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Parental symptoms of common mental disorders and children's social, motor, and language development in sub-Saharan Africa

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Abstract

Background: There is increasing interest in the social determinants of children's developmental outcomes in developing countries because of the links with schooling, behavioral, and employment outcomes. Yet, little is known about the impact of household and caretaker variables in influencing developmental outcomes in rural, developing country settings.

Aim: The study examined the relative impact of individual and household variables and caretaker symptoms of common mental disorders on children's personal–social, fine and gross motor, and language development.

Subjects and methods: A total of 431 children aged 3–24 months in a rural Ethiopian setting were studied. Children underwent a developmental assessment and parents independently provided information on household characteristics and were administered anxiety and depression symptom inventories.

Results: In adjusted multivariable models, maternal symptoms of mental disorders were associated with both global development and most developmental sub-scales ($p < 0.01$) except language developmental; there was no consistent relation between paternal symptoms of mental disorders and child development. Nutritional stunting was generally a risk factor for lower developmental scores but few household-level variables were associated with child development.

Conclusion: Child development in this setting is strongly associated with child age and maternal depression. If these findings are replicated elsewhere, they may suggest that interventions aimed at improving maternal depression may have an important role to play in efforts to improve child development and to mitigate the intergenerational transmission of poor health in sub-Saharan Africa.

Keywords: *Mental health, depression, biocultural, Ethiopia, poverty*

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Introduction

Human biologists have historically been concerned with the related issues of human growth and development (Bogin 1999). Much of their work has focused on the correlates or determinants of different growth trajectories and the occurrence and severity of undernutrition. A large part of the explanatory growth and development research paradigm has centered on identifying the individual, household, and ecological (e.g. seasonal) covariates that predict differences in achieved height, weight, and more rarely growth velocities. The rationale underlying this focus is, in part, due to the relationship between anthropometric indicators and mortality (Pelletier 1994) and in part due to the relationship between anthropometric indicators and child developmental progress (ACC/SCN 2002). As global mortality rates and the prevalence of undernutrition decline, it may be time to shift the human biology focus towards more specific measures of child development (Richter 2003). This is not to say that growth outcomes are unimportant, but rather that the failure to achieve cognitive, social–emotional and motor milestones in a timely fashion may also have implications for subsequent developmental, schooling outcomes, and behavior (Engle et al. 2007; Walker et al. 2007). Or, as eloquently put by Richter, as global child mortality rates decline it will be increasingly important to assess 'measures of quality of life to minimize children's suffering and to ensure that they move into adulthood with more assets than liabilities' (Richter 2003, p. 442). Human biologists should be as interested in development as they are in growth because children's developmental status or progress at achieving various developmental milestones may also be sensitive to the ecocultural environment. Further, as our field shifts towards a population health focus (McGarvey 2007) it will be increasingly important to measure functional outcomes and move beyond proxy indicators of wellbeing. In this paper we hope to make a small contribution to this area by adopting an exploratory approach to studying the social determinates of children's development.

We hope to make a second contribution as well, which speaks to the emerging interest in and calls by human biologists to integrate measures of psychosocial stress and mental health into their models. These calls are timely given the burgeoning interest by population health investigators in mental health outcomes (Murray and Lopez 1997). Our aim in this paper is not to measure mental health outcomes *per se*, but to recognize their existence and assess their possible influence on children's developmental scores. In this way we hope to contribute to the interest in the impact of caretaker mental health on children's development over and above the role played by undernutrition (WHO 2004). In developed countries, we know that infants of mothers with common mental disorders, particularly anxiety-mood disorders, have relatively poorer cognitive, social–emotional outcomes and relatively more behavioral problems than children of mothers without common mental disorders (McLearn et al. 2006) and the relation between maternal anxiety-mood disorders and poor childhood development is often but not always exacerbated by low socio-economic status (Bradley and Corwyn 2002; Conger and Donnellan 2007; although this is not as strong as one might expect, Petterson and Albers 2001). The likely mechanism is that depressed mothers or mothers with anxiety-mood disorders interact with their children in qualitatively different ways than mothers without anxiety-mood disorders (reviewed in Petterson and Albers 2001). Despite this interest, human biologists have been slow to include aspects of caretaker mental health into their conceptual models, which have often explicitly focused on material explanations, while endorsing the possible impact of culture on outcomes. Whether implicit or explicit, child growth and development outcomes are often investigated as a function of household, individual, and ecological correlates. It is often not clear whether household variables, for instance, predict child outcomes because the child is (potentially) directly

affected by those households variables or whether household variables influence caretaker behavior, which in turn impacts on child outcomes.

Hypotheses

In this study we test four hypotheses regarding the correlates of children's social–emotional, fine and gross motor, language, and overall development using data from a rural Ethiopian setting. First, children's scores on each sub-scale are associated with child age. Second, measures of household socio-economic status are positively associated with children's development scores. Nutritional stunting, which is rampant in many low-income developing countries, is known to be associated with both emotional–social, and cognitive development among young children and to be a strong predictor of subsequent cognitive development and school performance (Grantham-McGregor et al. 2007). Therefore, third, children who show evidence of nutritional stunting score lower on developmental scores, even after allowing for confounding covariates. Fourth, measures of maternal and paternal symptoms of mental disorders are negatively associated with children's developmental scores, although this will be stronger for women because of their dominant role in parental care. Because the specific developmental assessment that we use has not been validated in Ethiopia, we cannot make diagnostic statements about children's development. Rather, our overarching goal is to examine the variables that predict variation within a relatively homogeneous sample.

Methods

Sample

This study took place in Jimma zone, southwest Ethiopia in the Gilgel Gibe area outside of Jimma Town. This is a predominantly rural area where the primary occupation is subsistence agriculture. In the past years large numbers of inhabitants have been affected by the construction of hydro-electric dam, which disrupted lives and livelihoods and forced many people from their homes and to relocate to nearby towns and villages. Poverty, as throughout much of Ethiopia, is high and food insecurity is chronic. National estimates of child mortality in rural areas hover near 125/1000 and maternal mortality ratios exceed 800/100 000. These statistics and those on rates of undernutrition provide glimpses into the difficult lives of rural Ethiopians, but similar patterns exist throughout low-income, developing countries (UNFPA 2006).

The Gilgel Gibe Growth and Development Study (GGGDS) is a cohort study of families in the Gilgel Gibe region that is concerned with adult mental health and child development. The study involves questionnaire and anthropometric information collected from the parents, and developmental assessments conducted on their children. We report here on baseline information on correlates of child development.

Jimma University conducts ongoing complete demographic surveillance in the Gilgel Gibe area, which is used to collect vital data for a complete census of the population of some 8000 households in the Gilgel Gibe area. Records are updated multiple times each year. The cohort baseline for the GGGDS was a sample of households from this enumeration area that had a child between the ages of 3 and 24 months from the universe of all births in the Gilgel Gibe in the 2 years prior to the estimated start date of the survey. In other words, all births

in the 2 years prior to the study comprised the sampling universe, and from this we randomly sampled 550 children. From these, 113 children were not included because the children were unable to be located, had died, had moved from the study area, or had aged out of the study by the time the interviewer reached their households. This analysis includes 437 children for an overall response rate of 80%. Data were collected between December 2006 and January 2007.

A structured questionnaire was developed and administered to adult participants. Questionnaires and consent documents were developed in English then translated and back translated into the two dominant languages in the study area: Amharic and Affan Oromifa by native speakers. Interviewers underwent a week-long training period that included cognitive interviewing, practice interviewing, and role playing. Tests were periodically administered throughout the week to assess knowledge of the questionnaire. Following the training interviewers undertook a pilot study. After the pilot, interviewers and investigators met to discuss experiences, issues, and resolve questionnaire problems; data were also checked for consistency, outliers, and missing values. Upon completion of the pilot study, a follow-up training was conducted with a focus on resolving issues, allowing interviewers to share experiences, and finalizing the questionnaires. Households were then visited and all participants were interviewed in their house in a private area. Mothers and fathers were separately interviewed with separate survey forms. Written informed consent was obtained from all participants. The Institutional Review Boards of the University of Michigan and Jimma University reviewed and approved the study protocol.

Survey measures

Household socio-economic status (SES) was measured using three different indicators. First, a set of material assets were asked of each household. Items were summed and households' SES was categorized based on whether the household was above or below the median asset ownership. The second indicator of household SES was based on animal and livestock ownership; a summary score was created and households below the median level of ownership were categorized as having low livestock ownership. Fathers also provided a subjective measure of household SES by responding to a pictorial scale. This scale, called the ladder, presents respondents with a picture of a ladder and they are asked to place themselves on the ladder relative those in their community who have the most and those who have the least (Cantrill 1956; Goodman et al. 2001). Interviewers reported that respondents immediately grasped the concept of the ladder. Mothers provided corresponding responses to some of the material items and these were highly associated with their partner's responses. We therefore used the fathers' responses as estimates of the household SES.

Household level food insecurity was measured with a seven-item scale based on those used and validated in diverse settings in developing countries (Frongillo and Nanama 2006; Melgar-Quinonez et al. 2006; Swindale and Bilinsky 2006). Mothers and fathers were separately asked whether in the last 3 months, they: (1) worried about running out of food, (2) ran out of food, (3) reduced variety of food for children, (4) their children did not have enough to eat, (5) the respondent or other adult did not eat enough, (6) the respondent spent the whole day without food, and (7) had to ask others for food or money to buy food. These items were scored as yes/no and analysis showed that the scale had high internal consistency (Cronbach's Alpha 0.93). Responses of the husband and wife were summed and the average was taken. This was then coded into a dichotomous variable with scores in the upper third coded as food insecure. All other individuals were considered food secure.

Maternal and paternal scores were highly correlated ($p < 0.0001$) and showed high agreement (Kappa = 0.72).

Symptoms of common mental disorders were measured using the Hopkins Symptom Checklist (HSCL), an often-used inventory of symptoms of anxiety and depression. The HSCL has been validated in a number of diverse settings (Derogatis et al. 1974; Kaaya et al. 2002; Mollica et al. 2004). From the HSCL we calculated three variables. First, as a general measure of symptoms of mental disorders, we calculated the total inventory score by summing across each item; respondents could report that the symptom did not affect them at all or affected them very much with several intermediate options. For each item scores ranged from 1 to 4 and for the entire scale scores ranged from 25 (lowest symptoms) to 100 (highest symptoms), which were then divided by 25. This was our measure of symptoms of common mental disorders, which accounts for both symptom count and severity. Second, we followed established protocols and cut-offs (Mollica et al. 2004) to calculate indicators of high symptoms of anxiety and high symptoms of depression. To do this we used summed across the first 10 items and divided the sum by 10 to create a measure of anxiety and summed across the remaining 15 items and divided by 15 to obtain an indication of depression. For each of these measures, scores greater than or equal to 1.75 were considered evidence of high symptoms of anxiety or high symptoms of depression, as per established protocols (Mollica et al. 2004). The HSCL is a not a diagnostic tool; we rely on these cut-offs because they are used widely in other research studies and therefore facilitate comparisons.

Anthropometric measures

We assessed each parent's weight and height and calculated maternal and paternal body mass index (BMI). For each parent the BMI score was categorized into a dummy variable representing a BMI ≤ 18.5 or greater than 18.5; this is a commonly used cut-off indicating possible chronic energy deficiency (Ferro-Luzzi et al. 1992). For each child in the study, trained interviews measured weight (kg) and length (cm) using standard anthropometric procedures (Frisancho 1990). Measures of weight and length were converted into anthropometric indicators using the references from the WHO Multicentre Growth Reference Study. For each child, height and age were used to calculate z-scores, which were then used to categorize children as stunted [less than -2 standard deviations (SD) below the reference median] and not stunted (greater than or equal -2 SD below the reference median) following established protocols.

Other sociodemographic control variables were mothers and father's age (in years), child age (in months) and child gender. Educational status was not collected for this survey but it is known to be universally low in the study area.

Measures of children's development

For the developmental test we created a set of measures that were selected from a sample of items from the Denver II test on which children would be tested (Frankenburg et al. 1992b). Items that were culturally or locally inappropriate were excluded and others changed to reflect local conditions. For instance, the item 'can walk up stairs' was altered to reflect whether a child could walk over the raised threshold of a hut. Other items were eliminated if they failed to tap tasks that were salient in the lives of children in the study area; for instance, items related to drawing and writing were excluded because few children

in our age group have any exposure to pens and pencils and this would have created a large number of failures in these areas. Items covered four areas of development including personal–social development (11 items), fine (11 items) and gross motor (16 items) skills, and language acquisition (14 items). All individuals began with the 'easiest' items and proceeded with tasks until they reached three consecutive failures, at which point the child moved onto the next sub-scale. Some of the test items could be passed by maternal responses while others could only be passed by observing the child carry out the task (e.g. naming pictures or naming body parts). We referred to the Denver Developmental Test Manual (Frankenburg et al. 1992a) when deciding if items could be passed by maternal response. Items were scored on a pass/fail basis and summed within categories and across all categories. This resulted in a score for each sub-scale category and a summary score for development. Although not an explicit test of the validity of the scale, it is of some interest that the median score that tasks were passed in the USA reference sample was strongly correlated with the median age at which tasks were passed in the Ethiopian sample ($p < 0.0001$).

Statistical analysis

Descriptive statistics were calculated for all variables. Bivariate tests using *t*-tests were carried out to examine the unadjusted association between measures of symptoms of common mental health disorders (i.e. anxiety, depression, and the overall score on the HSL), household characteristics, and the measure of child development. The measure of symptoms of common mental disorders was included in multivariate models along with socio-economic and sociodemographic variables. Estimated coefficients and their standard errors (SE) were used to test for associations between hypothesized predictors of child development while controlling for factors, such as SES and age and parental nutritional status. Five multivariate models were fitted to examine predictors of the sub-components and the overall scores on the developmental test. Negative binomial regression models were used because the outcomes were counts of 'successes' on the developmental tests. The criterion for statistical significance was set at 0.05 and *p*-values less than 0.1 were considered marginally significant.

Results

Complete data were available for 437 children and their parents. Information on the study area and the household characteristics of the study population are shown in Table I and reflect high levels of poverty and the rural nature of the study site (Table I). The overwhelming majority of the homes had earthen floors (98%), thatched roofs (79%), and mud walls (98%). Most respondents received their drinking water from unprotected wells or spring, with only 9% having direct access to piped water. Less than two-thirds of homes had access to private or public latrines and 40% were relying on open air 'facilities'. Household measures of SES were all highly correlated with one another suggesting that collectively they tapped the intended domain (all $p < 0.05$; results not shown). Households with low material goods, low livestock, and that ranked low on the SES ladder were all more likely to be food insecure (all $p < 0.05$).

The population showed evidence of nutritional stress. Nearly 43% of fathers and a 34% of mothers had a body mass index below 18.5. One in five children had an unsatisfactorily low

Table I. Characteristics of study households in the Gilgel Gibe Child Growth and Development Study ($n = 437$).

Household characteristics	%
House floor material	
Earthen	98%
Other	2%
House roof material	
Thatched	79%
Other	21%
Wall material	
Mud	98%
Other	2%
Source of drinking water	
Unprotected well or spring	54%
River	22%
Protected well or spring	16%
Piped	
Toilet facility	
Private/public toilet	59%
Open area	40%
Household well-being	
High material goods, % yes[1]	53.1%
High livestock holdings, % yes[2]	47.1%
Food secure, % yes	75.3%
High SES ladder, % yes[3]	56.8%

[1]Ownership of material goods above sample median.
[2]Livestock holdings above sample median.
[3]Response to SES ladder above sample median.

weight for age, 44% had an unsatisfactorily height for their age, 15% a low body mass index for their age, and 15% had an unsatisfactory weight for their height (i.e. wasted). These values are very close to national level estimates for this age group and rural areas in Ethiopia (Macro International 2006).

Scores derived from the HSCL indicated high symptoms of common mental disorders (Table II). The overall levels of symptoms (anxiety and depression symptoms combined) were slightly higher among women (1.71) than among men (1.65). Nearly half of women had high symptoms of anxiety (i.e. average score on HSCL items 1–10 greater than or equal to 1.75) above the cut-off (47%), which was significantly more than men (37%). Levels of high depressive symptoms (i.e. average score on HSCL items 11–25 greater than or equal to 1.75) were comparable among men (34%) and women (37%). Scores on the anxiety and depression sub-scales were highly correlated ($p < 0.0001$).

Children's scores on all development measures were associated (all pairwise comparisons, $p < 0.01$) and increased with age (Figure 1). Few variables other than age were associated with developmental scores in bivariate tests (Table III). Children in homes characterized by high material goods, high livestock holdings, and food security were statistically indistinguishable from children living in poorer households across the sub-scales and the total developmental score. High symptoms of anxiety, of depression, and overall paternal symptoms of mental disorders were not associated with overall developmental scores or any

Table II. Selected characteristics of study participants ($n = 437$).

	Mean	SD
Parental nutritional status		
Maternal low BMI (<18.5), %	34.0%	
Paternal low BMI (<18.5), %	43.0%	
Parental symptoms of common mental disorders		
Maternal symptoms of common mental disorders (min. 1.0, max. 3.6)	1.71	0.52
Maternal high symptoms of anxiety,[1] % yes	47.4%	
Maternal high symptoms of depression,[2] % yes	37.1%	
Paternal symptoms of common mental disorders (min. 1.0, max. 3.3)	1.65	0.51
Paternal high symptoms of anxiety,[1] % yes	37.1%	
Paternal high symptoms of depression,[2] % yes	33.9%	

[1]High symptoms of anxiety assessed as items 1–10 on the HSCL $\geq$ 1.75.
[2]High symptoms of depression assessed as items 11–25 on the HSCL $\geq$ 1.75.

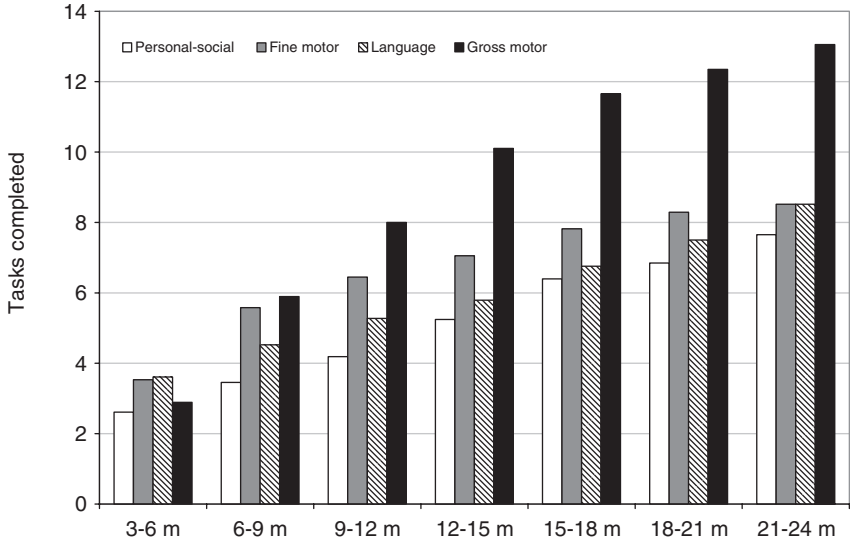

Figure 1. Children's developmental scores by age.

of the sub-scales, except that children with fathers with high symptoms of depression did score significantly lower on the personal–social scale ($p = 0.03$).

High symptoms of mental disorders among women, high anxiety and high symptoms of depression showed a greater number of significant associations with children's developmental outcomes. Using the overall measure of symptoms showed that maternal symptoms of mental disorders were negatively associated with their children's scores on personal–social ($p < 0.01$), fine motor ($p = 0.02$), gross motor ($p < 0.01$), and the overall developmental score ($p < 0.01$). These children also scored somewhat lower on the language scale ($p = 0.06$). Children with a mother with high symptoms of anxiety scored lower on the personal–social sub-scale ($p = 0.01$) but not the other sub-scales or the overall developmental score. Children with mothers with high symptoms of depression scored significantly lower on the personal–social ($p = 0.002$), fine motor ($p = 0.02$), and gross

Table III. Bivariate relationships between selected variables and the child development sub-scales and overall developmental score. Values are means and those in bold are statistically different at the 0.05 level ($n = 437$).

	Personal–social	Fine motor	Language	Gross motor	Developmental total
High SES ladder[1]	5.5	7.1	6.2	9.7	28.5
Low SES ladder	5.3	6.9	6.3	9.6	28.2
Low material goods[2]	5.4	7.0	6.2	9.5	28.2
High material goods	5.5	7.0	6.2	9.8	28.6
Food secure	5.4	7.0	6.2	9.7	28.3
Food insecure	5.5	7.2	6.3	9.7	28.7
Low livestock holdings[3]	5.5	7.0	6.3	9.7	28.5
High livestock holdings	5.3	7.1	6.0	9.7	28.2
Mother total HSCL ≥1.75, no[4]	**5.7**	**7.2**	6.4	**10.1**	**29.4**
Mother total HSCL ≥1.75, yes	**5.1**	**6.8**	6.0	**9.1**	**27.0**
Mother anxiety, no[5]	5.7	7.1	6.3	9.9	29.0
Mother anxiety, yes	5.2	6.9	6.1	9.5	27.7
Mother depression, no[6]	**5.7**	**7.2**	6.4	**10.1**	**29.3**
Mother depression, yes	**5.0**	**6.7**	6.0	**9.0**	**26.8**
Father total HSCL ≥1.75, no[4]	5.6	7.0	6.3	9.7	28.6
Father total HSCL ≥1.75, yes	5.2	7.1	6.1	9.7	28.1
Father anxiety, no[5]	5.6	7.0	6.3	9.7	28.5
Father anxiety, yes	5.3	7.1	6.1	9.7	28.1
Father depression, no[6]	**5.6**	7.0	6.3	9.7	28.6
Father depression, yes	**5.1**	7.0	6.1	9.7	28.0

[1]Response to SES ladder above or below sample median.
[2]Ownership of material goods above or below sample median.
[3]Livestock holdings above or below sample median.
[4]Anxiety and depression assessed as HSCL ≥ 1.75.
[5]Anxiety assessed as items 1–10 on the HSCL ≥ 1.75.
[6]Depression assessed as items 11–25 on the HSCL ≥ 1.75.

motor scales ($p = 0.008$). Consequently, children with mothers with high depression symptoms scored significantly lower on the overall developmental score ($p = 0.007$).

Negative binomial models were fitted to the data for each of the sub-scales and the overall developmental score (Table IV). For all sub-scales children's developmental scores increased with age, as expected, and the gains decreased at older ages as evidenced by the negative child age squared term; this was true for all scales except language. Stunted children scored lower on all sub-scales but this was significant only for the gross motor scale. Children living in households with above the median household goods, scored relatively better on the personal–social scale and the gross motor scale. Children from households with high livestock holdings actually scored lower on the gross motor scale and the language scale. Children living in food secure households scored lower on the personal–social sub-scale and the fine motor sub-scale. Children with relatively older fathers scored higher on the language scale. Symptoms of mental disorders among parents were also associated with children's developmental scores. Net of all other factors, children with fathers with greater symptoms of common mental disorders scored lower on the personal–social scale but not the other scales. Children with mothers who reported greater symptoms of mental disorders scored poorer on all sub-scales except language, although this was in the same direction.

The regression results for the total developmental scale (Table V), which likely provides a better picture of overall developmental performance, showed significant associations

Table IV. Multivariable regression models predicting children's development sub-scales ($n=437$).

	Personal–Social sub-scale			Gross motor scale			Fine motor scale			Language scale		
	B	SE	*p*	*B*	SE	*p*	*B*	SE	*p*	*B*	SE	*p*
Child factors												
Intercept	0.766	0.126	<0.01	0.685	0.125	<0.01	1.114	0.102	<0.01	1.088	0.115	<0.01
Child age, months	0.118	0.013	**<0.01**	0.189	0.013	**<0.01**	0.100	0.011	**<0.01**	0.059	0.013	**<0.01**
Child age × child age	−0.002	0.000	**<0.01**	−0.004	0.000	**<0.01**	−0.002	0.000	**<0.01**	−0.001	0.000	0.30
Gender, male	0.014	0.026	0.59	0.003	0.019	0.88	0.012	0.016	0.45	0.019	0.023	0.41
Stunted, yes	−0.004	0.028	0.90	−0.044	0.020	**0.02**	−0.034	0.018	0.06	−0.044	0.026	0.09
Parental factors												
Mother age, years	−0.006	0.003	0.08	−0.002	0.003	0.48	−0.003	0.002	0.18	−0.003	0.003	0.34
Father age, years	0.004	0.002	0.08	0.001	0.002	0.59	0.003	0.001	0.05	0.006	0.002	**<0.01**
Low BMI, mother	0.021	0.029	0.47	−0.019	0.021	0.37	0.037	0.018	**0.03**	−0.017	0.027	0.52
Low BMI, father	0.017	0.027	0.53	0.022	0.019	0.26	0.007	0.017	0.68	−0.008	0.019	0.67
Household factors												
High livestock	−0.038	0.027	0.17	−0.045	0.021	**0.03**	−0.013	0.017	0.44	−0.060	0.026	**0.02**
High material goods	0.063	0.027	**0.02**	0.055	0.020	**0.01**	0.007	0.018	0.71	0.041	0.024	0.09
High SES ladder	0.045	0.030	0.12	0.020	0.022	0.36	0.034	0.019	0.08	−0.023	0.019	0.23
Food secure	−0.075	0.031	**0.02**	−0.023	0.027	0.39	−0.061	0.021	**<0.01**	0.007	0.029	0.81
Symptoms of common mental disorders												
Father, total symptoms	−0.003	0.001	**0.02**	−0.001	0.001	0.48	0.001	0.001	0.76	−0.001	0.001	0.23
Mother, total symptoms	−0.005	0.002	**<0.01**	−0.003	0.001	**<0.01**	−0.002	**0.001**	**<0.01**	−0.002	0.001	0.15

Bold values

Table V. Multivariable regression model predicting children's overall development score ($n = 437$).

	Total scale score		
	B	SE	*p*
Child factors			
Intercept	2.229	0.083	**<0.01**
Child age, months	0.130	0.009	**<0.01**
Child age × child age	−0.003	0.000	**<0.01**
Gender, male	0.009	0.017	0.57
Stunted, yes	−0.035	0.017	**0.04**
Parental factors			
Mother age, years	−0.003	0.002	0.12
Father age, years	0.003	0.001	**<0.01**
Low BMI, mother	0.007	0.018	0.71
Low BMI, father	0.007	0.017	0.67
Household factors			
High livestock	−0.034	0.018	0.06
High material goods	0.039	0.017	**0.02**
High SES ladder	0.017	0.018	0.35
Food secure	−0.039	0.021	0.06
Symptoms of common mental disorders			
Father, total symptoms	−0.001	0.001	0.08
Mother, total symptoms	−0.003	0.001	**<0.01**

between developmental score and children's age, child stunting, household goods, and maternal symptoms of mental disorders. As per the sub-scales, older children passed more items although this effect appeared to diminish with age, as evidenced by the significant negative coefficient for the age squared term. Nutritionally stunted children scored poorer on the overall developmental score than children not stunted. High household material goods, an indicator of SES, was positively associate with children's developmental progress. Finally, high symptoms of mental disorders among mothers were negatively associated with children's developmental score. Women with greater symptoms had children who passed fewer developmental tasks, even after allowing for the influence of many other covariates. Subsequent analysis, which disaggregated the symptoms of mental disorders variable into high symptoms of anxiety and high symptoms of depression, showed that depression ($p < 0.01$) and not anxiety ($p = 0.51$) was responsible for the observed association between overall developmental score and maternal symptoms of common mental disorders (we note in the discussion that the depression effect must be viewed with caution).

Discussion

In a community-based study of a representative sample of children aged 3–24 months in a rural region of Ethiopia we found, as expected, that younger child age and stunting status were associated with the overall development progress of children in this study. Importantly, we also showed that even when taking nutritional stunting into account, children with mothers with higher symptoms of common mental disorders scored lower on all measures

of development except language, although even this was in the expected direction. Fathers' symptoms were generally not associated with children's overall development. These observations suggest that maternal mental health may be an important determinant of child development and subsequent health and fits both with local patterns of caretaking in the sense that women are the primary caregivers in the study region and with a model that links material deprivation and psychosocial stress to poor development through caregiver behavior.

The finding that maternal depression is linked with children's developmental outcomes is consistent with observational and experimental studies in developed countries that link poor outcomes among infants and young children with mothers who have depression or high symptoms of depression. Maternal mental health has been linked with preterm delivery (Sandman et al. 1997), behavioral problems, and growth outcomes. Several recent studies have identified links between maternal depression and low infant birth-weight in low-income, developing country settings. Patel and collaborators noted a consistent and robust relationship between maternal mental health (anxiety and depression) and birth outcomes in a cohort study of children born in Goa, India (Patel et al. 2004). Infants who were under the fifth percentile for weight at 5 months were 2.3 times more likely to have a depressed mother. Similar results were identified from a clinic-based study in Pakistan of infants 6–12 months of age; the odds of being malnourished were 7.4 times higher among children with depressed mothers. The authors of this study suggested reducing maternal anxiety and depression would result in a 30% reduction in the number of stunted children (Rahman et al. 2004). The results from the study presented here extend these findings by showing that even after controlling for the impact of nutritional stunting maternal depression remains a significant predictor of children's developmental outcomes among infants 3–24 months. Interestingly, maternal anxiety was not predictive of children's overall development score. A pilot study by Foss et al. (2004) compared outcomes among English and non-English speaking mothers (from Vietnam and the Democratic Republic of Congo) and their infants (0–25 months) using the Denver II and measures of anxiety and depression derived from the HSCL. Their results also showed that depression but not anxiety was associated with poorer outcomes on the Denver; our results are in agreement with theirs and others (Black et al. 2007) that place emphasis on depressive symptoms as central determinants of infant development.

Our results also showed that a measure of household SES was associated with children's developmental scores net of a host of other factors. Specifically, households that scored above the median on a measure of household goods had children that passed more tasks than children in households below the median. These children scored better on the overall, the personal–social and the gross motor scales; this is important because a majority of the tasks on the gross motor could be passed by observation only. On the other hand, food insecure households had children who performed better on the overall assessment suggesting that the link between socio-economic success and child develop is not a linear one. This finding is consistent with other studies showing mixed associations between development and measures of SES (Petterson and Albers 2001). A hypothesis that might account for these findings is that exposure to uncertain and unpredictable situations creates more challenging environments for children to which they must adapt. More rapid development may be one such indicator of adaptation to challenging environments. Indications from other field studies and human biological theory have also suggested that children's development will be tightly coordinated with ecological challenges and that children will modulate investment in growth and development in response to needs (Bateson et al. 1990; Chisholm 1999).

Our work was not designed to fully elucidate the pathways through which maternal symptoms of mental disorders are associated with developmental outcomes among children 3–24 months. Evidence from developed countries abounds to suggest that depressed mothers interact with their children in qualitatively different ways and that these are generally sub-optimal in the sense that are not responsive to children's developmental progression (McLearn et al. 2006). And, while we found little evidence that high symptoms of anxiety were associated with developmental scores among this sample, two issues suggest it would be unwise to conclude that anxiety is not an important determinant of children's wellbeing. First, there is some difficulty in disentangling high symptoms of anxiety and depression. In the present study, high symptoms in each category were highly related, which is consistent with a large body of literature on comorbidity. In the recent WHO multi-country survey, a majority of respondents who presented with symptoms of depression also presented with symptoms of anxiety (Goldberg and Lecrubier 1995). Small-area studies in developing countries have also found strikingly high rates of comorbidity. The overlap was so great that Patel, a leading cultural psychiatrist, has argued that anxiety and depression are not conceptually distinct illnesses and that the dichotomous categorization of depression and anxiety disorders is an outgrowth of the Western biomedical model (Patel 2001). Second, there is emerging evidence that prenatal maternal anxiety impacts on children's mood later in life (Talge et al. 2007). For instance, Van den Bergh et al. (2008) show that maternal anxiety at 12–22 weeks of pregnancy predicted girls' mood disorders when they reached 15 years of age. Identifying these latter effects will require prospective studies but suggest that to the extent that mothers occupy stressful environments in both the pre- and postnatal periods, we may wrongly attribute causal pathways or determinants. Finally, there appears to be little evidence on how children's motor, language, and personal social skills react to living in stressful environs. It is likely that survey data will not be useful in examining the extent to which caretaking practices vary by maternal mental health status; future research should include observational data on caretaker–child interactions.

The finding that nutritional stunting was associated with poorer developmental scores is consistent with a broader literature on the impact of nutritional status on children's growth and development. Poor nutritional status is associated with children who are more apathetic, have less positive affect and less secure attachment (Gardner et al. 1999; Graves 1978). Nutritional stunting and relative weight are also associated with a range of developmental outcomes and this is observed across diverse settings and in cross-sectional and longitudinal studies. Longitudinal studies have shown clearly that stunting by age 2 or 3 years is associated with a range of outcomes reflecting literacy, schooling success, and cognition. For example, in Guatemala, achieved height at 3 years predicted cognition, literacy, and numeracy during adolescence (Martorell and Ramakrishnan 1995). Another study that was carried out near the current study area found that children's weight for age was negatively associated with scores on the Bayley examine (Drewett et al. 2001). Our results, like many others studies, suggest that reduction in stunting by improving access to high quality complementary foods, promoting exclusive breastfeeding to age six, and improvements in hygiene might likely have an effect on human performance above and beyond reductions in childhood mortality and morbidity. It is possible too that parental symptoms of common mental disorders are associated with stunting. We did not explore this because of the possibility of reverse causality – stunted children may causes stress rather than be the outcome of it. The recall period of our anxiety and depression scales were insufficient to establish a temporal ordering.

Although many of the measures of household SES were not associated with the measures of child development, we think it would be incorrect to suggest that these phenomena do not

negatively impact on children's developmental progress. Elsewhere we have shown that these same measures of poverty and stressful life events strongly predict maternal and paternal anxiety and depression, and this was particularly true for high exposure to stressful life events and food insecurity (Hadley et al.). These findings are consistent with other work linking poverty and mental health outcomes (Wolf et al. 2002; Patel and Kleinman 2003; Hadley and Patil 2006; Patel et al. 2006). Thus, although food insecurity and the measures of SES had mixed associations with development outcomes, development was associated with maternal symptoms of mental disorders. We therefore suggest that poverty and food insecurity influence maternal anxiety and depression, and that these factors can be thought of as indirect contributors to children's development, with their effect mediated by maternal mental health status. The fact that we did not identify direct associations between the multiple measures of household SES and children's development suggests the potential that mothers, as primary caretakers, may absorb the negative ecological impacts that are facing children but that this may not be entirely successful. In support of this model, a number of studies have argued that mothers actively attempt to buffer their children from the ill effects of poverty, deprivation, and food insecurity (McIntyre et al. 2003; Hurtado et al. 2006). This may in turn result in unintended negative consequences for health and wellbeing and may account for the general finding that women report higher levels of depression.

There are a suite of limitations that should be considered when evaluating this work. First, there are no established norms for the HSCL or the Denver II in Ethiopia. Nevertheless, the measures are internally consistent; when judged against a set of norms that match universal human developmental patterns, children with depressed mothers scored lower. It is not yet clear what developmental patterns are normal for this population. Different socioecologies likely favor different developmental trajectories. Second, we show here results from a cross-sectional analysis, hence limiting inference about trajectory of child development. This may be particularly problematic if mothers become depressed because their children show signs of poor developmental progress; similar reverse causality has been shown for infant and child-feeding practices (Marquis et al. 1997). Third, we lack observations on caretaker behavior, which makes it difficult to understand the pathways through which maternal depression may influence outcomes. On the other hand, confidence is gained in the results by examining the developmental trends across children's ages, which are exactly what we would expect to see. This is especially true with language, which is the only sub-scale that does not show signs of decreasing attainment. Similarly, that stunted children also showed evidence of relatively poor development is consistent with a massive body of literature (Grantham-McGregor et al. 2007). The household measures of poverty are all highly associated and were consistent across mother–father pairs. A final limitation owes to the homogeneity in the measures of SES. We had hoped to include more items in our measures of SES but found very little variation across households. This limited our ability to make fine-grained assessments of the impact of SES on children's developmental outcomes. For this reason we elected to dichotomize many of our variables.

The prevalence of common mental health disorders is high in developing country settings (WHO 2001). The evidence shown here that maternal depression is associated with child development may have implications for our understanding of variation in children's developmental and for our approach to interventions that aim to improve child development. For human biologists, our results suggest that mental health, a rarely measured phenotypic characteristic and one that may lie on the pathway between SES and health outcomes, potentially has large impacts on several domains of children development. As such, cross-cultural variation in mental health and within-group variation in mental health may account for a substantial proportion of the observed variation in many outcomes

of interest to human biologists. From a population health perspective, our results have several implications. First, they suggest that non-nutritive intervention approaches may be beneficial, as has been indicated in several studies (reviewed in Engle et al. 2007, see also Walker et al. 2005). Second, these observations suggest that the burden of common mental disorders in developing world may include intergenerational consequences that would be astoundingly large. Because the determinants of mental health are simultaneously individual and macrosocial, they may not be directly amenable to intervention at the individual level alone. Interventions that target upstream processes that influence maternal mental health then are sorely needed. Still, appropriate individual and group interventions exist (Bolton et al. 2003) and a promising research avenue would be to examine the impact of such interventions on children's developmental outcomes. This approach proved promising in the STAR*D trial (Weissman et al. 2006) and provided strong evidence of not only the intergenerational link between depression and children's psychopathology, but also how that link can be weakened, if not broken. It remains to be seen whether interventions carried out at higher levels, such as entrenching the right to food into national constitutions (McClain-Nhlapo 2004), will have positive 'downstream' effects on child developmental outcomes. Further work exploring the pathways linking parental mental health status and development among infants and young children may offer insight into intervention strategies that ultimately result in better schooling outcomes and greater income generation among adults in developing countries.

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