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Factors Predicting Failure in an Intervention Program to Prevent Malnutrition among Children in Malawi

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Bachelor in the Science of Nursing
Emory University
2011

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Factors Predicting Failure in an Intervention Program to Prevent Malnutrition among Children in Malawi

By Alison McCray

Background
Moderate acute malnutrition affects 10% of children worldwide resulting in lifelong adverse effects including increased mortality, suppressed immune system function, and delayed growth and cognitive development. Malawi is a highly food insecure nation where many children experience multiple episodes of malnutrition. Little information exists regarding predictors of failure among children treated with supplementary therapeutic feeding; this study will establish a relevant literature base.

Methods
Approximately 2700 children diagnosed with moderate acute malnutrition were enrolled in the study and treated with supplementary food. Data were collected at time of enrollment, at 3, 6, and 12 months post-enrollment, and for any episode of malnutrition during follow up. Data collection included anthropometric measurements (length, weight, mid-upper arm circumference) demographic information, and a food insecurity survey. Logistic regression was performed to assess for predictors of therapeutic feeding treatment failure. Poisson regression was used to identify predictors of repeated failures. Linear regression was performed to identify predictors of weight gain over the total time followed, approximately 12 months.

Results
Female sex, younger age, and greater malnutrition at enrollment predicted failure to prevent malnutrition in an intervention program to prevent malnutrition. Notably, the food insecurity scale used was not a predictor of malnutrition. Weight-for-height Z-score (WHZ), female gender, younger age, and total time followed were predictors for total weight gained during time followed for the study.

Conclusions
Therapeutic feeding programs should be aware of factors predicting multiple episodes of malnutrition, ie. females, younger children, and those with more severe malnutrition at time of enrollment.

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And to the children of Project Peanut Butter: your smiles are my inspiration.

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Introduction

Malnutrition adversely affects children worldwide and is currently responsible for 4.4 million deaths annually among those under the age of five (12). This computes to over 12,000 young lives claimed each day, 500 every hour, and 8 deaths every minute. Children who survive acute and chronic malnutrition bear the burden of increased severity of infections and suppressed immune system function on a short-term basis. Even a single episode of malnutrition in childhood can lead to developmental delays and a lifelong decrease in capacity for growth and learning.

Moderate acute malnutrition (MAM) is defined as a weight-for-height Z-score between -2 and -3, affecting 10% of children at any given time worldwide (6). Malnutrition is often likened to an iceberg, due to the fact that most detrimental effects experienced are not immediately visible. MAM falls within this category; adverse effects quietly take a toll on 35 million children globally in the form of decreased growth and developed and increased mortality due mostly to infectious diseases (6). Malawi is a country of 14.9 million individuals, 2.7 million (18.2%) of whom are under the age of five years (13). More than half a million, or greater than one-fifth of these children, experience at least one episode of acute malnutrition before their fifth birthdays (11).

One aspect of nutrition is food security, defined by United States Agency for International Development (USAID) as "a state in which all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life" (4). Three different aspects of food security include: food availability, food access, and food utilization (14). Without fulfillment of these concepts, an individual is at risk for experiencing food insecurity. Malnutrition is a crude indicator of food insecurity within a population (1).

Malawi is a country whose citizens, especially those residing in rural areas, suffer from a great degree of food insecurity (1). Malawi is highly populated in comparison with surrounding countries, with a population density of 126 individuals per square kilometer (13). This is greater than four times and seven times higher than neighboring countries Mozambique and Zambia, respectively (13). With such a great number of individuals residing in a comparatively small land area, there lies a great challenge in consistently providing sufficient quantities of food (1).

One consequence of food insecurity is acute malnutrition (1). When individuals experience a lack of food availability and access, the risk for malnutrition increases dramatically (1). Individuals may present with marasmus, a form of wasting attributable to a total deficiency in caloric intake, or kwashiorkor, an edematous state associated with micronutrient deficiencies and high rates of mortality. Children under the age of five years are particularly vulnerable, and may experience many episodes of acute malnutrition (1).

The Household Food Insecurity Access Scale (HFIAS) is a tool designed for use within developing countries to measure food security status within an individual household (4). This tool, last revised by Coates et al. (2007), is composed of a series of questions designed to elicit responses regarding the quality of food access. Respondents answer inquiries such as "in the past month, did you or any household member go an entire day and night without eating anything because there was no food in the house due to a lack of resources?" (4). When an affirmative answer is provided, respondents are prompted to quantify the response (4). The HFIAS is the survey tool used in this study to determine the level of food insecurity experienced among families with enrolled children.

This study will explore the relationship between reported level of food insecurity and corresponding health outcomes of children presenting to outpatient nutrition clinics with a diagnosis of moderate malnutrition. This study will also identify characteristics of children who

are more likely to experience relapse episodes of acute malnutrition, defined as a weight-for-height Z-score less than or equal to -2. Specifically, this study aims to identify trends in short-term health outcomes of a cohort of approximately 2700 children from 6-59 months of age diagnosed with at least one episode of MAM. Health outcomes include: number of relapse episodes of acute malnutrition while enrolled in study, and percentage of growth in weight during enrollment and for the total time followed. Data were collected for study participants at time of enrollment as well as three months, six months, and twelve months post-study enrollment.

In addition, this research will relate common characteristics and defined health outcomes of children diagnosed with MAM to corresponding reported food insecurity levels. Food insecurity is established by the HFIAS questionnaire administered at enrollment and follow-up visits 3, 6, and 12 months post-enrollment, in addition to any relapses in between follow-ups for which the caregiver seeks treatment of the child at the outpatient nutrition clinic.

This study is significant because of the potential for earlier identification of children at risk for acute malnutrition and subsequent relapse episodes. If children with positive health outcomes following outpatient supplementary feeding programs present with common characteristics including reported food insecurity levels, children with similar characteristics may be targeted in other regions for increased identification and treatment of malnutrition. Food insecurity has not previously been studied in conjunction with acute malnutrition and health outcomes among children living in resource-poor settings in Africa. For this reason, no data are available within the literature regarding food insecurity and moderate acute malnutrition in childhood. Additionally, no studies have been done to identify risk factors among moderately malnourished children for repeated episodes of malnutrition.

This study was conducted by Emory University via Project Peanut Butter (PPB), a non-government organization based in Blantyre, Malawi, and the St. Louis Nutrition Project (SLNP), which coordinates research being done to improve pediatric therapeutic feeding programs. The data utilized for this study were originally collected for research conducted by SLNP, who granted access to the database.

Methods

Data set description

The target population (n = 2712) was made up of children ranging from 6-59 months of age who were diagnosed with moderate acute malnutrition (MAM), defined as a weight-for-height Z-score (WHZ) between -2 and -3 without pitting edema (6). Of these 2712 children, 2518 had some sort of follow up data collected and were the population utilized during analysis.

Study participants were diagnosed with MAM at 18 different pre-existing outpatient therapeutic feeding clinics in southern Malawi. Study participants were recruited originally for the purpose of studies conducted by SLNP (6), eliminating the need for active recruitment for this study. Trained volunteers and research nurses were responsible for diagnosing malnutrition in study participants and collecting study data.

Data were collected on each subject diagnosed with MAM, including anthropometric measurements [length, weight, mid-upper arm circumference (MUAC)]; demographic information including gender, caregiver(s), number of children under the age of five years living in the household, paternal presence within the household, twin status; and lastly, health information including HIV and TB status, and history of past hospitalizations.

Standard techniques were utilized to collect anthropometric measurements from study participants. A battery-powered electronic scale was used to measure weight to the nearest 5 grams. Length was measured to the nearest 0.5 centimeters using a mat or to the nearest 0.2 centimeters using a rigid board with participants placed in a supine position. A MUAC was measured with an insertion tape to the nearest 0.2 centimeters.

Trained volunteers fluent in the local language conducted interviews with caregivers of study participants to collect demographic and health information. In addition, the nine-item HFIAS questionnaire was completed at each initial visit for enrollment, healthy follow-up visits, and

subsequent episodes of acute malnutrition, termed ‘relapses.’ A copy of the patient intake form is available at the end of the text.

After the initial assessment and treatment of subjects for moderate acute malnutrition, follow-ups were scheduled at three months, six months, and one year following study enrollment. At the scheduled follow-up visits, children were assessed using the same screening methods. Children presenting at clinic during the follow-up period were treated as needed with nutritional supplementation for each episode of acute malnutrition.

Minimal research has been done to identify predictors of multiple episodes of malnutrition among children with MAM treated by therapeutic feeding; this study will contribute to building a base of literature.

Analysis

Documented anthropometric measurements were entered into Anthro v 3.1 (WHO, Geneva) to calculate WHZ. All the data collected were then entered into the statistical program SAS (SAS Institute, Cary NC) for analysis. Tests to examine descriptive statistics were performed for each variable collected.

Poisson regression was used to identify predictors for the number of relapse episodes of malnutrition during the one year follow-up period (SAS, PROC GENMOD). Subjects who relapsed were defined as any follow-up visit with a WHZ ≤-2. The length of follow-up time (in days) was used as an ‘offset’ to adjust for the fact that not all children were followed for the same amount of time. Statistical significance was determined by p-values less than 0.05. Values of 0.1 or less were listed in tables generated from data analysis. Preliminary analyses of the data were conducted to establish the prevalence of relapse during follow-up within this particular population, with 25% of study participants experiencing at least one relapse episode.

Logistic regression was used to identify predictors of baseline food insecurity, dichotomized into any food insecurity (9 questions) versus none.

Logistic regression was also used for the enrollment outcome "failure to recover from MAM" during the 12-week enrollment period (SAS, PROC LOGISTIC). Enrollment outcome for therapeutic feeding were either "graduate" or "failure," based on whether or not a study participant met his or her target weight goal (WHZ ≥-2) within the pre-determined 12-week maximum feeding period following study enrollment. As noted, study participants were followed for a maximum of 12 months to assess changes in weight after the initial therapeutic feeding period during enrollment regardless of whether or not the target weight goal (WHZ ≥-2) was met.

Lastly, linear regression was conducted to assess characteristics of children with overall percent weight change for the total period of time followed being the health outcome. All available variables were utilized in the model to identify characteristics of study participants who gained the most weight over the time period followed.

All variables in **Table 1** were potentially included in logistic and linear regressions, and all results with a p-value <0.10 were included in final models.

Ethical considerations

All data obtained were collected and made anonymous for IRB and Malawi College of Medicine Research and Ethics Committee (COMREC) approved St. Louis Nutrition Project studies. IRB approval was sought through Emory University and granted exemption due to the use of an established database not linked with personal identifiers.

Results

There were 2712 children enrolled in the study. However, some of the study participants (8%; n= 194) were lost to follow up and were not utilized in any data analysis since the outcomes of interest occurred during the follow up period. More than half (63%) of study participants were female, with a mean enrollment age of 20 months (SD 11.00) and nearly half (45%) between the ages of 12 and 23 months (**Table 1**).

Study participants entered with a weight of 7.40 kilograms (SD 1.58) on average, and a mean weight-for-height Z-score of -2.30 (SD 0.38). The primary caretaker reported for the majority of children was his or her mother (95%) with most reporting the father as living within the child's home (77%). Out of study participants, 3% were known to be HIV positive with 9% of mothers reported to be HIV positive.

The mean reported score from the Household Food Insecurity Access Survey was 6.2 with a standard deviation of 5.2. More than half (52%) of caretakers reported the household food insecurity level as severe. Nearly a quarter (23%) of study participants lived in moderately food insecure households, and almost one-fifth (18%) in reportedly food secure households.

Study participants gained on average 6.83% (SD 6.05) percent of body weight during the enrollment supplementary feeding period with initial enrollment weight as a reference. Ten percent (n= 241) did not meet the target weight (WHZ≥-2) at time of enrollment over 12 weeks, which was the maximum allotted time for supplementary feeding for one episode of malnutrition. The weight increase that occurred over the total time followed was 34.23% (SD 17.08), with 347 days being the average total time followed. One-fourth (n= 618) of study participants experienced at least one relapse episode of acute malnutrition (WHZ≤-2 ± pitting edema) with the number of relapse episodes ranging during follow up time from none to six. Of those that experienced at least one relapse episode, 45% had only one relapse in total.

Weight-for-height Z-score at time of enrollment was significantly associated with failure to meet target weight goals (WHZ≥-2) upon enrollment (OR 0.13, 95% CI 0.08, 0.21), observed by logistic regression (**Table 2**). Female children were more likely to fail meeting weight goal as well (OR 3.70, 95% CI 2.45, 5.58).

Poisson regression was applied to identify risk factors for relapse episodes. Female study participants were more likely to experience at least one relapse episode (RR 1.99, 95% CI 1.63, 2.44) as opposed to female participants. An association was observed between younger age and likelihood of relapse (RR 0.98, 95% CI 0.98, 0.99) as well. Weight increase during enrollment period and weight-for-height Z-scores were also significantly associated with relapse episodes (**Table 3**).

Another outcome of interest was overall weight increase during the time study participants were followed (**Table 4**). Even though females were more likely to experience acute relapse episodes of malnutrition, they were also more likely to experience the greatest overall weight increase. Statistically significant associations for overall weight gain were also identified between age, enrollment period weight change, initial enrollment weight-for-height Z-score and total time followed.

No significant predictors of reported food insecurity on enrollment were observed using logistic regression. All available demographic variables and enrollment measurements were utilized in the model, none of them bearing statistically significant associations with food insecurity being reported within the home. Within this study population, there is not one demographic group more likely to have reported food insecurity within the home than another.

In addition, there were no statistically significant differences in enrollment health outcomes between reported food insecurity levels, nor was reported food insecurity was not found to be a predictor for overall weight gain post-enrollment. Any reported food insecurity

had no statistically significant association with likelihood of relapse, seen with Poisson regression.

Discussion

Reported food insecurity level was not found to be associated in any way with health outcomes of children diagnosed with MAM. This can be a reflection of study population. Study participants were recruited from a population of children brought by caregivers to a pediatric nutrition clinic. Regardless of calculated food insecurity level, all children recruited for the study were diagnosed with MAM. If procedures for enrollment of study participants included active recruitment within surrounding rural communities instead of primarily children already diagnosed with malnutrition, more variability may have been observed.

One predictor for failure to recover from MAM was a greater degree of malnutrition upon enrollment, indicated by a lower WHZ. Out of enrolled study participants, 10% of children in the study failed to recover from MAM upon enrollment after receiving supplementary therapeutic food. It is consistent with previous research (9) that children who are more severely malnourished at the start of therapeutic feeding have a more difficult time reaching target weight goals. However, most therapeutic feeding programs focus on children with severe malnutrition (6), defined by a WHZ of -3 or less.

Another predictor of failure to recover from MAM is female gender. The risk for failure to recover was nearly four times greater for females than for males. (9)

Risk factors were identified for relapse episodes of malnutrition. Female gender, greater malnutrition, and younger age made study participants more likely to experience additional episodes of malnutrition following initial treatment with supplementary food. Little is known about repeated episodes of malnutrition in children with regard to gender; this study will contribute to building a base of literature.

In previous studies, female children in developing countries were shown to be more at risk for acute malnutrition as a result of cultural bias toward male children (2). As those studies were not conducted within the same geographical area with similar study populations, the same conclusion cannot be made from this single study. One area for future research may include assessments of child health indicators by gender.

Although female children were more likely to experience repeated episodes of malnutrition, they were more likely to gain weight during the total time followed than males. This phenomenon is not supported by similar results in previous research; additional research should be conducted before a generalization can be made regarding patterns of weight gain between genders.

Younger age was another risk factor for repeated malnutrition. This is consistent with previous literature (9). Younger children, in particular those being weaned from exclusive breastfeeding to other food sources, are at great risk for developing malnutrition as complementary foods may lack the micronutrient-dense mixture present within breast milk. However, younger children also gained more weight during the total time they were followed throughout the study period. This is consistent, given that growth and development occurs in proportionally greater increments during infancy and slows as a child ages.

Conclusion and recommendations

Malnutrition is a significant public health problem, particularly within developing countries. It contributes to the deaths of at least 4.4 million deaths each year among children under 5. It has a significant impact on children's ability to fight infection, increasing mortality rates for common communicable diseases. Growth and development is negatively impacted, a consequence lasting a lifetime for even one episode of malnutrition in childhood.

Repeated episodes of malnutrition are common in childhood, especially in food insecure environments. Predictors of repeated episodes of malnutrition have not been heavily studied; this study will contribute to building a literature base. Factors contributing in this study to multiple episodes of acute malnutrition include: female gender, younger age, and more severe malnutrition at time of screening.

These factors are not generally incorporated into therapeutic feeding program guidelines. Further research should be done to investigate the optimal treatment duration and formulation of supplementary foods for children who are younger, female, and more severely malnourished. If these groups can be treated to minimize risk for multiple episodes of malnutrition, the adverse effects of malnutrition will be minimized as well.

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Tables and figures

Table 1. Characteristics of enrolled study participants (n 2518)

Sex	
Male	941(37)
Female	1577(63)
Age	
6-11 months	713 (28)
12-23 months	1143 (45)
24-59 months	658 (26)
Weight, kilograms	7.40±1.58
MUAC*, centimeters	12.2±1.0
Weight-for-height Z-score	-2.30±0.38
Mother is the primary caretaker	2397 (95)
Father lives within the home	1944 (77)
Mother known to be HIV+	228 (9)
Child known to be HIV +	67 (3)
Ever admitted to hospital or inpatient nutrition rehabilitation unit	184 (7)
Twin	133 (5)
HFIAS** Score	6.2±5.2
HFIAS** Category	
Food Secure	449 (18)
Mild Food Insecurity	188 (8)
Moderate Food Insecurity	575 (23)
Severe Food Insecurity	1305 (52)
Total time followed	347±95
Percent change in weight during enrollment	6.83±6.05
Overall percent change in weight over entire follow up period	34.23±17.08
At least one relapse episode	620 (25)
Total number of relapse episodes ^	
0	1463 (58)
1	618 (25)
2	277 (11)
3	130 (5)
4	20 (<1)
5	8 (<1)
6	2 (<1)
Total number of healthy follow ups	
0	247 (10)
1 (3 months post-enrollment)	156 (6)
2 (6 months post-enrollment)	591 (23)

3 (12 months post-enrollment)	1524 (61)
Failure to meet target weight***	241 (10)

Reported values are as follows: n (%), mean ± standard deviation
*MUAC: Mid-Upper Arm Circumference
**HFIAS: Household Food Insecurity Access Scale. HFIAS categories were determined by application of referenced HFIAS manual guidelines.
***Target weight was defined by a weight-for-height Z-score of greater than -2
^A relapse episode was defined as any point after enrollment in which the study participant came to a study site and was measured with a weight-for-height z-score between -2 and -3.

Table 2. Logistic regression model of predictors for failure to recover from MAM *

Independent variable**	Odds ratio (95% CI)
Child is female	3.70 (2.45, 5.58)
Weight-for-height Z-score (continuous)	0.13 (0.08, 0.21)

*MAM: moderate acute malnutrition, defined as a weight-for-height Z-score between -2 and -3
**A full model with all possible predictors as listed in Table 1 was initially run; variables with a P-value of ≤0.10 were retained.

Table 3. Poisson regression model of predictors for acute malnutrition relapse episodes

Independent variable*	Rate Ratio (95% CI)
Child is female (Female = 1)	1.99 (1.63, 2.44)
Weight-for-height Z-score at enrollment (continuous)	0.40 (0.32, 0.52)
Age	0.98 (0.98, 0.99)
Weight increase during enrollment	0.94 (0.93, 0.95)

*A full model with all possible predictors was initially run; variables with a P-value of ≤0.10 were retained.

Table 4. Model predicting overall percent change in weight for entire time followed

Independent Variable*	Coefficient	Standard error	T-value	P-value
Sex (female vs male)	1.80	0.88	2.05	0.04
Age (in months)	-0.35	0.02	-13.01	<0.0001
Weight change during initial 12-week enrollment	0.46	0.05	9.23	<0.0001
Total time followed (in days)	0.06	0.003	18.82	<0.0001
Weight-for-height Z-score (continuous)	-3.52	1.13	-3.12	0.002

*A full model with all possible predictors was initially run; variables with a P-value of ≤0.10 were retained.

Figure 1. Data collection card, side 1

2009 - 2011 Moderate Malnutrition Study - St. Louis Nutrition Project STUDY NUMBER _____

CHILD'S NAME _____ DATE OF BIRTH _____ / _____ / _____

WHZ TARGET WEIGHT _____ (kg) MALE / FEMALE

WEEK	DATE (dd/mm/yy)	LENGTH (cm)	WEIGHT (kg)	MUAC (cm)	EDEMA	FEVER (days)	COUGH (days)	DIARRHEA (days)	VOMIT (days)	Eating Food Well?	HEALTH CENTER/ MEDICINE	COMMENTS
start		; ;			Y / N					Y / N	Y / N	
2		; ;			Y / N					Y / N	Y / N	
4		; ;			Y / N					Y / N	Y / N	
6		; ;			Y / N					Y / N	Y / N	
8		; ;			Y / N					Y / N	Y / N	
10		; ;			Y / N					Y / N	Y / N	
12		; ;			Y / N					Y / N	Y / N	

DEVELOPMENTAL ASSESSMENT:

Start:

Sit up? Y / N Stand alone? Y / N Walk alone? Y / N On 1 foot for 1 second? Y / N Both feet jump? Y / N Dress self (item over head)? Y / N Run? Y / N

Graduation / Finish / Transfer:

Sit up? Y / N Stand alone? Y / N Walk alone? Y / N On 1 foot for 1 second? Y / N Both feet jump? Y / N Dress self (item over head)? Y / N Run? Y / N

Missed: 1) _____ / _____ / _____ Sent message? *Y/N.* **2)** _____ / _____ / _____ Sent message? *Y/N.* **3)** _____ / _____ / _____ Home visit? *Y/N.*

OUTCOME: GRADUATE TRANSFER TO RUTF MISSED 3 CONSECUTIVE VISITS DEATH CHITENJE

on graduation

Figure 2. Data collection card, side 2

2009 - 2011 Moderate Malnutrition Study - St. Louis Nutrition Project

FOOD GROUP: **CHITENJE** / **SOYA** / **RUTF**

1. STUDY SITE: _____

2. VILLAGE HSA: _____

3. CHILD'S NAME _____ STUDY NUMBER: _____

4. Twin*? Y / N *Twins should both be enrolled as sharing is assumed

5. Caregiver: Mother / Grandmother / Aunt / Father / Sibling / Other _____

6. Caregiver's name _____ 7. Mother alive? Y / N 8. Phone #_____

9. Father's name _____ 10. Alive? Y / N 11. In the home? Y / N

12. VILLAGE _____ 13. Directions to home: _____

_____

_____

_____

14. How many children under 5 years of age stay in the house? _____

15. Is the child breastfeeding? Y / N 16. If no, what age did he/she stop? _____

17. Has the child been in the hospital or NRU before? Y / N If yes, when and why?_____

18. Is the child on TB treatment? Y / N

19. Is there an adult in the house being treated for TB? Y / N
*If an adult is being treated, and the child is not being treated- child should be evaluated for TB

20. Child VCT done? Y / N When? _____ Reactive / Non-Reactive

21. Is the child on ART treatment? Y / N 22. Is the child on Cotrimazole prophylaxis? Y / N

23. Mother VCT done? Y / N When? _____ Reactive / Non-Reactive

24. Currently taking antibiotics (Amoxyl, Cotrim/Bactrim, Metro/Flagyl, Penicillin)? Y / N

In the past month, did anyone in your household, due to lack of resources:

25. Worry that you would not have enough food?	No / 1-2 times / 3-10 times / more than 10 times
26 Not eat the kinds of food preferred?	No / 1-2 times / 3-10 times / more than 10 times
27. Eat a limited variety of foods?	No / 1-2 times / 3-10 times / more than 10 times
28. Eat foods that they did not want to eat?	No / 1-2 times / 3-10 times / more than 10 times
29. Eat a smaller meal than needed?	No / 1-2 times / 3-10 times / more than 10 times
30. Eat fewer meals in a day?	No / 1-2 times / 3-10 times / more than 10 times
31. Ever have no food of any kind in the house?	No / 1-2 times / 3-10 times / more than 10 times
32. Go to sleep at night hungry?	No / 1-2 times / 3-10 times / more than 10 times
33. Go a whole day and night without eating?	No / 1-2 times / 3-10 times / more than 10 times