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Risk Factors for Clinical Marasmus: A Case-Control Study of Bangladeshi Children

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Henry F J (Harvard Institute for International Development, Cambridge, MA 02138, USA), Briend A, Fauveau V, Huttly S R A, Yunus M and Chakraborty J. Risk factors for clinical marasmus: A case-control study of Bangladeshi children. *International Journal of Epidemiology* 1993; 22: 278–283.
A case-control study of risk factors of clinical marasmus was undertaken to guide intervention efforts in rural Bangladesh. Cases were children whose mid-upper arm circumference measured <110 mm and controls were children matched for age and sex with arm circumference >120 mm. Between June 1988 and June 1989, 164 such pairs of children aged 1–4 years were studied. The effects of various demographic, socioeconomic, environmental, and health factors, reported by mothers, were investigated in a multivariate analysis using conditional logistic regression. Results showed an increased risk of marasmus among children from families with other children under 5 years of age (odds ratio [OR] = 2.51; 95% confidence interval [CI]: 1.33–4.74), and children who consumed formula foods (OR = 16.41, 95% CI : 3.39–79.36). Higher maternal education was associated with reduced risk of marasmus, compared with no education, the OR for <5 years of schooling = 0.57, 95% CI : 0.23–1.41; OR for ≥5 years of schooling = 0.34, 95% CI : 0.15–0.76. The strong association of childhood marasmus with mother's education and child spacing supports the notion that non-nutritional factors should be essential components of efforts to reduce severe malnutrition in Bangladesh.

The prevalence of severe childhood malnutrition in Bangladesh is among the highest in the world.[1] Malnutrition is known to be a complex problem and although a multifaceted strategy is required to combat it the approach should be based on empirical evidence.

Malnutrition and poverty are interlinked, but it is not clear which aspects of poverty are most detrimental to the nutritional status of children. It is thus analytically important to isolate the indicators of poverty which discriminate households with childhood clinical marasmus. Selection of the key risk indicators is difficult in settings like Bangladesh where poverty is pervasive and the living conditions are generally so poor that proximate determinants of malnutrition do not vary much between children. A Bangladesh study, for example, reported household economic characteristics and age to be the most important factors yet they accounted for only 5% and 8% respectively of the variation in nutritional status.[2]

The interpretation of previous risk indicator studies is limited by other factors. For example, among the studies in Bangladesh which show an association between malnutrition and socioeconomic variables, only a few[2–4] have attempted to control for confounding. Furthermore, these studies were unable to indicate the extent to which malnutrition can be reduced by specific interventions because the relationships shown were not quantified. We evaluated a variety of demographic, economic, hygienic, biological, dietary and morbidity factors in an attempt to identify factors which might lead to severe malnutrition in rural Bangladeshi children.

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METHODS

This study was carried out in Matlab, a rural area located in the Ganges delta about 45 km southeast of Bangladesh's capital, Dhaka. Matlab is characterized by a subsistence agricultural economy, poor infrastructure and communication and uneven land distribution. An area of Matlab with a total population of about 95 000 people has been provided with family planning and health services since 1978.[5] This study area is known as the Matlab Mother and Child Health-Family Planning (MCH-FP) area.

More than half of the child deaths in Matlab are associated with a mid-upper arm circumference (MUAC) of <110 mm.[6] These deaths can be attributed to marasmus since low MUAC is characteristic of marasmus defined as a clinical condition with severe muscle wasting.[7] MUAC was used to select the cases and controls in this study because measures of weight-for-age tend to classify as marasmic older children, usually stunted and not wasted, with a lower risk of dying compared with definitions based on arm circumference.[6] In addition, our previous work in Bangladesh showed that sensitivity and specificity curves obtained from arm circumference (without correction for age) predicted death better than other nutritional indices.[8] Furthermore, we used a logistic model to show the large differences in the risk of death between MUAC <110 mm and >120 mm.[6]

The MCH-FP area is divided into four blocks. Every month the community health workers for each block measure the MUAC of all children between the ages of 6 and 59 months to select those who need referral to the Matlab Nutrition Rehabilitation Unit. Of the 12 000 children screened each month, about 200 have a MUAC <110 mm. Cases were selected randomly from the list of marasmic children identified by the community health workers and interviews of mothers were conducted within a month of initial identification. For each case, one child with a MUAC >120 mm was selected as a control. Controls were matched by sex and age (± 2 months). To select the controls, a bari (cluster of about 12 houses) was randomly selected from the same block as the case. The child who met the matching criteria and lived closest to that bari was chosen from the birth registers as the control. Children with an arm circumference of 110–120 mm (about 8% of screened children) were not included in this study. Interviews of case-control pairs were done within a few days of each other. We studied 164 case-control pairs aged 1–4 years over a 12-month period, 74% of these pairs were aged 12–23 months. This sample size is sufficient for detecting a minimum odds ratio (OR) of 2–3 (depending on the prevalence of the particular risk factor) at the 5% significance level with a power of 80%.

Data were collected from June 1988 to June 1989 using precoded questionnaires. Mothers were interviewed by female health assistants after the child's MUAC was remeasured to check the correct assignment as a case or control. At the end of the interview of a case, the health assistant proposed referral of the child to the Matlab Nutrition Unit and also offered free transportation to get there. In cases where the family refused referral, the interviewer gave nutritional and health advice for the recovery of the child.

A wide range of demographic, economic, environmental, biological, morbidity and dietary factors were considered (Table 1). Many of these factors are interrelated, in addition their association with marasmus may be confounded by some of the other listed factors. In order to identify risk factors for marasmus, taking these issues into account, a reduced set of explanatory variables was selected. Selection of variables for the model was based on their univariate association with marasmus, their interrelationships,

TABLE 1 *Variables used in analysis*

Demographic/socioeconomic	
Maternal age	Subsequent sibling within 1 year
Marital status	Caretaker of child
Marital problems	Singleton or twin
Father resident at home	Number of <5 year siblings alive
Birth order	Number of <5 year siblings dead
Family size	Number of <5 year siblings marasmic
Maternal weight and MUAC	Birthweight[a]
Mother's education and occupation	Land ownership and use
Father's education and occupation	Amount of food stored (rice)
Size and type of housing	Religion
Family income and debt	Household possessions (hurricane lamp, watch, radio, bed, quilt, plough)
Morbidity/dietary	
Diarrhoea in the last 15 days	Respiratory infections in the last 15 days
History of hospital admission	Maternal or paternal illness
Attendance at clinic	Food consumption in the previous 24 hours (banana, biscuit, *chapati*, *egg*, *potato*, dark green leaf vegetables, fish, other[c])
Breastfeeding status	
Use of bottle/formula foods[b]	
Age of introduction of solid foods	
Environmental	
Household water source/distance	Refuse disposal
Water quantity/use	Handwashing materials used
Latrine presence and use	

[a] Birthweight was assessed and recorded by a local midwife. Almost all babies were born at home and actual weights at birth were not available.
[b] Mainly milk powder consumed by bottle during the last 24 hours.
[c] Includes local foods such as suji, muri and khitchri.

their plausibility and utility as indicators of marasmus, their role as confounding factors, and their distribution in the population. Fourteen risk factors were selected for inclusion in the final analyses, these are listed in Tables 2 and 3. Although some of these 14 factors are interrelated, no pair of factors was highly correlated (maximum correlation 0.46 and most were <0.1) and no problems of multicollinearity were encountered later in fitting the models.

Analyses for matched data were conducted using SPSS-PC+ and EGRET.[9] Conditional logistic regression was used to estimate OR and their 95% confidence intervals (CI). Significance levels were assessed using the likelihood ratio test which yields a χ^2 statistic. Multivariate logistic models were formed in stages, beginning with factors less proximal to clinical marasmus, retaining those that were statistically significant and then finally adding in those factors most proximal to clinical marasmus. The first stage used factors 1–3 (Table 2), the second stage also included factors 4–7, the third stage added factors 8–10 (Table 3) and then finally the four proximal factors 11–14 were added. For variables identified as important risk factors for marasmus, the population attributable risk per cent was used to estimate the proportion of marasmus cases that might be prevented by the elimination of that risk factor.[10]

TABLE 2 *Distribution of sociodemographic risk factors for marasmus, odds ratios (OR) and 95% confidence intervals (95% CI), 151 matched cases and controls*[a]

Factor	Cases %	Controls %	OR (95% CI)
1. Mother's education (years)			
None	76	66	1.00
<5	13	11	1.04 (0.50–2.14)
5+	11	24	0.40 (0.21–0.76)
			χ^2 (df 2) 9.0, P = 0.01
2. Possessions[b]			
None	22	14	1.00
1 only	23	13	1.00 (0.44–2.26)
2–3	38	46	0.52 (0.26–1.00)
4–6	16	26	0.36 (0.16–0.80)
			χ^2 (df 3) 11.8, P = 0.008
3. Religion			
Muslim	88	81	1.00
Hindu	12	19	0.58 (0.30–1.09)
			χ^2 (df 1) 2.99, P = 0.08
4. Birth order			
1st	18	30	1.00
2–3	26	32	1.60 (0.81–3.13)
4+	56	37	3.14 (1.59–6.20)
			χ^2 (df 2) 13.4, P = 0.001
5. Number of siblings <5 years			
0	43	64	1.00
1+	57	36	2.55 (1.52–4.28)
			χ^2 (df 1) 14.0, P < 0.001
6. Other marasmic children in family			
No	83	93	1.00
Yes	17	7	2.67 (1.24–5.74)
			χ^2 (df 1) 7.1 P = 0.008
7. Number of previous deaths of <5 year children			
0	56	68	1.00
1	20	19	1.26 (0.73–2.19)
2	13	9	1.93 (0.86–4.32)
3+	10	3	4.13 (1.32–12.9)
			χ^2 (df 3) 8.8, P = 0.03

[a] 'Unmatched' percentage distributions are shown.
[b] See Table 1 for details.

TABLE 3 *Distribution of biological, morbidity and dietary risk factors for marasmus, odds ratios (OR) and 95% confidence intervals (95% CI), 151 matched cases and controls*[a]

Factor	Cases %	Controls %	OR (95% CI)
8. Mother pregnant			
No	84	90	1.00
Yes	16	10	1.82 (0.87–3.80)
			χ^2 (df 1) 2.6, P = 0.10
9. Birthweight			
Small	30	20	1.00
Medium	62	68	0.61 (0.35–1.07)
Large	9	11	0.50 (0.20–1.25)
			χ^2 (df 2) 3.8, P = 0.15
10. Mother's MUAC (mm)			
≤200	18	11	1.00
201–214	36	30	0.71 (0.34–1.47)
215–224	20	28	0.39 (0.17–0.87)
225+	25	30	0.47 (0.21–1.03)
			χ^2 (df 3) 7.3, P = 0.06
11. Diarrhoea in previous 15 days			
None	82	84	1.00
Acute	13	13	1.02 (0.53–1.96)
Persistent	5	3	2.00 (0.50–8.03)
			χ^2 (df 2) 1.0, P = 0.60
12. Still breastfeeding			
Yes	76	89	1.00
No	24	11	3.50 (1.60–7.68)
			χ^2 (df 1) 11.8. P <0.001
13. Consumption of formula food			
No	83	97	1.00
Yes	17	3	12.00 (2.84–50.78)
			χ^2 (df 1) 21.9, P < 0.001
14. Foods eaten[b]			
>2 food	54	57	1.00
1–2 food	41	34	1.30 (0.79–2.16)
None	5	9	0.51 (0.19–1.38)
			χ^2 (df 2) 3.7, P = 0.16

[a] 'Unmatched' percentage distributions are shown.
[b] See Table 1 for details.

RESULTS

Although 164 case-control pairs were studied complete data were available for only 151 (92%) such pairs. The crude OR for the 14 risk factors considered in the final analyses are presented in Tables 2 and 3. Results from the final multivariate model are given in Table 4.

TABLE 4 *Results from multivariate model*[a] *of risk factors for marasmus – odds ratios (OR) and 95% confidence intervals (95% CI), 151 matched cases and controls*

Factor	Cases %	Controls %	OR (95% CI)
Mother's education (years)			
None	76	66	1.00
<5	13	11	0.57 (0.23–1.41)
5+	11	24	0.34 (0.15–0.76)
			χ^2 (df 2) 7.9, P = 0.02
			Trend χ^2 (df 1) 7.9, P = 0.005
Number of siblings <5 years			
0	43	64	1.00
1+	57	36	2.51 (1.33–4.74)
			χ^2 (df 1) 8.8, P = 0.003
Birthweight			
Small	30	20	1.00
Medium	62	68	0.82 (0.42–1.58)
Large	9	11	0.72 (0.23–2.28)
			χ^2 (df 2) 0.5, P = 0.79
Diarrhoea in previous 15 days			
None	82	84	1.00
Acute	13	13	1.33 (0.57–3.11)
Persistent	5	3	1.85 (0.31–10.89)
			χ^2 (df 2) 0.9, P = 0.63
Still breastfeeding			
Yes	76	89	1.00
No	24	11	2.17 (0.87–5.40)
			χ^2 (df 1) 3.0, P = 0.08
Consumption of formula food			
No	83	97	1.00
Yes	17	3	16.41 (3.39–79.36)
			χ^2 (df 1) 20.8, P < 0.001
Foods eaten[b]			
>2 food	54	57	1.00
1–2 food	41	34	1.31 (0.72–2.39)
None	5	9	0.46 (0.15–1.40)
			χ^2 (df 2) 3.4, P = 0.18

[a] See text for details of model construction.
[b] See Table 1 for details.

Sociodemographic Factors (Table 2)

Several factors were strongly associated with marasmus. Higher birth order, the presence of under 5 year old siblings, the presence of other marasmic children in the family, family history of previous child deaths, low maternal education, and few household possessions were all associated with increased risks of marasmus. Children from Hindu families were at slightly lower risk compared to Muslim families. In the sequential model process only two factors were statistically significant—the presence of an under 5 year old sibling (OR = 2.51, 95% CI : 1.33–4.74) and maternal education. Compared with no education, the OR for <5 years of schooling = 0.57, 95% CI : 0.23–1.41; OR for ≥5 years of schooling = 0.34, 95% CI : 0.15–0.76.

Biological, Morbidity and Dietary Factors (Table 3)

Several factors showed an increased but non-significant risk of marasmus. Mother's pregnancy and her poor nutritional status (low MUAC) were both associated with higher risks of marasmus in their children. Those children of low birthweight or with a recent history of persistent diarrhoea were also at higher risk. Two of the dietary factors considered showed significant associations with marasmus—children who were not being breastfed and those receiving formula food (mainly milk powder consumed during the last 24 hours) had greater risks of being marasmic (OR = 3.50 and 12.00 respectively). Dietary intake was not quantified but the amount of food stored was used to separate children who were likely to be consuming more than others. The relationship with the type of food groups consumed was unclear and not significant. Of these factors, only the consumption of formula food remained statistically significant (OR = 16.4, 95% CI : 3.39–79.36) in the multivariate model (Table 4).

Environmental variables were in general either homogeneously distributed in the population (for example, <5% of households owned a latrine) or were associated with economic indicators.

DISCUSSION

In this study we attempted to identify factors which have significant independent risks for marasmus. In interpreting these results it should be noted that the importance of some variables is underestimated in this approach because some of their effect might be mediated through other factors in addition to any direct effect. In this study biases could have resulted because the interviews were not adminstered blind, i.e. the same personnel who remeasured MUAC for case ascertainment also conducted the interview. We found a high level of concordance between the sample of supervisors' interview reports (performed blind) when compared with those of the community health workers. This was true for both cases and controls. Also arguing against bias was the fact that most of the variables were objective and verifiable or were collected directly from the record-keeping system of the Matlab demographic surveillance system. That only one of the other maternal-reported variables was statistically significant suggests that such selective misreporting would be most unlikely.

The results show that the presence in the family of a sibling <5 years old is the biggest risk for a child being marasmic. When this factor was included in the risk prediction model other related factors such as family size, previous deaths of under 5 year olds and other under 5 marasmic children were no longer statistically significant. It is important to note that the presence of another sibling, but not family size, was the significant variable in the model. This suggests that child spacing is important even though previous work showed that the death of a sibling presents a greater risk to a young child irrespective of length of birth interval.[11] The presence of many young siblings i.e. the occurrence of close birth intervals may have adverse effects on nutritional status through early displacement from the breast and hence weaning. These results suggest that factors other than food shortage are of importance since no relationship was found between food availability and marasmus. We found that children with one or more siblings under 5 years were more than two times more likely to be marasmic than those with no young sibling, even after controlling for birth order, socioeconomic and other factors. This yields a population attributable risk per cent (PAR) of 34%.

A high PAR of 56% was associated with maternal education. Education is a complex social variable and its relationship to marasmus could have several components. Increased maternal education is commonly found in families having greater income and resources. Both of these factors can reduce the risk of marasmus. On the other hand, better educated women often work outside the home and spend less time on child care, which may lead to early cessation of breastfeeding and early weaning using formula food and other inadequate diets. All of these latter factors could increase the risk of marasmus. This study showed that, independent of these and other factors, the risk of marasmus decreased as maternal education increased. The lack of a significant relationship between marasmus and paternal education in this study suggests that the effect of the mother's education is not merely a marker of socioeconomic status. Research is needed to identify the predominant channels through which maternal education affects marasmus. For example, the role of intrafamilial power relationships and health-seeking behaviour was not studied here. By knowing how and why maternal education affects marasmus, it may be possible to enhance benefits through more efficient and less costly programmes other than general education campaigns.

Children who were breastfed had a lower risk of marasmus, however, when other factors were controlled this relationship was no longer significant ($P = 0.08$). Previous studies in Bangladesh have shown that while breastfeeding might not improve the nutritional status of older children it still has a significant and substantial impact on survival of malnourished children.[12,13] The hygienic and nutritional risks associated with feeding artificial milks by bottle are well known.[14] The consumption of formula food was associated with the highest risk of marasmus in this study (OR = 16.4), however, the wide 95% CI indicates that this result must be interpreted with caution. These results cannot differentiate whether children who ate formula food became malnourished or whether formula food was given to children because they were malnourished. The relatively low prevalence of formula feeding yielded a modest PAR of 16%.

This study shows that important risk indicators for marasmus in rural Bangladesh are maternal education, child spacing and infant feeding. This finding stresses that although the goal is to reduce malnutrition in the child, interventions cannot ignore the crucial significance of maternal health and behaviour. There should be greater appreciation of the mother's central role in household domestic activities especially those which pertain to child rearing. This study emphasizes that the causes of malnutrition are multidimensional and non-food factors should be essential components of the strategy to combat malnutrition. In some settings social, cultural and political factors may be of greater significance than nutritional explanations of the malnutrition process.

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