1. INTRODUCTION

Malnutrition is thought to contribute 53% of under-five mortality in the developing world. The global distribution of malnutrition overlaps that of malaria. The relationship between malnutrition and malaria is unclear[1]. Under-nutrition is widely believed to be protective for malaria, largely from hospital rather than community-based studies and no single study has convincingly refuted this view[45].

Both malaria and Protein Energy Malnutrition (PEM) are highly prevalent in young children of Sub Saharan Africa and the association between PEM and malaria continue to be controversial. Nutritional status is considered to be one of the major determinants of host resistance to infection.[2] Malnutrition is estimated to cause about half of the world's 12 million annual deaths in children less than 5 years of age as well as substantial proportions of infectious disease morbidity.[3]

The relationship between nutritional status and mortality is well documented, with increasing risk ratios of mortality.[4] In Sub Saharan Africa, malaria alone is estimated to kill around one million children every year.[5]Young children of Sub Saharan Africa represent the population most affected by both poor nutrition and malaria in the world.

Malnutrition has long been recognised as a serious public health problem in Zambia. Available data indicate that there has been no improvement in nutritional status here since the early 1970's[1]. The most common nutritional problems in children are Protein Energy Malnutrition (PEM) and micronutrient deficiencies of iron, vitamin A and iodine. However, it is believed that other micronutrient deficiencies such as zinc and vitamin C exist as dietary variety and quantity is generally poor. The common

national diets are largely cereal-based containing high phytate levels (zinc inhibitors). Malnutrition affects virtually every organ system. Dietary protein is needed to provide amino acids for synthesis of body proteins and other compounds that have a variety of functional roles[6]. Energy is essential for all biochemical and physiologic functions in the body. Furthermore, micronutrients are essential in many metabolic functions in the body as components and cofactors in enzymatic processes[7].

In addition to the impairment of physical growth and of cognitive and other physiologic functions, immune response changes occur early in the course of significant malnutrition in a child. These immune response changes correlate with poor outcomes and mimic the changes observed in children with acquired immune deficiency syndrome[6, 8] (AIDS). Loss of delayed hypersensitivity, fewer T lymphocytes, impaired lymphocyte response, impaired phagocytosis secondary to decreased complement and certain cytokines, and decreased secretory immunoglobulin A (IgA) are some changes that may occur. These immune changes predispose children to severe and chronic infections, most commonly, infectious diarrhoea, which further compromises nutrition causing anorexia, decreased nutrient absorption, increased metabolic needs, and direct nutrient losses[6-7].

Zambian children in the peri - urban and shanty compounds are most affected by both poor nutrition and malaria[9], and the relationship between these two conditions continue to be not well understood and needs to be elucidated. While a number of studies provide substantial evidence for PEM being associated with reduced malaria morbidity, others have not seen such associations or even demonstrated that PEM is associated with severe manifestations of malaria. Severely malnourished children are

thought to have a high parasitaemia while showing few or none of the classic signs of malaria.

It is thus necessary to asses and elucidate malaria disease burden in severely malnourished children to verify the indication for empirical antimalarial treatment in these children.

2. STATEMENT OF THE PROBLEM

Prevalence levels of both malaria and malnutrition are high in Zambia. Children admited with severe malnutrition are routinely treated with empiric anti-malarials. While a number of studies provide substantial evidence for PEM being associated with reduced malaria morbidity, others have not seen such associations

3. STUDY JUSTIFICATION

Presumptive treatment of malaria in febrile children is widely advocated for in Africa. This may occur in the absence of diagnostic testing or even when diagnostic testing is performed but fails to detect malaria parasites. However, there is lack of evidence to justify the current practice of presumptive treatment of malaria in children who are severely malnourished. There is scanty data on the prevalence of malaria parasitaemia in severely malnourished children globally or locally.

4. LITERATURE REVIEW

The world health organisation (WHO) defines malnutrition as "the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance and specific functions". Malnutrition is globally the most important risk factor for illness and death, contributing to more than half of deaths in children worldwide.[10]

Kwashiorkor and marasmus are two forms of PEM that have been described. The distinction between the two forms of PEM is based on the presence (kwashiorkor) or absence (marasmus) of oedema. WHO estimates that by the year 2015, the prevalence of malnutrition will have decreased to 17.6% globally, with 113.4 million children younger than 5 years affected as measured by low weight for age. The overwhelming

majority of these children, 112.8 million will live in the developing countries, particularly Sub Saharan Africa, where 30% of children have PEM[10].

Malnutrition is directly responsible for 300 000 deaths per year in children younger than 5 years in developing countries and contributes indirectly to over half the deaths in childhood worldwide. The adverse effects include physical and developmental manifestations. Poor weight gain and slowing of linear growth occur. Impairment of immunologic functions in these children mimics those observed in children with AIDS, predisposing them to opportunistic as well as other typical childhood infections[10-11].

At UTH, the Department of Paediatrics and Child Health admits approximately 15,500 sick children per year while admissions to ward A07 are 2,300 per year with seasonal variations in admission rates. Ward A07 is a specialist admission ward for nutrition rehabilitation to which the Addimision criteria are marasmus defined as severe wasting with weight for height (WFH) z-score <-3 SD or a Mid Upper Arm Circumference (MUAC) of <11cm. If oedema is present this is termed marasimic-kwashiorkor. Kwashiorkor is defined as clinical evidence of malnutrition with oedema affecting at least both feet and a WFH z-score >-3 SD. Medical Management of Severe Malnutrition follow the National Guidelines, which are closely based on the WHO Guidelines as described in the 1999 edition of Management of Severe Malnutrition WHO Manual for Physicians and other Senior Health Workers[12].

In Zambia, malaria is a major public health problem accounting for an estimated 45% hospitalisation and outpatient attendances[13]. It is generally endemic throughout the country although some hyper endemic, meso endemic and pockets of epidemic prone areas exist[14]. Malaria is a protozoal infection of the genus *plasmodium*. It is

transmitted through the bite of an infected female mosquito belonging to the genus *Anopheles.* There are four species of parasites that cause infections in humans; *Plasmodium falciparum, P. Vivax, P. Malariae and P. Ovale*. Each species has a different biological pattern in which it affects man. The most common species that is clinically significant causing the most lethal infection is *P. falciparum.* The disease burden is higher in children under five years of age causing an estimated 40% of mortality in this age group.[13] Human infection begins when a female *Anopheles* mosquito inoculates *Plasmodia* sporozoites into the blood system while feeding. Once inside the human host the parasite sporozoites moves to the liver where they develop in the hepatocytes into schizonts containing thousands of merezoites. From the liver merozoites enter the blood stream and invade the red blood cells developing into erythrocyte schizonts containing millions of merozoites. Capillaries of major organs are occluded by sequestered and resetting parasitized red blood cells and in this way there is multiple organ and system dysfunction. This complex life cycle of development of the plasmodium parasite gives way to the different clinical symptoms in the human host.

Plasmodium falciparum malaria and malnutrition are major causes of child morbidity and mortality[1] yet their precise interaction remains unknown, although many studies have shown that *Plasmodium falciparum* infection can result in acute weight loss, or whether recurrent malaria has a sustained effect on growth, remains unclear. Support for such an effect largely comes from intervention studies involving malaria control. For example, improvements in growth and other anthropometric indexes have been described in children protected from malaria by both chemoprophylaxis and

insecticide treated bed nets[15-16]. Nevertheless this experience has not been universal and the benefits of malaria control have been most apparent in young children[17-19]

A West African study (Burkina Faso) which looked at the association between PEM and malaria morbidity in a well defined population of young children exposed to *Plasmodium falciparum* transmission intensity, found no association in the incidence of *falciparum* malaria with malnutrition[20]. These findings are in contrast with a number of earlier studies, which claimed that PEM is associated with decreased malaria morbidity, as well as with some more recent studies providing evidence for PEM being associated with increased malaria morbidity[21-22]. Others have argued that bacterial causes are more responsible for mortality in African children than malaria in areas where the latter is endemic. Both malaria and bacterial illnesses generally are amenable to relatively simple therapeutic approaches but anti malarial drugs tend to be more widely available in African communities than are antibiotics[23-24]

In Vanuatu, researchers have observed an outbreak in *P.falciparum* malaria in re-fed famine victims, a finding that supported the prevailing view that malnutrition may actually protect against clinical malaria[22]. However, recent studies in Kenya and Gambia show that signs of severe malnutrition are associated with an increased parasite prevalence and higher parasitaemias and act as risk factors for the development of severe malaria and mild clinical attacks[23-24].

Malaria has been found to be an important cause of PEM in Zambia, Along with inadequate dietary intake and heavy burden of other infections and parasitic diseases[25]. There is convincing evidence that malaria has harmful effect on the growth of children. The role malaria and other infections play in reducing growth and causing malnutrition is well documented[25]. However, the role malnutrition plays as a risk

factor for malaria or for increased severity of malaria episodes is more controversial. Indeed some studies have shown that being underweight actually protected children against malaria. Golightly et al (unpublished observations) found that the ability of red blood cells from children with marasmus or kwashiorkor to support the growth of malaria parasites in vitro was impaired[26]. In his study (Golightly), re – feeding of malnourished children resulted in a more frequent occurrence of cerebral malaria, while another study found worse outcomes among children who were being treated for cerebral malaria following nutritional replenishment. In Columbia a study found that malnutrition suppresses antibody response to malaria[27] while another study in Tanzania did not any effect of the nutritional status on anti-malaria antibodies[28].

One striking feature of the global distribution of anthropometric markers of under-nutrition is its congruence with the distribution of endemic malaria. Although *p. falciparum* malaria and malnutrition are both highly prevalent in Sub Saharan Africa, the existence of any synergistic interaction has not been well established. In the Gambia, susceptibility to malaria was not correlated with prior anthropometric status[29] while, recent studies conducted in Kenya[30] and Gambia[31] show that signs of chronic malnutrition is associated with increased parasite prevalence and a higher parasitaemias and act as risk factors for development of severe malaria (Kenya) and mild clinical attack (The Gambia). A recent study in Zambian rural underweight children saw an association between being underweight and having malaria parasitaemia[32].

Nutritional deficiencies of protein, riboflavin and iron have also been found to provide protection against malaria, although this is still uncertain[33]. In view of these contradicting reports on the association of malaria and malnutrition this study seeks to

assess the prevalence of malaria parasitaemia in severely malnourished children. This will help elucidate whether indeed malnutrition is protective against malaria or vice versa.

5. MAIN OBJECTIVE

- To determine the prevalence of malaria parasitaemia in severely malnourished children.

5.1 SPECIFIC OBJECTIVES

- To describe socio-demographic characteristics of children presenting with malnutrition and malaria
- To compare the prevalence of malaria parasitaemia among children with Oedematous (kwashiorkor and marasimic-kwashiorkor) and non-oedematous (marasmus) severe malnutrition.
- To compare the prevalence of malaria parasitaemia between HIV infected and non- infected severely malnourished children.

6. RESEARCH METHODOLOGY

6.1 STUDY SITE

The study was conducted at two sites the University Teaching Hospital's malnutrition ward (ward A07) and Lusaka Urban Health Management Team's (Matero reference clinic), where children with severe malnutrition are treated and nutrition rehabilitation conducted. UTH is the largest referral hospital in Zambia. It is located in the city of Lusaka, with a population of just over 2 million according to the 2000 census[34].

Malaria is considered to be mesoendemic with peaks in the rain season October to April. More than 80% of the population live below the poverty datum line[35]. The Matero Reference Centre is a second level health centre in Lusaka which has the capacity to handle uncomplicated cases which do not require referral to UTH.

6.2 STUDY DESIGN

This was a cross sectional descriptive study of children aged 6 to 59 months admitted with a diagnosis of severe malnutrition; conducted between April and September 2009.

6.2.1 INCLUSION CRITERIA

In this study we included a total of 192 severely malnourished children (presence of oedema and/ or weight-for-height Z-score <-3) consecutively admited to UTH's ward A07 and Matero Reference Centre after obtaining informed consent from their mothers or caregivers; the age range of the children was 6-59 months. All children with other underlying severe conditions such as Cerebral Palsy (CP), hydrocephalus, severe cardiac conditions and those without consent from their parents or caregivers were excluded from the study. A structured questionnaire was used to collect demographic data, clinical evaluation, use of anti-malarial drugs and insecticide treated bed nets. Laboratory data was collected on laboratory forms.

6.3 DATA COLLECTION

The following parameters were recorded for all the enrolled children: Demographic characteristics (age, sex educational status of the mother/care giver, residence),

anthropometric measurements and /or clinical features (weight, height/length, MUAC and presence of oedema), Insecticide Treated Net (ITN) ownership and usage, usage of anti-malarial drugs (in the last 4 weeks) and HIV status.

A finger prick was done once consent was obtained. The first drop was wiped from the finger; the second drop was used to prepare a thick blood film, the third drop applied to a rapid diagnostic test (RDT). In addition, 5mls of venous blood was collected for Full Blood Count (FBC). Samples were immediately sent to the laboratory for processing, while sticking to the existing standard operating procedures[36] (SOP's). FBC was done by an automated FBC fax counting machine available at the department's laboratory while blood smears were stained in 3% Giemsa for 30-45 minutes and examined using light microscopy under oil immersion. Malaria parasite densities were estimated using the white blood cell method from the thick. A smear was declared negative after examination of 100 microscopic fields. All slides were read by two independent microscopists masked from RDT results.

6.4 SAMPLE SIZE

Using the precision method available on EPI-Info stat calculator version 3.4.1 (CDC Atlanta, GA, USA.), the sample size was calculated at 190. The prevalence of malaria parasitaemia in severely malnourished children was estimated at 10%[10]. Taking the prevalence of malaria parasitaemia to be within 5% of the estimate, and the study population of 2300, the sample size was thus calculated.

6.5 DATA ANALYSIS

Data was entered into EPI INFO version 6.0 and transferred into STATA statistical package version 10.0 for analysis. Overall prevalence of malaria parasitaemia in severely malnourished children was calculated, prevalence levels of malaria parasitaemia in children with oedematous and non-oedematous severe malnutrition were calculated, malaria prevalence among HIV infected and non-infected severely malnourished children and the difference tested for significance. Chi-square tests was used to test the significance of the difference, while, t-test was used to compare continuous variables. Analysis of variance was used to measure the difference in the means of malaria parasite densities between the two groups.

Prevalence results were compared with the proportion of MPS+ slides in a one month period (April 2009) in the paediatric laboratory at UTH.

6.6 ETHICAL ISSUES

Approval was sought from the University of Zambia Research Ethics Committee and the UTH Department of Paediatric and Child Health. The respondents were informed of their right to take part in the study and informed consent obtained from the parents or care givers of the respective respondents before enrolling them to the study. Assurances were given that all information provided by the respondents would be treated with utmost confidentiality. Respondents were availed with information regarding the authority they had to quit the study any time and to submit their complaints to the authority and even to the researcher. A grievance process was availed. The consent forms were translated in both Nyanja and Bemba the languages commonly spoken in the city of Lusaka. For those parents/guardians who could

neither read nor write, the consent was read for them and they asked to thumb print if they agree to take part in the study.

7. **RESULTS**

7.1. SOCIO-DEMOGRAPHIC DATA

7.1.1 PATIENT INFORMATION

The ages of the children recruited in the study ranged from 6 to 59 months (Table 1). The mean age was 19.6 months (10.8 SD); the mean age for females was 20.9 months (12.0 SD) and that of the males 18.5 months (9.0 SD). The age groups were stratified into five groups with the age ranges as shown in table 1. Of the 192 children, 91 (47%) were females (101 were males) and 58 (30%) were recruited from Matero Reference Centre (Table 1).

Table 1: Socio-demographic characteristics of the 192 severely malnourished children

	Male	**Female**	**Total**
Centre: UTH	67	67	134(69.8%)
Centre: MRC	34	24	58(30.2%)
Total	101(52.6%)	91(47.4%)	192(100%)
Age 6-11.9	24	19	43(22.4%)
12-23.9	52	44	96(50%)
24-35.9	20	18	38(19.8%)
36-47.9	3	4	7(3.6%)
48-59	2	6	8(4.2%)
Total	101	91	192(100%)

Note: UTH, University Teaching Hospital; MRC, Matero Reference Centre.

7.1.2 SOCIO-ECONOMIC STATUS OF THE STUDY POPULATION

All of the children were taken care of by female caregivers. The age range of the parent/care givers was between 14 to 65years. The majority of the caregivers only went up to primary school 49%, while only 2% had tertiary education and 13% not having received any formal education. The majority (89%) of the caregivers came from high density residential areas as defined by Zambian CSO>, only 2% came from very low density residential areas. Only 43% of the caregivers used ITN's and 1% did not know whether child slept under an ITN as they were not the usual caregiver (Table 2). In terms of the children having been pre-treated with an anti-malarial, half of the children in the study received malaria treatment prior to referral to the two centres.

Table 2: Socio-demographic characteristics (N=192).

		n (%)
Prior Use of Anti-Malarials in the preceding 4 weeks	Used	96 (50.0)
Use of ITN Bed Nets	Yes	83(43.2)
	No	106(55.2)
	Does Not Know	3 (1.6)
	Total	192(100)
Caregivers' education Status	None	25(13.0)
	Primary	93(48.4)
	Secondary	69(35.9)
	Higher	4(2.1)
	Total	192(100)
Residential Area	High density	170(88.5)
	Medium density	18(9.4)
	Low density	4(2.1)
	Total	192(100)

	Oedema	Non oedematous	Total
MPS	8(4%)	0(0%)	8(4%)[a]
RDT	8(4%)	3(1.6%)	11(5.6%)[b]
Negatives	95(49%)	78(41%)	173(90%)
Total			192(99.6%)

a; p- value = 0.03 b; p-value= 0.029

Table 3: Prevalence of malaria parasitaemia categorised by the type of malnutrition

7.2 CLINICAL PROFILE OF THE STUDY POPULATION

HIV infection was detected in 43% children; only 5.2% children never had the HIV test done. Over half of the children 58%, had oedematous severe malnutrition kwashiorkor and marasimic-kwashiorkor. The HIV infected children were less likely to present with oedema 40% (*p-value* = 0.03). Of the 111 children with oedematous severe malnutrition, 8 had RDT positive and all of these 8 had MPS positive as well, whereas no child without oedema had MPS positive result, although 3 had RDT positive result (Table 3). The median haemoglobin concentration was below 9g/dl. There was no significant difference in haemoglobin concentration with regard to the type of severe malnutrition or HIV status (*p-value < 0.05*). Total WBC count was significantly lower in the HIV-infected children than the HIV-negative. Among the HIV-infected children, the total WBC count was lower in Non-oedematous children than the oedematous children, however, this was not observed in the HIV- uninfected children.

Table 4: Haemoglobin and White Cell Profile for the severely malnourished children categorised by their HIV status and type of Malnutrition

	HIV Positive		HIV Negative	
	Oedema	**No Oedema**	**Oedema**	**No Oedema**
	N= 44(IQR)	**N=38(IQR)**	**N= 67(IQR)**	**N=37(IQR)**
Haemoglobin (g/dl)	8.2(6.4-9.6)	7.3(6.0-9.0)	8.0(6.1-9.3)	8.4(6.7-9.8)
White cell count ($x10^9$ cells/l)	11.0(8.3-17)	7.2(4.2-12)	10.0(7.7-17)	11.0(8.8-15)

Note: IQR, Inter Quartile Range.

7.3 PREVALENCE OF MALARIA PARASITEAMIA

Malaria parasitaemia (MPS) was found in 8 out of 192 children making the prevalence rate to be 4 %, whereas RDT positives were 11 out of 192 (prevalence rate 6%). All the children who had MPS positive also had RDT positive. MPS was positive in 4.9 % HIV positive children, 3.0 % HIV negative children had MPS positive and 10.0 % had an unknown HIV status. In those were RDT was positive, 6.1 % were HIV positive, 10.0 % had an unknown HIV status, and 5.0 % were HIV negative. Among those children who slept under an ITN 4.9 % had MPS positive and 3.0 % were negative while only 10.0 % was not known to have used ITN's. Similar results were seen with the RDT. 6.1% were positive whereas 5.0 % were negative.

Table 5: Prevalence of malaria parasitaemia in HIV infected severely malnourished children

	HIV+ (n=82)	HIV- (n=100)	Unknown status (n=10)	p
RDT+	5 (6.1%)	5 (5.0%)	1 (10%)	0.30
MPS+	4 (4.9%)	3 (3.0%)	1 (10%)	0.33

8. **DISCUSSION**

This study was conducted between April and September 2009. A total of 192 children with severe malnutrion were recruited from both the University Teaching Hospital Ward A07 and the Matero Reference Centre the only centres in the city of Lusaka that admit and treat children with severe Malnutrition.

The age ranges of the patients in the study were between 6 to 59 months. The mean age was 19.6 months. There was an almost equal distribution of between females (47%) and Males (53%), especially from the UTH's Ward A07 were there was a 1: 1 recruitment ratio between males and females. The ages of the patients were stratified into five groups with the majority of the patients seen in the age group12-23.9 months. This is expected as children suffer more from severe malnutrition at about this age as most mothers in Sub Saharan Africa wean off their children at about this age[37], although most mothers are now opting to replacement feeding early following exclusive breast feeding practised in the first 6 months in this HIV era and thus exposing their infants to severe forms of malnutrition early in life[38]. All the patients were in the care of female caregivers. The age of the parents/caregivers ranged between 14 and 65 years. The majority of the caregivers only obtained primary education (49%) while 13% never had any formal education. Only 2% of the caregivers had tertiary education and it is this cohort that actually came from low density residential areas. Most of the care givers came from high density residential areas (89%). Studies done in Zambia show that children's nutrition status is inversely related to their mother's educational status. Children whose mothers had no education were more likely to be malnourished as compared to those whose mothers had higher education. They showed that stunting varied from 55% for the

children whose mothers had little education to 30% for those whose mothers had higher education[39]. The bigger differences were attributed to the quality of care (i.e. food preparation, hygiene, weaning and preservation) as they both relate to health and nutrition.

Complex interactions between the host, parasite and mosquito vector lead to wide variability in the risk of malaria and its clinical presentation. In highly endemic areas, malaria can cause repeated episodes of disease, especially in less immune younger children. Among the study population, there was a statistically significant difference in bed net use in those children with parasitaemia and those without ($p = 0.009$). This showed in some way that ITN use may confer some protection to malaria infection.

Severe malnutrition and HIV infection often occur in a social milieu of extreme poverty and food insecurity, with the result that a high HIV infection pressure affects even uninfected children because of their mothers' or caretakers' chronic disease and through children becoming orphaned. In Zambia and Malawi, more than half of patients admitted to many nutrition rehabilitation units are HIV positive, with case-fatality rates of 40% or higher[40]. In this study, the burden of HIV was 43%, which is not very different with this earlier study; although in this study children were not followed up to see the outcome. Over half of the children (58%) had oedematous severe malnutrition kwashiorkor and marasimic-kwashiorkor. The HIV infected children were less likely to present with oedematous severe malnutrition *p-value* 0.03. This was consistent with other studies which showed that oedema was noted in 40% of HIV-positive children while it was seen in 60% of

HIV-negative children[41]. Severe wasting in the absence of oedema was a common feature observed in severe malnutrition with concurrent HIV- infection.

Malaria parasitaemia detected by Microscopy (Malaria Parasite Blood Slide-MPS) was seen in 8 out of 192 children recruited in the study. This translated into a 4% prevalence rate, whereas as the parasitaemia rate by malaria Rapid Diagnostic Test (RDT) was 5.6%. The difference between the two tests was expected because RDT is said to be more sensitive than MPS blood slide as it is an antigen based assay[42]. All the children who were MPS positive were also RDT positive.

The average malaria prevalence rate in the country reported by the national malaria indicator survey in 2008 was 10.2% with a very wide range among the nine provinces[43]. The prevalence rate in Lusaka province was 1.7% while Luapula province had prevalence rate of 21.8%[39] the highest in the country. Existing evidence strongly suggest that malnutrition increases the burden of malaria morbidity[43] although in this study the prevalence rate falls below the national prevalence rate (10.2%) for under fives, it was well above the Lusaka province prevalence rate (1.7%) where this study was conducted signifying that the prevalence rate may actually be higher in severely malnourished children. Overall, contrary to previously held beliefs that the malnourished individuals are not susceptible hosts to the malaria parasite, results of this study suggest that well nourished individuals are better able to mount an immune response and capable of withstanding and clearing the infection[44]. Comparing to the provincial prevalence rate of 1.7%, the 5.6% malaria parasitaemia found among malnourished children in this study is significantly high.

The presence or absence of oedema was an important second classification in terms of severity of the malnutrition irrespective of the Z-score. In this study we compared the prevalence of malaria parasitaemia in those with oedematous malnutrition (4%) to those without (0 to 1.6%), and it was found that the presence of oedema was an important predictor of parasitaemia (p = 0.017). Children who are malnourished are thought to have increased susceptibility to malaria for a variety of reasons, most notably through a reduction in the function of the immune system, especially the reduction in T-lymphocytes, impairment of antibody formation, and atrophy of the thymus and other lymphoid glands, more so in malnourished children with oedema than those without[37].

In this study the prevalence rate of malaria parasitaemia in severely malnourished children co-infected with HIV (4.9 %) was much the same as those without HIV infection (3.0 %: p= 0.3). This, to some extent, shows that the HIV status may not be an important predictive factor in these children. Despite the biological plausibility of synergism and the somewhat contradictory evidence, the precise relationship between malnutrition and malaria continues to remain difficult to empirically quantify within disease burden frameworks.

9. CONLUSION

The results of this study have shown that malnutrition may predispose children to malaria infection as demonstrated by the significantly higher malaria parasitaemia prevalence rate in severely malnourished children than that of the general population of the similar age group. In additional the study has demonstrated that oedematous severe malnutrition predisposes to malaria parasitaemia more than non oedematous severe malnutrition. However, HIV sero-status of the severely malnourished child did not significantly affect the prevalence rates of malaria parasitaemia in this study.

10. RECOMENDATIONS

1) All children admitted with severe malnutrition should be tested for malaria parasitaemia (with MPS and RDT) and treatment given to those that have been found to have parasitaemia.
2) Insecticides Treated Mosquito Nets (ITN's) should be used to protect severely malnourished children from malaria.
3) More research is needed especially to document the presence, clinical manifestations, outcome and immunological correlates of malaria in severely malnourished children.

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APENDIX I

Questionnaire on the Prevalence of Malaria Parasitaemia in Severely Malnourished Children at UTH ward A07 and Matero Reference Clinic.

Socio-demographics:

1. Age of the child in months ☐
2. Age of mother ☐
3. Sex of patient ☐
4. Marital status: 1. Married ☐ 2. Unmarried ☐ 3. Widowed ☐ 4. Divorced ☐
5. Health status of parents:
   a. Father 1. Health ☐ 2. Sick ☐ 3. Deceased ☐
   b. Mother 1. Health ☐ 2. Sick ☐ 3. Deceased ☐
6. Education status of the mother
   i. None ☐
   ii. Primary ☐
   iii. Secondary ☐
   iv. Higher ☐
7. Residence _____

ITN ownership/Usage;

8. Do you have a mosquito net 1.Yes ☐ or 2.No ☐
9. Does this child sleep under the mosquito net? 1Yes ☐ 2. No ☐

Anti malarial drug history

10. Did this child receive any anti-malaria in the last 4 weeks 1.Yes ☐ .No ☐

11. Which anti-malarial drug? 1. Fansida ☐ 2. Co-artem ☐ 3. Quinine ☐

HIV status

12. Has this child tested for HIV before? 1. Yes ☐ 2. No ☐

13. If no, are you willing to test? 1. Yes ☐ 2. No ☐

Clinical examination

14. Height/length _____ cm.

15. Weight_____ Kg.

16. Weight for height Z-Score 1. < -3 ☐ 2.<-2 ☐ 3<-1 ☐

17. Bilateral oedema 1. Yes ☐ 2.No ☐

18. MUAC ____ cm.

Investigations

19. Blood slide: Thick smear 1. Positive ☐ 2. Negative ☐

20. Rapid malaria test (RDT) 1. Positive ☐ 2. Negative ☐

21. RVD sero-status 1. Positive ☐ . Negative ☐

22. FBC; WBC ____, Hb ____.

APENDIX II

RESEARCH CONSENT FORM

Prevalence of malaria parasitaemia in severely malnourished children at ward A07 and Matero Reference Centre.

1. **Why are we giving you this form?**

   We are giving you this form, so as to give you information about the named study and also to give you a chance to ask questions about this study. Then you can decide if you would like to take part in this study that is trying to find out how often the gem that malaria (malaria parasite) are found in the blood of children with severe malnutrition at the University Teaching Hospital (UTH) and Matero Reference Centre.

2. **Who is carrying out this study?**

   Dr. Mwansa J. Kaunda as part of specialist training at the University of Zambia School of Medicine.

3. **Background Information**

   You are being asked to take part in the above mentioned study, were we would like to find out often the malaria parasites are found in the blood of the children with severe malnutrition at UTH's ward A07 and Matero Reference Centre. By participating in this study we will be able to get the information that we need in order to make relevant policies and interventions for this problem of malaria in malnourished children.

   We believe this is very vital information to all of us and you would help by participating in this study.

4. What Happens In This Research Study?

You will be interviewed now and may be followed up for further information as the study progresses. The information collected will be kept confidential.

5. Possible Problems

We believe that the processes being used will not be harmful to you and the child participating in this study although needle prick would cause pain to your child while collecting blood samples. However if we notice anything peculiar to you or your child during or after information is collected, we will let you know and facilitate your (you and your child) seeking appropriate medical help.

6. Benefits

It is hoped that the study will help reduce both over and under diagnosis as well as over or under treatment of malaria in severely malnourished children. Children will receive free diagnostic services and treatment as regards malaria and malnutrition during this study.

7. Confidentiality

Your name will never be made public by the investigators. The medical record will be treated the same as all medical records at the health centres. A code number that makes it very difficult for anyone to identify you will identify the research information gathered during this study from you. All information will be stored in a secure place. Information from this study may be used for research purposes and may be published; however, your name

will not be made public by the investigators**.** It is possible that, after the study is over, we may want to look again at the laboratory and interview record data collected during this study to help us answer another question. If this happens, still your name will not be made public by the investigators.

8. Payment for Research Related Injury

In the event that a problem results from a study-related procedure, Dr Mwansa in LUSAKA should be notified (0n +260 977 747 625), and you or your child will be facilitated to seek and receive appropriate medical care at the health facility.

9. Consent Formalities

9.1 Participant

I_____

(participant's parent or guardian's name, signature or thumb-print) have been informed about the study .I volunteer to have my child and I participate in the study. A copy of this form signed by me and one of the study investigators is being given to me.

Signature/Thumb_____

Date (D/M/Y) _____

9.2 Interviewer

I have explained this research study to the subject. I am available to answer any questions now or in the future regarding the study and the subject's rights.

Signature of Investigators & Printed Names

Signature_____

Date (D/M/Y) _____