## BACKGROUND

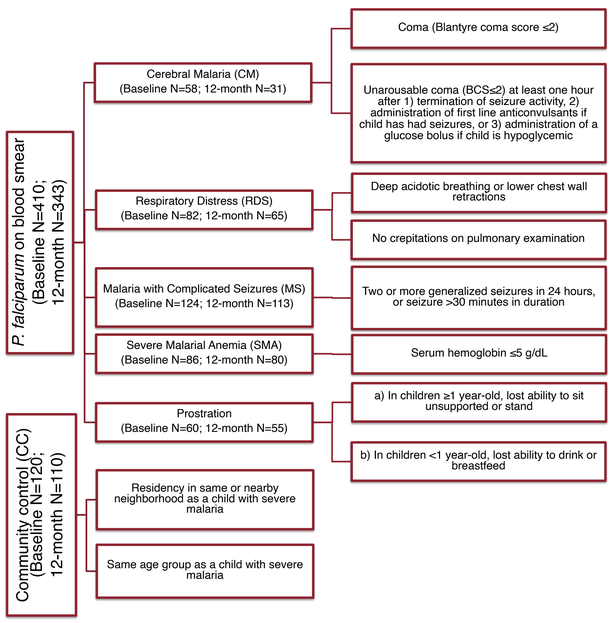
- **24 million children** are infected with *P. falciparum* each year in Sub-Saharan Africa.[1]
- In 2018, malaria produced an estimated **272,000 deaths** in children <5 years.[1]
- Worldwide, **67% of all malarial deaths** are among children <5 years.[1]
- Uganda carries **5%** of the global malaria burden.[1]
- **Undernutrition** is one of the most important risk factors associated with malaria.




## OBJECTIVES

- **AIM 1**: Establish whether Weight-for-Age Z-score at 0 (WAZ0) and 12 months (WAZ12), Height-for-Age Z-score at 0 (HAZ0) and 12 months (HAZ12), and Weight-for-Height Z-score at 0 (WHZ0) and 12 months (WHZ12) differ in Severe Malaria groups [Cerebral Malaria (CM), Respiratory Distress (RDS), Malaria with Complicated Seizures (MS), Severe Malarial Anemia (SMA), and Prostration (Pros)] versus Community Controls (CC)
- **AIM 2**: Determine if nutritional markers differ in manifestations of malaria associated with Higher Mortality (CM and RD) compared to groups with Lower Mortality (SMA, MS, and Pros)
- **AIM 3**: Compare nutritional markers by Mortality Status

## METHODS




## STATISTICAL ANALYSIS

$$z^{a} = \frac{score - mean\ in\ CC}{SD\ in\ CC}$$

[a] Z-score is widely recognized as the most important descriptor for analysis and presentation of malnutrition data in children.

***Independent sample T-test*** - to compare continuous variables (waz, haz, whz) between two different groups where sample statistic of interest is the *mean difference*, and sampling distribution can be assumed Normal

***Nutritional Markers of Interest:***

- *WAZ0* and *WAZ12*, Weight-for-Age Z-score at 0 and 12 months, <2SD is *underweight*
- *HAZ0* and *HAZ12,* Height-for-Age Z-score at 0 and 12 months, <2SD is *stunting*
- *WHZ0* and *WHZ12* Weight-for-Height Z-score at 0 and 12 months, <2SD is *wasting*

## RESULTS

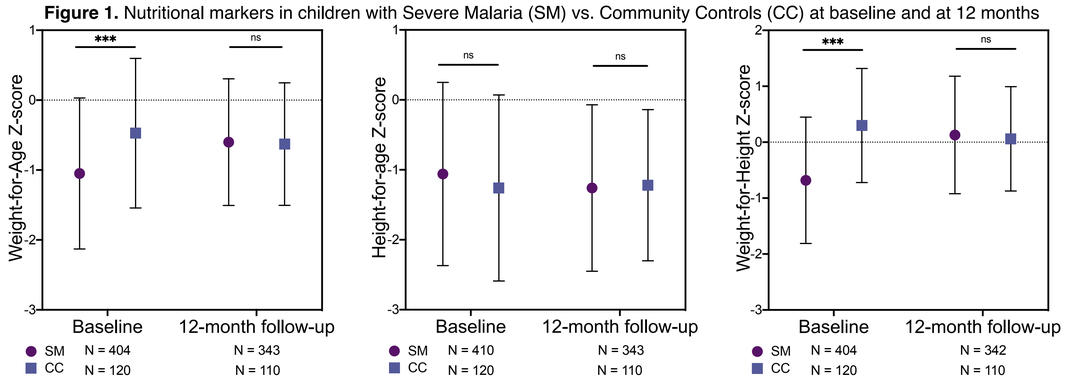
### DEMOGRAPHICS

**Table 1**. Demographic characteristics of study children (N=530)

| Characteristic | CM | RDS | MS | SMA | Pros | CC | Total |
|---|---|---|---|---|---|---|---|
| **Sex, N (% female)** | 23 (40) | 32 (39) | 54 (44) | 40 (47) | 26 (43) | 56 (47) | 231 (44) |
| **Age, Mean Years (SD)** | 2.33 (0.97) | 1.77 (0.87) | 2.16 (0.92) | 2.00 (0.84) | 2.20 (0.90) | 2.20 (1.02) | 2.11 (0.94) |

**AIM 1**: WAZ0 and WHZ0 nutritional markers among SM groups were consistently lower than in CC groups (p<0.001); however, by 12-month follow-up, SM scores WAZ12 and WHZ12 were not significantly different than those of CC. There were no major differences in HAZ between the two groups.

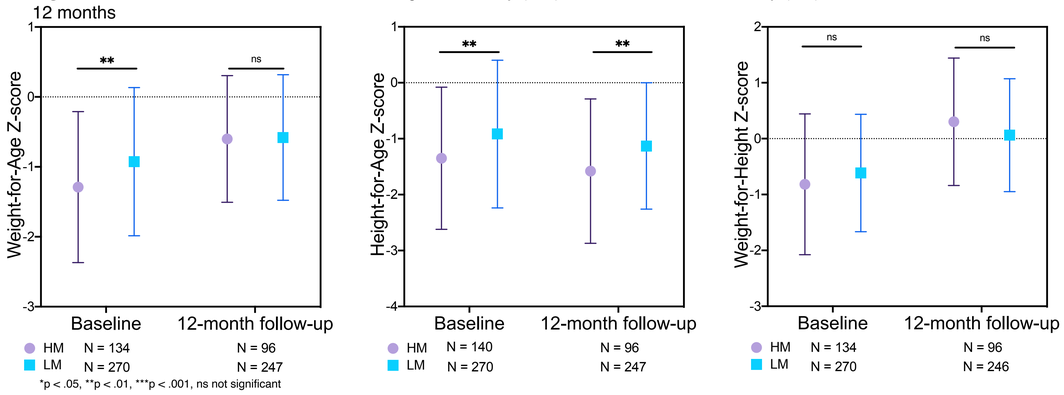
**Figure 1.** Nutritional markers in children with Severe Malaria (SM) vs. Community Controls (CC) at baseline and at 12 months




*p < .05, **p < .01, ***p < .001, ns not significant

**AIM 2**: WAZ0 and HAZ0 nutritional markers among HM groups were consistently lower than in LM groups (p<0.01). This difference remained consistent for the HAZ12 (p<0.01), but not for WAZ12. There were no major differences in WHZ between the two groups.

**Figure 2.** Nutritional markers in children with Higher Mortality (HM) malaria vs. Lower Mortality (LM) malaria at baseline and at 12 months




*p < .05, **p < .01, ***p < .001, ns not significant

**AIM 3**: 27 children died at admission or following discharge (CM, N=20; RDS, N=7). Compared to those who survived, those who died had significantly lower WAZ (p<0.05), but no major differences in HAZ or WHZ.

**Figure 3.** Nutritional markers in children by Mortality Status


*p < .05, **p < .01, ***p < .001, ns not significant

## DISCUSSION

- Underweight is associated with SM groups and HM groups at baseline only and with children who died. Stunting is associated with HM groups at both baseline and at 12-month follow-up. Wasting is associated with SM at baseline.
- These findings are substantiated by other similar studies on malnutrition and malaria:
  - *Malaria as a causal agent for Malnutrition*: Previous exposure to *P. falciparum* infection was a predictor for the manifestation of malnutrition in children <5 years in Ethiopia, and children previously exposed to malaria were 1.87 times more likely to be malnourished than children unexposed to malaria.[6]
  - *Malnutrition as a causal agent for Malaria*: Stunting, but not wasting, has been shown to be significantly associated with down-regulation of the anti-*P. falciparum* antibodies in pre-school children in Senegal, thereby modulating the overall immune response and increasing risk of infection.[7]
- There exists a complex relationship between malnutrition and severe malaria.[8]




## CONCLUSIONS

Underweight and wasting may be risk factors for severe malaria. Nutrition intervention programs are necessary to prevent stunting, underweight, wasting and child mortality by malaria and reduce the global disease burden caused by *P. falciparum.*

## ACKNOWLEDGEMENTS

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