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Predictors of poor anthropometric status among children under 2 years of age in rural Uganda

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Abstract

Objective: To assess predictors of poor anthropometric status among infants and young children.
Design: Cross-sectional survey.
Setting: The rural subsistence agricultural district of Hoima, western Uganda.
Subjects: Seven hundred and twenty children aged 0–23 months with their mothers/carers.
Methods: Participants were recruited in September 2002, using a two-stage cluster sampling methodology. A structured questionnaire was administered to mothers in their home settings. Information on health, household socio-economic status, child feeding practices and anthropometric measurement was gathered. Conditional logistic regression analysis was applied taking into account the hierarchical relationships between potential determinants of poor anthropometric status.
Results: The mean *Z*-score for weight-for-height was −0.2 (95% confidence interval (CI) −0.1, −0.7), for height-for-age was −1.1 (95% CI −1.2, −0.9) and for weight-for-age was −0.7 (95% CI −0.8, −0.6). Wasting was independently associated only with a history of fever in the 2 weeks prior to the survey (odds ratio (OR) = 4.4, 95% CI 1.5, 13), while underweight was associated with a history of fever (OR = 2.4, 95% CI 1.3, 4.4) and cough (OR = 3.0, 95% CI 1.3, 6.8). Stunting was positively associated with a wider range of factors, including: history of a fever episode (OR = 1.7, 95% CI 1.0, 2.9), lack of a latrine in the household (OR = 2.7, 95% CI 1.5, 4.9), failure to de-worm children 12 months or older (OR = 1.7, 95% CI 1.1, 2.8), and being born to a non-formally educated mother compared with mothers educated above primary school (OR = 2.1, 95% CI 1.1, 4.0).
Conclusions: In analyses guided by the hierarchical interrelationships of potential determinants of malnutrition, wasting and underweight turned out to be independently predicted by morbidity (proximal) factors. Stunting, however, was predicted by socio-economic (distal), environmental and health-care (intermediate) factors in addition to morbidity. Strategies aimed at improving the growth of infants and young children in rural communities should address morbidity due to common childhood illness coupled with environmental and socio-economically oriented measures.

Keywords
Wasting
Stunting
Underweight
Infants
Hierarchical conceptual analysis

Anthropometric indicators such as weight-for-height (wasting), height-for-age (stunting) and weight-for-age (underweight) are important in evaluating the health and nutrition status of children in low-income countries where malnutrition is still a large public health problem. Global trends from 1980 to 2000 showed no improvement in the prevalence of wasting, a decline of 7% in underweight and a 14% reduction in stunting[1]. Whereas most regions witnessed a general improvement in stunting rates, the situation in Eastern Africa worsened; this was the only region that exhibited an increase in the average prevalence of stunting. The region's average stunting prevalence of 48% among children under 5 years old is unacceptable[1].

It is estimated that malnutrition underlies more than half of all infant and child mortality in sub-Saharan Africa[2]. Uganda, a self-reliant country in food production, is not spared. A very rapid faltering in linear growth is observed between 6 and 9 months of age, a period when complementary foods are being introduced to children. At 9 months of age 30% of the children are already stunted and by 18 months up to 50% of the children in Uganda are stunted[3].

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Causes of poor anthropometric outcome are complex, ranging from biological and social to environmental factors. Variations in malnutrition are known to occur between countries of similar economic status, between regions of the same country[4] and even between individuals in the same household[5]. In poor communities there are some families whose children, against all odds, remain relatively well-nourished[6]. To address this complex interplay, some authors[7–9] have proposed the use of frameworks and models for studying and predicting the determinants of health and nutrition outcomes.

Based on international literature on the causes of malnutrition and how they are interrelated[7], we constructed a conceptual framework that uses the notion of proximate and distal determinants of growth. According to the framework (Fig. 1), distal determinants such as household socio-economic status may influence child growth directly and/or indirectly through determinants at the intermediate and proximate levels of the hierarchy. In turn, the intermediate determinants may influence child growth directly and/or indirectly through proximate-level determinants. Finally, the proximal determinants constitute the immediate direct influences on child growth.

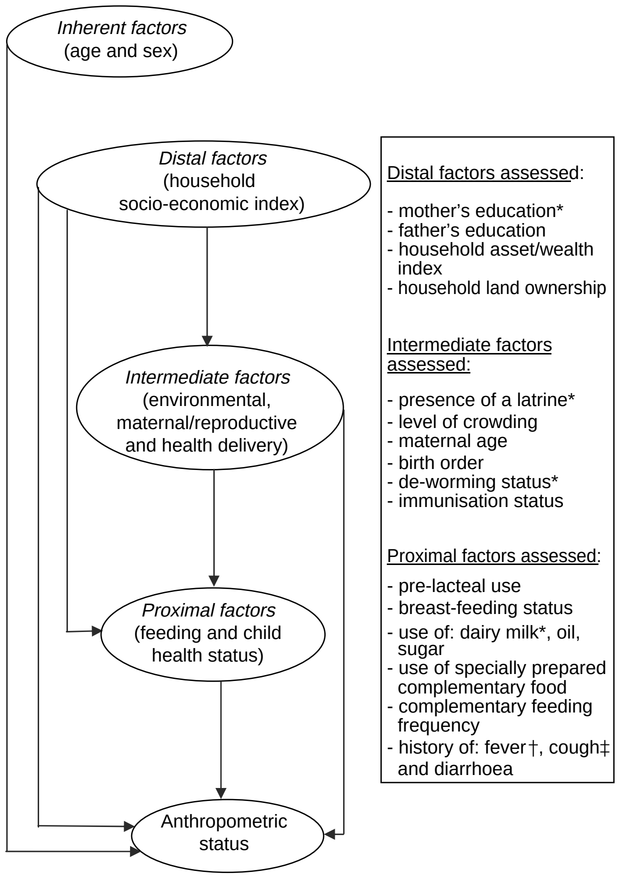

Fig. 1 Conceptual hierarchical framework of potential determinants for poor anthropometric status (left) and factors modelled for 720 children in the study (right). *Associated with stunting, †associated with all three anthropometric indices, ‡associated with underweight

Multilevel modelling following such a conceptual framework avoids underestimating influences of the more distal determinants, thus providing more rational information for policy.

The aim of the present study was to determine the extent to which determinants at the distal, intermediate and proximal levels of the conceptual framework are predictive of child growth in terms of their unconfounded direct contribution to wasting, stunting and underweight.

Methods

Study area and design

This was a cross-sectional survey carried out in September 2002 in the rural subsistence agricultural district of Hoima, western Uganda. The district shares a border with the Democratic Republic of Congo along Lake Albert.

The study enrolled a total of 720 child/mother pairs. The sample size was calculated based on the formula by Cochran[10], using the SampleXS (www.brixtonhealth.com) software. The sample was made large enough to estimate a prevalence rate of wasting similar to that assessed at the national level (4.0%)[3] at 95% confidence level and a 2% error of precision.

Participants were sampled using a two-stage cluster design. At the first stage of sampling, a total of 72 villages/clusters were selected on probability proportional to population size basis from the district population village list of the 1991 national census. At the second stage, a total of 10 households were systematically sampled from each village selected at the first stage. This involved randomly selecting the first household by spinning a bottle at the presumed centre of each village to obtain a starting direction, listing – on papers – all household heads in the selected direction up to the border of the village, folding the papers and randomly picking one name. The next household would be the one whose front door was nearest to the previous one. This provided a self-weighting sample with each child/mother pair in the district having an equal probability of being selected into the sample. A household was defined as a group of people living, cooking and eating together. One child under 2 years was enrolled per household after informed verbal consent of the mother/carer. Child age was obtained through birth certificates, health cards, or recall using a calendar of local events while taking precautions to minimise field errors[11]. In the case that a household had two children in the target age group or twins, one was selected randomly. A village leader followed data collectors through the village and traditional village protocol was observed, thus ensuring a near universal response rate (99%).

Information on infant and young child feeding practices, health status, anthropometry and indicators of household socio-economic status was gathered using a structured questionnaire that was administered to mothers in their home settings, following verbal informed consent.

Measurements

The dependent variables constituted wasting, stunting and underweight. Weight and recumbent length measurements were taken following recommendations[12]. Standardised 25 kg portable Salter Spring scales measuring to the nearest 0.1 kg were used to measure weight. Recumbent lengths were taken with specially designed length boards measuring to the nearest 0.1 cm. Based on weight, length, age and sex, anthropometric indices were constructed using the National Center for Health Statistics/World Health Organization (WHO) reference data[13] incorporated in Epi Info software (Centers for Disease Control and Prevention, Atlanta, GA, USA). Wasting was defined as weight-for-height Z-score less than -2, stunting as height-for-age Z-score less than -2 and underweight as weight-for age Z-score less than -2[13]. The distribution of the variables was explored and extreme outliers were identified and excluded from the analysis.

Inherent factors of growth, such as age, were assessed as a continuous variable in months and a categorical variable was constructed yielding four categories: 0–5 months, 6–11 months, 12–17 months and 18–23 months.

The education level of the child's parents was assessed on scales ranging from never went to school to college/university. Two categorical variables were constructed that yielded four categories for mothers: no formal education, stopped in primary, completed primary (which is 7 years in Uganda) and stopped above primary. Five categories were yielded for fathers: no formal education, stopped in primary, completed primary, stopped in secondary and secondary 4 or above.

Information on durable assets (cupboard, hurricane lamp, radio, bicycle, boat, telephone, refrigerator, motorcycle and car) and the materials of the dwelling structure was used to construct a relative index of household wealth (asset) status using principal components analysis[14]. The regression scores for the first principal component were used to create a new variable, which was then categorised into quintiles: poorest to least poor. Since land is usually accorded special status in many communities in Uganda[15], it was assessed independent of other household assets so as to evaluate its independent association with child growth. Using information obtained on land ownership, a categorical variable with five categories was constructed: no land at all, 1 acre, 2 acres, 3 or 4 acres and 5 or more acres.

Environmental, maternal and health delivery factors assessed included: (1) level of crowding in the household, categorised into four categories: 3 or fewer inhabitants, 4 to 5 inhabitants, 6 to 7 inhabitants and 8 or more inhabitants; (2) household possession of a latrine: available or not available; (3) maternal age in years: less than 25 years or 25 years and above; (4) child birth order; (5) immunisation card as a proxy for immunisation status: available and seen physically or not available; (6) deworming status in the past 6 months among children aged 1 year and above: de-wormed or not de-wormed; and (7) history of illness episode (fever, cough and diarrhoea) in the 2 weeks prior to the study with 'yes' and 'no' response categories.

Assessment of feeding covered both breast-feeding and complementary feeding practices. Responses to questions on breast-feeding included: (1) current breast-feeding status: breast-feeding or not breast-feeding; (2) history of pre-lacteals: received pre-lacteals, did not receive pre-lacteals or do not remember what happened; (3) based on a 24-hour dietary recall it was determined if the child was exclusively breast-fed. Further, the quality of complementary feeding was assessed on: (1) the kind of complementary food given in the previous 24 h: 'specially prepared food' or 'adult/family food'; and (2) 'yes' and 'no' response category questions on whether a dairy product (milk) or oil/butter or sugar was added to complementary food. Complementary feeding frequency in the 24 h preceding the survey was assessed as a continuous variable for which a dichotomous variable was constructed based on whether the frequency did or did not follow national recommendations.

Analysis

Data were entered in Epidata software (www.epidata.dk) and analysed using SPSS version 12.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to summarise the prevalence of wasting, stunting and underweight, and to obtain frequencies and proportions for other variables. Further analysis was done using logistic regression taking into account the hierarchical relationships between the potential determinants of malnutrition[8,9]. Interaction effects were evaluated for the model.

According to the conceptual model (Fig. 1), child's age and sex are considered inherent factors because they are not affected directly or indirectly by other groups of potential determinants at the distal, intermediate and proximal levels. Therefore, initially child's age and sex, simultaneously adjusted for each other, were analysed using unconditional logistic regression. While maintaining age and sex variables and using the SPSS backwards conditional logistic regression that excludes variables at the 0.1 significance level, distal determinants (socio-economic) were added into the model. The socio-economic variables that were significant, together with child's age and sex, were maintained for the subsequent model in which all intermediate determinants were added. Likewise, intermediate predictor variables that were significant, child's age and sex, and all distal predictor variables included in the previous model were maintained for the final model including all variables of proximal determinants.

In the results, we present odds ratios (OR) derived from the equation corresponding to the level at which a potential determinant was first entered[8,9]. This is in line with the hierarchical associations assumed by the model.

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It implies that distal factors and intermediate factors might confound the effects of intermediate and proximal factors, respectively, on children's anthropometric status. On the other hand, intermediate and proximal factors might mediate the effect of those at more distal levels (i.e. intermediate and distal factors). This conceptual framework may help to avoid the possibility that mediating variables mask the explanatory power of the more distal determinants. For example, part of the effect of socio-economic status on child nutritional status could be mediated through feeding practices. The overall effect of socio-economic status should therefore be evaluated in a model that excludes feeding practices otherwise its role could be underestimated.

Ethics

Approval for the study was granted by Makerere University Faculty of Medicine Ethics and Research Committee, the Uganda National Council for Science and Technology and the Regional Committee for Medical Research Ethics, West Norway (REK vest).

Results

Sample description

Of the children studied, 366 (51%) were females. The median age (interquartile range) was 10 (5–16) months for females and 11 (5–16) months for males. The mean age difference between boys and girls was 0.5 months (95% confidence interval (CI) −0.5, 1.4). Fifty-three per cent of the children were born to mothers aged below 25 years, while a total of 164 (23%) were first-born babies to their mothers, 157 (22%) second-born, 131 (18%) third-born, 175 (24%) were fourth- or fifth-born and 92 (13%) were sixth-born or above. Of the children, 458 (64%) possessed an immunisation card that was present with them. Considering children aged 1 year and above, 205 (59%) were de-wormed in the last 6 months. The prevalence of cough, fever and diarrhoea in the 2 weeks prior to the study was 71%, 49% and 28%, respectively. Among the children with complete data, 18 (14%) were low-birth-weight. Key socio-economic and environmental factors are presented in Table 1.

Table 1 Distribution of key socio-economic and environmental factors in study households

Variable	Frequency (%)
Mother's education ($n = 713$)	
None	148 (21)
Stopped in primary	282 (40)
Completed primary	131 (18)
Above primary	152 (21)
Father's education ($n = 626$)	
None	59 (9)
Stopped in primary	179 (27)
Completed primary	151 (24)
Stopped in secondary	95 (15)
Secondary 4 or above	142 (23)
Land ownership ($n = 706$)	
No land	73 (10)
1 acre or less	179 (25)
2 acres	167 (24)
3 to 4 acres	152 (22)
5 or more acres	135 (19)
Household level of crowding ($n = 720$)	
3 or fewer inhabitants	98 (14)
4 to 5 inhabitants	250 (35)
6 to 7 inhabitants	205 (28)
8 or more inhabitants	167 (23)
Latrine is available at household ($n = 718$)	612 (85)

Totals of the numbers in the different categories do not add up to 720 because of missing values.

Anthropometric status

The mean Z-score for weight-for-height was −0.2 (95% CI −0.1, −0.7), for height-for-age was −1.1 (95% CI −1.2, −0.9) and for weight-for-age was −0.7 (95% CI −0.8, −0.6). The mean Z-score differences between boys and girls were statistically significant only for stunting ($P = 0.005$). A total of 22 (3%) children were excluded from the anthropometric analysis due to incomplete data on age and height or were extreme outliers. Of the remaining 698 children, 30 (4%) were wasted, 172 (25%) were stunted and 84 (12%) were underweight. The highest proportion of wasting of 7% was in the age group 12–17 months, while underweight and stunting were still increasing at 18–23 months (Fig. 2).

Factors associated with poor anthropometric status

Table 2 depicts the potential determinants for wasting. As shown, the only factor that was independently associated with wasting was history of a fever in the 2 weeks before the study (OR = 4.4). A child who did not possess an immunisation card was more likely to be wasted (OR = 2.3) than a child with a card; however, the relationship was not statistically significant.

As shown in Table 3, factors associated with stunting cut across all levels of determinants in the hierarchical model. Being born to a mother with little or no formal education,

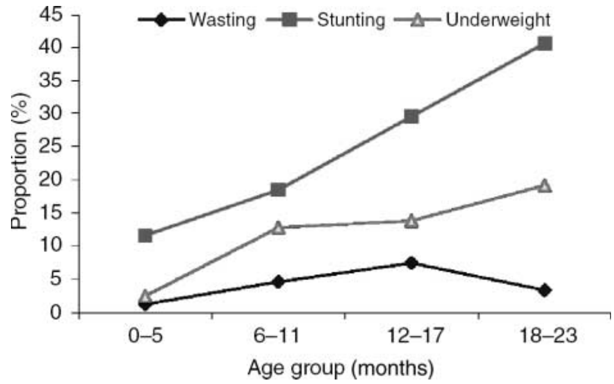

Fig. 2 Percentage of children under 2 years of age with low weight-for-height (wasting), low height-for-age (stunting) and low weight-for-age (underweight), by age group

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Table 2 Low weight-for-height (wasting) regressed upon potential influencing factors at different levels of proximity to the outcome variable ($n = 698$)

Potential determinant	Odds ratio	95% confidence interval
Child's age in months	1.0	0.9, 1.1
Child's sex is male	1.2	0.6, 2.4
Child did not own an immunisation card	2.3	0.9, 5.5
Child did not receive milk in last 24 h	0.4	0.2, 1.0
Child had a fever episode in last 2 weeks	4.4	1.5, 13**

**, $P < 0.01$.

a male child and an older child were associated with higher odds of being stunted. There was no significant fever × child's age interaction, suggesting that the influence of fever with respect to stunting was similar in younger and older infants. The model containing inherent factors, mother's education and the intermediate factors revealed no significant association of mother's education with stunting. A significant interaction was observed between mother's education and the significant intermediate factors (latrine and de-worming status), implying that the latter mediated the association of the former in a manner consistent with the postulated hierarchy in the conceptual framework.

Underweight was significantly associated with only proximal factors (Table 4). History of fever and cough were associated with higher odds of being underweight (OR = 2.4 and 3.0, respectively). No significant interactions were observed among the predictor variables for underweight.

Discussion

This study examined the potential determinants of malnutrition in children under 2 years of age in rural Uganda. It employed a conceptual hierarchical framework to guide the analyses and the interpretation of results.

Table 3 Low height-for-age (stunting) regressed upon potential influencing factors at different levels of proximity to the outcome variable ($n = 698$)

Potential determinant	Odds ratio	95% confidence interval
Child's age in months	1.1	1.1, 1.2***
Child's sex is male	2.6	1.5, 4.4***
Mother's education		
Above primary	1.0	
Completed primary	1.0	0.5, 2.0
Stopped in primary	2.1	1.2, 3.8*
None	2.1	1.1, 4.0*
Household had no latrine	2.7	1.5, 4.9**
Child not de-wormed	1.7	1.1, 2.8*
Child did not receive milk in last 24 h	1.8	1.1, 3.0*
Child had a fever episode in last 2 weeks	1.7	1.0, 2.9*

*, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

Table 4 Low weight-for-age (underweight) regressed upon potential influencing factors at different levels of proximity to the outcome variable ($n = 698$)

Potential determinant	Odds ratio	95% confidence interval
Child's age in months	1.1	1.1, 1.2***
Child's sex is male	1.1	0.7, 1.7
Child is weaned	0.4	0.2, 0.9*
Child did not receive specially prepared complementary food in last 24 h	0.6	0.3, 0.9*
Child had a fever episode in last 2 weeks	2.4	1.3, 4.4**
Child had cough in last 2 weeks	3.0	1.3, 6.8**

*, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

Findings indicate that wasting and underweight were strongly associated with proximal determinants, especially morbidity. Stunting, however, was associated with factors at all levels of the conceptual framework, which included socio-economic, environmental, health and morbidity factors. The potential determinants for poor anthropometric status identified in this study were generally similar to those described elsewhere[16–19].

Although the present study contributes to the understanding of the complex pattern of factors associated with growth for infants and young children in rural set-ups, it has noteworthy limitations. First, study children were not assessed for oedema to identify possible kwashiorkor. This bears implications of lowering the reported prevalence of underweight. Second, birth weight, a known determinant of linear growth[16], was not controlled for in the analysis. Birth weight was dropped because of many missing data, attributable to the fact that the majority of mothers in Uganda deliver outside the health unit[3]. Despite limitations, the theoretical conceptual framework used in the analysis and interpretation of factors associated with poor growth avoids situations in many studies that treat explanatory factors as if belonging to the same hierarchical level in multivariate models. Such approaches are sometimes based entirely on statistical associations rather than balancing statistical significance with some degree of biological or social interpretation[9].

Faltering for the three anthropometric indicators that were assessed in this study exhibited a similar pattern to what is described in Uganda and globally[3,20], i.e. starting soon after birth and rising rapidly between 6 and 12 months of age. Although the prevalence of 4% for wasting, 25% for stunting and 12% for underweight could be considered as medium by WHO categorisation[13], such a deduction cannot be made for this study since that arbitrary classification is usually based on children aged up to 5 years.

Another familiar finding[13] was the fact that only the proximal factors of morbidity were significantly associated with wasting and underweight. Stunting, however, was associated with proximal, intermediate and distal factors. Given the postulated hierarchical associations in the conceptual framework, these findings demonstrate that at the origin of stunting determinants lies socio-economic status. This lends support to the use of stunting as a socio-economic status indicator in addition to highlighting the necessity for the economic empowerment of households as a means of enhancing child health.

As reported elsewhere[8,21], an inverse relationship between level of stunting and maternal education was observed, suggesting a need to promote gender-balanced formal education in rural communities. Similarly stunting was positively associated with health-care and environmental factors, especially failure to de-worm and lack of latrine facilities. Although some trials have failed to find a significant effect of de-worming on growth[22], others have demonstrated a causal relationship between helminthiasis and malnutrition[23,24]. Child de-worming and activities to improve sanitation should therefore be emphasised.

In keeping with other studies done in Africa[25–27], a higher prevalence of stunting was observed in males than females. The cause of this discrepancy is not well established in the literature, but there is a belief that boys are more influenced by environmental stress than girls[28]. Further disturbing results were observed with feeding practices. For instance, children who were not provided with dairy milk in the 24-hour recall were less likely to be wasted; those who were still breast-feeding at the time of study and those who had received complementary food specially prepared for them in the 24-hour recall were positively associated with underweight. Unfortunately information from this single study, based on 24-hour recall, was insufficient to explain these findings. However, poor anthropometric outcomes are occasionally reported to be more prevalent in breast-feeding than weaned children due to bias of reverse causality[29,30].

Conclusions

Taking into account hierarchical relationships between a number of proposed determinants of children's malnutrition, wasting and underweight turned out to be independently predicted by proximal child morbidity factors such as fever and cough. Stunting, however, was predicted by socio-economic (distal), environmental and health-care (intermediate) and morbidity (proximal) factors. These results suggest that strategies aimed at improving the growth of infants and young children in rural communities should address morbidity due to common childhood illness, coupled with environmental and socio-economically oriented measures.

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