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Pass God no more?

Kwashiorkor among patients admitted in a Therapeutic Feeding Programme in Sierra Leone. Why do certain children develop oedema, where others don't?

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Abbreviations

ACF	=	Action Contre la Faim
HAZ	=	Height for Age Z-score
IDI	=	In Depth Interview
MCH	=	Magbenteh Community Hospital
MoHS	=	Ministry of Health and Sanitation
MUAC	=	Mid-Upper Arm Circumference
NCHS	=	National Centre for Health Statistics
NGO	=	Non-Governmental Organization
ORS	=	Oral Rehydration Solution
OTP	=	Outpatient Therapeutic Programme
PHU	=	Peripheral Health Unit
SAM	=	Severe Acute Malnutrition
SC	=	Stabilisation Centre
SLDHS	=	Sierra Leone Demographic and Health Survey
SSLDF	=	Swiss Sierra Leone Development Foundation
TFP	=	Therapeutic Feeding Programme
UNICEF	=	United Nations Children's Fund
WAZ	=	Weight for Age Z-score
WHO	=	World Health Organization
WHZ	=	Weight for Height Z-score

Abstract

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Pass God no more? Kwashiorkor among patients admitted in a Therapeutic Feeding Programme in Sierra Leone. Why do certain children develop oedema, where others don't?

Key words: kwashiorkor, malnutrition, Sierra Leone, age, season, outcome.

Institution: Magbenteh Community Hospital and Therapeutic Feeding Programme.

Background: Severe Acute Malnutrition can present as kwashiorkor (oedema) or marasmus (wasting). The prognosis of kwashiorkor is considered to be worse and its pathogenesis is not fully understood. Proposed causative factors in literature are: social circumstances, breastfeeding practices, diet and infection.

Objectives: Identification of potential risk factors for kwashiorkor by comparing two groups of patients (kwashiorkor versus marasmus).

Methods: A treatment facility based observational study consisting of three components:

- analysis of archived patient charts
- in depth interviews
- a questionnaire

Results: Kwashiorkor children were on average older, equally stunted and less wasted than marasmus children. Adverse social circumstances, poor breastfeeding practices and food insecurity seemed to be more common in the marasmus group. Inadequate diets, frequent illnesses and unsafe drinking water were problems equally present in both groups. Median duration between being weaned and admission for malnutrition was 4 to 5 months for both groups. Kwashiorkor did not have a worse prognosis than marasmus in this programme; mortality and cure rates were equal and defaulter rate was worse in the marasmus group (10.8% vs. 18.3%, p = 0.003).

Limitations: The objectives of the study were exploratory and descriptive in nature and data collection was not meant to find statistically significant associations. Sample sizes were opportunistic and not based on power-calculations.

Conclusions: The marasmus patients were younger, more socio-economical disadvantaged and subjected to poorer breastfeeding practices compared to the kwashiorkor patients. Also they defaulted more often.

Introduction and background

The author of this thesis worked as a medical doctor in the Magbenteh Community Hospital in Sierra Leone from September 2007 until November 2009. This hospital is built and run by a Non-Governmental Organization (NGO) called the Swiss Sierra Leone Development Foundation (SSLDF) and operates on a non-profit basis. Children below the age of 5 are treated for free. It has 100 beds for inpatients and an outpatient department. Furthermore the hospital runs a Therapeutic Feeding Programme (TFP) where patients suffering from Severe Acute Malnutrition (SAM) are treated. This programme incorporates a referral centre for inpatient treatment called the Stabilisation Centre (SC) and a clinic for the Outpatient Therapeutic Programme (OTP). During her stay, the author was the medical coordinator of the TFP. In this position she witnessed that the majority of malnourished children, despite their deplorable condition on admission, responded rapidly to treatment with therapeutic food and medicines and transformed into stable, alert and very hungry little creatures within days. However in sharp contrast with these success stories, an important proportion of cases did not respond favourably to the treatment and died. This sparked her interest in malnutrition and ultimately led to the subject of this thesis. Although it is perforce limited, it will hopefully contribute to a further improvement of the already very successful feeding programme in Magbenteh.

The location

The republic of Sierra Leone is a West African country bordering Liberia, Guinea and the Atlantic Ocean. The country has a population of about 5 million people, with a median age of 17,5 years. They originate from at least 20 different ethnic backgrounds, but the main groups are the Mende (30%), Temne (30%) and Krio (10%). The main religion is Islam, with 60% of the population being Muslim. The climate is hot and tropical, with a dry season from December until April and a rainy season from May until November. The rainy season is particularly wet, with up to 5 meters rainfall in the coastal regions. The country is emerging from a brutal civil war that lasted from 1991 until 2002, and left the already underdeveloped infrastructure in ruins. Only the two largest cities have electricity and only a few major roads are paved. Almost half the population has no access to safe drinking water and 89% does not use improved sanitation (hygienic separation of the excreta from human contact) (1). An estimated 70% of the population lives below the poverty line (2).

In 2009 Sierra Leone ranked 180 out of 182 in the Human Development Index of the United Nations, making it one of the least developed countries in the world (3). This position is mainly earned by the low literacy rate (35%) (2) and the low life expectancy at birth (47 years) (3). High mortality rates in early childhood contribute significantly to this. In the most recent Demographic and Health Survey (SLDHS) infant mortality (under 1 year of age) was estimated at 89 per 1000 live births and under five mortality at 140/1000 (annex 1, table 8.1) (4). Malnutrition is very common among children under five (annex 1, table 11.1) and is estimated to contribute to 46% of the mortality in this age group (5). Besides malnutrition the major health problems in the country are: malaria, anaemia, respiratory infection, diarrhoea and maternal and neonatal mortality (4, 6). HIV is considered a health priority by the Ministry of Health and Sanitation (MoHS) although the estimated adult prevalence rate can be considered as relatively low at 1.5% - 1,7% (annex 1, table 14.3) (2, 4).

Problem statement

Patients suffering from SAM can present with two different clinical pictures, namely kwashiorkor and marasmus. Kwashiorkor is characterized by the presence of oedema, skin changes (peeling, exfoliation), chronic diarrhoea and liver function problems (7, 8). Marasmus is characterized mainly by severe wasting, which is usually defined as a z-score (number of standard deviations from the median) for weight for height below -3 (WHZ < -3), using the World Health Organization's (WHO) growth standards of 2006 (9).

The rainy season is commonly known as "the hunger season" in Sierra Leone. Planting is done once a year, during the first rains, but the yield of the previous harvest are often already running low, while the new crops are not yet ready for harvesting, resulting in food shortages. Malaria-mosquitoes profit from the humid conditions, heavy rains and the overflowing of drainage structures, which leave stagnant water puddles and swamps everywhere. Drinking water sources become contaminated with dirt being washed into them. Food gets mouldy or spoiled easy. Therefore the burden of disease is also higher in this season. Previous observational research in the inpatient facility of the TFP showed an increase in the number of admissions in the rainy season (figure 1a), that was larger for kwashiorkor than for marasmus (figure 1b).

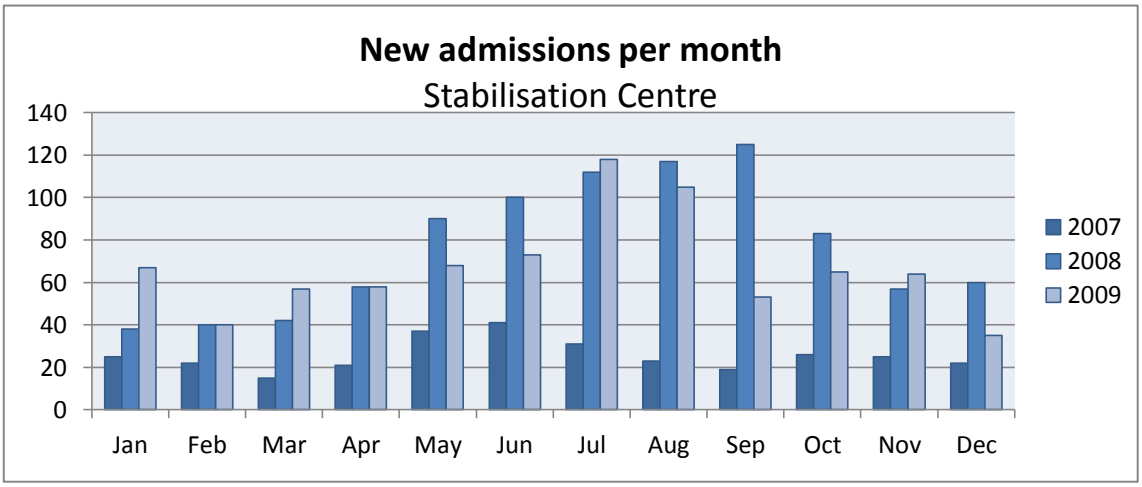

Figure 1a: New admissions per month – Stabilisation Centre.
Source = Magbenteh Community Feeding Programme Statistical Report 2009.

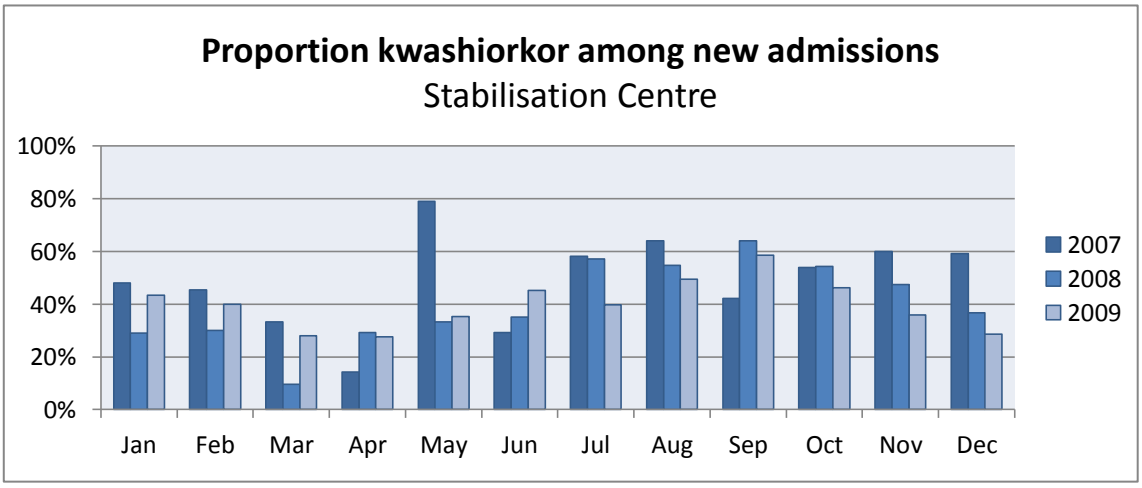

Figure 1b: Proportion kwashiorkor among new admissions – Stabilisation Centre.
Source = Magbenteh Community Feeding Programme Statistical Report 2009.

The higher incidence of kwashiorkor in the rainy season has been reported already by several authors (8, 10, 11). It is a very interesting observation, especially since the pathogenesis of kwashiorkor is not yet fully understood. Several theories have been proposed (see literature review), but despite a lot of research in the past decades none were proven and it remains unclear why certain children develop marasmus, while others develop kwashiorkor. This makes the development of specific treatment strategies difficult. Therefore kwashiorkor and marasmus are treated the same, despite their differences in clinical presentation and the fact that the outcome of children with kwashiorkor is generally considered to be poor compared to those with marasmus (12-15).

The purpose of this thesis is to gain a better understanding of the potential factors involved in the development of kwashiorkor among patients of the TFP in Magbenteh, in order to optimize the programme in general and improve the survival of kwashiorkor patients specifically. Towards this goal, the following steps were taken:

1) A literature review, identifying the most prevailing hypotheses regarding the pathogenesis of kwashiorkor.

2) An observational study among the patients of the Magbenteh TFP, evaluating the risk factors identified in the literature review.

3) Comparison of the outcomes of the kwashiorkor and marasmus patients, as part of the observational study, in order to verify whether the prognosis of kwashiorkor patients was indeed worse in this programme and enable the formulation of useful recommendations.

The contents of this thesis will be relevant for the management and personnel of the TFP in Magbenteh, for United Nations Children's fund (UNICEF) Sierra Leone and for the District Health Management Team of the MoHS in Bombali, Sierra Leone, as well as for health personnel and managers working in the field of nutrition in West-Africa and the rest of the world.

Literature review

The pathophysiology of kwashiorkor is still not fully understood, despite a lot of research in the past decades. This part of the thesis gives an overview of the most prevailing hypotheses.

Search

PubMed was searched systematically, using the following combinations of terms:

- kwashiorkor Sierra Leone
- kwashiorkor West-Africa
- cause kwashiorkor
- prevalence kwashiorkor marasmus

The search was restricted to studies published in English. Articles for which no full text or abstract could be found online, were also excluded. The search term "prevalence kwashiorkor marasmus" identified 390 records, therefore the search was limited to articles written after 1989 for this term. The remaining articles (n = 177) were screened for relevancy based on title and abstract (see below). Further relevant titles were found from the reference list of identified papers.

Reasons why articles were considered irrelevant:

1) Concerning morbidity and mortality in developing countries in general.
2) Restricted to or mainly focusing on therapeutic interventions.
3) Describing personal experiences.
4) Concerning secondary malnutrition (related to an underlying chronic disease).
5) Concerning psychosocial aspects.
6) Concerning consequences not causes.
7) Concerning nutritional problems in developed countries.
8) Concerning high tech animal-model biochemical research.
9) Concerning malnutrition in general, not separating the different forms.
10) Concerning HIV-related nutritional problems specifically.

Articles concerning HIV related malnutrition were not included, since HIV prevalence is low in Sierra Leone and seemed to be very low in the feeding programme. Not all patients were routinely tested, but all suspected cases (not improving, typical opportunistic infections etc.) were and the majority of them was HIV negative.

Baseline characteristics of kwashiorkor patients

A prospective community based study in Malawi concluded that children who developed kwashiorkor were more wasted (WHZ significantly lower) than children that didn't develop oedema. They were also more stunted, meaning that their height for age (HAZ) was significantly lower (10). In a different study that compared children from Uganda (where the predominant form of malnutrition

is kwashiorkor) and The Gambia (where marasmus is more common) investigators concluded that the Ugandan children were less stunted and had a better (although not perfect) weight for age (WAZ) during their first 3 years of life than the Gambian children. The Gambian children that developed kwashiorkor were found to be taller (78 cm vs. 72 cm) and older (27 vs. 18 months) than the ones with marasmus (16). Other authors have also come to the conclusion that kwashiorkor patients are usually less stunted in height compared to marasmus patients (17). In summary kwashiorkor patients are found to be older, less stunted and less wasted than marasmus patients, but more stunted and wasted than the general population.

Conceptual framework

A conceptual framework for kwashiorkor was not found in the literature studied. For malnutrition in general variations of the framework below (figure 2) are normally used.

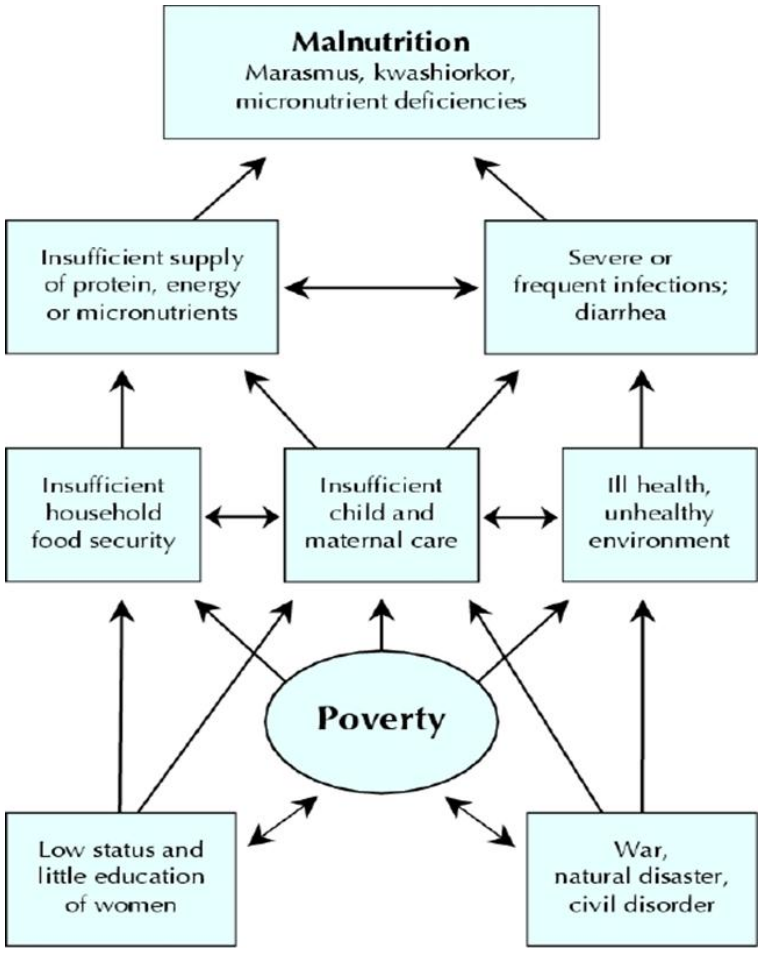

Figure 2: Conceptual framework of direct and indirect causes of malnutrition.
Source = Article of Müller and Krawinkel - Malnutrition and health in developing countries (12).

Social circumstances

As Müller and Krawinkel depict in their conceptual framework (figure 2), poor social circumstances form the indirect cause of malnutrition, resulting in inadequate food, insufficient care and ill health. This has been described in numerous articles, but only few have investigated kwashiorkor patients specifically. The name kwashiorkor indicates a relation with social circumstances, since it means “the disease that the young child develops when displaced from the mother by another child or pregnancy” in the Ga language in Ghana (12). This name was given by dr. Cicely Williams in 1933,

who also called it the disease of the deposed child (7) and furthermore noticed that the mothers of kwashiorkor children were often ill or had died (18). The social risk factors most commonly discussed in the literature are given in table 1.

Table 1: Social risk factors for malnutrition.

	Malnutrition in general	Kwashiorkor specifically	References
Young age of the mother	X		(19, 20)
Mother unmarried	X	X	(19, 21, 22)
Lack of paternal support		X	(22)
Low level of education of the mother	X	X	(21, 22)
Poor parental health	X	X	(18, 21)
One or more parents deceased	X	X	(18, 21)
Child not staying with parents	X		(19, 21)
Death of sibling(s)	X		(21)
Having a younger sibling	X		(18)
Being a twin	X		(21, 23)
Being of high birth order (≥ 3)	X		(21)
Lack of birth spacing (≥ 3 children of < 5 years of age)		X	(23)
Low socio-economic status	X	X	(20-23)
Lack of ownership of land	X		(19, 20)
Lack of ownership of livestock	X		(19, 20)
Not growing own maize or beans	X		(19)

Lack of breast milk

Dr Cicely Williams observed that kwashiorkor occurred mainly in children that recently had been weaned, especially when they were very young (18). But also breastfed children could develop kwashiorkor, when the woman was old (grandmother), sick, malnourished, pregnant or micronutrient deficient (7, 18). More recent authors agree with these conclusions (8). The reason for this relation was described very clearly in an article from West Africa in 1958: "Weaning is the most dangerous time of all for the child, since he is then deprived of his mother's milk without having learned to replace it by an adult-type diet that has been introduced progressively. The child then lives for several months in a state of balance or of slight deficiency. If a parasitical or infectious condition gains a hold at that time, the balance is immediately disrupted and kwashiorkor makes its appearance" (24). A recent case control study in South Africa confirmed that significantly more kwashiorkor patients (45%) had never been breastfed compared to well-nourished controls (24%) (22).

Diet

Macronutrients – role of protein

For a long time it was assumed that a lack of protein in the diet was the cause of kwashiorkor, and a lack of energy intake (calories) caused marasmus. This theory originated partly from the fact that patients responded well to a milk based diet (8) and on the observation that total serum protein rose during treatment (25). Gopalan in India was the first one to prove that there was no difference in the protein/energy ratios of the diets eaten by children suffering from kwashiorkor and children suffering

from marasmus (26). Other studies made clear that there was no relation between the plasma protein level and the presence, degree, disappearance and speed of clearance of oedema (27). Instead the speed of clearance of oedema is related to the energy intake and kwashiorkor cases respond well to diets high in energy and low in protein (14, 28). Lack of protein seems to results in stunting, which is a chronic form of malnutrition (17, 29).

Micronutrients – specific deficiency

With the "protein-theory" becoming less likely, the idea rose that kwashiorkor could be caused by a specific deficiency. Golden proposed to divide nutrients in two types, namely the ones that cause growth failure (type II) and the ones that cause specific clinical signs when deficient (type I). Examples of type II nutrients are protein, zinc, magnesium and potassium. Examples of type I nutrients are iron (anaemia), thiamine (beriberi), vitamin C (scurvy) and niacin (pellagra). He suggested kwashiorkor was caused by a deficiency in one or more of the type I nutrients (29, 30). This theory is supported by observations that the disease can be prevented or cured with a varied diet rich in milk or eggs, including egg yolk (25), as opposed to diets mainly consisting of maize (7, 18). A nutrient, other than protein, present in milk and egg yolks would then be responsible for the protective or beneficial effects. The theory explains how breastfed children can develop kwashiorkor, if the breast milk is deficient in the necessary nutrient(s), due to the condition of the (foster) mother. However the responsible (micro)nutrient has not been identified. Williams observed that children with kwashiorkor often suffered from angular stomatitis and that addition of cod liver oil to the diet postponed the skin changes (7, 18). This makes riboflavin (vitamin B2) a good candidate, since angular stomatitis is caused by ariboflavinosis and liver products and milk are very rich in this micronutrient, while degermed maize and white rice are very poor in riboflavin (31). A study in Malawi explored the role of diet in the pathogenesis of kwashiorkor. A list of 53 food items, identified during focus group discussions as typical food for young children, was investigated. None of these food items had a significant association with the development of kwashiorkor (10). A limitation of this study was the facts that the diet of the complete study population was very poor in animal-source food and therefore probably deficient. Furthermore the study population was involved in a randomized controlled trial, providing about half of them with an antioxidant supplement, containing riboflavin (32). Therefore a specific deficiency causing kwashiorkor cannot be excluded based on this study.

Aflatoxin poisoning

Another food based theory is the one of "aflatoxin-poisoning". Aflatoxin is a mycotoxin present in food infested by mould. In warm and humid conditions it is found in maize, cassava, rice, groundnuts, chickpeas, dried okra and peanut butter. It transfers into breast milk. Ingestion results in hypoalbuminaemia, liver damage and immunosuppression (11, 33). A study in Sudan detected aflatoxin more often in the serum of kwashiorkor cases (36,4%) than in that of normal children (15,9%), marasmic children (19,3%) and marasmic kwashiorkor children (21,9%). Also serum concentrations were higher in the kwashiorkor group (11). However it was unclear if these high concentrations resulted from higher exposure or from impaired excretion. The aflatoxin concentration in the urine was lower in the kwashiorkor cases, suggesting an excretion problem. Therefore causation could be in the opposite direction, with high serum levels of aflatoxin being a consequence of the liver dysfunction and metabolic disturbances of kwashiorkor instead of being a cause (29).

Infection

Infection often seems to precipitate kwashiorkor. Especially diseases like measles, malaria, respiratory tract infections and diarrhoea are often reported before the development of oedema (8, 32). One author even stated specifically that "marasmus is known to lead to kwashiorkor in the presence of infections like gastro-enteritis and measles" (34). HIV on the contrary, seems to be more associated with marasmus than kwashiorkor (35, 36). Episodes of infections have been shown to lead to a drop in weight and serum albumin in a 3 year prospective study in Uganda. During a similar study in the seventies in the Gambia a significant negative correlation between height gain and the presence of diarrhoea or gastroenteritis in the previous period was found, while weight gain had a significant negative correlation with both gastroenteritis and malaria (37). Evidence that infection also plays a role in the development of oedematous malnutrition comes from a previously mentioned prospective study in Malawi. In this study, children with kwashiorkor had a significantly higher prevalence of fever, cough or diarrhoea in the 28 day period before the development of oedema than the general population . On the other hand half of the children developing oedema reported none of these symptoms (10), suggesting that infection maybe a frequent, but not a necessary component in the development of kwashiorkor.

Malaria

The prevalence of kwashiorkor seems to be bound to specific geographic regions, although this is not well documented, since recording of the presence of oedema is not routinely done in nutritional surveys. The condition is for example very common in Uganda (35), but more rare in the Gambia (37) and Ethiopia (8). There seems to be an association with a humid climate or wet seasons (38) and "The geographical regions where kwashiorkor is common are generally malarious" (29). Despite this little research has been done on malaria as a cause of kwashiorkor or other forms of malnutrition. One exception is a study in the Gambia in 1951 that compared protected children (chloroquine) with unprotected children. A positive effect of malaria protection on weight gain in the first 2 years of life was suspected, but the sample size was too small to detect significant differences. Also the study didn't look at the occurrence of oedema (39). Otherwise most studies involved in malnutrition and malaria look at the effect of the nutritional status on malaria morbidity, not vice versa. Parasite density is often low in malnourished malaria patients and cerebral malaria is very rare in children with kwashiorkor, therefore it has long been thought that malnutrition was protective for malaria. However recent literature, including a review article done in 2000, attributes higher risks on malaria morbidity, mortality and serious neurological sequelae to malnourished patients, despite lower parasite counts (40, 41). Unfortunately none of these studies answered the question whether malnutrition had led to an increased susceptibility for malaria or malaria infection had caused malnutrition. The only evidence to support that malaria contributes to the development of malnutrition comes from the two previously mentioned studies in the Gambia (37, 39). Furthermore indirect proof that malaria negatively influences nutritional state is provided by a study in Kenya among children aged 1-11 months. In an area with seasonal malaria transmission the use of insecticide treated bednets positively influenced the weight for age during the wet season, but not during the dry season (42).

Oxidative stress

The oxidative stress theory states that "kwashiorkor is caused by an imbalance between the production of free radicals (oxidative stress) and their safe disposal (antioxidant function of the

body)" (8, 17), causing tissue damage and leaky cell membranes. This imbalance is either caused by a higher exposure to oxidative stress, or by a deficiency in the protective mechanisms, or both.

Free radicals and antioxidants

A free radical is any atom or molecule that contains one or more unpaired electrons, making it more chemically reactive. A reaction caused by a radical can start a free radical chain reaction in which new radicals are formed. Free radical production takes place in the body as a normal mechanism, for example in the immune system, where activated phagocytes use free radicals, like superoxide and nitric oxide, to kill pathogens. When free radicals attack cell membranes, lipid peroxidation takes place, making the membranes leaky (43). This process kills invaders, but can also damage the normal cells of the body. Therefore protective mechanisms are in place to limit the damage (44). Free radicals can either be broken down via several enzyme pathways, or be scavenged by antioxidants. The most well-known examples of antioxidants are vitamin C, E and carotene (40), but "at least 14 different micronutrients are involved in ensuring adequate protection against an increased flux of free radicals" (8, 44). The tripeptide glutathione plays an important role. It is an essential element of the pathway that removes superoxide, via the enzyme glutathione peroxidase. During this process glutathione gets oxidised into GSSG, but another enzyme reaction reduces it back to glutathione, making it reusable over and over again. If the level of oxidative stress exceeds the capacity of this process, glutathione also works as a free radical scavenger and as an element in the process that removes superoxide via the enzyme glutathione-S-transferase. However during these two processes glutathione gets consumed instead of being recycled (17, 43, 44).

Deficient protective mechanisms

Concentrations of important antioxidants like vitamin A, vitamin E and carotene are reduced in both oedematous and non-oedematous malnutrition, but the reduction seems more marked in children with oedematous forms, than in children with marasmus. It is not sure whether levels are low, due to consumption while scavenging free radicals (indicating an effective disposal mechanism), or if they are decreased due to causes like inadequate dietary intake, resulting in a defective level of protection (44).

Role of free iron

Iron is a catalyst of free radical reactions, if it is not bound to transferrin (transport protein in blood) or ferritin. Ferritin binds iron in tissues like the liver, but is also present in blood. Plasma ferritin is used in laboratory testing as a measure of total body storage of iron, with high levels indicating iron overload. Research shows that plasma ferritin is raised in kwashiorkor patients, especially in the ones that die (44). Levels of transferrin are found to be very low in kwashiorkor, allowing free iron to circulate in the body thus increasing oxidative stress (29).

Increased oxidative stress

Kwashiorkor patient are subject to increased oxidative stress. This was demonstrated in a study in Malawi that found significantly higher levels of oxidized amino acids (a marker of oxidative damage) in the urine of kwashiorkor children, compared to well-nourished children and to children admitted with cerebral malaria (45). The enzymes that reduce GSSG back into glutathione are found to be more active in both forms of malnutrition, suggesting an increase in oxidative stress in both. In marasmus patients this results in normal levels of glutathione, but in kwashiorkor the glutathione levels are low, suggesting that oxidative stress exceeds the capacity of the normal pathways in kwashiorkor, but not in marasmus (29, 44).

Causality

Unfortunately oxidative stress can be both a cause and a consequence of tissue damage. Therefore finding increased free-radical damage markers, does not tell, whether this is a cause or a consequence of kwashiorkor (43). During a large randomized controlled trial in Malawi, healthy children at risk for malnutrition were supplemented for 20 weeks with a high-dose mix of antioxidants, to see if this would protect them from developing kwashiorkor. No significant effect of supplementation on weight gain, height gain, health complaints or the development of oedema could be found. The investigators concluded that antioxidant depletion may be a consequence rather than a cause of kwashiorkor (32).

Conceptual framework for kwashiorkor

Oxidative stress can bring most of the previously mentioned theories under its wings. An inadequate diet can cause deficiency of antioxidants, resulting in impaired disposal of free radicals. Infections and specifically malaria cause increased oxidative stress (45, 46), which even becomes worse when the patient is riboflavin-deficient (46). Aflatoxin ingestion and endotoxins from intestinal bacterial overgrowth also increase oxidative stress (8, 17, 29). The following conceptual framework (figure 3), inspired by the example of Muller and Krawinkel (12), depicts the main causative factors for kwashiorkor found in this literature review. It serves as a basis for the objectives of the observational study. However, since no laboratory testing was done the roles of oxidative stress and aflatoxin could not be investigated.

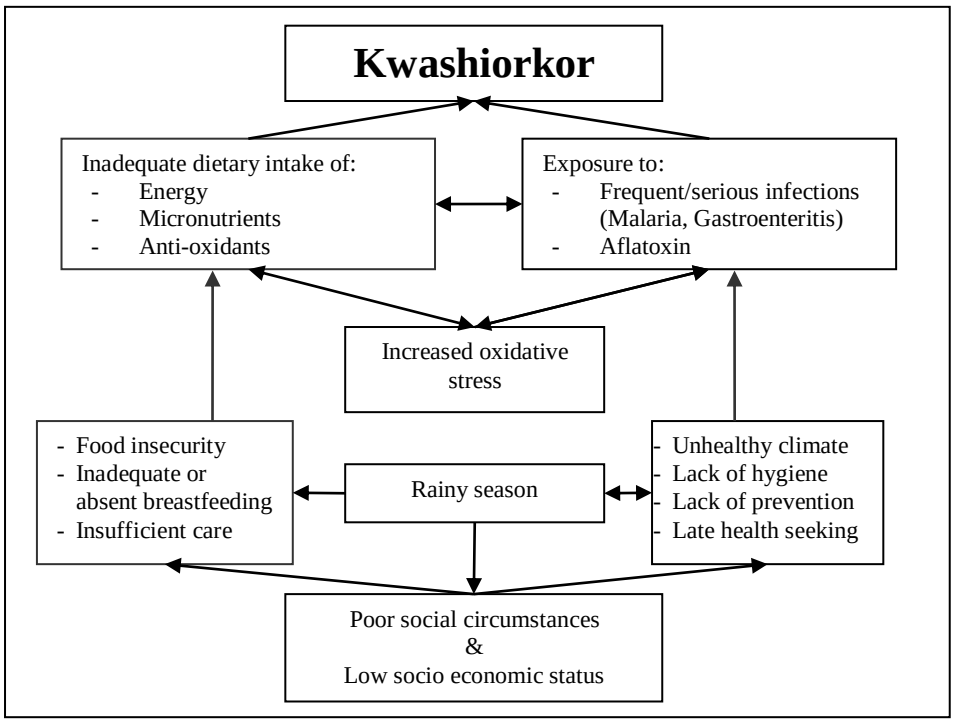

Figure 3: Conceptual framework for kwashiorkor.

Magbenteh TFP observational study:

Objectives

Research question:

To identify potential risk factors for kwashiorkor by comparing two groups of children (kwashiorkor patients versus marasmus patients) admitted in the Therapeutic Feeding Programme of the Magbenteh Community Hospital in Bombali district, Sierra Leone.

Specific objectives:

1) To describe differences in baseline characteristics of children admitted with kwashiorkor and children admitted with marasmus. The following hypotheses will be tested:

    a. Kwashiorkor patients are relatively older.

    b. Kwashiorkor is equally distributed over the sexes.

    c. Kwashiorkor is related to stunting.

    d. Kwashiorkor is related to moderate wasting.

2) To compare exposure to potential causative factors for malnutrition, in children admitted with kwashiorkor and children admitted with marasmus. The factors to be investigated are:

    a. social circumstances

    b. breastfeeding practices

    c. diet
        - staple food
        - meal frequency
        - specific ingredients
        - (seasonal) accessibility

    d. exposure to infection
        - recent episodes of illness
        - recent treatment history
        - preventative measures:
            - bednet use
            - vaccination status
        - drinking water source

    e. season of admission

Extra objective:

3) Compare the outcome of kwashiorkor patients and marasmus patients in this TFP.

Methods

The study consisted of three different components:

- Analysis of the archived patient charts of the inpatient facility, further referred to as “patient charts”.
- A qualitative semi-structured in depth interview (IDI) with a maximum variation sample of caretakers of kwashiorkor cases and marasmus cases at the inpatient facility, further referred to as “*IDIs*”.
- A cross-sectional study of malnourished children, admitted in the programme, using a quantitative structured questionnaire, further referred to as “*questionnaires*”.

The rationale behind this approach was that the patient chart analysis provided basic information over a long period of time and from a large patient group, relevant for objective 1 and 3 as well as for the factor season in objective 2. However it didn’t provide detailed information about diet, breastfeeding practices and medical history prior to admission, needed for objective 2. This was provided by the IDIs, which gave the necessary insight in these matters, including detailed information about cultural beliefs and practices and practical constraints. The questionnaires showed whether the issues discovered during the IDIs were consistently present in a larger group. The three different components will be discussed separately after the general information concerning the setting and the study population.

Setting and study population

All components of the study were treatment facility based. Selection of patients was done at the TFP site in Magbenteh.

Sierra Leone is divided in the Northern, Eastern and Southern Province and the Western Area, where the capital Freetown is located. The Northern Province is the biggest and is divided in 5 districts: Bombali, Kambia, Konaidugu, Port Loko and Tonkolili. The Magbenteh Community Hospital (MCH) is located in Bombali district near the district capital Makeni (see map, annex 2). The government-run district hospitals are normally the main referral centres for malnourished patients, but in Bombali the MCH fills this position. This is a result of the long history of the site. Already during the war Action Contre la Faim (ACF) ran a successful feeding programme here, which was later handed over to the SSLDF. Supported by UNICEF and other donors, the centre could continue to offer free, friendly and high quality services. In the meantime the government hospital in Makeni also opened an SC, but since the Magbenteh treatment centre is only a few kilometres away, the facility in Makeni remains small.

Each district of the country is supposed to have at least one inpatient facility for malnourished children, but this was not yet the case at the time of the study. Port Loko and Konaidugu lacked the necessary facilities as did the neighbouring district of Kono, in the Eastern Province. As a consequence the patient population of the TFP was not restricted to patients from Bombali only (table 2).

Table 2: Origin of new admissions – Stabilisation Centre.

Province	District	N	%
Northern Province	Bombali	352	43.8
	Port Loko	291	36.2
	Tonkolili	120	14.9
	Konaidugu	3	0.4
	Kambia	-	-
Eastern Province	Kalaihun	-	-
	Kenema	1	0.1
	Kono	13	1.6
Western area (Freetown)		23	2.9
Southern province		-	-

Source = Magbenteh Community Feeding Programme Statistical Report 2009.

Most of the patients came to the centre spontaneously, but some were referred, either by government-run peripheral health units (PHU) and OTP sites or via other NGOs (table 3).

Table 3: Mode of referral – Stabilisation Centre.

	N	%
Spontaneous	545	68
PHU	69	9
SSLDF screening	17	2
OTP	44	5
NGO	119	15
Other	11	1
Total	805	100

Source = Magbenteh Community Feeding Centre Statistical Report 2009.

The vast majority of the patients were below the age of 5 years. Older children and adults frequently had secondary malnutrition caused by a concurrent illness such as tuberculosis, typhoid fever or HIV, although the latter was uncommon.

The programme only admitted patients who fulfilled the diagnostic criteria of SAM according to the national protocol of Sierra Leone. This meant they either had bilateral pitting oedema, or were severely wasted. Severe wasting was defined as having a weight for height measurement less than 70% of the median reference values (the 1977 National Centre for Health Statistics (NCHS) standards). Also a Mid-Upper Arm Circumference (MUAC) of less than 110 mm in a child aged between 1 and 5 years was an admission criterion (47).

On admission in the programme, patients were examined and their appetite was tested. In case of absent appetite, a poor general condition, complications or otherwise unfavourable circumstances, they were admitted to the inpatient facility. If none of these problems were present, they could be treated as outpatients at an OTP site close to their home (max. 10 km). In practice very few patients entered the OTP programme. Patients were not referred to OTP sites outside Bombali, because of long distances and absence of a proper referral system. In Bombali district patients were referred, but due to the low coverage (9 sites in 5000 square kilometre) only few people lived close enough to one. Therefore the majority of patients was admitted and stayed at the inpatient facility until they reached the discharge criteria of the programme.

Ethical considerations

This study was approved by the Hospital Ethics Committee of the Magbenteh Community Hospital and Therapeutic Feeding Centre. Ethical clearance was furthermore obtained from the Research Ethics Committee of the Royal Tropical Institute in Amsterdam, The Netherlands. A written informed consent statement was read to all the candidates. This statement was signed either by thumb print or signature upon joining the study.

Patient charts

Study design

Data were collected from all inpatient admission charts with exit dates from 1-10-2008 until 31-09-2009, representing one full year prior to the study period of the IDIs and questionnaires that started in October 2009. Information on baseline characteristics and outcome was copied from the charts and recorded in EpiData v3.1 (annex 3). The use of exit dates instead of admission dates was a result of the filing system. Exits should not be mistaken with discharges since they also include other outcomes, like death or defaulting (see page 17).

Participants

Although information was collected for all admitted patients, during analysis only the patients aged 6-60 months were included. Patients above 60 months were excluded, firstly because anthropometric indices (HAZ, WHZ) according to the WHO standards are only available until 60 completed months of age (48). Secondly the pathology of older patients is often very different with underlying chronic medical problems. Patients below 6 months were excluded, because the admission criteria for this group are different and mostly related to adverse social circumstances and breastfeeding problems. Furthermore height is usually not recorded for these patients, making it impossible to calculate anthropometric indices.

Variables

On admission weight, height and presence of oedema were measured by a registrar and recorded in the patient chart, together with age, sex and date of admission. At the time of exit, the outcome and exit date were recorded on the chart by the same registrar.

Kwashiorkor or marasmus

The presence of oedema was examined by pressing two thumbs on the dorsum of both feet, the pretibial areas of both lower legs and the dorsum of both hands. It was recorded in the charts as + (only feet), ++ (feet and legs) or +++ (generalised). Kwashiorkor was diagnosed on admission and was defined as malnutrition in combination with any grade of oedema. The remainder of patients were classified as marasmus.

Age

Information about age (in months) was collected from the caretaker. Birth certificates are scarce in Sierra Leone, but sometimes the caretakers could show the child's vaccination card, enabling the registrar to check the correctness of the age given.

Height

Height or length were measured to the nearest 0.5 cm using a standard height board, provided by UNICEF. For simplicity only the term height is used in this text, but all children <24 months of age were measured in a supine position.

Weight

Weight was measured to the nearest 100 gram, using a Salter Harris hanging scale provided by UNICEF, which was calibrated regularly. Children were undressed and suspended from the scale in weighing pants.

HAZ and WHZ

Anthropometric indices were calculated using the 2006 WHO standards, in the programme WHO Anthro v3.0.1 (48). Information on weight, height, sex and age was imported from EpiData. Information on the presence of oedema was not imported, since the programme is set to "discard the weight value for a child with oedema and record -3 for all weight-related indicators" (48). If information about oedema was withheld, the programme considered the child to have no oedema and calculated all values. The graphs presented in the result section, were drawn in WHO Anthro. It should be noted that the programme only included cases in the graph with a z-scores within a pre-set normal range, which could not be adapted. Therefore the number of cases shown in the graphs is different from the total number included in the study. The normal ranges of the programme were set as follows:

- HAZ = -6 to 6
- WHZ = -5 to 5

Stunting and wasting were defined as HAZ < -2, and WHZ < -2, severe stunting and severe wasting as HAZ < -3 and WHZ < -3.

Season of admission

Admission dates ranged from 26-07-2008 until 28-09-2009, but archiving was done on exit dates. Since duration of admission varied, not all patients admitted between these dates were included in the study. The patients were grouped in 4 "seasons of admission" (table 4).

Table 4: Definition of four seasons of admission – patient charts.

Season	Months	Admission dates
Early rainy season	June – August	26/07/2008 – 31/08/2008 & 01/06/2009 – 31/08/2009
Late rainy season	September – November	01/09/2008 – 30/11/2008 & 01/09/2009 – 28/09/2009
Early dry season	December – February	01/12/2008 – 31/12/2008 & 01/01/2009 – 28/02/2009
Late dry season	March – May	01/03/2009 – 31/05/2009

Outcome

Cured: The patient reached the criteria for discharge: free of oedema for at least 14 days and a weight for height of >85% of the median on two subsequent occasions.

Death: The patient passed away.

Default: The patient left the programme before the discharge criteria were reached and against medical advice.

Transfer to OTP: The patient lived within a 10 kilometres radius of an OTP site and his/her condition was stabilised. Treatment continued as an outpatient. The condition was considered stable if: appetite was good, weight gain had started or oedema had started to resolve, no unfavourable (social) circumstances or medical complications were present and injectable drugs were no longer needed .

No cure: The patient stayed in the programme for a long period, but didn't reach the discharge criteria. Investigations had been done to find the reason for this and all treatable underlying conditions had been treated. The decision to "discharge" the uncured patient was made by a medical doctor. Frequently an underlying condition was assumed or diagnosed such as congenital heart disease, traumatic oesophageal stricture, hypoxic-ischaemic encephalopathy or malaria-related brain damage.

Data quality

The registrar was the same person during the entire study period. He handled the majority of all admissions and exits. During weekends, the admission procedure was taken over by the nursing aids, but discharges and the administration of other types of exits only took place during the week. During his annual leave, a temporary registrar was hired. All patients had a personal identification number, which was used during data entry to prevent double entry.

Study size

Sample size was dependent on the number of exits during the study period and was therefore opportunistic. The study was exploratory and descriptive in nature and the design was not meant to find statistically significant associations.

Statistical methods

Data were imported and analysed in STATA 10.0 for Windows (annex 4). Student's t-test for continuous variables (age, HAZ, WHZ) and Pearson's Chi-square test for categorical variables (sex, season, outcome) were used to compare baseline characteristics between the kwashiorkor and the marasmus group. All tests were two-tailed. A p-value <0.05 was considered significant. Missing data are depicted in the flow diagram in the results section (figure 4). When data were missing the patient in question was left out of the analysis for that specific issue. For the variable "outcome" patients with "no cure", were also left out of the analysis, because the number was too low (n=4) to allow a Chi-square test otherwise. Distributions of continuous variables and graphs concerning these, were produced in EpiData Analysis v2.1.0.157.

IDIs

Study design

An in depth interview was done in a maximum variation sample of caretakers of TFP inpatients. Based on the information found in the literature review, a semi-structured questionnaire with a set of open questions was made (annex 5). The questions were piloted and adapted twice in order to ensure relevance for the local setting and understanding by the caretakers. The interviews were done by a female Dutch medical doctor, with assistance of a local female nursing student, specifically hired for the purpose of translating and helping with cultural barriers. A sound recording was made during the interview, which was transcribed. Subsequently the information was arranged in the following themes:

- Social circumstances
    - Main caretaker
    - Family composition
    - Livelihood
- Breastfeeding practices
- Diet of the patient (complementary or not)
- Seasonal constraints
- Recent medical history of the patient
- Health seeking behaviour
- Illness preventing behaviour
    - Bednet use
    - Vaccinations
- Drinking water source
- Caretaker's own idea concerning the cause of the condition

Participants & study size

Maximum variation sampling was used for the selection of caretakers to be interviewed. With this method the extremes of the study population need to be selected (49). Since the population of the TFP is unsteady, with admissions and discharges every day, a series of selection criteria was chosen based on characteristics that were expected to be important, namely the area of origin (which district, rural versus urban) and the experience of the caretaker (first time parent or not). Based on these criteria the following subjects were to be selected in both patient groups:

- 2 caretakers from rural Bombali, 1 experienced, 1 inexperienced (first child)
- 2 caretakers from rural Tonkolili, 1 experienced, 1 inexperienced
- 2 caretakers from rural Port Loko, 1 experienced, 1 inexperienced
- 2 caretakers from the urban area in/close to Makeni, 1 experienced, 1 inexperienced
- If available 2 caretakers representing a minority case, like:
    - Patients with a male caretaker
    - Patients coming from very far
    - Patients above 5 years of age
    - Patients below 6 months of age

Since inpatients are usually in a more advanced stage of the disease, from further distances and/or subject to more constraints than children that can be treated as outpatients, it was decided to restrict the selection to inpatients.

The sample size of 8-10 per group was chosen based on the fact that the research population was relatively homogenous, the content of the interview simple and the number of analysts limited. Therefore, based on literature (50), saturation was expected after 6-12 interviews.

Variables

Kwashiorkor or marasmus
The two diagnoses were defined in the same way as in the patient chart study.

Social circumstances
A household was defined as a group of people living together. They would usually cook and eat together.

Breastfeeding practices & diet
Weaning is the process of stopping breastfeeding. The terms “weaned”, “being weaned” or “after weaning” were used to define that a child had completely stopped breastfeeding. Complementary food is other food given in addition to continued breastfeeding.

Exposure to infection
Besides the recent history of illnesses and treatment, several indirect parameters were explored by including questions about preventative measures: bednet use, vaccination status and management of drinking water.

Data quality
The vast majority of caretakers in the SC are female. In Sierra Leone women generally find it easier to talk to someone of their own sex. Therefore it was important that the interviewer was female. Unfortunately it was difficult to find skilled personnel capable of doing IDIs, therefore the principal investigator had to do the IDIs herself, to assure thorough exploration and clarification of interesting or obscure information.

Questionnaires

Study design
A questionnaire was completed by the caretakers of all newly admitted children in the TFP during one month. It was designed based on the information found in the IDIs and covered the same themes, but this time data were quantitative (annex 6). It was piloted and adapted once, to avoid confusing or inappropriate questions and answering options. Since the majority of caretakers were illiterate the questionnaires were read to them and the answers filled by a local female nursing student who was specifically hired and trained for this purpose.

Participants
All caretaker admitted with their children in the TFP between 15-10-2009 and 13-11-2009 were asked to participate. The study period was planned towards the end of the rainy season, because a large proportion of patients was expected to suffer from kwashiorkor during that period. Caretakers

from both inpatients and outpatients were included. Since teenage pregnancies are common in Sierra Leone a considerable proportion of non-adult caretakers was expected. In order to prevent selection bias they were also eligible for inclusion. Caretakers of children below 6 months and above 60 months of age were excluded to enable comparison with the population of the patient chart study.

Variables

Basic data

In the patient charts section the admission procedure was explained. Details on age, sex, height, weight, date of admission and presence of oedema were copied from the patient chart on the questionnaire file by the interviewer. Anthropometric indices were calculated using WHO Anthro as explained before.

Adverse social circumstances

Only verbal information was collected from the caretakers. No tests or physical examinations were performed to verify if the mother was healthy or pregnant. The definition of a household was similar to the definition used during the IDIs.

Breastfeeding practices

The definitions concerning weaning and complementary food were the same as the definitions used during the IDIs.

Diet

After the example of Lin et al. (10) a list of food items was made, that was based on the results of the IDIs, combined with the following food items of particular interest:

- food frequently poisoned with aflatoxin: (dried) okra, peanuts (11, 33)
- food rich in antioxidants: citrus fruit, tomatoes, green leafy vegetables (43)
- food rich in riboflavin: milk, egg, liver, meat, chicken (31)

The caretakers were asked if the child had “ever eaten” the different food items.

Exposure to infection

None of the symptoms of illness were specifically defined, therefore whatever the caretaker considered to be diarrhoea, fits, fever etc. was accepted. Vaccination status was not specified, the caretaker was simply asked if the child had been vaccinated. Bednet use was defined as “sleeping under a bednet most nights”.

Data quality

During the pilot sessions the interviewer was observed and given feedback in order to ensure quality data. Also during the first weeks of this part of the study, the filled questionnaires were checked for completeness and correctness at the end of the day, in order to allow corrections while the caretaker questioned was still in the centre. Data were double entered in EpiData, cross checked and corrected.

Study size

The number of admissions during the study period determined the sample size. As mentioned before, the objectives of the study were exploratory and descriptive in nature and data collection was not meant to find statistically significant associations. Sample sizes were opportunistic and not based on power-calculations.

Statistical methods

The p-values given in the general information about baseline characteristics were calculated in STATA (annex 7). All other data (frequencies, confidence intervals, means, medians etc.) were calculated in EpiData Analysis. Missing data are reported in the flow diagram in the results section (figure 8). When data were missing the patient in question was left out of the analysis for that specific issue.

Results

Patient charts

Participants

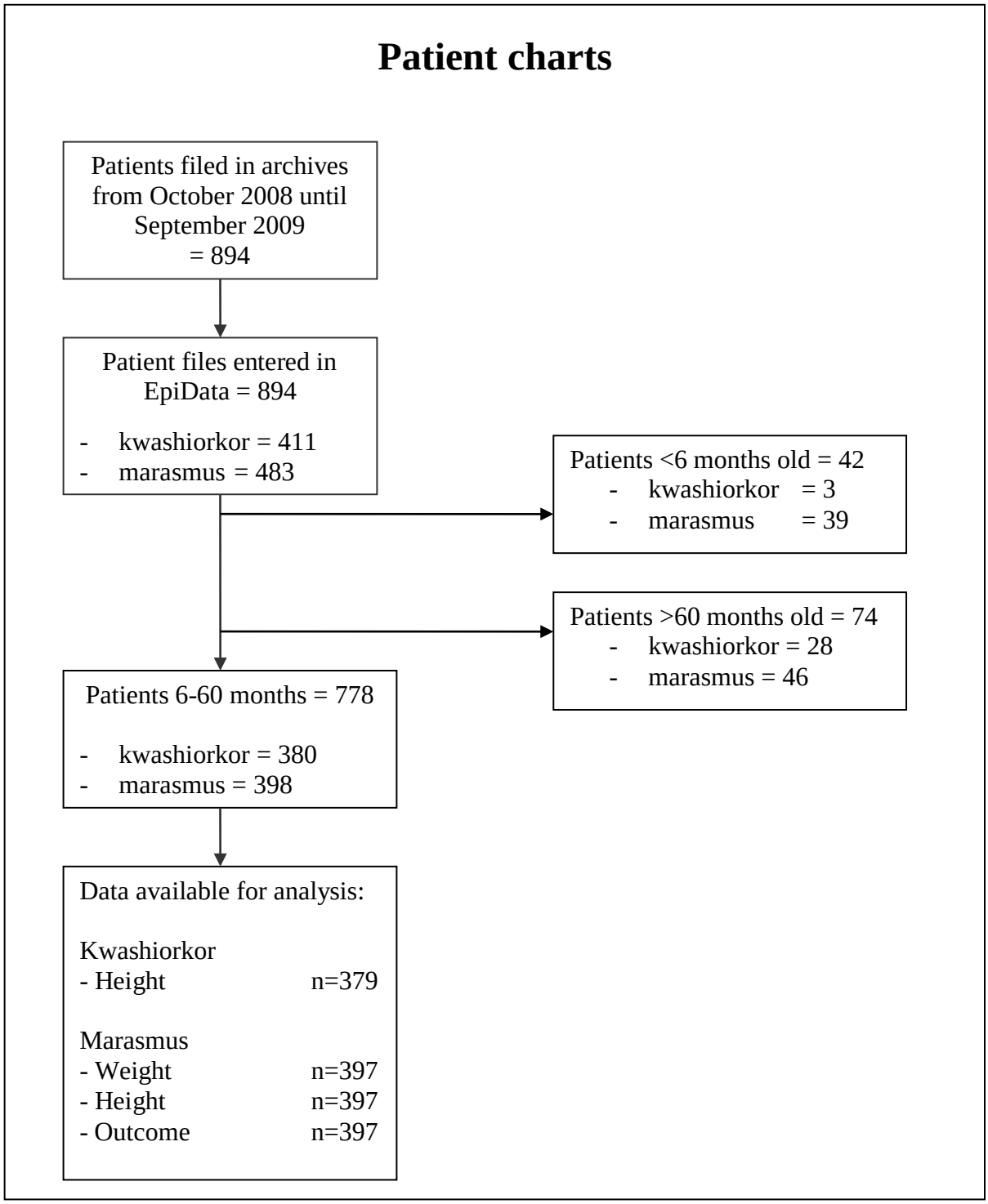

Figure 4: Flow diagram patient charts – inclusion and exclusion criteria & completeness data. Based on an example in Vandenbroucke et al. STROBE: explanation (51).

Table 5: General information – patient charts.

	Kwashiorkor (n = 380)	Marasmus (n = 398)	Total (n = 778)
Oedema:			
- **none**	-	398	398
- **+**	92	-	92
- **++**	165	-	165
- **+++**	123	-	123
Readmission cases	9	9	18

Age

The age distribution was not symmetrical. The phenomenon of "rounding up or down to a whole number (or, in this case, to a whole year)", was clearly visible with peak ages at 6, 12, 24, 36, 48 and 60 months (figures 5a and 5b).

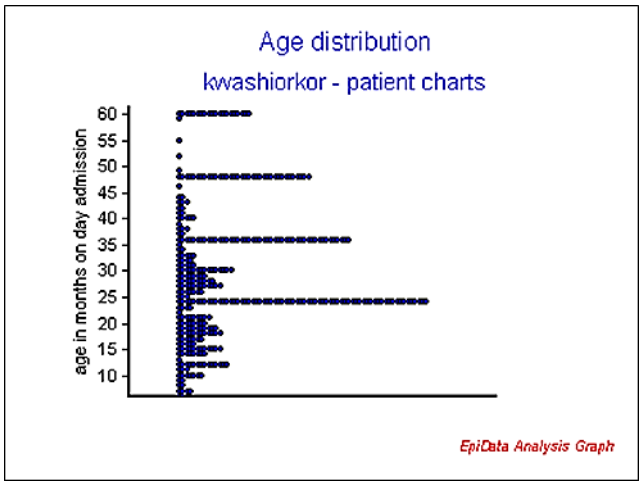

Figure 5a: Age distribution kwashiorkor.

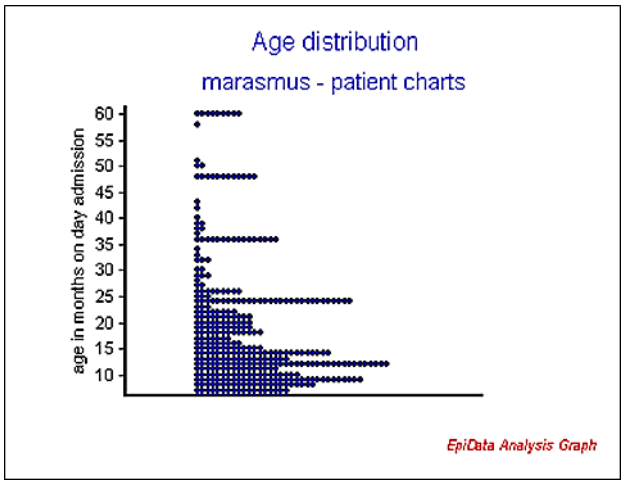

Figure 5b: Age distribution marasmus.

Therefore both median and mean ages were calculated (table 6), which were both higher in the kwashiorkor group. The difference in mean age was significant ($p < 0.00001$).

Table 6: Age distribution – patient charts.

	Kwashiorkor (n = 380)	Marasmus (n = 398)	Total (n = 778)
Mean age (months)	29.4 (28.0–30.7)	18.5 (17.3–19.7)	23.8 (22.8–24.8)
p5	11.0	7.0	7.0
Median age (months)	26.5	14.0	21.0
p95	60.0	48.0	48.0

Sex

Both conditions were equally distributed over the sexes (p = 0.092) (table 7).

Table 7: Sex distribution – patient charts.

	Kwashiorkor (n = 380)	Marasmus (n = 398)	Total (n = 778)
Male	190 (50.0%)	223 (56.0%)	413 (53.1%)
Female	190 (50.0%)	175 (44.0%)	365 (46.9%)

Height for age

There was no significant difference in mean HAZ between the two groups (p = 0.1793). Stunting (65.7%) and severe stunting (40.2%) were common in the entire research population (table 8).

Table 8: HAZ scores – patients charts.

	Kwashiorkor (n = 380)	Marasmus (n = 398)	Total (n = 778)
Height (cm)[#]:			
- **mean**	80.0 (79.0–81.1)	72.7 (71.7–73.8)	76.3 (75.5–77.1)
- **p5**	66.5	60.5	61.8
- **median**	80.0	70.9	75.3
- **p95**	98.5	93.6	96.0
Mean HAZ[#]	-2.8 (-2.9 – -2.6)	-2.6 (-2.8 – -2.4)	-2.6 (-2.8 – -2.4)
HAZ[#] < -2	259 (68.3%)	251 (63.1%)	510 (65.7%)
HAZ[#] < -3	161 (42.4%)	152 (38.2%)	313 (40.2%)

 # = n different, data missing – see figure 4

Figure 6 shows the HAZ scores of the research population. As explained in the methods section, only 764 children are included in this graph. Twelve children fell below the cut-off point of -6 and for 2 patients height data were missing, making HAZ calculation impossible.

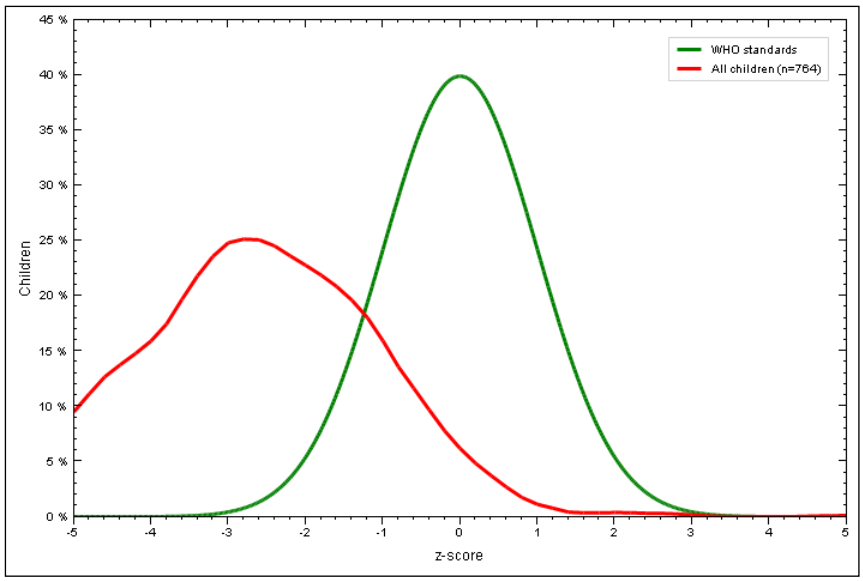

Figure 6: HAZ scores all patients – patient charts.
The programmes sets the cut-off point at -6, but the curve strangely enough starts from -5, therefore an additional 46 patients are not shown.

WHZ

The mean WHZ score on admission for the marasmus patients was -4.5 which is far below the admission criterion of < -3. In the kwashiorkor group 43.4% of the patients were also severely wasted (marasmic-kwashiorkor) and 63.9% had a WHZ score below -2, meaning that 20.5% (63.9 minus 43.4) of the kwashiorkor patients could be diagnosed moderately malnourished based on their weight (table 9). Although both groups had low WHZ scores, the marasmus group had a significantly lower mean WHZ score ($p < 0.00001$).

Table 9: WHZ scores – patient charts.

	Kwashiorkor (n = 380)	Marasmus (n = 398)	Total (n = 778)
Weight (kg)[#]:			
- **mean**	8.6 (8.4 – 8.9)	6.1 (5.9 – 6.3)	7.3 (7.2 – 7.5)
- **p5**	5.4	3.9	4.0
- **median**	8.4	5.8	6.9
- **p95**	12.9	10.0	11.9
Mean WHZ[#]	-2.6 (-2.8 – -2.4)	-4.5 (-4.7 – -4.5)	-3.6 (-3.7 – -3.5)
WHZ[#] < -2	243 (63.9%)	395 (99.2%)	638 (82.0%)
WHZ[#] < -3	165 (43.4%)	391 (98.2%)	556 (71.5%)

 # = n different, data missing – see figure 4

Kwashiorkor

Figure 7a shows the WHZ scores of the kwashiorkor group. Again 22 patients fall below the cut-off point. Furthermore weight-data were missing for one patient and another patient was over 120 cm in height, which is outside the range of the WHO standards.

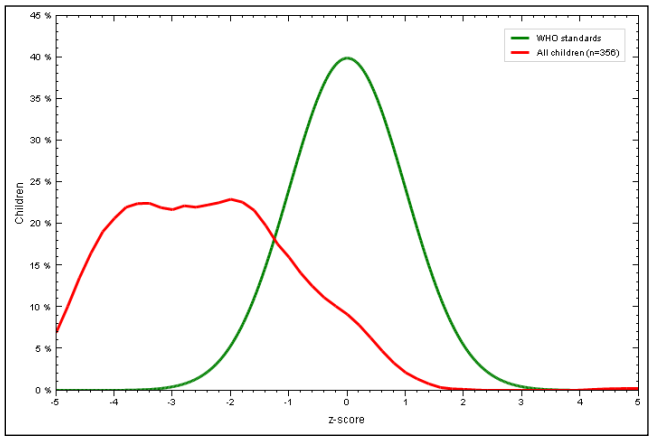

Figure 7a: WHZ scores kwashiorkor – patient charts.

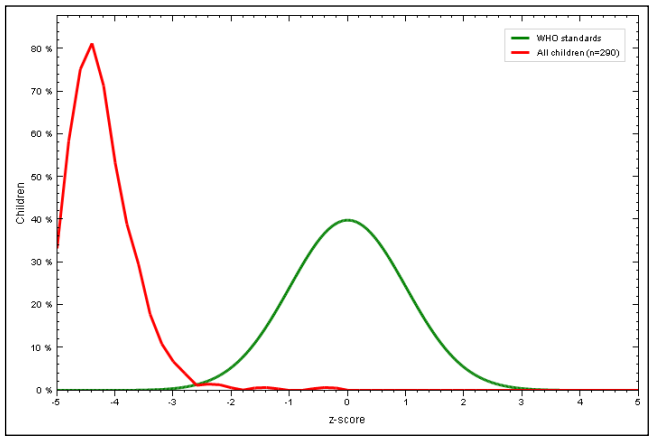

Fig. 7b: WHZ scores marasmus – patient charts.

Marasmus

Sierra Leone hasn't started using the 2006 WHO standards yet, therefore the curve (figure 7b), doesn't have a steep cut-off point at -3. It doesn't show 107 children with a score below -5.

Season of admission

The suspicion of a seasonal trend in the proportion of admissions with kwashiorkor, was confirmed by the patient chart research (table 10). Both conditions were more common in the rainy season than in the dry season, but admissions for kwashiorkor were significantly more rare in the late dry season and significantly more common in the late rainy season compared to admissions for marasmus.

Table 10: Season of admission – patient charts.

	Kwashiorkor (n = 380)	Marasmus (n = 398)	Total (n = 778)	p-value
Early rainy season	134	134	268	0.640
* **Late rainy season**	131	96	227	0.001
Early dry season	62	69	131	0.704
* **Late dry season**	53	99	152	<0.0001

** = statistical significant difference p<0.05*

Outcome

The prognosis of kwashiorkor patients was not worse than that of marasmus patients (table 11). The death rate was equal in both groups. The cure rate was higher in the kwashiorkor group (p = 0.009), but marasmic children were more often discharged to complete their treatment in the OTP. These cases should also be considered as having a successful outcome, since stabilised patients normally get cured without further problems in the OTP. When the OTP cases were added to the cured cases, the difference in "successful outcomes" between the kwashiorkor (292 = 77.0%) and the marasmus group (283 =71.8%) was no longer significant (p = 0.069). Marasmus children were almost twice as likely to default (10.8% vs. 18.3%, p = 0.003).

Table 11: Treatment outcome – patient charts.

	Kwashiorkor (n = 379)	Marasmus (n = 394)	Total (n = 773)	p - value
* **Cured**	261 (68.9%)	236 (59.9%)	497 (64.3%)	0.009
Dead	46 (12.1%)	39 (9.9%)	85 (6.5%)	0.320
* **Default**	41 (10.8%)	72 (18.3%)	113 (14.6%)	0.003
OTP	31 (8.2%)	47 (11.9%)	78 (10.1%)	0.084

** = statistical significant difference p<0.05*

IDIs

Participants

During the interviews it appeared the answers of the caretakers were quite similar, in spite of their different backgrounds. After 16 interviews it was decided that a saturation of the data was reached. The selected participants are presented in table 12 and their baseline characteristics in table 13.

Table 12: Result maximum variation sampling – IDIs.

Category	Kwashiorkor	Marasmus
Bombali rural inexperienced		
Bombali rural experienced	2	1
Tonkolili rural inexperienced		1
Tonkolili rural experienced	1	1
Port Loko rural inexperienced	1	1
Port Loko rural experienced	1	
Makeni urban inexperienced		1
Makeni urban experienced	1	1
Minority cases:		
- **child old/young**		
- **living very far**	1 (also child old)	1 (also minority tribe)
- **grandmother caretaker**	1 (also live far)	1 (also teenager)

Table 13: Baseline characteristics participants – IDIs.

Case	Oedema	Age (months)	Sex	Height (cm)	Weight (kg)	HAZ@	WHZ@	Readmission
K1	+	8	male	68.0	5.3	-1.8	-5.0	no
K2	+	15	female	74.0	5.6	-1.6	-5.2	no
K3	+	24	female	82.5	7.5	-1.2	-4.1	no
K4	++	24	male	77.0	6.8	-3.5	-4.6	no
K5	+	27	female	80.0	8.1	-2.9	-2.6	no
K6	+++	34	female	77.0	8.3	-4.7	-1.6	no
K7	++	36	female	79.5	6.0	-4.2	-5.6	no
K8	++	36	female	84.0	8.6	-3.1	-2.9	no
M1	-	8	female	67.3	5.3	-1.2	-4.1	no
M2	-	14	male	76.5	6.2	-0.6	-5.4	no
M3	-	15	male	71.0	6.0	-3.5	-4.5	no
M4	-	27	female	88.0	8.1	-0.5	-4.5	no
M5	-	48	female	81.8	7.5	-5.0	-3.9	no
M6	-	60	male	84.0	8.0	-5.7	-4.3	no
M7	-	72	male	115.3	14.0	Too old	Too old	no
M8&	-	168	female	-	-	Too old	Too old	no

& = Post-operative case (typhoid fever) staying in hospital. Anthropometry not recorded.
@ = Calculated with WHO Anthro v3.0.1. – anthropometric calculator. Due to a software error it was impossible to enter ages of 14, 24 and 60 month. Therefore 13, 23 and 59 months were entered instead, resulting in overestimation HAZ for those ages.

Social circumstances

Mother not main caretaker

In several cases the grandmother was the main caretaker. In the kwashiorkor group a 15 months old girl lived had stopped breastfeeding 3 months ago because the "*breast of the mother got dry*" due to a severe illness. At that time the child was brought to the grandmother. The grandmother thought the illness of the mother had transferred trough the breast milk, making the child malnourished. Another 8 month old kwashiorkor patient stayed with his grandmother, since his mother died of a severe skin infection, when he was 3 months of age. According to the grandmother the "*father doesn't care about the child and doesn't support it*". She fed him Bennimix, a traditional weaning food containing among others sesame seeds (benniseed), supplied to her by a missionary clinic. The child had not been in a good condition since the death of the mother. The grandmother believed this was caused by the fact that the child didn't receive breast milk anymore. In the marasmus group one girl had been "given" to her grandmother from mother's side after weaning at the age of 2, because the grandmother had requested this. This is a common practice in Sierra Leone. The mother of the girl lived less than a mile away. When her child became ill, she visited more frequently and tried to support the grandmother with rice, bananas and Oral Rehydration Solution (ORS). The mother said the grandmother "*works very hard to provide the child with food*", but thought the child became ill because the grandmother "*doesn't give proper care, like hand washing before eating and letting her play in the water and the mud*". Regardless of this suspicion she said she would give the girl back to the grandmother after regaining her health, because the grandmother requested this and it would be very difficult to refuse.

Single teenage mother

In both groups one single teenage mother was interviewed. Their main problem was the lack of support from the fathers of their children and the absence of an own income. They lived with their parents and were dependent of them. One of them stated there was "*no food for the baby and no money to go to the hospital*". At 8 months of age this child had never received any complementary food yet, only breast milk and hot water.

Mother abandoned by father

An older mother in the kwashiorkor group explained that her husband had disappeared 2 years ago. She now lived together with the families of her brother and sisters. She had to farm her own piece of land and provide the food for her children herself. She stated that "*the whole family has difficulties*", but explained that it was easier for her brother because "*he has two wives and many children, who help him with the farming*". She thought the malnutrition was caused by diarrhoea, that started because the child picked things from the ground and put them in his mouth. She said that she prevented this behaviour when she saw it, but she had to leave her children at home when she was farming and at those moments "*nobody takes care*".

Household composition

Most interviewed caretakers lived in big households, with several generations and families under one roof. Sharing a husband with another wife was very common and often extra children were staying in the family. These children were sometimes, but not always, orphans. The presence of a second wife was sometimes considered an advantage. According to one caretaker she and her "mate" did

business together and took care of the family, while their husband "*doesn't do anything, no job, no farming, nothing*".

Household livelihood

The most common livelihood was farming and people possessed very little ready money. Regular jobs, contract work or petty trading were rare. Usually families had to sell part of their crops to have any cash money. Also crops were traded for other types of food. All farmers indicated that their rice crop would never last until the next harvest, making it necessary to eat inferior alternatives, like foufou (porridge of fermented cassava root) during the rainy season. One mother explained that "*if we have good crops, we will sell some and buy some amount of rice for the rainy season*". The only exceptions in terms of livelihood were urban people, who didn't farm, but either had a job, or traded goods.

Breastfeeding practices

All mothers in both groups were giving breast milk or had given breast milk until the child was about 2 years of age. The only young children not receiving breast milk were the two whose mothers were dead or ill. Cultural believes seemed to dictate that a woman should not have any sexual contact while breastfeeding. One woman said she believed the child would fall sick if she would allow her husband to have intercourse with her, while she was breastfeeding. Other women said they had weaned the child, because they wanted to become pregnant again or because their husband requested it, in order to be able to have intercourse again. Furthermore one mother said that she had weaned the child at the age of 2, because it was ill very frequently and other people told her, this was caused by the breastfeeding.

Diet

Staple food and meal frequency

Rice was the preferred staple food for all caretakers. Almost every caretaker mentioned the rainy season as a difficult time in which many food items were not available or expensive and money was scarce. This resulted in a different menu, with foufou replacing rice and frugal side dishes. The normal meal frequency was twice a day, but several caretakers said this would be reduced to one meal a day, if they didn't have enough money or supplies left. One caretaker said they sometimes went a whole day without food.

Specific ingredients – side dishes

The rice was usually eaten with a sauce of palm oil and green leafy vegetables or a soup containing salt, stock cubes, pepper, tomatoes and peanut paste. The soup and sauce would also contain fish, beans or meat if any of these were available. Foufou was usually not eaten with the vegetable sauce (apparently not a palatable combination), but only with the soup. Most people didn't have enough money to buy meat, but some families had access, by hunting for it with traps. Fish was eaten more commonly, and either caught or bought. Eggs were eaten only occasionally by some and none of the caretakers ever consumed milk.

Accessibility of food items – seasonal constraints

The accessibility of fish varied. Some caretakers indicated it was more difficult to get in the rainy season, due to lack of money or high rivers, but for others it was more difficult in the dry season due to dry rivers. Palm oil was accessible throughout the year for most caretakers, but for caretakers that

didn't produce it themselves it became too expensive in the rainy season. According to all caretakers fruits were available in large amounts in the dry season, but were unripe in the rainy season. Most caretakers could access green leafy vegetables throughout the year, but some had constraints in the dry season, because of a lack of water for the plants to grow, while others had problems in the rainy season, because of lack of money to buy them. Both beans and groundnuts were easiest available at the end of the rainy season, after the harvest.

Urban living people

For urban living people the situation was quite different. One young single mother said the dry season was the most difficult time, because her father, who was a carpenter, had less work in that time of the year. She said they sometimes ate only plain rice with a little pepper in that season. Another urban mother, that supported her family by petty trading, said the rainy season was the most difficult time, due to high food prices on the market. All the money she made during that season was used to buy food and then she still had to reduce the size of the portions and leave out expensive ingredients, like fish, palm oil, rice and groundnuts.

Children's (complementary) diet

Most caretakers indicated that the children joined the family meals. They would usually eat the same food, but some caretakers said they would withhold certain food items, for health reasons. Foufou was said to cause dysentery or oedema. One mother withheld eggs and chicken, because they would cause convulsions. Another mother said fish and meat would give the child worms. One grandmother said banana would make the child eat its own stools. Only a few caretakers prepared special food for young children, usually a mix of rice, green leaves, palm oil, fish, stock cubes and groundnuts or beans, pounded and cooked to make a fine porridge. One grandmother tried to feed the child porridge of cassava root, yam and plenty of palm oil every day. When asked what food items were specifically healthy for young children, most caretakers mentioned rice, green leaves, palm oil, groundnuts, beans, fish and beef. Only one mother mentioned eggs. Two caretakers mentioned fruit and one of them was convinced it had to be eaten early in the morning to be good. One grandmother said boiled banana with palm oil was healthy. Custard pap, Bennimix and formula milk were mentioned by a few caretakers, but they couldn't afford these products.

Exposure to infection

Recent episodes of illness

All caretakers reported an episode of illness around the start of the malnutrition. The most frequently reported symptoms were diarrhoea, vomiting, fever, distended abdomen, cough, anaemia and skin problems.

Recent treatment history

Most caretakers preferred to go to a clinic or hospital with an ill child, but for some this was very difficult due to the costs of treatment and transport, especially in the rainy season. Therefore they would first try native herbal treatment and/or drugs they could buy from a peddler in the village. Another reason for caretakers to try native treatment was if the drugs provided by the clinic or hospital were ineffective. There were no differences between the caretakers of kwashiorkor patients and marasmus patients.

Preventative measures

When asked how to prevent illness in their children, most caretakers only mentioned hygienic measures, like hand washing. Also "*giving good medicines*" was mentioned several times. It seemed the whole concept of prevention of illness was not very well established in their minds. However when asked specifically about vaccination all children were found to be vaccinated. One mother confessed she had taken the child only twice, because the distance to the clinic was too far and the transport too expensive. When asked about bednets only 3 caretakers, all of marasmus patients, said they didn't have one. The bednets were used with variable correctness. Some said they used them every night in spite of the heat, but others said the lifted them up during hot nights, "*but not if the mosquitoes are many*". Two mothers of kwashiorkor children said that good nutrition would prevent illness, but they could only afford this in the dry season. One mother kept her child inside the house or on her back during the rainy season to prevent it from "*catching cold*".

Drinking water source

In the kwashiorkor group 7 out of 8 caretakers said their drinking water came straight from a river or stream. In the marasmus group only 3 out of 8 got their water from a river or stream. The rest used either communal bucket wells, handpump wells or a communal tap. Nobody had a private water source. None of the caretakers ever treated the water by boiling or chlorinating it. Several caretakers reported that the well they used was chlorinated every now and then by volunteers. Two of them reported they were advised by the volunteers that the water was not fit for drinking just after chlorination. Therefore they would use river water instead in the period just after chlorination. Even a relatively wealthy educated mother that could read and write wasn't aware about the possible contamination of water from a communal well. Both her daughter and husband had developed typhoid fever with a bowel perforation requiring surgical repair, resulted in malnutrition in her daughter. When this mother was asked about the cause of the illness, she never thought about the water, but said that "*maybe the food was not good?*".

Caretaker's perception

Most caretakers thought the malnutrition was a result of a prolonged period of illness and the lack of good medicines. One mother thought the ORS given to her child for diarrhoea caused the oedema. Another mother blamed the salt in the food. Also food problems in the rainy season and absence of clean drinking water were mentioned. Two breastfeeding mothers blamed their breast milk. One thought her milk was not nutritious enough, because she didn't eat enough proper food, the other one thought that the drugs she took against onchocerciasis, had passed into the milk, causing diarrhoea in the child. But most caretakers were unsure and resigned about why this had happened to their child. They would say "*Pass god no more*", a commonly used phrase in Sierra Leone that means "Only God knows" in the Krio language.

Questionnaires

Participants

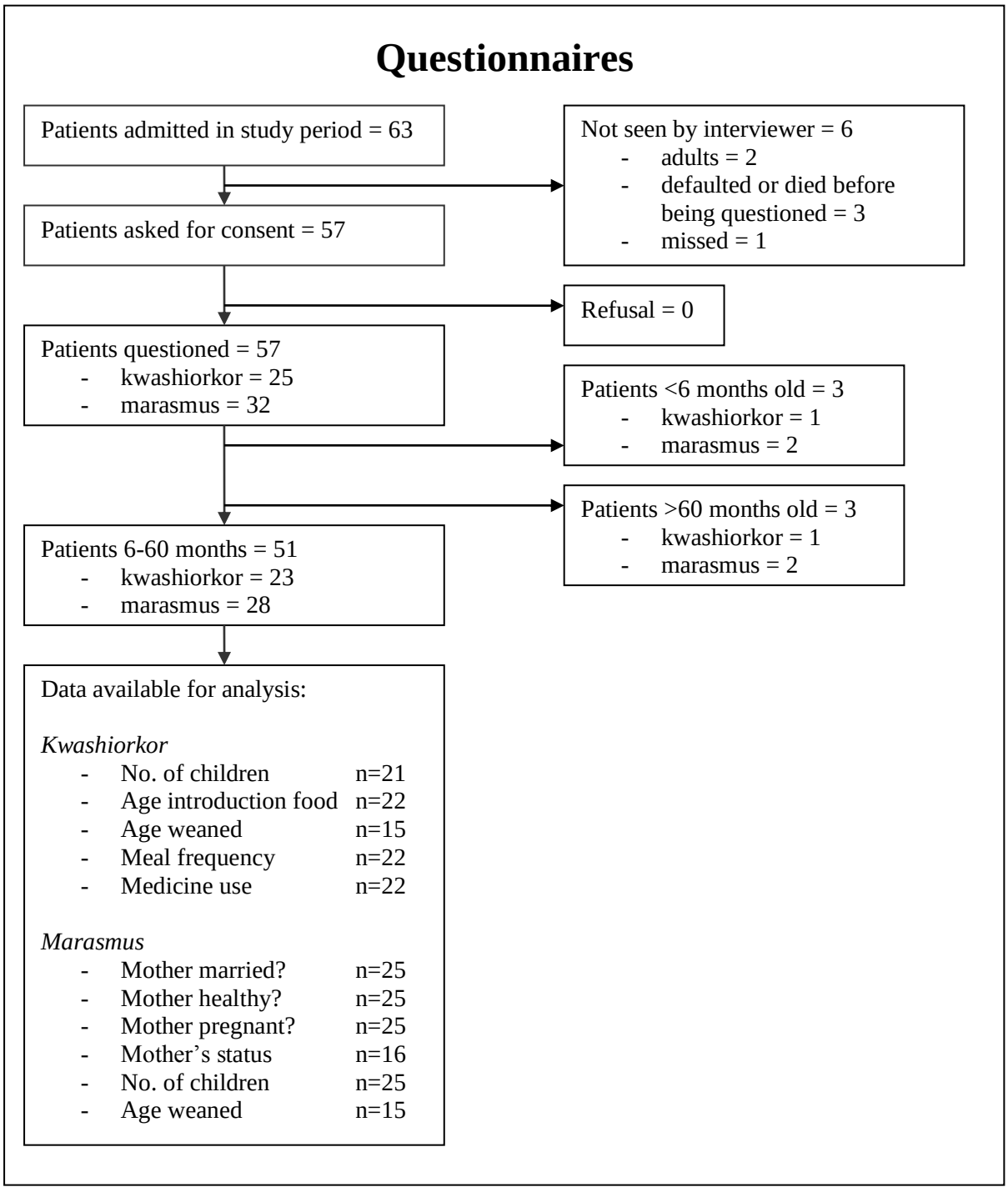

Figure 8: Flow diagram questionnaires – inclusion and exclusion criteria & completeness data. Based on an example in: Vandenbroucke et al. STROBE: explanation (51).

Baseline characteristics

The baseline characteristics of the patients in the questionnaire study (table 14) were comparable to those found in the patient charts study. (For comparison see the main results in table 15.) Mean age and mean WHZ were again significantly different between the groups, despite the small sample size.

Table 14: Baseline characteristics – questionnaires.

	Kwashiorkor (n = 23)	Marasmus (n = 28)	Total (n = 51)	p-value
Oedema:				
- **none**	-	28	28	
- **+**	4	-	4	
- **++**	10	-	10	
- **+++**	9	-	9	
* **Mean age (months)**	25.8 (21.5 – 30.1)	18.4 (13.9 – 22.9)	21.7 (18.5 – 25.0)	0.0202
Age distribution:				
- **p5**	7.8	6.5	7.0	
- **median**	25.0	15.0	20.0	
- **p95**	47.0	49.2	45.0	
Sex:				
- **male**	9	14	23	
- **female**	14	14	28	0.6026
Mean height (cm)	79.7 (76.9 – 82.4)	72.1 (68.4 – 75.9)	75.5 (73.0 – 78.1)	
Mean weight (kg)	8.4 (7.6 – 9.2)	6.1 (5.4 – 6.8)	7.1 (6.5 – 7.7)	
Mean HAZ	-2.2 (-2.8 – -1.7)	-2.9 (-3.6 – -2.1)	-2.6 (-3.1 – -2.1)	0.1757
* **Mean WHZ#**	-2.6 (-3.3 – -2.0)	-4.4 (-4.8 – -3.9)	-3.6 (-4.0 – -3.1)	<0.00001
Readmission cases	0	1	1	

** = statistical significant difference p<0.05*

 # = n different, marasmus group 27: programme gives no value to 1 patient due to low score. (When information about age is withheld, programme gives value -5.5.)

Table 15: Summary main findings – patient charts.

	Kwashiorkor	Marasmus	Total	p-value
* **Mean age (months)**	29.4 (28.0–30.7)	18.5 (17.3–19.7)	23.8 (22.8–24.8)	<0.00001
Age distribution:				
- **p5**	11.0	7.0	7.0	
- **median**	26.5	14.0	21.0	
- **p95**	60.0	48.0	48.0	
Sex:				
- **male**	190	223	413	
- **female**	190	175	365	0.092
Mean height (cm)	80.0 (79.0 – 81.1)	72.7 (71.7 – 73.8)	76.3 (75.5 – 77.1)	
Mean weight (kg)	8.6 (8.4 – 8.9)	6.1 (5.9 – 6.3)	7.3 (7.2 – 7.5)	
Mean HAZ	-2.8 (-2.9 – -2.6)	-2.6 (-2.8 – -2.4)	-2.6 (-2.8 – -2.4)	0.1793
* **Mean WHZ**	-2.6 (-2.8 – -2.4)	-4.5 (-4.7 – -4.5)	-3.6 (-3.7 – -3.5)	<0.00001

** = statistical significant difference p<0.05*

Social circumstances

Parents and caretakers

Differences between the two groups were small (table 16), but there were a few interesting findings. There were no pregnant mothers in the marasmus group, but 4 (18%) in the kwashiorkor group. Both groups had similar numbers of mothers breastfeeding a younger child, but these children were not always siblings, since only 3 patients had younger siblings (table 17). The marasmus group seemed to have a higher proportion of unmarried mothers (36.0% vs. 4.5%) and of mothers that were not staying with the father of the malnourished child (34.6% vs. 13.6%). The mean age of the unmarried women was 29 years and the median age 30 years. The mean age of the "mothers not staying with father" was 28 years and the median age 23 years, so the single mothers weren't necessarily very young.

Table 16: Social circumstances = parents/caretakers – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n=28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Main caretaker:						
- **mother**	16	69.6	*(49.1 – 84.4)*	21	75.0	*(56.6 – 87.3)*
- **grandmother**	6	26.1	*(12.5 – 46.5)*	4	14.3	*(5.7 – 31.5)*
- **aunt**	1	4.3	*(0.8 – 21.0)*	3	10.7	*(3.7 – 27.2)*
Mother alive	22	95.7	*(79.0 – 99.2)*	26	92.9	*(77.4 – 98.0)*
Mother healthy[@#]	20	90.9	*(72.2 – 97.5)*	23	92.0	*(75.0 – 97.8)*
Mother pregnant*[@#]	4	18.2	*(7.3 – 38.5)*	-	-	-
Mother breastfeeding:						
- **younger child**[@]	3	13.6	*(4.7 – 33.3)*	4	15.4	*(6.1 – 33.5)*
- ***a younger sibling***	*2*			*1*		
Mother married*[@#]	21	95.5	*(78.2 – 99.2)*	16	64.0	*(44.5 – 79.8)*
Father alive	23	100	*(85.7 – 100)*	26	92.9	*(77.4 – 98.0)*
Mother staying with father*[@]	19	86.4	*(66.7 – 95.3)*	17	65.4	*(46.2 – 80.6)*
Status mother[&#]**:**						
- **only wife**	9	47.4	*(27.3 – 68.3)*	9	56.3	*(33.2 – 76.9)*
- **first wife**	4	21.1	*(8.5 – 43.3)*	1	6.3	*(1.1 – 28.3)*
- **2nd wife**	5	26.3	*(11.8 – 48.8)*	4	25.0	*(10.2 – 49.5)*
- **3rd wife**	1	5.3	*(0.9 – 24.6)*	2	12.5	*(3.5 – 36.0)*
Age caretaker (years):						
- **mean**	29.2		*(24.3 – 34.2)*	26.4		*(22.7 – 30.1)*
- **p5**	17.2			12.7		
- **median**	25.0			24.0		
- **p95**	62.0			48.7		

** = factor that may be relevant?*
@ = question only answered when mother was alive
 # = n different, data missing – see figure 8
& = question only answered when mother was staying with father of child

Household composition

Child mortality was high in all the families, regardless whether their child was admitted with kwashiorkor or marasmus. Over 40% of the families (21 out of 51) already lost one or more children (table 17). Also all 4 twin siblings of the admitted twin children had died (data not shown here). Having younger siblings was very uncommon in both groups, but being of a high birth order (3rd or higher living child) was very common and seemed to be more frequent in the kwashiorkor group. Twins seemed to be more common in the marasmus group.

Table 17: Social circumstances = siblings – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n=28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Being one of a twin*	1	4.3	*(0.8 – 21.0)*	3	10.7	*(3.7 – 27.2)*
Having siblings that died	9	39.1	*(22.2 – 59.2)*	12	42.9	*(26.5 – 60.9)*
Having younger sibling(s)	2	8.7	*(2.4 – 26.8)*	1	3.6	*(0.6 – 17.7)*
Being ≥ 3rd living child*	12	52.2	*(33.0 – 70.8)*	9	32.1	*(17.9 – 50.7)*
Number of living siblings:						
- **mean**	2.0		*(1.3 – 2.6)*	1.2		*(0.7 – 1.7)*
- **p5**	0.0			0.0		
- **median**	2.0			1.0		
- **p95**	4.8			4.0		

** = factor that may be relevant?*

Household livelihood

In the marasmus group there seemed to be relatively less farmers and more traders (table 18). The fact that none of the caretakers reported to use their crops for sale/exchange is strange, since several people during the IDIs mentioned this as something they would do. It seems this option has somehow been misunderstood by the subjects during the questionnaires.

Table 18: Social circumstances = livelihood – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n=28)		
	N	*%*	(95% CI)	*N*	*%*	(95% CI)
Farming for own consumption*	15	65.2	(44.9 – 81.2)	12	42.9	(26.5 – 60.9)
Farming for sale/exchange	0	-	-	0	-	-
Trading of goods/food*	9	39.1	(22.2 – 59.2)	16	57.1	(39.1 – 73.5)
Someone has regular job	6	26.1	(12.5 – 46.5)	4	14.3	(5.7 – 31.5)
Irregular/contract work	3	13.0	(4.5 – 32.1)	3	10.7	(3.7 – 27.2)
Support from outside (relatives)	6	26.1	(12.5 – 46.5)	2	7.1	(2.0 – 22.6)
Other$	1	4.3	(0.8 – 21.0)	1	3.6	(0.6 – 17.7)

** = factor that may be relevant?*

$ = kwashiorkor - aunt traditional healer, marasmus - family member chairman of the town

Summary social circumstances

Table 19 gives an overview of the social circumstances for which a difference between the kwashiorkor and marasmus group was suspected.

Table 19: Social circumstances = main findings – questionnaires.

	Kwashiorkor		Marasmus	
	%	*(95% CI)*	*%*	*(95% CI)*
Mother pregnant	18.2%	*(7.3 – 38.5)*	-	
Mother unmarried	4.5%	*(0.8 – 21.8)*	36%	*(20.2 – 55.5)*
Mother not staying with father	13.6%	*(4.7 – 33.3)*	34.6%	*(19.4 – 53.8)*
Father dead	-		7%	*(2.0 – 22.6)*
Household not farming	34.8%	*(18.8 – 55.1)*	57.1%	*(39.1 – 73.5)*
Child one of a twin	4.3%	*(0.8 – 21.0)*	10.7%	*(3.7 – 27.2)*
High birth order (≥3)	52.2%	*(33.0 – 70.8)*	32.1%	*(17.9 – 50.7)*

Breastfeeding practices

Table 20: Breastfeeding practices – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n = 28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Breastfeeding	6	26.1	*(12.5 – 46.5)*	11	39.3	*(23.6 – 57.6)*
Eating (complementary) food	23	100	*(85.7 – 100)*	23	100	*(87.9 – 100)*
Age introduction food*:						
- **mean**	6.1		*(5.4 – 6.9)*	7.8		*(5.8 – 9.8)*
- **p5**	2.0			1.5		
- **median**	6.0			5.3		
- **p95**	9.0			22.2		
Introduction <6 months?#	2	8.7	*(2.4 – 26.8)*	7	25.0	*(12.7 – 43.4)*
Age of being weaned*#:						
- **mean**	21.4		*(18.7 – 24.1)*	12.0		*(7.4 – 16.6)*
- **p5**	13.0			0.0		
- **median**	21.0			14.0		
- **p95**	29.0			22.0		
Being weaned before:						
- **6 months**	2	11.1	*(3.1 – 32.8)*	7	41.2	*(21.6 – 64.0)*
- **12 months**	2	11.1	*(3.1 – 32.8)*	9	52.9	*(31.0 – 73.8)*
- **24 months**	11	61.1	*(38.6 – 79.7)*	16	94.1	*(73.0 – 99.0)*
Weaned – no. of months ago:						
- **mean**	6.8		*(3.5 – 10.1)*	8.3		*(2.8 – 13.9)*
- **p5**	2.0			1.0		
- **median**	5.0			4.0		
- **p95**	15.0			27.0		

** = factor that may be relevant?*

 # = n different, data missing – see figure 8

There seemed to be more children still breastfeeding in the marasmus group. In the kwashiorkor group >90% received no complementary food before the age of 6 months and almost 90% continued breastfeeding at least until 12 months of age. There were also no cases of very late introduction of complementary food. In the marasmus group on the other hand, a quarter of the children was eating complementary food before the age of 6 months and more than half of them were being weaned before the age of 12 months. Furthermore some children were given complementary food extremely late (table 20). A relatively large group (kwashiorkor 26%, marasmus 39%) became malnourished while still breastfeeding. For the weaned patients the median number of months between being weaned and admission in the TFP was 5 months in the kwashiorkor group and 4 months in the marasmus group. The mean values were higher, but the distribution was not equal (figure 9).

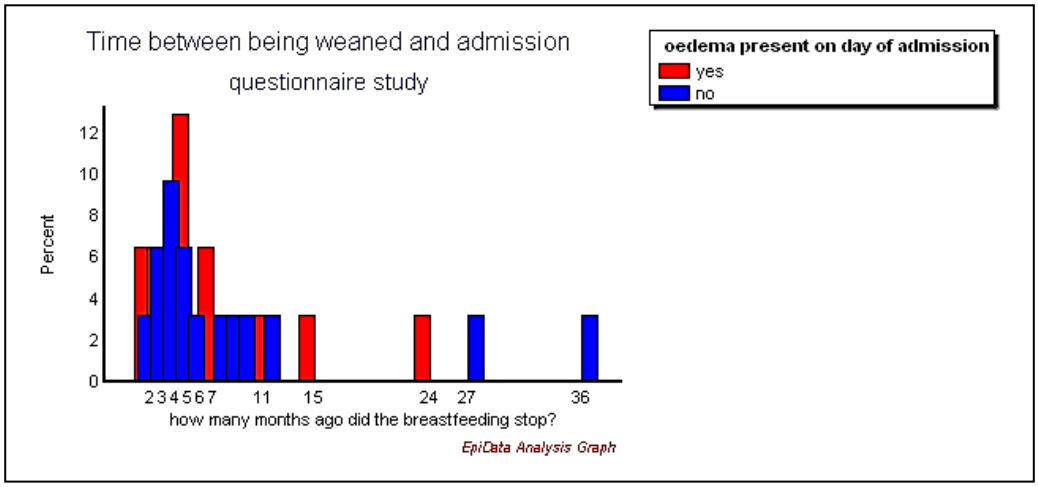

Figure 9: Number of months between being weaned and admission – questionnaires.

The reasons for weaning were varied as can be seen in table 21.

Table 21: Reasons for weaning – questionnaires.

	Kwashiorkor (n = 17)			Marasmus (n = 17)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Child old enough	1	5.6	*(1.0 – 25.8)*	1	5.9	*(1.0 – 27.0)*
Child ill	2	11.1	*(3.1 – 32.8)*	4	23.5	*(9.6 – 47.3)*
Child refusing the breast	1	5.6	*(1.0 – 25.8)*	-	-	-
Mother dead	-	-	-	1	5.9	*(1.0 – 27.0)*
Mother ill	2	11.1	*(3.1 – 32.8)*	1	5.9	*(1.0 – 27.0)*
Mother has breast problems	1	5.6	*(1.0 – 25.8)*	1	5.9	*(1.0 – 27.0)*
Mother going back to school	-	-	-	2	11.8	*(3.3 – 34.3)*
Request father/husband	5	27.8	*(12.5 – 50.9)*	2	11.8	*(3.3 – 34.3)*
Pressure from other people	-	-	-	1	5.9	*(1.0 – 27.0)*
No specific reason	5	27.8	*(12.5 – 50.9)*	2	11.8	*(3.3 – 34.3)*
Unknown	-	-	-	2	11.8	*(3.3 – 34.3)*

Diet

Staple food and meal frequency family

In both groups several families reduced their meal frequency and/or switched from rice to cassava as their staple food during the rainy season. It seemed more common for the families of marasmus patients to eat only one meal a day in the dry season. In the rainy season half the families in both groups ate only once a day (table 22).

Table 22: Diet = staple food and meal frequency – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n=28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Staple food in dry season:						
- **white rice**	6	26.1	*(12.5 – 46.5)*	11	39.3	*(23.6 – 57.6)*
- **local rice[&]**	17	73.9	*(53.5 – 87.5)*	17	60.7	*(42.4 – 76.4)*
Staple food in rainy season:						
- **white rice**	15	65.2	*(44.9 – 81.2)*	22	78.6	*(60.5 – 89.8)*
- **local rice[&]**	1	4.3	*(0.8 – 21.0)*	2	7.1	*(2.0 – 22.6)*
- **cassava**	7	30.4	*(15.6 – 50.9)*	4	14.3	*(5.7 – 31.5)*
Meals/day family – dry*:						
- **one**	8	34.8	*(18.8 – 55.1)*	14	50.0	*(32.6 – 67.4)*
- **two**	15	65.2	*(44.9 – 81.2)*	13	46.4	*(29.5 – 64.2)*
- **three**	-	-	-	1	3.6	*(0.6 – 17.7)*
Meals/day family – rainy:						
- **one**	12	52.2	*(33.0 – 70.8)*	16	57.1	*(39.1 – 73.5)*
- **two**	11	47.8	*(29.2 – 67.0)*	11	39.3	*(23.6 – 57.6)*
- **three**	-	-	-	1	3.6	*(0.6 – 17.7)*

** = factor that may be relevant?*
& = unpolished

Children's (complementary) diet

The differences between the two groups were not very big. Consumption of animal-source food was low in both patient groups. Especially if taken into consideration that the question was phrased: "Does the child ever eat…", without any specification about how often. The only animal-source food eaten commonly was fish, which was eaten by about 75% of patients. About half the children did receive milk to some extent, more often in the marasmus group. Other animal-source food was given more often in the kwashiorkor group. Green leafy vegetables and bananas were eaten frequently, especially in the kwashiorkor group. Consumption of tomatoes and citrus fruit was less common. Dried okra was very rarely eaten, but peanuts were eaten quite commonly (table 23).

Table 23: Diet = specific ingredients children's diet – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n=28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Meals/day child[#]:						
- **one**	3	13.0	*(4.5 – 32.1)*	1	3.6	*(0.6 – 17.7)*
- **two**	16	69.6	*(49.1 – 84.4)*	18	64.3	*(45.8 – 79.3)*
- **three**	3	13.0	*(4.5 – 32.1)*	7	25.0	*(12.7 – 43.4)*
- **four**	-	-	-	1	3.6	*(0.6 – 17.7)*
- **five**	-	-	-	1	3.6	*(0.6 – 17.7)*
Patient (ever) consumes:						
- **milk[@]**	9	39.1	*(22.2 – 59.2)*	15	53.6	*(35.8 – 70.5)*
- **egg**	9	39.1	*(22.2 – 59.2)*	8	28.6	*(15.3 – 47.1)*
- **chicken**	4	17.4	*(7.0 – 37.1)*	2	7.1	*(2.0 – 22.6)*
- **meat**	7	30.4	*(15.6 – 50.9)*	5	17.9	*(7.9 – 35.6)*
- **fish**	19	82.6	*(62.9 – 93.0)*	19	67.9	*(49.3 – 82.1)*
- **liver**	1	4.3	*(0.8 – 21.0)*	-	-	-
- **tomato**	5	21.7	*(9.7 – 41.9)*	3	10.7	*(3.7 – 27.2)*
- **green leafy vegetables**	21	91.3	*(73.2 – 97.6)*	18	64.3	*(45.8 – 79.3)*
- **banana**	17	73.9	*(53.5 – 87.5)*	18	64.3	*(45.8 – 79.3)*
- **citrus fruit**	11	47.8	*(29.2 – 67.0)*	16	57.1	*(39.1 – 73.5)*
- **palm oil**	20	87.0	*(67.9 – 95.5)*	22	78.6	*(60.5 – 89.8)*
- **peanut (groundnut)**	16	69.6	*(49.1 – 84.4)*	19	67.9	*(49.3 – 82.1)*
- **okra**	1	4.3	*(0.8 – 21.0)*	-	-	-
- **pulses (beans)**	9	39.1	*(22.2 – 59.2)*	7	25.0	*(12.7 – 43.4)*

 # = n different, data missing – see figure 8
@ = excluding breast milk

Table 24 gives an impression of the low quality/low diversity diets some of the studied children were subjected to. Several of them had never eaten any animal-source food item, nor had they eaten any protein-rich vegetable alternative, like peanuts or beans.

Table 24: Diet = impression of diversity – questionnaires.

	Kwashiorkor		Marasmus		Total		
	N	*%*	*N*	*%*	*N*	*%*	*(95% CI)*
Never eaten any animal source food besides fish.	10	43.5	11	39.3	21	41.2	(28.8 – 54.8)
Never eaten any animal source food including fish.	2	8.7	5	17.9	7	13.7	(6.8 – 25.7)
Never eaten any animal source food or pulses.	2	8.7	5	17.9	7	13.7	(6.8 – 25.7)
Never eaten any animal source food, pulses or peanuts.	2	8.7	2	7.1	4	7.8	(3.1 – 18.5)

Exposure to infection

All caretakers reported illnesses in the period before the malnutrition became apparent and all children had various symptoms and had been given various medicines. Also traditional medicines were used often. Utilisation of bednets and vaccination services seemed to be high in both groups. The difference in drinking water source between the two groups, as seen in the IDIs, was less outspoken, but it still seemed river water was more frequently used in the kwashiorkor group. This didn't seem to result in a higher occurrence of gastro-intestinal disturbances like diarrhoea and vomiting or a higher use of ORS in the kwashiorkor patients (table 25).

Table 25: Exposure to infection – questionnaires.

	Kwashiorkor (n = 23)			Marasmus (n=28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Ill before malnutrition started	23	100	*(85.7 – 100)*	28	100	*(87.9 – 100)*
Symptoms:						
- **fever**	23	100	*(85.7-100)*	27	96.4	*(82.3 – 99.4)*
- **fits**	2	8.7	*(2.4 – 26.8)*	5	17.9	*(7.9 – 35.6)*
- **skin rash**	4	17.4	*(7.0 – 37.1)*	2	7.1	*(2.0 – 22.6)*
- **diarrhoea**	15	65.2	*(44.9 – 81.2)*	22	78.6	*(60.5 – 89.8)*
- **vomiting**	9	39.1	*(22.2 – 59.2)*	16	57.1	*(39.1 – 73.5)*
- **dysentery**	2	8.7	*(2.4 – 26.8)*	3	10.7	*(3.7 – 27.2)*
- **cough**	20	87.0	*(67.9 – 95.5)*	21	75.0	*(56.6 – 87.3)*
- **other**[&]	-	-	-	1	3.6	*(0.6 – 17.7)*
Medicines used before malnutrition started[#]	22	100	*(85.1 – 100)*	28	100	*(87.9 – 100)*
Type of medicines:						
- **vitamin A**	-	-	-	-	-	-
- **mebendazol**	7	31.8	*(16.4 – 52.7)*	2	7.1	*(2.0 – 22.6)*
- **iron**	18	81.8	*(61.5 – 92.7)*	25	89.3	*(72.8 – 96.3)*
- **chloroquine**	2	9.1	*(2.5 – 27.8)*	-	-	*(87.9 – 100)*
- **ACT**	16	72.7	*(51.8 – 86.8)*	20	71.4	*(52.9 – 84.7)*
- **ORS**	13	59.1	*(38.7 – 76.7)*	19	67.9	*(49.3 – 82.1)*
- **paracetamol**	19	86.4	*(66.7 – 95.3)*	27	96.4	*(82.3 – 99.4)*
- **traditional medicines**	15	68.2	*(47.3 – 83.6)*	18	64.3	*(45.8 – 79.3)*
Using a bednet	18	78.3	*(58.1 – 90.3)*	24	85.7	*(68.5 – 94.3)*
Vaccinated	23	100	*(85.7 – 100)*	27	96.4	*(82.3 – 99.4)*
Drinking water source*:						
private closed	1	4.3	*(0.8 – 21.0)*	1	3.6	*(0.6 – 17.7)*
communal closed	9	39.1	*(22.2 – 59.2)*	16	57.1	*(39.1 – 73.5)*
communal open	3	13.0	*(4.5 – 32.1)*	6	21.4	*(10.2 – 39.5)*
river/stream	9	39.1	*(22.2 – 59.2)*	5	17.9	*(7.9 – 35.6)*
other	1	4.3	*(0.8 – 21.0)*	-	-	-

** = factor that may be relevant?*
 # = n different, data missing – see figure 8
& = abdominal pain in a patient with typhoid perforation

Caretaker's perception

When asked to choose from various options (annex 7) what they thought was the main reason their child developed malnutrition, most caretakers gave answers related to illness. Food and breastfeeding issues were rarely mentioned (table 26).

Table 26: Main cause malnutrition according to caretaker – questionnaires.

	Kwashiorkor (n=23)			Marasmus (n=28)		
	N	*%*	*(95% CI)*	*N*	*%*	*(95% CI)*
Diarrhoea	3	13.0	*(4.5 – 32.1)*	6	21.4	*(10.2 – 39.5)*
Other illness	8	34.8	*(18.8 – 55.1)*	8	28.6	*(15.3 – 47.1)*
Lack of good medicines	4	17.4	*(7.0 – 37.1)*	1	3.6	*(0.6 – 17.7)*
Lack of good food	-			4	14.3	*(5.7 – 31.5)*
Caretaker doesn't know	4	17.4	*(7.0 – 37.1)*	2	7.1	*(2.0 – 22.6)*
Illness of mother transferred	-			1	3.6	*(0.6 – 17.7)*
Illness of father transferred	-			1	3.6	*(0.6 – 17.7)*
Mother dead	1	4.3	*(0.8 – 21.0)*	-		
Breast milk not good	-			1	3.6	*(0.6 – 17.7)*
Early weaning	1	4.3	*(0.8 – 21.0)*	-		
More than 1 answer given[&]	2	8.7	*(2.4 – 26.8)*	4	14.3	*(5.7 – 31.5)*

& marasmus = 3 cases diarrhoea + other illness, 1 case illness and lack of good medicines
& kwashiorkor = 1 case diarrhoea and other illness, 1 case lack of medicines and lack of food

Discussion

Objective 1 – baseline characteristics

Kwashiorkor children were on average older, equally stunted and less wasted than marasmus children. Sex distribution was equal. Furthermore the severity of wasting and stunting in the entire research population was remarkable.

These results confirmed the first two hypotheses, concerning age and sex, but the last two hypotheses had to be rejected. Although a relation was found between kwashiorkor and stunting, the same relation existed for marasmus. Therefore the hypothesis in the way it was intended in this thesis, namely as an explanation why certain children develop kwashiorkor instead of marasmus, was not confirmed. A relation between wasting and kwashiorkor was found, but was not restricted to moderate wasting. In fact the majority of kwashiorkor patients had either severe wasting or no wasting at all, leaving only a small group moderately wasted.

Comparing the data of this study with existing literature was hampered by the fact that many other studies differed on key elements, like the age groups examined or the classifications used to define the different forms of malnutrition. The Wellcome classification was frequently used, which is based on weight for age (WFA) instead of weight for height, defining kwashiorkor as WFA < 80% of the median with oedema and marasmus as WFA < 60% without oedema (21). Since WFA is influenced by both wasting and stunting, marasmus can be overdiagnosed using these criteria. Kwashiorkor may be underdiagnosed due to the use of a weight criterion, which may not be reached in case of severe oedema. Furthermore there is more room for error using WFA, since age cannot be measured objectively. Finally most studies used the NCHS standards instead of the new WHO standards as reference population. These standards give very comparable z-scores for HAZ, but for WHZ they result in higher (less negative) z-scores. These differences in methods may partly explain the large variety in findings in the studied articles.

Age

A community based study in Malawi reported a mean age for kwashiorkor patients of 19 months (10), which is 10 months younger than the mean age of the kwashiorkor patients and similar to the mean age of the marasmus patients found in the Magbenteh study. On the other hand a community based study in the Gambia (16) and a treatment-centre based study in Malawi (52) found mean ages among kwashiorkor patients ranging from 26.7 until 29.4 months, thus very comparable to the findings in Magbenteh. Since the first mentioned Malawian study is very recent, it is possible that a high HIV prevalence affected their results. However since the Magbenteh study was treatment centre based, it could also be possible that younger children suffering from kwashiorkor did not survive long enough to reach the facility.

Sex

A study in South Africa identified male sex as a risk factor for SAM in children (21), but another study in Kenya found female sex to be a risk factor for SAM (19), while a study in Uganda found no differences (20).

Stunting

Both groups had equally high proportions of stunted and severely stunted children, indicating that many SAM patients in the programme had already been exposed to chronic malnutrition, before the

acute problem started. Older children normally show a higher incidence and degree of stunting than younger children (23, 53), therefore the fact that the kwashiorkor children were older could have acted as a confounding factor, negatively influencing the results of this group. This may explain the difference with other studies that found kwashiorkor patients to be less stunted than marasmus patients (16, 17). The prevalence of stunting among the kwashiorkor patients was higher than in the general Sierra Leonean population. The SLDHS reported 36.4% stunting and 20.6% severe stunting in children under five years of age, with levels increasing with age, peaking at 47.5% and 26.0% in the age group of 24-35 months (see annex 1, table 11.1)(4). Three of the studied articles (10, 32, 52) reported mean HAZ scores for kwashiorkor patients, ranging from -3.58 to 2.0 (all used NCHS standards). The mean HAZ score found in this study (WHO standards) falls within this range.

Wasting

WHZ scores are rarely described in kwashiorkor patients, since the weight of the oedema makes it a difficult value to calculate and compare. The mean WHZ scores for kwashiorkor patients found during the literature review ranged from -2.09 to 0.89 (all using NCHS standards) (10, 32, 54). The study reporting the lowest values (54) was the only one calculating WHZ with the lowest weight during admission (after oedema had resolved) thus giving the best estimation of the actual level of wasting. The Magbenteh study showed a lower mean WHZ in the kwashiorkor group, which is extra remarkable, since no corrections were made for the weight of the oedema on admission, resulting in underestimation of the actual degree of wasting. It seems most patients in the TFP are in a very advanced stage of malnutrition. The low coverage of treatment facilities in Sierra Leone and the poor accessibility due to bad roads and costs of transport in this poor population may explain this.

Objective 2 – causative factors

Adverse social circumstances

The kwashiorkor group seemed to be less affected by social problems than the marasmus group, with less disrupted family situations. The livelihood of the families in the kwashiorkor group was more often farming, which logically means they owned land. Therefore the risk factor “lack of ownership of land” (19, 20) seemed to apply relatively more to the marasmus group. The differences in livelihood may be explained by the fact that marasmic cases seemed to come from the urban areas more often. It wasn’t asked specifically (see limitations), but based on the address information it could be deduced, that in the kwashiorkor group 4 patients (17.3%) came from a bigger city (3 Makeni, 1 Freetown), while in the marasmus group 11 children (39.3%) came from Makeni. During the IDIs caretakers from urban areas reported difficulties during the dry season instead of the rainy season, since they did not depend on farming but on jobs or trading. This may explain the differences in reported meal frequencies between the two groups. It seemed the families in the marasmus group experienced more food insecurity than in the kwashiorkor group, especially during the dry season, since 50% of them only ate one meal a day in this normally richer season.

Only 2 children in the kwashiorkor group (aged 43 and 48 months) had younger siblings. In the marasmus group only one, 60 months old, child had 2 younger siblings. Therefore the issue of the “deposed child” as Dr Williams formulated in Ghana in 1935 (7), didn’t seem to be a very big problem in this setting. However the lack of pregnant mothers in the marasmus group was remarkable, since there were 4 pregnant women in the kwashiorkor group. The fact that the kwashiorkor children are on average older could be a confounding factor for this. Looking in detail at the answers of the

pregnant caretakers, it appeared that none of them were breastfeeding anymore. Two of them had stopped only 4 months ago. Given the cultural issues around breastfeeding discovered during the IDIs, it could be possible that they weaned the affected child abruptly because of a new pregnancy or the wish to fall pregnant again. However the affected children were not very young, namely 24,26, 33 and 36 months and they had been weaned at 20, 22, 18 and 29 months of age respectively. In conclusion it seemed that adverse social circumstances, in this study, were not clearly related to kwashiorkor, but perhaps to marasmus. An explanation for this may be found in the fact that a relatively big proportion of the marasmus group seemed to originate from Makeni, which is within walking distance of Magbenteh, enabling a selection of poorer patients to reach the treatment centre.

Breastfeeding practices

The WHO advices exclusive breastfeeding until 6 months of age and continued frequent breastfeeding until 2 years of age or beyond (55). When looking at the age of being weaned and the age of introducing complementary food, the caretakers in the kwashiorkor group seemed to follow these guidelines better than those in the marasmus group. The fact that more children were still breastfeeding in the marasmus group, was probably mainly due to the younger average age. The group of children becoming malnourished while still breastfeeding seemed larger in the marasmus group (39% vs. 26%) which would be consistent with poorer practices in that group. This could be related to the more frequent occurrence of adverse social circumstances in the marasmus group.
In both groups the majority of children became malnourished after weaning was completed. Because of the suspected relation between malnutrition and the lack of breastfeeding, the median number of months between being completely weaned and the onset of problems was calculated, which was 4-5 months for both groups. However the mean age of being weaned was much lower in the marasmus group, which may explain their younger mean age on admission.

Diet

The preferred diet of the study population was quite well balanced. It contained items from most food groups with green vegetables, palm oil, pulses, nuts and fruit. The only things lacking consistently were dairy products. Eggs and meat were also eaten very rarely. In fact the only animal product that seemed to be eaten on a day to day basis was fish. The biggest problem seemed to be that the diet became more frugal, with less and smaller portions during difficult times of the year. Switching from rice to foufou during those times also made the food less energy dense (31).

The vast majority of mothers indicated they fed their child 2 meals a day. The WHO advises 2-3 meals for the age of 6-8 months and 3-4 meals from 9-24 months, with additional healthy “snacks” 1-2 times a day. When the child is no longer breastfed (as was the case in 67% of the research population) more frequent meals are advised (55, 56). It can therefore be concluded that meal frequency was too low in the study population.
Green vegetables, banana, palm oil and peanuts seemed to be eaten by most children, but pulses were only eaten by about 30%. Furthermore the diets seemed to be low in animal source products. Marasmus children seemed to consume more milk and less other animal-source food items. This could be related to their younger mean age and younger mean age of weaning. The WHO states that “diets that do not contain animal-source food cannot meet all nutrient needs for children aged 6-24 months, unless fortified products or nutrient supplements are used.”(56). Especially riboflavin amounts are very low in vegetable sources (31). Judging from these advices, the quality of the

children's diet in the study population was seriously problematic in both groups. However the caretakers didn't seem to be aware of this, since only 4 caretakers in the marasmus group and 1 caretaker in the kwashiorkor group reported "lack of good food" as a main cause of the condition of the child.

Exposure to infection

The burden of infection was high in both groups and access to proper treatment limited. Although caretakers did not mention vaccines and bednets spontaneously when asked about prevention, the use of these methods still seemed to be high. Caretakers mentioned proper hygiene very often as an important way to prevent illness, but they were shockingly ignorant when it came to clean drinking water. While only 4% had a private water well and almost 50% used an unsafe (open) water source, nobody treated the water in any way, to make it safe for drinking. The kwashiorkor group seemed to use water from rivers or streams more often, while the marasmus group used mainly communal wells, either open or closed. This didn't result in more gastro-intestinal problem in the kwashiorkor group. If any group had more complaints it was the marasmus group. This may seem contradictory, but it could actually be easier to become infected with gastroenteritis from a communal bucket well, that is contaminated by the whole village, than from a fast flowing relatively clean river. A cross sectional survey in Uganda reported a relation between urban living and diarrhoea. Prevalence of diarrhoea among young children in the week preceding the study was found to be higher in the urban areas, than in the rural areas (23). If marasmus is indeed more common in urban areas there may be a relation with diarrhoeal disease. In any case, exposure to infection didn't seem to be higher in the kwashiorkor group.

Season of admission

The incidence of marasmus in the programme started to increase at the end of the dry season, earlier than that of kwashiorkor, which increased at the beginning of the rainy season. The incidence of marasmus also decreased earlier, before the end of the rainy season. This difference should somehow be explainable by a disparity between the two groups. Families of marasmus patients seemed to come from urban regions more often and seemed to have more food insecurity, especially in the dry season. Since over 50% of the families in the marasmus group were not involved in farming, they were largely dependent on the food for sale on the markets. It could be possible that availability and price already start changing for the worse at the end of the dry season, commencing the "hunger season" earlier for them, than for people who still have some stores of their own. The reverse may be true towards the end of the rainy season.

Objective 3 – outcome

Contrary to what was found in the literature, the prognosis of the kwashiorkor patients was not worse than that of the marasmus patients. The cure rate of the kwashiorkor cases seemed higher than that of the marasmus patients, but the difference was no longer significant when the OTP-transfer cases were added to the successful outcomes.

The mortality rate of 12.1% among kwashiorkor cases was much lower than the mortality rates of 24 to 37% described in the studied literature (13, 14). It seems treatment protocols and therapeutic food have improved since these articles were written, resulting in higher success rates and lower mortality. It is interesting to see the higher default rate in the marasmus group. It is possible that Sierra Leoneans see oedema as a more serious problem than wasting, since so many children are thin in the general population, with a wasting prevalence of 10.2% (see annex 1, table 11.1) (4).

Also improvement in kwashiorkor cases is often more quickly visible and quite impressive. This could result in a higher motivation to seek and continue treatment for kwashiorkor than for marasmus. Furthermore the marasmus group seemed more disadvantaged than the kwashiorkor group in this study, which may have acted as a confounding factor.

A new theory?

Three decades ago Whitehead wrote an interesting article (16). He had observed that in Uganda (kwashiorkor country) children ate adequate food in their first year of life and grew well. But during the second and third year of life this would change for the worse. In the Gambia (marasmus country) on the other hand, children did not receive adequate food in their first year of life and grew very little. However during their second year of life their diet would start to improve a little. He stated that the Gambian child, if lucky and strong enough to survive its first year, would have a small body to maintain through the still difficult, but slightly easier 2nd and 3rd year. On the other hand the Ugandan child, surviving the easy first year with a normal size body, would be completely unprepared for the confrontation with the hardship of the second and third year. He suggested that kwashiorkor could be caused by a sudden deterioration of the diet in a previously properly fed child. He didn't specify why the diet in the Ugandan children changed so suddenly, but a logical explanation would be that they were weaned. His ideas and observations are compatible with the results of this study, which showed that marasmus children were younger and more often subject to poor breastfeeding practices than kwashiorkor children.

The process of the predictive adaptive response is intensely studied in recent years in the field of foetal development. It describes the phenomenon that a foetus, when faced with adversity, reduces its growth and starts programming itself in a way that increases the chances of survival in an adverse environment after birth. This process involves changes in body composition and in the set points for numerous regulatory systems (57, 58). It seems something similar may happen to the (future) marasmus patient, while the (future) kwashiorkor patient remains unable to adapt to a hostile environment, as Gopalan already suggested (26). This idea may be a new theory concerning the pathogenesis of kwashiorkor worth exploring.

Limitations

Selection bias affecting the entire study population

There are 4 other Stabilisation Centres in the Northern Province. Three of them are located at the district hospitals in Kambia, Tonkolili and Bombali and managed by the MoHS. One of them is managed by an NGO in the district of Tonkolili. The last three are located relatively close to Magbenteh (30, 4 and 55 kilometres respectively). Good reputation, big size and the fact that all treatment is free are probably important issues why most patients from Bombali and many patients from other districts come to the facility of the Magbenteh hospital. But a proportion of patients visits the other facilities and selection bias cannot be excluded. It is, for instance, possible that part of the malnourished population in Makeni seeks care at the district hospital, which is located in the centre of town. How this potential selection affects the results is hard to predict, without information from the other SCs.

An even bigger problem is the selection that takes place due to transport constraints and far distances. It is very likely that the poorest and most ill patients never make it to any treatment facility (in time) at all. This selection most likely affects both the kwashiorkor group and the marasmus

group, although it is possible that more efforts are made to make sure an oedematous child is admitted, than a child that is “only very thin”.

Information bias affecting the entire study population

The problem with diagnosing kwashiorkor is the fact that oedema is a very general symptom, which can also be caused by different conditions than malnutrition. Especially malaria often causes oedema in young children. A number of false-positive kwashiorkor cases in that study group cannot be excluded and would most likely weaken any association.
Since birth certificates and identification cards are scarce in Sierra Leone almost all data concerning age (patient and caretakers) are based on recall of the caretaker. This leaves ample room for error.

Limitations patient charts

Selection bias

The biggest problem with this data set is that it only includes inpatient files, while the TFP has both in- and outpatient facilities. The programme opened 4 OTP sites from January (1 site open) until April 2009 (4 sites open). In October 2009 three sites had to be handed over to the MoHS, because of lack of funding. Only the site on the hospital grounds remained. It was decided not to include any outpatients in the analysis, because of the continuously changing number of treatment sites and the fact that no full year of data was available. By ignoring the outpatients, uncomplicated cases of the geographical area around Makeni were selectively excluded from the research population to an increasing extent from January 2009. It is possible this were mainly marasmus patients since severe oedema and skin problems are reasons to admit a patient in the inpatient facility. In retrospect the outpatients should have been included to prevent selection bias.

Information bias

Some of the charts were incomplete or unreadable. The investigator had to read through the files while entering the data, a very time consuming process. Therefore no double entry could be done. Furthermore there is the risk that charts were missing in the archive. To control for this, the statistics of the feeding programme were compared with the number of charts entered (table 27).

Table 27: Completeness of data entry – patient charts.

	Exits in the statistics	Charts entered in the study
Nov-08	64	70
Dec-08	73	75
Jan-09	47	45
Feb-09	53	55
Mar-09	56	59
Apr-09	62	63
May-09	58	59
Jun-09	77	75
Jul-09	94	95
Aug-09	99	99
Sep-09	94	93
Oct-09	62	106
Total	**839**	**894**

Only small differences (1 or 2 up or down) existed, with the exception of October 2009, when the difference was 44 in favour of the charts entered. The most logic explanation for this is a mistake in the statistical report.

In conclusion, the quality of the data is not perfect, but since the number of charts included is high, it seems unlikely that a few missing or unreadable charts will affect the general trend.

Limitations IDIs

Investigator bias & recall bias

The fact that the principal investigator conducted the IDIs herself is potentially a source of bias, since she may have been subconsciously seeking confirmation of the research hypotheses. Furthermore respondents may give more socially desirable answers towards a person they consider important or are dependant of. Fortunately the investigator was not doing any clinical tasks in the TFP at the time of the study and the caretakers didn't know she was the medical coordinator. Also they were advised in the informed consent procedure that their answers would not affect the treatment of their children in any way. Even if there was an effect, this would probably have affected both the kwashiorkor and the marasmus group.

Selection bias

Two marasmus patients had already died and one kwashiorkor case defaulted before the IDI had taken place. Since these cases are the ones in the worst condition or facing the most serious constraints it is unfortunate they didn't make the selection.

Information bias

This part of the study is completely based on subjective data, namely the replies of the respondents. Thus information can easily be biased by misunderstanding, cultural barriers, socially acceptable replies, recall bias, shame etc. The possibility of socially acceptable replies certainly needs to be kept in mind with the subjects of breastfeeding practices, bednet use and vaccination status, since mothers may feel guilty for not following the advice given in health-sensitisation campaigns.

Since the interviewer was not a native speaker, the need for translation during the IDIs will have resulted in loss of information. Furthermore some caretakers spoke languages the translator didn't master, making a second translator necessary. Since some languages are rarely spoken outside certain regions, this usually had to be done by another caretaker of the same tribe, which greatly interfered with the necessary privacy.

The most difficult subject to collect reliable information on was exposure to infections. All children had elaborate histories of subsequent illnesses, before being admitted in the feeding programme. Their caretakers had usually given various treatments from various sources, without always knowing the names or types of the drugs. Therefore the report on this subject is very limited.

Limitations questionnaires

Selection bias

One marasmus patient and one patient, of whom no information about the presence of oedema was available, had already died before the questionnaire had taken place. Also one marasmus case defaulted before the questionnaire had taken place. Finally one kwashiorkor patient was accidentally forgotten to be questioned.
Unlike the patient chart analysis, the questionnaires study group did include the outpatients of the OTP site on the hospital grounds (n=7). One patient that was initially missed during admission, because of being transferred too quickly, could be questioned as a "new admission" in the OTP.

Information bias

The data of this part of the study are again completely based on the subjective replies of the respondents and are subject to the same problems as were mentioned under the limitations of the IDI: misunderstanding, shame etc.

Some respondents spoke languages the local interviewer didn't master, making use of a translator necessary. As said before this often involved another caretaker of the same tribe.

A serious weakness of this part of the study was the lack of clear definitions in the questions asked. None of the symptoms of illness were specifically defined, nor was vaccination status. The intake of different food items was asked, without defining a time frame (e.g. in the last week). These variables should have been more strictly defined in order to make them comparable between the groups and with other literature.

As mentioned before, subjects related to illness and treatment were difficult to investigate reliably. Especially the question concerning the use of various specific medicines was very difficult, since caretakers often did not know exactly what had been prescribed, resulting in unreliable answers. Therefore conclusions concerning the investigated factor "exposure to infection" are more or less limited to the drinking water source.

Limited sample size

The questionnaires were meant to be done a month earlier, in the second half of the rainy season, when admission numbers in the TFP are very high, with a large proportion of kwashiorkor patients. However due to the unexpectedly lengthy process of obtaining ethical approval, data collection was delayed until almost the end of the rainy season, resulting in a smaller sample size than expected. The purpose of the study was never to find statistically significant differences, but even trends for some of the more rarely occurring candidate factors examined like "mother ill", "mother dead", "mother not staying with the child", may have become obscured due to the limited number of respondents.

Flaws in the design of the questionnaire

Based on address information a larger proportion of the marasmus group than the kwashiorkor group was suspected to be of urban origin, which could explain some of the findings. In retrospect respondents should have been asked specifically, whether they originated from an urban or a rural area.

A list of specific food items was presented to the respondents. The items on this list were selected based on the answers during the IDIs and information in the literature. Papaya, mango and pumpkin were not included in this list, since none of the caretakers mentioned them during the IDIs. This is unfortunate since these food items are valuable sources of antioxidants and vitamins and they are commonly eaten in Sierra Leone.

A more general question concerning the consumption of any type of food from the different food groups (e.g. green vegetables, animal-products, fruit), should have been added. With this information food diversity scores could have been calculated and compared, which was impossible with the available data.

The questionnaire was designed to collect “season specific” information about the diet. For every food item, the question was asked how often this was eaten per week in the dry and in the rainy season. Unfortunately these data proofed to be too incomplete and too unreliable to be analysed. Many times information was missing for unclear reasons (not answered, not recorded or not eaten?) and recorded information could often be interpreted in different ways. Caretakers apparently found it difficult to answer this question, but also the interviewer should have been instructed better how to handle this part of the questionnaire.

Conclusions and recommendations

The objectives of this thesis were partly based on the assumption that kwashiorkor patients have a worse prognosis than marasmus patients. This study has not confirmed that, therefore the objective of increasing specifically the survival of kwashiorkor patients, became irrelevant. However the results can be used to improve the preventative and therapeutic aspects of the programme and may benefit other actors in the field of child health and nutrition in Sierra Leone or anywhere else.

Main conclusions

Adverse social circumstances, poor breastfeeding practices and food insecurity seemed to be more common in the marasmus group. In both groups the quantity and quality of the children's diet was a big problem, as was the quality of drinking water. This may explain why in both groups malnutrition usually started a few months after weaning. The later age of being weaned in the kwashiorkor group, may (partly) explain why these children became malnourished at an older age than the marasmus patients. The outcome of both conditions was comparable, apart from the fact that marasmus patients defaulted more often than kwashiorkor patients.

Recommendation 1 – health education

Three important health topics need to be brought to the attention of caretakers of young children in Sierra Leone:

1) Poor quantity and quality of food given to children over 6 months of age, causes malnutrition. The diet can be improved by (simplification of WHO guidelines):
    a. Giving enough meals per day:
        - 6-8 months: 3 meals plus breastfeeding (otherwise more meals).
        - 9-24 months: 4 meals plus breastfeeding (otherwise more meals).
        - 1 time a day you can give your child fruit or bread with peanut paste instead of a cooked meal.
    b. Giving animal-source food as often as possible. Fish and eggs may be easier than meat and milk and are also very healthy for children.
    (Special attention should be given to local beliefs mentioned in the IDIs.)
    c. Giving pulses every day if possible, cooked together with rice or other cereals.
    d. Giving fruit. This is a healthy and important food group for children.

2) Companies try to sell you expensive products for your child, like formula milk, but it is not necessary to give these if your child eats a varied diet and you continue breastfeeding until the child is 2 years old.

3) Water from rivers/streams, but also from communal wells, needs to be made safe for drinking, before you give it to your child. You need to boil it, let it cool down before drinking it and store it in a clean covered container. Use only clean cups.

This can be implemented quickly and easy in the TFP, by adding these subjects to the already existing health education programme of the caretakers. However this is a limited audience. UNICEF Sierra Leone, the MoHS and other partners in the field of nutrition are developing community based strategies for the prevention and treatment of malnutrition in all districts in Sierra Leone. These health messages should become part of that campaign.

Recommendation 2 – decrease defaulting from the TFP

The chart study showed significantly higher defaulter rates among marasmus patient. This may be partly due to the fact that recovery in marasmus patients is less quick and impressive than in kwashiorkor cases. The staff of the TFP should target their efforts more specifically to caretakers of marasmus patients to motivate them to stay in the programme. This should not be too complicated and could involve:

- On admission: clear explanation about the condition, the normal weight for this age and the target weight to be reached before discharge. Explanation about the importance of correcting the weight sufficiently, to prevent problems in the future.
- Giving positive attention to the fact and amount of weight gain at every weighing session.
- Improve referral systems, to enable transfer of stabilised children to an OTP site near their home as soon as possible (number of sites will also need to increase).

Recommendation 3 - more research

This study was only exploratory and lacks power to proof associations. However it did raise some suspicions about differences between the marasmus and kwashiorkor group. One interesting but not well studied difference may be that marasmus children seem to come from urban areas more often. This could mean they have different types of problems, when it comes to livelihood, food access, drinking water etc. Also this group seems to have more social problems. Therefore it would be interesting to repeat an improved version of the questionnaire, but this time as a proper case control study, comparing both patient groups with each other and with the normal population. A power calculation should be done to assure an adequate sample size. Children visiting the under-five outpatient department of the Magbenteh Hospital with minor problems could serve as controls.

Also the “theory” of marasmus children undergoing a predictive adaptive response deserves further evaluation. However this requires a much more comprehensive approach. Ideally a community based cohort study should be done in a population at risk for marasmus and kwashiorkor. Children should be followed from before birth until the age of 5. The study should gather information about obstetric problems, birth weight, breastfeeding, morbidity, anthropometry and diet. Ideally it should also test glucose tolerance and circulating insulin concentrations of the subjects on at least a few occasions (58). Performing this type of extensive research is unfortunately beyond the abilities of the author of this thesis and the SSLDF.

Acknowledgements

I want to thank the staff of the Magbenteh Community Hospital and Feeding Programme for their hard work and care of the patients. This thesis wouldn’t have been completed without Marit de Wit – van Lenthe who helped me with the analysis of the data; my field assistant Mariatu A. Sesay and my supervisor. I want to thank my husband for his support and most importantly I want to thank the caretakers who agreed to participate in this study.

Annexes

Annex 1 – Information from SLDHS 2008

The following tables and figures were published in the report of the Sierra Leone Demographic and Health Survey 2008 (4).

Table 8.1 Early childhood mortality rates

Neonatal, post-neonatal, infant, child, and under-five mortality rates for five-year periods preceding the survey, Sierra Leone 2008

Years preceding the survey	Neonatal mortality (NN)	Post-neonatal mortality[1] (PNN)	Infant mortality ($_1q_0$)	Child mortality ($_4q_1$)	Under-five mortality ($_5q_0$)
0-4	36	53	89	56	140
5-9	61	71	132	73	195
10-14	51	70	120	80	190

[1] Computed as the difference between the infant and neonatal mortality rates

Table 8.1 Early childhood mortality rates
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Table 11.1 Nutritional status of children

Percentage of children under five years classified as malnourished according to three anthropometric indices of nutritional status: height-for-age, weight-for-height, and weight-for-age, by background characteristics, Sierra Leone 2008

Background characteristic	Height-for-age			Weight-for-height				Weight-for-age				Number of children
	Percentage below -3 SD	Percentage below -2 SD[1]	Mean Z-score (SD)	Percentage below -3 SD	Percentage below -2 SD[1]	Percentage above +2 SD	Mean Z-score (SD)	Percentage below -3 SD	Percentage below -2 SD[1]	Percentage above +2 SD	Mean Z-score (SD)	
Age in months												
<6	6.5	13.6	0.0	4.8	15.3	12.0	-0.1	4.5	14.2	10.0	-0.2	240
6-8	11.2	20.5	-0.6	4.6	10.8	11.0	-0.1	6.2	13.8	4.3	-0.6	146
9-11	8.6	18.4	-0.5	9.6	14.9	8.2	-0.5	6.3	17.3	3.0	-0.7	140
12-17	19.8	32.7	-1.2	5.3	11.9	5.9	-0.4	7.7	20.9	3.9	-0.9	341
18-23	20.7	37.6	-1.3	2.4	8.3	4.8	-0.3	4.6	18.5	3.3	-0.8	196
24-35	26.0	47.5	-1.6	3.1	8.8	9.8	0.0	5.5	20.7	5.1	-0.9	486
36-47	24.7	39.6	-1.5	5.0	10.2	9.7	-0.1	9.1	23.6	2.1	-1.0	626
48-59	23.1	43.0	-1.7	2.9	7.6	6.6	-0.1	8.1	25.5	0.7	-1.1	589
Sex												
Male	22.5	38.6	-1.4	4.6	9.9	8.4	-0.2	7.9	23.6	3.4	-0.9	1,341
Female	18.7	34.3	-1.2	3.9	10.5	8.4	-0.1	6.3	18.8	3.5	-0.8	1,423
Birth interval in months[2]												
First birth[3]	18.2	32.0	-1.2	4.4	11.1	6.4	-0.2	5.6	18.5	3.6	-0.8	409
<24	23.5	38.1	-1.5	7.2	13.4	12.0	-0.2	12.3	28.1	3.2	-1.0	276
24-47	22.0	38.9	-1.4	3.9	9.0	7.2	-0.1	6.1	22.7	3.3	-0.9	917
48+	17.6	31.4	-1.1	3.9	10.7	11.7	-0.1	6.3	16.4	4.5	-0.7	547
Size at birth[2]												
Very small	17.9	36.7	-1.2	6.4	14.9	4.8	-0.5	6.2	27.9	3.5	-1.0	147
Small	23.7	40.5	-1.6	3.9	12.4	8.5	-0.2	11.6	30.3	5.5	-1.1	273
Average or larger	20.1	35.0	-1.3	4.3	9.7	9.1	-0.1	6.1	19.0	3.2	-0.8	1,641
Missing	18.5	29.2	-1.2	5.5	11.0	11.3	0.0	6.3	17.6	5.8	-0.7	88
Mother's interview status												
Interviewed	20.3	35.6	-1.3	4.4	10.4	8.8	-0.1	6.8	21.0	3.6	-0.9	2,149
Not interviewed, but in household	17.6	37.4	-1.3	3.1	10.3	5.0	-0.1	6.8	19.8	3.4	-0.8	137
Not interviewed, and not in the household[4]	22.5	39.5	-1.3	3.7	9.1	7.6	-0.2	8.3	22.0	2.9	-0.9	476
Mother's nutritional status[5]												
Thin (BMI <18.5)	22.5	37.7	-1.4	8.4	18.0	4.0	-0.7	11.3	29.7	3.2	-1.3	235
Normal (BMI 18.5-24.9)	20.4	36.7	-1.3	3.8	9.2	7.7	-0.2	6.7	21.9	3.1	-0.9	1,309
Overweight/obese (BMI ≥25)	19.7	32.6	-1.3	3.7	9.4	12.3	0.2	5.0	15.5	5.0	-0.6	557
Missing	16.1	32.5	-1.1	7.1	14.1	12.3	-0.2	7.0	17.8	2.4	-0.8	140
Residence												
Urban	13.9	29.7	-0.9	5.4	11.3	10.3	-0.1	6.7	15.7	4.4	-0.6	750
Rural	23.0	38.9	-1.4	3.8	9.8	7.7	-0.2	7.2	23.1	3.2	-0.9	2,014
Region												
Eastern	16.4	33.6	-1.2	4.1	9.9	11.6	0.1	6.3	17.7	5.7	-0.6	507
Northern	22.6	39.5	-1.4	3.3	8.6	5.8	-0.2	7.5	23.5	2.7	-1.0	1,328
Southern	24.0	38.1	-1.4	6.5	14.5	11.7	-0.2	8.7	23.6	3.4	-1.0	546
Western	14.0	26.9	-0.9	4.4	9.9	8.6	-0.2	4.5	13.9	3.4	-0.7	383
Mother's education[6]												
No education	21.2	37.9	-1.4	4.6	10.8	8.0	-0.2	8.1	23.2	3.7	-0.9	1,799
Primary	21.4	31.1	-1.2	6.3	10.1	12.3	0.0	3.0	14.2	2.4	-0.7	253
Secondary or higher	11.2	22.4	-0.8	0.7	7.8	9.0	-0.1	1.2	10.8	4.3	-0.5	226
Wealth quintile												
Lowest	22.6	36.5	-1.3	4.1	11.6	9.5	-0.1	7.0	21.8	3.6	-0.8	605
Second	26.2	43.6	-1.6	3.7	9.0	7.3	-0.2	7.7	25.7	1.4	-1.1	581
Middle	20.7	37.7	-1.3	4.3	9.4	7.8	-0.2	8.0	23.4	3.6	-0.9	616
Fourth	18.9	36.5	-1.3	4.5	9.1	8.8	-0.1	7.1	19.5	4.5	-0.8	590
Highest	11.2	22.7	-0.6	4.8	12.6	8.8	-0.2	4.6	11.8	4.7	-0.5	373
Total	20.6	36.4	-1.3	4.2	10.2	8.4	-0.2	7.1	21.1	3.5	-0.9	2,764

Note: Table is based on children who slept in the household the night before the interview. Each of the indices is expressed in standard deviation units (SD) from the median of the WHO Child Growth Standards adopted in 2006. The indices in this table are NOT comparable to those based on the previously used NCHS/CDC/WHO standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight. Total includes 2 children with information missing on mother's interview status and 8 children with information missing on mother's education

[1] Includes children who are below -3 standard deviations (SD) from the WHO Child Growth Standards population median

[2] Excludes children whose mothers were not interviewed

[3] First born twins (triplets, etc.) are counted as first births because they do not have a previous birth interval

[4] Includes children whose mothers are deceased

[5] Excludes children whose mothers were not weighed and measured. Mother's nutritional status in terms of BMI (Body Mass Index) is presented in Table 11.10.

[6] For women who are not interviewed, information is taken from the Household Questionnaire. Excludes children whose mothers are not listed in the Household Questionnaire

Table 11.1 Nutritional status of children

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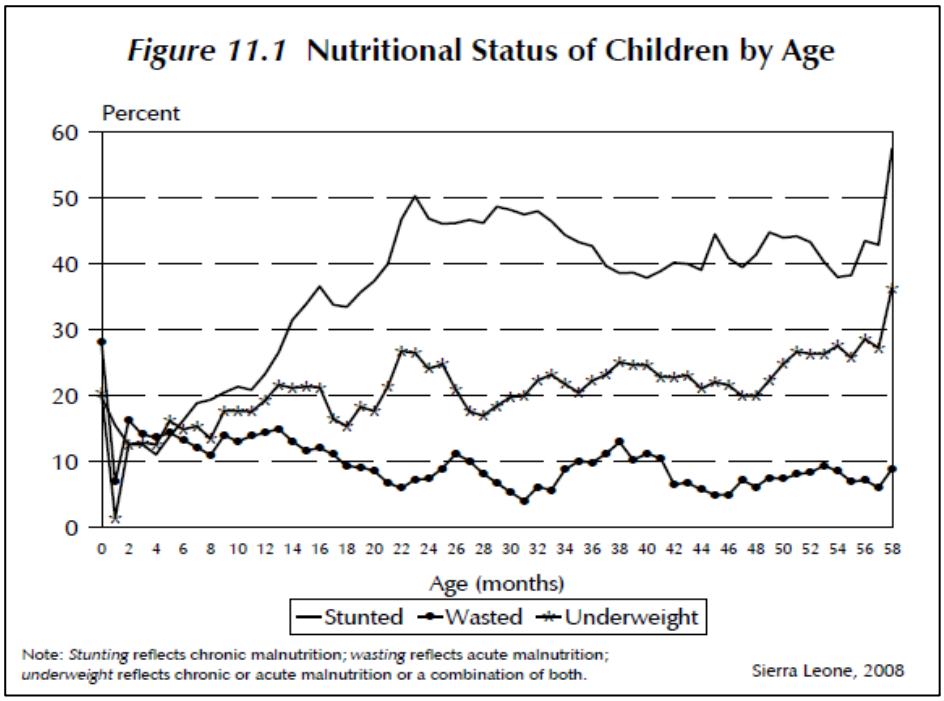

Figure 11.1 Nutritional status of children by age
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Table 14.3 HIV prevalence by age

Among the de facto women and men age 15-49 who were interviewed and tested, the percentage HIV positive, by age, Sierra Leone 2008

	Women		Men		Total	
Age	Percentage HIV positive	Number	Percentage HIV positive	Number	Percentage HIV positive	Number
15-19	1.3	529	0.0	487	0.7	1,016
20-24	1.5	559	1.3	365	1.4	924
25-29	2.2	772	1.5	407	2.0	1,179
30-34	2.4	471	1.8	352	2.1	823
35-39	1.2	568	1.4	499	1.3	1,067
40-44	2.1	308	0.9	309	1.5	617
45-49	1.0	241	2.1	306	1.6	547
Total 15-49	1.7	3,448	1.2	2,726	1.5	6,174
50-59	na	na	0.6	301	na	na
Total 15-59	na	na	1.2	3,027	na	na

na = Not applicable

Table 14.3 HIV prevalence by age
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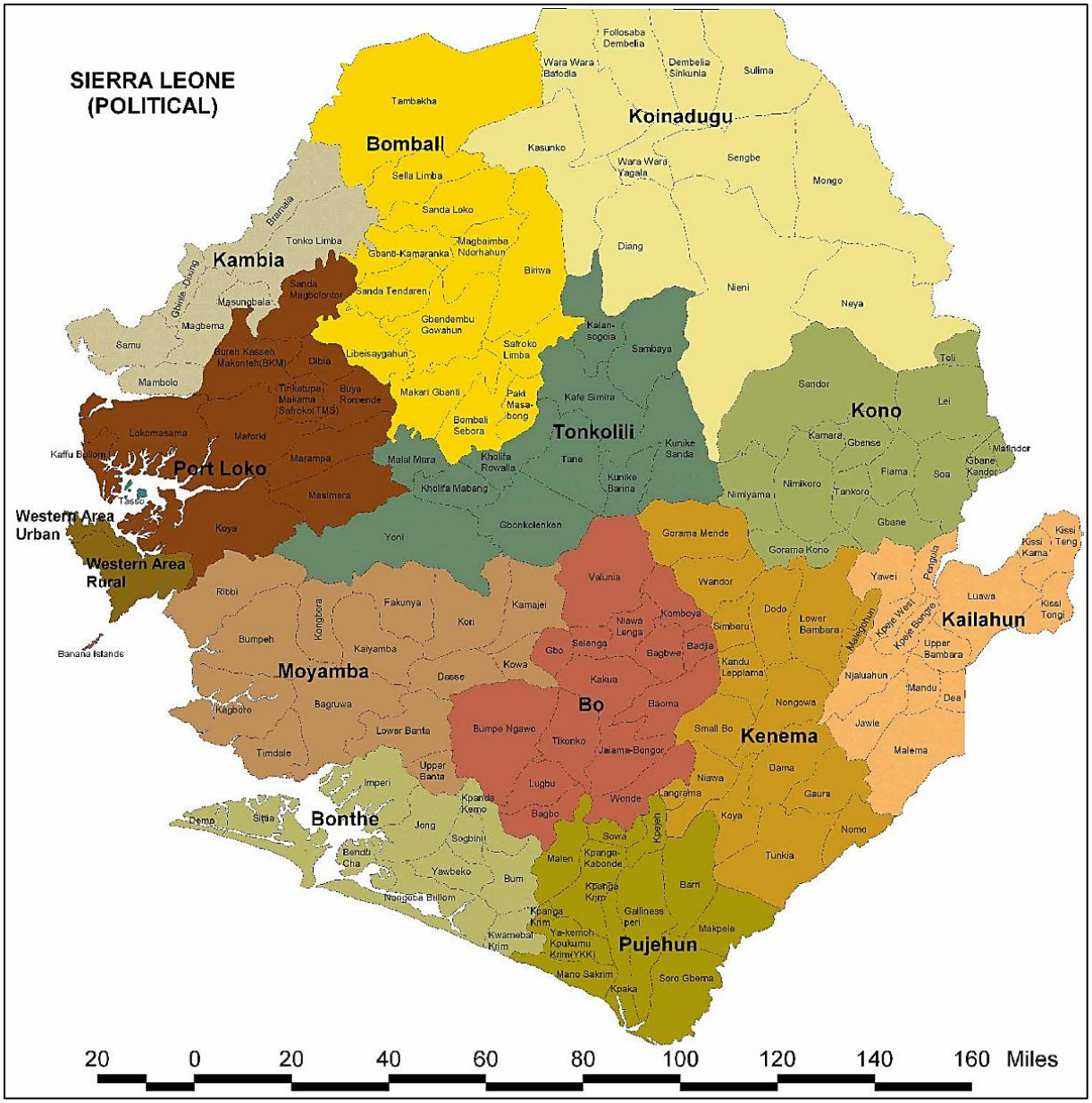
Annex 2 – Map of Sierra Leone



Map Sierra Leone
Source: Official website of the Ministry of Health and Sanitation of Sierra Leone www.health.sl

Annex 3 – EpiData data entry form patient chart study

id	patient number	####
adress1	name of village of residence	_____
adress2	extra info if available	_____
PHU	name of nearest PHU if available	_____
age	age in months on day admission	####
sex	sex of patient	#
admission	date of admission	<dd/mm/yyyy>
readmission	is it a readmission?	#
height	height in cm on day admission	###.#
weight	weight in kg on day admission	##.#
oedema1	oedema present on day admission	#
oedema2	amount of oedema	#
exit	date of exit	<dd/mm/yyyy>
duration	number of days admitted	###
outcome	result of treatment	#
HIV1	tested for HIV?	#
HIV2	HIV test positive?	#
TB1	TB suspected?	#
TB2	Keith Edward done?	#
TB3	Keith Edward score	##
TB4	TB treatment started?	#
special	special findings (orphan, granny, twin, rash)	_____

Annex 4 – STATA analysis patient charts study

```
-------------------------------------------------------------------------------------------------------------------------------

log:  C:\Documents and Settings\Marit\My Documents\Carla\werkset1_demograpic.log
log type:  text
opened on:  14 May 2010, 14:42:32
. set memory 100m
(102400k)
. use "C:\Documents and Settings\Marit\My Documents\Carla\werkset1.dta", clear

. ************demographics**********
.
. by oedema1, sort : summarize agem
-------------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        agem |       380    29.35621    13.05036         6         60
-------------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        agem |       398    18.49146    12.13506         6         60


. by oedema1, sort : tabulate sex
-------------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1

      Sex |      Freq.     Percent        Cum.
------------+-----------------------------------
   Female |        190       50.00       50.00
     Male |        190       50.00      100.00
------------+-----------------------------------
    Total |        380      100.00
-------------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2

      Sex |      Freq.     Percent        Cum.
------------+-----------------------------------
   Female |        175       43.97       43.97
     Male |        223       56.03      100.00
------------+-----------------------------------
    Total |        398      100.00
```

```
. encode sex, generate(sex1)
. by oedema1, sort : summarize sex1
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        sex1 |       380         1.5    .5006592         1          2
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        sex1 |       398    1.560302    .4969751         1          2

. *********note male=1 female=2***********

. by oedema1, sort : summarize waz
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         waz |       380   -3.295316    1.374698      -6.7         .97
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         waz |       397   -4.521738    1.036612     -7.48      -1.66

. by oedema1, sort : summarize whz
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         whz |       378   -2.597989    1.622815     -6.84       4.85
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         whz |       397   -4.593703    .8243774     -7.71       -.36
```

```
. tabulate oedema1 outcome
           |                    #outcome
 #oedema1 |       1        2        4        5        6        9 |     Total
----------+-------------------------------------------------------------------+----------
        1 |     261       46       41       31        1        0 |       380
        2 |     236       39       72       47        3        1 |       398
----------+-------------------------------------------------------------------+----------
    Total |     497       85      113       78        4        1 |       778


. **********analyse**********

.  ttest agem, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |     380    29.35621    .6694694    13.05036    28.03987    30.67255
       2 |     398    18.49146    .6082755    12.13506    17.29561     19.6873
---------+--------------------------------------------------------------------
combined |     778    23.79815    .4913746    13.70574    22.83357    24.76273
---------+--------------------------------------------------------------------
    diff |            10.86475    .9030178                9.092106     12.6374
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =  12.0316
Ho: diff = 0                     degrees of freedom =      776

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000


.  tabulate oedema1 sex1, chi2
           |        Sex
 #oedema1 |    Female       Male |     Total
----------+----------------------+----------
        1 |       190        190 |       380
        2 |       175        223 |       398
----------+----------------------+----------
    Total |       365        413 |       778

          Pearson chi2(1) =   2.8383   Pr = 0.092
```

```
. ttest waz, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |     380   -3.295316    .0705205    1.374698   -3.433976   -3.156655
       2 |     397   -4.521738    .0520261    1.036612    -4.62402   -4.419456
---------+--------------------------------------------------------------------
combined |     777   -3.921943    .0487643    1.359291   -4.017669   -3.826218
---------+--------------------------------------------------------------------
    diff |            1.226422    .0871084                1.055426    1.397419
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =  14.0793
Ho: diff = 0                     degrees of freedom =      775

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000


. ttest whz, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |     378   -2.597989    .0834686    1.622815   -2.762112   -2.433867
       2 |     397   -4.593703    .0413743    .8243774   -4.675044   -4.512362
---------+--------------------------------------------------------------------
combined |     775    -3.62031    .0582192    1.620755   -3.734596   -3.506023
---------+--------------------------------------------------------------------
    diff |            1.995713    .0918212                1.815465    2.175962
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =  21.7348
Ho: diff = 0                     degrees of freedom =      773

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

```
. ttest haz, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |     379   -2.758127    .0826163    1.608368   -2.920572   -2.595682
       2 |     397   -2.603728    .0798677    1.591354   -2.760746    -2.44671
---------+--------------------------------------------------------------------
combined |     776   -2.679137    .0574552    1.600517   -2.791923    -2.56635
---------+--------------------------------------------------------------------
    diff |         -.1543987    .1148816            -.3799152    .0711178
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                t =  -1.3440
Ho: diff = 0                     degrees of freedom =      774

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0897         Pr(|T| > |t|) = 0.1793          Pr(T > t) = 0.9103


. *********recoding*******
. gen season1=season
. recode season1 1=1 2/9=0
(season1: 510 changes made)
. gen season2=season
. recode season2 1=0 2=1 3/9=0
(season2: 778 changes made)
. gen season3=season
. recode season3 1=0 2=0 3=1 4=0
(season3: 778 changes made)
. gen season4=season
. recode season4 1/3=0 4=1
(season4: 778 changes made)

. tabulate oedema3 season1, chi2
           |       season1
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |       264       134 |       398
         1 |       246       134 |       380
-----------+----------------------+----------
     Total |       510       268 |       778

          Pearson chi2(1) =   0.2190   Pr = 0.640
```

```
. tabulate oedema3 season2, chi2
        |       season2
  oedema3 |        0        1 |     Total
-----------+----------------------+----------
      0 |      302       96 |       398
      1 |      249      131 |       380
-----------+----------------------+----------
    Total |      551      227 |       778

       Pearson chi2(1) =  10.0834   Pr = 0.001

. tabulate oedema3 season3, chi2
        |       season3
  oedema3 |        0        1 |     Total
-----------+----------------------+----------
      0 |      329       69 |       398
      1 |      318       62 |       380
-----------+----------------------+----------
    Total |      647      131 |       778

       Pearson chi2(1) =   0.1447   Pr = 0.704

. tabulate oedema3 season4, chi2
        |       season4
  oedema3 |        0        1 |     Total
-----------+----------------------+----------
      0 |      299       99 |       398
      1 |      327       53 |       380
-----------+----------------------+----------
    Total |      626      152 |       778

       Pearson chi2(1) =  14.7649   Pr = 0.000

. save "C:\Documents and Settings\Marit\My Documents\Carla\werkset1_demographic.dta", replace
file C:\Documents and Settings\Marit\My Documents\Carla\werkset1_demographic.dta saved
. log close
log:  C:\Documents and Settings\Marit\My Documents\Carla\werkset1_demograpic.log
log type:  text
closed on:  14 May 2010, 14:42:33
-------------------------------------------------------------------------------------------------------------------

log:  C:\Documents and Settings\Marit\My Documents\Carla\grote_set.log
log type:  text
opened on:  23 Jun 2010, 10:58:24
. set memory 100m
```

```
(102400k)
. use "C:\Documents and Settings\Marit\My Documents\Carla\grote_set.dta", clear

. **********recoding**********
. gen oedema3=oedema1
. recode oedema3 2=0
(oedema3: 398 changes made)
. gen outcome1=outcome
. recode outcome1 1=1 2/5=0 6/9=.
(outcome1: 281 changes made)
. gen outcome2=outcome
. recode outcome2 1=0 2=1 3/5=0 6/9=.
(outcome2: 778 changes made)
. gen outcome4=outcome
. recode outcome4 1/3=0 4=1 5=0 6/9=.
(outcome4: 778 changes made)
. gen outcome5=outcome
. recode outcome5 1/4=0 5=1 6/9=.
(outcome5: 778 changes made)
. gen good1=outcome
. recode good1 1=1 2/3=0 4=1 5=0 6/9=.
(good1: 778 changes made)

.  tabulate oedema3 outcome1, chi2
           |      outcome1
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |       158       236 |       394
         1 |       118       261 |       379
-----------+----------------------+----------
     Total |       276       497 |       773

          Pearson chi2(1) =   6.7661   Pr = 0.009

.  tabulate oedema3 outcome2, chi2
           |      outcome2
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |       355        39 |       394
         1 |       333        46 |       379
-----------+----------------------+----------
     Total |       688        85 |       773

          Pearson chi2(1) =   0.9893   Pr = 0.320
```

```
. tabulate oedema3 outcome4, chi2
           |      outcome4
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |       322        72 |       394
         1 |       338        41 |       379
-----------+----------------------+----------
     Total |       660       113 |       773

          Pearson chi2(1) =   8.6045   Pr = 0.003

. tabulate oedema3 outcome5, chi2
           |      outcome5
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |       347        47 |       394
         1 |       348        31 |       379
-----------+----------------------+----------
     Total |       695        78 |       773

          Pearson chi2(1) =   2.9935   Pr = 0.084

. tabulate oedema3 good1, chi2
           |      good1
  oedema3 |         0         1 | Total
-----------+----------------------+----------
         0 |       115       283 | 398
         1 |        88       292 | 380
-----------+----------------------+----------
     Total |       203       575 | 778

Pearson chi2(1) = 3.3173 Pr = 0.069

. **********notes**********
. notes outcome1 : 1=1 cured
. notes outcome2 : 2=1 death
. notes outcome4 : 4=1 defaulter
. notes outcome5 : 5=1 OTP
. notes good1 : 1=1 and 5=1 successful outcome
. save "C:\Documents and Settings\Marit\My Documents\Carla\grote_set.dta", replace
file C:\Documents and Settings\Marit\My Documents\Carla\grote_set.dta saved
. log close
log:  C:\Documents and Settings\Marit\My Documents\Carla\grote_set.log
log type:  text
closed on:  23 Jun 2010, 10:58:24
-------------------------------------------------------------------------------------------------------------------
```

Annex 5 – Guiding questions for in depth interview

Part 1: Information about the admitted patient (take from patient file)

1) sex: male / female
2) age in months on admission:
3) height in cm on admission:
4) weight in kg on admission:
5) MUAC on admission:
6) oedema on admission: no / + / ++ / +++
7) date of admission:
8) readmission?: yes/no

Part 2: basic information

9) What is your age?
10) Where is the child from?
    - Name village:
    - Which chiefdom:
    - Which district:
11) What is the name of the closest PHU?:
12) Are you literate (able to read/write)?:
13) What is your religion?:

Part 3: Family information

14) What is your relationship to the child?
15) Describe the family of the child;
16) Where (with whom) does the child normally live?
17) Is the mother of the child well?

Part 4: food and livelihood information

18) How does your family generate income?

19) Where do you get your food?

20) Are there any constraints in getting food?

21) Are there seasonal differences in how you get your food, what you eat etc.?

22) What do you normally eat at home?

23) What do you feed to the child and why:

- breastfed yes/no and why?
- what type of complementary food?
- certain things specifically not given and why?
- certain things specifically given and why?
- certain things you think are especially good for the child and you would like to give?
- Do you manage to give these items (often)? If not, why?

24) Where and how do you get food for the child?

25) Who (else) decides what the child eats?

Part 5: medical history

26) Has the child been ill and if yes, what kind of illness(es)?

27) How and where do you normally treat the child when it is ill and why?

28) How do you normally try to prevent illnesses in the child?

- hygiene?
- bednets?
- vaccinations?
- other?

29) Did you join into the government programmes for children, like vaccinations etc.?

30) Was there any specific illness before the oedema started/ child started losing weight?

31) Where do you get your drinking water?

32) What do you think is the main reason why the child developed this condition?

Annex 6 – Questionnaire

Part 1: Information about the admitted patient (take from patient file):

1) sex: male / female
2) age in months on admission:
3) height in cm on admission:
4) weight in kg on admission:
5) oedema on admission: no / + / ++ / +++
6) date of admission:
7) readmission?: yes/no

Part 2: basic information caretaker:

1) What is your age?
2) Where is the child from?
   - Name village:
   - Which chiefdom:
   - Which district:
3) What is the name of the closest PHU?:
4) What is your religion?
5) Are you literate (able to read/write)? yes / no
6) What is your relationship to the child?:

Mother ☐
Father ☐
Grandmother ☐
Other: ……

Part 3: family information

7) Where does the child normally stay (who is the main caretaker):

		Since when does the child stay with a caretaker other than the mother?
Mother	☐	++++++++++++++++++++++++++
Father	☐	
Grandmother	☐	
Aunt	☐	
Sister	☐	
Other:	…….	

8) Are the parents of the child alive?

- father: yes / no
  - ⇨ If no, when did he die?
- mother: yes / no
  - ⇨ If no, when did she die?:

9) If the mother is alive, is she:

- Married? yes / no
- In good health? yes / no
- Pregnant? yes / no
- Breastfeeding a younger child? yes / no

10) If the mother is alive, is she staying with the father of the child? yes / no

11) If the mother is staying with the father is she:

Only wife ☐
First wife ☐
Second wife ☐
Other: …….

12) How many people live in the household of the child?:

13) Who is the head of the household (relation to the child):

Grandfather (mothers side) ☐
Grandmother (mothers side) ☐
Grandfather (fathers side) ☐
Grandmother (fathers side ☐
father ☐
mother ☐
Other: …….

14) Number of older brothers and sisters of the child, alive:

15) Number of younger brothers and sisters of the child, alive:

16) Number of older brothers and sisters of the child, deceased:

17) Number of younger brothers and sisters of the child, deceased:

18) Number of adopted/other children in household:

19) Is the child a twin? yes/no
- ⇨ if yes, is the other twin alive? yes/no
- ⇨ if yes, is the other malnourished yes/no

Part 4: food and livelihood information

20) How does your family generate income/food (**more options possible**):

Farming for own consumption	☐
Farming for sale/exchange	☐
Trading (of goods/food etc.)	☐
Regular job	☐
Seasonal/contract base job	☐
Support from outside (relatives)	☐
Other:	…….

21) What is the main ingredient (staple food) the family eats?

	Dry season	Rainy season
White rice	☐	☐
Local (brown) rice	☐	☐
Cassava (porridge, foufou)	☐	☐
Other:	……..	…….

22) How many meals do they (usually) eat a day in the dry season:

23) How many meals do they (usually) eat a day in the rainy season:

24) Is the child breastfed by the mother? yes/no
- ⇨ If no, when did the breastfeeding stop?:
- ⇨ If no, why did the breastfeeding stop?:

25) Is the child breastfed by someone else? yes/no
- ⇨ If yes, who:

26) Does the child eat other food than breast milk? yes/no
- ⇨ if yes, from what age?:
- ⇨ if yes, how many (small) meals a day?:

27) Does the child ever eat the following things and if yes, how often per week?

Food item	**Thick if yes**	**How many times per week?**	
		Dry season	***Rainy season***
Milk	☐		
Egg	☐		
Chicken	☐		
Meat	☐		
Fish	☐		
Liver (of any animal)	☐		
Tomato	☐		
Green leafy vegetables	☐		
Banana	☐		
Orange or grapefruit	☐		
Palm oil	☐		
Peanut (groundnut) or peanut paste	☐		
(Dried) okra	☐		
Chick peas/beans/lentils	☐		

Part 5: information about illnesses

28) Does the child sleep under a bednet most nights? yes / no

29) Has the child been vaccinated? yes / no

30) Was the child ill before the problem (oedema/wasting) started? yes / no

31) If the child was ill, what kind of illness/symptoms **(more options possible)**

Fever ☐
Fits ☐
Skin rash ☐
Diarrhoea ☐
Vomiting ☐
Dysentery (mucoid or bloody stool) ☐
Cough ☐
Other …….

32) Were any of the following drugs given shortly before the problem started or shortly before the problem became worse **(more options possible)**?

Vitamin A	☐
Mebendazol	☐
Iron tablets or syrup (blood syrup)	☐
Chloroquine	☐
ACT (yellow and white tablets)	☐
ORS	☐
Paracetamol	☐
Traditional medicines	☐

33) Where do you usually get your drinking water?

Private closed well/tap	☐
Private open well (bucket)	☐
Communal closed well/tap (pump)	☐
Communal open well (bucket)	☐
River/stream	☐
Other	……

34) What do you think is the main cause of the condition of the child?:

Diarrhoea	☐
(Other) illness	☐
Lack of good medicines	☐
Lack of (good) food	☐
Doesn't know (no idea)	☐
Other	……

Annex 7 – STATA analysis questionnaire study

```
-------------------------------------------------------------------------------------------------------------------------
log:  C:\Documents and Settings\Marit\My Documents\Carla\werkset2_demograpic.log
log type:  text
opened on:  19 May 2010, 15:00:06
. set memory 100m
(102400k)
. use "C:\Documents and Settings\Marit\My Documents\Carla\werkset2.dta", clear

. gen oedema3=oedema1
. recode oedema3 2=0
(oedema3: 28 changes made)
. gen outcome1=outcome
. recode outcome1 1=1 2/9=0
(outcome1: 15 changes made)
. gen outcome2=outcome
. recode outcome2 1=0 2=1 3/9=0
(outcome2: 51 changes made)
. gen outcome3=outcome
. recode outcome3 1=0 2=0 3=1 4=0 5=1 6=1 7=1 9=1
(outcome3: 51 changes made)
. gen outcome4=outcome
. recode outcome4 1/3=0 4=1 5/9=0
(outcome4: 51 changes made)


. ************demographics**********

. by oedema1, sort : summarize agem
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        agem |        23    25.78435    10.00402         7         48
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        agem |        28    18.42929    11.55835         6         60
```

```
. by oedema1, sort : tabulate sex
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1
      Sex |      Freq.     Percent        Cum.
------------+-----------------------------------
   Female |         14       60.87       60.87
     Male |          9       39.13      100.00
------------+-----------------------------------
    Total |         23      100.00
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2
      Sex |      Freq.     Percent        Cum.
------------+-----------------------------------
   Female |         14       50.00       50.00
     Male |         14       50.00      100.00
------------+-----------------------------------
    Total |         28      100.00

. encode sex, generate(sex1)
. by oedema1, sort : summarize sex1
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1
   Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
       sex1 |        23    1.391304    .4990109         1          2
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2
   Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
       sex1 |        28         1.5    .5091751         1          2

. *********note male=1 female=2**********

. by oedema1, sort : summarize waz
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1
   Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        waz |        23   -3.058261    1.252099     -5.19      -1.02
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2
   Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        waz |        28   -4.490714    1.397521     -7.72      -1.32
```

```
. by oedema1, sort : summarize whz
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 1
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         whz |        23   -2.645217    1.398691     -5.21       -.48
-------------------------------------------------------------------------------------------------------------------------
-> oedema1 = 2
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         whz |        27      -4.38    1.168546     -7.34      -1.27

. tabulate oedema1 outcome
           |              #outcome
  #oedema1 |         1         2         4         5 |     Total
-----------+--------------------------------------------+----------
         1 |        19         2         0         2 |        23
         2 |        17         0         5         6 |        28
-----------+--------------------------------------------+----------
     Total |        36         2         5         8 |        51


. **********analyse***********

.  ttest agem, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |      23    25.78435    2.085983    10.00402    21.45828    30.11041
       2 |      28    18.42929    2.184324    11.55835    13.94742    22.91115
---------+--------------------------------------------------------------------
combined |      51    21.74627    1.595577     11.3947    18.54146    24.95109
---------+--------------------------------------------------------------------
    diff |            7.355062    3.064003                1.197717    13.51241
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =   2.4005
Ho: diff = 0                     degrees of freedom =       49

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9899         Pr(|T| > |t|) = 0.0202          Pr(T > t) = 0.0101
```

```
. tabulate oedema1 sex1, chi2
          |        Sex
 #oedema1 |    Female      Male |     Total
-----------+----------------------+----------
        1 |       14         9 |       23
        2 |       14        14 |       28
-----------+----------------------+----------
    Total |       28        23 |       51
        Pearson chi2(1) =   0.6026   Pr = 0.438

. ttest waz, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs       Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |      23   -3.058261    .2610806    1.252099   -3.599709   -2.516813
       2 |      28   -4.490714    .2641067    1.397521   -5.032617   -3.948812
---------+--------------------------------------------------------------------
combined |      51   -3.844706    .2106329     1.50422   -4.267775   -3.421637
---------+--------------------------------------------------------------------
    diff |           1.432453    .3754572                .677944    2.186963
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =   3.8152
Ho: diff = 0                     degrees of freedom =       49

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9998         Pr(|T| > |t|) = 0.0004          Pr(T > t) = 0.0002

. ttest whz, by(oedema1)
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs       Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |      23   -2.645217    .2916471    1.398691   -3.250057   -2.040378
       2 |      27      -4.38    .2248868    1.168546   -4.842261   -3.917739
---------+--------------------------------------------------------------------
combined |      50     -3.582    .2175185    1.538088    -4.01912    -3.14488
---------+--------------------------------------------------------------------
    diff |           1.734783    .3629699                1.004983    2.464582
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =   4.7794
Ho: diff = 0                     degrees of freedom =       48

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

```
. ttest haz, by(oedema1)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       1 |      23   -2.223913    .2591623    1.242899   -2.761383   -1.686443
       2 |      28   -2.876071    .3733845    1.975765   -3.642193    -2.10995
---------+--------------------------------------------------------------------
combined |      51   -2.581961    .2382572    1.701497   -3.060515   -2.103407
---------+--------------------------------------------------------------------
    diff |           .6521584     .474625            -.3016362    1.605953
------------------------------------------------------------------------------
    diff = mean(1) - mean(2)                                      t =   1.3740
Ho: diff = 0                     degrees of freedom =       49

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9122         Pr(|T| > |t|) = 0.1757          Pr(T > t) = 0.0878

. *********recoding*******

. tabulate oedema3 outcome1, chi2
           |      outcome1
   oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |        11        17 |        28
         1 |         4        19 |        23
-----------+----------------------+----------
     Total |        15        36 |        51

          Pearson chi2(1) =   2.9156   Pr = 0.088

. tabulate oedema3 outcome2, chi2
           |      outcome2
   oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |        28         0 |        28
         1 |        21         2 |        23
-----------+----------------------+----------
     Total |        49         2 |        51

          Pearson chi2(1) =   2.5342   Pr = 0.111
```

```
. tabulate oedema3 outcome3, chi2
           |      outcome3
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |        22         6 |        28
         1 |        21         2 |        23
-----------+----------------------+----------
     Total |        43         8 |        51

          Pearson chi2(1) =   1.5479   Pr = 0.213

. tabulate oedema3 outcome4, chi2
           |      outcome4
  oedema3 |         0         1 |     Total
-----------+----------------------+----------
         0 |        23         5 |        28
         1 |        23         0 |        23
-----------+----------------------+----------
     Total |        46         5 |        51

          Pearson chi2(1) =   4.5536   Pr = 0.033

. *******notes to variables************
. notes oedema1 : 1=oedema 2=no oedema
. notes oedema3 : 1=oedema 0=no oedema
. notes outcome1 : 1=1
. notes outcome2 : 2=1
. notes outcome4 : 4=1
. notes outcome3 : 3, 5, 6, 7, 9=1
.
. save "C:\Documents and Settings\Marit\My Documents\Carla\werkset2_demographic.dta", replace
file C:\Documents and Settings\Marit\My Documents\Carla\werkset2_demographic.dta saved
. log close
log:  C:\Documents and Settings\Marit\My Documents\Carla\werkset2_demograpic.log
log type:  text
closed on:  19 May 2010, 15:00:08
-------------------------------------------------------------------------------------------------------------------------------
```

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