Original article

A study on relationship between various anthropometric measurements used as indicators of acute malnutrition in a slum of Kolkata

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Abstract

Background: According to the 2008 Lancet Series on Maternal and Child Undernutrition an estimated 19 million children under -5 suffer from severe acute malnutrition, some 55 million children age 5 or younger suffer from moderate acute malnutrition. In 2006, WHO released new international growth standards. Acute malnutrition is best assessed by weight for height (W/H), but in community level it is not recommended to use.

Objectives: 1. To find out the prevalence of acute malnutrition among 6-59 months children in a slum of Kolkata. 2. To compare weight for age (W/A) with weight for height (W/H) and weight for age (W/A) and mid upper arm circumference for age (MUAC/A) as combination indicator with weight for height (W/H) for determination of acute malnutrition.

Methods: This Community based cross-sectional study was done in the service area of Urban Training Centre in Baghbazar, Kolkata with 84 children aged 6-59 months. Anthropometric measurements of the study population were done using standard methods. Data of the anthropometric measurement were analyzed using WHO Anthro for personal computers, version3.2.2, January 2011 to compute the Z scores of W/A, W/H and MUAC/A. SPSS version16.0 was used to analyse the data.

Results: In the study population the prevalence of wasting (W/H) is 23.8%. If combination of indicator low weight for age and MUAC for age was used as an indicator for assessing acute malnutrition then the prevalence rises to 35.7%. The sensitivity and negative predictive value has been increased when combination of indicator low weight for age and MUAC for age was used as an indicator for assessing acute malnutrition in comparison to W/A alone.

Conclusion: If W/A and MUAC/A can be used as combined for screening acute malnutrition in the community instead of W/H there would be more chance to screen the acute malnourished children from the community.

Key words: Acute malnutrition, anthropometry, sensitivity, NPV, z-value, correlation

Introduction:

Acute malnutrition among children aged 6-59 months is a key indicator routinely used for describing the presence and magnitude of humanitarian emergencies. In the past, the prevalence of acute malnutrition and admissions to feeding programs has been determined using the growth reference developed by the World Health Organization (WHO), Centres for Disease Control and Prevention (CDC) and the National Center for Health Statistics (NCHS). In 2006, WHO released new international growth standards[1] and recommended their use in all nutrition programs. Children are undernourished if their diet does not provide adequate calories, protein, and micronutrients or they are unable to utilize fully the food they eat for example due to illness; malnutrition affects children first and foremost under the age of 5yr, especially in the first two years of life; it weakens the immune system and thereby increases the risk of dying from pneumonia, diarrhoea, malaria and other infectious diseases[2]. To describe acute malnutrition at the population level, two prevalence indicators are normally reported: global acute malnutrition (GAM) and severe acute malnutrition (SAM)[3]. GAM and SAM are the principal indicators reported in nutrition surveys and are used to compare population prevalence of acute malnutrition across time and geographic areas. Childhood undernutrition is an underlying cause of 35 percent of deaths among under-5 children in the developing world. According to the 2008 Lancet Series on Maternal and Child Undernutrition, SAM is one of the most important contributing causes of childhood mortality. An estimated 19 million children under 5 suffer from SAM, with half a million dying directly because of SAM each year. These numbers do not include children suffering from bilateral pitting oedema, which is the most lethal form of acute malnutrition[4].

Under nutrition is responsible for 11 percent of disability adjusted life years among young children worldwide. Severe wasting during the first 24 months of life leads to a loss of up to 18 points of an individual's expected intelligence quotient score. The negative impact of undernutrition on the physical and mental potential of the population diminishes national productivity, costing countries as much as 3 percent of their gross domestic product. The international aid community has traditionally considered high rates of acute malnutrition the result of crises such as drought and conflict rather than a chronic problem with developmental causes. As a public health concern, acute malnutrition has therefore mainly been the target of stand-alone, emergency nutrition interventions. While humanitarian emergencies do cause widespread undernutrition, in reality, the majority of acutely malnourished children live in stable countries not currently experiencing a crisis. They are undernourished because of complex behavioural and environmental factors rather than a temporary loss of access to food due to an emergency. Addressing the majority of the global burden of undernutrition requires that nutrition programmes be integrated into health systems in sustainable ways[5].

Underweight (Weight/Age = W/A) reflects both chronic malnutrition and acute malnutrition; inadequate weight relative to age (WFA) < -2 to ≥ -3 z-score indicates moderate undernutrition and < -3 z-score indicates severe underweight. Wasting (Weight/Height = W/H) reflects acute malnutrition inadequate weight relative to length or height (WFH) < -2 to ≥ -3 z-score indicates moderate wasting and < -3 z-score indicates severe wasting. Inadequate muscle tissue and fat stores in the body can be measured by mid upper arm circumference (MUAC)-for-age (6–59 months) where < -2 to ≥ -3 z-score indicates moderate wasting and < -3 z-score indicates severe wasting[1].

Weight-for-Height/Length should be taken only at treatment-facilities before admission into therapeutic/supplementary feeding programs, because of its complexity and proneness to mistakes[6]. It is recommended not to use this anthropometric measurement technique in primary health care settings and communities. Mid-upper arm circumference (MUAC) is a measure of the diameter of the upper arm and gauges both fat reserves and muscle mass. Measurement is simple and requires minimal equipment; MUAC has therefore been proposed as an alternative index of nutritional status for assessing malnutrition. According to WHO for screening and case-detection of acute malnutrition in the community W/A is more precise, sensitive, specific and more predictive than W/H; MUAC/A is more acceptable, low cost, precise, sensitive, specific and more predictive than W/H[7]. With this background the present study was designed

1. To find out the prevalence of acute malnutrition among 6-59 months children in a slum of Kolkata.
2. To compare z score of weight for age (W/A) with weight for height (W/H) and mid upper arm circumference for age (MUAC/A) in the study population.
3. To compare weight for age (W/A) with weight for height (W/H) and weight for age (W/A) and mid upper arm circumference for age (MUAC/A) as combination indicator with weight for height (W/H) for determination of acute malnutrition.

Materials and Methods:

Study Type: Community based observational study with cross-sectional study design.

Study Area: In the service area of Urban Training Centre in Baghbazar area under Department of Community Medicine R.G. Kar Medical College, Kolkata.

Study Period: 1st July 2011 to 31st July 2011.

Study Population: All the children aged between 6-59 months of the Urban Field Practice area in Baghbazar were included in the study. Total 87 children were in the age group during the study period. Among the 87 children 3 children could not be included in the study because of their absence during the study period. All the 84 children present during the study period were included in the study after getting verbal consent from their parents or care givers.

Techniques and Tools: All the children thus included in the study were subjected to anthropometric measurement.

Anthropometric measurements were carried out following standard methods. The data included weight, recumbent length (for children less than 24 months of age) and height (for children more than 24 months of age) and MUAC. Weight was measured to the nearest 0.1 Kg and Salter weighing machine was used for weight measurement. Height was measured against a non stretchable tape fixed to a vertical wall, with the participant standing on a firm/level surface and it was measured to the nearest 0.5 cm. Recumbent length (for children less than 24 months of age) was measured by using an infantometer. The children were dressed in light underclothing and without any shoes during the measurement. MUAC was measured by a non stretchable tape. After determination of midpoint between the elbow and the shoulder of the left arm (the arm was relaxed and hanging down by the side of the body); the tape was placed around the midpoint of left arm to measure MUAC to the nearest 0.1cm. Each measurement was done twice, and the mean of the two readings was recorded. If any pair of readings exceeded the maximum allowable difference for a given variable (e.g. weight, 100 g; length/height, 7 mm), the measurements were repeated. The same measuring instruments were used throughout the study. Age of the child was determined by reviewing the records (Birth certificate, discharge certificate, Immunisation card) and local events calendar method was used if any record was not available.

Statistical Analysis: Data of the anthropometric measurement were analyzed using WHO Anthro[8] for personal computers, version3.2.2, January 2011 to compute the Z scores of W/A, W/H and MUAC/A. SPSS version16.0 was used to analyse the data.

Result:

Acute malnutrition is best assessed by weight by height (W/H) and MUAC for under-five children. Weight by age (W/A) is used as an indicator of both acute and chronic malnutrition. MUAC/A can also be used as an indicator of acute malnutrition[7]. Inclusion of age in indicators would make it more sensitive to random errors in age than to random errors in anthropometry[9].

Table No.1 shows age and sex wise distribution of the study population. Out of 84 children 36 are male and 48 are female.

Table No.1: Age and Sex distribution of the children (n = 84)

Age Distribution (months)	Male (%)	Female (%)	Total (%)
6-11	1(2.8)	8(16.7)	9(10.7)
12-23	2(5.6)	5(10.4)	7(8.3)
18-23	5(13.9)	5(10.4)	10(11.9)
24-29	3(8.3)	5(10.4)	8(9.5)
30-35	9(25)	7(14.6)	16(19)
36-41	4(11.1)	4(8.3)	8(9.5)
42-47	5(13.9)	4(8.3)	9(10.7)
48-53	5(13.9)	4(8.3)	9(10.7)
54-59	2(5.6)	6(12.5)	8(9.5)
	36(100)	48(100)	84(100)

Prevalence of wasting (W/H) is 23.8% and prevalence of underweight (W/A) is 31% in the study population. Prevalence of acute malnutrition is 25% in the study population when low MUAC for age was used as an indicator. If combination of indicator low weight for age and MUAC for age was used as an indicator for assessing acute malnutrition then the prevalence rises to 35.7% (Table No.2)

Table No.2: Pattern and distribution of acute malnutrition (n=84)

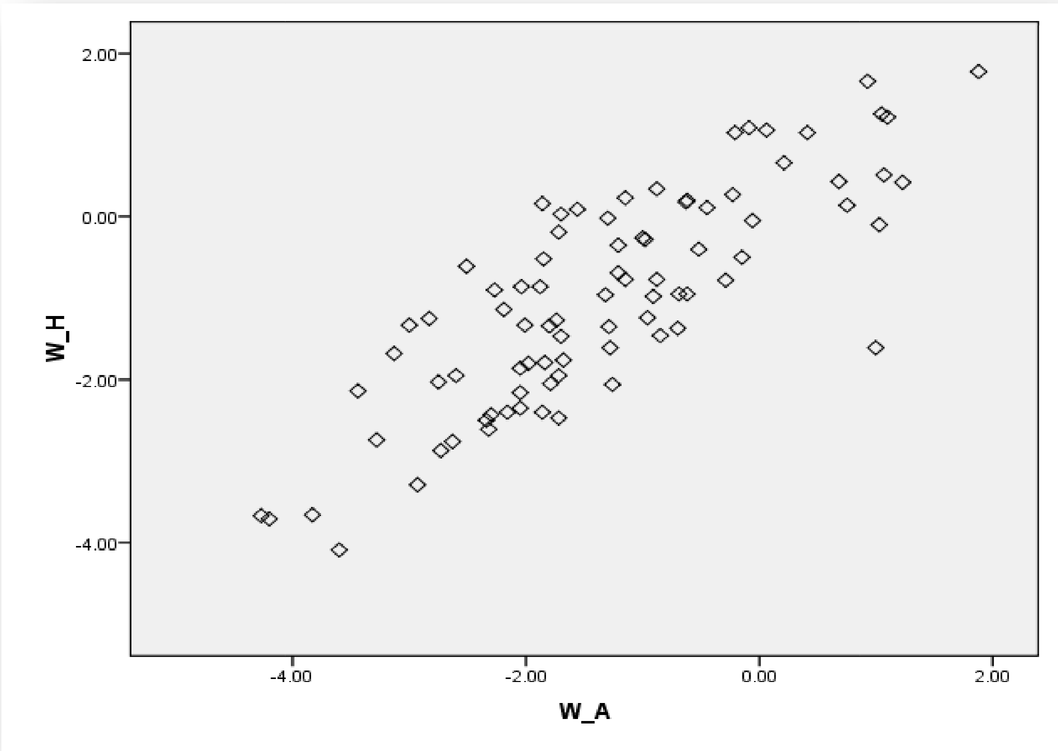
Pattern of malnutrition	total	percentage (%)
Underweight (W/A)	26	31.0
Wasting (W/H)	20	23.8
Low MUAC/AGE	21	25.0
W/A + MUAC/A	30	35.7

Table No.3 shows a strong correlation between the z score of W/A with W/H and W/A with MUAC/A. A significant linear correlation (Fig No.1 & Fig No.2) has been demonstrated between the z score of W/A with W/H ($r = .816$; $p = .000$; $r^2 = .665$) and W/A with MUAC/A ($r = .829$; $p = .000$; $r^2 = .687$). If the z score of MUAC/A is adjusted for W/H, then correlation of determination (r^2) between the z score of W/A with W/H is reduced to .661 and if z score of W/H is adjusted for MUAC/A, then correlation of determination (r^2) between the z score of W/A with MUAC/A is reduced to .683.

Table No.3: Correlation between z score of different anthropometric measurements for acute malnutrition

	W/H	MUAC/A
W/A		
Pearson correlation coefficient (r)	.816	.829
P value	.000	.000
Correlation of determination (r^2)	.665	.687
Adjusted r^2	.661	.683

Fig 1: Scatter diagram showing linear reationship between z score of W/A and W/H



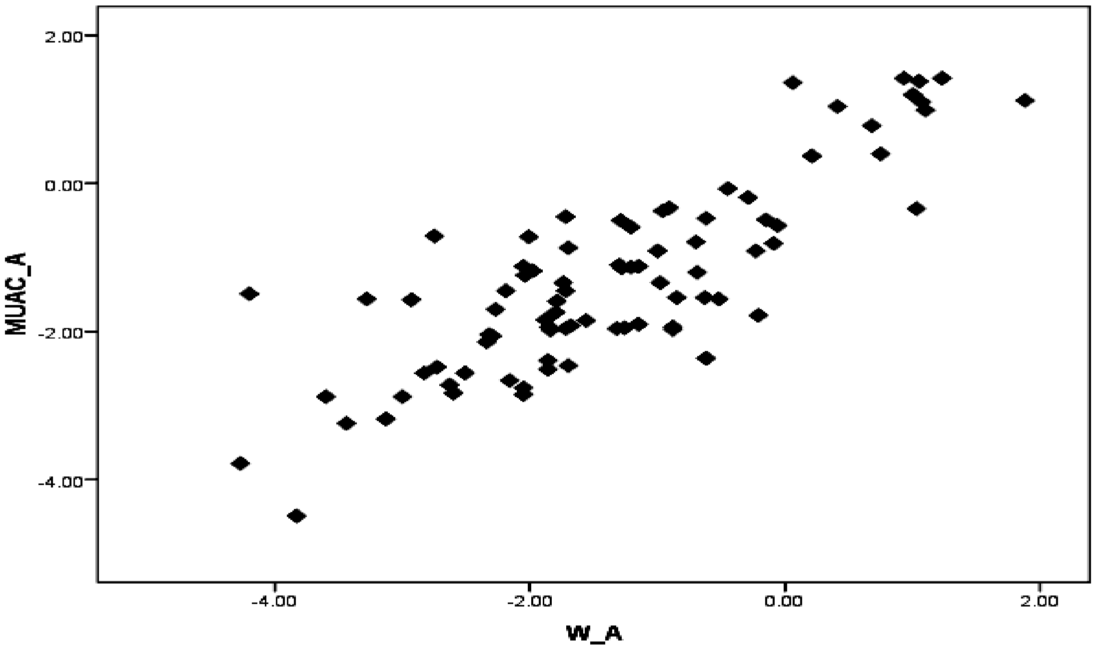


Fig 2: Scatter diagram showing linear reationship between z score of W/A and MUAC/A

Results of screening test (Table No.4) and evaluation (Table No.5) using low weight for age (W/A) an indicator of acute malnutrition as compare to the gold standard weight for height (W/H) show the test to be 80% sensitive and 84.37% specific. Table No.4 shows that positive predictive value and negative predictive value of the screening test is 61.54% & 93.1% respectively. If W/A is used as an indicator of acute malnutrition children of the study population with acute malnutrition are 5.12 times (positive likelihood ratio = 5.12) more likely to have positive test than are those who are not malnourished and negative test is almost a fourth (negative likelihood ratio =.24) as likely in a child who is malnourished than in normal child (Table No.5).

Table No.4: Screening test result for assessment of acute malnutrition of W/A with W/H

ACUTE MALNUTRITION			
W/H / **W/A**	yes	No	total
yes	16(TP)	10(FP)	26(TP+FP)
no	4(FN)	54(TN)	58(FN+TN)
total	20(TP+FN)	64(FP+TN)	84(TP+FP+FN+TN)

Table No.5: Evaluation of screening of acute malnutrition by W/A with W/H

Measures	Results
Sensitivity	80%
Specificity	84.37%
Positive predictive value	61.54%
Negative predictive value	93.1%
Positive likelihood ratio	5.12
Negative likelihood ratio	.24

Results of screening test (Table No.6) and evaluation (Table No.7) using mid upper arm circumference for age (MUAC/A) a indicator of acute malnutrition as compare to the gold standard weight for height (W/H) show the test to be 60% sensitive and 85.94% specific. Table No.7 shows that positive predictive value and negative predictive value of the screening test 57.14% & 87.3% respectively. If MUAC/A is used as an indicator of acute malnutrition children of the study population with acute malnutrition are 4.27 times (positive likelihood ratio = 4.27) more likely to have positive test than are those who are not malnourished.

Table No.6: Screening test result for assessment of acute malnutrition of MUAC/A with W/H

ACUTE MALNUTRITION			
W/H / **MUAC/A**	yes	No	total
yes	12(TP)	9(FP)	21(TP+FP)
no	8(FN)	55(TN)	63(FN+TN)
total	20(TP+FN)	64(FP+TN)	84(TP+FP+FN+TN)

Table No.7: Evaluation of screening of acute malnutrition by MUAC/A with W/H

Measures	**Results**
Sensitivity	60%
Specificity	85.94%
Positive predictive value	57.14%
Negative predictive value	87.3%
Positive likelihood ratio	4.27
Negative likelihood ratio	.47

Results of screening test (Table No.8) and evaluation (Table No.9) using low weight for age (W/A) and mid upper arm circumference for age (MUAC/A) as a composit indicator of acute malnutrition as compare to the gold standard weight for height (W/H) show the test to be 85% sensitive and 79.68% specific. Table No.9 shows that positive predictive value and negative predictive value of the screening test 56.67% & 94.44% respectively. If W/A and MUAC/A is used as a combination indicator of acute malnutrition children of the study population with acute malnutrition are 4.18 times (positive likelihood ratio =4.18) more likely to have positive test than are those who are not malnourished and negative test is almost a fifth (negative likelihood ratio =.19) as likely in a child who is malnourished than in normal child (Table No.9).

Table No.8: Screening test result for assessment of acute malnutrition of W/H with W/A + MUAC/A

ACUTE MALNUTRITION			
W/H / **W/A +MUAC/A**	Yes	No	total
yes	17(TP)	13(FP)	30(TP+FP)
no	3(FN)	51(TN)	54(FN+TN)
total	20(TP+FN)	64(FP+TN)	84(TP+FP+FN+TN)

Table No.9: Evaluation of screening of acute malnutrition by W/H with W/A + MUAC/A

Measures	**Results**
Sensitivity	85%
Specificity	79.68%
Positive predictive value	56.67%
Negative predictive value	94.44%
Positive likelihood ratio	4.18
Negative likelihood ratio	.19

Discussion:

In India around 43% of its children under the age of five are malnourished or undernourished and malnutrition is much more common in India than sub-Saharan Africa. It is estimated that one in every three malnourished children in the world live in India. The prevalence of wasting in India is about 20%[10]. Our present study shows prevalence of acute malnutrition in an urban slum of Kolkata among under-5 children is 23.8% if we take W/H as indicator and 25% if we take MUAC/A as indicator. In a context of unprecedented economic growth (9-10 percent annually) and national food security, over 60% of Indian children are wasted, stunted or a combination of the above. As a result, India ranks number 62 in the poverty and hunger index (PHI) out of a total of 81 countries and is included among the low performing countries in progress towards MDG1 with countries such as Nepal (number 58), Ethiopia (number 60), or Zimbabwe (number 74) [11]. Malnutrition thus makes an impact on the national development. Acute malnutrition is a devastating public health problem of epidemic proportions. Acute malnutrition is a devastating disease of epidemic proportions. Worldwide, some 55 million children age 5 or younger suffer from moderate acute malnutrition[12]. Each year, some 5 million of these children die because they lack access to treatment[13]. These deaths are entirely preventable. Childhood acute malnutrition is as much a medical problem as it is a social problem because it directly affects a broad range of issues: a country's mortality rates, educational prospects, productive employment, and economic capacity, etc.

Malnutrition also happens to be one of the principal mechanisms behind the transmission of poverty and inequality from one generation to the next. These devastating consequences also carry a heavy economic cost: it is estimated that productivity losses alone exceed 10% of a person's lifetime income, and up to 3% of a country's GDP. Mental development and growth are affected, and there is a heightened risk of disease and diminished productivity in later life with children of acute malnutrition[14] and acute malnutrition is closely linked to child mortality[15].

A Mozambique study[16] showed that the z score of Weight for age was positively correlated with the z score of weight for height. Our present study also showed a positive linear strong correlation between z score of weight for age with weight for height and also z score of weight for age with MUAC for age. This implies that if z score of weight for height and MUAC for age increases or decreases z score of weight for age also increases or decreases and this change of z score is statistically significant ($p = .000$).

As for screening test in community, a test with high sensitivity and high negative predictive value would be considered good. As it is previously mentioned that measurement of height in community is not always accurate and precise particularly for less than 2 years children where length instead of height is measured by infantometer, diagnosing acute malnutrition by W/H indicator should be considered for hospital settings. Our present study shows that the sensitivity and negative predictive value had been increased if W/A and MUAC/A were taken as combined instead of W/A and MUAC/A used alone to assess acute malnutrition in community level in comparison to gold standard W/H. Though the positive likelihood ratio (LR+) had been decreased but the negative likelihood ratio (LR-) showed that negative test is almost a fifth as likely in a child who is malnourished than in normal child if W/A and MUAC/A are combined in comparison to one fourth in W/A and almost one in two children in MUAC/A when they are used alone. So, using W/A+MUAC/A as a combined indicator would give less false negative result but more false positive result i.e. Acute malnutrition diagnosis for community level is a cumbersome job for the grass root health workers. Though weight for height is gold standard for diagnosis for acute malnutrition it is very difficult for the community health workers to measure height accurately and precisely. For ICDS programme and during routine immunisation programme AWWs, ANMs are well equipped to measure the weight of the under-5 children. Mid upper arm circumference measurement at the community level is an easy and simple tool to operate. Though proper age estimation of age not always an easy procedure to do chance of under diagnosing of acute malnutrition in the community is reduced.

Conclusion:

because of low literacy rate particularly in the rural community and due to home delivery but as immunisation coverage is increasing steadily age estimation from the immunisation card and local festival records would not be a difficult job to do. If W/A and MUAC/A can be used as combined for screening acute malnutrition in the community instead of W/H it would be more chance to screen the acute malnourished children from the community.

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References:

1 World Health Organization. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva, Switzerland: World Health Organization; 2006.

2 Acute Malnutrition Summary Sheet. Save the Children, USA. www.savethechildren.org/atf/cf (last accessed on 2/11/2011)

3World Health Organization. Physical status: the use and interpretation of anthropometry. World Health Organ Tech Report Ser 1995;854.

4 Black, RE, LH Allen, ZA Bhutta, LE Caulfield, M de Onis, M Ezzati, C Mathers, and J Rivera. 2008. Maternal and child undernutrition: Global and regional exposures and health consequences. The Lancet 371(9608): 243-60.

5 Gross, R, and P Webb. Wasted time for wasted children: Severe child undernutrition must be resolved in nonemergency settings. The Lancet. 2006; 367: 1209-11

6 The Mother and Child Health and Education Trust. Mother, Infant and young children nutrition and malnutrition.

7 Myatt M, Khara T, Collins S. A review of methods to detect cases of severely malnourished children in the community for their admission into community based therapeutic care programs. Technical Background Paper. 2005:14

8 http://www.who.int/childgrowth/en (last accessed on 2/11/2011)

9 Bairagi R, Effects of bias and random error in anthropometry and in age on estimation of malnutrition, Am J Epidemiol, 1986;123(1):185-91.

10 Unicef. Available at URL: http://www.unicef.org/infobycountry/india_statistics.html#53 (last accessed on 2/11/2011)

11 Gentilini, U., Webb, P., How are we doing on poverty and hunger reduction? A new measure of country performance. Food Policy. 2008. doi:10.1016/j.foodpol.2008.04.005 (last accessed on 2/11/2011)

13 The Lancet. Maternal and Child Undernutrition Series paper 1. 2008;January

[13] Pelletier DL. The relationship between child anthropometry and mortality in developing countries: implications for policy, programs and futures research. N Nutr. 1994 (supple): 2047S-81S

14 Unicef. Fast Facts: Acute Malnutrition. www.unicefusa.org/work/emergencies/horn-of-africa/Horn-of-Africa-Malnutrition-201011.pdf (last accessed on 2/11/2011)

15 De Onis M. Measuring nutritional status in relation to mortality. Bull World Health organ. 2000;78:1271-1274

16 WorldBank.HaelthOutcome#2:Anthropometrics.siteresources.worldbank.org/INTPAH/Resources/Publications/459843-1195594469249/HealthEquityCh4.pdf(last Accessed on 2/11/2011).