Heights and Weights as a Humble Tool in Monitoring

INTRODUCTION

Large projects with international financial support are required to conduct comprehensive Environment Impact and Health Impact Assessment studies before starting a major project. Once approved for funding, the projects are regularly monitored by International Financing Institutions and other funding agencies to ensure that the project impacts do not jeopardize the health of the population. On the other hand, companies operating large projects, are required to demonstrate that health of the individuals in the project impacted areas are not only maintained but improve during the construction, operation and after the completion of the project. To monitor these impacts, there are a number of environmental and health indicators used to demonstrate wellbeing of the impacted populations. Obtaining full information for these indicators is often tedious, time consuming and costly, requiring high level of surveys and professional expertise.

NTPC Health Program, as a part of its Social Development Plan,[1] worked with the local health authorities to ensure that the communities benefit from the developments brought into the area. Mindful of measuring the impacts on the health of the populations and the requirements under the concession agreement between the Government of Lao PDR and NTPC, the health program has conducted a number of surveys and studies to monitor the health of the impacted people in addition to developing the routine health data collection for continuous monitoring.

Measuring of the body weights and heights was one of the methods used right through the life of the project. It is simple and important means of tangibly assessing the degree of nutritional or other socioeconomic deprivation in a population. Sudden fall in the body weight in an individual or in a sub-group of a population can be a useful pointer to the special needs of the population. Lowering of the Body Mass Index (BMI) profile may demonstrate that the population is being adversely affected [2] by environmental impacts, such as sudden changes brought about by the construction of a dam.

Much attention has been given to the obesity epidemic[3] and its association with increased morbidity and mortality engulfing both rich and the poor countries in the recent years. However, the information on underweight or below normal Body Mass Index (BMI) seems to be sparse and used little in population studies. It has been suggested that a BMI of 16–18·5 could be an international standard for undernutrition and a BMI of less than 16 the definition for severe undernutrition.[4] Any adult, in the absence of disease, having BMI below 18.5 is suffering from chronic food shortages. According to the WHO expert committee only about 3-5% of the population is expected to have a BMI below 18.5 and anything below 3% serves as a warning sign of food insecurity requiring monitoring and remedial actions. Many deprived and rural and remote communities have higher than expected proportion of people with BMI below 18.5. The Nam Theun 2 project area population at the start of the project had shown that over 14% of the population

[1] NTPC Social Development Plan. NTPC 2004. www.namtheun2.com
[2] WHO. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series 854. Geneva, World Health Organization 1995.
[3] WHO. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: World Health Organization, 2000.
[4] Editorial.The undernutrition epidemic: an urgent health priority. The Lancet. Vol 374 October 31, 2009. p1473.

had a BMI below 18.5. Any improvements of this indicator over time can serve as a sure sign of improvement in food insecurity.

Body Mass Index (BMI):

It is a key index for relating weight to height. BMI is a person's weight in kilograms (kg) divided by height in meters squared (Weight in Kgs/Height^2 in Mts). The BMI is preferred to define underweight, normal weight and overweight and obesity to the traditional height/weight charts. For most people, a normal BMI ranges from 18.5 to 24.9. Those individuals with BMI lower than 18.5 are considered underweight and those with BMI ranging from 25-29.9 are considered overweight; and obese, if BMI is 30 or more (Box 1). These are international standards and apply equally to all adults of either sex.

> **Box 1**
> **BMI Categories**
> - Underweight: <18.5
> - Normal weight: 18.5–24.9
> - Overweight: 25.0–29.9
> - Obesity: BMI of 30.0 or greater
>
> *Source: Adapted from WHO 2004*

Interpretation of BMI
Body Mass Index (BMI) is a number calculated from a person's weight and height. BMI is a fairly reliable indicator of body fatness for most people. BMI can be considered an alternative for direct measures of body fat. As the calculation of BMI requires only height and weight, it is an inexpensive and easy-to-perform method of screening for weight categories that may lead to health problems.[5] Calculating BMI is one of the best methods for population assessment of not only overweight and obesity, but also of the underweight status.

Rapid appraisal using BMI calculations are quick and results can be obtained after data entry in a short time. Tools are available for rapid appraisals such as computerized anthropometric programs, developed by WHO - the WHO Anthro for children Under-5 and the WHO Anthro Plus for children 5-19 years.[6] For adults a simple spreadsheet can be as effective to calculate the BMI.

Use of BMI in NTPC Health Program
The NTPC health program has used measuring of the heights and weights in the impacted populations as one of the tools for assessing the health status of the populations. The program recorded and monitored these measurements in the population surveys conducted at the Initial Health Check and Survey (IHS) before the project started, at the Mid Term survey and in the Final Health survey, towards the end of the project.

The BMI, as an indicator, has been used to demonstrate that simple measuring of heights and weights in a population can be a useful tool where sudden changes, such as acute shortages of food, are likely to be responsible for deterioration of the health of the population. Large sections of the population, if affected for example by a large dam, where people have lost their land due to inundation and other project activities and face acute shortages of food soon after construction phase, can be monitored for the

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[5] http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/ accessed on 6 May 2013.
[6] WHO Anthro 2005 for mobile devices version 1.00, 2006: Software for assessing growth and development of the world's children. Geneva: WHO, 2006

impacts simply by measuring their heights and weights over short periods of time and corrective measures taken to mitigate any adverse effects.

Methods

The NTPC health program, bound by the Concession Agreement between NTPC and the Lao PDR, conducted the initial health checks and survey (IHS) soon after the relocation of the 14 impacted villages in the Nakai Plateau. This was followed by the Mid Term health survey (MTS) and the Final Health survey (FHS) in 2010 and 2013 respectively. Village meetings were held prior to the surveys to discuss the purpose of the survey and to seek full cooperation of the villagers. The selected health workers from the local health authorities were trained to carry out the surveys. All health surveys, except IHS, were conducted in each village on a designated date and time, often in the community center. The IHS was conducted in a makeshift tent in the villages, as the community centers were still under construction. Ethical approvals were obtained from the National Ethical Committee for each one of the surveys.

The Initial Health Checks included the whole population with more than 85% of resettlers participating in the survey. The IHC&S had also provided complete family files for the resettled populations. A random sample of 25% of the households was selected from the family files for the Mid Term and the Final Health surveys. Heights and weights, as part of the health checks, were measured for all members of the household. Children Under-5s were weighed using salter® portable hanging scales; and children older than five and adults by ordinary bathroom scale. Children below two year of age were measured on a locally

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Box 2

Stunting, Wasting and Overweight[7]

Stunting: reflects shortness-for-age; an indicator of chronic malnutrition and calculated by comparing the height-for-age of a child with a reference population of well-nourished and healthy children. According to the UN Standing Committee on Nutrition's 5th Report on the World Nutrition Situation (2005) almost one third of all children are stunted.

Underweight: measured by comparing the weight-for-age of a child with a reference population of well-nourished and healthy children. It is estimated that the deaths of 3.7 million children aged less than five are associated with the underweight status of the children themselves or their mothers (source: Comparative Quantification of Health Risks, 2004).

Wasting: reflects a recent and severe process that has led to substantial weight loss, usually associated with starvation and/or disease. Wasting is calculated by comparing weight-for-height of a child with a reference population of well-nourished and healthy children. It is often used to assess the severity of emergencies because it is strongly related to mortality.

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improvised length board in centimeters. Adult heights were measured by a measuring tape attached to a vertical wall or a pole in centimeters. Participants' age and sex among other variables were also recorded. Where available, date of birth was recorded for children Under-5. The accuracy of date of birth improved over time for mid and Final Health surveys as new births were all recorded in updating the family files.

For reporting purposes, children Under-5 WHO Anthro Program was used for calculating stunting, wasting and underweight (Box 2) through the automatic report generation built in the program. The program also generates BMI for the Under-5s as part of the automatic reporting mechanism.

For school going children and adolescents (5-19 years of age), WHO Anthro Plus[8] Program was used with similar capability of producing automatic summary reports.

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[7] http://www.wfp.org/hunger/glossary accessed on 15 May 2013

[8] WHO AnthroPlus for personal computers Manual: Software for assessing growth of the world's children and adolescents. Geneva: WHO, 2009 (http://www.who.int/growthref/tools/en/).

Adults were simply weighed and heights measured and data recorded and later entered into excel files for the calculation of BMI. The survey data was analyzed using SPSS® by age, sex and locality of the populations surveyed.

Results

The 14 resettled villages and two villages with partial resettlement with an approximate population of 7000 formed the base population. Results are analyzed and discussed under three major age groups, the Under-5s representing the preschool children, the school children and adolescents 5-19 year olds and the adults aged 20 years or older.

Under-5s

Among the Under-5s, stunting rates revealed decline from 43.1% in the IHS to 34.2% in the Final Health survey in 2013. Underweight declined from 27.6% to 18.3% in the final survey. However, the most important indicator from the point of view of acute food insecurity, the wasting also declined form 10.4% to 4.2% during the same period. All three categories showed consistent decline over the project life (Figure 1).

Figure 1
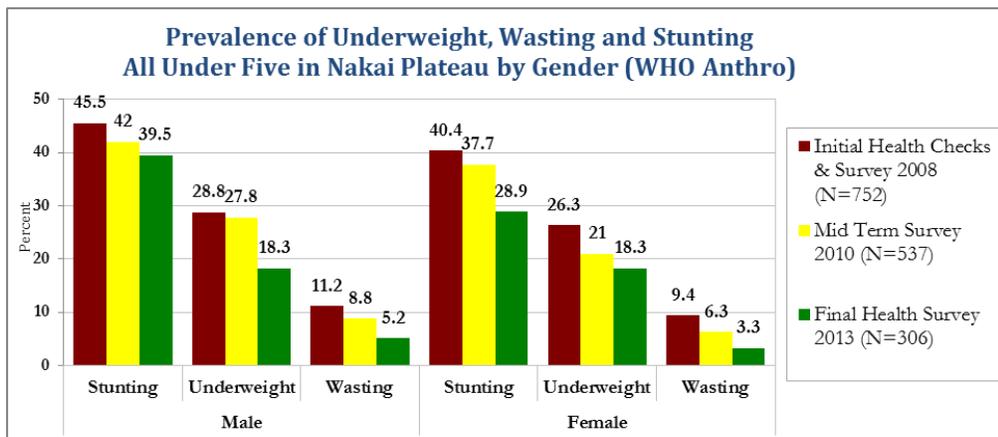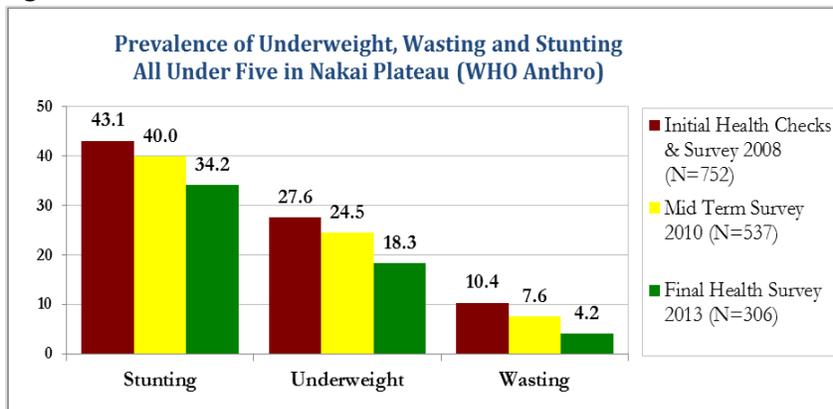
Sex differences among the Under-5s were marked with poor performance on the part of the boys than the girls over the period. At the Final Health survey in February 2013, underweight was similar for both

the sexes at 18% of all Under-5s surveyed, stunting status was much better for the girls at 28.9% as opposed to 39.5% for the boys. Similarly wasting was higher among boys than girls, 5.2% and 3.3% respectively. As is apparent form the Figure 1, all these values were considerably lower in the FHS than at the IHS. Girls demonstrated better improvements compared to males over the life of the project.

Current nutritional status of the Under-5s have improved considerably since 2005, when the project first started, an indication that the children Under-5 are secure from the point of view of availability of food.

Nutritional Status of 5-19 year old

Stunting among deprived populations is a major impediment to optimum growth which affects the adulthood in the development of physical and psychological personality of a young adult leading to economic productivity and quality of reproduction among women. Whilst comparing stunting over short periods of time is a poor indicator of acute food shortages, over a longer time, as in the case of the NTPC health program of eight years, it serves as a useful indicator to demonstrate the impact of sustained and
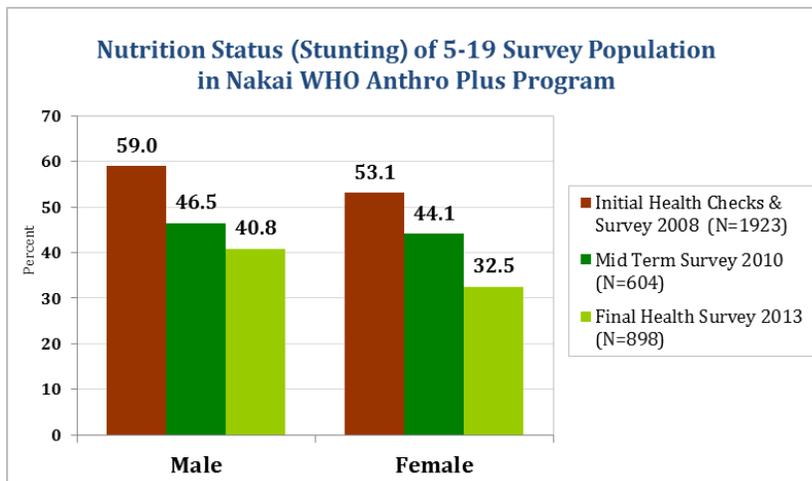
sufficient food availability in the impacted area. Stunting has declined among children 5-19 from 56% to 36% from the IHS to the FHS, a significant 20% point decline. The improvements were slightly better among females then males, probably due to the ability of adolescent girls to gain more weight physiologically around menarche.

Adults

Among adults aged 20 years and older, those with BMI below 18.5 declined from 14.2 in IHC&S to 10.3 in the Final Health survey (Table 2). Women over 20 years of age at the IHS had below normal BMI almost two times that of men, (Female 18.5 and Male 9.5). Although it improved over time, the differences in gender remained at that level. Age group analysis shows that the maximum gain was made by the age group 30-39 and both younger and older age groups showing lesser improvements. People older than 50 years had very high levels of below normal BMI. Although women had a better start than men in their childhood and adolescent years, later in life they suffer much more than men, indicating that women do not receive as good nutrition as men. However, both sexes showed marked improvements during the life of the project.

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Table 2: BMI Below Normal (<18.5) or Above Normal (>25) by Gender and Aged >20

Sex	IHS 2008 (n=2418)		MTS 2010 (n=955)		FHS 2013 (n=1258)	
	<18.5	*>25*	*<18.5*	*>25*	*<18.5*	*>25*
Male	9.5	8.1	8.8	12.8	6.7	14.3
Female	18.4	12.2	11.6	16.9	12.5	23.2
Total	14.2	10.3	10.6	15.4	10.3	19.9

Table 3: BMI Below Normal (<18.5) or Above Normal (>25) by Age Groups

Age Groups	IHS 2008 (n=2418)		MTS 2010 (n=955)		FHS 2013 (n=1258)	
	<18.5	*>25*	*<18.5*	*>25*	*<18.5*	*>25*
20-29	7.2	8.9	8.7	11.3	6.0	17.8
30-39	11.5	12.1	6.6	16.9	4.4	21.3
40-49	12.1	13.0	8.6	19.9	9.2	23.8
50-59	23.5	8.4	14.9	17.7	18.8	19.3
≥60	39.6	6.5	25.3	13.2	28.5	16.2

Table 4: BMI Below Normal (<18.5) or Above Normal (>25) by Age Groups and Sex

Age Groups	IHS 2008 (n=2418)				MTS 2010 (n=955)				FHS 2013 (n=1258)			
	Male (n=1132)		Female (n=1286)		Male (n=604)		Female (n=351)		Male (n=463)		Female (n=795)	
	<18.5	*>25*	*<18.5*	*>25*	*<18.5*	*>25*	*<18.5*	*>25*	*<18.5*	*>25*	*<18.5*	*>25*
20-29	4.4	4.4	9.5	12.6	4.8	6.0	9.3	13.0	1.8	10.7	7.9	20.9
30-39	8.1	7.7	14.2	15.6	3.1	12.5	8.5	19.3	1.7	10.0	5.9	27.5
40-49	6.1	12.2	17.9	13.8	9.8	13.1	7.8	24.4	5.3	18.1	11.6	27.4
50-59	14.0	11.3	34.1	5.2	10.4	20.9	18.9	14.9	10.7	18.7	24.5	19.8
≥60	29.1	8.5	50.4	4.4	25.0	13.6	25.5	12.8	22.6	17.7	33.8	14.7

Figure 3

BMI Below 18.5 by Age Group and Sex

Figure 4

BMI ≥25 by Age Group and Sex

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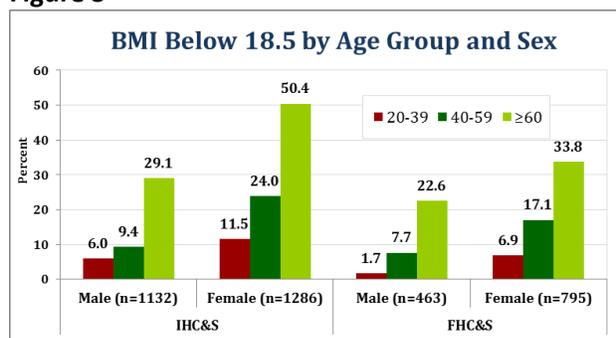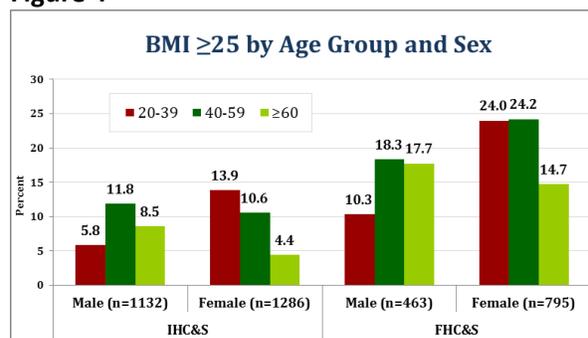
Table 5: BMI Below Normal (<18.5) or Above Normal (>25) Aged ≥20

Health Facility	IHS 2008 (n=2418)		MTS 2010 (n=955)		FHS 2013 (n=1258)	
	<18.5	>25	<18.5	>25	<18.5	>25
Nongbouakham ICHC	13.3	9.7	9.4	16.1	10.0	21.7
Sop On ICHC	20.2	4.9	16.1	13.5	9.3	15.8

The geographical distribution of the resettled population according to the two Integrated Community Health Centers (ICHCs), also show similar results. Both Nongbouakham and Sop On ICHCs showed reduction in the numbers of people having BMI below normal, with much more marked improvements by Sop On health center. The villages under Sop On ICHC, had very high number of people coming from remote and poor areas before relocation and hence reflected much higher number of people with BMI below 18.5. The Final Health survey shows that those differenced have disappeared and population of both health facilities show similar levels of below normal BMI. However, these levels are still double the expected rates of 3-5% in a population and require continuous monitoring for improvements.

Looking at it from the over nutrition angle (Figure 4), although not a healthy sign, any evidence of increase in numbers of people with overweight or obese, however goes to prove that availability of food is not a problem. Data shows that numbers of people with BMI above 25, a sign of prosperity, has been increasing for all ages, sex and localities.

The Project Impacts Affecting Food Supply

Any major project having environmental impacts can adversely affect the health of the impacted population and Nam Theun 2 is no exception. The function of Environment Impact Assessment (EIA) and Health Impact Assessment (HIA) is to mitigate these effects and eventually see that the population is not negatively affected. As described earlier, the project has a number of monitoring measures in place to study and demonstrate that the health of the people is not affected negatively. From the NTPC Living Standard Measurement Survey (LSMS) and the NTPC Health surveys, data is emerging to demonstrate that health and wellbeing of the impacted populations has been secured through mitigation and by various developments and compensatory mechanisms.

Inevitably, relocation has forced changes to the way of life for the impacted populations. Apart from three major villages, which grew rice on the plains of the Nam Theun River, most of the relocated villages lived in remote parts of the Nakai Plateau. These communities were hunters and gatherers; relying heavily on non-timber forest products. Their farming practices were centered on slash and burn; use land for a while and as productivity of the land falls, to move on. The resettlement has forced each family to use the designated land for farming. They also have access to new aquatic sources of food, especially better fishing in addition. A combination of agricultural and aquatic sources of food is expected to provide for their needs.

Food insecurity is defined as the limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable food in socially acceptable ways.[9] Issues whether

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[9] Bickel G, Nord M, Price C, Hamilton W, Cook J. Guide to measuring food insecurity, March 2000. http://www.ers.usda.gov/media/327683/efan02013j_1_.pdf (accessed on 20 May 2013)

households get enough food, how it is distributed within the household and whether that food fulfills the nutrition needs of all members of the household show that food security is clearly linked to health.[10]

Most immediate effect of under nutrition or food scarcity is demonstrated among children by wasting and adults by loss of body weight. Any loss of weight over a short period can easily be detected. If the construction of the dam has in some way impacted on the populations and reduced the overall food availability, it is likely to be observed by general fall in weight among adults and not gaining adequate weight over time among children, especially the Under-5s.

Table 6: Possible Scenarios as Impacts of the Project:

No.	Scenario	Impact
1.	No change in food availability	No Impacts Expected
2.	Scarcity of food due to inundation and other environmental effects of the project	Negative Impact
3.	Improved availability of food either due to natural increase in availability or increased purchasing power or both	Positive Impact

Without any changes in the general availability of food in a community, there is no reason to expect any excessive positive or negative change from time to time. However, if there are sudden shortages of available food and general food insecurity, the first impacts will be apparent in the weight reduction among adults and less than expected or poor weight gain among growing children (Table 6).

Health surveys conducted by the NTPC health program, as means of monitoring the health of the people, measuring heights and weights of all resettlers during the initial health checks and survey and again during the Mid Term and the Final Health surveys, demonstrate clearly the improvements in weight gains in the impacted populations. This is consistent among all age groups, gender and geographical locations, indicating that there are no signs of any deterioration in the health in the impacted population. On the other hand there are significant improvements in health over the life of the project.

If the impacted populations were negatively impacted with the food shortages, the effects would be apparent in the population by falling weights among the adults and not adequate weight gains among the Under-5s. Moreover, increase in the numbers of people with BMI depicting overweight and obesity is hardly consistent with the food insecurity.

Effects of Poor Nutrition
The consequences of poor nutrition and health result in a reduction in overall well-being and quality of life, and in the levels of development of human potential. Malnutrition can result in productivity and economic losses, as adults afflicted by nutritional and related disorders are unable to work; education losses, as children are too weakened or sickly to attend school or to learn properly; health care costs of caring for those suffering from nutrition-related illnesses; and costs to society of caring for those who are

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[10] Food Security. WHO. http://www.who.int/trade/glossary/story028/en/ (Accessed 20 May 2013)

disabled and, in some circumstances, their families as well. Poor nutrition during pregnancy[11] also affects fetal development, neural tube defects, effects on mother and epigenetic changes[12].

Prolonged low level of food intake and/or low absorption of food consumed, e.g. undernutrition in the earliest phase of life, from conception to 24 months of age causes largely irreversible damage to physical and mental development during childhood. Each form of malnutrition depends on what nutrients are missing in the diet, for how long and at what age. This can be simply translated to the amount of food consumed at each meal, the quality of the food consumed and the frequency of meals in a day.

Effects of infection on nutritional status:

Poorly nourished individuals show marked reduced immune system resulting in poor bodily fight against common infections like fever, diarrhea, common childhood diseases such as measles, upper respiratory infections, undernutrition among the frail and elderly and several cancers are some of the examples. Often in poverty ridden and traditional communities, it is the volume of starchy food consumed by which the body tries to make up for quality.

Vulnerability of children to under nutrition:
Volume of rice in Lao diet constitutes main bulk of the meal, often with some spicy sauce to make it palatable. This is where children, especially below two years of age, suffer most as they cannot consume large quantities of rice at a time. Common practice to eat just twice a day, among adults as well as children with very little in between the two meals, leads to a chronic under nutrition state. People in rural areas, in particular women and children, are affected most. Chronic deficient diet, especially of proteins, results in retarded growth referred to as stunting. Once stunting has taken place it is permanent and child will not attain optimum height even if fed adequately later in life.

What can be learnt from the use of BMI?

The WHO expert committee classified prevalence of low BMI into the categories shown in Table 7. In the CFSV study[13], the overall prevalence of underweight (BMI <18.5) among women of reproductive age in Laos was found to be 11.5 percent (95 percent CI, 10.1-13 %), medium prevalence of underweight according to the WHO expert committee.

Table 7: Underweight and its Interpretation

No	Prevalence	BMI <18.5	Interpretation
1.	Low prevalence	5-9%	Warning sign, monitoring required
2.	Medium prevalence	10-19%	Poor Situation
3.	High prevalence	20-39%	Serious situation
4.	Very high prevalence	>40%	Critical situation
Source: WHO Expert Committee.1995			

The resettled population from IHS data showed that 14.2% the population were underweight and women were twice as likely to be underweight than men (women 18.5% and men 9.5%), classifying it

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[11] Germaine Miese-Looy, Jessica Rollings-Scattergood, and Anna Yeung. Long-term health consequences of poor nutrition during pregnancy. SURG – Studies by Undergraduate Researchers at Guelph. Vol 1 (2) 2008

[12] Guoyao Wu, Fuller W. Bazer, Timothy A. Cudd, Cynthia J. Meininger,and Thomas E. Spencer. Maternal Nutrition and Fetal Development. The Journal of Nutrition. American Society for Nutritional Sciences. (Accessed from jn.nutrition.org on May 19, 2013).

[13] Lao PDR: Comprehensive Food Security and Vulnerability Analysis (CFSVA). December 2007.

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to be in medium prevalence and of poor situation. The Final Health survey conducted in February 2013 shows these figures at 10.3% (women 12.5% and men 6.7%). Although improvements have taken place, the situation remains poor and will be requiring efforts to improve the underweight state in the resettled villages.

Periodic measurements of the heights and weights of the impacted population in the project area have been possible along with other required activities without having to spend extraordinary efforts. The information obtained provides a useful tool to monitor the nutritional status of the impacted populations and any adverse effects of the project. This comprehensive assessment, by age, gender and geographical location, serves as a useful monitoring tool of the health of the impacted populations.

Conclusion

The data from surveys conducted in the resettlement villages clearly indicate that there is no evidence of acute food shortages in the impacted populations. Had there been sudden scarcity of food or resources to buy food, it would have demonstrated in reduction in the BMI of the affected populations. Although there is still considerable undernutrition in the area due the past poverty and deprivation and food habits, the project mitigations have brought about improvements in the area. This is a clear indication that NTPC Hydroelectric Project has not jeopardized the health of the populations impacted. On the contrary there is evidence that the project impacts have already improved the health status of the populations in the project area and is continuing to do so.

The NTPC experience contributes many lessons learnt through using this methodology. First of all this kind of data collection provides base line information which is extremely important in future assessment of health of the impacted populations. Secondly, it demonstrates that health status of the people can be monitored over time by simple measurements of heights and weights, which can be replicated at low cost, without the need of highly trained manpower. Third, that different age groups, gender and geographical locations can further enhance the evidence for differential effects of any environmental impacts. Last, that the high risk individuals or sub groups of populations can be identified for focused approach for any improvements. The Under-5 children, women of reproductive age and the elderly are some of high risk groups. Incorporation of this methodology in growth monitoring for Under-5s was instrumental in assessing the nutritional status of children in the project area.

Tremendous interest in food insecurity raised by the 2008 food crisis pointed to the lack of timely data and knowledge rooted in methodological and conceptual shortcomings and it was pointed out that the problem lies in the lack of an appropriate monitoring system for food insecurity and that few data existed about what actually happens at the community and household levels, and how experiences vary across age, class, and space.[14] From the experience of NTPC health program, using this indicator is a first step in that direction and could be effectively used in monitoring programs of large and small projects having social and environmental impacts on the populations.

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[14] Craig Hadley, Kenneth Maes. A new global monitoring system for food insecurity? Department of Anthropology, Emory University, Atlanta, GA 30322, USA. Lancet Vol 374 October 10, 2009. p1223-24.