Maternal common mental disorder and infant growth – a cross-sectional study from Malawi

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Abstract

The objective of the study was to investigate the association between maternal common mental disorder (CMD) and infant growth in rural Malawi. A cross-sectional study was conducted at a district hospital child health clinic. Participants were consecutive infants due for measles vaccination, and their mothers.

Mean infant weight-for-age and length-for-age z-scores were compared between infants of mothers with and without CMD as measured using the self-reporting questionnaire (SRQ).

Of 519 eligible infants/mothers, 501 were included in the analysis. Median infant age was 9.9 months. 29.9% of mothers scored 8 or above on the SRQ indicating CMD. Mean length-for-age z-score for infants of mothers with CMD (-1.50 SD 1.24) was significantly lower than for infants of mothers without CMD (-1.11 SD 1.12) Student's *t*-test: $P = 0.001$. This association was confirmed in multivariate analysis. Mean weight-for-age z-score for infants of mothers with CMD (-1.77 SD 1.16) was lower than for infants of mothers without CMD (-1.59 SD 1.09) but this difference was not significant on univariate (Student's *t*-test: $P = 0.097$) or multivariate analysis.

The study demonstrates an association between maternal CMD and infant growth impairment in rural sub-Saharan Africa.

Keywords: maternal mental health, infant growth, low income countries, depression, postnatal, postpartum.

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Introduction

Undernutrition remains a leading cause of infant mortality and morbidity in low-income countries. Aetiological factors include food insecurity, poverty and co-morbid disease, but also social and cultural factors.

The recent *Lancet* series on global mental health highlighted the links between mental health and physical disorders of public health importance (Prince *et al.* 2007). Recent studies from Asia show that maternal mental ill health is an independent risk factor for poor infant growth (Stewart 2007). Depression and anxiety are common among women during pregnancy and the postnatal period in low-income countries, with recorded prevalence of depression as high as 35% (Cooper *et al.* 1999). Collectively termed maternal common mental disorder (CMD), these conditions are disabling and often chronic. Prospective cohort studies from Pakistan and India have found that maternal CMD occurring during pregnancy or the early postpartum period predicts infant weight and length faltering at 6–12 months of age (Patel *et al.* 2003; Rahman *et al.* 2004a). This association persisted after accounting for confounders including poverty, household composition, maternal education and birthweight. Possible factors mediating the impact of maternal CMD on infant growth include breastfeeding difficulties (Patel *et al.* 2002) and impaired hygiene and healthcare practices, resulting in more frequent infant diarrhoeal episodes (Rahman *et al.* 2007).

The association between maternal CMD and infant growth found in Asia has been replicated in one of three published studies from Africa. A recent cohort study from Nigeria (Adewuya *et al.* 2007) found that infants of mothers depressed at 6-weeks postpartum were more likely to be underweight and stunted at 3 and 6 months of age. A South African cohort study found no evidence for an association, although it was limited by a high rate of loss to follow-up (Tomlinson *et al.* 2006). In a multi-site cross-sectional community-based study, Harpham *et al.* (2005) found an association between maternal CMD and infant growth impairment in India and Vietnam, but not in Ethiopia.

This study took place in rural Malawi, which is among the 10 poorest countries in the world. 14.1% of people aged 15–49 years are HIV infected. [NSO (Malawi) 2006]. It is estimated that 22% of children under five are underweight (weight-for-age z-score < -2) and 48% stunted (length-for-age z-score < -2) [NSO (Malawi) & ORC Macro 2005].

We tested the hypothesis that, among infants attending a district hospital child health clinic who were due for measles immunization, infants of mothers with CMD would be lighter and shorter than those infants whose mothers did not have CMD.

Method

The study site was the child health clinic at Thyolo District Hospital, Malawi. This government hospital is situated in a rural district with a population of approximately 550 000 [NSO (Malawi) 2006]. The predominant work in the area is subsistence farming and employment on tea-growing estates.

The child health clinic is run according to World Health Organisation (WHO) Integrated Management of Childhood Illness guidelines. Infants are brought to the clinic for immunization, growth monitoring and medical assessment/treatment. The non-governmental organization, Medicine Sans Frontiers (Belgium), supports a 'Prevention of Mother to Child [HIV] Transmission' (PMTCT) programme integrated into the government health service. The majority of pregnant women who attend Thyolo Hospital are tested at their first antenatal visit, and are aware of their HIV status. HIV positive mothers are offered ongoing health and infant feeding advice within the child health clinic. Mothers fulfilling disease progression criteria also have access to free anti-retroviral treatment.

Vaccination against measles is given to any non-immunized child aged 9 months or over, irrespective of the primary reason for clinic attendance. Measles immunization coverage by 2 years of age in Malawi is 87% [NSO (Malawi) 2006]. In this study, all infants brought to the clinic were screened by the research fieldworkers while in the waiting area. Any infant who was due for measles immunization, and who had been brought to the clinic by his/her own mother, was

recruited. Infants who were not accompanied by their mother, were too unwell to be immunized, or had obvious physical deformity, were excluded. Mothers who were not Chichewa speakers were also excluded.

The purpose of the study was explained to each mother by a trained fieldworker, and written consent was obtained (or thumbprint for those mothers who were illiterate). Interviews were conducted in Chichewa, the official (and most widely spoken) language of Malawi. Mothers were administered a health and demographics questionnaire. Their weight, height and mid upper arm circumference (MUAC) were measured. Infant weight, length and MUAC were then measured. The mothers were next administered the Chichewa version of the self-reporting questionnaire (SRQ) by a second fieldworker blind to infant weight-for-age or length-for-age z-score.

The SRQ is a WHO-designed brief measure of CMD (WHO 1994). It consists of 20 questions with 'yes/no' answers exploring symptoms of depression, anxiety and somatic manifestations of distress. It has been validated for use in many developing countries. We undertook a rigorous process of forward and back translation, piloting and validation of the SRQ against the Structured Clinical Interview for DSM-IV (SCID) (First *et al.* 2002) in a randomly selected group from the study sample ($n = 114$). SCID is a semi-structured interview that determines formal diagnosis according to the Diagnostic and Statistical Manual of Mental Disorders 4th edition classification. We used a score of 8 or more on the SRQ to define CMD, as we determined that this was the optimal cut-off for detecting major and minor depressive episode. This was consistent with previous similar studies (Harpham *et al.* 2005).

The two fieldworkers were experienced Chichewa-speaking Malawian nurses. They were trained in administration of the SRQ, and were also given refresher training in anthropometric techniques by a paediatrician (JB). Infants were weighed naked on electronic scales accurate to 0.01 kg. Lengths were measured on a locally made calibrated length-board by the two fieldworkers.

Data were collected on variables that may act as confounders to any association between maternal CMD and poor infant growth.

Infant factors

1. Age. Infant weight and length were adjusted for infant age. Age of the infant at time of recruitment was also an indicator of how long after age 9 months the infant remained un-immunized, a possible indicator of maternal healthcare seeking behaviour. For this reason, infant age was included separately in the multivariate analysis.

2. Sex.

3. First recorded postnatal weight. This was taken from the infant health record. Many births in Malawi take place outside of a health facility, and birthweight is not always recorded. However, a weight is routinely recorded at the infant's first postnatal check (usually at 6–8 weeks), and was available for most of the subjects. To account for variation in the timing of this measurement, the date of recording was noted and the weight converted into a weight-for-age z-score.

4. Diarrhoea and fever in the 2 weeks prior to the interview. This information was based on maternal report only, and did not include formal symptom criteria.

Maternal health factors

1. Age.

2. Weight, height, MUAC. These provide a measure of maternal nutritional status and proxy measure of maternal general health.

3. HIV status. This was based on self-report cross-checked against the maternal health record. HIV status of infants was not available as this requires Polymerase Chain Reaction (PCR) for diagnosis in infants under 18 months of age.

Psychosocial factors

1. Maternal educational level, grouped into attendance at school to Standard 6 and above, or below that level. Schooling in Malawi consists of primary (Standard 1 to 8) and secondary (Form 1 to 4) education.

2. Marital status.

3. Maternal occupation.

4. Access to a confiding relationship with spouse or other relative.

5. Four or more surviving children.
6. Paternal occupation and whether he lived at home.
7. Wealth. This was measured using the WHO-designed assets questionnaire as used in the Demographics and Health Survey national survey of households conducted in Malawi every 4 years [NSO (Malawi) & ORC Macro 2005]. This records information on the presence of various household items, type of water supply, toilet, building materials and number of persons per sleeping room. A weighting for each item is given based on the distribution of the item in the Malawian population, and a validated wealth score generated.

Statistical analysis

Infant weights and lengths were converted into weight-for-age and length-for-age z-scores based on WHO standardized growth data (1978) using Epi-Info. Univariate analyses compared mean weight-for-age and length-for-age z-scores against maternal CMD and potential confounding variables (using Spearman correlation coefficients for continuous variables and Student's *t*-test for categorical variables).

Those variables which could potentially confound the association between maternal CMD and the

infant growth outcome measures (except those that would cause problematic multicollinearity) were entered into multiple regression analyses. All these variables were entered simultaneously into linear regression with mean substitution of missing data. Analyses were conducted using SPSS 13.0 (SPSS Inc. 2004).

Of the variables included in the regressions, only HIV status had greater than 10% missing data (see last column of Tables 1 and 2). Analyses were repeated with and without HIV status and those results are presented.

Based on estimates from studies in developing world settings, we assumed a prevalence of maternal CMD of 20% among mothers of normal weight children, and 40% among mothers of underweight infants (Rahman *et al.* 2004b). To detect this difference with 95% confidence and 80% power, a total of 91 infants in each group would be required.

Ethical approval

Ethical Approval for the study was given by the University of Manchester Research Ethics Committee, UK, and the College of Medicine Research Ethics Committee, Malawi.

Table 1. Continuous variables associated with infant weight-for-age and length-for-age z-scores on univariate analysis (Spearman Correlation Coefficients)

	Infant weight-for-age z-score		Infant length-for-age z-score		Number on whom data available <i>n</i>
	Correlation coefficient	<i>P</i> -value	Correlation coefficient	<i>P</i> -value	
Maternal					
Height	0.163	<0.001	0.246	<0.001	501
Weight	0.241	<0.001	0.234	<0.001	501
Mid upper arm circumference	0.164	<0.001	0.137	0.002	501
Body mass index	0.173	<0.001	0.107	0.016	501
Age	-0.008	0.868	0.035	0.440	487
Infant					
Age	-0.156	<0.001	-0.180	<0.001	501
Birthweight	0.238	<0.001	0.285	<0.001	278
Weight-for-age z-score at first recorded postnatal weighing	0.504	<0.001	0.463	<0.001	467
Psychosocial					
Demographics and Health Survey Wealth Index	0.100	0.025	0.096	0.032	499

Table 2. Categorical variables associated with mean infant weight-for-age and length-for-age z-scores on univariate analysis (Student's *t*-test)

Variable	Variable categories	Number in each category	Infant weight-for-age z-score		P-value	Infant length-for-age z-score		P-value	Number on whom data available
			Mean	SD		Mean	SD		
Maternal HIV status	Positive	57	-1.81	1.42	0.198*	-1.57	1.19	0.009	314
	Negative	257	-1.55	1.05		-1.13	1.14		
Infant Sex	Male	256	-1.67	1.19	0.531*	-1.34	1.21	0.020	501
	Female	245	-1.61	1.04		-1.10	1.12		
Diarrhoea in last 2 weeks	Yes	343	-1.75	1.12	<0.001	-1.33	1.18	0.003	499
	No	156	-1.38	1.07		-0.99	1.12		
Fever in last 2 weeks	Yes	364	-1.75	1.12	<0.001	-1.28	1.21	0.071	498
	No	134	-1.32	1.04		-1.07	1.07		
Psychosocial									
Common mental disorder	Present	150	-1.77	1.16	0.097	-1.50	1.24	0.001	501
	Absent	351	-1.59	1.09		-1.11	1.12		
Married	Yes	441	-1.62	1.11	0.279	-1.19	1.17	0.066	501
	No	60	-1.79	1.19		-1.49	1.19		
Father of child living at home	Yes	415	-1.61	1.10	0.233	-1.18	1.17	0.038	501
	No	86	-1.77	1.21		-1.46	1.15		
Paternal occupation	Paid work	333	-1.57	1.12	0.067	-1.16	1.18	0.040	494
	Other	161	-1.77	1.10		-1.39	1.14		
Confidante	Spouse/relative	422	-1.63	1.11	0.581	-1.18	1.16	0.031	501
	Neither	79	-1.70	1.15		-1.49	1.23		
Attended education above Standard 6	<Standard 6	268	-1.82	1.15	<0.001	-1.40	1.22	<0.001	501
	≥Standard 6	231	-1.42	1.04		-1.02	1.09		
Maternal occupation	Housewife	455	-1.63	1.11	0.366	-1.20	1.17	0.067	498
	Other	43	-1.79	1.18		-1.54	1.14		
Number of own Children	3 or less	397	-1.58	1.13	0.025	-1.21	1.14	0.492*	501
	4 or more	104	-1.86	1.02		-1.30	1.29		

*Equal variances not assumed.

Results

Recruitment took place at consecutive clinics between January and March 2006. Mean number of subjects recruited per clinic day was 9.3 (range 2–25), reflecting daily variations in clinic attendee numbers. Of those mothers/infants meeting inclusion criteria ($n = 519$), five refused, and a further 13 had missing data for primary exposure/outcome variables. Therefore, 501 mothers/infants were included in the analyses.

Sample characteristics

Two hundred and fifty-six (51.1%) of the infants were male. Median age was 9.9 months (inter-quartile range 9.4–10.9). Birthweight was only available for 278 (55.5%) of the infants [mean 3.2 kg (SD 0.5), mean z-score -0.2 (SD 1.2)]. An early postnatal weight was recorded for 467 (93.2%) of the sample, with mean weight-for-age z-score of 0.7 (SD 1.2).

One hundred and eighty-four (36.7%) of the infants were underweight (weight-for-age z-score < -2), and 124 (24.8%) were stunted (length-for-age z-score < -2). Mean infant weight-for-age z-score was -1.64 (SD 1.12), mean infant length-for-age z-score was -1.23 (SD 1.17), and mean infant weight-for-length z-score was -0.91 (SD 1.10). By maternal report, 343 (68.5%) of the infants had had diarrhoea, and 364 (72.7%) a febrile illness, during the previous 2 weeks.

One hundred and fifty (29.9%) of the mothers scored 8 or more on the SRQ indicating CMD. Mean maternal age was 24.4 years (SD 5.4). Mean maternal body mass index was 21.0 (SD 2.5). 441 (88%) of the mothers were married and 455 (90.8%) described

their occupation as housewife. 231 (46.1%) had attended school to Standard 6 level or above. 104 (20.8%) had four or more living children. 422 (84.2%) were able to confide in their husband or a relative. Of the fathers of the infants, 333 (66.5%) were in paid employment, and 415 (82.8%) were living at home. 314 (62.7%) of the mothers had been tested for HIV and knew their status. 57 (18.2%) of these women were HIV infected, and 257 (81.8%) HIV uninfected.

Univariate analyses

Tables 1 and 2 show mean infant weight-for-age z-score and length-for-age z-score, and associations with continuous (Table 1) and categorical (Table 2) variables. There was a trend for lower mean weight-for-age z-score among infants of mothers with CMD but this was non-significant [-1.77 (SD 1.16) vs. -1.59 (SD 1.09) Student's *t*-test: $P = 0.097$, Table 2]. Mean length-for-age z-score was lower in infants of mothers with CMD, and this association was significant [-1.50 (SD 1.24) vs. -1.11 (SD 1.12) Student's *t*-test: $P = 0.001$, Table 2].

The 314 subjects on whom HIV status was known did not differ significantly on maternal, infant and socioeconomic variables from those for whom HIV status was not known. Among these 314 subjects, mean infant length-for-age z-score was significantly lower for HIV infected than HIV uninfected mothers [-1.57 (SD 1.19) vs. -1.13 (SD 1.14) Student's *t*-test: $P = 0.009$, Table 2]. Mean infant length-for-age z-score was lower in mothers with CMD vs. mothers without CMD, in both HIV infected and non-infected groups, although these differences did not reach significance (Table 3).

Table 3. Mean infant length-for-age z-score by maternal common mental disorder (CMD) in HIV infected and non-infected groups (Student's *t*-test)

HIV status	CMD	<i>n</i>	Mean length-for-age z-score	Standard deviation	<i>P</i> -value	Mean difference in length-for-age z-score	95% confidence interval
Not infected	No	190	-1.05	1.06	0.063	-0.30	-0.62 to 0.02
	Yes	67	-1.35	1.31			
Infected	No	32	-1.46	1.23	0.427	-0.25	-0.89 to 0.38
	Yes	25	-1.71	1.14			

Multivariate analyses

Two multiple linear regression analyses were conducted with infant weight-for-age z-score and length-for-age z-score as the dependent variables. The following variables were entered into these analyses: maternal height, maternal weight, maternal CMD, wealth index, education to Standard 6 or above, four or more surviving children, maternal occupation, marital status, paternal occupation, mother able to confide in husband or relative, recent infant diarrhoea, recent infant fever, infant age, infant sex and weight for age z score at first postnatal weighing.

No association was found between maternal CMD and infant weight-for-age z-score ($b = -0.016$, $P = 0.867$, Table 4), but maternal CMD was associated with infant length-for-age z-score ($b = -0.271$, $P = 0.008$, Table 5). This association persisted when the regression was repeated excluding weight-for-age at first postnatal weighing ($b = -0.258$, $P = 0.026$). Adjusted difference in mean infant length-for-age z-score between mothers with and without CMD was -0.27 [95% confidence interval (CI) -0.47 to -0.07]. For infants of the median age in the study (9.9 months), this would represent a mean difference of -0.7 cm (95% CI -1.25 to -0.20) in length.

Studentized residuals, leverage and tolerance levels were within acceptable limits, confirming that the

assumptions of the multiple regressions were met. The smallest tolerance value for the independent variables in the regression was 0.637, and the maximum VIF (variance inflation factor) was 1.57, which confirms that multicollinearity was not a problem with these variables (Field 2005). The linear regression was repeated without substitution of missing data and the same variables remained associated with length-for-age z-score in the regression, except for maternal profession.

As HIV status was known for only 314 (62.7%) of the mothers, it was not included in the main analysis. The linear regression for infant length-for-age z-score was repeated for the 314 subjects. Maternal CMD was no longer significantly associated with infant height-for-age z-score either when the same variables as in the main analysis were included ($b = -0.243$, $P = 0.062$) or when HIV status was added as an independent variable ($b = -0.219$, $P = 0.094$, Table 6).

Discussion

This study found infant length-for-age to be significantly associated with maternal CMD among infants brought to a child health clinic and due for measles immunization (median age 9.9 months) in rural Malawi. This association persisted after adjustment

Table 4. Weight-for-age z-score linear regression ($n = 501$)

	Unstandardized coefficients		P-value	95% confidence interval for B	
	B	Standard error		Lower bound	Upper bound
Maternal height	0.002	0.009	0.843	-0.015	0.019
Maternal weight	0.026	0.008	0.001	0.011	0.041
Maternal common mental disorder	-0.016	0.096	0.867	-0.204	0.172
Demographics and Health Survey Wealth Index	0.005	0.048	0.921	-0.090	0.100
Education Standard 6 or above	0.210	0.091	0.022	0.031	0.390
Four or more children	-0.285	0.107	0.008	-0.497	-0.074
Not housewife	-0.233	0.155	0.135	-0.538	0.072
Not married	-0.012	0.137	0.930	-0.281	0.257
Father not in paid work	-0.110	0.093	0.235	-0.292	0.072
No spouse/relative confidante	0.015	0.119	0.901	-0.218	0.248
Infant diarrhoea in last 2 weeks	-0.193	0.113	0.089	-0.415	0.030
Infant fever in last 2 weeks	-0.166	0.118	0.160	-0.399	0.066
Infant age	-0.012	0.011	0.287	-0.034	0.010
Female sex	-0.002	0.085	0.977	-0.169	0.164
Weight for age z-score at first postnatal weighing	0.423	0.037	<0.001	0.350	0.496

Table 5. Length-for-age z-score linear regression ($n=501$)

	Unstandardized coefficients		<i>P</i> -value	95% confidence interval for B	
	B	Standard error		Lower bound	Upper bound
Maternal height	0.029	0.009	0.002	0.011	0.047
Maternal weight	0.008	0.008	0.322	-0.008	0.024
Maternal common mental disorder	-0.271	0.101	0.008	-0.471	-0.072
Demographics and Health Survey Wealth Index	0.022	0.051	0.667	-0.079	0.123
Education Standard 5 or above	0.163	0.097	0.093	-0.027	0.353
Four or more children	-0.071	0.114	0.533	-0.295	0.153
Not housewife	-0.347	0.165	0.035	-0.671	-0.024
Not married	-0.059	0.145	0.682	-0.344	0.225
Father not in paid work	-0.157	0.098	0.110	-0.350	0.036
No spouse/relative confidante	-0.152	0.126	0.226	-0.399	0.094
Infant diarrhoea in last 2 weeks	-0.311	0.120	0.010	-0.547	-0.076
Infant fever in last 2 weeks	0.157	0.125	0.210	-0.089	0.404
Infant age	-0.013	0.012	0.274	-0.037	0.010
Female sex	0.139	0.090	0.124	-0.038	0.315
Weight for age z-score at first postnatal weighing	0.422	0.039	<0.001	0.345	0.499

Table 6. Length-for-age z-score linear regression including HIV status ($n=314$)

	Unstandardized coefficients		<i>P</i> -value	95% confidence interval for B	
	B	Standard error		Lower bound	Upper bound
HIV positive	-0.250	0.152	0.101	-0.549	0.049
Maternal height	0.034	0.012	0.007	0.009	0.058
Maternal weight	0.002	0.010	0.841	-0.018	0.022
Maternal common mental disorder	-0.219	0.130	0.094	-0.475	0.037
Demographics and Health Survey Wealth Index	0.046	0.066	0.486	-0.084	0.177
Education Standard 5 or above	0.212	0.123	0.085	-0.029	0.453
Four or more children	-0.199	0.148	0.180	-0.492	0.093
Not housewife	-0.377	0.201	0.062	-0.773	0.020
Not married	0.045	0.184	0.809	-0.318	0.407
Father not in paid work	-0.068	0.129	0.602	-0.322	0.187
No spouse/relative confidante	-0.142	0.159	0.374	-0.455	0.171
Infant diarrhoea in last 2 weeks	-0.088	0.155	0.571	-0.394	0.218
Infant fever in last 2 weeks	0.115	0.163	0.479	-0.205	0.435
Infant age	-0.019	0.016	0.249	-0.051	0.013
Female sex	0.149	0.117	0.203	-0.081	0.378
Weight for age z-score at first postnatal weighing	0.373	0.050	<0.001	0.275	0.471

for confounding variables including poverty, maternal nutritional status and early infant postnatal weight.

The study is limited by the cross-sectional design and so is unable to determine the direction of the association between maternal CMD and infant stunting. Maternal CMD may affect the mother's ability to provide adequate nutritional care to her infant; conversely, the stress of having a poorly growing child might predispose to maternal CMD. Both mecha-

nisms may be important, although prospective studies from Asia provide strong evidence for maternal CMD being a risk factor for infant growth impairment in low-income settings (Stewart 2007).

The finding of an association between maternal CMD and infant growth replicates previous studies from Pakistan, India, Vietnam, and Nigeria. The failure to demonstrate an association between maternal CMD and infant weight contrasts with most of

these studies [although Harpham *et al.* (2005) found an association with infant length and not weight in the Indian arm of their multi-site study]. The explanation for this may lie in the pattern of growth faltering in Malawi. In a longitudinal study of child growth in rural Malawi, Maleta *et al.* (2003) found that the incidence of length faltering was maximal at 3–6 months of age, and earlier than the maximal incidence of weight faltering (9–15 months), whereas in South East Asia, underweight is the dominant pattern of early growth faltering. This could explain why in Malawi, by the time of measles immunization at 9 months, the main effect of CMD might be on length, rather than on weight. As maternal CMD is often a chronic disorder (Rahman & Creed 2007), it is likely that many of the mothers depressed at the time of recruitment will also have been so during pregnancy and the early puerperium. Length impairment (stunting) is well recognized as a manifestation of chronic growth restriction. Another possible explanation is that weight is more susceptible to short-term variation because of acute food shortage, and that this would 'swamp' the impact of a chronic risk factor such as maternal depression. It is notable that this study took place from January to March 2006 while Malawi was suffering a period of marked food insecurity resulting from a failed harvest in the previous year. This may be reflected in the finding of a prevalence of underweight in this sample of 36.7% compared with a published figure of 32.4% in infants aged 10–11 months [NSO (Malawi) 2006]. Replication of the study outside of a period of food shortage would help elucidate the impact of food supply and other seasonal factors on the relationship between maternal CMD and infant weight.

This was the first study of its type to be conducted in a population with a high prevalence of HIV and in which data on maternal HIV status was available for a majority (62.7%) of the sample. HIV/AIDS is an important factor affecting both maternal and infant health outcomes. The size of the mean difference in infant height-for-age z-score between mothers with and without CMD was similar in both HIV infected and uninfected groups, suggesting the possibility that maternal CMD and HIV infection might have an additive impact on infant growth. On multivariate

analysis, the association between maternal CMD and infant height-for-age z-score became non-significant in the sub-analysis of those mothers who knew their HIV status. The loss of association significance occurred whether or not maternal HIV status was included as co-variable, and the size of effect of CMD on length-for-age z-score was similar to that in the main analysis. This indicates that it was probably the smaller sample size that accounts for the loss of association significance in addition to any confounding effect of maternal HIV status. Further studies are required to confirm this. From this current study, any conclusions about the effect of HIV infection are also limited by the lack of data on infant sero-status, although, with the PMTCT interventions in place at the time of the data collection, less than 18% of infants born to mothers infected with HIV would be expected to have acquired infection by 1 year of age (Guay *et al.* 1999; Miotti *et al.* 1999).

Other strengths of the study include the relatively large sample size and low refusal rate. We succeeded in accounting for the major likely confounders although there remains the possibility that there are important unidentified factors. The study took place in a rural area in southern Malawi during a period of food insecurity, and it is unknown whether the results could be generalized to other settings. Our use of a sample drawn from infants brought to a child health clinic introduces the risk of referral bias, i.e. the mothers/infants' attending the clinic may not be representative of the population as a whole. By recruiting all infants due for immunization (irrespective of why they were brought to the clinic), we limited the possibility that the mothers were a group particularly motivated to bring their infant for immunization. As 87% are vaccinated in this community by age 2 years, the immunized children may be assumed to be representative of all children this age. However, CMD itself may be a factor in determining whether a mother brings her child to clinic for medical attention when she perceives her child as unwell. A future community-based study would be needed to eliminate this potential bias.

The values for birthweight and early postnatal weight were recorded from health records so that accuracy of the measurements could not be assured.

As with other similar studies, birthweight was missing for a large proportion of the infants, but an early postnatal weight was available for most subjects. Maternal CMD was significantly associated with stunting when this was accounted for suggesting that CMD is associated with impaired infant postnatal growth and not only tracking from small size at birth. However, although we were able to record an early postnatal weight, there was no measure of early infant length, a likely stronger predictor of later length.

Infant undernutrition is a major public health issue in low income countries such as Malawi. It is associated with infant morbidity and mortality, and irreversible impairment of physical and mental development (World Bank 2006). The reduction in mean length of 0.7 cm (for infants age 9.9 months) associated with maternal CMD is important, as CMD is a potentially remediable risk factor. There is now evidence for the effectiveness of affordable treatments for CMD in low-income countries (Patel *et al.* 2007); future studies should aim to treat maternal CMD and determine whether this reduces infant growth impairment. Our current findings support the call for greater recognition of the importance of maternal mental health by both governments and global health organizations (Prince *et al.* 2007).

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Competing interests

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Key messages

- Infant undernutrition is associated with mortality, morbidity and lifelong developmental impairment.
- Previous studies from Asia show that maternal CMD is an independent risk factor for infant growth impairment.
- This study found that maternal CMD is highly prevalent in rural Malawi and is associated with infant stunting in this setting.
- Awareness of maternal mental health problems should be included in programmes tackling infant undernutrition in sub-Saharan Africa.

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