THE RISK FACTORS FOR SEVERE ACUTE MALNUTRITION AMONG THE CHILDREN OF AGE GROUP 6 – 59 MONTHS A COMMUNITY BASED CASE- CONTROL STUDY FROM SOUTHERN INDIA

A dissertation submitted in partial fulfillment of the requirement of

The Tamil Nadu Dr. M. G. R. Medical University

For the M. D. Branch XV (Community Medicine)

Examination to be held in April 2015

CERTIFICATE

This is to certify that "**The risk factors for Severe Acute Malnutrition among the children of age group 6 – 59 months a community based case- control study from Southern India"** is a bonafide work of Dr. Sam Marconi, in partial fulfillment of the requirements for the M.D. Community Medicine examination (Branch XV) of the Tamil Nadu DR M.G.R. Medical University to be held in 2015.

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ACRONYMS

WHO	World Health Organization
SAM	Severe Acute Malnutrition
MAM	Moderate cute Malnutrition
GAM	Global Acute Malnutrition
PEM	Protein Energy Malnutrition
AIDS	Acquired Immuno-Deficiency Syndrome
GSHS	Global School-based Student Health Survey
UN	United Nations
GHI	Global Hunger Index
NFHS	National Family Health Survey
MUAC	Mid-Upper Arm Circumference
HUNGaMa	Hunger and Malnutrition
UNICEF	Unite Nation International Children's Emergency Fund
WHZ	Weight-for-Height Z score
HAZ	Height-for-Age Z score
WAZ	Weight-for-Age Z score
MUACZ	Mid-Upper Arm Circumference Z score
ICDS	Integrated Child Development service Scheme
NCHS	National Centre For Health Statistics
SD	Standard Deviation
CI	Confidence interval
OR	Odds ratio
WFA	Weight for Age
WFH	Weight for Height
WCGS	WHO Child Growth Standards
MGRS	Multi-centric Growth Reference
TINP	Tamil Nadu Nutrition Project

MDG	Millennium Development Goal
PHC	Primary Health Centre
SC/ST	Schedule Caste/ Schedule Tribe
SES	Socioeconomic Scale
LBW	Low Birth Weight
CHD	Congenital Heart Disease
ARI	Acute Respiratory Infection
LRI	Lower Respiratory Infection
HIV	Human Immuno Deficiency Virus
TB	Tuberculosis
IQ	Intelligent Quotient
DALY	Disability Adjusted Life Year
GDP	Gross Domestic Product
CMAM	Community Management of Acute Malnutrition
RUTF	Ready to Use Therapeutic Food
F100	Formula 100 therapeutic milk
CHAD	Community Health and Development
LCECU	Low Cost Effective Care Unit
PI	Principal Investigator
BMI	Body Mass Index
RDA	Recommended Daily Allowance

ABSTRACT

Title: The risk factors for Severe Acute Malnutrition among the children of age group 6 – 59 months a community based case- control study from Southern India.

Department: Community Health department

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Degree and subject: M.D. Community Medicine

Name of the guide: Dr. Jasmin Helan Prasad

This study aimed to identify the various risk factors and determinants of severe acute malnutrition (SAM) as defined by WHO growth reference standards in children aged 6 months to 59 months living in Vellore.

Methods: A community based case-control study matched for age (±2months), gender and location was done among the children of the age group 6- 59 months residing in both rural and urban Vellore. Children of age group 6-59 months with SAM according to WHO definition, i.e., weight for height of less than -3SD with or without nutritional oedema were classified as cases. Children with weight-for-height z-score more than -1 SD and MUAC ≥13.5cms were classified as controls. With 2 controls per case, the required sample size was 54 cases and 108 controls. Structured and semi-structured questionnaires used to identify the risk factors including dietary intake. The Z scores were calculated using WHO anthro software. Analysis was done using SPSS v20. Uni-variate and multivariate analysis was done to generate an odds ratio and 95% confidence interval for the risk factors.

Results: A total of 160 children were recruited in the study. Among them 54 had severe acute malnutrition (cases) and 106 were controls. Majority of the cases 64.8% and 50% of the controls belonged to low SES. After adjusting all confounders, Severe Acute Malnutrition was significantly associated with birth weight <2.499kg {AOR- 8.95 (95% CI: 2.98-26.85)}, not exclusively breastfed for 6 months {AOR 4.67 (95% CI: 1.72-12.65)}, inadequate calorie intake {AOR 8.09 (95% CI: 3.15-20.82)} and mothers' underweight {AOR 6.87 (95% CI: 1.92-24.55)}.

Conclusion: From this study it was concluded that determinant factors of SAM were low birth weight, lack of exclusive breastfeeding, poor calories intake and mother's low BMI.

Key words: Children, Malnutrition, risk factors.

1 Introduction

Acute malnutrition is a public health problem of epidemic proportions. Right now 52 million children of the age group less than five years experience acute malnutrition and 34 million of them are bound to have Severe Acute Malnutrition (SAM). Deaths among children under the age of five years due to malnutrition is around 1 million every year(1). According to the World Health Organization(WHO), starvation and malnutrition are the hazardous conditions to the world's public health (2). Mortality rate among malnourished children in the countries like Congo, Bangladesh and Uganda is 5-20 times higher as compared to well-nourished children. Severe acute malnutrition can either be the direct or indirect cause of mortality/morbidity among children suffering from common childhood illnesses such as lower respiratory infection (LRI) and Diarrhea(3).

Decreased food intake, increased energy expenditure and poor health conditions lead to illnesses which results in a poor nutritional condition. Malnutrition is the principle mechanism which causes transmission of poverty from one generation to other generation. Malnutrition happens in the form of micronutrient deficiencies, stunting, and/or acute condition like SAM (1).

A Lancet article dated 2013 reports a 37% reduction in the prevalence of stunting among children less than 5 years of age in 2012 as compared to 1990. However, this reduction in global burden was not fast enough to bring down the malnutrition problem. Hence it is mandatory for global commitment to quicken the efforts.

Combating child malnutrition is of great public health importance to the future economic development and social well-being of countries. In order to adequately deal with the problem of child malnutrition, it is very important to know the causes and risk

factors of child malnutrition. It is essential to credit and acknowledge the current progresses in the possible initiatives necessary to bring down the burden of child malnutrition in developing countries(4). While the reason for child malnutrition is heterogeneous and interconnected, various research say that the main factors can be sub classified into different levels. The immediate causes of any child's nutritional status are due to poor dietary intake and habits. These determinants were influenced by other factors like food security, morbidity condition of mother and child, and also the environmental conditions(4).

The aim of this study is to identify the various risk factors and determinants of severe acute malnutrition as defined by WHO growth reference standards in children aged 6 months to 59 months living in both Vellore town (urban) and Kaniyambadi block (rural) of Vellore District, Tamil Nadu and to measure the association between the specific risk factors and SAM.

2 Justification

Malnutrition is one of the major public health problem faced by children under the age of five years in developing countries. The prevalence of malnutrition plays an important role in the economic burden of the society as well as the country. Malnutrition affects children in many ways, inclining them to various infectious diseases, cognitive deficiencies and psychosocial mal-development.

India has made advancement in reducing child mortality and hunger. According to international report, India is still short of development goals(5). India has brought down most of the known risk factors for SAM by improvement in social condition, educational status of the community, small family size and better functioning of public distribution system thereby decreasing the food insecurity level.

Even with the above said measures, childhood malnutrition is still life threatening and a burden to the community. There are unidentified risk factors still existing in the community causing malnutrition. Hence lot of efforts has to be taken to identify the factors to combat the malnutrition problem in India.

The prevalence of malnutrition in India and various part of India is relatively well documented, but there is very minimal information for risk factors of Severe Acute Malnutrition. So far, there have been many hospital based studies conducted to determine the risk factors for SAM. In this study a community based case-control study was done to determine the risk-factors of SAM among the children of age group 6-59 months residing in both Kaniyambadi block and Vellore town.

3 Objectives

1. To identify the various factors associated with Severe Acute Malnutrition (SAM) among the children of age group 6-59 months in Vellore district, South India

   Sub-objectives:

   1. To measure the association between the socio-demographic factors and SAM

   2. To measure the association between dietary intake of children and SAM

   3. To study the association between birth related factors, other morbidity and SAM

4 Literature review

4.1 Malnutrition in childhood:

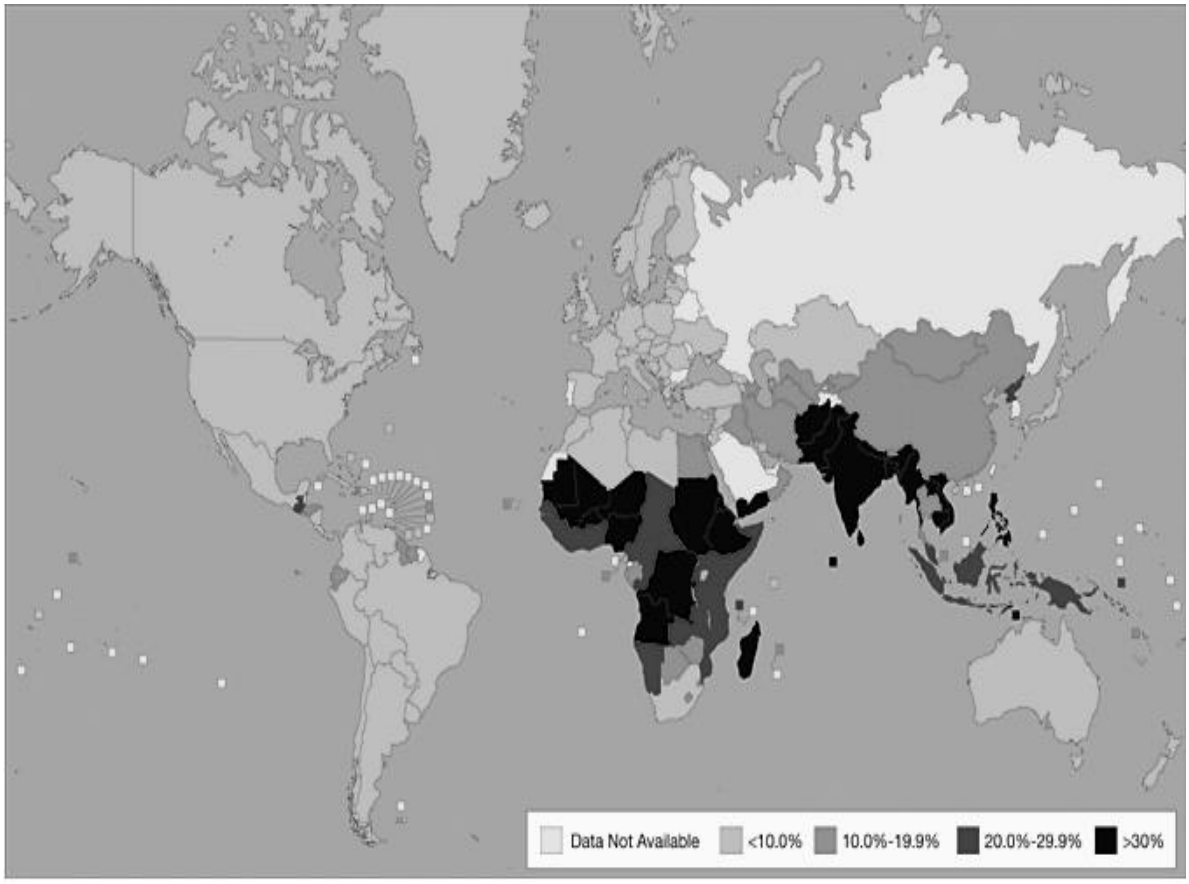
Malnutrition is a serious public health problem and a pathological condition that results when a person's diet contains inadequate amount of nutrients(6). Malnutrition refers to both under nutrition and over nutrition. In common usage the word malnutrition refers to under nutrition and protein energy malnutrition (PEM). The severe forms of PEM are marasmus, kwashiorkor and marasmic - kwashiorkor. The term severe acute malnutrition (SAM) combines all forms of PEM(7). Malnutrition contributes to more than one third of all childhood deaths(8). Globally, malnutrition is the major risk factor for all common childhood illnesses. It worsens the preexisting morbidity (9) and increases the risk of mortality(10).

4.2 Burden of malnutrition:

4.2.1 Global burden of Malnutrition:

According to a recent survey most of the under nutrition children are from developing countries like Africa and South Asia(11). In Africa and South Asia, 27-51% of women of reproductive age group are under weight, and it is expected that about 21% of their children will be underweight(12). The condition in Africa is likely to be due to the effect of AIDS epidemic, along with the political instability(13). Since malnutrition is associated with poverty and communicable disease, its prevalence is more among developing countries. The figure below illustrates the geographical pattern of underweight children globally.

Figure 4-1 Geographical distribution of underweight in children of less than 5 years:(13)



The prevalence of underweight and overweight are relatively high among adolescents in developing countries. Data collected from the global school-based student health survey(GSHS) in Africa revealed the unadjusted rates of malnutrition to vary from 12.6% to 31.9%(14).

In 2005, a nutritional survey done in 139 low and middle income countries (analysis of 388 nutritional surveys), estimated the prevalence of underweight in children aged 5 years and below to be 20.2%,.The prevalence of stunting and severe wasting was 32% and 3.5% respectively. Global prevalence of wasting (weight for height Z score less than -2) is estimated to be 10%(15).

The prevalence of malnutrition in different UN regions varied from country to country. Amongst these countries, the highest prevalence of underweight children was seen in South Central Asia and East Africa and was 33% and 28% respectively. The highest prevalence of wasting was 5.7%, which was seen in South Central Asia. Thus, among all the developing nations, South Central Asia is affected the most with childhood malnutrition(15).

Globally, underweight prevalence is expected to decline from 26.5% in 1990 to 17.6% in 2015, In developed countries, the prevalence is estimated to decline from 1.6 to 0.9 % (13), Whereas in developing countries, the prevalence is expected to decrease from 30.2% to 19.3%. Except for the sub-region of sub Saharan, in all other regions, the prevalence is projected to decrease in the year 2015.(13). The following table shows estimates and % of relative change in various regions of the world.

Table 4-1 Prevalence of underweight in 1990 and 2015:

s. no	Region	Estimates (95%CI) in millions		% of relative change(95% CI)
		1990	2015	
1.	Africa	25.8(25.2-26.3)	43.3(42.2-44.4)	68.3(62.7-74.1)
2	Asia	131.9(119.2-144.7)	67.6(53.4-81.7)	-48.8(-59.3 - -35.5)
3	Latin America	4.8(3.4-6.2)	1.9(1.1-2.7)	-60.2(-76.1 - -33.8)
4	Developing	162.6(149.8-175.5)	112.8(98.6-127.1)	-30.6(-40.2 – 19.5)
5	Developed	1.2(0.6-2.4)	0.6(0.1-2.6)	-54.1(-93.9 – 244.4)
6	Entire world	163.8(151-176.7)	113.4(99.2-127.6)	-30.8(-40.3 - -19.7)

4.2.2 Burden of malnutrition in India:

World Bank estimates India to be one of the highest ranking countries for childhood malnutrition(16). Globally, the prevalence of underweight children in India is high as compared to other countries in the world. According to World Bank, the prevalence of malnutrition in India is twice that of sub Saharan African countries. Though India has large number of nutritional programs, yet there is no progress in the nutritional status of children. (16)

In Global Hunger Index (GHI) Survey, India is ranked 15th amongst various developing countries with regard to the hunger situation. As compared to 1990, India has changed its position from its 'extremely' alarming state to alarming state of hunger.(17)

National family health survey 3 (NFHS 3) done in 2005-2006, measured weight, height, Mid upper arm circumference (MUAC) and skin-fold thickness of children aged 5 years and below. The degree of malnutrition was classified using 2006 World Health Organisation (WHO) child growth standards. The overall prevalence of malnutrition was estimated to be 19.8% for wasting, 6.4% for severe wasting, 48% and 42.5% for stunting and underweight respectively(18).

A survey done by the Naandi Foundation of Hyderabad for the Citizen's Alliance Against Malnutrition, released a report called HUNGaMa report in 2011. The report presented a data on anthropometric survey done among the 109,093 children under 5 years of age in 9 states (covering 3360 villages and 112 rural districts). According to Child development Index, 100 of these districts are the lowest ranking districts (termed 'Focused Districts') that is used by United Nations international children's emergency fund (UNICEF) India. Focused Districts are majorly found in the states of Bihar,

Jharkhand, Madhya Pradesh, Orissa, Rajasthan and U.P. Along with 100 Focused Districts, 2 best districts from 3 top ranking states i.e., 6 districts from Kerala, Tamil Nadu and Himachal Pradesh ware also studied(19). The following table shows the report of the HUNGaMa survey:

Table 4-2 The HUNGaMa survey- prevalence of Malnutrition:

	Prevalence in 100 focused districts	Prevalence in 6 best districts of focus states	Prevalence in 6 best districts of the best states
Wasting WHZ <-2	11.4%	12.4%	13.5%
Stunting HAZ <-2	58.8%	43.3%	32.5%
Underweight WAZ <-2	42.3%	32.6%	21.9%

From the above table, it is evident that the prevalence of malnutrition in India is still high. The HUNGaMa survey shows a positive deflection in improvement of child nutrition in India, even in the 100 Focused Districts (40% are underweight and 60% of children are stunted)(19).

4.2.3 Burden of malnutrition in Tamil Nadu:

In the year 2005 – 2006 NFHS III surveyed a sample of 6344 households which represents both rural and urban population. The response rate at the household level was 99% in this survey. Among the children surveyed, 31% of the children aged less than 5 years were stunted for their age group, 22% of them were too thin for their height and

30% of them were underweight (includes chronic and acute malnutrition(20). Following table shows the prevalence of malnutrition and difference between Tamil Nadu and India(20).

Table 4-3 Prevalence of malnutrition- comparison between Tamil Nadu and rest of India

	All India	Tamil Nadu
SAM (WHZ <-3)	6.4%	8.9%
WASTING (WHZ <-2)	19.8%	22.9%
STUNTING (HAZ <-2)	48.0%	30.9%
UNDERWEIGHT (WAZ <-2)	42.57%	29.8%

A total of 547 children in rural Tamil Nadu affected by tsunami were studied. The Study revealed that 29.8% of the children were malnourished and among them 12.9% of the children were severely malnourished(21). Another study, conducted in 14 villages of Veddapatti block, Coimbatore examined 797 children of age group 6 months to 36 months by an anthropometry survey. Among the study population, 38.89% of them were malnourished with the female gender being affected predominantly. (22)

4.2.4 Burden of malnutrition in Vellore:

Among the 176 children studied from semi- urban slum located in Vellore, one third of the children were stunted by the age of 2 years. Two third of them experience at least one episode of growth failure during 2 years of follow up.(23) It also showed that

the prevalence of malnutrition was on an increasing trend between 6 months to 18 months of age, and decreased after 24 months(23).

In an unpublished study done in Vellore among the urban children of age group 2-5 years attending Integrated Child Development Service Scheme (ICDS) center in 2012, estimated the prevalence of SAM to be around 3.7%.

Table 4-4 Prevalence of malnutrition in Vellore:

	Vellore ICDS urban project 2012	Tamil Nadu NFHS3
SAM (WHZ <-3)	3.7%	8.9%
WASTING (WHZ <-2)	22.3%	22.9%
STUNTING (HAZ <-2)	39.3%	30.9%
UNDERWEIGHT (WAZ <-2)	42.8%	29.8%

As compared to rest of Tamil Nadu (according to NFHS 3 data), the above mentioned study has a lower prevalence of severe wasting, similar prevalence of wasting and higher prevalence of stunting and underweight.

From the above literature, it is clear that the burden of under nutrition is high in India.

4.3 Measuring malnutrition:

Anthropometric information can be used to measure the individual's nutritional status. It also helps in identifying the prevalence of malnutrition among the population being surveyed.

The basic information needed to measure anthropometric measurements are: (24)

1. Age
2. Sex
3. Length/ height
4. Weight
5. MUAC
6. Edema

4.3.1 Measurement of malnutrition in children less than 5 years:

To know the child's nutritional condition, the child's nutritional status is compared with healthy children who are considered as a reference population. The references are helpful in comparing a child's status with the median children of the same gender and age(24). The WHO globally accepted the reference created by CDC and its National Centre for health Statistics (NCHS)(25).

Expression of nutrition indices:

1. Standard deviation, or Z score
2. Percentage of Median
3. MUAC
4. Edema as a confounding factor

4.3.1.1 Standard deviation or Z scores:

Worldwide accepted method to measure malnutrition is to assign Z-score, which is also known as Standard deviation (SD) score. The *Z*-score expresses the values as

several standard deviations (SDs) below or above the median of the healthy reference population(26). Following formula summarizes the Z score:

$$z - score = \frac{(observed\ value\ of\ child - median\ value\ of\ the\ reference\ population)}{standard\ deviation\ of\ reference\ population}$$

Z-score notations:

1. WHZ – weight for height Z score
2. HAZ – height for age Z score
3. WAZ- weight for age Z score
4. MUACZ – mid upper arm circumference Z score

4.3.1.2 Percentage of median:

Another method is the percentage of Median which is commonly used as admission or discharge criteria for selective feeding programs. Percentage of median is the ratio (expressed in percentages) of the child's weight to the median weight of a child of the same height in the reference population.(24)

$$percentage\ of\ median = \frac{measured\ weight\ of\ the\ child}{median\ weight\ of\ the\ reference\ population} * 100$$

4.3.1.3 Mid - upper arm circumference: (MUAC):

MUAC is the one of the anthropometric measures used to measure wasting. It is the circumference of the left upper arm at the midpoint between the shoulder (acromion) and the elbow (olecranon process)(27).

It is an indicator of malnutrition (acute) independent of child's age and the gender. During severe malnutrition, subcutaneous fat decreases which results in decrease

in MUAC. Due to its simplicity and acceptability, it is readily available to use when other equipment are not available to use(27). Following table shows interpretation of MUAC measurements.(28)

Table 4-5 Interpretations of MUAC measurements

Measurements	Degree of malnutrition
>13.5 cm	Normal
13.5- 12.5 cms	Mild malnutrition
12.4-11.5 cms	Moderate malnutrition
<11.5 cm	Severe malnutrition

4.4 Classification of malnutrition:

Malnutrition classified based on:

1. Anthropometric classification - quantitatively
2. Clinical classification – qualitatively

4.4.1 Anthropometric classification:

Anthropometry is used not only for monitoring growth and nutritional assessment, it is also used to classify malnutrition(29). Based on anthropometric, malnutrition has been classified into three forms:(30)

1. Wasting
2. Stunting

3. Underweight

1. **Wasting:** Child is said to be wasted if the weight of the child is lower when compared to the weight of a healthy child of the same height and gender. Wasting occurs as a result of severe malnutrition(31). It may result from an acute shortage of food and from underlying medical problems(32).

2. **Stunting:** The child's height is lower than what is expected of a healthy child of the same age and sex. It results in failure to achieve growth's biological potentials. It results from chronic and past malnutrition(31)(32).

3. **Underweight:** The child's weight is less than what is expected for that age and sex. It's a composite of stunting and wasting. (31)

There are different types of anthropometric classifications based on weight for age, height for height, mid-upper arm circumference, and presence/absence of edema.

Table 4-6 Different types of anthropometric classification: (33)

Classification	Definition	Grading	
Gomez	Weight below % median WFA	Mild – grade 1	75%- 90% WFA
		Moderate- grade 2	60%- 74% WFA
		Severe – grade 3	< 60%WFA
Waterlow	SD below median WFH	Mild	80%- 90% WFH
		Moderate	70%- 80% WFH
		Severe	<70% WFH
Kanawati	MUAC divided by occipitofrontal head circumference	Mild	<0.31
		Moderate	<0.28
		Severe	<0.25

4.4.2 Clinical classification:

Different types of clinical classification are available. The most commonly accepted and used is Wellcome classification. It classifies children as undernourished, kwashiorkor, marasmus or marasmus kwashiorkor(31).

Table 4-7 Welcome Classification of PEM:

Weight for age (% of reference standards)	Edema	
	Present	Absent
80-60	Kwashiorkor	Undernourished
<60	Marasmus	Marasmic kwashiorkor

4.4.3 Classification of acute malnutrition, according to severity: (34)

According to WHO/ UNICEF,

1. Moderate acute malnutrition (MAM):

   Weight for height Z score is <-2 but ≥-3

2. Severe Acute Malnutrition (SAM):

   MUAC<11.5cms

   Weight for height Z score is <-3

   Bilateral pitting edema

   Marasmic-kwashiorkor (both wasting and edema)

3. Global Acute Malnutrition (GAM):

   Prevalence of both SAM and MAM at certain population levels.

4.5 Severe Acute Malnutrition: (SAM)

SAM is a new terminology, coined by the World Health Organization (WHO) and UNICEF in 2009. It represents severe wasting, kwashiorkor or marasmic kwashiorkor. The main purpose is to identify the children who are at risk of death due to severe wasting and to find out the children who would benefit from nutritional therapy(35). It is defined for children of age 6 months to 59 months (5 years). The diagnostic criteria are:(35)

1. WHZ - Weight for height Z score less than -3 (according to 2006 WHO child growth standards
2. MUAC less than 115 mm
3. Bilateral pedal edema

If any one of the above mentioned criteria is fulfilled, then a child is identified as having Severe Acute Malnutrition (SAM).

The above mentioned diagnostic criteria for definition of SAM is modified from 1999 WHO definition of severe malnutrition. In 1999, only – 3 SD of the NCHS reference and/or pedal edema was used.

The significant changes in the new diagnostic criteria are:

1. Inclusion of MUAC (<11.5 cms)

2. Change of reference population from NCHS to 2006 WHO child Growth standards (WCGS) which was based on WHO multi- centric growth reference study.

The WHO multi-centric growth reference study (MGRS) is as follows:(36):

a. MGRS undertaken between the year 1997 and 2003
b. It developed to assess the growth and development of the young children and infants around the world
c. Collected primary data on around 8500 children from the widely different ethnic group and from different cultural background
d. Data collected from- Brazil, Ghana, India, Norway, Oman and the USA
e. It's expected to provide a single standard reference that represents children internationally
f. It describes the physiological growth of children from birth to five years of age

4.6 Causes of malnutrition:

According to UNICEF, the different causes of malnutrition are interconnected, which includes (7)

1. Immediate cause
2. Underlying cause
3. Basic cause

Table 4-8 Underlying reasons for cause of malnutrition:(7)

Immediate cause	Underlying cause	Basic cause
• Inadequate diet • Stress and trauma • Disease • Poor psychosocial care	• Household food security • Inadequate maternal and child care • Inadequate health service and Environment • Information and education	• Poor availability and control of resources • Poor environment • Agricultural degradation • Instability of the politics • Urbanization • Population size, growth and distribution • Natural disasters • Religious and cultural factors

4.7 Theories of malnutrition:

1. The classical theory
2. Gopalan's theory of dysadaptations
3. Golden's theory of free radical

4.7.1 The classical theory:

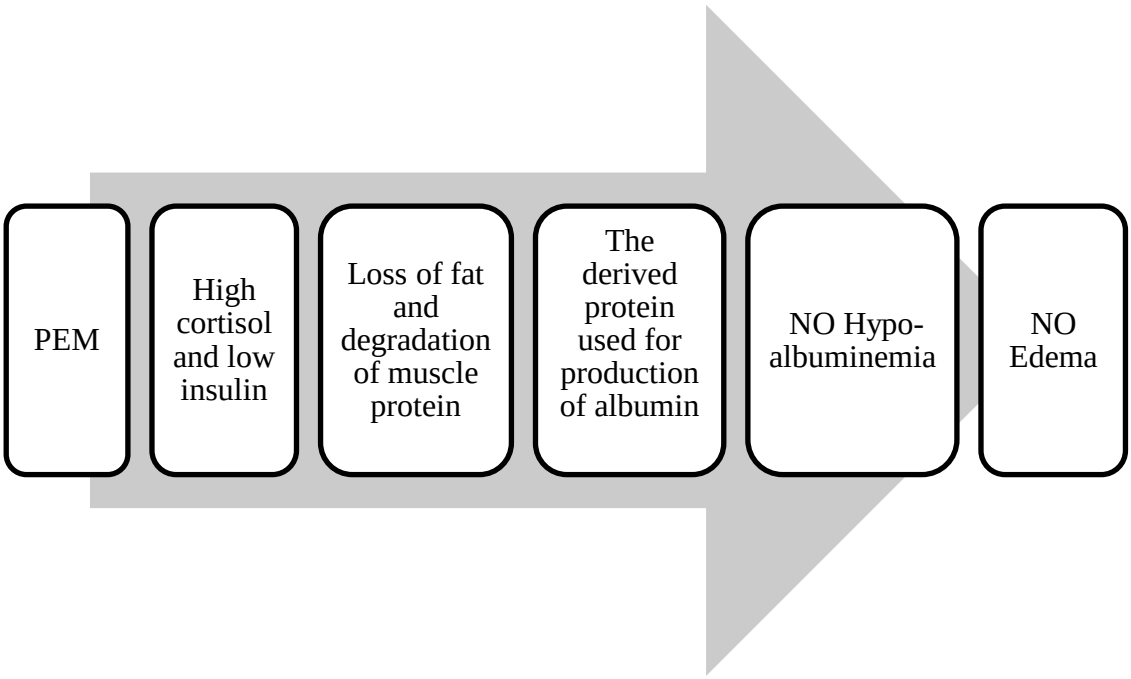
This theory was proposed by Williams. The concept ascribes that marasmus to protein and calorie deficiency, whereas kwashiorkor to high-carbohydrate and low protein diet. The marasmus occurs due to early sudden weaning followed by starvation

and infection contributing to the wasting. Kwashiorkor was due to late weaning and repeated infections leading to malnutrition with edema(37).

4.7.2 The dysadaptation theory:

This theory was proposed by Gopalan. This theory suggests that the children with marasmus adapted to the deficient protein calorie intake. These children follow the adaptation theory and hence free from the edematous malnutrition. The following figure explains the adaptation theory(37).

Figure 4-2 Adaptation theory

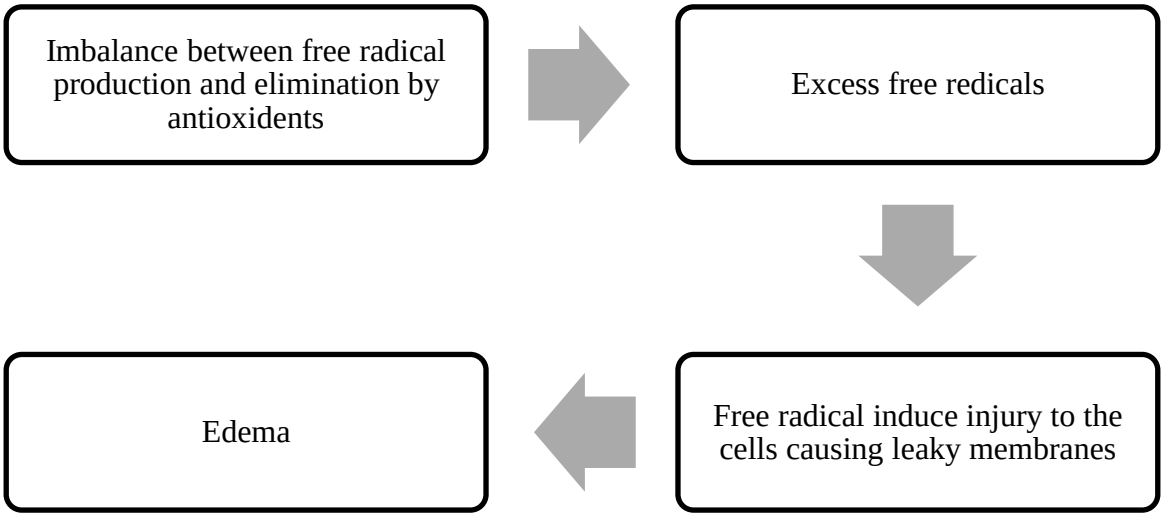


In kwashiorkor, this adaptation theory failed to occur. In these children, the dietary protein was used for energy production. In response to frequent infection, dietary protein used for production of acute phase reactants. Hence the child with kwashiorkor develops hypoalbuminemia and eventually develops malnutrition with edema(37).

4.7.3 Golden's free radical theory:

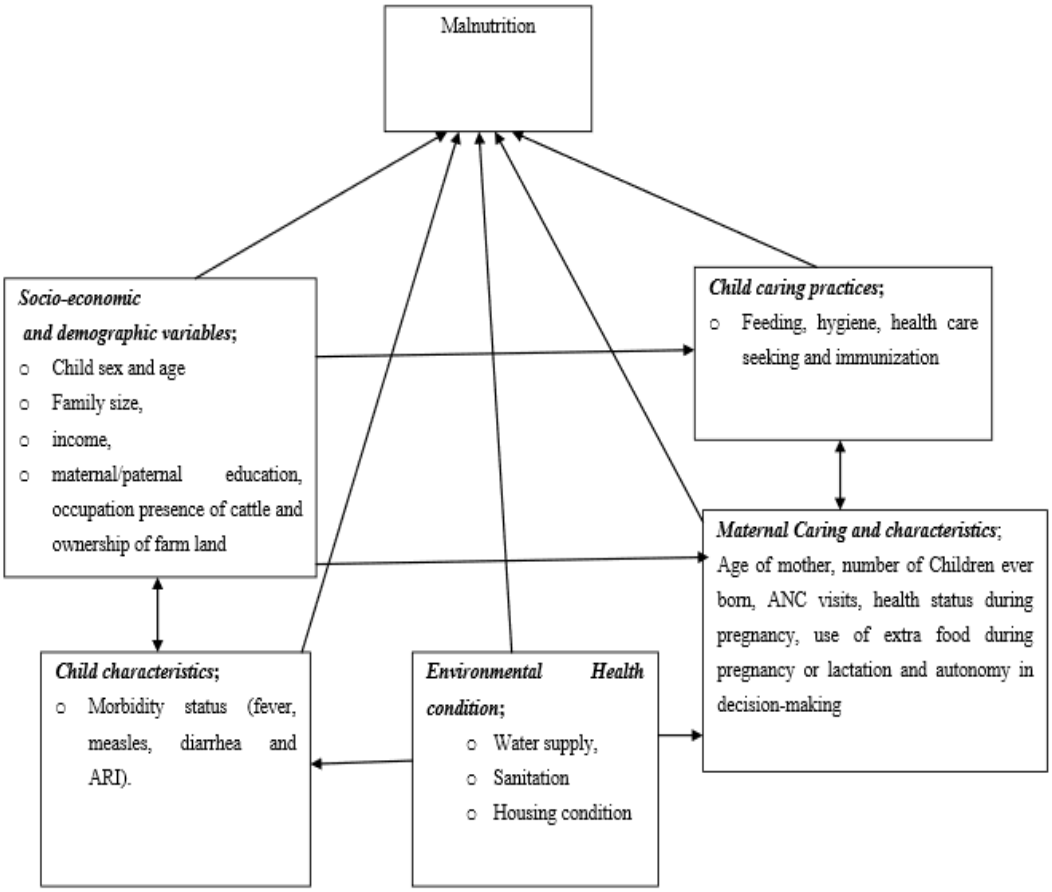
Gopalan's theory failed to explain all the features of kwashiorkor. It is the currently accepted theory for PEM. The following figure explains the free radical's theory which causing edema in the Marasmic child(37).

Figure 4-3 Free radical theory



4.8 Factors associated with Malnutrition:

Figure 4-4 Various factors which are interconnected with malnutrition:



Five categories of factors are considered to be associated with Malnutrition**(38).**

1. Socioeconomic and Demographic variables
2. Child Characteristics
3. Environmental characteristics
4. Child care practices
5. Maternal and paternal caring and characteristics

4.8.1 Socioeconomic and demographic variables:

Gender of the child, place of residence, types of family, religion, caste, head of the household and the number of people who share a common kitchen, socioeconomic status are few socio-demographic variables which are associated with malnutrition.

4.8.1.1 Gender:

The child being a girl is considered as a risk factor for Malnutrition. A case-control study conducted in rural Tamil Nadu , among children of age group less than 5 years states that female gender(OR- 3.44, p= 0.02) was a significant risk factor for malnutrition(39).

In another study conducted among Children (n=2954) attending the Tamil Nadu Integrated Nutrition Project(TINP), funded by World Bank, clearly showed the evidence of association between female sex and malnutrition(40). Similar study done in Mumbai also showed that sex of the child was significantly associated with malnutrition(41).

Whereas a study done in Chandigarh among preschool children did not show any statistical association between the gender and malnutrition(42).

4.8.1.2 Residence:

A study was done in sub-Saharan Africa to see the level and pattern of rural-urban differential in childhood malnutrition. It used data from health surveys of fifteen Sub- Saharan African countries. The study showed a considerable difference in urban and rural, primarily due to increase in urban malnutrition. Study also recommends Millenium Development Goals (MDGs) should focus on urban poor to combat the malnutrition(43).

The evidence from 36 developing countries showed urban children had better nutritional status when compared to rural children. But recent research suggest that prevalence of malnutrition among urban children is on the rise(44). Studies show that malnutrition in Delhi and Mumbai are prevalent when compared to developed nations like United States and Italy. On comparing the stunting status, children of Delhi and Mumbai are twice as stunted as children from Pakistan (stunting 27%)(45). Another study done in Rural Meerut, showed that the prevalence of malnutrition is more in rural area as compared to urban area, as children in urban experience better care from parents than rural children(46).

4.8.1.3 Family:

A cross sectional study was done in a primary health care centre (PHC) in Machhra block of Meerut district, covering 406 children of age group 1 – 6 years old. The burden of PEM was higher ($p < 0.05$) in the nuclear family (63.8%) when compared to joint family (52.9%). This was because the children in the joint family were nutritionally cared better as there was inclination by all the family members to share the food with the children(46).

4.8.1.4 Religion:

A case- control study was done in Bangladesh to identify risk factors for marasmus. The study showed that religion has a strong association with malnutrition. It is statistically significant for children aged 18months or more(47). According to HUNGaMA survey, children belonging to Muslim religion have poor nutrition on the whole.(19)

4.8.1.5 Caste:

The HUNGaMa survey report says that, children who belong to schedule caste or schedule tribe (SC/ST) caste have very poor nutrition as compared to other castes which exist in India. The specific effects may vary considerably state by state(19). A study done in Allahabad (U.P) showed the highest prevalence of Malnutrition i.e., 56.63% in children belonging to Scheduled caste (SC) followed by backward caste. The most probable cause is the large family which is more prevalent among schedule caste than any other backward caste.(48)

A commentary published in economic and political weekly says that the nutritional status of SC/ST and Muslim communities are significantly lower than the other social and religious groups. Approximately 58% of SC Muslim children are malnourished when compared to their particular group's average. In the same study, after adjusting for various factors, by a logistic regression model, the chance of SC/ST children becoming malnourished is 1.4 times that of children from other social groups. (49)

A study was done in northern India, to identify the gap in child malnutrition between the ST/SC and rest of the Indian population. The study showed that gap was primarily due to ST/SC's lower wealth, underutilization of health services and poor education(50).

4.8.1.6 Family Size:

Positive correlation is noted in the case of Family size and malnutrition. As the number of living children increases, the chance of one of the children becoming

malnourished is very high. A study done in Pakistan observed prevalence of malnutrition was 66.7% among the cases if the family had more than 4 living children(51). Another study done in Ethiopia, showed that family size of more than 3 children was a risk factor for severe acute malnutrition with an odds Ratio of 1.96 (95% CI 1.04- 3.73)(52).

In a study done in Candelaria, Colombia with 1094 children under the age 6 years showed that malnutrition is not so evident in the families where the number of children was 4 and less(37.8%). Whereas in the families with more than 4 children, 44.1% of children were malnourished(53). Similar study done in Colombia and Thailand, showed the difference in the number of living children between the cases and controls was statistically different. Mothers of cases had 4.1 living children as compared to mothers of controls who had 3.6 living children(54). Another study done in Gwalior showed better nutritional status of children with smaller family size(55).

4.8.1.7 Socio- economic status: (SES)

SES plays a major role in determining the nutritional status of any individual in the family. A study done in Rajasthan with 1000 under 5 children revealed 82% of the underweight children belonged to the low SES group(56). In 2003, a study done in Nigeria, among 4187 children showed contrasting results, the study showed narrow gap between the richer and the poorer on malnutrition(57). Another similar case-control study of maternal knowledge of malnutrition and health-care-seeking attitudes in rural Tamil Nadu, showed that SES has a stronger association for malnutrition than availability of health care and attitude towards health seeking behaviours among mothers(58).

Increasing rural income increases the food security in terms of food accessibility, and thereby reducing malnutrition significantly in countries with very low income. A 40% reduction in prevalence of malnutrition has been witnessed by doubling per capita income. Evidence shows poor malnourished rural households to have lower incomes than non-malnourished rural households(59).

4.8.1.8 Food security:

Hunger has direct effects on the health of many people around the world. Even those who have access to food suffer from malnutrition due to various reasons. Children suffer from malnutrition but also to common communicable disease due to their susceptibility to illness. Hunger and malnutrition, together directly affects economic development of the country(60).

In a study done during 2011-2013, 842 million people were estimated to be affected with chronic hunger, and poor access to adequate food to lead a normal life(61). A case- control study done in Malaysia on 274 children (137 children in each arm), showed malnutrition was significantly associated with child hunger (aOR 16.38 05% CI: 1.34-199.72), a low Calorie intake (aOR- 0.99, 95% CI – 0.98-0.99), low birth weight (aOR- 6.83, 95% CI- 1.62- 28.89) and any acute illnesses (aOR- 2.79, 95% CI 1.06-7.31)(62).

4.8.2 Child Characteristics:

Low birth weight (LBW), pre-term, birth order, birth spacing, congenital disorder, feeding practices are few of the child related factors associated with SAM.

4.8.2.1 Birth weight:

According to NFHS3 data, LBW is the major determinant of child's chronic malnutrition(63). Low birth weight and Malnutrition reflects the poor nutrition status of the mother and young girls through their life cycle. A vicious cycle of LBW and malnutrition developed which is transmitted across many generations. Thus, LBW become an major determinant of malnutrition among children(64).

A study done in urban Indonesia showed that LBW (birth weight < 2500 grams) was strongly associated with stunting of the child. It also states that LBW children have poor growth compared to children with normal birth weight(65). A similar study done in south Africa also showed that malnutrition was not so prevalent among children whose birth weight was more than 2500 grams(66).

4.8.2.2 Pre-Term:

Malnutrition in pre-term children has adverse neurodevelopmental and growth effects. Regular nutritional practice is not sufficient enough for the preterm baby to grow. Hence fortified formula feed is recommended for pre-term babies. Failure to meet daily requirement eventually leads to failure to thrive and severe malnutrition in the later life of these children(67).

4.8.2.3 Birth Order:

Study done in Uttar Pradesh revealed that in children with birth order three and lower, the chance of malnutrition in later life was lower as compared to children with birth order four and above(68). A study done in rural Maharashtra did not show any statistical significant association between birth order and malnutrition(63). In many

studies, birth order was found to be significant in uni-variate analysis, but after adjusting for various other factors like low birth weight it became insignificant(63). Another study done in Uttar Pradesh projected that malnutrition was not a problem among the children whose birth order is either one or two.

Malnutrition is significant in children of birth order 4 and above(22). A cross-sectional study done in Hooghly district, West Bengal, showed a strong association between female child of a higher birth order and malnutrition compared to male child(69). Another study showed high prevalence of malnutrition among the first order children compared to other siblings in the family (48).

4.8.2.4 Birth spacing:

In 1996, a study was done by Ricci and Becker to find a correlation between malnutrition and the birth spacing between the siblings. The study states that, malnutrition was evident when the age gap between the two children was less than 24 months. Also in a study done in Bangladesh, revealed that the chance of becoming malnourished was reduced as the birth space between the two siblings increased(70).

4.8.2.5 Congenital Disorder:

A hospital based, retrospective study done in the USA showed a strong association between the malnutrition and congenital heart disease. Acute or chronic malnutrition occurred in 70% of children with congenital heart disease (CHD) ($p<0.001$). They concluded the study stating that malnutrition is very common among the children with CHD(71).

4.8.3 Environmental characteristics:

A Study done on 802 children in Southern Brazil showed that environmental characteristics such as type of housing, overcrowding, sewage disposal are strongly associated with malnutrition. The study also showed that, no access to treated or piped water were significant for stunting and wasting(72). Another study done by World Bank showed that, poor access to water and sanitation at the village level was significantly associated with malnutrition(73).

4.8.4 Child caring practices:

Among the child care practices, feeding practices have direct association with malnutrition.

4.8.4.1 Feeding practices:

The main cause of malnutrition in childhood was inappropriate feeding practices which includes late initiation of breast feeding, lack of exclusive breast feeding, late onset of complementary feeds, inappropriate weaning foods. Initiating breastfeeding within an hour of life can bring down neonatal mortality by 22%. Nearly 16% of neonatal mortality can be prevented if all children under the age of one were breastfed. Breastfeeding has a positive effect on bringing down the no. of under-5 mortality. A major cause for diseases like pneumonia and diarrhea is the lack of exclusive breastfeeding, unhygienic bottle feeding practices and infant formula feeds(74). Data from NFHS 2 (1998-99), was analyzed to check whether recommended feeding practices prevents children from malnutrition. At the end, the report concluded to avoid bottle

feeding advised direct breastfeeding. Exclusive breastfeeding for the first 4–6 months and introduction of supplementary feeding at 7^{th} month prevent child from malnutrition(75).

A Study done in Allahabad to determine the effects of feeding practices on malnutrition showed initiation of breast-feeding after 6 hours of birth, not giving colostrum and poor complementary feeding techniques were the significant ($P<0.05$) risk factors for malnutrition(76). WHO reported inappropriate feeding as the main cause for one-third of the malnutrition. A cross-sectional study was done to assess the burden of malnutrition and association between feeding practices and malnutrition among under-5 years of age children in poor counties of China. About 2201 children and caregivers were studied about feeding practices. The health status of the children was assessed using height, weight and MUAC. The report says, low prevalence of exclusive breastfeeding (only 17.5%) was noted in the study population. A report also claims that, higher prevalence of malnutrition was seen in the children who were never breast fed in their life time. The study suggested to increase caregivers' knowledge on feeding practices to improve the health status of children in remote areas(77).

4.8.5 Child morbidity:

4.8.5.1 Diarrhoeal disease:

Children suffering from diarrhoea have underlying malnutrition, which in turn worsens the diarrhoea. Each episode of diarrhoea makes the underlying malnutrition even worse. Diarrhoea is one of the leading cause of wasting and underweight in children under 5 years old(78). Persistent diarrhoea leads to sudden weight loss and malnutrition among children who are previously healthy. Both malnutrition and diarrhoea often occurs in the same child. The one condition often worsen the other(79).

A study done in Kenya revealed a strong correlation between diarrhoea and malnutrition (the correlation coefficient is 0.8). Among the study population, one fourth of the children were at risk of malnutrition(80). A Hospital based study done in Hyderabad showed that most of the children with malnutrition had associated diarrhoea resulting in high case fatality.(81). A study done in Chad (Africa), showed that occurrence of diarrhoeal episode in the past 2 weeks was a strong risk factor for malnutrition(OR-10.72% , 95% CI 4.27-26.88, p= 0.000) (82). A prospective study done in Sukkur also showed malnutrition among children who experienced recurrent diarrhoea in the past(51).

4.8.5.2 Respiratory infection:

A study done in Brazil was used to observe the association between acute respiratory infection (ARI) and malnutrition in children of less than 5 years of age. In that study, Malnutrition was associated with acute respiratory infection, after adjusting for confounders (OR: 2.03; 95% CI: 1.202.43). In the same study, a positive correlation was seen between malnutrition and child death due to respiratory infections like pneumonia. Among under-5 of age children, acute respiratory infections (ARIs) was the most common reason for high mortality and morbidity. ARIs contribute about 30–50% of consultations in pediatric OPD and almost 20–40% of hospitalizations in children's hospital. The major risk factors and leading cause of ARIs were poverty, low monthly income, maternal and paternal illiteracy, lack of exclusive breastfeeding, faulty feeding practices and malnutrition(83).

Measles is a viral respiratory infection having very severe adverse effect on the nutritional status of the children. About 3-4% of children who had measles, usually

experience malnutrition during the post viral period. When compared to African children, Asian children experience less mortality due to measles. Malnutrition worsens the primary illness leading to higher mortality(84).

4.8.6 Parental characteristics:

Parental education and occupation, illnesses in any one parent may affect the nutritional status of children.

4.8.6.1 Parents' Education:

According to HUNGaMa's survey, mother's education determines the nutritional status of the children. Among the 100 focus districts, 66% of the mother did not attend school in their life time. Stunting and wasting was more prevalent in the children of illiterate mothers. The prevalence of underweight children was around 45 % among mothers who cannot read and write in any one language. Among mothers who had 10 years of schooling, the prevalence of malnutrition of their children was around 27 %(19). A study done in Bangladesh, showed parental education was a significant risk factor for malnutrition(70). A study done by Nutrition unit of All India Institute of Medical Sciences, revealed a strong association between malnutrition and maternal literacy ($P < 0.025$). In the same study, father's education was not associated with child's nutritional status(85).

A methodological survey was undertaken in Sri Lanka, to study the burden of malnutrition and factors contributing to it. The study was done on children of age 5 years and less. The study showed that, 25 % of children whose mother had low education had a strong association with their child's under nutrition (22). Another study done in west

Bengal on 600 children of 5 years and less, showed, illiteracy of both the parents as a significant risk factor for malnutrition(86).

4.8.6.2 Parents' Occupation:

Mothers play a major role in the family. Absence of mothers, affects the well-being of the children and all the family members. Mother's employment status has a direct effect on child and influences the child feeding practice, in turn affects the child's nutritional status. A study done by Miller, claims that children of mothers working in an irregular shift have a high chance of becoming malnourished compared to the children of mothers working in a regular timely shift. A similar study was done in Malaysia explored that, working mothers tend to stop breastfeeding much earlier as compared to unemployed mothers(87).

4.8.6.3 Mother's knowledge on nutrition:

A case control study was done in rural south India to explore the mother's knowledge on malnutrition. In that study, both the case and the control group showed a significant difference in the knowledge of malnutrition (OR = 2.62, p = .05)(58).

4.8.6.4 Decision making power:

A woman's status in the community determines the child's nutritional status. A study done in South Asia, Sub- Saharan Africa and Latin America, tried to assess the association between woman's status and child's health status. The study reveals that, women with low social status have poor control over resources, poor access to health information, and very poor self-esteem. Above said factors directly affects the women's own health and nutritional status, which in turn, affects their children's birth weight, and

eventually decreases the nutritional status of their children at an earlier stage in life. Data of 117,242 children from 36 countries showed, higher the women's social status , greater is the effect on child's health and nutritional status(88).

4.8.6.5 Parent's illness:

A study done in South Africa showed that, Human Immuno-deficiency Virus (HIV) in the family (OR 217.7, 95% CI 22.7 – 2091.3), history of contact with the Tuberculosis (TB) contact (OR 3.2, 95% CI 0.9-11.0) is a significant risk factor for malnutrition among children(89).

4.9 Effects of childhood Malnutrition:

Due to malnutrition a child undergoes reduction in weight, illnesses due to reduced protein and calorie intake, and developmental delay. They also have several macro and micro nutrient deficiencies. Hence in danger of developing long term and short term implications(90).

4.9.1 Short term implications:

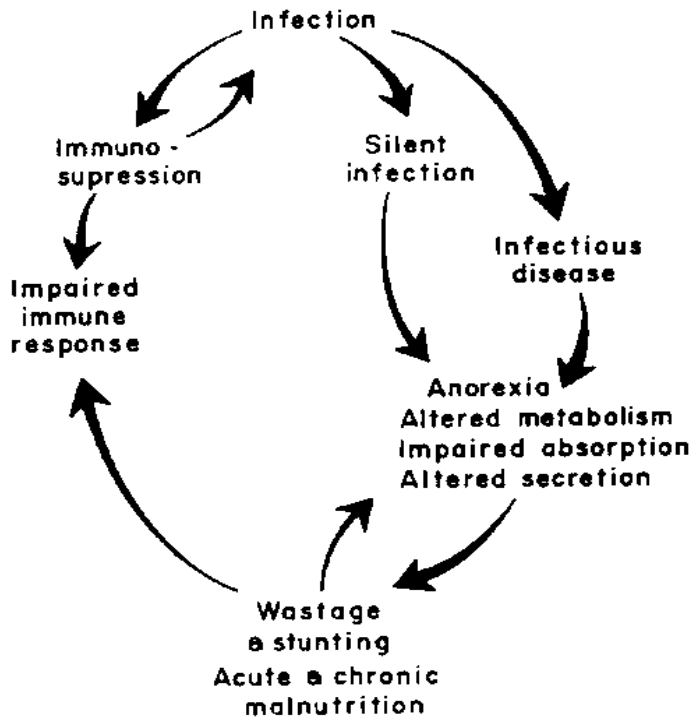
Major growth developments take place before 2 years of age. Hence nutrient deficiencies can have effects and consequence in young children(90).

4.9.1.1 Immune implication:

Nutrition is the major determinant of immune system in the body. Worldwide, malnutrition is the most common cause of immunodeficiency. Malnutrition is associated with a significant dysfunction of cell-mediated immunity, the function of phagocyte, impairment in the complement system, altered secretory immunoglobulin A antibody concentrations, and production of cytokine. Altered immune responses were perceived as

a result of nutrient deficiency. Among the micronutrients, vitamin A, vitamin C, vitamin E, vitamin B6, folic acid, selenium, zinc, copper and iron have great impact on immune responses. Low-birth-weight infants have a long term dysfunction of cell-mediated immunity that can be restored by dietary zinc intake(91).

Figure 4-5 showing immune implication in malnutrition: (92)



4.9.1.2 Growth Implications:

Nutritional deficiencies commonly occur in young children. Due to poor nutritional status a child may contract an infection like gastrointestinal infection. In turn, a gastrointestinal infection causes mal-absorption of nutrients and puts the child at even greater risk of nutritional deficiencies. Consequently, nutrient deficiency combined with infection can cause growth retardation.

Additionally, deficiency in one essential nutrient leads to deficiency in other nutrients. For example, deficiencies in Zinc and Magnesium cause anorexia. This anorexia leads to inadequate intake of proteins and other micronutrients. Hence, inadequate intake coupled with poor absorption of zinc and protein can retard bone growth and development. This in turn leads to long term complications.(90).

4.9.2 Long term implications:

The short-term implications eventually lead to long-term complications, such as growth and cognitive implications.

4.9.2.1 Cognitive Implications:

Chronic Malnutrition causes delay in motor and cognitive development, such as(90):

- Attention deficit disorder
- Poor school performance
- Low IQ scores
- Impaired memory
- Dyslexia
- Socially deprived
- Poor language skills
- Poor mathematical skills

4.10 Consequences of malnutrition:

The various consequences are not understood because of their hidden characteristics. More often victims themselves are not aware of their condition because of

the non-existence of signs. Malnutrition sets up early in life and eventually makes the child more malnourished by the end of second year of life. Since the damage to the child has already set in by 2 years of age, the recovery of the child from after- effects become less likely(93).

The various consequences are:

1. Increased risk of mortality and morbidity
2. Low productivity
3. Poor school performance and attendance
4. A vicious cycle (poverty perpetuation)
5. Intergenerational cycle

4.10.1 Increased risk of mortality and morbidity:

Malnutrition considerably decreases the resistance to infection and increases the chance of mortality and morbidity (33). The reports on the child's weight for age from 53 countries (developing) states that 56% of the child death is mainly due to malnutrition and it's after effects. In the same report, the mortality due to malnutrition ranges from 13% to 66%. This obviously shows that malnutrition has greater impact on child survival and morbidity(94). According to a study done in Atlanta, children with moderate form of malnutrition are at risk of dying 2.2 times more than normal healthy children at the end of 2 years of follow-up. Whereas in severely malnourished children the risk of dying is 6.8 times more as compare to healthy children at the end of two years of follow-up(95).

A study was done to know the relationship between the anthropometric indicator and the child mortality in 12 Asian and African countries. Among the children studied,

20% to 75% of the child mortality was mainly due to anthropometric deficit only. Surprisingly, mild-to-moderate malnutrition causes 16% to 80% of all nutritional related mortality rather than severe malnutrition(96).

Registrar General of India released a survey report on 'Causes of Death – 2001-03 in India'. The report says that 2.8% of death in children aged 0-4 years was caused by nutritional deficiencies. Whereas in the age group 5- 14 years, 1.8% of the deaths were due to nutritional deficiency(97).

4.10.2 Low productivity:

Nutritional development contributes to increased productivity, development of the economy, and reduction of poverty by reducing morbidity and mortality(98).

According to WHO, in the developing world underweight was the leading risk factor for morbidity. In nations with high child mortality, underweight leads to almost 15% of the total disability-adjusted life years (DALY) losses. Whereas in the developed nations, 7.4 percent of DALY losses is due to overweight and was ranked as the seventh risk factor(99).

Childhood malnutrition has a direct impact on economic yield. Iodine deficiency which leads to mental impairment has a direct link to productivity loss. There is a 1.38% drop in productivity for every 1% reduction of height. It also estimated that for every 1% reduction of iron status there is 1% drop in productivity(100).

4.10.3 Poor school performance and Attendance:

Malnutrition in early childhood was strongly correlated with poor mental ability in later years of age.(101). Adequate and good nutrition is mandatory for mental

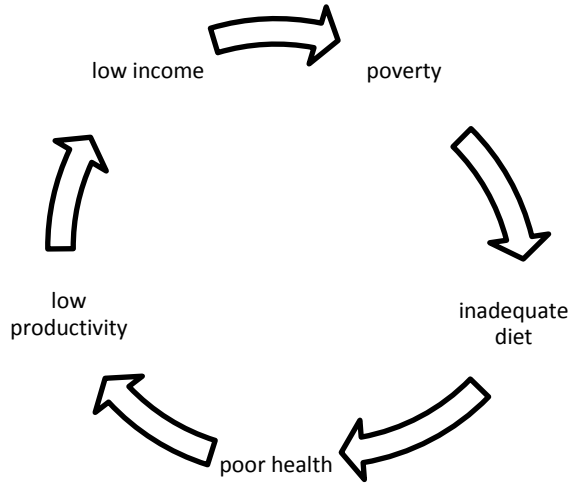
development and better school performance. Childhood Malnutrition is the main reason for reduced learning ability and performance in school(102). A study done in Brazil, says that children with longstanding malnutrition condition will develop changes in the cognitive function. This can cause have irreversible changes in the nervous system. The study recommends the assessment for intellectual ability for all children malnourished in the past (103).

Malnutrition and cultural inadequacy were not the definitive causes of poor school performance of the children. They were the immediate causes. Data from a study carried out in a semi-rural school near Santiago, in 1970, says that poverty was the complex underlying condition. The nutritionist or the educators alone cannot solve the problem of low school performance(104).

4.10.4 A vicious cycle: (poverty perpetuation)

Malnutrition has been always a component of a vicious cycle which involves poverty and disease.

Figure 4-6 vicious cycle of malnutrition and poverty (105)



The above mention three factors are interlinked with each other, so that each contributes to the other in the vicious cycle. A change in the political and socio-economical factor will eventually bring about a change in the health. This can discontinue or interrupt the cycle. WHO wants to change this cycle of poverty to cycle of health, wealth and growth by contributing to child growth and malnutrition database(32).

4.10.5 Intergenerational cycle:

Malnutrition has an intergenerational cycle. A malnourished woman will give birth to a low birth weight child (LBW). The LBW baby will eventually grow as a malnourished child to a malnourished young women and then to a malnourished pregnant woman. Hence the cycle continues(106).

Figure 4-7 intergenerational cycle of growth failure: (107)

4.11Economic consequences of Malnutrition:

Child malnutrition, poverty and poor health are interconnected. They are locked in a poor health vicious cycle. As this cycle becomes stronger it disrupts the economic

growth's foundation. By reducing the burden of malnutrition, the economic burden of the country can be brought down markedly(108).

Malnutrition and under nutrition bring down the economic growth and increase the burden of poverty by three routes:

1. Poor physical status leads to poor productivity- direct loss
2. Malnutrition cause poor cognitive function which leads to deficits in schooling – indirect loss.
3. Loss due to increased cost of health care system.

Productivity losses are found to be more than 10% of lifetime earnings for every individual. The gross domestic product (GDP) lost is as high as 2 to 3 % due to malnutrition. Hence, reducing the malnutrition directly reduces poverty(109). Recognition of this reduction is evident in the first millennium development goals (MDG) definitions.

4.12Nutrition and Millennium Development Goals (MDG):

Malnutrition is targeted in the Millennium Development Goals. It is directly involved in MDG1 and in MDG4 it was indirectly involved. All the MDGs are closely interconnected to achieve all goals(110).

MDG 1: "Eradicating extreme hunger and Poverty – reducing the burden of childhood malnutrition to 50 % by 2015. The target for India was to achieve 28.6% by 2015. But it has been projected that India might bring down the prevalence from 53% in 1990 to 40% by 2015"(111).

MDG 4: “Reducing child mortality – reducing the mortality by two thirds by 2015. The under 5 mortality was 74.6/1000 live births. And India planning to bring down further to 70/1000 live births by 2015”(111).

4.13 Community based detection of SAM:

Measuring weight-for-height by checking the height and the weight at the community level is complex and expensive. Hence, a two-stage screening is adapted to detect children with malnutrition. Mid-upper-arm circumference (MUAC) or bilateral pitting pedal edema is used as the first stage screening tool. If any child has MUAC less than 11 cm or with pedal edema is referred for admission. The 2nd stage of screening happens during the admission process by checking the height, weight of the child, MUAC and bipedal edema of the child. These were found to be the best predictors for identifying malnutrition in the community(112).

4.13.1 Community management of acute malnutrition (CMAM):

It refers to the management of acute malnutrition through:

1. Community outreach programme.
2. Outpatient care for children of age, five years and less with uncomplicated SAM
3. Inpatient care for children of age, five years and less with complicated SAM and infants under 6 months of age with SAM
4. Supplementary feeding and nutritional counseling for the management of MAM

4.13.2 Community-Based Therapeutic Care (CTC)

It is a community-based approach for the management of SAM in emergency settings. It comprises of inpatient care, outpatient care, supplementary feeding programme and community outreach programme.

Core to outpatient treatment is the innovation of ready-to-use therapeutic food (RUTF), which was prepared to match therapeutic milk's nutrient profile (F100). It's a dry solid food which is soft and paste like. It can be easily eaten by a child. RUTF can be eaten without the addition of water. Commonly used RUTF is a lipid-based nutrient-energy-dense paste. It can be used at home with minimal risk of bacterial contamination.

4.14 Epidemiological study designs:

4.14.1 Types of study design:

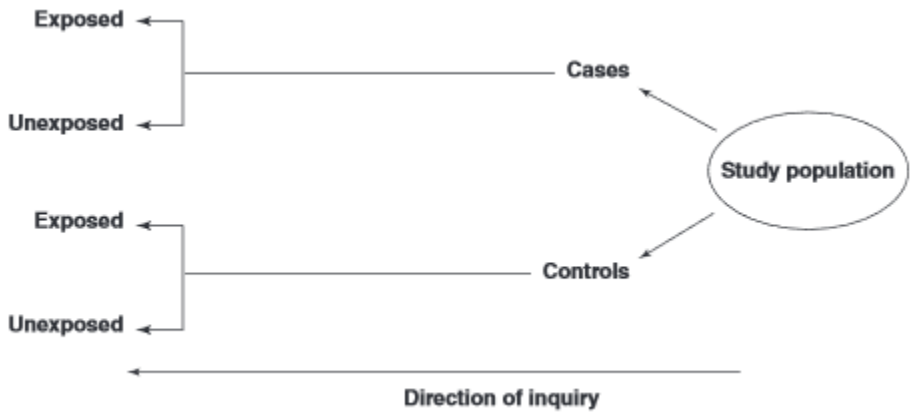
- Interventional (experimental studies):
    - Clinical trial
    - Field trial
        - Aggregated level (community trial)
        - Individual level
- Observational (non-experimental) studies:
    - Cohort studies
    - Case-control studies
    - Cross sectional surveys
    - Routine data based studies

- Individual level
- Aggregated level (ecological studies)

4.14.2 Case-control studies:

It is a observational study, suitable to investigate rare diseases and appropriate for disease with long incubation period. This is because the case–control study starts with subjects who have already developed the disease. The following figure explains the case-control study design.

Figure 4-8 Case-control study design



4.14.2.1 Advantages of case-control study:

- Well suited to the study of rare disease and long incubation period
- Relatively inexpensive
- Relatively quick to conduct
- Comparatively few subjects required
- No threat to subjects
- Multiple potential causes of a disease can be studied
- Occasionally existing records can be used

4.14.2.2 Disadvantages of case-control study:

- Relies on recall for information on past exposure
- Validation of information is difficult or sometimes impossible
- Controls of extraneous variables may be incomplete
- Rates of disease in exposed and unexposed individuals cannot be determined
- Selection of an appropriate comparison group may be difficult

5 Methodology

5.1 Study setting:

This Study was carried out among the children under the age of five years residing at Kaniyambadi Block in Vellore District and Vellore town Tamil Nadu.

5.1.1 Kaniyambadi block:

A rural block in Vellore district in Tamil Nadu, with a population of about 1, 20,000 people living in 88 villages. The community health, department of the Christian medical college, Vellore (CMC) provides community based integrated health care to the block through its Community Health and Development (CHAD) program. This program has been focusing on maternal and child health care, immunization services, adolescent health care, geriatric health care, secondary level hospital care for common morbidities and socioeconomic development activities through community participation.

5.1.2 Vellore town:

The study was conducted in Old Town, Salvanpet and the neighboring areas of Vellore town, in the southern Indian state of Tamil Nadu. This is an area with low-income and has a population of 67,174. The health care services to this community are provided by Low Cost Effective Care Unit (LCECU) which is the urban health center of Christian medical college, Vellore. Vellore city has a population of approximately 400,000 people in urban and peri-urban areas.

5.2 Study Design:

The most appropriate method to identify the risk factors of condition with low prevalence is Case- control study. In this study, a community based Case – Control study design has been used.

5.3 Study participants:

5.3.1 Cases:

Children of age group 6-59 months with SAM according to WHO definition(113), i.e., weight for height of less than -3SD with or without nutritional oedema were classified as cases

5.3.2 Controls:

Children with weight-for-height z-score more than -1 SD and MUAC ≥13.5cms (114) were classified as controls.

5.3.3 Selection of cases:

A primary study has been undertaken by the department of community health since 2012 to evaluate the impact of three feeding regimens on the recovery of children from uncomplicated Severe Acute Malnutrition in India. As part of that study, children in the age group of 6 months to 59 months of age were screened for SAM. For the current study, children with SAM as identified by the primary study were included.

The study is being conducted in three sites namely urban slums and resettlement colonies in Delhi, rural Rajasthan, rural and urban Tamil Nadu(18). For the primary

study, the community health department of CMC, Vellore conducted a door to door survey to identify the children with MUAC <13 cms. Children with MUAC <13 cms were referred to the study clinic located in the CHAD hospital, Bagayam. The children were assessed in the study clinic by a trained medical officer. Anthropometric measurements like height, weight and MUAC were taken. The Z-score for weight for height was calculated with the help of WHO anthro software. If the child's Z-score was found to be less than -3, the principal investigator of this study was informed for possible recruitment in to the current study. They were visited by the Principal Investigator (PI) of this study at the child's house on the same day before interventions by the primary study (like nutritional education and supplements). After obtaining verbal consent, children were reassessed to ascertain the SAM status by checking the child's height and weight. Before enrolling in to the current study, an informed valid consent was obtained from the mother or primary care giver at the child's house.

5.3.4 Selection of controls:

Suppose, if the case was found in a particular area, the children of same age, gender as that of cases were identified in the same area by snow ball technique. The height and weight of the identified children were measured. If the weight for height z-score >-1 and a MUAC of >13.5cms, the child was recruited in the risk factor study after obtaining valid informed consent from the mother or primary care giver. For each case, two controls were selected in the study from the same village/area within 2 weeks of identifying the case. Controls were matched for age (+/- 2 months) and gender. As the role of gender in malnutrition has been extensively studied, gender has been matched in order to study the effect of other risk factors.

Figure 5-1 Protocol for selection of cases:

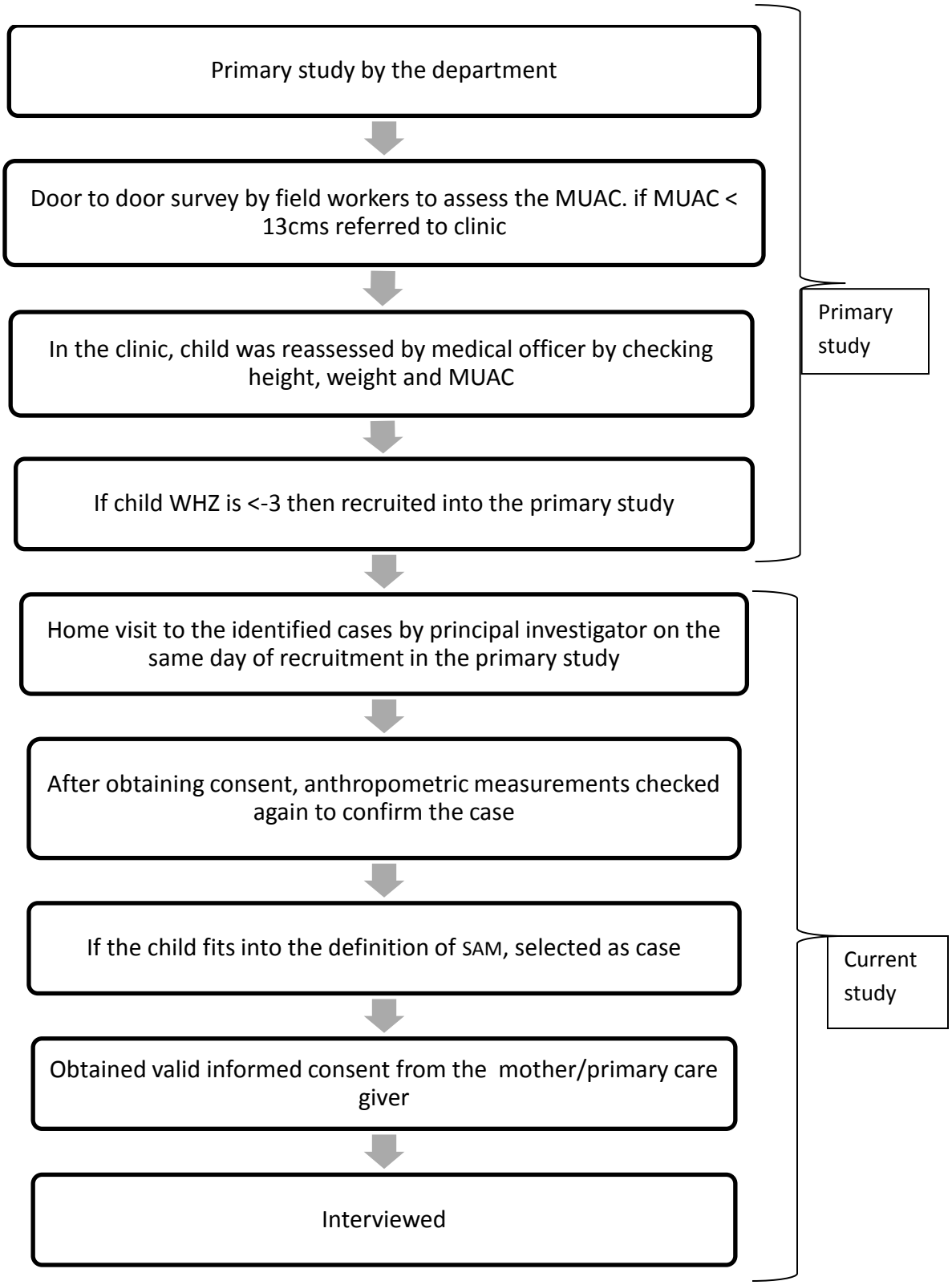
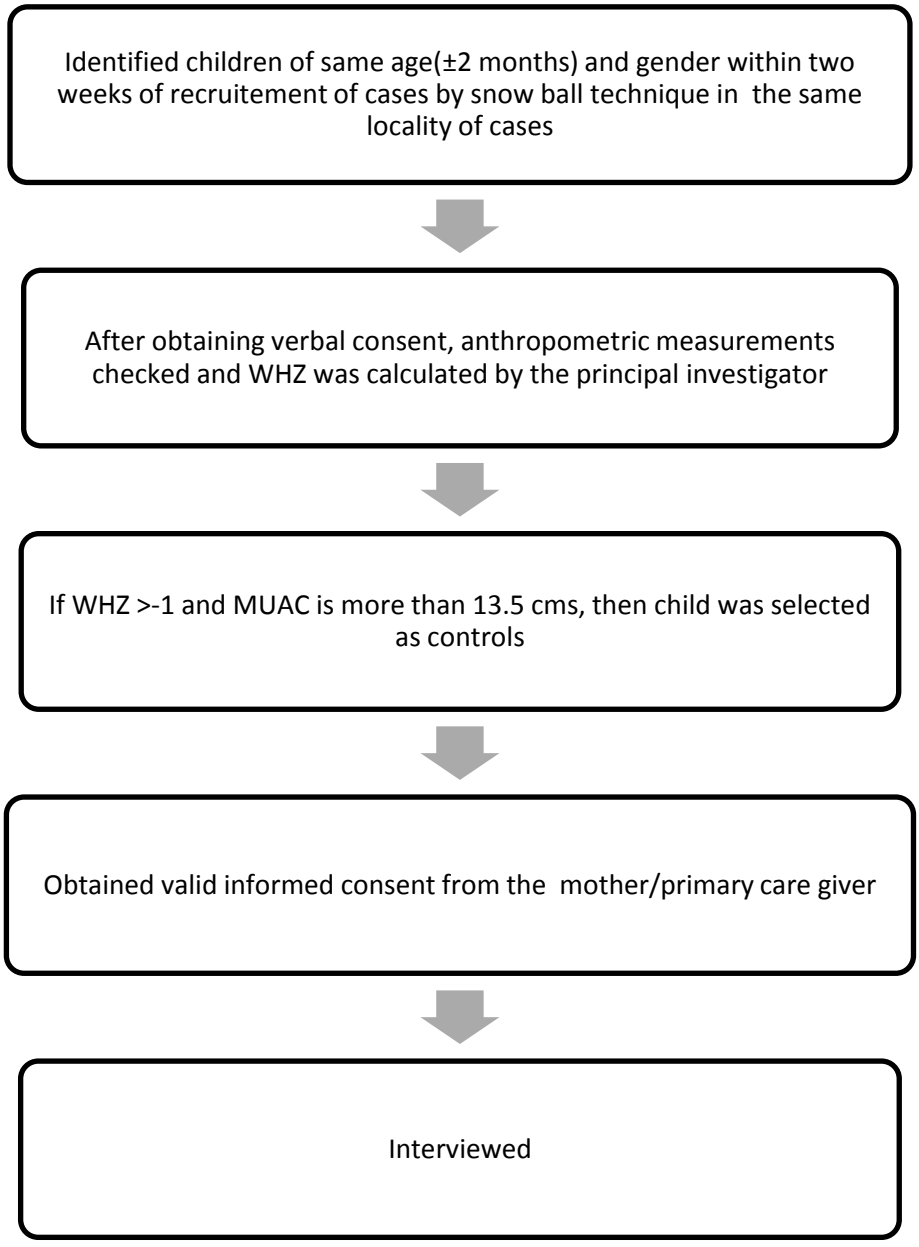


Figure 5-2 Protocol for selection of controls: (only for current study)



5.4 Sample Size:

Among various risk factors, lack of exclusive breastfeeding was the significant risk factor in various studies. A study done in Ethiopia by Solomon Amsalu revealed that lack of breastfeeding for first six months is a significant risk factor for severe acute malnutrition with an odds ratio of 3 (95%CI- 1.58- 5.73)(52). Hence, lack of exclusive breastfeeding for 6 months is considered as a risk factor for this study.

The sample size is calculated using the following formulae:

$$n = \frac{r+1}{r} * \frac{(\bar{p})(1-\bar{p})\left(Z_{\propto/2} + Z_{\beta}\right)^2}{(P_1 - P_2)^2}$$

Where, $\overline{p}$ = mean proportion exposed in cases and controls

$Z_{\propto/2}$ = Significance

Z_{β} = desired power

P_1 = Proportion of cases exposed

P_2 = Proportion of controls exposed

r = ratio of controls to case

With 2 controls per case, an alpha error of 5%, with a power of 80%, an anticipated odds ratio of 3 for 'lack of exclusive breastfeeding"(52) and the proportion of controls who lack of exclusive breast feeding as 60%(19), the required sample size was 54 cases and 108 controls.

5.5 Data collection:

Data collection was done by direct interview by PI, extraction of information from birth records and actual measurement of height, weight and MUAC

5.6 Study Tool:

Study tool had 3 components.

a. Structured and semi-structured questionnaires to identify the risk factors including dietary intake
b. Medical records for birth related information and morbidity
c. Anthropometric assessments to check the nutritional status

5.6.1 Assessment of risk factors:

Once the cases were identified at the clinic, a verbal consent was obtained to visit their houses by the principal investigator on the same day. The controls were identified by the principal investigator at their homes. After obtaining valid informed consent from both the cases and controls, a direct interview of the mother or primary care giver was done using a structured and semi-structured pre-tested piloted interviewer administered questionnaires. The following information was obtained.

- Demographic details
- Family health and dynamics
- Household and economic factors
- Breast feeding and weaning history
- Dietary intake

- Mothers' knowledge on nutrition

5.6.1.1 Assessment of Dietary intake

a. *Semi-structured questionnaire for 24 hour Food Recall Questionnaire*:

Child's caloric and protein intake was assessed by one 24 hour recall method and food frequency method. Standard cups, glasses, ladles, spoons and paper disks were used to assess the actual amount of food consumed by the children. Then the nutrients present in the raw ingredients were calculated using the database of 'Nutritive Value of Indian Foods' had given by the National Institute of Nutrition (NIN)(115). The nutrients from the ready-made foods like biscuits and other packaged food items were calculated from the information given by the manufacturers.

b. Food Frequency questionnaire:

Only 7 food groups out of 14 food groups in the Food Frequency Questionnaire of National Institute of Nutrition, Hyderabad, were used. They were fruits, milk products, animal proteins (egg, meat, chicken and pork), sweets, savories, bakery items and soft drinks, which were relevant to the study.

5.6.1.2 Assessment of mother's knowledge on nutrition:

Mother's nutritional knowledge was assessed by simple questions regarding breastfeeding, weaning, and nutrition. Totally there were 7 questions. Each right answer was scored as 1 or 0.5 appropriately. A total score of 5 and more out of 10 was considered as adequate knowledge.

5.6.2 Assessment of birth related factors and current/past morbidity

Review of Hospital records and road to health cards were done to collect information on birth-related characteristics like birth weight and gestational age. Previous hospital admission details were gathered for past medical history and associated morbidity

5.6.3 Anthropometric Measurements:

Electronic weighing scales were used to measure the weight. Children were weighed twice wearing vests and bloomers. The average of the two readings was taken. Heights were measured using the stadiometer/ height board, whereas children younger than two years were measured using infant-o-meter.

MUAC was measured using the inch tape. Weight was measured to the nearest 0.1 kg, height to the nearest 0.1 cms and MUAC measured to 2mm precision.

5.7 Study Variables:

5.7.1 Dependent variables:

The dependent variables were gender and age specific anthropometric z-scores of weight-for-height (WHZ), weight-for-age (WAZ) and height-for-age (HAZ). Based on the weight for height z-scores, a child was classified as:

i) Severe Acute Malnourished child, WHZ < -3 SD (case);

ii) Healthy child of Indian Standard, WHZ > -1 SD (control).

5.7.2 Independent variables:

This study identified seven domains affecting children's nutritional status. Each domain comprised of several variables:

a) Demographic Details: gender of the child, place of residence, type of family, religion, Caste, no. of people share a common kitchen, family size
b) Birth characteristics: birth weight, gestational age at birth, birth order, age gap between the siblings, place of birth, congenital disorder at birth
c) Medical history and morbidity: past and recent child illnesses, history of worm infestation
d) Nutritional history: breast feeding practices like exclusive breast feeding, age of weaning, poor feeding practices. Adequate calorie and protein intake, family history of eating non-vegetarian food.
e) Family health and dynamics: any illness in the family, history of contact with TB, malnutrition among siblings, undernourished mother (lower BMI),
f) Household socioeconomic characteristics: parental age, parental working status, parental education level, poverty status, open air defecation
g) Anthropometric measurements like Height/Length, weight and MUAC of the study child. MUAC of the other siblings to screen their nutritional status.

5.8 Data Management:

5.8.1 Anthropometric data:

Anthropometric data were entered into EpiData software. The database from EpiData was exported into the software WHO ANTHRO v3.2.2. The software is specially designed for anthropometric calculations and surveys. Using the software exact WHZ, HAZ, WAZ and MUAC for age Z score was calculated for each child. After data entry, the database generated was transferred to SPSS v. 20 for analysis.

5.8.2 Demographic and Factors related to SAM data:

Demographic and various other factors related to SAM data were entered into data entry software, EpiData v 3.1. The final database was transferred to SPSS v. 20 and merged with the anthropometry database to create a combined database.

5.8.3 Nutritional data:

Caloric values and protein values of the food items according to "some common Indian recipes and their nutritive values" by National institute of nutrition (NIN) were calculated for all the food items which were collected during the 24 hour recall method. The final total protein and calorie intake of each child was entered into EpiData. The difference between the actual calorie/protein intake and daily recommended calorie/protein per day (according to RDA 2010) were also calculated and entered in the EpiData. The database from EpiData was transferred to SPSS software for analysis.

5.9 Data Analysis:

5.9.1 Descriptive statistics:

The socio-demographic characteristic and various factors of the study population have been presented using the frequency and percentages for categorical variables, mean ± SD for continuous variables. Similarly, exposure factors are also described.

5.9.2 Risk Factor analysis:

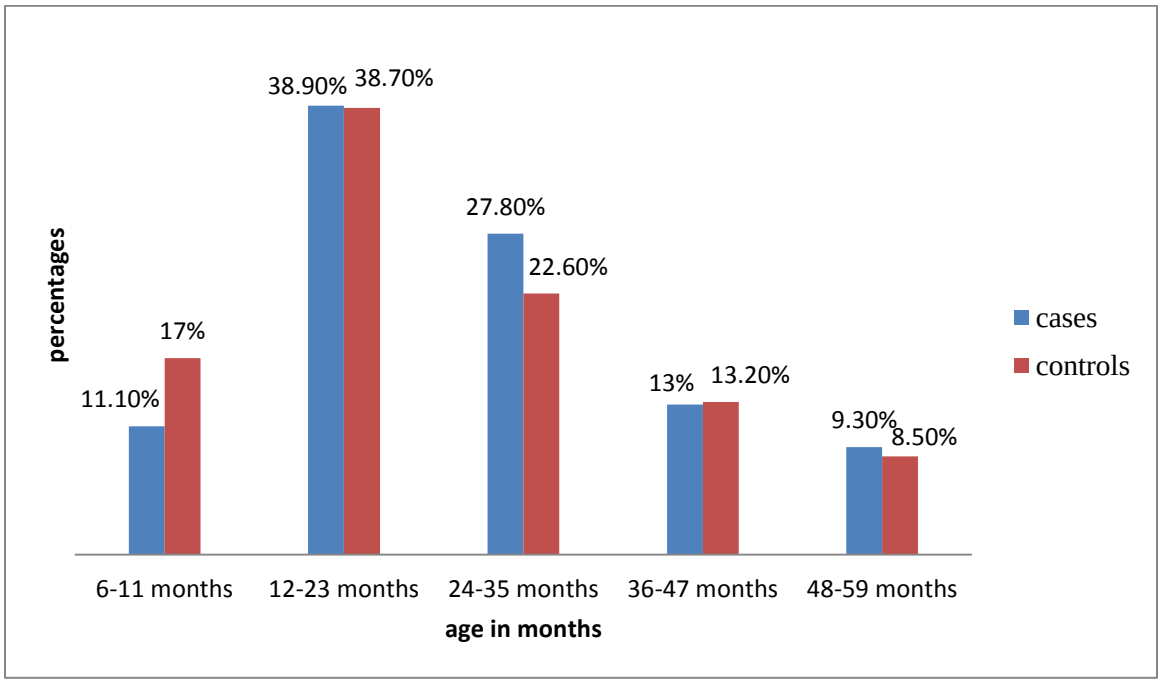
Bivariate analysis was done using Chi square test to know the associations between categorical variables. Independent t test was done to compare means between two groups. Uni-variate analysis was done to generate an odds ratio and 95% confidence interval for the risk factors. Risk factors which had significant p values were included in the multivariate analysis by a backward conditional logistic regression model.

6 Results

6.1 Demographic characteristics of study population:

A total of 160 children were recruited in the study. Among them 54 had severe acute malnutrition (cases) and 106 were age, sex and location matched controls. For 2 cases only one age, sex and location matched controls were available, hence total number of controls were 106. Of the 54 cases and 106 controls, 38 % of children were between the age group of 12- 23 months and 27.8% of cases and 22.6% of controls were in the age group of 24- 35 months. The mean age was 24 months in both the cases and controls (cases- 24.35±12.9, control- 24.24± 12.7). The median was 23 months in both the groups.

Figure 6-1 Age distribution of the study population



The socio-demographic characteristics of the study population are given in table 6-1.

Table 6-1 Demographic Characteristics of study population

Variable	Category	Cases N=54 n (%)	Controls N=106 n (%)
Gender	Male	26 (48.1%)	51 (48.1%)
	Female	28 (51.9%)	55 (51.9%)
Residence	Urban	39 (72.2%)	81 (76.4%)
	Rural	15 (27.8%)	25 (23.6%)
Type of house	Hut	7 (13.0%)	6 (5.7%)
	Mixed	7 (13%)	47 (44.3%)
	Pucca	36 (66.6-%)	51 (48.1%)
	Mansion	4 (7.4%)	2 (1.9%)
Type of family	Nuclear	25 (46.3%)	61 (57.5%)
	Joint/Extended	29 (53.7%)	45 (425%)
Caste	OC/ BC	22 (40.8%)	40 (37.7%)
	MBC	22 (40.7%)	48 (45.3%)
	SC/ST	10 (18.5%)	18 (17%)
Religion	Hindu	37 (68.5%)	90 (84.9%)
	Christian	8 (14.8%)	-
	Muslims	9 (16.7%)	15 (15.1%)
SES (BG Prasad's)	I (>Rs. 5156)	1 (1.9%)	5 (4.7%)
	II (Rs. 2578-5155)	3 (5.6%)	11 (10.4%)
	III(Rs. 1547-2577)	15 (27.8%)	37 (34.9%)
	IV(Rs. 773-1546)	23 (42.6%)	45 (42.5%)
	V (<Rs. 773)	12 (22.2%)	8 (7.5%)

Among both the cases and the controls, 51.6% were female children. More than 70% of children from both the groups were from urban area. Nearly two third of the

cases lived in pucca houses. Most of the controls lived either in pucca or mixed house. Among cases, 46.3% were from nuclear family as compared to 57.5% among controls.

A total of 40.7% of children in the case group and 45.3% of children from the control group belonged to Most Backward Caste. Only 18.5% of cases and 17% of controls were from SC/ST community. Majority of children among the cases and controls were from Hindu religious background (68.5% and 84.9% among cases and controls respectively).

According to BG Prasad classification, 64.8% of cases and 50% of controls belonged to low socioeconomic background (Class IV and V).

6.2 Parental age, education, occupation and family size:

6.2.1 Age:

Mean age of mothers was similar among cases and controls (26.41 years and 25.38 years respectively).

Table 6-2 Mothers' age

Variable	Case/control	Mean(±SD) (in years)	Median (in years)	IQR (in years)
Mothers' age	Cases	26.41 (±3.819)	26	24-29
	Controls	25.38 (±3.811)	25	23-28
Mothers' age at marriage	Cases	20.56 (±3.506)	19	19-23
	Controls	20.54 (±2.605)	20	19-22
Mothers' age at index child's birth	Cases	24.37 (±3.916)	23	21-26
	Controls	23.39 (±3.446)	23	21-25

Mean age at marriage of mothers was 20 years in cases and controls. There is no difference in the mother's age at the time of birth of the index child among cases and controls (p-value 0.105).

6.2.2 Education:

Majority of the mothers and fathers in both the groups had studied beyond primary school education. Regarding fathers education, 20.5% of cases and 22.7% of controls studied beyond high school education. Table 6-3 gives the details on the educational status and occupation of both mothers and fathers of cases and controls.

Most mothers (85.2% among cases and 90.6% among controls) were housewives. Among those who were working, majority were unskilled manual laborers. When the mothers were at work, the children were being cared by the grandparents.

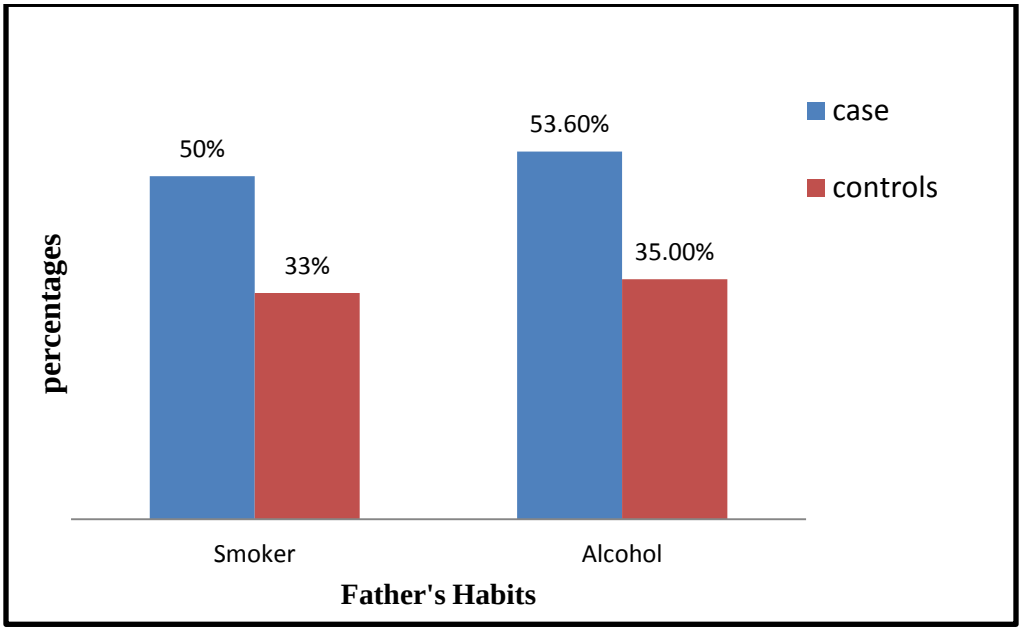
Among the fathers of the cases, 48.2% were unskilled/semiskilled daily wage laborers as compared to 49.3% among controls. Among 160 children studied, only one (1.9%) father was unemployed due to frequent illnesses. He was the father of a SAM child.

Most fathers (92.6% of cases and 95.3% of controls) were living with their families. Among the fathers of the cases 50% were smokers and 53.6% consumed alcohol as compared to 33% and 35% of fathers of the controls respectively.

Table 6-3 Education and occupation of parents of the study participants

Educational status	Mother (cases-54, control- 106)		Father (cases-54, control- 106)	
	Cases n (%)	Controls n (%)	Cases n (%)	Controls n (%)
Illiterate	5 (9.3%)	4 (3.8%)	5 (9.3%)	4 (3.8%)
Primary	11 (20.4%)	19 (17.9%)	11 (20.4%)	24 (22.6%)
Middle	12 (22.2%)	28 (26.4%)	14 (25.9%)	24 (22.6%)
High school	18 (33.3%)	28 (26.4%)	13 (24.1%)	30 (28.3%)
Higher secondary	5 (9.3%)	21 (19.8%)	7 (13%)	11 (10.4%)
Diploma/degree/post graduate	3 (5.6%)	6 (5.6%)	4 (7.5%)	13 (12.3%)
Occupation				
House wife	46 (85.2%)	96 (90.6%)		
Unskilled	5 (9.3%)	0 (0%)	16 (29.6%)	45 (42.5%)
Semi-skilled	1 (1.9%)	2 (1.9%)	9 (16.7%)	9 (8.5%)
Skilled	1 (1.9%)	0 (0%)	14 (25.9%)	27 (25.5%)
Clerical/shop owner	0 (0%)	6 (5.7%)	10 (18.5%)	13 (12.3%)
Semi-professional/ Professional	1 (1.9%)	2 (1.9%)	4 (7.4%)	12 (11.3%)
Unemployed			1 (1.9%)	0 (0%)

Figure 6-2 proportion of fathers of cases and control who smoke and consume alcohol



Mean of number of family members of cases was 5.46 as compared to 5.1 in the control group. Among the cases, 20.4% mothers had only one living child and 53.7% had two living children. Among the controls, 43.4% mothers had one living child and 39.6% had two living children. The death of one sibling was noticed in 13% of cases and 4.7% of controls.

6.3 Birth related characteristics of the Child:

In this study, mean birth weight among cases and controls was 2.37 kg (±0.548) and 3.02 kg (±0.537) respectively. This difference is statistically significant with the chi-square p-value of <0.0001. The majority of mothers of cases took iron and calcium supplementation. The majority of cases (96.3%) and controls (99.1%) were born in hospital or in any institution. Only 16.7% of cases and 6.6% of control were preterm. Congenital diseases were present in 13% of cases and 1.9% controls. Nearly half of the

cases were of birth order 2 as compared to two-thirds of the controls who were of birth order one. The age interval between siblings of cases was more than 2 years in 67.4% as compared to 51.7% of the controls.

Figure 6-3 Birth weight of cases and controls

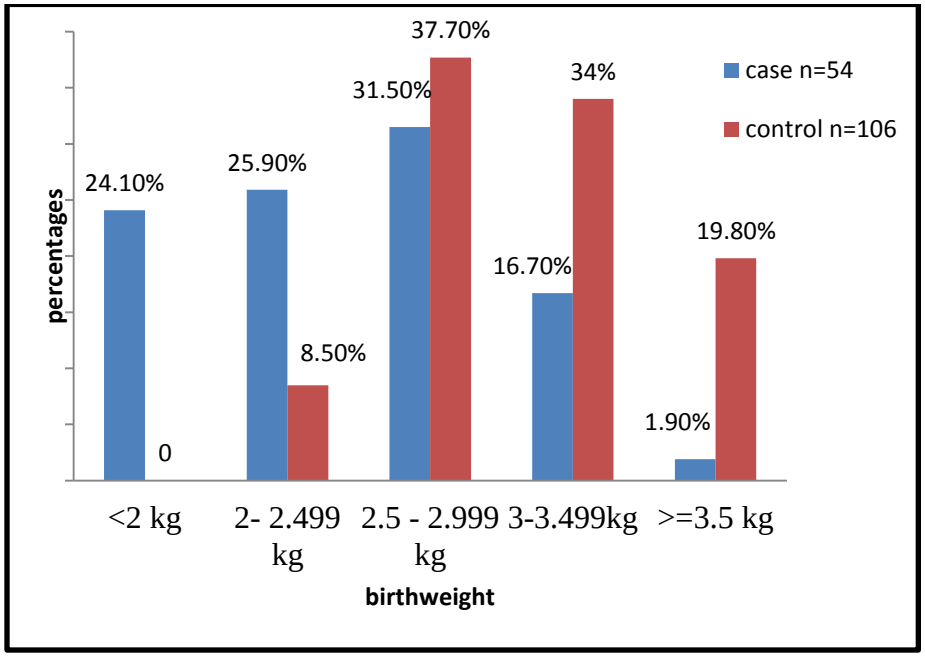
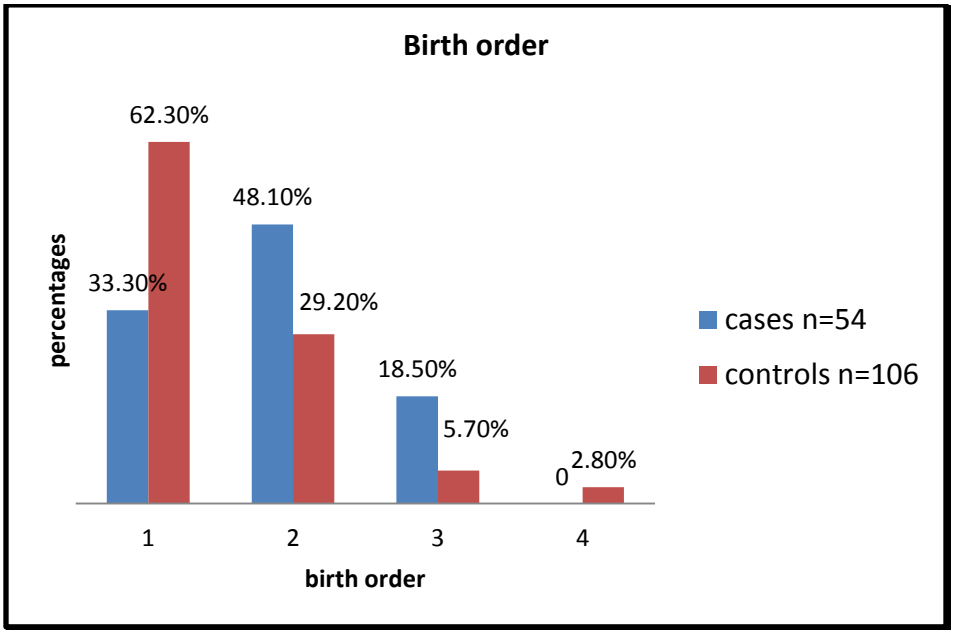


Figure 6-4 Birth order of cases and controls



6.4 Breast feeding practices:

Exclusive breastfeeding for 6 months was practiced in 55.6% of cases and 88.7% of the controls. At the time of the study, 38.9% of cases were breastfed as compare to 39.6% of controls. Among those who were not currently breastfed, the mean duration of breast feeding among the cases and controls were 12(±7.2) and 15.23(±7.6) months respectively. This difference was not statistically significant (p-value 0.131).

Table 6-4 Duration of breast feeding and initiation of complementary feeds:

Feeding practices	**Duration in months**	**Currently not breast fed**	
		Cases N=33 **n (%)**	**Controls N =64** **n (%)**
Duration of breast feeding	0-3 months	4 (12.1%)	3 (4.7%)
	4-6 months	4 (12.1%)	9 (14.1%)
	7-12 months	13 (39.4%)	13 (20.3%)
	13-18 months	6 (18.2%)	25 (39.1%)
	19-24 months	6 (18.2%)	9 (14.1%)
	>=25 months	-	5 (7.8%)
Initiation of Complementary feeds	0-4 months	2 (3.7%)	3 (2.8%)
	5-6 months	23 (42.6%)	55 (51.9%)
	7-12 months	26 (48.1%)	47 (44.3%)
	13 and more	3 (5.6%)	1 (0.9%)

6.5 Medical history and morbidity of the index child:

Routine immunization was complete in 81.5% of cases and 94.3% of controls. At the time of the study, 20.4% of cases and 3.8% of controls had medical problems other than SAM.

Table 6-5 Medical history and morbidity among cases and controls:

Variable	Category	Cases N=54 n (%)	Controls N=106 n (%)
Immunization status (age appropriate)	Complete	44 (81.5%)	100 (94.3%)
	Incomplete	10 (18.5%)	6 (5.7%)
Current medical problem	Yes	11 (20.4%)	4 (3.8%)
	No	43 (79.6%)	102 (96.2%)
Diarrhoea last month	Yes	19 (35.2%)	25 (23.6%)
	No	35 (64.8%)	81 (76.4%)
Resp. Infection last month	Yes	41 (75.9%)	85 (80.2%)
	No	13 (24.1%)	21 (19.8%)
Hospitalization in last 1 year	Yes	11 (20.4%)	7 (6.6%)
	No	43 (79.6%)	99 (93.4%)
Chronic Diarrhoea	Yes	4 (7.4%)	2 (1.9%)
	No	50 (92.6%)	104 (98.1%)
History of Passing worms in stools	Yes	5 (9.3%)	5 (4.7%)
	No	49 (90.7%)	101 (95.3%)

There was significant difference in current medical problem (p-value 0.001) and hospitalization in the past one year (p-value 0.009) between the cases and controls. During the last one month, there was no difference in the occurrence of diarrhoea, respiratory infection and measles among the cases and the controls. Only 4 children among cases and 2 children among controls had chronic diarrhea. History of passing worms in stool was present in 5 children among the cases and controls.

6.6 Medical history and morbidity among parents:

Among the cases, three mothers had tuberculosis, one mother had HIV and two mothers had diabetes Mellitus. Among the controls, only one mother had tuberculosis. This difference is statistically significant (p-value 0.006). There was no significant difference in the chronic illness of fathers and hospitalization in the past one year in both the groups. Very few parents in both groups had history of hospitalization in the past one year.

Table 6-6 Morbidity among parents:

Variable	Category	Mother		Father	
		Cases N=54 n (%)	Controls N=106 n (%)	Cases N=54 n (%)	Controls N=106 n (%)
Chronic illness	Yes	6 (11.1%)	1 (0.9%)	2 (3.7%)	-
	No	48 (88.9%)	105 (99.1%)	52 (96.3%)	106 (100%)
Hospitalization in last year	Yes	1 (1.9%)	3 (2.8%)	5 (9.3%)	2 (1.9%)
	No	53 (98.1%)	103 (97.2%)	49 (90.7%)	104 (98.1%)

6.7 Socioeconomic status of the study population:

According to BG Prasad's classification of Socioeconomic Status, 64.8% of cases and 50% of controls belonged to low socioeconomic status (which includes class IV and V). Only 9.3% of cases and 0.9% of controls earned less than Rs.100 per day which is Tamil Nadu's minimum wages for 6 hours of work. The average income per day of the parents was 241.46 (± 159.62) and 330.64(± 381.10) for both the cases and controls respectively. Only 33.3% of cases and 58.5% controls in the study population had a ration card.

Table 6-7 Socioeconomic characteristics:

Variable	Category	Cases N=54 n (%)	Controls n=106 n (%)
SES(BG Prasad)	Low (Class IV, V)	35 (64.8%)	53 (50%)
	High (class I, II, III)	19 (35.2%)	53 (50%)
Income per day	Less than Rs.100/day	5 (9.3%)	1 (0.9%)
	More than Rs.100/day	49 (90.7%)	105 (99.1%)
Availability of Ration Card	Yes	36 (66.7%)	44 (41.5%)
	No	18 (33.3%)	62 (58.5%)
Receiving social security	Yes	16 (29.6%)	15 (14.2%)
	No	38 (70.4%)	91 (85.8%)

About, 66.7% of cases and 45.3% controls had debts to pay. Due to lack of money 9.3% of cases and 0.9% of controls skipped at least one meal in the last one month. In this study the families of 70.4% of cases and 85.8% of controls did not get extra income through any form of social security.

6.8 Anthropometric measurements:

6.8.1 Stunting: Height for Age (low height for their age and sex)

Among 160 children studied, 50% of cases and 66% of controls were in the normal height for age cut off points i.e., HAZ >-2 to 3 SD (according to WHO classification). Among cases, 27.8% were stunted and 18.5% were severely stunted (HAZ <-3). Among controls 13.2% were stunted and another 13.2% were severely stunted. Only, 3.7% of cases and 7.5% of controls were very tall.

Figure 6-5: Proportion of stunting among cases

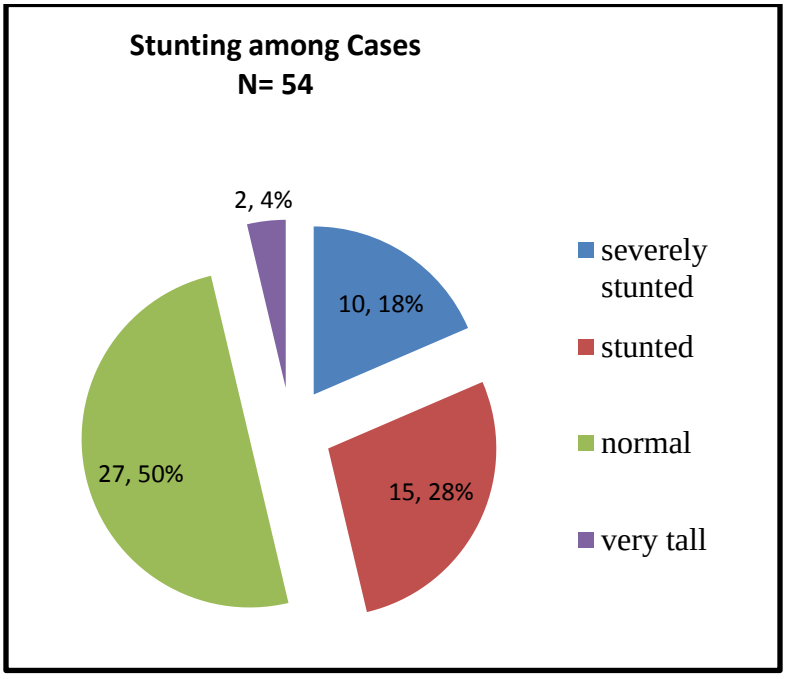
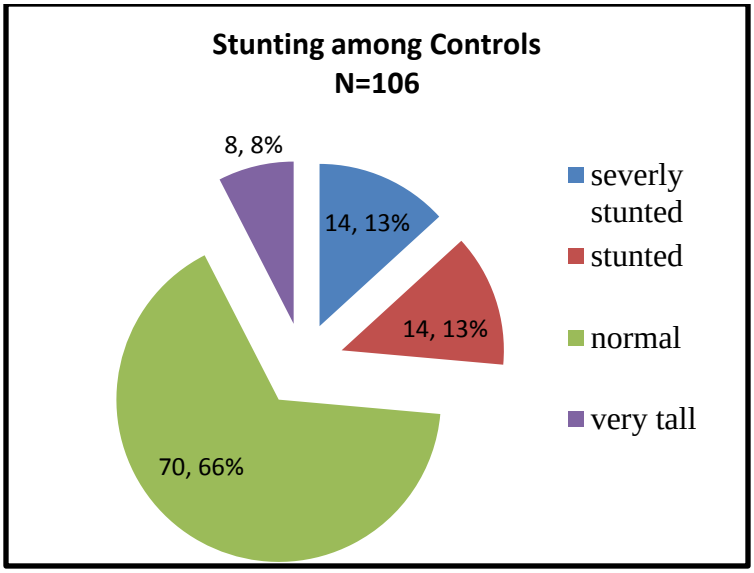


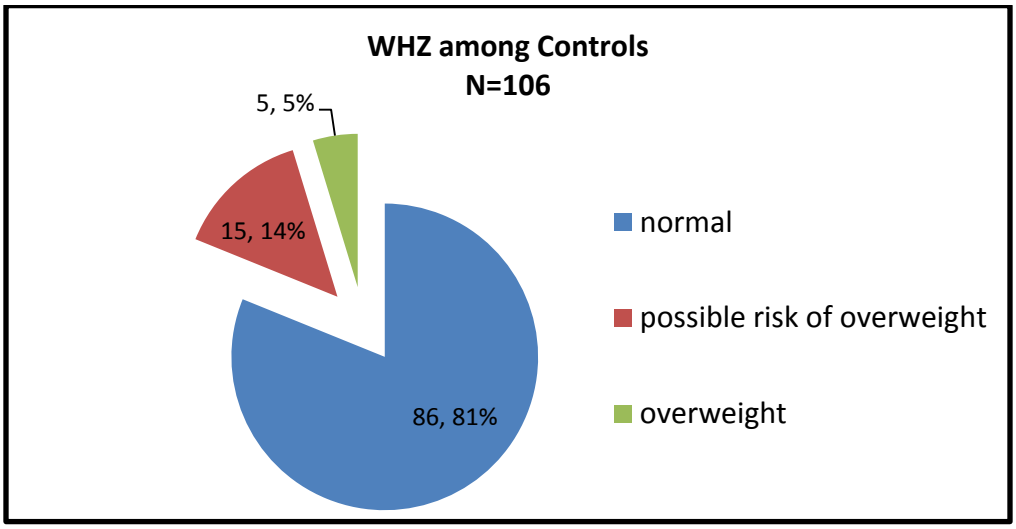
Figure 6-6 Proportion of stunting among controls



6.8.2 Wasting: Weight-for-Height Z score (low weight for their expected Height and Age)

As per case definition, all children in the cases were below – 3 SD. Among controls, 81.1% of the children belonged to normal category.

Figure 6-7 WHZ category among Controls

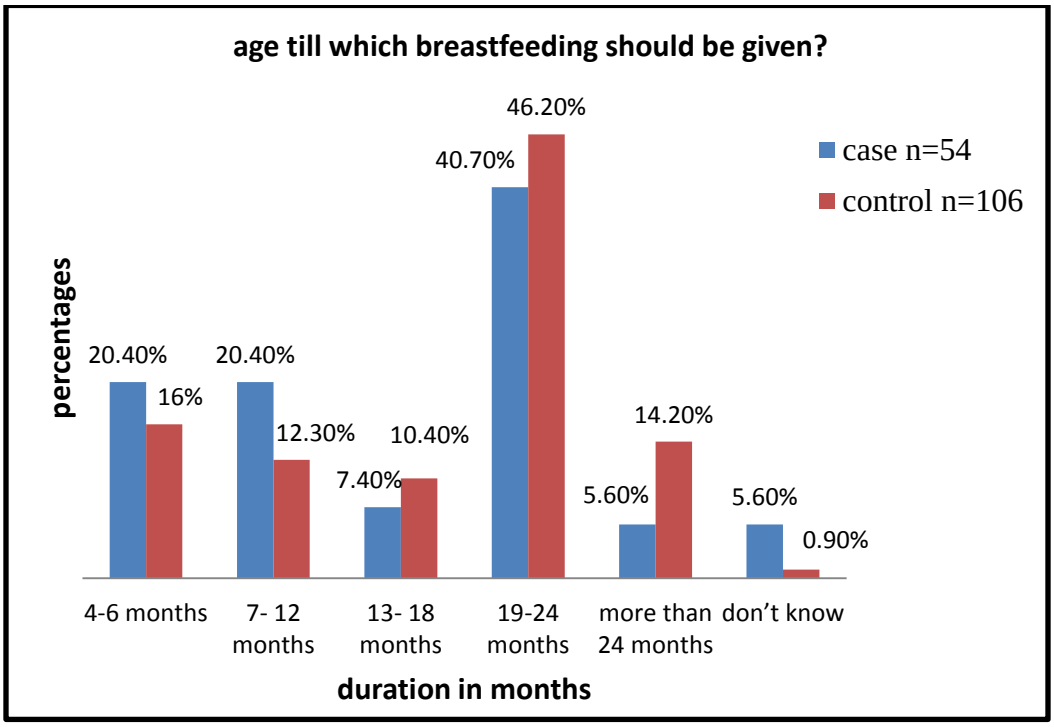


Few children in the control group (14.2%) had a possible risk of overweight and only 4.7% of controls fell into the category of overweight.

6.9 Mother's knowledge on nutrition:

Mothers' knowledge about breastfeeding and nutrition was assessed by asking 7 simple questions to both the mothers of cases and controls. When asked about the desirable duration of breast feeding, 40.7% mothers of cases and 46.2% of mothers of controls said that breastfeeding can be given up to 19-24 months.

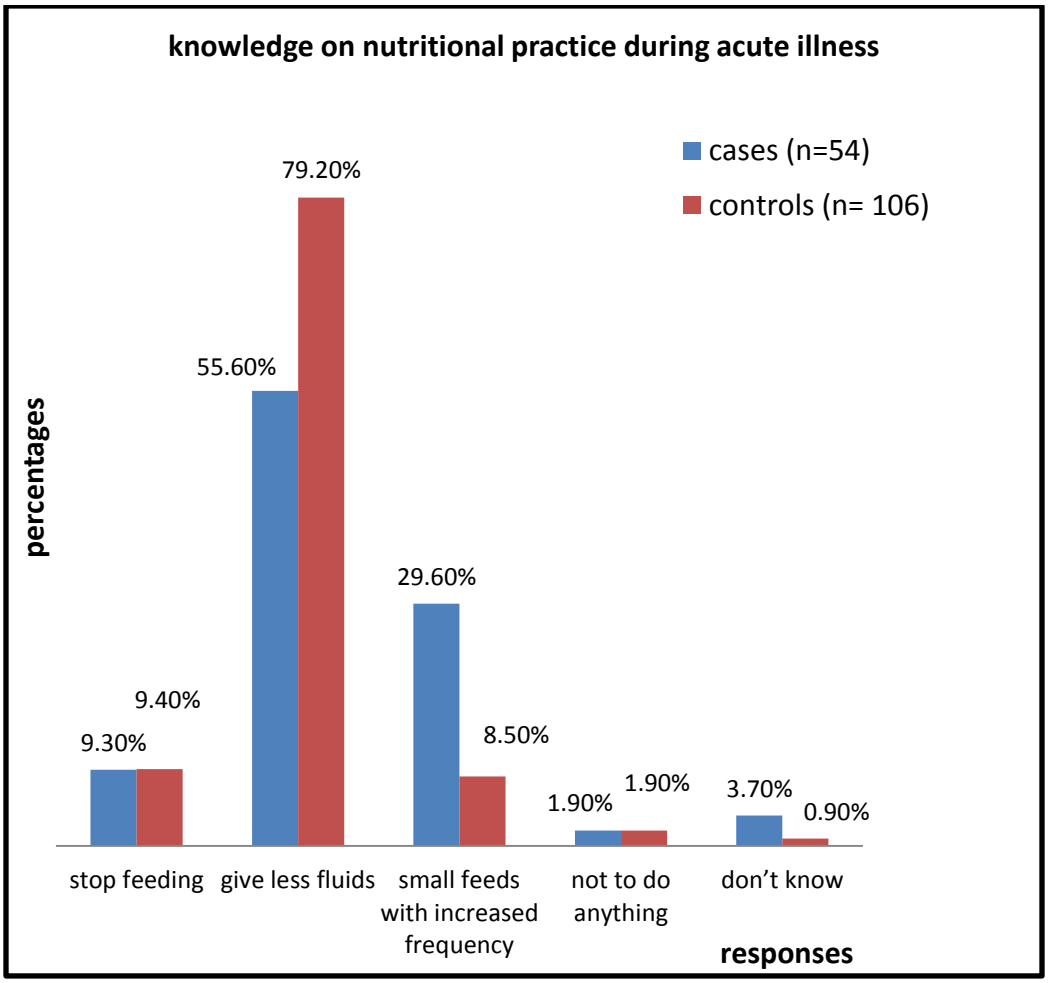
Figure 6-8 Mother's knowledge regarding duration of breastfeeding



Regarding initiation of complementary feeds, 63 % of mothers of cases and 64.2 % of mothers of controls mentioned that complementary food had to be started by the age of 6 months. Only 1.8% of mothers of cases and 3.7% of controls reported that cow's milk should be given undiluted.

When asked about the feeding practice during an illness like diarrhoea, more than half (55.6%) the mothers of cases and three-fourths (79.2%) of mothers of controls admitted that they would give less fluids. Nearly one third (29.6%) of the mothers of cases and 8.5% mothers of controls knew that small feeds with increased frequency had to be given during an episode of diarrhoea.

Figure 6-9 Mothers knowledge on nutritional practice during acute illness



The mothers of both cases and controls were asked to name four food items which contain proteins, vitamins and iron individually. Majority of them, in both the cases and controls, did not know even one food item with the above mentioned nutrients.

6.10 Food frequency:

In this study, only 20.4% of cases and 18.9% of controls consumed any one fruit daily. Nearly half of the cases (46.3%) and controls (42.5%) consumed at least one food item which had animal protein (Egg, Chicken, Meat and Pork). Among the animal protein, egg was the most commonly consumed food in both the groups. 37% cases and 50.9% controls consumed sweets and savories on a daily basis. Nearly three-fourth of the children in both the groups consumed soft drinks, biscuits or chips daily.

6.11 RISK FACTORS FOR SEVERE ACUTE MALNUTRITION:

Information on various potential risk factors were collected and analyzed to assess their association with children having SAM. Results are presented under separate sections as socio-demographic factors, child's birth related factors, child's morbidity related factors, child's diet related factors, family members' illness and socioeconomic factors.

6.11.1 Socio-demography factors and its association with malnutrition:

Religion, type of family, father's education and occupation, mother's education and occupation, mother's age and family size were dichotomized and analyzed to find out whether these risks were associated with the nutritional status of children. Table 6-8 gives details on the different socio-demographic variable and its association.

In this study, 46.3% of cases and 57.7% of controls belonged to nuclear family and there is no association between type of family and SAM. Of the 160 children studied 68.5% of cases and 84.9% of controls were from Hindu religious background. The odds of child developing SAM was 0.39 (95% CI: 0.18-0.85) among the Hindu religion

(protective) as compared to other community (Christians and Muslims), and this association was statistically significant (p-value 0.015).

Table 6-8 Demography related risk Factor:

	Cases N=54 n (%)	Control N=106 n (%)	OR (95% CI)	Chi square p-value
Religion - Hindu	37 (68.5%)	90 (84.9%)	0.39 (0.18-0.85)	0.015*
Type of family- Nuclear	25 (46.3%)	61 (57.7%)	0.64 (0.33-1.23)	0.177
Father's occupation- Unskilled/semi-skilled	26 (48.1%)	54 (50.9%)	0.89 (0.46 – 1.72)	0.867
Father's education- Illiterate/primary	16 (29.6%)	28 (26.4%)	1.17 (0.57-2.43)	0.667
Mother's age at child's birth- Less than 21 years	7 (13%)	24 (22.6%)	0.51 (0.20-1.27)	0.143
Mother's occupation- Working Mother	8 (14.8%)	10 (9.4%)	1.67 (0.62-4.51)	0.308
Mother's education- Illiterate/primary	16 (29.6%)	23 (21.7%)	1.52 (0.72-3.19)	0.269
Family size- 4 and more	4 (7.4%)	6 (5.7%)	1.33 (0.36-4.94)	0.666

* Statistically significant

Father's occupation and education did not show any statistically significant association with malnutrition (occupation p-value is 0.338, education p-value 0.667). Similarly, mother's working status and the education did not show any significant association with severe acute malnutrition (occupation p-value is 0.308; education p-value is 0.269).

The odds of developing SAM in children among those mothers who had delivered an index child at the age of 21 years and less was 0.51 (95% CI: 0.20-1.27) when compared to mothers delivered an index child after the age of 21 years, and it is not statistically significant. Birth order ≥3 [OR 2.449 (95% CI: 0.93-6.45) and p-value 0.064] and family size ≥4 [OR 1.33 (95% CI: 0.36-0.4.94) and p-value 0.666] also did not show any statistical association.

6.11.2 Birth related factors and its association with malnutrition:

Birth weight, gestational age of the mother at delivery, immunization status, congenital disorder, child being single and child's birth order were categorized and analyzed for an association with severe acute malnutrition.

In this study, 50% of the cases and 8.5% of controls were born with low birth weight. The odds of developing SAM among the low birth weight children was 10.77 (95% CI: 4.53-25.64) as compared to children with normal birth weight. This association is statistically significant (p-value <0.001). The mean difference between the birth weights of cases and controls were also statistically different from each other (p-value <0.001).

Table 6-9 Child's Birth Related Risk Factors:

	Cases N=54 n(%)	Control N=106 n(%)	OR (95% CI)	Chi-square p-value
Low birth weight (≤2.499 kg)	27 (50%)	9 (8.5%)	10.77 (4.53-25.64)	<0.001*
Preterm (≤36+6 weeks)	9 (16.7%)	7 (6.6%)	2.83 (0.99-8.07)	0.045*
Immunization: Incomplete (age appropriate)	10 (18.5%)	6 (5.7%)	3.79 (1.3-11.07)	0.010*
Congenital disorder: Present	7 (13%)	2 (1.9%)	7.75 (1.55-38.7)	0.004*
The child being single	11 (20.4%)	46 (43.4%)	0.33 (0.16-0.72)	0.004*
Birth order: > 2	10 (18.5%)	9 (8.5%)	2.45 (0.93-6.45)	0.064

* Statistically significant

Among the children, 16.7% of cases and 6.6% of controls were born before 37 weeks of gestation. The association between SAM and preterm was statistically significant (p value 0.045) although the odds ratio is 2.83 and 95% CI includes 1. Incomplete immunization status of a child (18.5% of cases and 5.7% of controls) had an odds of 3.79 (95% CI: 1.3-11.07) for the child to develop SAM as compared to child who had complete immunization. The association between the immunization status and SAM was statistically significant (p-value 0.010). We found that, 13% of cases and 1.9 % of controls had some form of congenital defect at birth. The difference between the cases and controls was statistically significant with a p-value of 0.004. Children with congenital defect had higher chance of developing SAM [OR 7.75 (95% CI: 1.55-38.70)

and p-value 0.004]. Among the study children, 20.4 % of cases and 43.4% of controls were the only child to their parents. Being a single child showed a protection for developing SAM (OR 0.33 and 95% CI: 0.16-0.72), and it was statistically significant (p-value 0.004).

6.11.3 Factors related to child's morbidity and its association with malnutrition:

Current medical illness, chronic diarrhoea, hospitalization of the child, history of passing worms in the stool were dichotomized and analyzed for association between SAM and the above mentioned risk factors. At the time of interview, 20.4% of cases and 3.8% of controls had some sort medical problems like upper respiratory infections, diarrhoea and measles. Presence of chronic illness has a higher risk of developing SAM (OR 6.52 and 95% CI: 1.97-21.63). Only 7.4% of cases and 1.9% of controls had chronic diarrhoea in the past and presence of chronic diarrhoea in children is not associated with SAM.

Table 6-10 Child's Morbidity Related Risk Factors:

	Cases N=54 n (%)	**Control N=106 n (%)**	**OR (95% CI)**	**Chi-square p-value**
Presence of current medical illness	11 (20.4%)	4 (3.8%)	6.52 (1.97-21.63)	0.001*
Presence of chronic Diarrhoea	4 (7.4%)	2 (1.9%)	4.16 (0.73-23.48)	0.082
Child Hospitalized in the past one year	11 (20.4%)	7 (6.6%)	3.62 (1.31-9.96)	0.009*
History of worms in the stool - Present	5 (9.3%)	5 (4.7%)	2.06 (0.57-7.46)	0.262

* Statistically significant

In the study population, 20.4% of cases and 6.6% of controls had the history of hospitalization in the past one year. The odds of developing SAM among the children who were hospitalized in the past one year was 3.62 (95% CI: 1.31-9.96) as compared to those who were not admitted in the past year. The association between hospitalization and SAM is statistically significant (p-value 0.009). History of passing worms in the stool did not show significant association.

6.11.4 Factors related to child's diet and its association with malnutrition:

Exclusive breast feeding, weaning practices, adequate calorie intake, adequate protein intake and children attending Balwadi (only for children more than 2 years) were categorized and analysed for associations between these variables and SAM.

In this study, 44.4% of cases and 11.3% of controls did not have exclusive breastfeeding for 6 months and the risk of developing SAM is much higher among children who were not breastfed (OR 6.27, 95% CI: 2.8-14.03). Late initiation of complementary feed (more than 6 months) in both cases and controls did not show any statistical significance (p-value 0.444).

Among 160 children 70.4% of cases and 24.5% of controls did not have adequate calorie intake appropriate for their age. The odds of developing SAM among the children who did not have an adequate calorie intake were 7.31 (95% CI: 3.51-15.21) as compared to the children who had an adequate calorie intake. The association between protein intake and SAM was statistically significant (p-value <0.001) but the odds could not be calculated as there were no children in the control group who had inadequate protein intake.

Table 6-11 Child's Diet Related Risk Factors:

	Cases N=54 n(%)	**Control N=106 n(%)**	**OR (95% CI)**	**Chi-square p-value**
Lack of exclusive breastfeeding (<6 months)	24 (44.4%)	12 (11.3%)	6.27 (2.8-14.03)	<0.001*
Late initiation of weaning (> 6 months)	9 (16.7%)	13 (12.3%)	1.43 (0.57-3.69)	0.444
Inadequate Calorie intake (Age appropriate)	38 (70.4%)	26 (24.5%)	7.31 (3.51-15.21)	<0.001*
Inadequate Protein Intake (Age appropriate)	8 (14.8%)	0	-	<0.001
Not Attending Balwadi (only for child >= 2 years) Case-27, controls- 47	15 (55.6%)	28 (59.6%)	0.85 (0.33-2.21)	0.736

*Statistically significant

Of the 74 children aged over 2 years, 55.6% of cases and 59.6% of children did not attend Balwadi and this is not statistically significant (p-value 0.736). The following table shows the mean calorie difference between cases and controls.

Table 6-12 Difference in mean calorie and protein intake between cases and controls:

Variable	Category	Mean(SD)	Mean difference (95% CI)	T test	p-value
Calorie difference	Case(54)	172.2 (304.70)	295.6 (200.11-391.09)	6.150	<0.001*
	Controls(106)	128.39 (250.32)			
Protein difference	Cases(54)	9.78 (9.53)	-8075 (-11.64 - -5.86)	-6.014	<0.001*
	Controls106)	18.54 (7.28)			

*statistically significant

6.11.5 Factors associated with family members and its association with malnutrition:

Mother's chronic illness, father's chronic illness, father's smoking habits, father's alcohol consumption, mother's BMI, history of contact with TB , sick child other than index child, child death, malnourished siblings were categories and analyzed for associations and to know the strength of associations.

In this study, mothers of 11.1% of cases and 0.9% of controls had some chronic illness. The odds of developing SAM was 13.13 (95% CI: 1.53-112.04) among the mothers of the children who had chronic illness as compared to mothers of children who did not have any chronic illness. The association between mother's chronic illness and SAM was statistically significant (p-value 0.006). There was no statistical association between father's chronic illness and child developing SAM. Both history of smoking and history of alcohol consumption were statistically significant with odds ratio of 2.03 (95% CI: 1.04-3.96, p-value0.037) and 1.98 (95% CI: 1.02-3.85, p-value 0.042) respectively.

Table 6-13 Parental and Sibling Related Risk Factors:

	Cases N=54 n(%)	Control N=106 n (%)	OR (95% CI)	Chi square p-value
Mother having chronic illnesses	6 (11.1%)	1 (0.9%)	13.13 (1.53-112.04)	0.006*
Father having chronic illnesses	2 (3.7%)	0	-	0.113
Father smoking- present	27 (50%)	35 (33%)	2.03 (1.04-3.96)	0.037*
Father alcohol consumption- Present	30 (55.6%)	41 (38.7%)	1.98 (1.02-3.85)	0.042*
Mother's BMI-Underweight (<18.5)	13 (24.1%)	8 (7.5%)	3.88 (1.5-10.08)	0.003*
Mother's poor nutritional knowledge	47 (87.03%)	74 (69.8%)	3.97 (1.3-12.13)	0.011*
History of TB contact at home	7 (13%)	2 (1.9%)	7.75 (1.55-38.7)	0.004*
Presence of a sick child other than index child	2 (3.7%)	0	-	0.113
Siblings death- Present	7 (13%)	5 (4.7%)	3.01 (0.91-9.98)	0.061
Siblings being malnourished	8 (14.8%)	9 (8.5%)	1.87 (0.68-5.17)	0.220

* Statistically significant

Among the mothers of study children, 24.1% of mothers of cases and 7.5% of mothers of controls had a BMI less than 18.5 (underweight). The odds of becoming SAM was 3.88 (95% CI: 1.5-10.08) among the mothers of the children whose BMI was less than 18.5 (underweight) as compared to mothers with BMI more than 18.5 (normal). There was a statistically significant association between mothers' BMI and SAM (p-value 0.003). Majority of the mothers, 87% of mothers of cases and 69.8% of mothers of

controls had poor knowledge on nutrition. The odds ratio between mother's nutritional knowledge and SAM was 3.97 (95% CI: 1.3-12.13). The mean score of knowledge for mothers of cases was 2.7(±1.37) and for mothers of control was 3.321 (±1.96). These differences between the mean scores were statistically significant (p-value 0.02).

In the study, 13% of cases and 1.9% of controls had history of contact with TB. This difference was statistically significant (p-value 0.004) with the OR 7.75 (95% CI: 1.55-38.7). There was no statistical association between SAM and siblings' death, malnourished siblings and sick child other than the index child.

6.11.6 Socio-economic factors and its association with malnutrition:

SES, ration from public distribution system (PDS), social security, less than 3 meals due to non- availability, debt to pay were categorized and analyzed for associations with SAM.

Among the study children, 64.8% of cases and 50% of controls belonged to low socio-economic status according to BG Prasad's classification. The children who belonged to low socioeconomic status had an odds of 1.84 (95% CI: 0.94-3.62) to develop SAM as compared to children who belonged to higher socioeconomic status, but there was no statistical association between SAM and SES (p-value 0.075).

About 66.7% of cases and 40.6% of controls got rice from public distribution system regularly. The difference was statistically significant (p-value 0.002) with an odds ratio of 2.93(95% CI: 1.46-5.82).

Only few of the cases (29.6%) and controls (14.2%) received some form of social security assistance from the government. The odds of developing SAM was 2.55(95% CI: 1.15-5.68) among the families of children who received some form of social security as compared to families of children who did not get any form of social security. The association between SAM and Social security was statistical significant (p-value 0.019).

Table 6-14 Socioeconomic Related Risk Factors

	Case N=54 n (%)	Control N=106 n (%)	OR (95% CI)	Chi square p-value
Low SES (BG Prasad's)	35 (64.8%)	53 (50%)	1.84 (0.94-3.62)	0.075
Family getting rice from PDS	36 (66.7%)	43 (40.6%)	2.93 (1.46-5.82)	0.002*
Social security assistance-present	31 (29.6%)	15 (14.2%)	2.55 (1.15-5.68)	0.019*
Less than 3 meals due to non-availability- present	5 (9.3%)	1 (0.9%)	10.71 (1.22-94.18)	0.009*
Debt to pay -Yes	36 (66.7%)	48 (45.3%)	2.42 (1.22-4.78)	0.010*

*Statistically significant

Very few cases (9.3%) and controls (0.9%) skipped one meal due to non-availability. The children who had skipped a meal due to non-availability had higher risk of developing SAM (OR 10.71, 95% CI: 1.22-94.18) as compared to children who did not skip any meal. There was a statistically significant association between SAM and less than 3 meals due to non- availability (p-value 0.009). Families of 66.7% of cases and

45.3% of controls had to pay some amount of debt every month, and the difference was statistically significant (p-value 0.010) with an odds ratio of 2.42 (95% CI: 1.22-4.78).

6.12 Multivariate analysis by Logistic regression:

A logistic model was derived by entering the following variables:

Birth weight, congenital disorder, exclusive breastfeeding, SES, father's smoking habit, father's alcohol consumption, mother's BMI, inadequate calorie intake, incomplete immunization, child's hospitalization, presence of household TB contact, current medical illness (child), mother's nutritional knowledge, being single child and Hindu community. The above mentioned variables showed statistically significant association with SAM in the uni-variate analysis. As controls were matched for gender and age, these were not included in the multivariate analysis.

Presence of congenital disorder and being a single child was significant in the uni-variant analysis and after adjusting for various variables, it became insignificant with an OR 0.89 (95% CI: 0.08-10.07) and OR 0.58 (95% CI: 0.18-1.81) respectively. Though the odds ratio of low SES (OR-1.3), current medical illness (OR-3.7), incomplete immunization (OR-1.3), presence of household TB contact (OR-1.01), mother's nutritional knowledge (OR-1.8), father's smoking habit (OR-1.01) and father's alcohol consumption (OR- 1.3) were more than one, but the confidence interval included one. Hence the above mentioned factors become statistically insignificant after logistic regression model. Hindu religion, current medical problem and hospitalization in the past one year lost its significance after adjusting for various variables in the logistic regression model. The logistic regression model is shown below in table 6-15.

Table 6-15 logistic regression model for factors associated with SAM

	Case N=54 n (%)	Control N=106 n (%)	OR (95% CI)	AOR (95% CI)	p-value
Demography related risk factors:					
Religion- Hindu	37 (68.5%)	90 (84.9%)	0.39 (0.18-0.85)	0.54 (.14-2.1)	0.374
SES-Low	35 (64.8%)	53 (50%)	1.84 (0.94-3.62)	1.31 (0.48-3.58)	0.603
Child's birth related risk factors:					
Birth weight <2.5 Kg	27 (50%)	9 (8.5%)	10.77(4.53-25.64)	8.95 (2.98-26.85)	**<0.001***
Congenital disorder +	7 (13%)	2 (1.9%)	7.75 (1.55-38.7)	0.894 (0.08-10.07)	0.928
Being single child	11 (20.4%)	46 (43.4%)	0.33(0.16-0.72)	0.58 (0.18-1.81)	0.347
Child's morbidity related risk factors:					
Current Medical illnesses+	11 (20.4%)	4 (3.8%)	6.52 (1.97-21.63)	3.70 (0.57-23.94)	0.169
Hospitalization- present	11 (20.4%)	7 (6.6%)	3.62(1.31-9.96)	0.84 (0.16-4.56)	0.841
Immunization incomplete	10 (18.5%)	6 (5.7%)	3.79 (1.3-11.07)	1.32 (0.24-7.2)	0.747
Child's diet related risk factors					
Not exclusively breastfed	24 (4.4%)	12 (11.3%)	6.27(2.8-14.02)	4.67 (1.72-12.65)	**0.002***
Inadequate Calorie	38 (70.4%)	26 (24.5%)	7.31(3.51-15.21)	8.093 (3.15-20.82)	**<0.001***
Parent/sibling related risk factors:					
Household TB contact-Present	7 (13%)	2 (1.9%)	7.75 (1.55-38.7)	1.01 (0.13-7.66)	0.995
Mother's BMI-Underweight (<18.5)	13 (24.1%)	8 (7.5%)	3.88(1.5-10.08)	6.87 (1.92-24.55)	**0.003***
Mother's nutritional knowledge- poor	47 (92.2%)	74 (74.7)	3.97 (1.3-12.13)	1.8 (0.47-6.93)	0.393
Father smokes- present	27 (50%)	35 (33%)	2.03(1.04-3.96)	1.02 (0.33-3.12)	0.979
Father alcohol consumption- present	30 (55.6%)	41 (38.7%)	1.98(1.02-3.85)	1.3 (0.41-4.13)	0.659

* Statistically significant

In the backward conditional logistic regression model, after adjusting for all other factors, birth weight <2.499kg {AOR- 8.95 (95% CI: 2.98-26.85)}, not exclusively breastfed for 6 months {AOR 4.67 (95% CI: 1.72-12.65)}, inadequate calorie intake {AOR 8.09 (95% CI: 3.15-20.82)} and mothers' underweight {AOR 6.87 (95% CI: 1.92-24.55)} were the factors significantly associated with the Severe acute malnutrition.

Table 6-16 significant risk factors for SAM after adjusting for various variables

Risk factors	**AOR (95% CI)**	**p-value**
Birth weight <2.5 Kg	8.95 (2.98-26.85)	**<0.001***
Not exclusively breastfed	4.67 (1.72-12.65)	**0.002***
Inadequate Calorie	8.093 (3.15-20.82)	**<0.001***
Mother's BMI-Underweight (<18.5)	6.87 (1.92-24.55)	**0.003***

*Statistically significant

The above mentioned risk factors portraits the importance of maternal and child care for the prevention of SAM in both rural and urban.

7 DISCUSSION

Malnutrition is the leading cause of morbidity and mortality among children due to acute illness and its adverse effects. This study aimed at identifying the risk factors for severe acute Malnutrition in rural and urban areas of Vellore, South India. In order to identify the risk factors associated with SAM, a case- control study matched for age, sex and location was carried out. In India, previously published papers on risk factors for SAM were mostly done in hospital setting where the risk factors might be different from actual factors causing the malnutrition. This study was conducted in a community set up, to find out about the actual risk factors causing malnutrition in the community, so that it can be generalized to the general population.

7.1 Demography related risk factors:

In the study population, the majority of the children both the cases and controls belonged to the age group 12-23 months. The mean age was 24 months in both the cases and controls. The proportion of children with SAM started decreasing thereafter. A study done in semi-urban Vellore, also showed that the prevalence of malnutrition was on an increasing trend between 6 months to 18 months and decreased after 24 months(23). According to NFHS III (Tamil Nadu) data, the prevalence of malnutrition was similar in urban and rural, with slightly higher proportion in the rural areas(18). In this study, most of the children (around 70%) belonged to the urban community. These children were from semi- urban slums of Vellore, where the parental care and environmental condition were poorer than rural Vellore. In this study, 40.7% of cases and 45.3% were belonged to most backward group followed by backward class, but according to NFHS III (India) data, majority of the children belonged to SC/ST community(18). In this study majority

of the cases (68.5%) and controls (84.9%) belonged to the Hindu community followed by the Muslim community. Being a Hindu religion was a protective factor in this study which is similar to the HUNGaMa survey where children belonging to Muslim community had poor nutrition(19).

According to Vellore city census data 2011, the average literacy in Vellore is around 87.67% with males being more literate(91.68%)(116). Similarly, in this study, 90.7% of mothers and fathers of cases were able to read and write. Among controls, 96.2% of fathers and mothers were able to read and write. Maternal illiteracy plays an important role in malnutrition when compared to paternal illiteracy. In this study, poor parental education was not found to be risk factor for SAM, but the report from HUNGaMa says that stunting and wasting were more prevalent in the children of mothers with poor education (19). Another similar study done in Delhi showed that there was a strong association between malnutrition and the maternal education (85).

Absence of mothers affects the wellbeing of the children. It influences the child's feeding practice. In this study population, only 14.8% of mothers of cases and 9.4% of mothers of controls were employed and were leaving behind their children at home with caregivers (grandparents). A study done by Miler showed that children of working mothers in an irregular shift have a high risk of becoming malnourished, compared to children of mothers doing a regular shift(87). In this study, the association between SAM and mother's occupational status did not show any statistical significance, as only a small proportion of mothers were employed in both the cases and control group.

The study in Uttar Pradesh showed that malnutrition was not a problem among the children whose birth order was one or two. In this study we did not find any statistical significance with birth order three and more. According to "district level household and facility survey-4" in Tamil Nadu, the average number of children in a family is two(117). In this study, though the average number of children in the family was two, family size of four and more did not show any statistical significance for developing SAM.

Surprisingly, according to this study, none of the demographic factors, except religion being protective factor, contribute to the development of severe acute malnutrition.

7.2 Child's related risk factors:

Child's related risk factors includes: birth related, morbidity related and diet related.

7.2.1 Child's birth related risk factors:

According to NFHS III data, low birth weight is the major determinants of chronic childhood malnutrition. The birth weight is influenced by many socioeconomic factors like being rural or urban, wealth, caste, religion, education, and tobacco use by mother(63). In this study, 50% of the cases and only 8.5% of the controls had birth weights less than 2.5 kg. The association between the low birth weight and SAM was statistically significant with p value of <0.0001 {adjusted OR-7.631 (95% CI: 2.422-24.045)}. A similar study conducted in Indonesia showed that LBW was strongly associated with malnutrition. The above finding was consistent with several other studies(64)(66)(67). Study done in Ghana showed preterm babies were prone to develop

malnutrition in later life(67). This study did not find any significant association between prematurity and the child's nutritional status. This may due to two reasons, either preterm babies die before crossing early neonatal period or due to availability of better nursery care in recent years.

Immunization against childhood disease like tuberculosis, diphtheria, measles, and whooping cough reduce childhood mortality and morbidity. Children who develop these diseases usually suffer from malnutrition, impaired cognitive, emotional and social skills(118). In this study, there was a statistical association OR 3.788(95% CI: 1.296-11.070) between incomplete immunization and SAM. Similar findings were reported in New Delhi with aOR- 12.13(95% CI: 4.32- 34.09) (119). We found that, being a single child in the family was a protective factor for SAM. This may be due undivided parental attention and nutritional care provided to the only child.

In this study, 13% of the cases and only 1.9% of the controls had congenital disorders. Most of them were congenital heart disease. The study showed a statistical association between the severe acute malnutrition and congenital disorders. Similar findings were seen in the study conducted in a USA where in malnutrition occurred in 70% of the children who were born with congenital heart disease (71).

7.2.2 Child's morbidity related risk factors:

Medical illness like diarrhoea, ARI, measles and chickenpox at the time of interview were found to be significantly associated with malnutrition. The practice of reducing oral fluid intake during acute illness, which was the most commonly followed practice, could be the reason of malnutrition during the acute illness. Though the current

illness was a risk factor, the previous episodes of diarrhoea and respiratory infections were not an important determinant for child malnutrition. Similar findings were seen in the study conducted in Malaysia where there was no statistical association between child's frequency of illness and the various forms of malnutrition(120). The studies done in Laos, Nicaragua and Vietnam (121)(122) were contrary to this and showed an association between the frequency of illness and malnutrition. History of worm infection was not significantly associated with child's nutritional status in the study.

According to the literature, malnourished children were prone to develop common communicable diseases and therefore to increased hospitalization. When these children get admitted they do not receive proper nutritional support, which can worsen the pre-existing malnutrition(123). In this study, history of hospitalization in the past one year was significantly associated with malnutrition. Similarly, a study done in Brazil showed that among the normal weight children, 10 % of children experienced loss of weight at the time of discharge(123).

7.2.3 Child's diet related risk factors:

Exclusive breastfeeding for the first 6 months of life is the best way of feeding infants. Thereafter infants should receive soft and commonly available foods (complementary) with breastfeeding(124). Breastfeeding can be continued up to 2 years of age or beyond. According to HUN Gama survey, 60% of the children did not received exclusive breast feeding for first six months (19). In the current study, 44.4% of cases and only 11.3 % of controls did not receive exclusive breastfeeding. There was a significant association between the lack of exclusive breastfeeding and malnutrition with AOR of 4.67 (95% CI: 1.72-12.65). A similar finding was noted in the study done in Ethiopia(52).

Early introduction of solid foods was common among cases as compared to controls. Exclusive Breast feeding after 6 months of age will not meet the nutrient requirement of the growing children. Hence, starting soft, healthy and home based food at the age of six months is recommended. Literature shows that, starting complementary feeds beyond one year was a risk factor for malnutrition. A study done in Ethiopia showed that starting complementary feed after 12 months of age was a significant risk factor for malnutrition(52), but in this study majority of the parents of the cases and control started giving complimentary food by the age of 7 months. This study did not show any significant association between late complementary feeds and malnutrition.

According to Gopalan's theory of dysadaptation, the dietary protein was used for energy production and hence children with malnutrition develop edema due hypoalbuminemia. Child with marasmus did not use dietary protein for energy production and escapes edema. Similarly in this study, none of the children had edema. The dietary calorie intake of cases, were inadequate as compared to controls on the basis of recommended daily allowance (RDA). The poor calorie intake may be due to non-availability of food, frequent illness and faulty feeding practices. Though the protein intake met the daily requirement, it was lesser when compared to controls. This is because the staple food in south Indian is rice, which has a fair enough amount of protein in it. A similar finding was reported in a study done in Malaysia(62). It was found that many of the cases had inadequate calorie and vitamin A intake. In this study, cases were found to consume less fruits and animal proteins as compared to controls. Surprisingly consumption of milk products like curd and butter milk was more among cases than controls. A study done in Malaysia reveals that most of the cases and controls consumed

junk foods and soft drinks. This study was similar to the Malaysian study as around 70 % of cases and controls consumed junk food, like bakery items, daily.

7.3 Parents and siblings related risk factors:

In this study, 11.1% mothers of cases and 0.9% of controls had chronic illness. The association between the mother's chronic illness (like HIV and TB) and SAM was statistically significant. Similar finding was observed in the study done in south Africa(89). The factors which could have contributed to SAM were early cessation of breastfeeding, poor nutritional care and support due to mother's illness. Majority of the mothers of cases had poor nutritional knowledge when compared to mothers of controls. Similar finding was shown in a study done in rural south India, where both the case and the control groups showed a statistically significant difference in nutritional knowledge with an OR- 2.62 (58).

As per intergenerational cycle, malnourished women will give birth to a LBW child, who will eventually grow as malnourished child. To confirm the above statement, the finding in this study also showed majority of mothers of cases were underweight as compared to mothers of controls. The association between the Mother's low BMI and SAM was statistically significant. This is similar to the study done using the NFHS III data(125).

Paternal smoking has been shown to divert expenditure from food to tobacco, putting the children at greater risk of developing chronic malnutrition. In this study, 50% of fathers of cases and 33% of fathers of controls had history of smoking, which was statistically significant, similar results were shown in study done in Indonesia(126).

According to the study done in Indonesia, the prevalence of under-5 mortality due to malnutrition was higher in families where the fathers were smokers. In this study there was no association of SAM and illness or death of the siblings in the family.

7.4 Socio-Economic related risk factors:

The majority of the children in the study were from nuclear family (46.3% of cases and 57.5% of controls) and with low socioeconomic status according to BG Prasad's classification. In this study, 64.8% of cases and 50% of controls were belonged to low socioeconomic status. There was no statistical significance between low socio-economic status and SAM. In contrary to this, a study done in Rajasthan showed 82% of the underweight children belonged to the low SES group(56). Similarly study done in rural south India, also showed that SES has a strong association for malnutrition(57).

The effects of poverty on child malnutrition are widespread. Poor households and individuals are unable to achieve food security, have inadequate resources for care, and are unable to avail modern health care facilities.

In this study, poverty was more prevalent among the families with malnourished children. Lower income among the families of cases was probably due to their fathers having low income generating occupation and the mothers not working. The common occupations among the fathers of cases were manual labour, drivers and agricultural labour. A majority of the mothers of cases were housewives who did not contribute to the income of the family. In this study factors such as debt to pay, less than three meals due to non-availability of food, ration from PDS and assistance from social security were found to be a significant predictors of severe acute malnutrition.

8 Summary

From the results of this study it is concluded that determinant factors of SAM are not only limited to the medical causes of malnutrition but also various factors which are accountable in causing child malnutrition. According to the findings of this study, among the socio-demographic factors, only religion showed association with malnutrition. Being a Hindu protects against children going into severe acute malnutrition [OR 0.39 (95% CI: 0.18- 0.85)]. However, in the multivariate analysis, religion did not show significant association with SAM [OR 0.55 (95% CI: 0.14-2.11)].

Uni-variate analysis showed that children of low birth weight, and born with some form of congenital disorder were more likely to be severely malnourished as compared to child with normal weight, and child without any congenital disorder. However, after adjusting for other variables, presence of any congenital disorder did not show significant association with SAM [OR 0.89 (95% CI: 0.08-10.07)]. Low birth weight children (<2.5kg) after adjusting, has 8.9 times higher risk of having SAM (95% CI: 2.98-26.85).

Though being the only child of the family has been identified as a protective factor for SAM in uni-variate analysis, the association became weak after adjusting for other factors [OR 0.58 (95% CI: 0.18-1.81)].

This study shows that hospitalization in the past one year and medical illnesses at the time of interview are significant risk factor for SAM [OR 3.62 (95% CI: 1.31- 9.96)] and [OR 6.52 (95% CI: 1.97-21.63)] respectively.

Even after adjusting for various variables, this study confirms that Severe Acute Malnutrition occurs due to lack of exclusive breast feeding for first six months of life

[aOR 4.67 (95% CI: 1.72-12.65)] and inadequate calorie intake thereafter [aOR 8.09 (95% CI: 3.15-20.82)].

Among the factors related to parental morbidity, mothers who had chronic illness showed a significant association with SAM [OR 13.13 (95% CI: 1.54-112.04)]. Mothers who had poor nutritional knowledge [OR 3.97 (95% CI: 1.3-12.13)] and whose BMI was less than 18.5 [OR 3.88 (95% CI: 1.5- 10.1)] has a strong association for SAM. Among the fathers, history of alcohol consumption [OR 1.98 (95% CI: 1.02-3.85)] and smoking [OR 2.03 (95% CI: 1.04-3.96)] showed a statistical significance with SAM. Among the factors related to siblings, none of them significantly associated with SAM. History of child hanging out with family members who have tuberculosis also showed a significant association with SAM [OR 7.75 (95% CI- 1.55-38.7)]. However, after adjusting for various variables, above variables did not show any statistical association with SAM except mother's low BMI [aOR 6.87(95% CI: 1.92-24.55)].

Surprisingly, children who belonged to low socioeconomic status according to BG Prasad's scale did not show any association with SAM. Other poverty related factors like using ration from PDS, financial assistance from government social security, skipping meals due to non- availability and if the family have any debt to pay showed a strong association with SAM. After adjusting for other variables, none of the above mentioned socio-economic factors were significantly associated with SAM.

9 Implications of the study

The study findings will help to increase the knowledge about the factors associated with severe acute malnutrition. Not many community based case-control studies done in India to identify the risk factors. Unlike other hospital based study, these study findings can be generalized to the general population also. Our results will be helpful for NGOs and local government to bring up the new policy and program to improve the condition and reduce the burden of malnutrition in the community.

10 Limitations

- Few SAM children from primary study were not recruited in the risk factor study due to non-availability of principal investigator when the children visited the clinic

- Majority of the cases mothers of and control had difficulty in recollecting the duration of the breastfeeding and initiation of complementary feeds. A potential recall bias could have happened in the study.

- The calorie intake was based on 24 hour diet recall; it only gives the information of food consumption for a particular day. Since it was a one day recall, it may cause over estimation or under estimation of the actual food intake of the children.

- The principal investigator was aware of the cases and controls and their nutritional status of the subjects. Potential interviewer bias could have been introduced in the study.

- Since it was a community based study, finding two appropriate controls for each case was very difficult.

11 Recommendations

- Lack of exclusive breastfeeding for six months is significant risk factors. Counseling of mothers about the importance of exclusive breast feeding and starting complementary feeds on time during their ante-natal visits is highly recommended.

- Of all the cases, 50% of them were born with low birth weight and it found to be a risk factor for SAM. Hence, Counseling of pregnant mothers and women in the reproductive age group about nutritious, healthy and safe food during pregnancy is recommended.

- Poor calorie intake is a significant risk factor for SAM. Counseling of mothers on appropriate and adequate amount of food intake for children is recommended.

- Majority of the cases and controls were not aware of correct feeding practices during acute illness. Hence, counseling the mothers about the feeding practices during the acute morbidity of the children is needed.

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Annexures 1

Study tool:

The Risk factors for Severe Acute Malnutrition among the children of age group 06-59 months – A Community based case-control study from southern India - QUESTIONNAIRE

1. S. no:_____ 2.case/control:_____

3. Date of interview:_____ 4. Interviewer: Dr. SAM MARCONI.D

5. Child name: _____

6. Respondent: (with relationship to child): 1.Mother 2. Father 3. Grandmother 4. Grandfather

8. Place of residence: 1.Rural 2. urban 9. Village/town:_____

10. Address:_____

11. Types of house: 1.Small hut 2. Large Hut 3.Mixed 4. Pucca 5. Mansion

12. Type of family? 1. Nuclear 2. Joint 3. Extended 13. Caste:_____

14. Religion: 1. Christian 2. Hindu 3. Muslim 4. Others, specify_____

15. How many people stay in this house and share a same kitchen? _____

16. Head of the household? (with relation to the index child)
1. Mother 2. Father 3. Grandmother 4. Grandfather 5. Other (specify) _____

17. What is the occupation of the father?_____

18. What is the education of the father?_____

Information on the Mother:

1.Age of the mother:_____ 2. Age of mother at marriage:_____

3. Age of mother at study child's birth?_____

4. Obstetric score: G P L D A END SB ID

5. Educational qualification of the mother?_____

6. Does the mother work outside the house? 1. Yes 2. No

7. If yes, What is the occupation of the mother? (actual)_____

8. what is the type of occupation of the mother? 1. Daily basis 2. Regular monthly salary

9. what is the mother's income alone?(actual)_____

10. If mother is working outside, who takes care of the child?
1. Father 2. Grandparents 3. Older siblings 4. Other family members 5. Neighbour 6. Others_____

11. Is there any sick child staying along with the index child? 1. Yes 2. No

12. If Yes to Q 9, what is the illness?_____

13. Did the mother take iron and vitamin pill when she is pregnant? 1. Yes 2. No

Information on the index child:

1. Date of birth:_____ 2. Age_____(MONTHS) 3. Sex of the child: 1. Male 2. Female

4. What is the Birth weight of the child?_____

5. What is the Gestational age of the child at birth?_____

6. What is the Birth order of the child?_____

7. What is the age of the child before the index child (if any)?_____months

8. What is the age of the child after the index child (if any)?_____months

9. Place of birth of index child?
1. PHC 2. Govt.hospital 3. Pvt. Hospital 4. CMC 5. CHAD 6. Home
7. Others_____

10. Is the index child diagnosed to have any congenital disorder diagnosed at birth? 1. Yes 2. No
(IF YES, WHAT_____)

Nutritional survey

1. Is the child still breastfeeding? 1. Yes 2. No

2. If not breast feeding, for how many months did you breastfed this child?_____

3. If the child is less than 24 months and not breast feeding, why did you stop breastfeeding this child?

1. Child Refused 2. Time To Wean 3. No Milk 4.Workload 5. New Pregnancy 6. Mother Illness 7. Others,_____)

4. Did you give cow's milk during the first six months of age? 1. Yes 2. No

5. If yes, at which month you gave cow's milk to this child?_____

6. If yes, did you dilute the cow's milk before giving to the child? 1. Yes 2. No

7. Did you give infant formula feed to the child in the first six months? 1. Yes 2. No

8. Did you bottle feed the child in the first six months? 1. Yes 2. No

9. At which month, the child was given semi-solid of soft foods for the first time?_____

10. Who feeds the child usually if not breast feeding?

1. Mother 2. Father 3. Grandparents 4. Siblings 5. Relatives 6. Others_____

11. Who decide the food FOR THE child IF NOT BREAST FEEDING?

1. Mother 2. Father 3. Grandparents 4. Siblings 5. Relatives 6. Child himself

7. Others_____

12. Could please tell me everything that your child ate from 8AM yesterday morning till 8AM this morning?

(To be filled in 24 hr recall questionnaire)

13. Is the child attending balwadi centre? 1. Yes 2. No

14. Does the child eat non- food items like sand, chalk, etc.,? 1. Yes 2. No

15. Does the family eat meat/chicken? 1. Yes 2. No

16. If yes, in month, how often do you buy the following:

Chicken:	How much:
Meat:	How much:
Egg:	How much:

17. How much oil is used by the family per week?_____

18. How much milk is used by the family per day?_____

Mother's knowledge on breastfeeding, weaning and nutrition:

1. Till what age we should breast feed the child? (1 mark)_____

2. At what age we should start giving the complementary feeds to the child?(1 mark)
_____

3. What should be the dilution when we feed the child with animal milk? (1 mark)
_____

4. What should we do if a child is suffering from any illness like ARI/diarrhoea/Measles?(1 mark)
   (a) should stop feeding
   (b) give less fluid until my child is better
   (c) should feed small quantities at frequent intervals and give plenty of fluids
   (d) not do to anything

5. can you name some protein rich diet?_____
   i. Egg (0.5 mark)
   ii. Milk and milk products(0.5mark)
   iii. Animals product(fish/chicken/mutton)(0.5 marks)
   iv. Pulses and legumes(0.5 marks)
6. Can you name some vitamin rich foods?_____
   i. Greens (0.5marks)
   ii. vegetables(carrot)(0.5 marks)
   iii. Fruits (papaya/orange/guava)(0.5 marks)
   iv. Cereals (0.5marks)
7. Can you name some iron rich foods?_____
   i. Greens (0.5 marks)
   ii. Goats liver(0.5 marks)
   iii. Dates/jiggery(0.5 marks)
   iv. Rice flakes(0.5 marks)

Immunization details of the index child:

1. TICK (√) APPROPRIATLY:

BCG	OPV	DPT				HEP B				MEASLES	COMBIVAC				HIB				VIT A
		1	2	3	B	1	2	3	B		1	2	3	B	1	2	3	B	

2. From above details is the child immunization status is complete AND appropriate for the age?

1. Yes 2. No

Morbidity survey of the index child:

1. Does your child allergic to any food stuff? 1. Yes 2. No (IF YES, FOR WHAT_____)

2. Is the child passing worms in stool? 1. Yes 2. No

3. Is there presently any serious medical problem for the child? 1. Yes 2. No (IF YES, FOR WHAT_____)

4. Did the child have diarrhoea during the last one month? 1. Yes 2. No

5. How frequently the child is getting diarrhoea?

1. < 1 week 2. every two week 3. every month 4. every three months 5. others_____

6. Where did you take the child when he/she had diarrhoea last time?

1. PHC 2. Govt.hospital 3. Pvt. Hospital 4. CMC 5. CHAD 6. Home 7. Others_____

7. In the past, did ever child suffered from continuous diarrhoea for more than 14 days? 1. Yes 2. No

8. Did the child have cough/ARI during the last one month? 1. Yes 2. No

9. How frequently the child is getting cough/ARI?

1. < 1 week 2. every two week 3. every month 4. every three months 5. others_____

10. Where did you take the child when he/she had ARI/cough last time?

1. PHC 2. Govt.hospital 3. Pvt. Hospital 4. CMC 5. CHAD 6. Home 7. Others_____

11. Has the child been hospitalized in the last one year? 1. Yes 2. No (IF YES, FOR

WHAT_____)

12. If yes, how many times the child has been hospitalized in the last one year?_____

13. Have ever your child suffered from Measles in the past? 1. Yes 2. No

14. Have ever your child suffered from chicken pox in the past? 1. Yes 2. No

15. Does your child play/hang around with the person who is diagnosed to have TB? 1. Yes 2. No

Morbidity survey of the mother:

1. Does the mother suffering from any chronic medical condition? 1. Yes 2. No

2. If yes, what CHRONIC medical condition? 1. TB 2. HIV 3. Malignancy 4.Others_____

3. Has the mother been ill in past? 1. Yes 2. No

4. Has the mother been ever hospitalized in the past one year? 1. Yes 2. No (IF YES, FOR WHAT_____)

Morbidity survey of the father:

1. Does the father smoke? 1. Yes 2. No

2. Does the father drink alcohol? 1. Yes 2. No

3. Is the father suffering from any chronic medical condition? 1. Yes 2. No

4. If yes, what CHRONIC medical condition? 1. TB 2. HIV 3. Malignancy 4.Others_____

5. Has the father been ill in past? 1. Yes 2. No

6. has the father been ever hospitalized in the past one year? 1. Yes 2. No (IF YES, FOR WHAT_____)

Environmental factor:

1. Does the house have a latrine? 1. Yes 2. No

2. Where do you defecate? 1. Latrine 2. Open air 3. Other _____

3. Do you grow any vegetable/fruit in your house? 1. Yes 2. No

4. If yes, what are they used for? 1. To consume 2. Trade 3. Others_____

5. Do you raise any animals other than pets? 1. Yes 2. No

6. If yes, what for they are used? 1. To consume 2. Trade 3. Agricultural purpose 4. Others_____

Information on socio-economic factor:

1. How many persons works in this family?_____

2. What is the total income in the family per month?_____

3. Does your family have ration card? 1. Yes 2. No

4. Do you have BPL card? 1. Yes 2. No

5. Do you use the ration from PDS? 1. Yes 2. No

6. Does any family member get income from the social security? 1.Family pension 2. old age pension 3. disability pension 4. NO

7. Who decides what food to cook, what to buy and where to buy? 1. Father 2. Mother 3. Grandparents 4. Others_____

8. How many meals do family member eat per day?_____

9. Have you skipped any meals due lack of money? 1. Yes 2. No

10. Where does the father of the index child live? 1. With family 2. Living separately 3. Died

11. Does the family have any debts to pay? 1. Yes 2. No

Physical examination of the index child:

1. **Pallor** 1. Yes 2. No 2. **Pedel edema** 1. Yes 2. No 3. **Bitot's spot** 1. Yes 2. No

4. Any other physical finding if significant:_____

5. Weight _____(Kgs) 6. Height/Length_____(cms) 7. Left MUAC_____(cms)

Physical examination of the mother:

1. Height: 2. Weight: 3. Any other finding:

Nutritional status of other child in the family:

s.no	Name	Age in months	Wt(kgs)	Ht(cms)	Lt.MUAC(cms)	pallor	Pedel edema	bitots	Other significant
						Y/N	Y/N	Y/N	
						Y/N	Y/N	Y/N	
						Y/N	Y/N	Y/N	
						Y/N	Y/N	Y/N	
						Y/N	Y/N	Y/N	

Risk-factors for Severe Acute Malnutrition- 24 hr dietary recall

Time of day	Items	Quantity
Early morning		
Break fast		
Mid-morning		
Lunch		
Tea time		
Dinner		
Beverages		
In between snacks		
Bed-time		
Type of oil used		

Food Frequency Questionnaire:

Item used	Form	Quantity	Frequency		
			Daily	Weekly (1/2/3)	Monthly (1/2/3)
Fruits a. Plantain b. Guava c. Papaya d. Sapota e. others	• raw • juice				
Milk: a. curd b. butter milk	• as such • standard • diluted				
Non-veg a. egg	• boiled • omelette • fried				
b. fish	• fried • stew • others				
c. chicken	• fried • stew • others				
d. meat (mutton/beef)	• fried • stew • others				
Other: pork, liver					
sweets& deserts	• payasam • kesari • ice-cream • fried(laddu, jangiri,jammunj ilabi)				
Savoury	• chips • papad R/F • Wafers (kurkure) • Murukkus • Bajji • Bonda • Samosa • Mixture				
a. Soft drinks b. Sugar cane juice					
Bakery	• Bread • Bun • Biscuit(salt/swe et) • Cake • Puffs • others				

Annexures 2

INFORMATION SHEET- English

Risk factors for Severe Acute Malnutrition

Information sheet – adults

The following information is provided to inform you about this study and your participation in it. Please read this information carefully and feel free to ask any questions you may have about this study and information given below. You will be given a copy of this information sheet and you will be given an opportunity to ask questions, and your questions will be answered. Your participation in this research study is voluntary. You are also free to withdraw from this at any time. Your withdrawal will not affect any of your treatment or benefit you receive from our institution(CMC vellore and CHAD hospital)

Purpose of the study:

Severe acute malnutrition (SAM) is a condition which occurs due to inadequate nutrition and socioeconomic condition which leads to significant wasting and/or swelling of the legs and is often complicated by concurrent infective illnesses . This study is designed to find out the risk factors of very low weight for height(severe acute malnutrition) so that we can try to prevent the occurrence of SAM.

Methods to be followed:

If your child is found to have severe acute malnutrition, we will ask you the questions about your child's birth details, food habits, health condition, immunization details. We will also ask about your family members and your socio-economic status too. These questions may be asked by the field worker who visit your house or by a doctor.

Approximate duration of study:

One year (march 2013 to feb 2014)

Expected cost:

There will be no cost to you

Descriptions of the discomforts, inconveniences, and / or risk that that can be reasonably expected as a result of participation in this study:

Some of the questions we ask about you and about your child may be uncomfortable for you since there are some personal questions.

Unforeseeable risk:

There are no unforeseeable risks to you or the child

Compensation in case of study-related injury:

We do not expect any injury related to this study and hence will not be compensating you monetarily

Anticipated benefits from this study:

If we know why children are becoming malnourished in our community we may be able to plan activities to prevent the occurrence of severe malnutrition.

Alternative treatment available:

Not applicable.

Compensation for participation:

We will not be giving you money to answer questions or be a part of this study

Circumstances under which the principal investigator may withdraw you from the study participation:

If you wish not to answer the questions or if you do not want us to come to your house regarding this, you can withdraw from this study.

What happens if you choose to withdraw from study participation:

The information you give us will not be used by us and it will be destroyed.

Contact information:

If you have any questions about this research study or possibly, please feel free to contact:
Dr.Sam Marconi 0416-2284207 or Dr. Jasmine Helan 0416-2284207

Confidentiality:

All efforts, within reason, will be made to keep your personal information, in your research Record, confidentially.

Privacy:

Your information may be shared with government and Institutional Review Board of Christian Medical College.

Annexures 3

WRITTEN INFORMED CONSENT DOCUMENT

Date____/___/2013

Study Title: The Risk factors for Severe Acute Malnutrition among the children of age group 06-59 months – A Community based case-control study from southern India

Name of the study participant (mother):_____

Husband's name_____

Age_____ Village/town_____

I have been informed by the investigator that this study is being carried out to learn about the

Risk factors of severe acute malnutrition among young children. The severe acute malnutrition can lead on to life threatening conditions . I have understood that the result of this study will help in planning activities to reduce such loss

I am also informed that if I agree, the investigator will ask me questions relating to my child and this will be completed on the same day. I understand that some of the questions may be

uncomfortable for me to answer and may cause me emotional stress.

There is no risk to me/ my family or my child apart from this.

I understand that all information given by me will be kept confidential and be used for the purpose of the study only. However, the results from the study may be shared with Government officials.

I understand that my participation in this study is purely voluntary. My unwillingness to participate or decision to withdraw will not affect my current or future care with any of the program run by the investigator's institution (Christian Medical College, Vellore & CHAD hospital).

I have been informed that if I suffer from any medical or psychological problem at the time of study and if I am willing; the investigator will arrange for subsidised medical care(depends on socioeconomic status) in the CHAD hospital.

Please initial the box:

(i) I confirm that I have read and understood the information sheet ----------for the above study and have had the opportunity to ask questions ( ).

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason without my medical care and legal rights being affected ( ).

(iii)I understand that the investigator and other researchers will not need my permission to look at my study information both in respect of the current study and any further research that may be conducted in relation to it. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published ( ).

(iv)I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s) ( ).

(v)I agree to participate in the above study ( ).

If you have any questions about this research study, please contact Dr.Sam Marconi 0416-2284207, 9841582702 or my advisor, Dr. Jasmine at 0416-2284207, .

Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to stop.

Signing this document means that the research study, including the above information, has been described to you orally, and that you voluntary agree to participate.

Signature/ thumb impression

of the participant ……

Date……

Signature/thumb impression of the Witness …….

Date……

Signature of Investigator ……

Date……..

Annexure 4

எழுத்து பூர்வமான ஒப்புதல் படிவம்

தேதி _____/ _____/2013

ஆய்வின் தலைப்பு : தென்னிந்தியாவில் உள்ள 6 முதல் 59 மாதங்கள் உள்ளவர்கள் இடையே ஏற்பட கூடிய மிகவும் கடுமையான ஊட்டச்சத்திற்கான ஆபத்து காரணிகள்: சமுதாய அடிப்படையில் பொருத்தமான நபர்– கட்டுப்பாடு ஆய்வு.

ஆய்வில் பங்கேற்பவரின் பெயர் (தாய்) :

கணவரின் பெயர் :

வயது : கிராமம்/நகரம் :

இளம் குழந்தைகள் இடையே மிகவும் கடுமையான ஊட்டசத்து குறைபாடு ஏற்படுத்தக்கூடிய, வாழ்க்கையை அச்சுறுத்தக்கூடிய நிலையில் உள்ள ஆபத்து காரணிகளைப் பற்றி தெரிந்து கொள்வதற்காக இந்த ஆய்வு நடத்தப்படுகிறது என்பது எனக்கு ஆய்வாளரால் தெரிவிக்கபட்டது. இந்த ஆய்வின் முடிவுகள், ஏற்படகூடிய எடை இழப்புகளை குறைப்பதற்கான திட்டமிடுதல், செயல்பாடுகள் போன்றவற்றிக்கு உதவியாக இருக்கும் என்பதையும் இதனால் எனக்கோ, என் குழந்தைக்கோ, நேரடியான எந்த விதமான உதவியும் கிடைக்காது என்பதையும் நான் புரிந்து கொண்டேன்.

நான் சம்மதம் தெரிவித்தால், ஆய்வாளர் என்னிடம் குழந்தையை பற்றி கேள்விகள் கேட்கலாம் மற்றும் அதே நாளில் முடிக்கலாம் என்ற தகவலும் தெரிவிக்கபட்டது. என்னிடம் கேட்கப்படும் சில கேள்விகள் அசௌகரியமானதோ, மன உளைச்சல் ஏற்படுத்த கூடியதாகவோ இருக்கலாம். ஆனால் இது ஆய்வின் முக்கியமானதாக இருப்பதால் என்னிடம் கேட்கப்படுகிறது என்பதை புரிந்து கொண்டேன். இதன் பிறகு எனக்கோ, என் குடும்பதிற்கோ அல்லது என் குழந்தைக்கோ எந்த விதமான ஆபத்தும் இல்லை.

எனக்கு தெரிவிக்கபட்ட தகவல்கள் அனைத்தும் இரகசியம் காக்கபட்டு, இந்த ஆய்வின் நோக்கத்திற்காக மட்டுமே பயன்படுத்தபடும் என்பதை நான் புரிந்துகொண்டேன். எப்படியாயினும் இந்த ஆய்வின் முடிவுகள் அரசாங்க அதிகாரிகளிடம் பகிரிந்துகொள்ள நேரிடலாம்.

நான் புரிந்து கொண்டது என்னவென்றால் என்னுடைய பங்கேற்றல் முற்றிலும் தன்னிசையானது,ஆய்வில் நான் விருப்பமுடன் பங்கேற்பதற்கோ அல்லது விலகிகொள்வதற்கு முடிவு எடுப்பற்கோ, தற்போது அல்லது வரும் காலங்களில்,ஆய்வாளர் சார்ந்த நிறுவனத்தினால் (சி.எம்.சி வேலூர் மற்றும் சாட் மருத்துவமனை) வழங்கபட்டு வரும் கவனிப்புகளை எந்த விதத்திலும் பாதிக்காது.

ஆய்வின் போது எனக்கு ஏதேனும் உடல் நலகுறைவு அல்லது மனரீதியான பிரச்சனைகள் ஏற்பட்டால், நான் விருப்பபட்டால், சி.எம்.சி திட்டத்தின் மூலமாகவோ அல்லது ஆரம்ப சுகாதார நிலையத்தின் மூலமாகவே எனக்கு தேவையான கவனிப்புகளை ஆய்வாளர் ஏற்பாடு செய்வார் என்பது எனக்கு தெரிவிக்கபட்டது.

தயவுசெய்து கட்டத்தில் குறிப்பிடவும்:

1. மேலே குறிப்பிட்ட ஆய்விற்கான தகவல்தாளை நான் வாசித்தேன் மற்றும் புரிந்து கொண்டேன் என்றும், மற்றும் கேள்விகள் கேட்பதற்கு வாய்ப்பு அளிக்கப்பட்டது என்றும் உறுதியளிக்கின்றேன். ( )
2. ஆய்வில் பங்கெடுப்பது என்னுடைய தன்னார்வத்தினால்த்தான் என்பதையும் எந்த நேரத்திலும் காரணங்கள் கூறாமல் விலகிக்கொள்ள சுதந்திரம் அளிக்கப்படுகின்றது என்பதையும் இதனால் எனக்கு வழங்கபடும் மருத்துவ கவனிப்புகளிலோ சட்ட உரிமைகளிலோ பதிப்பு ஏற்படாது என்பதையும் புரிந்து கொண்டேன். ( )
3. தற்போது நடத்தப்படும் இந்த ஆய்வு மற்றும் வரும் காலங்களில் இது தொடர்பான மற்றைய ஆய்வுகளுக்காக ஆய்வாளர் அவர்களோ அல்லது மற்ற ஆராய்ச்சியளர்களோ என்னைப் பற்றி ஆய்வு தகவல்களை கையாள்வதற்கு என்னுடைய அனுமதி தேவையில்லை என்பதை புரிந்து கொண்டேன். நான் இதை ஏற்றுக் கொள்கிறேன். எப்படியானாலும் தகவல்களை மூன்றாம் நபரிடம் பகிந்து கொள்ளும் போதோ அல்லது வெளியிடும் போதோ என்னுடைய அடையாளம் எதுவும் வெளிவராது என்பதை புரிந்து கொண்டேன். ( )
4. இந்த ஆய்வின் தகவல்கள் அல்லது அதன் முடிவுகளை அறிவியல் நோக்கத்திற்காக மட்டுமே பயன்படுத்துவதற்கு எந்தவித தடையும் இல்லை என்று சம்மதிக்கிறேன். ( )
5. மேலே கூறப்பட்ட ஆய்வில் நான் பங்கெடுக்க சம்மதிக்கிறேன். ( )

தங்களுக்கு இந்த ஆய்வு குறித்து ஏதேனும் கேள்விகள் இருந்தால் தயவு செய்து மருத்துவர். சாம் மார்கோனியை 0416–2284207,9841582702 என்ற எண்களிலோ அல்லது என்னுடைய ஆலோசகர் மருத்துவர். ஜாஸ்மின் ஹெலன் அவர்களை 0416–2284207 என்ற எண்ணிலோ தொடர்பு கொள்ளவும்.

இந்த ஆய்வில் நீங்கள் பங்கெடுப்பது தன்னிச்சையானது மற்றும் இந்த ஆய்வில் பங்கெடுக்க மறுப்பு தெரிவிப்பதாலோ அல்லது விலக்கிகொள்ள முடிவு செய்தாலோ உங்களுக்கு எந்தவிதமான அபராதமோ அல்லது பயன்கள் இழப்போ ஏற்படாது.

இந்த படிவத்தில் கையொப்பமிடுவதால் மேலே கொடுக்கப்பட்ட தகவல்கள் உட்பட இதன் ஆய்வு குறித்து உங்களுக்கு வாய்மொழியாக விளக்கப்பட்டது என்பதற்கும், தன்னிச்சையாக பங்கெடுப்பதற்கும் சம்மதம் தெரிவிப்பதாக கருதப்படும்.

பங்கெடுப்பவரின் கையொப்பம்/கைவிரல்ரேகை
தேதி:

சாட்சியாளரின் கையொப்பம்:
தேதி:

ஆய்வாளரின் கையொப்பம்:
தேதி:

தகவல் படிவம்

மிகவும் கடுமையான ஊட்டச்சத்து குறைபாடுகளின் ஆபத்தான காரணிகள்

தகவல் படிவம் –

பின்வரும் கொடுக்கப்பட்டுள்ள தகவல்கள் மூலம் உங்களுக்கு தெரிவிப்பது என்னவென்றால் இந்த ஆராய்ச்சித்திட்டம் பற்றியதும் மற்றும் ஆகும் தயவு செய்து கவனமாக நீங்கள் இதைப் படிக்கவும் மற்றும் கீழே கொடுக்கப்பட்டுள்ள ஆய்வைப்பற்றிய மற்றும் தகவல்கள் குறித்து கேள்விகள் இருந்தால் தயங்காமல் கேட்கலாம். உங்களுக்கு கேள்விகள் கேட்பதற்கு வாய்ப்பளிக்கப்படுகிறது மற்றும் உங்கள் கேள்விகளுக்கு பதில் அளிக்கப்படும். மேலும் உங்களுக்கு இந்த தகவல் படிவத்தின் நகல் வழங்கப்படும்.
இந்த ஆய்வில் நீங்கள் பங்கெடுப்பது தன்னிசையானது இந்த ஆய்வில் இருந்து எப்பொழுது வேண்டுமானலும் தயங்காமல் நீங்கள் விலகிக்கொள்ளலாம்.

ஆய்வின் நோக்கம்:

மிகவும் கடுமையான ஊட்டச்சத்து குறைபாடுகள்(சாம்) போதிய சத்தான உணவு இல்லாமையால் ஏற்படுகிறது, மற்றும் சமூக பொருளாதார நிலை காரணங்கள் தொடர்பாக உடல் எடை இழப்பு மற்றும் அல்லது வீக்கம், மற்றும் இதனால் அடிக்கடி ஏற்படக்கூடிய சிக்கலான தொற்று உடல்நலமின்மை போன்ற காரணங்கள் உள்ளன. இந்த ஆய்வானது உயரத்திற்கேற்ற குறைந்த எடை, மிகவும் கடுமையான ஊட்டச்சத்து குறைபாடுகளின் ஏற்படுவதற்கான ஆபத்தான காரணிகளை கண்டறிவதற்காக உருவாக்கப்பட்டுள்ளது. இதனால் மிகவும் கடுமையான ஊட்டச்சத்து குறைபாடுகளின் ஏற்படாமல் தடுப்பதற்கு முயற்சி செய்ய முடியும்.

செய்யவேண்டிய வழி முறைகள்:

உங்கள் குழந்தைக்கு மிகவும் கடுமையான ஊட்டச்சத்து குறைபாடுகளின் இருப்பது கண்டறியப்பட்டால் உங்களிடம் உங்கள் குழந்தையின் பிறப்பு குறித்த தகவல்கள், உணவு பழக்கங்கள், உடல்நிலை மற்றும் தடுப்பூசி போட்டது போன்ற கேள்விகள் கேட்கப்படும். மேலும் உங்கள் குடும்ப உறுப்பினர்கள் மற்றும் சமூக பொருளாதார நிலை குறித்தும் கேட்கப்படும். இந்த கேள்விகளை உங்கள் வீட்டிற்கு வரும் களப்பணியாளர் அல்லது மருத்துவர் முதன்மை ஆய்வாளர் உங்களிடம் கேட்பார் .

தோராயமான ஆய்வு நாட்கள்:
ஓர் ஆண்டு (மார்ச் 2013 முதல் பிப்ரவரி 2014 வரை)

எதிபார்க்கும் செலவினங்கள் :

உங்களுக்கு எந்த பண செலவுகளும் இல்லை.

நடைமுறையில் அசௌகரியங்கள் ,சங்கடங்கள் மற்றும் அல்லது அபாயங்கள் போன்ற ஏற்றுக்கொள்வதற்கு தகுந்த முடிவுகள் இந்த ஆய்வில் பங்கெடுப்பதன் மூலம் ஏற்படலாம்:

சில கேள்விகள் உங்களைப்பற்றியோ உங்கள் குழந்தையைப்பற்றியோ கேட்கும் போது உங்களுக்கு அது அசௌகரியமானதாக இருந்தாலும் சில தனிப்பட்ட விவரங்கள் குறித்து கேள்விகள் கேட்கப்படும்.

மறைமுகமான அபாயங்கள் :

உங்களுக்கோ அல்லது உங்கள் குழந்தைக்கோ மறைமுகமான எந்த ஒரு அபாயமும் இதில் ஏற்படாது.

ஆய்வு தொடர்பாக காயங்கள் ஏற்பட்டால் இழப்பீடு:

நாங்கள் ஆய்வு தொடர்பாக எந்த ஒரு காயங்களும் ஏற்படுமென எதிர்பாக்கவில்லை எனவே இழப்பீட்டிற்கான பணம் கொடுக்கப்பட மாட்டாது.

இந்த ஆய்வின் மூலம் எதிர்பார்க்கப்படும் நன்மைகள் :

உங்கள் சமுதாயத்தில் மிகவும் கடுமையான ஊட்டச்சத்து குறைபாட்டினால் குழந்தைகள் ஏன் இறக்கின்றது/ பாதிக்கப்படுகின்றது குறித்த விவரங்கள் எங்களுக்கு தெரியவந்தால், வரும் காலங்களில் இது போன்ற நடப்பதை சிறிதலவாவது தடுக்க முடியும்.

இருக்கின்ற மாற்று வைத்தியம்:

பொருந்தாது

பங்கெடுப்பதற்குரிய இழப்பீடு:

இந்த ஆய்வில் பங்கேற்பதற்காகவோ உங்களிடம் கேட்க்கப்படும் கேள்விகளுக்காகவோ எந்த ஒரு இழப்பீடும் வழங்கப்பட மாட்டாது.

எந்த சூழ்நிலையில் முதன்மை ஆய்வாளர் உங்களை ஆய்வில் பங்கு பெறுவதிலிருந்து விலக்கிடுவார்:

நீங்கள் கேள்விக்கு பதில் சொல்லுவதை விரும்பவில்லை என்றால் (அல்லது) இந்த ஆய்வு சம்பந்தமகா உங்கள் இல்லத்திற்கு நாங்கள் வருவதை விரும்பவில்லை என்றால் ஆய்விலிருந்து உங்களை விலக்கி விடுவோம்.

நீங்கள் ஆய்வில் விலகினாலும் உங்களுக்கு உங்கள் குடுபத்திற்க்கும் வழங்கப்படும் மருத்துவ பராமரிப்பு நிறுத்தப்படாது.

ஆய்விலிருந்து நீங்கள் விலகிக் கொள்ள விரும்பினால் என்ன ஆகும்.

நீங்கள் கொடுத்த தகவல் எங்களால் பயன்படுத்தப்படாது மற்றும் அத்தகவலை நாங்கள் அழித்து விடுவோம்

தொடர்பு கொள்வதற்கான விவரங்கள்:

உங்களுக்கு ஆய்வு குறித்து கேள்வி இருந்தால் மற்றும் வாய்ப்பியிருந்தால் தொடர்பு கொள்ள வேண்டிய நபர்கள் மருத்துவர். சாம் மார்க்கோனி 0146–2284207 அல்லது மருத்துவர். –ஜாஸ்மின் ஹெலன் 0416–2284207.

இரகசியத்தன்மை:

அனைத்து முயற்சிகளும், காரணங்களுக்குப்பட்டு, ஆய்வு கோப்புகளில் உள்ள உங்களைப்பற்றி தனிப்பட்ட விவரங்கள் ரகசியமாக வைக்கப்படும்.

தனித்துவம்:

உங்களைப்பற்றி விவரங்கள் அரசாங்கத்திடமோ மற்றும் கிருத்துவ மருத்துவ கல்லூரி நிர்வாகத்தின் பரிசீலனைக் குழலினரிடமோ பகிர்ந்து கொள்ளப்படும் .

Annexure 5

INSTITUTIONAL REVIEW BOARD (IRB)
CHRISTIAN MEDICAL COLLEGE
VELLORE 632 002, INDIA

Dr. B J Prashantham, M.A, M. A., Dr. Min (Clinical)
Director, Christian Counselling Centre
Chairperson, Ethics Committee

Dr. Alfred Job Daniel, D Ortho MS Ortho DNB Ortho
Chairperson, Research Committee & Principal

Dr. Nihal Thomas
MD,MNAMS, DNB(Endo), FRACP(Endo), FRCP(Edin)
Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

March 6, 2013

[redacted]
PG Registrar
Department of Community Health
Christian Medical College
Vellore 632 002

Sub: **FLUID Research grant project NEW PROPOSAL:**
The Risk factors for Severe Acute Malnutrition among the children of age group 06-59 months – A Community based case-control study from Southern India.
[redacted]CHAD Hospital, Dr. Jasmine Helen Prasad, Dr. Anuradha Bose, Dr. Kuryan George, Community Health.

Ref: IRB Min. No. 8153 dated 09.01.2013

Dear [redacted]

The Institutional Review Board (Blue, Research and Ethics Committee) of the Christian Medical College, Vellore, reviewed and discussed your project entitled "The Risk factors for Severe Acute Malnutrition among the children of age group 06-59 months – A Community based case-control study from Southern India." on January 09, 2013.

The Committees reviewed the following documents:

1. Format for application to IRB submission
2. Information Sheet and Informed Consent Form (English and Tamil)
3. Cvs of Drs. [redacted] Anuradha Bose, Kuryan George, Jasmine Helen Prasad
4. A CD containing documents 1 - 3

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MD,MNAMS, DNB(Endo), FRACP(Endo), FRCP(Edin)
Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

The following Institutional Review Board (Research & Ethics Committee) members were present at the meeting held on January 9, 2013 in the CREST/SACN Conference Room, Christian Medical College, Bagayam, Vellore 632002.

Name	Qualification	Designation	Other Affiliations
Dr. Susanne Abraham	MBBS, MD	Professor, Dermatology, Venerlogy & Leprosy, CMC.	Internal, Clinician
Dr. Benjamin Perakath	MBBS, MS, FRCS	Professor, Surgery (Colorectal), CMC.	Internal, Clinician
Dr. Ranjith K Moorthy	MBBS MCh	Professor, Neurological Sciences, CMC	Internal, Clinician
Dr. P. Prasanna Samuel	B.Sc, M.Sc, PhD	Professor Dept. of Biostatistics, CMC	Internal, Statistician
Dr. Balamugesh	MBBS, MD(Int Med), DM, FCCP (USA)	Professor, Dept. of Pulmonary Medicine, CMC.	Internal, Clinician
Dr. Simon Rajaratnam	MBBS, MD, DNB (Endo), MNAMS (Endo), PhD (Endo), FRACP	Professor, Endocrinology, CMC	Internal, Clinician
Dr. Anup Ramachandran	PhD	The Wellcome Trust Research Laboratory Gastrointestinal Sciences	Internal
Dr. Chandrasingh	MS, MCH, DMB	Urology, CMC	Internal, Clinician
Dr. Paul Ravindran	PhD, Dip RP, FCCPM	Professor, Radiotherapy, CMC	Internal

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Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

Dr. Anand Zachariah	MBBS, MD, DNB	Professor, Dept. of Medicine, CMC	Internal, Clinician
Mrs. Pattabiraman	BSc, DSSA	Social Worker, Vellore	External, Lay Person
Mr. Sampath	BSc, BL	Advocate	External, Legal Expert
Mr. Harikrishnan	BL	Lawyer, Vellore	External, Legal Expert
Mr. Samuel Abraham	MA, PGDBA, PGDPM, M.Phil, BL	Legal Advisor, CMC.	Internal, Legal Expert
Mr. Joseph Devaraj	BSc, BD	Chaplain, CMC	Internal, Social Scientist
Dr. B. J. Prashantham (Chairperson), IRB Blue Internal	MA (Counseling), MA (Theology), Dr Min(Clinical	Chairperson(IRB)& Director, Christian Counselling Centre	External, Scientist
Dr. Jayaprakash Muliyil	BSC, MBBS, MD, MPH, DrPH(Epid), DMHC	Retired Professor, Vellore	External, Scientist
Dr. Nihal Thomas	MD MNAMS DNB(Endo) FRACP(Endo) FRCP(Edin)	Secretary IRB (EC)& Dy. Chairperson (IRB), Professor of Endocrinology & Addl. Vice Principal (Research), CMC.	Internal, Clinician

We approve the project to be conducted as presented.

The Institutional Ethics Committee expects to be informed about the progress of the project, any serious adverse events occurring in the course of the project, any changes in the protocol and the patient information/informed consent. And on completion of the study you are expected to submit a copy of the final report.

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VELLORE 632 002, INDIA

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Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

A sum of Rs 21,500/- (Rupee Twenty One Thousand Five Hundred only) will be granted for 1 year.

Yours sincerely,

Dr. Nihal Thomas
Secretary (Ethics Committee)
Institutional Review Board

Dr Nihal Thomas
MBBS MD MNAMS DNB (Endo) FRACP(Endo) FRCP(Edin)
Secretary (Ethics Committee)
Institutional Review Board

CC: Dr. Jasmine Helen Prasad, Department of Community Health, CMC