

# Dietary diversity and the lack of household food stocks are diet-related risk factors for leprosy in North-west Bangladesh: a case-control study

A.E.T. van Muiden<sup>1</sup>, I.M. Wagenaar<sup>2</sup>, prof. dr. J.H. Richardus<sup>3</sup> and dr. ir. G. Smant<sup>4</sup>. May 2014.

<sup>1</sup> MSc student Biology of Health and Disease of Wageningen UR, Wageningen, <sup>2</sup> PhD student of the Department of Public Health, Erasmus MC, Rotterdam and daily supervisor, <sup>3</sup> Professor of the Department of Public Health, Erasmus MC, Rotterdam and supervisor and <sup>4</sup> Assistant Professor of the Subdivision of Nematology, Wageningen UR, Wageningen and supervisor.

## Abstract

Although the prevalence of leprosy is decreasing, the elimination target is still not reached in all countries. Leprosy is assumed to be closely associated with poverty, but there is doubt on which aspects of poverty are associated with leprosy susceptibility and progression. Recent food shortage and food shortage ever in life were reported as risk factors for leprosy. The goal of this study is to identify the difference between the food patterns of recently diagnosed leprosy patients and controls in North-west Bangladesh, during the food shortage period from the end of September until the end of November.

A case-control study was performed in the leprosy endemic districts Nilphamari and Rangpur in North-west Bangladesh. Data was collected using a structured questionnaire during home visits. The questions covered demographics, socio-economics, health and diet. Besides, anthropometric measures were taken and a 9-scaled dietary diversity score (DDS) was calculated based on a 24-hour recall. The results were analysed using logistic regression.

Fifty-two leprosy cases and 100 controls were interviewed. The most important health and diet-related factors were the body mass index (BMI), the DDS and the presence of household food stocks. Other significant factors were household food expenditure and square meters of land owned ( $p < 0.10$ ). Combining all factors above in the final model, only food expenditure remained a significant risk factor for leprosy in North-west Bangladesh ( $p = 0.000$ ). A deeper analysis on dietary diversity showed that a lack of 'meat and fish' and 'other fruits and vegetables' in the diet are risk factors for leprosy in North-west Bangladesh ( $p = 0.006$  and  $p = 0.019$  respectively).

In conclusion, this study shows that BMI, DDS and household food stocks are the major health and diet-related risk factors for leprosy. A DDS below 4, a low intake of 'other fruits and vegetables' and a low intake of 'meat and fish' are good predictors for leprosy. Nutritional education can be a potential high-impact approach.

**Keywords:** Leprosy, risk factors, nutrition, diet, food expenditure, case-control, North-west Bangladesh, DDS, HFIAS, food stocks, micronutrients, immune response

## Introduction

Leprosy is one of the 17 neglected tropical diseases<sup>1</sup>, and is an important public health problem in several developing countries. In 1991, the WHO aimed to eliminate leprosy before the year 2000, but did not succeed so far. The elimination rate was set at a prevalence of less than 1 case per 10,000 inhabitants per country<sup>2</sup>. In Bangladesh the disease was officially eliminated in 1998, but prevalence is still above the elimination target in the poorest regions<sup>3</sup>.

There is little knowledge about the risk factors for infection and development of leprosy. An important reason for this is the incubation time of 5 to 15 years

after *Mycobacterium leprae* infection, which makes it very hard to investigate causalities<sup>4, 5</sup>. A well-known risk factor for leprosy is household contact with a (lepromatous) leprosy patient<sup>6, 7</sup>, which could be explained by the fact that genetics play an important role in leprosy susceptibility<sup>8-10</sup>. Also, leprosy is assumed to be closely associated with poverty, although there is no direct correlation<sup>11</sup>.

There is doubt on which aspects of poverty are associated with leprosy susceptibility and progression. Kerr-Pontes *et al.*<sup>12</sup> showed in a case-control study that ever having experienced food shortage was associated with leprosy in Brazil, while Feenstra *et al.*<sup>13</sup> did not find a relation with food shortage ever in life in Bangladesh.

Their results showed however that leprosy was significantly related to the experience of food shortage in the last year<sup>13</sup>. Feenstra *et al.*<sup>13</sup> defined food shortage as a period in which a family had to reduce the number of meals a day or had to reduce the intake of foods other than rice. Feenstra *et al.*<sup>13</sup> registered if this event occurred in the past year (recent), or also or only before that time (ever in life). Kerr-Pontes *et al.*<sup>12</sup> did not state the definition of food shortage in their study and only measures were taken for ever in life experience.

Studies on nutrition in North-West Bangladesh showed that there is seasonal fluctuation in food accessibility and in intake. The strongest seasonal deprivation of energy intake is seen in September-November, the season prior to the major rice harvest<sup>14-16</sup>. During periods of decreased food accessibility, the most common coping strategy is to reduce the dietary diversity<sup>14</sup>.

This study aimed to identify the difference between the food patterns and the nutritional situation of recently diagnosed leprosy patients and controls during the food shortage period from the end of September until the end of November. This all with the purpose to identify the diet related risk factors for the development of leprosy.

## Methods

### Study setting

This case-control study was conducted in the districts Nilphamari and Rangpur in the North West of Bangladesh. Bangladesh is one of the most densely populated and poorest countries in the world, with 43.3 % of the population living below the poverty line of \$ 1.25 per day<sup>17</sup>. Nilphamari and Rangpur are among the poorest regions in Bangladesh<sup>18</sup> and in these regions leprosy is still endemic.

### Study population

Patients were selected from the registration database of DBLM (Danish Bangladesh Leprosy Mission) hospital in Notkhana, Nilphamari. DBLM hospital is a specialised leprosy centre with 25 connected satellite clinics, all part of The Leprosy Mission (TLM) Bangladesh. Data of all patients newly diagnosed in the first half of 2013 was collected from the DBLM database. Only patients between the age of 18 and 50 years were included and a pre-selection was made based on (self-)stigma. In this way, patients that were not at ease with home-visits were excluded.

Controls were randomly selected from the control population of the in 2006 finished COLEP study<sup>19</sup>. During the COLEP study, 1000 inhabitants of 20 villages in

Nilphamari and Rangpur districts participated<sup>19</sup>. For our study, two typical rural villages and one suburban village were selected and per village 34 controls were randomly selected using a computerized sampling method. A selected control who was not at home at the time of the interview, was visited up to two more times. When after the third visit the control was still not interviewed, a neighbour with similar age was interviewed instead. Controls were excluded if they or a family member were ever diagnosed with leprosy and only one control per household could participate.

### Data collection

Data on patients and controls was collected during an interview, using a structured questionnaire, a 24-hour recall and anthropometric measures. Interviews were conducted during home visits by two trained interviewers, fluent in Bengali and English. Both were staff members of the training centre of TLM Bangladesh, Nilphamari.

#### Questionnaire

Each interview started with a structured questionnaire, consisting of general questions about the subject and his/her household and questions on personal health. Also, the Household Food Insecurity Access Survey (HFIAS) was taken, with nine occurrence and nine frequency questions. The HFIAS is a predesigned tool that was developed by the Food and Nutrition Technical Assistance (FANTA)<sup>20</sup>. Finally, questions were asked about the subjects' food shortage history, which were based on the questionnaire used by Feenstra *et al.*<sup>13</sup>. The list of questions was adopted and completed with some supplemental questions.

The questionnaires for cases and controls were developed in English, translated separately by both translators to Bengali and translated back to English by the other translator. The best version of each question was used and optimized. The questions of the HFIAS were kindly provided in Bengali by the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The complete questionnaire was translated to English and minor adjustments were made to optimize. The whole questionnaire was pre-tested on patients and controls and adjusted where necessary. A final test and adjustment round was performed before the study started (see appendix).

#### 24-hour recall

The second part of the interview consisted of a 24-hour dietary recall of the previous day starting from the moment of waking-up. Qualitative nutritional content of all meals and snacks (also outside the household) of the full day was recorded in chronological order. When

an overview of the diet was composed, the interviewers asked more specific information about all consumed items per meal, such as specific content of the recipe, drinks next to the meals and snacks that were consumed in-between meals.

The 24-hour recall was only conducted when the previous day was as usual and not influenced by special occasions. Therefore, no interviews were planned in the week after Eid al-Adha.

#### Anthropometry

Each interview was completed by measuring weight and height of each subject. A portable balance with 0.5 kg accuracy was used to measure weight of subjects without wearing shoes. Subjects were barefooted placed against a wall and the length was measured from crown to floor using measurement tape.

#### Dietary Diversity Score

Results from the 24-hour recall were used to calculate a Dietary Diversity Score (DDS). A DDS with nine food groups, developed and tested by the Food and Agriculture Organization (FAO), was used, with the following food groups: 'Starchy staples', 'Dark green

leafy vegetables', 'Other vitamin A rich fruits and vegetables', 'Other fruits and vegetables', 'Organ meat', 'Meat and fish', 'Eggs', 'Legumes, nuts and seeds' and 'Milk and milk products'. This score is a simple count of the food groups consumed during the previous day, therefore the score could be between 0 and 9<sup>21</sup>.

#### Analysis

The results of the questionnaire, DDS and anthropometric measures were analysed using the Statistical Package for the Social Sciences (SPSS for Windows, release 22.0.0.0, BMI SPSS Inc., Chicago, Illinois). The variables were first tested in a univariate logistic regression with case/control as dependent variable. Based on the characteristics of the variables and results from the univariate logistic regression is a framework composed of four blocks as shown in Figure 1. The first block contains of Demographic factors that have an influence on the Socioeconomic factors of block two. These factors are interconnected with both Health and Diet-related factors. Health and diet are both suspected risk factors for leprosy, but leprosy might also have an (indirect) effect on health and diet.

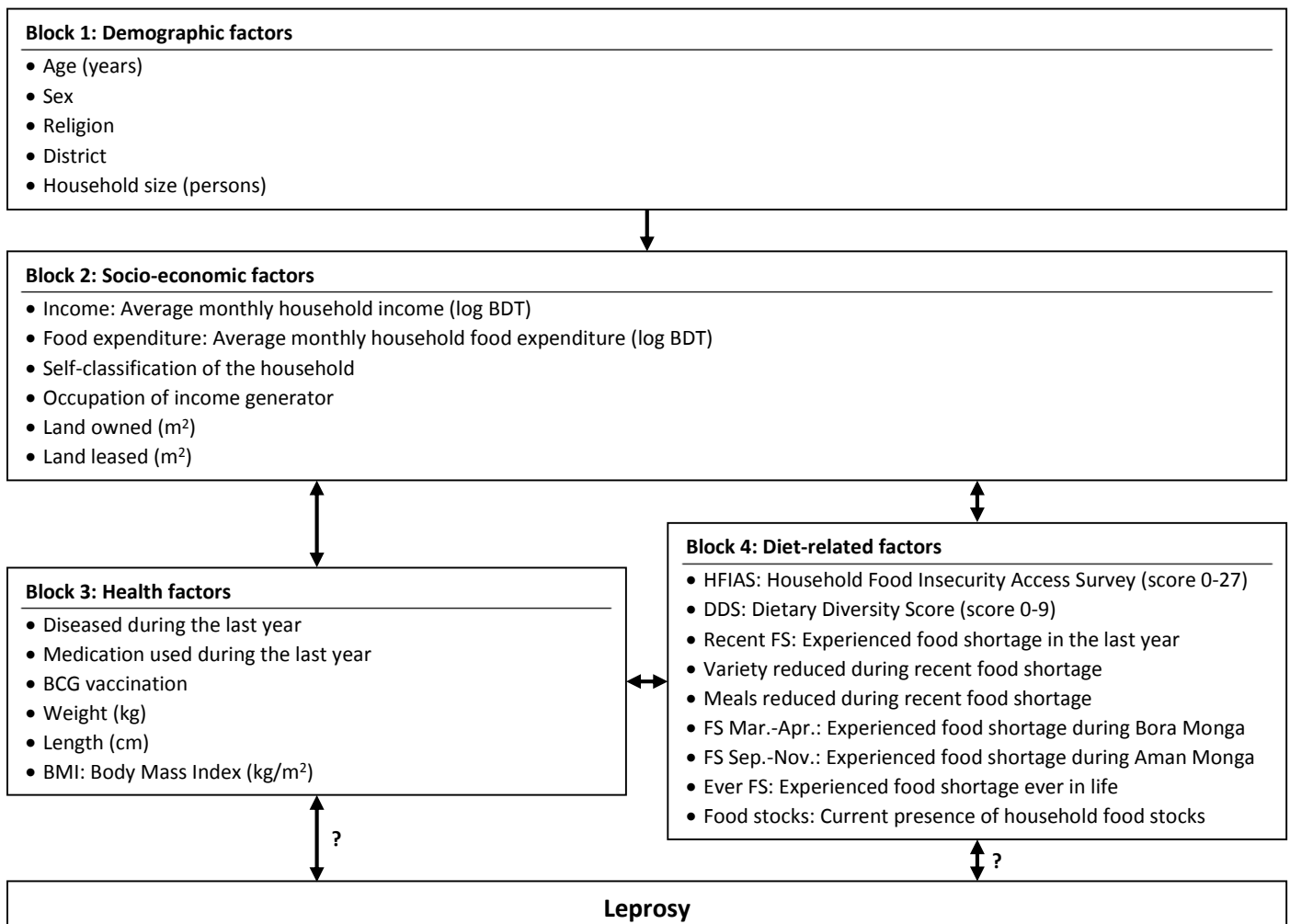


Figure 1 Framework for multivariate logistic regression, consisting of the demographic, socio-economic, health and diet-related block.

Two factors, food expenditure and BMI, were related to several blocks. Food expenditure would fit in both socio-economic as diet related factors. Due to the strong correlation with income, this factor was placed in the socio-economic block. BMI was placed in the health block, and not in the diet related block, because it is a factor that can be influenced by other factors than nutrition. Each block was tested using a blockwise stepwise backwards elimination logistic regression, further on called a multivariate hierarchical analysis. Variables with a p-value above 0.10 were combined in a final model on which again a multivariate hierarchical analysis was performed. Age and sex were always included in the multivariate analyses and were not eliminated.

## Ethical consideration

Ethical approval was given by the institutional review board of TLM Bangladesh, Nilphamari. All participants were informed verbally about the aim and methodology of the study and signed for consent.

## Results

Throughout October and November 2013, 52 leprosy cases and 100 controls were interviewed during home visits. Table 1 shows the characteristics of both groups. To identify the risk factors for leprosy, income was adjusted for the change in income since clinical symptoms appeared and this was the case for 8 (15.4%) patients. The M/F sex ratio was 1.26 for cases and 0.92 for controls and the age distribution in both groups were similar. Compared to the cases, more persons lived in the poorer Nilphamari district in the control group (67.0%). Multibacillary (MB) leprosy was diagnosed by 34.6% of the patients and 28.8% showed leprosy related impairments, the patients who were diagnosed with disability grade 1 and 2.

*Table 1 Demographics and clinical characteristics of leprosy cases and controls presented as N (%).*

Factors		Case N = 52	Control N = 100
Sex	Male	29 (56%)	48 (48%)
	Female	23 (44%)	52 (52%)
Age (years)	18-29	13 (25%)	37 (37%)
	30-39	17 (33%)	27 (27%)
	40-50	22 (42%)	36 (36%)
District	Nilphamari	27 (52%)	67 (67%)
	Rangpur	25 (48%)	33 (33%)
Leprosy type	PB	34 (65%)	-
	MB	18 (35%)	-
Disability grade	0	37 (71%)	-
	1	9 (17%)	-
	2	6 (12%)	-

In Table 2, the result of the univariate and multivariate analysis is shown. The crude OR and the 95% CI of the univariate analysis are shown. The OR and the 95% CI of the multivariate hierarchical analysis per block are shown in the last column of Table 2. Of the demographic factors, religion ( $p = 0.028$ ) and district ( $p = 0.017$ ) are statistically significantly risk-factors for leprosy after hierarchical elimination ( $p < 0.10$ ). Square meters of land owned ( $p = 0.058$ ) and the average monthly household food expenditure (log of BDT) ( $p = 0.000$ ) from the socio-economic block remains significant after hierarchical elimination ( $p < 0.10$ ). Of the diet related factors, the DDS ( $p = 0.024$ ) and the presence of household food stocks ( $p = 0.036$ ) show to be associated with an increased risk for leprosy, while in the health block only BMI ( $p = 0.020$ ) remains significant ( $p < 0.10$ ). The significant variables from each block (Table 2) were inserted into a multivariate logistic regression model. In the first half of Table 3, the OR and their 95% CI are shown for the inserted variables. The OR and 95% CI of the final multivariate regression model after hierarchical elimination are presented in the last column of Table 3. Food expenditure ( $p = 0.000$ ) appears to be the only remaining significant risk factor for leprosy development in North-west Bangladesh in this multivariate analysis.

The socio-economic factors, like food expenditure, are indirect risk-factors for leprosy. Within the health and diet-related blocks, BMI, DDS and the presence of household food stocks remain significant in the multivariate analysis. The DDS is a composed variable, based on scoring in nine food groups. Therefore, the individual food groups were examined and the scores, crude ORs and 95% CIs are shown in Table 4. The consumption of 'Other fruits and vegetables' ( $p = 0.019$ ) and 'Meat and fish' ( $p = 0.006$ ) are statistically associated with a decreased risk for leprosy.

There is no officially established DDS cut-off point to indicate adequate or inadequate dietary diversity<sup>21</sup>, but a DDS equal or above 4 or 5 is often used to indicate sufficiency. In Figure 2, the percentages of subjects with an adequate diet are shown for both cut-off values. For a DDS equal or above 4, 30.8 % of the cases would have an adequate diet, while this is 54.0 % for the controls. For this cut-off point, a significant difference was found ( $p = 0.007$ ). A DDS equal or above 5 resulted in an adequate diet for 17.3 % of the cases and 25.0 % of the controls. Here, no significant difference was found ( $p = 0.283$ ).

CONFIDENTIAL

Table 2 Results of the univariate logistic regression and the blockwise stepwise backwards elimination analysis.

Factors		Case N = 52	Control N = 100	Univariate analysis		Multivariate analysis	
				Crude OR (95% CI)	p-value	OR (95% CI)	p-value
<b>Block 1: Demographic factors</b>							
Age (years) <sup>a</sup>		35.0 ± 9.5	33.3 ± 10.4	1.02 (0.98 - 1.05)	0.331		
Sex <sup>b</sup>	Male	29 (56%)	48 (48%)	1.00			
	Female	23 (44%)	52 (52%)	0.73 (0.37 - 1.44)	0.364		
Religion <sup>b</sup>	Muslim	40 (77%)	88 (88%)	1.00			
	Hindu	12 (23%)	12 (12%)	2.20 (0.91 - 5.32)	0.080	2.85 (1.12 - 7.27)	0.028
District <sup>b</sup>	Nilphamari	27 (52%)	67 (67%)	1.00			
	Rangpur	25 (48%)	33 (33%)	1.88 (0.95 - 3.73)	0.071	2.46 (1.17 - 5.17)	0.017
Household size (persons) <sup>b</sup>		4.6 ± 1.4	5.2 ± 2.1	0.82 (0.67 - 1.01)	0.066		
<b>Block 2: Socio-economic factors</b>							
Income (log BDT) <sup>a</sup>		3.61 ± 0.30	3.81 ± 0.30	0.12 (0.03 - 0.40)	0.000		
Food expenditure (log BDT) <sup>a</sup>		3.61 ± 0.19	3.77 ± 0.20	0.02 (0.00 - 0.13)	0.000	0.02 (0.00 - 0.16)	0.000
Self-classification <sup>b</sup>	Very poor	17 (33%)	14 (14%)	1.00	0.004		
	Poor	21 (40%)	29 (29%)	0.60 (0.24 - 1.47)	0.262		
	Low middle income	11 (21%)	35 (35%)	0.26 (0.10 - 0.69)	0.007		
	Middle income	3 (6%)	22 (22%)	0.11 (0.03 - 0.46)	0.002		
	Rich	0 (0%)	0 (0%)	-	-	-	
	Very rich	0 (0%)	0 (0%)	-	-	-	
Occupation <sup>b</sup>	Labourer	26 (50%)	28 (28%)	1.00	0.029		
	Shopkeeper / Small business	10 (19%)	13 (13%)	0.83 (0.31 - 2.21)	0.707		
	Other	8 (15%)	25 (25%)	0.35 (0.13 - 0.90)	0.029		
	Farmer	5 (10%)	19 (19%)	0.28 (0.09 - 0.87)	0.027		
	Business	3 (6%)	15 (15%)	0.22 (0.06 - 0.83)	0.026		
Land owned (m <sup>2</sup> ) <sup>a</sup>		9.6 ± 30.0	78.1 ± 168.4	0.99 (0.98 - 1.00)	0.032	0.99 (0.98 - 1.00)	0.058
Land leased (m <sup>2</sup> ) <sup>a</sup>		3.5 ± 11.5	4.1 ± 16.2	1.00 (0.97 - 1.02)	0.811		

a. Scale variable presented as mean ± standard deviation.

b. Categorical variable presented as N (%).

c. Factors related to the last year.

CONFIDENTIAL

Table 2 Continued.

Factors		Case N = 52	Control N = 100	Univariate analysis		Multivariate analysis	
				Crude OR (95% CI)	p-value	OR (95% CI)	p-value
<b>Block 3: Health factors</b>							
Diseased <sup>b,c</sup>	No	24 (46%)	49 (49%)	1.00			
	Yes	28 (54%)	51 (51%)	1.12 (0.57 - 2.19)	0.739		
Medication <sup>b,c</sup>	No	21 (40%)	51 (51%)	1.00			
	Yes	31 (60%)	49 (49%)	1.54 (0.78 - 3.03)	0.215		
BCG <sup>b</sup>	No	26 (50%)	46 (46%)	1.00			
	Yes	26 (50%)	54 (54%)	0.85 (0.44 - 1.67)	0.639		
Weight (kg) <sup>a</sup>		50.0 ± 10.0	52.7 ± 8.9	0.97 (0.93 - 1.01)	0.098		
Length (cm) <sup>a</sup>		156.7 ± 10.1	156.1 ± 8.0	1.01 (0.97 - 1.05)	0.684		
BMI (kg/m <sup>2</sup> ) <sup>a</sup>		20.3 ± 3.1	21.6 ± 3.0	0.86 (0.77 - 0.97)	0.017	0.87 (0.77 - 0.98)	0.020
<b>Block 4: Diet-related factors</b>							
HFIAS (score 0-27) <sup>a</sup>		10.2 ± 7.4	6.4 ± 7.0	1.08 (1.03 - 1.13)	0.003		
DDS (score 0-9) <sup>a</sup>		3.2 ± 1.1	3.8 ± 1.4	0.67 (0.51 - 0.90)	0.007	0.71 (0.52 - 0.96)	0.024
Recent FS <sup>b,c</sup>	No	10 (19%)	36 (36%)	1.00			
	Yes	42 (81%)	64 (64%)	2.36 (1.06 - 5.27)	0.036		
Variety reduced <sup>b,c</sup>	No	10 (19%)	38 (38%)	1.00			
	Yes	42 (81%)	62 (62%)	2.57 (1.16 - 5.72)	0.020		
Meals reduced <sup>b,c</sup>	No	17 (33%)	55 (55%)	1.00			
	Yes	35 (67%)	45 (45%)	2.52 (1.25 - 5.07)	0.010		
FS Mar.-Apr. <sup>b,c</sup>	No	36 (69%)	75 (76%)	1.00			
	Yes	16 (31%)	24 (24%)	1.39 (0.66 - 2.93)	0.389		
FS Sep.-Nov. <sup>b,c</sup>	No	19 (37%)	46 (47%)	1.00			
	Yes	33 (64%)	53 (54%)	1.51 (0.76 - 3.00)	0.243		
Ever FS <sup>b</sup>	No	2 (4%)	16 (16%)	1.00			
	Yes	50 (96%)	84 (84%)	4.76 (1.05 - 21.58)	0.043		
Food stocks <sup>b</sup>	No	25 (48%)	26 (26%)	1.00			
	Yes	27 (52%)	74 (74%)	0.38 (0.19 - 0.77)	0.007	0.45 (0.22 - 0.95)	0.036

a. Scale variable presented as mean ± standard deviation.

b. Categorical variable presented as N (%).

c. Factors related to the last year.

Table 3 Results of the combined multivariate logistic regression containing the significant variables of the blockwise multivariate analysis.

Factors		Before hierarchical elimination		After hierarchical elimination	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Religion	Muslim	1.00			
	Hindu	2.12 (0.74 - 6.08)	0.161	-	-
District	Nilphamari	1.00			
	Rangpur	2.37 (1.03 - 5.48)	0.043	-	-
Food expenditure		0.06 (0.01 - 0.68)	0.087	-	-
Land owned		0.99 (0.99 - 1.00)	0.023	0.01 (0.00 - 0.10)	0.000
BMI		0.90 (0.78 - 1.04)	0.166	-	-
DDS		0.89 (0.62 - 1.28)	0.525	-	-
Household food stocks	No	1.00			
	Yes	0.69 (0.31 - 1.56)	0.376	-	-
Age		1.02 (0.98 - 1.06)	0.426	1.02 (0.98 - 1.06)	0.395
Seks	Male	1.00			
	Female	0.46 (0.20 - 1.03)	0.059	0.51 (0.24 - 1.09)	0.081

## Discussion

The results of the study were based on a framework of factors that were suspected to have a relation with the development of leprosy. Average household food expenditure was the only remaining factor with high significance in the multivariate analysis. The food expenditure of the household is a socio-economic factor, of which it is assumed that they have an indirect effect on the development of leprosy. Therefore, the factors with high multivariate significance within their block of reference might be as important. DDS, the presence of household food stocks, the BMI of the subject, the square meters of land owned, religion and the district where the person lives. But also other aspects that did not show up in the final model, but with high univariate significance, might increase the risk to

develop leprosy. Examples are the average income of the household ( $p = 0.000$ ), food shortage in the last year ( $p = 0.036$ ) and food shortage ever in life ( $p = 0.045$ ). These variables were highly correlated with other variables and therefore eliminated from the model. Food expenditure showed very high correlations with all factors from the socio-economic block and the diet related block.

Significant diet-related factors were DDS and the presence of household food stocks. These factors are, as the significant socio-economic factors, related to the available amount of food. DDS in terms of diversity and household food stocks can be used to overcome food shortages in periods of low income, high prices or low availability. Based on the results of other studies, we expected that recent food shortage and food shortage

Table 4 Diversity of the diet presented as N (%).

Factors		Case	Control	Univariate analysis	
		N = 52	N = 100	Crude OR (95% CI)	p-value
Starchy staples	No	0 (0%)	0 (0%)	1.00	
	Yes	52 (100%)	100 (100%)	- -	-
Dark green leafy vegetables	No	34 (65%)	62 (62%)	1.00	
	Yes	18 (35%)	38 (38%)	0.86 (0.43 - 1.74)	0.682
Other vitamin A rich fruits and vegetables	No	52 (100%)	99 (99%)	1.00	
	Yes	0 (0%)	1 (1%)	0.00 (0.00 - 0.00)	1.000
Other fruits and vegetables	No	15 (29%)	13 (13%)	1.00	
	Yes	37 (71%)	87 (87%)	0.37 (0.16 - 0.85)	0.019
Organ meat	No	52 (100%)	98 (98%)	1.00	
	Yes	0 (0%)	2 (2%)	0.00 (0.00 - 0.00)	0.999
Meat and fish	No	27 (52%)	29 (29%)	1.00	
	Yes	25 (48%)	71 (71%)	0.38 (0.19 - 0.76)	0.006
Eggs	No	44 (85%)	77 (77%)	1.00	
	Yes	8 (15%)	23 (23%)	0.61 (0.25 - 1.48)	0.272
Legumes. nuts and seeds	No	36 (69%)	71 (71%)	1.00	
	Yes	16 (31%)	29 (29%)	1.09 (0.52 - 2.26)	0.821
Milk and milk products	No	43 (83%)	72 (72%)	1.00	
	Yes	9 (17%)	28 (28%)	1.86 (0.80 - 4.31)	0.149



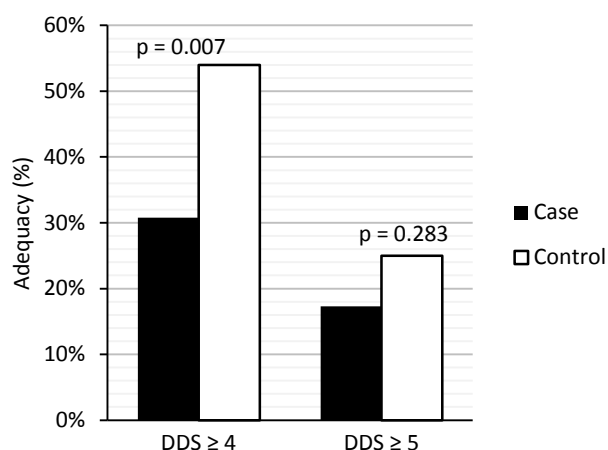


Figure 2 Percentage of subjects with an adequate diet based on the DDS cut-off value.

development of leprosy. This was not found in the hierarchical multivariate analysis, although both factors are significant risk factors for development of leprosy in univariate analysis.

The only identified significant health factor was BMI. A low BMI indicates the consumed amount of food is too low, but is not an acute health indicator. The subject has probably experienced food shortages more recently. However, recent or ever food shortage was not found to be a significant variable in the diet-related block. In the univariate analysis, both food shortages were significantly more occurring in cases than controls. BCG was not identified to have a significant effect on being a case or control, while it has been a widely used to protect for leprosy. Many studies established that BCG has a protective effect against leprosy<sup>11, 12, 22</sup>.

Significant socio-economic factors were food expenditure and square meters of land owned. These variables are both related to how much food was available for the subjects household, whether the food was bought or produced on their own land. The square meters of land leased was not found to be significant in the final model. Land owned is correlated with wealth, but is not eliminated in the model. It might therefore be that produced food on leased land must be sold to be able to pay the rent of the land, while owned land has no costs and therefore the food can be used for own purposes.

Significant demographic factors were religion and district, which might be caused by the differences in lifestyle and income between Hindus and Muslims. Besides, there were relatively more Hindus in the case group (23 %), than in the control group (12 %) and relatively more controls came from Nilphamari.

The major limitation of this study is that data was collected after diagnosis and, especially with the long incubation time of leprosy, it will never be completely

clear what were the exact causalities. This has been tried to overcome by only including recently diagnosed cases and correcting for changed income. Secondly, 9 patients indicated that their diet changed since the diagnosis of leprosy. This change (either positive or negative) was often caused by a new intra-household distribution. The questions related to food shortage were answered on household level rather than on an individual base. Therefore, the 9 cases were not excluded from the analysis. Third, a 24-hour dietary recall was conducted to establish the subjects' diet and the HFIAS questions similarly only covered a short recent period (last 4 weeks), while the rest of the questionnaire focussed on the last year and longer ago. This has been chosen to limit the bias of memory. A fourth limitation is that the results of a questionnaire are subjective and might therefore be easily influenced. This effect was reduced by using the same questionnaire for cases and controls and using only two trained interviewers to conduct the interviews.

The aim and set-up of this study were based on the results of Feenstra *et al.*<sup>13</sup>, who found that a recent period of food shortage was significantly associated with leprosy in the same region in Bangladesh as this study. Kerr-Pontes *et al.*<sup>12</sup> found that experienced food shortage ever in life was significantly associated with leprosy in Brazil. However, in this study recent and ever in life food shortages were not associated with leprosy in multivariate analysis. Both factors were significant in the univariate analysis ( $p = 0.036$  and  $p = 0.043$  respectively). Compared to Feenstra *et al.*<sup>13</sup>, a higher percentage of subjects experienced food shortage in the last year (69.7 % compared to 39.4 %) and ever in life (88.1 % compared to 63.3 %). This is a remarkable difference, because both studies were conducted in the same region. This can be caused due to the fact this study was conducted four years later, in a period with large shifts in income and food prices. Another difference can be the different period of data collection and therefore the perception of the subjects. Feenstra *et al.*<sup>13</sup> took the interviews before the major food shortage period (August), while the interviews in this study were conducted during the major food shortage period (October and November). The major difference is that this study focused on multiple diet-related factors, which all were taken into account in the multivariate analysis. Both types of food shortage were eliminated, because other diet-related factors (e.g. DDS and household food stocks) had a stronger association with leprosy.

The DDS was one of the significant diet-related risk factors. Analysis on the adequate diversity of the diet for leprosy patients showed that 30.8 % of the cases



would have an adequate diet, while 54.0 % of the controls would have an adequate diet when a DDS equal or above 4 is used ( $p = 0.007$ ). A DDS score below 4 might be a good indicator for disease prediction. More detailed analysis of the DDS was performed on the 9 food groups of which the DDS consists. This showed that 'other fruits and vegetables' and 'meat and fish' had a protective effect against leprosy. For 'other fruits and vegetables' this can be related to the content of vitamin B, C and K in the diet, but the type of micronutrients is depending on the type of fruit or vegetable consumed<sup>23</sup>. For 'meat and fish' this can be related to the content of vitamin D, iron, zinc and selenium in the diet<sup>23</sup>.

Inadequate food intake has previously been linked to tuberculosis, another mycobacterial disease, where it is found that malnutrition affects the cell mediated immunity (CMI) to *Mycobacterium tuberculosis*. Altered CMI is related to development of the clinical disease, and not to the infection with the bacterium<sup>24,25</sup>. Development of leprosy is suppressed by macrophages, which are part of the CMI<sup>26</sup>. A change in the macrophage count or functioning due to the diet could be related to leprosy development. A review by Passos Vázquez *et al.*<sup>23</sup> indicates that antioxidants and immune modulatory nutrients can influence the development of leprosy.

In conclusion, this study shows that BMI, DDS and household food stocks are the major health and diet-related risk factors for leprosy. The average household food expenditure was found to be the most significant risk factor for leprosy in a multivariate analysis. However, the close link between food expenditure and food intake makes the assumption that malnutrition is a risk factor for leprosy development stronger. The immunological mechanism for the found results remains unclear, but there are two suspected options. First food shortage, especially the lack of certain micronutrients, can suppress the immune response and therefore clinical symptoms of the disease can develop. Another option can be that the period of abundance after a period of food shortage can cause immune reconstitution and thereby to recognition of *M. leprae* by the immune system.

Although it remains difficult to break through the vicious cycle<sup>27</sup>, the importance of a diverse diet and the key components of nutrition should be educated, specifically to leprosy contacts, to reduce the development of clinical leprosy. During focus groups discussions it became apparent that women do know what type of foods are important for children, but not for adults. Nutritional education would also influence other aspects of health and a good program can therefore be a potential high-impact approach. Another

suitable intervention can be to supply high quality foods or a small piece of land to produce their own foods.

A follow-up study on nutritional intake in the region would be the most interesting. The nutritional measures should contain next to qualitative intake, quantitative intake and be repeated regularly. Ideally blood-serum samples should be taken, to measure the presence of essential micronutrients. Regular screening for leprosy should be conducted to establish the diseased people and treat them as soon as possible. It is important to establish at what period the first symptoms started and what the nutritional situation at that time was.

## Acknowledgements

We thank dr. ir. I.D. Brouwer of Wagenin UR for her help with the study design, dr. A. Geluk of LUMC for her help in understanding the immunological escaping techniques of *M. leprae* and ir. C.W.N. Looman for his help with the statistical study design.

Special thanks for the staff of The Leprosy Mission Bangladesh in Nilphamari for their help with the development of the questionnaire and the conduction of the interviews.

Personally, I would like to thank I.M. Wagenaar and prof. dr. J.H. Richardus, who supported me during the whole process.

This research was supported by a grant of the Q.M. Gastmann-Wichers-Foundation, who were not involved in the study.

## References

1. WHO. *Neglected tropical diseases - About us*. 2014 [cited 2014 January 16]; Available from: [http://www.who.int/neglected\\_diseases/about/en/](http://www.who.int/neglected_diseases/about/en/).
2. WHO. *Leprosy elimination - Leprosy Today*. 2014 [cited 2014 January 16]; Available from: <http://www.who.int/lep/en/>.
3. Withington, S., et al., *Current status of leprosy and leprosy control in Bangladesh: an ongoing collaboration*. Leprosy review, 2005. **76**(3): p. 209-219.
4. ILEP, *How to diagnose and treat leprosy*. 2001, The international federation of anti-leprosy associations (ILEP): London.
5. Britton, W.L., DN *Leprosy*. Lancet, 2004. **363**(9416): p. 1209-19.
6. Rao, P., et al., *Impact of MDT on incidence rates of leprosy among household contacts. Part 1. Baseline data*. Int. J. Lepr, 1989. **57**: p. 647-651.
7. Van Beers, S.M., M. Hatta, and P.R. Klatser, *Patient contact is the major determinant in incident leprosy: implications for future control*. International Journal of Leprosy and Other Mycobacterial Diseases, 1999. **67**(2): p. 119-128.

8. Mira, M.T., et al., *Chromosome 6q25 is linked to susceptibility to leprosy in a Vietnamese population*. Nature genetics, 2003. **33**(3): p. 412-415.
9. Siddiqui, M.R., et al., *A major susceptibility locus for leprosy in India maps to chromosome 10p13*. Nature genetics, 2001. **27**(4): p. 439-441.
10. Tosh, K., et al., *A region of chromosome 20 is linked to leprosy susceptibility in a South Indian population*. Journal of Infectious Diseases, 2002. **186**(8): p. 1190-1193.
11. Lockwood, D.N., *Commentary: leprosy and poverty*. International Journal of Epidemiology, 2004. **33**(2): p. 269-270.
12. Kerr-Pontes, L.R., et al., *Socioeconomic, environmental, and behavioural risk factors for leprosy in North-east Brazil: results of a case-control study*. International journal of epidemiology, 2006. **35**(4): p. 994-1000.
13. Feenstra, S.G., et al., *Recent food shortage is associated with leprosy disease in Bangladesh: a case-control study*. PLoS neglected tropical diseases, 2011. **5**(5): p. e1029.
14. Hillbruner, C. and R. Egan, *Seasonality, household food security, and nutritional status in Dinajpur, Bangladesh*. Food & Nutrition Bulletin, 2008. **29**(3): p. 221-231.
15. Khandker, S.R., *Poverty and income seasonality in Bangladesh*. 2009.
16. Tetens, I., et al., *Rice-based diets in rural Bangladesh: how do different age and sex groups adapt to seasonal changes in energy intake?* The American journal of clinical nutrition, 2003. **78**(3): p. 406-413.
17. Worldbank, T. *Data - Bangladesh*. 2010 [cited 2014 May 8]; Available from: <http://data.worldbank.org/country/bangladesh>.
18. Rahman, M.H. and M.S. Hossain, *Convergence in per capita income across regions in Bangladesh*. The Bangladesh Development Studies, 32 (1), 2009: p. 45-60.
19. Moet, F.J., et al., *The prevalence of previously undiagnosed leprosy in the general population of northwest Bangladesh*. PLoS neglected tropical diseases, 2008. **2**(2): p. e198.
20. Coates, J.S., Anne and Bilinsky, Paula, *Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3)*. 2007, FHI 360/FANTA.: Washington, D.C.
21. FAO, *Guidelines for measuring household and individual dietary diversity*. 2011, Food and Agriculture Organization of the United Nations (FAO) Rome.
22. Setia, M.S., et al., *The role of BCG in prevention of leprosy: a meta-analysis*. The Lancet infectious diseases, 2006. **6**(3): p. 162-170.
23. Passos Vázquez, C.M., et al., *Micronutrients influencing the immune response in leprosy*. Nutricion Hospitalaria, 2014. **29**(1).
24. Cegielski, J. and D. McMurray, *The relationship between malnutrition and tuberculosis: evidence from studies in humans and experimental animals*. The International Journal of Tuberculosis and Lung Disease, 2004. **8**(3): p. 286-298.
25. Metcalfe, N., *A study of tuberculosis, malnutrition and gender in Sri Lanka*. Transactions of the Royal Society of Tropical Medicine and Hygiene, 2005. **99**(2): p. 115-119.
26. Walker, S. and D. Lockwood, *The clinical and immunological features of leprosy*. British medical bulletin, 2006. **77**(1): p. 103-121.
27. Schaible, U.E. and H. Stefan, *Malnutrition and infection: complex mechanisms and global impacts*. PLoS Medicine, 2007. **4**(5): p. e115.

## Appendix

## Questionnaire Food Shortage

## a. General Information (can be filled in before the visit)

1	Name:	Age:	Sex: <input type="checkbox"/> Male <input type="checkbox"/> Female
2 <i>Case only</i>	Registration number:		
3 <i>Case only</i>	Date of diagnosis:	Start of symptoms (delay):	
4 <i>Case only</i>	Type of leprosy WHO classification:	<input type="checkbox"/> PB <input type="checkbox"/> MB	
	Type of leprosy Ridley Jopling classification:	<input type="checkbox"/> TT <input type="checkbox"/> BT <input type="checkbox"/> BB <input type="checkbox"/> BL <input type="checkbox"/> LL	
5 <i>Case only</i>	Disability Grade: <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2	Completed MDT?	<input type="checkbox"/> Yes <input type="checkbox"/> No
6 <i>Case only</i>	Involved in trial?	<input type="checkbox"/> Yes:	<input type="checkbox"/> No
7	Village:	Union:	Upazela: District:
8	Date of interview:     /     /2013	Initials interviewer:	
9	Reason in case interview is not done:		
10 <i>Control only</i>	Do you know anyone that is diagnosed with leprosy? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes:     Who? <input type="checkbox"/> Family member → Stop interview, exclude the control <input type="checkbox"/> Neighbour <input type="checkbox"/> Friend <input type="checkbox"/> Other:		

## b. Household

11	Religion: <input type="checkbox"/> Muslim <input type="checkbox"/> Hindu <input type="checkbox"/> Christian <input type="checkbox"/> Other	
12	Household size (# of people that eat here):	Number of adults (above 18):

## c. Occupation and income

13	What is <b>your</b> (Y) occupation? What is the occupation of the <b>income generator</b> (IG) ?
	<input type="checkbox"/> Student <input type="checkbox"/> Shopkeeper/small business <input type="checkbox"/> Other: <input type="checkbox"/> Housewife <input type="checkbox"/> Teacher <input type="checkbox"/> Labourer → Land leaser <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Fishermen <input type="checkbox"/> Government official <input type="checkbox"/> Farmer → Land owner? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Business <input type="checkbox"/> No job      Chotoc? ( DM):
14	What is the average monthly income of the household? Tk
15	Is there variation in the monthly income? <input type="checkbox"/> Yes <input type="checkbox"/> No <i>If yes: Minimum income: Tk Maximum income: Tk</i> <i>When do you generally experience the minimum income?</i>
16	You can write any remarks or comments about income here:
17	What amount of money do you spend monthly on food? Tk
18 <i>Case only</i>	Has your income changed since the diagnosis of leprosy? <input type="checkbox"/> Yes <input type="checkbox"/> No <i>If yes: What is the difference? +/- Tk</i>
19	How would you classify your household? (answered by patient) <input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Low middle income <input type="checkbox"/> Middle income <input type="checkbox"/> Rich <input type="checkbox"/> Very rich
20	How would you classify the household? (answered by interviewer when different) <input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Low middle income <input type="checkbox"/> Middle income <input type="checkbox"/> Rich <input type="checkbox"/> Very rich

## d. Health

21	Do you suffer from any disease or did you during the last year? <input type="checkbox"/> Yes <input type="checkbox"/> No <i>If yes: What disease do/did you have?</i>  <i>When did you have it?</i>
22	Do you or did you use medications in the last year? <input type="checkbox"/> Yes <input type="checkbox"/> No <i>If yes: What? (ask to see the medication) or for which disease?</i>
23	Did you receive a BCG vaccination? (check scar) <input type="checkbox"/> Yes <input type="checkbox"/> No
24 <i>Women only</i>	Were you pregnant during the last year or are you now? <input type="checkbox"/> Yes <input type="checkbox"/> No Do you currently give breastfeeding? <input type="checkbox"/> Yes <input type="checkbox"/> No

**e. HFIAS**

*The following questions will be about your food pattern and feeling regarding this, during the last 4 weeks (30 days).*

25	In the past 4 weeks (30 days), did you worry that your household would not have enough food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 26
25a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
26	In the past 4 weeks (30 days), were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 27
26a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
27	In the past 4 weeks (30 days), did you or any household member have to eat a limited variety of foods due to a lack of resources?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 28
27a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
28	In the past 4 weeks (30 days), did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 29
28a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
29	In the past 4 weeks (30 days), did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 30
29a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
30	In the past 4 weeks (30 days), did you or any household member have to eat fewer meals in a day because there was not enough food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 31
30a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
31	In the past 4 weeks (30 days), was there ever no food to eat of any kind in your house because of lack of resources to get food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 32
31a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times)	

CONFIDENTIAL

		<input type="checkbox"/> Often (more than 10 times)	
32	In the past 4 weeks (30 days), did you or any household member go to sleep at night hungry because there was not enough food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 33
32a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	
33	In the past 4 weeks (30 days), did you or any household member go a whole day and night without eating anything because there was not enough food?	<input type="checkbox"/> No <input type="checkbox"/> Yes	→ 34
33a	How often did this happen?	<input type="checkbox"/> Rarely (1–2 times) <input type="checkbox"/> Sometimes (3–10 times) <input type="checkbox"/> Often (more than 10 times)	

**f. If questions 27, 29 and 30 are answered with 'Yes', please answer the following questions**

34	27	<p><i>You said you had to eat a limited variety of food, what type of food did you have to give up (compared to normal)?</i></p> <p><input type="checkbox"/> Meat</p> <p><input type="checkbox"/> Fish</p> <p><input type="checkbox"/> Vegetables: .....</p> <p><input type="checkbox"/> Fruits: .....</p> <p><input type="checkbox"/> Lentil</p> <p><input type="checkbox"/> Egg</p> <p><input type="checkbox"/> Milk</p> <p><input type="checkbox"/> Other: .....</p>									
35	29	<p><i>You said you had to eat smaller quantities, can you explain what the difference is?</i></p> <p><i>Normal amount of rice:</i></p> <p><i>Amount of rice now:</i></p>									
36	30	<p><i>You said you had to eat fewer meals a day, how many meals do you eat in a normal period, and how many meals do you eat during shortage period?</i></p> <table style="width: 100%;"> <tr> <td style="width: 50%;"><i>Normally</i></td> <td style="width: 50%;"><i>Shortage period</i></td> </tr> <tr> <td><input type="checkbox"/> 1</td> <td><input type="checkbox"/> 0</td> </tr> <tr> <td><input type="checkbox"/> 2</td> <td><input type="checkbox"/> 1</td> </tr> <tr> <td><input type="checkbox"/> 3</td> <td><input type="checkbox"/> 2</td> </tr> </table>		<i>Normally</i>	<i>Shortage period</i>	<input type="checkbox"/> 1	<input type="checkbox"/> 0	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 3	<input type="checkbox"/> 2
<i>Normally</i>	<i>Shortage period</i>										
<input type="checkbox"/> 1	<input type="checkbox"/> 0										
<input type="checkbox"/> 2	<input type="checkbox"/> 1										
<input type="checkbox"/> 3	<input type="checkbox"/> 2										

**g. Food**

The last questions were about a recent period of 4 weeks, the following questions will be about periods longer ago. Food shortage in this questions is defined as 'a period in which your family had to reduce the number of meals a day or have to give up/reduce the intake of certain types of foods.

37	<p>Has your household experienced food shortage during the last year? <input type="checkbox"/> Yes <input type="checkbox"/> No → Question 38</p> <p><i>If yes: Did you reduce the number of meals? Did you also reduce the intake of certain types of foods?</i></p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <table border="0"> <tr> <td><i>Normally</i></td><td><i>Shortage period</i></td><td><i>What foods?</i></td><td></td><td></td></tr> <tr> <td><input type="checkbox"/> 1</td><td><input type="checkbox"/> 0</td><td><input type="checkbox"/> Rice</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td><input type="checkbox"/> 2</td><td><input type="checkbox"/> 1</td><td><input type="checkbox"/> Meat</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td><input type="checkbox"/> 3</td><td><input type="checkbox"/> 2</td><td><input type="checkbox"/> Fish</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td></td><td></td><td><input type="checkbox"/> Vegetables: .....</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td></td><td></td><td><input type="checkbox"/> Fruits: .....</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td></td><td></td><td><input type="checkbox"/> Lentil</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td></td><td></td><td><input type="checkbox"/> Egg</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td></td><td></td><td><input type="checkbox"/> Milk</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> <tr> <td></td><td></td><td><input type="checkbox"/> Other:.....</td><td><input type="checkbox"/> Reduce</td><td><input type="checkbox"/> Give up</td></tr> </table> <p>When did this take place (month)? 2012/2013</p> <p>How long is the period that you experienced food shortage?</p> <p>Did this occur more often in your life? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p><i>If yes: in the same period every time?</i> <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p><i>If no: in what year was the food shortage the worst?</i> → Question 39</p>	<i>Normally</i>	<i>Shortage period</i>	<i>What foods?</i>			<input type="checkbox"/> 1	<input type="checkbox"/> 0	<input type="checkbox"/> Rice	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> Meat	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> Fish	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up			<input type="checkbox"/> Vegetables: .....	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up			<input type="checkbox"/> Fruits: .....	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up			<input type="checkbox"/> Lentil	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up			<input type="checkbox"/> Egg	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up			<input type="checkbox"/> Milk	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up			<input type="checkbox"/> Other:.....	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up
<i>Normally</i>	<i>Shortage period</i>	<i>What foods?</i>																																																	
<input type="checkbox"/> 1	<input type="checkbox"/> 0	<input type="checkbox"/> Rice	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> Meat	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> Fish	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
		<input type="checkbox"/> Vegetables: .....	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
		<input type="checkbox"/> Fruits: .....	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
		<input type="checkbox"/> Lentil	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
		<input type="checkbox"/> Egg	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
		<input type="checkbox"/> Milk	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
		<input type="checkbox"/> Other:.....	<input type="checkbox"/> Reduce	<input type="checkbox"/> Give up																																															
38	<p>Have you or anyone of your household experienced food shortage ever in life? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p><i>If yes: When did this take place (year/ periods)?</i></p> <p><i>How long is the period that you experienced food shortage?</i></p>																																																		
39	<p>Do you have household food stocks? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p><i>If yes: How long will you be able to eat from this?</i></p>																																																		
40	<p>Did your food intake change since you were diagnosed with leprosy? <input type="checkbox"/> No <input type="checkbox"/> Less <input type="checkbox"/> More</p> <p><i>If yes: Was this due to a change in income?</i> <input type="checkbox"/> Yes <input type="checkbox"/> No</p>																																																		



**h. 24 hour recall**

Lastly, we would like you to ask to describe everything that you ate and drank yesterday during the day or night, whether at home or outside the home. It is important you tell every detail, even if it is small. And it is easiest if you start at breakfast till the time that you go to sleep.

*For the interviewer: Ask generally what the subject has eaten, when he/she finishes ask for more (breakfast, lunch, dinner, snacks, drinks, or obvious things they forgot (like dal and rice).*

*Then you can ask the details:*

*If the respondent mentions general term like 'vegetables' ask what kind.*

*If respondent mentions mixed dishes like sauce or stew, ask what ingredients were in that dish*

**Always ask: anything else?..**

*General (English or English transcript of bangla)*

<b>Breakfast</b>	
<b>Snack</b>	
<b>Lunch</b>	
<b>Snack</b>	
<b>Diner</b>	
<b>Snack</b>	

*Specifically*

<b>Bangla</b>	<b>English</b>

**i. Weight and height**

41	Weight (kg):	Height (m):
----	--------------	-------------