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What's new? Investigating risk factors for severe childhood malnutrition in a high HIV prevalence South African setting¹

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Abstract

Aim—To identify risk factors for severe childhood malnutrition in a rural South African district with a high HIV/AIDS prevalence.

Design—Case-control study.

Setting—Bushbuckridge District, Limpopo Province, South Africa.

Participants—100 children with severe malnutrition (marasmus, kwashiorkor, and marasmic kwashiorkor) were compared with 200 better nourished (>-2 SD weight-for-age) controls, matched by age and village of residence. Bivariate and multivariate analyses were conducted on a variety of biological and social risk factors.

Results—HIV status was known only for a minority of cases (39%), of whom 87% were HIV positive, while 45% of controls were stunted. In multivariate analysis, risk factors for severe malnutrition included suspicion of HIV in the family (parents or children) (OR 217.7, 95% CI 22.7–2091.3), poor weaning practices (OR 3.0, 95% CI 2.0–4.6), parental death (OR 38.0, 95% CI 3.8–385.3), male sex (OR 2.7, 95% CI 1.2–6.0), and higher birth order (third child or higher) (OR 2.3, 95% CI 1.0–5.1). Protective factors included a diverse food intake (OR 0.53, 95% CI 0.41–0.67) and receipt of a state child support grant (OR 0.44, 95% CI 0.20–0.97). A borderline association existed for family wealth (OR 0.9 per unit, 95% CI 0.83–1.0), father smoking marijuana (OR 3.9, 95% CI 1.1–14.5), and history of a pulmonary tuberculosis contact (OR 3.2, 95% CI 0.9–11.0).

Conclusions—Despite the increasing contribution of HIV to the development of severe malnutrition, traditional risk factors such as poor nutrition, parental disadvantage and illness, poverty, and social inequity remain important contributors to the prevalence of severe malnutrition. Interventions aiming to prevent and reduce severe childhood malnutrition in high HIV prevalence settings need to encompass the various dimensions of the disease: nutritional, economic, and social, and address the prevention and treatment of HIV/AIDS.

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Keywords

Case-control study; drug abuse; food intake; HIV/AIDS; kwashiorkor; malnutrition; marasmus; poverty; risk factors; South Africa

Background

Several studies have investigated the risk factors for malnutrition among young children in developing countries. A Pubmed search using the terms “child”, “malnutrition”, and “risk factors” identified 26 relevant papers on this topic since 1976, with studies conducted in 17 different countries [1-26]. Established risk factors vary widely in different settings with few consistent epidemiological patterns emerging globally. Leading risk factors include low family socioeconomic and education levels, difficult family dynamics (e.g. mother pregnant with another child, father unemployed, or separated), sub-optimal nutrition (e.g. lower breastfeeding rates or stopping breastfeeding at earlier age, lack of food) and poor environmental and hygiene conditions (e.g. inadequate housing, absence of water and sanitation). Few studies, however, have investigated risk factors for severe, rather than mild or moderate, malnutrition [6,7,14,15,17], and only one has described these in a high HIV prevalence setting [4]. Furthermore, most have used hospital rather than community controls, and therefore may have missed key risk factors.

While South Africa is categorized as a middle-income country, it also has one of the highest inequities in societal wealth distribution globally [27]. Consequently, malnutrition rates are still high among the poorest social strata, e.g. rural, black African children. At the study site in rural Limpopo Province, protein-energy malnutrition (mainly kwashiorkor) was the second leading cause of death in children under five years between 1992 and 1995, accounting for 15% of deaths in this age group [28]. Since then, the advent of the HIV/AIDS pandemic has escalated both the number of malnourished children in the area, and resultant mortality.

Debates continue regarding the most appropriate and cost-effective way to reduce childhood severe malnutrition. The identification of important causal factors in particular settings is one of the important steps in the development of effective intervention programmes [29]. Recognizing the high malnutrition rates (in an area with a relatively low infant and child mortality rate) [28], and the particularly high (>20% among pregnant women) prevalence of HIV in our study area [30], we felt an imperative to better understand the underlying causes and determinants of severe childhood malnutrition. This was necessary before we expended considerable effort on designing and implementing potentially cost-effective and sustainable

interventions. We therefore conducted a case-control study comparing hospitalized severely malnourished children with better-nourished peers living in the same disadvantaged environment, to identify risk factors for severe malnutrition.

Material and methods

Study area

The Bushbuckridge District in Limpopo Province, South Africa, has a population of over half a million people. It is situated in the southeast corner of South Africa's northernmost province adjacent to its border with Mozambique. The area is dry and overpopulated, with plots too small to support subsistence farming. Unemployment rates are high (>30%) and many who find employment work as migrant labourers elsewhere. The area's health needs are served by three district hospitals, two health centres, and a network of some 45 clinics.

Study design

Risk factors were determined using a case-control study, a design most appropriate for events with relatively low prevalence, such as severe malnutrition. We enrolled 100 hospitalized, severely malnourished children and matched them with 200 controls of similar age and living in the same village as the case. Both cases and controls had to be less than five years old and live in the Bushbuckridge district. Fieldwork was conducted over a one-year period (April 2003 to March 2004).

Classification

The diagnosis of severe malnutrition was based on the Wellcome classification of malnutrition, i.e. weight-for-age less than 80% of median with oedema (kwashiorkor); or weight for age less than 60% of median, with (marasmic kwashiorkor) or without oedema (marasmus) [31]. A child was defined as wasted if his/her weight-for-height was below -2 standard deviation (SD) scores (z-scores) from the Centers for Disease Control (CDC) 2000 reference value [32]. Similarly, stunting and underweight-for-age was defined as children below -2 z-score for height-for-age and weight-for age, respectively. A child was classified as being HIV infected if the HIV Elisa test was positive (in a child older than 12 months) or if the child had clinical signs of HIV and his/her mother was HIV positive (in a child younger than 12 months).

Inclusion criteria were age under five years and residence in the Bushbuckridge district; cases were children severely malnourished at admission, and controls were neither underweight nor overweight at the time of examination.

Recruitment

Cases—Cases were identified at the three district referral hospitals (Mapulaneng, Matikwana and Tintswalo) by hospital staff. Primary caregivers were interviewed by trained study fieldworkers in the hospital ward. In situations where a child died before an interview was possible, the interview was performed at the child's home.

Controls—Each case was matched with two controls of a similar age (but not sex) living in the same neighbourhood (village). The fieldworkers identified the controls by travelling to the village from which the case originated, identifying the home of the relevant case and asking passers-by if they knew of any child of that age group in the immediate area. Controls were matched to the same age $\pm$ one month if the case was less than one year old, $\pm$ three months if one to three years old, and $\pm$ six months if three to five years old. The process was repeated until two children who were within normal weight-for-age centiles ($>$

-2SD and <+2SD) were identified. Identified children's caregivers were then interviewed using the same questionnaire as that used for the cases.

Questionnaire

Four local fieldworkers were trained to conduct the interviews and to undertake the anthropometrical measurements. A 172-item, pre-coded questionnaire was designed to include information on anthropometrics, diet and weaning, health of child and mother, parental characteristics, household composition, socioeconomic status, and behaviour patterns. This questionnaire was translated and back-translated by research assistants with language expertise in the two local languages – XiTsonga and Sepedi – with the interview conducted in the caregiver's preferred language. Children's date of birth, birth weight, and immunization status were obtained from their Road to Health Card whenever possible (available in 75% of instances). Dietary diversity was calculated by summing the number of unique foods (grouped into eight categories) consumed by the child in the preceding seven-day period. The maximum score was 8, with one point given for each group consumed [33].

Weighing and measuring

Fieldworkers obtained the anthropometric measurements. The project supervisor (TdM) trained the fieldworkers and monitored subsequent performance. Electronic weighing scales (Hanson, UK) were used and calibrated before each session. The children were weighed with minimum clothing (diapers for babies and underclothes for older children) and the average of two readings was taken. Heights were measured using measuring tapes. Children younger than two years were measured supine. Weights were measured to the nearest 0.01 kg and height to the nearest 0.1 cm.

Ethical considerations

Ethical clearance was obtained from the University of the Witwatersrand's Committee for Research on Human Subjects (Medical) and from the Limpopo Province Research Committee. Community consent and feedback of research findings receives continuous attention in all projects conducted at the study site.

Statistical analysis

The sample size was estimated to be sufficient to detect a minimum odds ratio of 2.0 for a prevalence of 2%, at the 95% confidence level and with a power of 80%. Data were entered into a Microsoft Access database. The univariate analysis was performed with STATA version 5 (Stata Corp., College Station, TX, USA) and the multivariate analysis using SPSS version 11.0 (SPSS Inc, 2001). EpiInfo 6.0 (Centers for Disease Control and Prevention, Atlanta, GA, USA) was used to convert anthropometrical measurements to percentage weight-for-age and height-for-age, and to z-scores (using the CDC 2000 reference standard) [32].

Risk factors for severe malnutrition were investigated by comparing cases and controls, and using linear logistic regression (logit model). Factors contributing to severe malnutrition were grouped in large categories: socioeconomic risk factors, nutritional risk factors, factors linked with HIV/AIDS, and associated morbidity. A wealth index was built, by adding dummy variables associated with 29 features of modern housing and ownership of various household appliances and goods, with a scale from 1 to 24 (1 representing the lowest value and 24 the maximum found in the sample). We combined the average level of education of mother and father by combining the mean number of years schooling into a single variable labelled "Parents' education". Variables linked with breastfeeding were combined into a single variable labelled "Breastfeeding practices", which included early (<12 months) and

abrupt breastfeeding cessation, and weaned for abnormal causes. Variables linked with feeding practices were combined into a single variable labelled “Food diversity”, which included consumption of vegetables, green leaves, fruits, eggs, dairy products, fish or meat in the past week. Mothers’ and fathers’ deaths were combined into a “Parents’ death” and illnesses into a “Parents’ illness” category. Evidence of TB in either parents or children was combined into “TB in family” category. An “HIV in family” category was based on either the mother or child being HIV positive (obtained through hospital records). In addition, we recoded data to indicate any suspicion of HIV in either the mother or father, by studying responses to reasons for stopping breastfeeding, reported chronic illness(es) in the parents, and reasons for any hospitalization of parents.

Results

One hundred severely malnourished cases and 200 controls were enrolled. The biological mother was interviewed in 87% of instances. There were no significant differences between the two groups in age and sex composition. As expected, anthropometric measures were all significantly poorer among cases (Table I). High stunting rates (45%) were noted among controls.

Classification of cases

Of the 100 severely malnourished children, 40 (40%) had kwashiorkor, 38 (38%) were marasmic, and 22 (22%) presented with marasmic kwashiorkor. HIV testing was done at the discretion of the attending doctor, who usually performed the test if clinical signs indicative of HIV were recognized. HIV ELISA results were available for only 39 (39%) cases, of whom 34 (87%) tested positive. HIV prevalence varied somewhat among tested children according to pathology: marasmus (94%), marasmic kwashiorkor (91%), and kwashiorkor (73%). A quarter (25%) of the cases died during their hospital stay.

Birth characteristics

Cases were lighter at birth than controls (2.79 vs. 2.98 kg, $p=0.01$), and were more likely to be of higher birth order (3 or more). They were somewhat more likely to be born at home, but the difference was only borderline (14% vs. 6.5%, OR 2.3, 95% CI 0.9–5.7, $p=0.05$). More cases had a deceased sibling (Table II).

Medical history and associated morbidity

Cases being severely malnourished by definition, it was expected that they would have higher morbidity than controls. Cases were more likely to have been previously hospitalized, particularly for diarrhoea, and to have experienced an illness in the past month. While complete immunization rates were similar in the two groups (51% vs. 63%), cases were more likely to have consulted a traditional healer. Almost a quarter of cases had a TB contact (at home or through daily contact), four times higher than controls (see Table II).

On multivariate analysis, diarrhoea in the past 12 months (prior to hospitalization for cases, or prior to home visits for controls) was an obvious risk factor (OR=2.73) (Table III). Furthermore, the duration of the diarrhoea was significantly longer in cases. Exposure to a TB contact was important (OR=5.32) as was previous hospitalization (OR=6.78). All these risk factors remained at the same significance level after controlling for wealth.

Nutritional history

The questionnaire included a series of questions about breastfeeding, feeding practices, and foods consumed in the past week. Most mothers (>99%) in both groups breastfed, but a majority had introduced either fluids (51%) or solids (70%) within four months of birth.

Fewer cases were still breastfeeding, and in children who were no longer breastfeeding, cases stopped breastfeeding about four months earlier on average (15 vs. 19 months, $p<0.01$). Caregivers of cases were more likely to admit that the child went hungry occasionally and these children were more likely to consume three or fewer meals per day. Cases had significantly lower diversity in their diets, consuming about 1.7 fewer food types per week (see Table II).

Seven factors remained significant in the multivariate analysis (see Table III). A first group of risk factors was constituted by breastfeeding variables. Breastfeeding being stopped before 12 months or abruptly, and for causes other than what are regarded as the norm were all strong risk factors for severe malnutrition (OR=2.57, 2.26, and 2.40 respectively). “Abnormal” causes included breast feeding being stopped because of child illness; mothers becoming pregnant, ill, leaving or dying; and the fear of HIV transmission (only three cases). The second group was constituted by feeding variables. In particular, a balanced diet in the past week produced significantly lower risks of developing severe malnutrition: vegetables (OR=0.35), green leaves (OR=0.54), fruits (OR=0.23). In addition, “having to cut the size of children’s meals or skipping meals because there was not enough money to buy food”, an indicator of severe poverty, was also significant (OR=2.09). Another variable had the same effect, “child said he/she was hungry because not enough food”, but the effect disappeared in the multivariate analysis. All effects remained similar after adding an indicator of poverty (income class or wealth index). Eating wild foods (vegetables, insects, fruits, herbs) was not significant after controlling for other factors, and the sign of each variable was positive, suggesting that eating wild food is above all an indicator of severe poverty.

Family health and dynamics

Mothers of severely malnourished children were more likely to be unmarried, not to have completed secondary education (matriculated), and to have been admitted to hospital in the preceding year (see Table II). There was no difference in age, employment status, or parity between the two groups of mothers. Fathers of cases were more likely to be deceased or to be living at a different residence from that of the child. They were also less likely to be the head of the household and more likely to smoke marijuana (see Table II). There was no difference in age, employment status, or education levels between the two groups of fathers.

Many families in the study were headed by a single parent, but cases were more likely to belong to a single-parent household. The father was not the head of the household in more than two-thirds of homes, with this being the situation for more than three-quarters of cases (see Table II). There was no significant difference in residence status, abuse of alcohol, spousal or child abuse, or encounters with the law between the two groups.

Multivariate analysis revealed five significant risk factors associated with parental health (see Table III). Two factors were associated with the mother: mother had an illness that forced the child to stop breastfeeding (OR=4.80), and mother had experienced the loss of a child other than the index child (OR=2.47). Three factors were associated with the father: father had died (OR=33.0), father was hospitalized in the past 12 months (OR=3.84), and father smoked marijuana (OR=4.83).

Suspicion of parental HIV infection also appeared as a strong risk factor (OR=9.10). These risk factors stayed robust after controlling for wealth, and the two borderline risk factors now became significant at the $p=0.05$ threshold. Other factors were not significant after controlling for the five factors described above. In particular pulmonary tuberculosis was insignificant after controlling for HIV, as was the case for alcohol abuse (mother or father) and domestic violence (against women or children).

Household and economic factors

Most (63%) households earned less than R1,000 (South African rand: ≈US\$150) per month, well below the poverty line (defined in 2001 as an income of R1,541 per month for a household of five) [34]. Cases generally lived in poorer households with fewer household assets and lower incomes. Only a third of cases were recipients of government-provided child social support grants, compared with more than one-half of controls. Unemployment rates were high in both groups, but cases were less likely to reside in households where at least one member was employed (see Table II).

Six socioeconomic factors for severe malnutrition were identified as noteworthy on multivariate analysis (see Table III). Three demographic factors were important: multiple births had a higher risk than single births (OR=4.35), as did births of order 3 and more (OR=2.66), and married mothers had a lower risk than unmarried mothers (OR=0.30). Father's education was not significant, although at least 10 years of paternal education reduced the risk of severe malnutrition by about half (OR=0.52). Mother's education had a similar effect originally, which disappeared once the other factors were taken into account.

Wealth was an obvious and strong risk factor: a wealth index of 10 or more (less poor households) reduced the risk of severe malnutrition by two-thirds (OR=0.35). Interestingly, receiving a child support grant still had a positive effect after controlling for wealth (OR=0.47), suggesting that offering this grant to poor families strongly reduces the risk of severe malnutrition. Income classes had the same effect as the wealth index, and both could be used interchangeably in the regression analyses, although the wealth index had a higher variance and offered results that were more robust. The effect of income class was no longer significant when wealth was controlled for.

Synthesis

A final synthesis of the leading risk factors of severe malnutrition was undertaken where a few variables were grouped together to simplify the analysis (as outlined in the methods section). Factors associated with the medical history were excluded because of reverse causality. This analysis resulted in little change to the overall picture (Table IV).

A first group of variables played a large role in childhood malnutrition owing to the high risk or prevalence of the factor involved: evidence of HIV in the family (parents or children) (OR=217.7), weaning practices (OR=3.0), and food diversity (OR=0.53). A second group appeared to have a moderate role: sex (males were now at significantly higher risk than females) (OR=2.7), higher birth order (3 or more) (OR=2.3), and the absence of a child support grant (OR=0.44). A final group of three variables played a more modest role: wealth of the family (OR=0.91), father smoking marijuana (OR=3.9), and evidence of pulmonary tuberculosis in the family (OR=3.2).

Discussion

The study has identified a number of alternative ways that severe malnutrition can be tackled in this predominantly poor, rural community. Diverse risk factors such as poor household food security, unhealthy feeding practices, sub-optimal access to quality health services, disruptions of family structure (influenced by the effects of HIV), and inadequate access to child support grants all contributed to the problem and lend themselves to potential interventions. None is mutually exclusive, and the need to focus on multiple interventions, including economic, educational, health, and social welfare services, in the prevention and management of severe malnutrition is made overt.

Two independent determinants, nevertheless, predominated. First, the role of sub-optimal feeding (particularly breastfeeding and weaning) practices and poor nutrient intake (low food diversity or lack of food associated with poverty), even after controlling for many other potentially confounding factors, including income, was paramount. Second, and of equal importance, was the role of HIV, either as a direct (infected child) or indirect (parents infected, sick, or dead) influence.

The dominance of kwashiorkor as a cause of severe malnutrition and of under-five mortality is noteworthy considering the extremely high percentage of HIV positivity in the children who were tested for this disease. Marasmic malnutrition is often more common in HIV-infected children [35-37], with kwashiorkor comprising about 22–33% of hospital admissions for severe malnutrition in other African countries. While the association between kwashiorkor and HIV is well recognized, this finding reaffirms the view that primary nutritional deficiencies still contribute substantially to severe malnutrition in this high HIV prevalence area. The high (25%) mortality from severe malnutrition, despite reasonable standards of hospital care, can also be attributed to the effects of HIV. Our findings support the contention that attaining <5% case-fatality rates in children with severe malnutrition, as proposed by the World Health Organization, is hard to achieve in high HIV settings [38,39].

The 45% stunting rate found in controls is a manifestation of the high levels of chronic under-nutrition in this region. The rate is almost double that found in local and national surveys conducted in other parts of South Africa [40]. The finding has important implications for both the interpretation of the study findings and the design of malnutrition interventions in the region. There is increasing acceptance that the aetiology of stunting may be different from that of acute wasting [41]. Some countries have witnessed a dramatic fall in the prevalence of wasting owing to improved health service delivery and identification and treatment of acutely malnourished children, despite stunting rates remaining high [42]. Thus, while severe malnutrition (and wasting) in the region may be amenable to short- and medium-term health system interventions, preventing mild and moderate childhood malnutrition may require greater attention to many of the “distal” determinants (political, economic, cultural, and social factors) that rarely cause ill health by themselves, and are highlighted in this paper. Further, the disadvantages (risks) identified for severely malnourished children in this setting are accentuated if one considers that the controls they were being compared with were far from “normal” by developed world standards and bore a high burden of stunting.

The strong association between severe malnutrition and poor food security, limited food diversity, and sub-optimal breastfeeding and weaning practices was expected and has been shown by many researchers previously. What is striking, in addition, is the poor exclusive breastfeeding rates and early introduction of supplementary feeds in both groups. Dietary diversity is an indicator of household food security and a dietary diversity score of less than six has been proposed as the cut-off to identify children with an inadequate diet [33]. Our results suggest that this cut-off is also helpful in predicting the development of severe malnutrition among children who are of normal weight and possibly stunted.

Another disturbing finding is the preponderance of single-parent households in this area, with half of controls also having this status. This phenomenon is common in South Africa [43], owing to late marriage and low contraceptive use among adolescents, and is, to a certain extent, a residual legacy of apartheid. In the past, legislation forced working-age men, many of them fathers, to seek employment in the cities and towns and prevented them from marrying early or, when married, from taking their spouses with them. Many cohabited with their spouses but never married because of their inability to pay a “lobola” or dowry to

the women's family. In this study, the absence of a father, whether through death, urban migration, or non-marriage, contributed significantly to the risk of malnutrition.

A strongly consistent finding in studies done in different settings and continents is the benefits of women's education in preventing child malnutrition [44]. The small or negligible effect of mother's and father's education in our study is worth noting. Obviously, parental education is important, but its effects seem to be mediated through a variety of other determinants, such as income and food practices. Furthermore, the average level of education in this area is rather high by African standards, and the mean level of education differed only slightly between cases and controls (8.0 versus 9.5 years of schooling), which is likely to dampen the effect of education per se.

A key factor affecting all underlying determinants of malnutrition is poverty. The effects of poverty on child malnutrition are pervasive. Poor households and individuals are unable to achieve food security, have inadequate resources for care, and are less able to avail themselves of modern health services (sometimes using traditional healers instead, as in this study). South Africa is one of the few countries in sub-Saharan Africa that offers state-funded child social support grants (R190 [US\$28] per month) to children younger than 14 years of age in needy families. Most caregivers claim to use the money to feed children. Notwithstanding the relatively small amount of money provided, our data confirm the beneficial effect of being a grant recipient in protecting against severe malnutrition, reducing the risk by more than half, everything else being equal. However, the low grant uptake in an area where more than 90% of households would be expected to qualify for grants offers another potential intervention target, i.e. expanding efforts to increase grant access.

A particular strength of this study was the effort made to match cases with controls living in the same setting (village and location). This reduces confounders and allows stronger inferences to be made regarding the potential role of identified risks. Despite the care taken in the sampling scheme, selection bias might have occurred in the selection of controls as we depended on neighbours to direct us to appropriate households rather than pre-selecting controls. Furthermore, the high stunting rates in controls might be attributed to a measurement bias (inadequate measurement technique in the field). However, field staff were carefully trained and their practice regularly monitored; further, a province-wide stunting rate of 36% has previously been described [40]. We were unable to obtain HIV results in more than half the cases and depended solely on an HIV ELISA test (performed mainly in cases older than 15 months of age). None of the control's HIV status was known. This obviously biases any comparisons. Finally, we recognize that we may have omitted to measure determinants that are difficult to assess and are typically unobserved, but are important to nutritional outcome, such as cultural factors influencing caring behaviours.

The study has identified a number of new risk factors that are worthy of further investigation. Negative outcomes associated with higher birth order (3 or more) require further investigation to determine whether this arises from child competition, or is rather the consequence of benign neglect from caretakers. Similarly, fathers smoking marijuana remained a consistent risk factor in all multivariate models. This could be related to a number of negative attitudes or behaviours, including insufficient money and food being available for children owing to the diversion of resources to enable continuation of the father's habit, lack of attention to childcare, and so forth. The precise role of HIV and TB in the aetiology of severe childhood malnutrition remains to be better delineated. However, even an incomplete initial attempt (by this study) to define the link suggests that they are likely to be important, explaining the increasingly severe malnutrition-related mortality noted over the past five years in the study area.

How can the health service best respond to the study findings? Potential areas for intervention could include more intense attention, through activities such as regular growth monitoring and culturally appropriate nutrition counselling, to underweight children or those who are failing to thrive [45]. The latter could arguably be best achieved by supporting the wider and more thorough implementation of Integrated Management of Childhood Illness (IMCI) services at all primary healthcare centres in the region [46]. Better monitoring of all hospitalized children following discharge (probably best done through home visits by health promoters) [47], may be a worthwhile investment. Community-wide exclusive breastfeeding promotion – at least for the first four months of life – as well as weaning education is warranted, recognizing that the task is complicated by the high HIV prevalence in mothers in the study area. Attention to removing barriers to child support grants could also stem severe malnutrition in the region. Finally, the primacy of prevention of mother-to-child HIV transmission strategies, whether to prevent severe malnutrition or other diseases contributing to childhood mortality and morbidity, as well as the treatment of HIV infected children and parents, cannot be overemphasized.

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Table 1
Demographic and anthropometric characteristics of study children, Bushbuckridge district, South Africa, 2003–04.

Characteristic	Cases <i>n</i> =100	Controls <i>n</i> =200	<i>p</i> -value
Age (months)	21.6	22.0	0.79
Sex ratio (M/F)	1.27	1.04	0.46
Birth weight (kg)	2.79 (±0.48)	2.98 (±0.49)	0.012
Current weight (kg)	6.89 (±1.8)	11.09 (±2.3)	<0.001
Weight (z-score)	-3.86 (±1.02)	-0.48 (±1.01)	<0.001
Height (cm)	71.3 (±8.9)	77.3 (±9.0)	<0.001
Height (z-score)	-3.71 (±1.71)	-1.91 (±1.26)	<0.001
Stunting (%)	81	45	<0.001
Wasting (%)	45	0	<0.001

Values in parentheses are standard deviations.

Table II
Bivariate analysis of risk factors for severe malnutrition, Bushbuckridge district, South Africa, 2003–04.

Risk factor	Cases % n=100	Controls % n=200	Odds ratio	95% confidence interval
Birth characteristics				
Birth order 3	51	33	2.1	1.2–3.5
Death of sibling(s)	15	6.5	2.5	1.1–6.1
Contact with and use of health services				
Previous hospital admission	38	9	5.9	3.0–11.9
Admission for diarrhoea	20	3	9.8	3.4–34.1
Admission for lower respiratory tract infection	14	4	4.5	1.6–13.6
Recent illness(es)	84	52	4.9	2.6–9.5
Visit to traditional healer	30	13	2.9	1.5–5.4
TB contact	24	8	3.6	1.7–7.7
Nutrition				
Still breastfeeding	18	50	0.2	0.1–0.4
Diet diversity score <6	58	13	9.2	5.0–17.1
Breastfed <12 months	29	7.5	5.0	2.4–10.7
Weaned early for “wrong” reasons	57	22	4.8	2.8–8.4
Child hungry	38	18	2.9	1.6–5.2
Fed 3 or fewer meals per day	43	27	2.0	1.1–3.4
Cut meal size or frequency because of inadequate money	54	36	2.1	1.2–3.5
Ate vegetables in past week	70	97	0.1	0.01–0.3
Ate fruits in past week	61	91	0.2	0.1–0.4
Parental characteristics				
Mother				
Unmarried	76	56	2.5	1.4–4.4
Mother not completed primary school	36	19	2.4	1.3–4.3
Completed matric (Grade 12)	16	37	0.3	0.2–0.6
Hospital admission in last year	15	6	2.8	1.1–6.7

Risk factor	Cases % n=100	Controls % n=200	Odds ratio	95% confidence interval
Mother's illness (weaning period)	41	19	3.0	1.4–6.1
Father				
Deceased	11	1	24.8	3.5–1074
Lives elsewhere	69	54	2.2	1.3–4.0
Head of household	23	37	0.5	0.3–0.9
Smokes marijuana	16	4	4.3	1.6–12.3
Family structure				
Single-parent family	71	49	2.5	1.4–4.3
Head of household not father of child	77	64	1.9	1.1–3.5
Economic markers				
Asset survey in lowest 3 quintiles	71	53	2.4	1.2–3.8
Recipient of a child support grant	33	55	0.4	0.2–0.7
Employed household member	60	77	0.5	0.3–0.8
Household income < R1000 (~\$150) per month	83	65	2.7	1.4–5.6
Socioeconomic status below average	72	54	2.1	1.2–3.8

Table III

Multivariate analysis of risk factors for severe malnutrition, Bushbuckridge district, South Africa, 2003–04.

Variable	Odds ratio per unit Exp(B)	95% confidence interval		p-value
		Min	Max	(P)
Significance				
Medical history				
Diarrhoea in past month	2.73	1.18	6.28	0.019
Duration of diarrhoea (days)	1.20	1.06	1.34	0.003
Home contact with TB case	5.32	2.10	13.45	0.000
Ever hospitalized	6.78	3.19	14.41	0.000
Nutritional factors				
Weaned <12 months	2.57	1.08	6.11	0.033
Weaned abruptly	2.26	1.10	4.65	0.027
Weaned for abnormal cause	2.40	1.13	5.08	0.022
Ate vegetables in past week	0.35	0.18	0.67	0.002
Ate green leaves in past week	0.54	0.29	0.99	0.048
Ate fruits in past week	0.23	0.11	0.47	0.000
Had to cut meals size	2.09	1.15	3.78	0.015
Parental health				
Mother's illness (weaning)	4.80	2.45	9.42	0.000
Mother experienced child loss	2.47	1.12	5.41	0.024
Father died	33.03	4.04	270.30	0.001
Father hospitalized in past year	3.84	0.95	15.47	0.058
Father smokes marijuana	4.83	1.85	12.64	0.001
Suspected HIV in family	9.10	0.93	89.15	0.058
Demographic and socioeconomic factors				
Multiple birth	4.35	0.79	23.84	0.091
Birth order 3	2.66	1.46	4.82	0.001
Mother married	0.30	0.16	0.57	0.000
Father's education (no. of years)	0.94	0.87	1.02	0.114

Variable	Odds ratio per unit Exp(B)	95% confidence interval		p-value		Significance
		Min	Max	(P)		
Wealth index (per unit)	0.90	0.84	0.97	0.005		*
Child support grant	0.47	0.27	0.82	0.007		*

* $p < 0.05$
 ~ borderline.

Table IV
 Synthesis of risk factors for severe malnutrition, Bushbuckridge district, South Africa, 2003–04.

Variable	Odds ratio per unit	95% confidence interval		p-value
	Exp(B)	Min	Max	(P)
Sex, male	2.72	1.23	6.02	0.014
Birth order 3	2.28	1.01	5.14	0.046
Child support grant	0.44	0.20	0.97	0.042
Wealth index (per unit)	0.91	0.83	1.01	0.084
Weaning practices	3.04	2.03	4.56	0.000
Food diversity	0.53	0.41	0.67	0.000
Parents died	38.01	3.75	385.36	0.002
Father smokes marijuana	3.91	1.06	14.46	0.041
HIV in family	217.70	22.66	2091.29	0.000
TB in family	3.21	0.94	10.97	0.064

* $p < 0.05$

~ borderline.