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Early malnutrition predicts parent reports of externalizing behaviors at ages 9–17

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Abstract

Objective—To determine whether externalizing behaviors are more prevalent in youth who have experienced an episode of malnutrition in the first year of life than in healthy comparison youth.

Method—Parents of previously malnourished youth and a matched healthy comparison group completed a behavior rating scale when the youth were 9–15 years of age and again, 2 years later, when they were 11–17 years of age. Longitudinal multiple regression analysis was applied to evaluate group differences adjusted for baseline age, sex, household standard of living, and maternal depressive symptoms.

Results—Early childhood malnutrition was associated with problems in executive functioning at both occasions. Malnutrition also predicted discernibly higher parent-reported levels of aggression toward peers at 9–15 years than at 11–17 years. These findings were independent of baseline age, sex, household standard of living, and maternal depressive symptoms. Problem behaviors in general decreased during follow-up.

Conclusion—Parents report persisting problems with executive functioning through adolescence in youth who suffered an episode of moderate-to-severe protein-energy malnutrition in the first year of life, while reports of aggression, although more common when this cohort were younger, did not persist at follow-up.

Keywords

Executive function; Aggression; Malnutrition; Youth; Cross-cultural; Longitudinal study

Introduction

Early childhood malnutrition has been implicated in subsequent cognitive and behavioral impairments in childhood and adolescence, included decreased attention, conduct problems, and lowered IQ.^{1–4} Most published studies, however, have been unable to distinguish among the effects of low birth weight, chronic malnutrition, and an acute episode of under-nutrition during critical periods of brain and behavioral development, as well as the complicating effects of the social milieu within which malnutrition occurs.

This report is one of a series^{5–10} describing long-term behavioral consequences in a cohort of Barbadian children with normal birth weights who experienced an episode of protein-energy malnutrition (marasmus) limited to the first year of life. Because index children were identified at the time of hospital admission and subsequently enrolled in the Barbados Nutrition Centre intervention program until 12 years of age, the early malnutrition episode and their later growth and development of the children were documented in detail. These children were compared to healthy children from the same classrooms and neighborhoods matched for age and sex. Both groups were followed longitudinally into adolescence and are currently being evaluated as adults. The previously mal-nourished youth demonstrated no evidence of continuing malnutrition after the infant episode, with complete catch-up in physical growth by the end of puberty.⁵ These same children, however, displayed continuing cognitive deficits, including lower IQ⁶ and impaired fine motor skills.⁷

Importantly, these previously malnourished children also displayed behavioral sequelae when they reached school age. For example, teachers reported a four-fold increase in attention problems in the index children relative to controls.¹¹ These teacher reported attention symptoms, moreover, mediated the association between malnutrition history and poor performance on a high school entrance examination at 11 years of age.⁸ Teachers and parents also reported that these children had continuing attention problems when they were 9–15 years of age, an effect that persisted even after adjusting for ecological and socioeconomic factors in the home environment.¹² Aggressive behaviors were also more common among the index children at 5–11 years of age (T1), based on teacher and parent reports.^{11,13} However, at ages 9–15, aggressive behaviors reported by teachers and parents were no longer present after correcting for differences in the home environments of the malnourished and comparison children.¹² Persistence during childhood and adolescence could herald more significant problems as these adolescents transition to adulthood, indicating that the impact may be life long. Thus, the current report addresses parental ratings of these behaviors at ages 9–15 years and again at 11–17 years in order to examine any change over time.

Finally, mothers of the previously malnourished children reported increased depressive symptoms at all time periods.⁹ These symptoms may have been present from infancy and indeed have contributed to the malnutrition episode¹⁴ and the manifestation of behavioral problems in the index group. It is also possible that aberrant behaviors among the index children may have contributed to impaired maternal mood. Thus, consideration of the potential contribution of maternal depressive symptoms is necessary to establish independent effects of childhood malnutrition on behavioral outcomes.

The current study addressed three questions: (1) Do parents report a higher prevalence of externalizing behaviors in youth who were malnourished as infants? (2) Are externalizing behaviors in this cohort affected by socioeconomic disadvantage or the presence of maternal depressive symptoms? (3) Do these behaviors increase or decrease during childhood and adolescence?

Methods

Site

The study was conducted in Barbados, a Caribbean country whose current population is approximately 260 000 inhabitants. The ethnic composition of the population is 92% Negro (the preferred term in use in Barbados), and the remainder being Caucasian (4%), or of Asian, Lebanese, and Syrian origin. Barbados is currently ranked at 42 on the Human Development Index.¹⁵ In 1970, the infant mortality rate was 46 per 1000 live births, but at the present time, that rate is 7.8 per 1000 live births. Although moderate–severe cases of infant malnutrition were of significant concern when this study was undertaken in the 1970s, infant malnutrition is now virtually eliminated from the island due to its improved economy and the impact of island-wide nutrition education.^{16,17}

Design and sampling

Data were collected as part of a now 40-year longitudinal study of the long-term effects of early malnutrition on behavior and development conducted at the National Nutrition Centre, Bridgetown, Barbados, in cooperation with the local Ministries of Health and Education. The National Nutrition Centre enrolled all children on the island with documented malnutrition or at risk for malnutrition and followed them to 12 years of age. From the time of admission to the Centre, the children were seen every 6 weeks and their growth, health, and development were routinely documented. Referral to the Centre was obligatory as part of a national campaign to address malnutrition on the island and therefore free of any selection biases arising from self-referrals.

Fig. 1 shows the study design, including the composition of the groups across time. All previously mal-nourished children were examined at baseline in the first year of life (1967–1972) and later followed up at T1 (ages 5–11), T2 (ages 9–15), and T3 (ages 11–17). The children were selected as follows: In 1977 (T1), all school-aged children enrolled in the National Nutrition Centre who had been hospitalized in their first year of life with a diagnosis of Grade II or III¹⁸ marasmus between 1967 and 1972 were invited to participate. The marasmus group ($n = 129$) thus included nearly all children on the island who had experienced one episode of this type of malnutrition. Three healthy comparison children were identified from the same neighborhoods and classrooms as the children with marasmus and were matched by sex, age (within 3 months), and handedness; one of the three candidates ($n = 129$) was ultimately selected, based on availability of birth data, pre-school heights and weights, and immunization data. Both groups were again examined at T2 and at T3. Other inclusion criteria for all groups were normal birth weight, absence of pre- or post-natal complication, and no known neurological deficits. None of the children experienced further malnutrition after the first year of life.

At T3, 54 children who were hospitalized in the first year of life (between 1967 and 1972) with kwashiorkor were recruited into the study in order to determine whether outcomes differed. These children were matched for age, sex, and handedness with 62 children who had marasmus and 61 comparison children from the longitudinal sample to achieve the best matches across all three groups. As a result, the size of the marasmus and control groups at T3 was reduced; longitudinal analyses, reported later, are based on all of the available data at T2 and T3 for the marasmus and control groups. Comparison of the marasmus and healthy comparison children at T3 with children from those groups who participated at T1 or T2 only revealed no differences in age, sex, maternal depressive symptoms, or standard of living.

Informed consent was provided by all participating families under Protocol E1962, which was approved by the Boston University Medical Center Institutional Review Board and by the Ethics Committee of the Ministry of Health, Barbados. Current oversight is provided by the Judge Baker Children's Center Human Research Review Committee (Assurance No. FWA 00001811).

Measures

Barbados Child Behavior Scale (BCBS) – parent version—We assessed behavioral functioning using a 76-item questionnaire that was administered to parents at T2 and at T3 by a Barbadian child psychologist who was blind to the child's nutritional history. The purpose of the questionnaire, developed for use in Barbados, was to describe behavioral dimensions and not to diagnose specific psychiatric disorders. There were no available standardized instruments appropriate to Barbados were available in the early 1970s when this study was instituted. Because attention problems were so prevalent in the index children,^{8,11} 19 questions derived from the Connors Rating Scale¹⁹ were also included. Most of the items were rated on a four-point scale ranging from never to always.

Correlations among individual items were analyzed by principal components factor extractions²⁰ based on data combined across T2 and T3 to allow for valid comparisons across time points. Items for which 90% or more of responses were the same were eliminated (10 of 76 items). Factor scores were standardized to have zero mean and unit variance and reliabilities of these factors were estimated by Armor thetas that measure internal consistency.²¹ Six rotated factors accounting for 32% of the total variance emerged. Table 1 lists items that contributed most strongly (factor loading ≥ 0.45) to each factor. All items were used to calculate factor scores, however.

Canonical correlations among the six parent report factors at T2 and T3 ($R_c = 0.69$; $P < 0.0001$) confirmed the reliability of the observations over time. Bivariate correlations for individual factors at T2 and T3 were significant ($P < 0.001$) for five of the six factors: $R = 0.54$ (activity), 0.50 (executive function), 0.44 (aggression), 0.42 (cooperation), and 0.34 (sleep problems). Factor 6 was not reliable over time and was dropped from subsequent analyses.

Maternal depressive symptoms—Depressive symptoms were measured using the Minnesota General Adjustment and Morale Scale.²² Factor analysis of the items identified a

first unrotated principal component (Armor theta = 0.72), accounting for 16% of the total variance, that appeared to reflect depressive symptoms, especially hopelessness.⁹ It also showed high concurrent validity with the Zung Depression and Anxiety Scales in an independent sample of healthy Barbadian women.^{14,23} Factor scores were used in the analyses.

Household standard of living—Household standard of living was assessed by the Barbados Ecology Questionnaire (BEQ), which was based on a scale used in Jamaica by Richardson *et al.*²⁴ and modified for use in Barbados.^{25,26} The questionnaire was administered to mothers and primary caretakers and validated by home visits at each test period. It contains 50 items assessing demographic variables that were most relevant to the social context at the time. Factor analysis, based on data combined across T1–T3, identified a first principal component (Armor theta = 0.86) that appeared to represent the household standard of living.⁹

Data analysis

For each questionnaire, less than 1% of responses to individual items were missing. Missing values were replaced by mean substitution. The role of infantile malnutrition in predicting parent-reported youth behaviors was evaluated by a series of longitudinal multiple regression analyses (MRA) (described below) that evaluated the effect of malnutrition on youth behaviors, adjusting for age and sex of the adolescent and maternal depressive symptoms and household standard of living over time (T2 and T3). These analyses, evaluated the independent (unique) effects of each predictor after correcting for the effects of the other predictors. Two sets of longitudinal MRAs²⁰ were applied. The first set regressed the outcomes on history of childhood malnutrition, time, and their interaction, adjusting for age and sex. The second set included maternal depressive symptoms and household standard of living as well to test for mediation. The longitudinal MRAs accounted for the correlation between T2 and T3 measures of youth behaviors and also allowed for heterogeneous variances across the two occasions (i.e., an unstructured covariance).

At T3, the parents of two subjects did not complete the BCBS-parent reports, and these cases were not included in any analyses.

Results

Table 2 shows means and standard deviations (unadjusted) for the five factors at each time point. In addition, preliminary analysis indicated that household standard of living was higher for the healthy comparison group ($F(1,211) = 17.66$; $P < 0.0001$). More detailed description of specific demographic characteristics is reported elsewhere.¹⁰

The primary question was whether parents would report elevated levels of behavior problems for the previously malnourished youths. Table 3 summarizes results for the models adjusting for sex, age, household standard of living, and maternal depressive symptoms. Unique effects ($P < 0.01$) of malnutrition were present only for Factor 4 (executive function). Children with histories of malnutrition had an increased prevalence of executive function deficits as compared with healthy comparisons. For this factor, the estimated effect

of malnutrition history (0.37) was identical before and after (0.37) correcting for maternal depressive symptoms and standard of living. In the case of Factor 1 (peer aggression), there was a significant nutrition $\times$ time interaction ($P < 0.05$); parents reported more problems with peer aggression in the previously malnourished group at T2 than at T3. That is, malnutrition predicted significantly higher reported levels of aggression toward peers at 9–15 years than at 11–17 years. This interaction effect was basically identical (0.38) before and after correcting for household standard of living and maternal depression.

For Factor 2 (cooperative with adults), in contrast, the estimated effect of malnutrition was 0.30 before and 0.18 after correction for maternal depressive symptoms and standard of living. There were no significant main effects of malnutrition (nor interactions) for Factor 3 (Activity) or Factor 5 (sleep problems).

In addition to the findings reported in Table 3, there were significant age effects for Factors 1 (peer aggression), 3 (activity levels), and 4 (executive function); problem behaviors declined with age for all three. Factors 3 (activity) was higher for boys and Factor 5 (sleep problems) was higher for girls. A significant unique effect of household standard of living was present for Factor 2 (cooperative with adults), with youth from homes with lower standard of living showing less cooperation with adults. Unique effects of maternal depressive symptoms were present for Factors 1 (peer aggression), 4 (executive functions), and 5 (sleep problems) with increased parent reports of behavioral problems among offspring of mothers reporting increased depressive symptoms.

Discussion

This study establishes the independent and long-term effects of early childhood malnutrition on executive function, persisting through childhood and adolescence (through 17 years of age), and the increased prevalence of aggressive behaviors at least through 9–15 years. Neither of these effects was attenuated by adjusting for maternal depressive symptoms and household standard of living. A lower household standard of living was, however, associated with parental reports of reduced cooperative behavior in these youth, whereas maternal depressive symptoms were independently associated with increased parent-reported aggressive behaviors, executive function deficits, and sleep problems.

The findings of elevated problems in executive functioning are consistent with our earlier reports of increased attention deficits in the previously malnourished children at 5–11 years. At that time (T1), teachers identified 60% of previously malnourished children with high levels of attention problems compared with only 15% of healthy comparison children.²⁷ In a subsequent study of these same children at 9–15 years of age (T2), parent and teacher reports each endorsed increased distractibility among previously malnourished children, and parent and teacher reports were highly correlated.¹² Although the level of such problems declined during the follow-up period, the significant effects of the malnutrition history persisted at 11–17 years of age. This finding is also consistent with an early study by Richardson *et al.*,²⁸ who followed 5–10-year-old Jamaican schoolboys malnourished in the first 2 years of life. We have recently identified a higher prevalence of attention deficits in the previously malnourished cohort at 37–43 years relative to controls.²⁹ Attention and

executive function deficits thus appear to represent persisting and permanent long-term outcomes of infant malnutrition.

In contrast, elevated aggressive behaviors in the index group were reported by parents and teachers at T1 and T2,¹² but the magnitude of these differences was no longer maintained in the current parent reports at T3. Self-reports by these same youth, however, did document an elevated prevalence of aggressive behaviors in the index group at the third time point.³⁰ Thus, parent and youth perceptions regarding aggressive behaviors appears to diverge at ages 11–17 years. Different perceptions by parents and adolescents have generally been recognized.^{31–33} In particular, as adolescents become more socially independent, especially vis-à-vis peers, parents may no longer be in a position to observe their children's aggressive behavior.

The elevated levels of aggression in youth with histories of early malnutrition also support findings from two other studies. Children from Mauritius who were malnourished at 3 years of age exhibited increased externalizing behaviors at ages 8, 11, and 17.³⁴ These behaviors were mediated by IQ at ages 8 and 11 but not by social adversity. In a second series of studies in Jamaica, Walker *et al.*^{3,4} reported increased conduct disorder in 11-year-old children whose growth had been stunted in the first few years of life.³⁵ These children also displayed increased hyperactivity and a tendency to more oppositional behaviors at 17 years of age.^{3,4} Psychosocial stimulation in early childhood reduced the prevalence of attention problems, but not oppositional or antisocial behaviors. In contrast to the present study, however, the effects of early childhood malnutrition could not be separated from prenatal or more chronic malnutrition and associated health problems in these studies.

Several possible limitations are noted. First, because of the study design, fewer children were tested at T3, as compared with T1 and T2, raising concern of potential selection bias. The T3 children, however, did not differ demographically from those included at the earlier time points. Second, these data were collected 25–30 years ago, and the instruments used were therefore somewhat idiosyncratic to this study. The consistency with other reports, however, suggests that these findings are valid. We are currently evaluating this sample into middle life, including detailed evaluation of their psychiatric status and adaptation to the demands of adulthood (e.g., employment, marital status). Data collected when these individuals were children and adolescents will provide an essential platform for understanding the lifelong consequences of early malnutrition.

Finally, it is well known that maternal depression can impact parental reports of child behavior.³⁶ In fact, mothers of children in the previously malnourished group in our study reported more symptoms of depression at all time points from when their children were 5–17 years of age.⁹ Maternal depressive symptoms were significantly and independently associated with parent reports of externalizing behaviors. However, as noted in Table 3, even when the analyses adjusted for maternal depressive symptoms, executive function problems, and aggressive behaviors were significantly elevated in the previously malnourished youth, thus confirming that the behavioral problems in the index group were independent of maternal depressive symptoms.

In sum, our data indicate that an episode of moderate-to-severe malnutrition confined to the first year of life is associated with later elevations in problems with self-regulation, manifested in executive functioning, and aggression toward peers and persisting through adolescence. These problem behaviors may well have implications for the longer-term adjustment of individuals with such histories. Given the continuing risk for infant malnutrition, these findings have significant public health implications for the mental health of children worldwide.

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References

1. Galler, JR. Behavioral consequences of malnutrition in early life.. In: Galler, JR., editor. Nutrition and behavior. Plenum Press; New York, NY: 1984. p. 63-117.
2. Galler JR, Barrett LR. Children and famine: long-term effects on behavioral development. *Ambul Child Health*. 2001; 7(2):85–95.
3. Walker SP, Chang SM, Powell CA, Simonoff E, Grantham-McGregor SM. Effects of psychosocial stimulation and dietary supplementation in early childhood on psychosocial functioning in late adolescence: follow-up of randomised controlled trial. *British Medical Journal*. 2006; 333(7566): 472. [PubMed: 16877454]
4. Walker SP, Chang SM, Powell CA, Simonoff E, Grantham-McGregor SM. Early childhood stunting is associated with poor psychological functioning in late adolescence and effects are reduced by psychosocial stimulation. *J Nutr*. 2007; 137(11):2464–9. [PubMed: 17951486]
5. Galler JR, Ramsey FC, Salt P, Archer E. Long-term effects of early kwashiorkor compared with marasmus. I. Physical growth and sexual maturation. *Journal of Pediatric Gastroenterology and Nutrition*. 1987; 6(6):841–6. [PubMed: 3119811]
6. Galler JR, Ramsey FC, Forde V, Salt P, Archer E. Long-term effects of early kwashiorkor compared with marasmus. II. Intellectual performance. *Journal of Pediatric Gastroenterology and Nutrition*. 1987; 6(6):847–54. [PubMed: 3119812]
7. Galler JR, Ramsey FC, Salt P, Archer E. Long-term effects of early kwashiorkor compared with marasmus. III. Fine motor skills. *Journal of Pediatric Gastroenterology and Nutrition*. 1987; 6(6): 855–9. [PubMed: 3119813]
8. Galler JR, Ramsey FC, Morley DS, Archer E, Salt P. The long-term effects of early kwashiorkor compared with marasmus. IV. Performance on the national high school entrance examination. *Pediatric Research*. 1990; 28(3):235–9. [PubMed: 2122403]
9. Galler JR, Bryce CP, Waber D, Hock RS, Exner N, Eaglesfield D, et al. Early childhood malnutrition predicts depressive symptoms at ages 11–17. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*. 2010; 51(7):789–98.
10. Galler JR, Bryce CP, Waber DP, Zichlin ML, Fitzmaurice GM, Eaglesfield GD. Socioeconomic Outcomes in Adults Malnourished in the First Year of Life: A 40-Year Study. *Pediatr*. 2012; 130(1):e1–7. PMID: PMC3382923.
11. Galler JR, Ramsey F, Solimano G, Lowell WE. The influence of early malnutrition on subsequent behavioral development. II. Classroom behavior. *Journal of the American Academy of Child Psychiatry*. 1983; 22(1):16–22. [PubMed: 6402541]

12. Galler JR, Ramsey F. A follow-up study of the influence of early malnutrition on development: behavior at home and at school. *J Am Acad Child Psychiatry*. 1989; 28:254–61.
13. Galler JR, Ramsey F, Solimano G. A follow-up study of the effects of early malnutrition on subsequent development. II Fine motor skills in adolescence. *Pediatr Res*. 1985; 19:524–7. [PubMed: 3925427]
14. Galler JR, Harrison RH, Biggs MA, Ramsey F, Forde V. Maternal moods predict breastfeeding in Barbados. *Journal of Developmental and Behavioral Pediatrics*. 1999; 20(2):80–7. [PubMed: 10219685]
15. UNDP. Human Development Report. Barbados: 2010.
16. Ramsey, F.; Demas, N.; Trotter, P. National health and nutrition survey of Barbados. Pan American Health Organization; Washington, DC: 1984.
17. Ramsey, FC., Dr.; Ramsey, Frank. an autobiography. Dynamic Colour Inc.; Barbados, West Indies: 2006.
18. Gomez F, Ramos Galvan R, Frenk S, Cravioto Munoz J, Chavez R, Vazquez J. Mortality in second and third degree malnutrition. 1956. *Bulletin of the World Health Organization*. 2000; 78(10): 1275–80. [PubMed: 11100622]
19. Conners CK. A Teacher rating scale for use in drug studies with children. *Am J Psychiatry*. 1969; 126:884–8. [PubMed: 4900822]
20. SAS Institute Inc. SAS/STAT 9.2 user's guide. SAS Institute Inc.; Cary, NC: 2008.
21. Armor, D. Theta reliability and factor scaling.. In: Costner, HL., editor. *Sociological methodology*. Jossey-Bass; San Francisco: 1974. p. 17-50.
22. Rundquist, EA.; Sletto, RF. Personality in the depression – a study in the measurement of attitudes. University of Minnesota Press; Minneapolis: 1936.
23. Galler JR, Harrison RH, Ramsey F, Forde V, Butler SC. Maternal depressive symptoms affect infant cognitive development in Barbados. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*. 2000; 41(6):747–57.
24. Richardson SA. The background histories of schoolchildren severely malnourished in infancy. *Adv Pediatr*. 1974; 21:167–95. [PubMed: 4217092]
25. Galler JR, Ramsey F. The influence of early malnutrition on subsequent development. VI The role of the microenvironment of the household. *Nutr Behav*. 1985; 2:161–73.
26. Galler, JR. The interaction of nutrition and environment in behavioral development.. In: Dobbing, J., editor. *Early nutrition and later achievement*. Academic Press; New York: 1987. p. 175-207.
27. Galler JR, Ramsey F, Solimano G, Lowell WE, Mason E. The influence of early malnutrition on subsequent behavioral development. I. Degree of impairment in intellectual performance. *Journal of the American Academy of Child Psychiatry*. 1983; 22(1):8–15. [PubMed: 6402542]
28. Richardson SA, Birch HG, Grabie E, Yoder K. The behavior of children in school who were severely malnourished in the first two years of life. *J Health Soc Behav*. 1972; 13(3):276–84. [PubMed: 4561049]
29. Galler JR, Bryce CP, Zichlin ML, Fitzmaurice G, Eaglesfield GD, Waber DP. Infant Malnutrition is associated with persisting attention deficits in middle adulthood. *J. Nutr*. 2012; 142(4):788–94. [PubMed: 22378333]
30. Galler JR, Bryce CP, Waber DP, Hock RS, Harrison R, Eaglesfield GD, Fitzmaurice G. Infant malnutrition predicts conduct problems in adolescents. *Nutr Neurosci*. 2012; 15(4):186–92. [PubMed: 22584048]
31. Achenbach TM, Verhulst FC, Baron GD, Akkerhuis GW. Epidemiological comparisons of American and Dutch children: I. Behavioral/emotional problems and competencies reported by parents for ages 4 to 16. *J Am Acad Child Adolesc Psychiatry*. 1987; 26(3):317–25. [PubMed: 3496325]
32. Achenbach TM, Verhulst FC, Edelbrock C, Baron GD, Akkerhuis GW. Epidemiological comparisons of American and Dutch children: II. Behavioral/emotional problems reported by teachers for ages 6 to 11. *J Am Acad Child Adolesc Psychiatry*. 1987; 26(3):326–32. [PubMed: 3496326]
33. Rutter, M.; Tizard, J.; Whitmore, K., editors. *Education, health and behavior*. Longman and green; London: 1970.

34. Liu J, Raine A, Venables PH, Mednick SA. Malnutrition at age 3 years and externalizing behavior problems at ages 8, 11, and 17 years. *Am J Psychiatry*. 2004; 161(11):2005–13. [PubMed: 15514400]
35. Chang SM, Walker SP, Grantham-McGregor S, Powell CA. Early childhood stunting and later behaviour and school achievement. *J Child Psychol Psychiatry*. 2002; 43(6):775–83. [PubMed: 12236612]
36. Gartstein MA, Bridgett DJ, Dishion TJ, Kaufman NK. Depressed Mood and Maternal Report of Child Behavior Problems: Another Look at the Depression-Distortion Hypothesis. *J Appl Dev Psychol*. 2009; 30(2):149–60. [PubMed: 20161323]

Figure 1.
Research design: Barbados nutrition study.

Table 1

Factor structure of the BCBS parent interviews measured at T2 and T3

Items	Factor loadings*
<i>Factor 1 (peer aggression) ($\Theta = 0.81$)</i>	
Is child bossy with other children?	0.75
Does the child bully other children?	0.67
Does child get into fights with other children?	0.61
Does child dominate other children?	0.59
Does child have temper outbursts?	0.57
Does child have quarrels with other children?	0.55
Does child talk back?	0.52
Is child mean or cruel to other children?	0.48
<i>Factor 2 (cooperative with adults) ($\Theta = 0.76$)</i>	
How cooperative is child with parents?	0.60
Is child affectionate with you?	0.58
Has child been well behaved since early childhood?	0.57
Does child speak with you about him/herself?	0.50
Does child like school?	0.47
Does the child get along with adults?	0.47
Is child liked by teachers?	0.45
<i>Factor 3 (activity level) ($\Theta = 0.67$)</i>	
Does child like to go places outside home?	0.52
How active is child?	0.49
Is child accident-prone?	0.47
Is child quiet in one place for long periods of time?	-0.45
<i>Factor 4 (executive function deficits) ($\Theta = 0.66$)</i>	
Distractibility	0.57
How are child's schoolwork habits?	-0.53
How good is child's memory?	-0.50
Is your child childish?	0.47
Is child easily frustrated with schoolwork?	0.47
<i>Factor 5 (sleep problems) ($\Theta = 0.59$)</i>	
Does child fall asleep easily at bedtime?	0.62
Does child sleep peacefully through the night?	0.50

* Only items with factor loadings >0.45 are listed. However, all items in the questionnaire were used to calculate factor scores.

Table 2

Mean scores ($\pm$ SD) at two ages for previously malnourished and comparison youth on the BCBS-parent report unadjusted for covariates

	Marasmus	Comparison
<i>Factor 1: peer aggression</i>		
T2	0.39 $\pm$ 1.16	-0.05 $\pm$ 0.96
T3	-0.34 $\pm$ 0.80	-0.34 $\pm$ 0.79
<i>Factor 2: cooperative with adults</i>		
T2	-0.01 $\pm$ 1.15	0.19 $\pm$ 1.11
T3	-0.28 $\pm$ 1.00	0.15 $\pm$ 0.73
<i>Factor 3: activity level</i>		
T2	0.18 $\pm$ 1.03	0.32 $\pm$ 1.09
T3	-0.29 $\pm$ 0.78	-0.35 $\pm$ 0.72
<i>Factor 4: executive function deficits</i>		
T2	0.24 $\pm$ 1.00	0.0 $\pm$ 0.94
T3	-0.09 $\pm$ 0.94	-0.38 $\pm$ 0.82
<i>Factor 5: sleep problems</i>		
T2	-0.24 $\pm$ 1.08	-0.45 $\pm$ 1.17
T3	0.43 $\pm$ 0.68	0.21 $\pm$ 0.61

Table 3

Longitudinal MRAs of BCBS parent reports at T2 and T3, correcting for sex, age, maternal depressive symptoms, and household standard of living

Predictors	Nutrition			Time			Nutrition × time		
	Estimate	SE	F	Estimate	SE	F	Estimate	SE	F
Factor 1: peer aggression	−0.25	0.15	2.82	−0.74	0.11	43.46***	0.38	0.16	5.42*
Factor 2: cooperative with adults	0.18	0.12	2.60	−0.11	0.09	1.39	–	–	–
Factor 3: activity level	−0.02	0.11	0.05	−0.56	0.07	56.38***	–	–	–
Factor 4: executive function deficits	−0.37	0.12	8.93**	−0.32	0.08	15.52***	–	–	–
Factor 5: sleep problems	−0.15	0.11	1.80	0.62	0.08	53.74***	–	–	–

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$