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Evaluation and improvement of the nutrition in
the Shangrila Orphanage Home, Nepal

Submitted by

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Declaration

I declare that I have written this report independently, that I have not used any other sources than those stated and that I have all literally and indirectly referenced data and information clearly marked as such.

..... 5.01.2015

Date


.....

Signature

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Abbreviations

CDC	Centers of Disease Control and Prevention
E%	% of total energy intake
FAO	Food and Agriculture Organization
GI	Glycemic Index
ICMR	Indian Council of Medical Research
PUFA	poly unsaturated fatty acid(s)
RDA	recommended daily allowance
RNI	recommended nutrient intake
SOH	Shangrila Orphanage Home
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNU	United Nations University
WFP	World Food Program
WHO	World Health Organization

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Summary

Introduction: High malnutrition rates are one of the major development challenges for Nepal. Malnutrition is a deficit in nutrients mainly caused by unbalanced diets. Consequences of malnutrition in childhood are reduced physical and mental performance. Nepalese diets typically include high shares of staple foods leading to poor intake of micronutrient.

The Shangrila Orphanage Home (SOH) is located in the Kathmandu valley. It is operated by the Nepalese Shangrila association in cooperation with the German association Govinda Entwicklungshilfe e.V.

Aim of the research project was to evaluate the current food supply in the SOH with focus on its nutrient content and to improve the diet in the orphanage.

Methods: The study was designed as a non-experimental, descriptive action research. The study population consisted of 45 orphans. First information about the food procurement and preparation was collected. Subsequently a nutrient analysis of the weekly food plan was carried out using the software NutriSurvy 2007. Macronutrient intake and micronutrient was analyzed and compared with the recommended nutrient intake (RNI) values by WHO/FAO. Together with the SOH team methods for improving the food preparation and amendments in the food plan were developed. The implementation was monitored, supervised, and followed up by a second nutrient analysis.

Results and conclusions: Some shortcomings concerning the food supply could be identified and improved. Less valuable food items were substituted. The analysis proved deficits in many micronutrients. Due to the improved food plan the intake of most micronutrients could be raised. Vitamin A deficiency could be overcome. However, most of the investigated micronutrients are still deficit. The consumption of egg, vegetable, soya products, milk, and dairy products must be raised to reach the recommendations for vitamin B12, folic acid, calcium, iron and zinc. Because vitamin D self-synthesis rates and salt iodine content were unknown the study could not make out the actual vitamin D and iodine supply.

Discussion: The nutrient analysis was based on the estimated food intake and therefore the degree of uncertainty is high. To check the nutrient status of the individual children biochemical analysis like urinary iodine and hemoglobin test must be carried out. To increase the diet diversity predominant eating habits must be changed. Therefore it is most important to increase staff member's awareness for the importance of micronutrient intake to avoid malnutrition.

1 Introduction

The Federal Republic of Nepal is a landlocked country in South Asia. It is one of the least developed countries in the world (UN 2014). Low life expectancy, high social inequality, child undernourishment, and serious food insecurity are some of the major development challenges of the country (UNCDF 2014 and WFP 2014a).

In Nepal there is one of the worldwide highest malnutrition rates (WFP 2014a). Malnutrition occurs if a person's diet does not contain the nutrients required. Consequences of insufficient nutrient intake are reduced physical and cognitive performance. Even if the quantity of food a person obtains is sufficient the quality of the diet can be inadequate. In malnutrition affected populations the diets mainly lack micronutrients. Resulting physical and cognitive deficits maintain poverty and slowdown economic growth (WFP 2014b). Vitamin A, zinc, iron and iodine are known as the most critical nutrients concerning malnutrition for some time (BIESALSKI 2013a, p. 29). However, nowadays also folic acid, vitamin D, and vitamin B12 are seen as key players (ibid).

There are different forms of vitamin A deficiencies, which are described by BIESALSKI as follows. If vitamin A reserves in the liver are exhausted, clinical symptoms of the deficiency arise. First night blindness occurs. Thereupon Bitot's spots can arise on the cornea. Finally xerophthalmia can develop. It is characterized by dryness of cornea and conjunctiva. Besides this severe vitamin A deficiency there is a mild form of chronic undersupply without clinical symptoms. Children with chronic vitamin A undersupply are susceptible to respiratory infections and anemia (BIESALSKI 2013b, 32).

In human bodies zinc is enrolled in various metabolic activities and immunological processes (BIESALSKI 2013a, p. 41). In a zinc deficiency, barrier function of mucosa declines, leading to higher disease incidence (ibid.).

As part of hemoglobin iron functions as oxygen transporter, providing oxygen to all organs and tissues. Signs of mild iron deficiency are fatigue, weakness, and reduced physical performance. Anemia occurs if iron reserves are depleted and hemoglobin is diminished (Biesalski 2013a, 45).

Iron is also involved in cognitive development and iron deficiency may even result in lower academic outcomes (MELANSON 2008, p. 398 and TARAS 2005, p. 206).

Iodine is required for thyroid function and production of thyroid hormones, which are enrolled in many metabolic processes. Iodine deficiency leads to formation of goiter. Sufficient iodine is

especially required during physical and cognitive development of children, therefore it is important to avoid even mild iodine deficiency at this age (BIESALSKI 2013a, p. 50).

After chemical modulation vitamin D has hormone-like functions in the human body. Primarily vitamin D promotes absorption of calcium in the intestine and sustains constant serum calcium and phosphate level to ensure adequate bone mineralization (BIESLSKI 2010, p. 146-148). Moreover vitamin D modulates the immune system, cell growth, and muscle function (ibid.). Severe vitamin D deficiency leads to rickets in children, which is characterized by softening of the bones.

Vitamin B12 is involved in various metabolic processes as a coenzyme (BIESALSKI 2010, p.169). Deficiency in vitamin B12 leads to megaloblastic anemia. In children deficiency can cause development delay and mental retardation (BAHADIR et al. 2014 and BAHL et al. 2013).

Similar to vitamin B12, folic acid works as a coenzyme (BIESALSKI 2010, p. 181). BAHL et al. associate plasma folate concentration with mental development scores (2013). Consequently, adequate intake of folate should be ensured in childhood.

Considering malnutrition in context of developing countries there is usually less focus put on calcium. Nevertheless, sufficient calcium intake is important during childhood. More than 99% of human body's calcium is located in bones (MORLION 2010, p. 194). From infancy to early adulthood bone mass accrual takes place (CHIPLONKAR et al. 2011). Inadequate calcium intake leads to osteoporosis in the higher age.

According to the World Health Organization (WHO) “malnutrition is estimated to contribute to more than one third of all child deaths” (2014a). In Nepal forty-one percent of the children under five are stunted (low height for age); moreover anemia, underweight, and wasting (low weight for height) are widespread (WFPb 2014). According to the “Nepal Thematic Report on Food Security and Nutrition 2013” one cause for the malnourishment in Nepal is the poor diet diversity that is found in most households. On average Nepalese food consumption is made up by 72% of staple foods. Reasons therefore are financial constraints, limited availability of nutritious food especially in mountain regions and lack of knowledge and awareness for the importance of micronutrients (National Planning Commission 2013, pp. 7-88).

Underdevelopment is also main cause for the numerous orphans in Nepal. Poor health conditions and social services, life-threatening working conditions as well as social norms and traditions are the main reasons for orphanhood (Platz, 2009). The Shangrila Orphanage Home (SOH) in Neopane Gaon (Kathmandu valley) is an orphanage that accommodates up to 50 orphans. The SOH is operated by the Nepalese association Shangrila in cooperation with the German association

Govinda Entwicklungshilfe e.V. All executive activities and management decisions are executed by the Shangrila Association. The German association is mainly supervising and sponsoring. The study was conducted by a nutritionist as part of a five-month traineeship in the orphanage. Due to the long stay a familiarization phase was possible, which created a solid foundation of trust and a basic understanding of the culture.

Aim of the research project was to evaluate the current food supply in the SOH with focus on nutrient content and to improve the diet in the orphanage.

This report first describes the methods used. Subsequently, the findings of the investigations of the previous food supply are presented and discussed. In addition to the nutrient analysis, also food procurement and preparation were examined. Based on these findings amendment strategies were developed to improve nutrient content and food preparation methods. These strategies are described in chapter 3.3. The acceptance of the new catering in the orphanage among staff members and orphans are described in the following chapter. Finally the results of the nutrient analysis of the improved food plan are presented. In the last chapter the success of the project is discussed and options to further improve the orphanage's food supply are suggested.



Picture 1: In summer 2014 the SOH was the home of 45 orphans

2 Methods

2.1 Study design

The study was designed as a non-experimental, descriptive action research. The population of the study consisted of 45 children, 26 girls and 19 boys aged 5 to 17 years and 8 orphanage workers who were purposely sampled. The orphanage workers included the manager, three kitchen workers and four care givers: inter alia the main warden and one care giver who was responsible for the food procurement.

The research project examined the food supply in the orphanage, with main focus on nutrient composition. First, information on food procurement was collected and the preparation in the kitchen was examined. Therefore the daily routine in the kitchen of the orphanage was observed for one week. During this period many conversations took place with the involved staff members and a relationship of trust was established.

After that a nutrient analysis of the original food system was made, which is further described in the following sub-chapter. Observations, upcoming issues and the results of the nutrient analysis were discussed with management and kitchen team. In a participatory approach methods to improve the SOH catering were developed. Far-reaching changes of the food system were outlined in workshops for both children and staff in order to create better understanding. The implementation of the new methods was monitored and followed up by a second nutrient analysis. Frequent communication with all people involved was the basis for a sustainable improvement of the food system.



Picture 2: SOH kitchen team



Picture 3: Breakfast in the orphanage

2.2 Nutrient analysis

Main task was to estimate the nutrient intake of the children and to check whether their needs are met. The nutrient analysis was done with the software NutriSurvey 2007. Vitamin A, B12, D and folic acid as well as the minerals Calcium, Iron, Iodine and Zinc were analyzed. In addition the supply of macronutrients was checked. For the analysis the category female aged eleven to fourteen was chosen, because it was the category mainly represented by the children in the orphanage. Average portions of the different meals were composed and the different food items were weighed. These measurements were used to calculate the nutrient intake with NutriSurvey. Therefore the following food databases were integrated in the software: Indian food database, Vietnamese food database, national nutrient database of the United States and Bundeslebensmittelschlüssel, the German national nutrient database. The estimated food intake was inserted for every day of the week according to the food plan to calculate the weekly nutrient intake. The weekly nutrient intake was then converted to an average daily intake and compared with the recommended nutrient intake (RNI) by WHO and Food and Agriculture Organization (FAO). There are no national recommendations for Nepal concerning the nutrient intake. The national nutrition program of Nepal refers to the recommendations of WHO and FAO as well as to the recommended daily allowances (RDA) from the Indian Council of Medical Research (ICMR), “because of resemblance of Nepali food consumption pattern , food availability and culture with India” (Department of Food Technology and Quality Control 2012, p. 2).

3 Results and conclusions

3.1 Food procurement and preparation

There were different food sources for the SOH catering. Large amounts of fruits and vegetables derived from the organically managed Shangrila kitchen garden others were bought from villagers. Additional fruits and vegetables were bought in a fruit shop. The fruit and vegetable supply was determined by the season. There were no proper cooling facilities therefore fresh milk was delivered daily. Dry food items and packaged food were once a month purchased from a wholesaler and stored in the orphanage. The food procurement followed a strict scheme and was determined by the logistical and financial constraints.

The food market in the region was very diverse. The orphanage was surrounded by rural villages with small scale farmers and small food processing units. However, the urban structures of the close by capital found their way into the region, leading to high supply of imported food items mainly from India.

There was a plan for the weekly food routine (Table 1). As shown in the table a snack provided for the children in the early morning. It consisted of cup of boiled milk with biscuits or rice flakes. There were two main dishes served in the orphanage, breakfast and dinner. The main dishes contained always rice and potatoes. Very often the national dish Dal Bhat was served. It consisted of rice and lentil soup and was served with cooked vegetable. Many different sorts of vegetable were supplied inter alia spinach, brinjal, cauliflower and cabbage. Instead of lentil soup sometimes bean soup was offered. Once a week soya balls were eaten. Sometimes pickles were prepared. For school and after school there was some tiffin provided. For ethical reasons the food supply in the orphanage was purely vegetarian. In order to check the compliance of the food plan the food supply was recorded for two weeks. The protocol showed that the food was in general supplied according to the food plan.

Table 1: Original SOH food plan

The table shows the food plan before the amendments were introduced. Food supply in the orphanage has followed a weekly routine. Thus on particular week days equal food was supplied only fruit and vegetable supply varied. Food items classified as less valuable were replaced within the modification period.

Day	Morning Snack	Breakfast	School Tiffin	Home Tiffin	Dinner
Sunday	Milk + Biscuits*	Rice + Bean Soup	Rice Flakes + Dalmut*	Puffed Rice+ Dalmut* + Juice + Egg	Dal Bhat + Vegetable
Monday	Milk + Rice Flakes	Rice + Soya Balls + Potatoes + pickles	Bread + Jam	Rice Flakes + Curd	Rice + Bean Soup
Tuesday	Milk + Biscuits*	Dal Bhat + Vegetable	Biscuits*	Rice Flakes + Potato Soup	Dal Bhat + Vegetable
Wednesday	Milk + Rice Flakes	Rice + Soya Balls + Potatoes + pickles	Puffed Rice + Dalmut*	Chow mein	Dal Bhat + Vegetable
Thursday	Milk + Biscuits*	Rice + Bean Soup	Biscuits*	Donought* + Tea	Dal Bhat + Vegetable
Friday	Milk + Rice Flakes	Dal Bhat + Vegetable	Noodles* + Rice Flakes + Dalmut*	Rice Flakes + Bean Soup + Fruit	Dal Bhat + Vegetable
Saturday	Milktea + Chocolate Biscuits	Rice + Bean Soup +Milk		Polenta / Noodle Soup *	Dal Bhat + Vegetable

Chow mein = fried noodles with vegetable, Dal Bhat = lentil soup with rice, * food items which were replaced

The observations showed that the food preparation was generally satisfactory expect for some short comings. The critical points were deficiencies in hygiene, overheating of oil, use of potatoes and tomatoes with green spots, and use of mustard oil for frying and cooking.

The main hygienic shortcomings in kitchen and food store were poorly cleaned kitchen utensils, irregular cleaning routines and cockroach infestation.

With increasing heat, formation of various mutagenic and carcinogenic compounds rises during frying (DANA and SAGUY 2003). To reduce the formation of acrolein and trans-fatty acids fat should not be heated more than required in the frying process.

Potatoes and Tomatoes with green spots contain considerable amounts of solanine. Even small doses of solanine can lead to gastrointestinal disorders such as diarrhea, vomiting and abdominal pain (DEUBER et al. 2012).

Mustard oil is used every day for frying and cooking and therefore can have a notable effect on the orphans' health. The consumption of mustard oil is considered critically and it is legally restricted in many countries because the oil contains erucic acid. In animal studies this fatty acid was associated with myocardial lipidosis and heart lesions (Hammann et al. 2014).



Picture 4: The kitchen of the SOH



Picture 5: Fire stove outside



Picture 6: Dal Bhat



Picture 7: Fruit and vegetable market in Lagankel



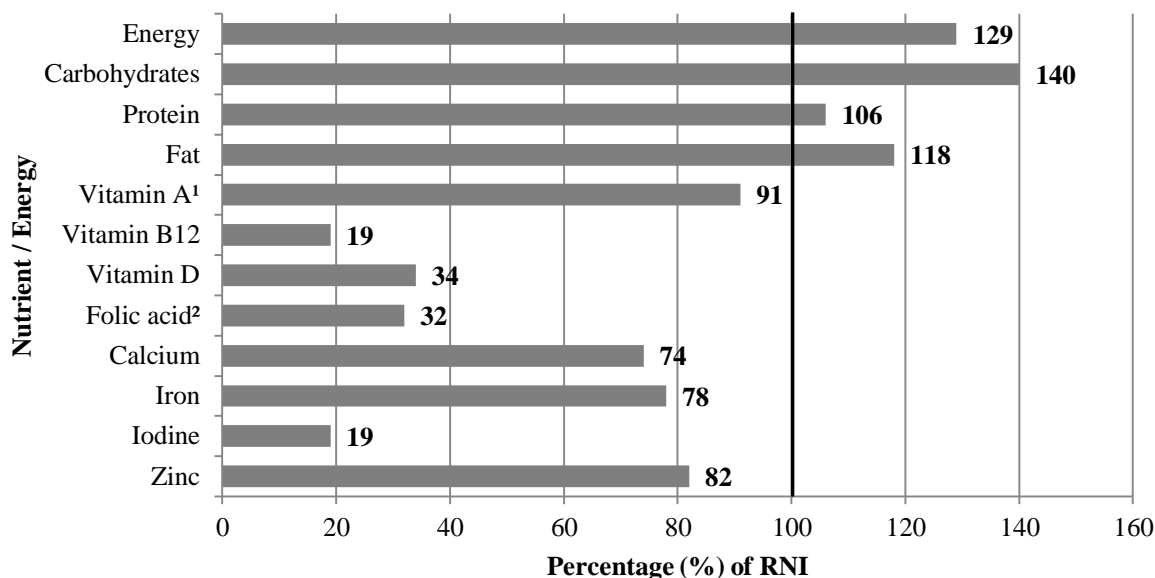
Picture 8: Gas stove in the kitchen



Picture 9: Bean soup

3.2 Nutrient analysis of the original food plan

The results of the nutrient analysis with NutriSurvey for the estimated weekly food intake according to the original food plan are given in Figure 1. The nutrient intake was calculated for eleven to fourteen year old female orphans and compared with the corresponding RNI.



¹ retinol equivalents, ² folic acid equivalents

Figure 1: Percentages of the RNI reached with the original food plan

The figure shows the estimated nutrient intake in relation to the RNI of the children in the Shangrila Orphanage Home in Nepal. The food intake was calculated for the female orphans aged eleven to fourteen year. Therefore average portions of the meals were made and food items were weight. These measures were used to calculate the weekly nutrient intake by the orphans with NutriSurvey. The results were converted to an average daily intake to compare them with the RNI.

The analyzed macronutrient intake respectively energy intake was 29% above the recommendations. Protein intake was only 6% higher than the WHO/FAO recommendation, whereas fat intake was 18% higher and carbohydrate consumption even 40%.

Oil and ghee used for frying and cooking were main fat source. But also doughnuts, Dalmut and biscuits contributed fat to the diet. Milk and curd only made up a small share of the fat intake.

Figure 1 shows that the carbohydrate intake was very high (140% of the RNI). It was mainly caused by consuming rice and rice products, but also biscuits, noodles and potatoes are rich in carbohydrates. As in most of the Nepalese households also in the SOH staple food consumption was very high.

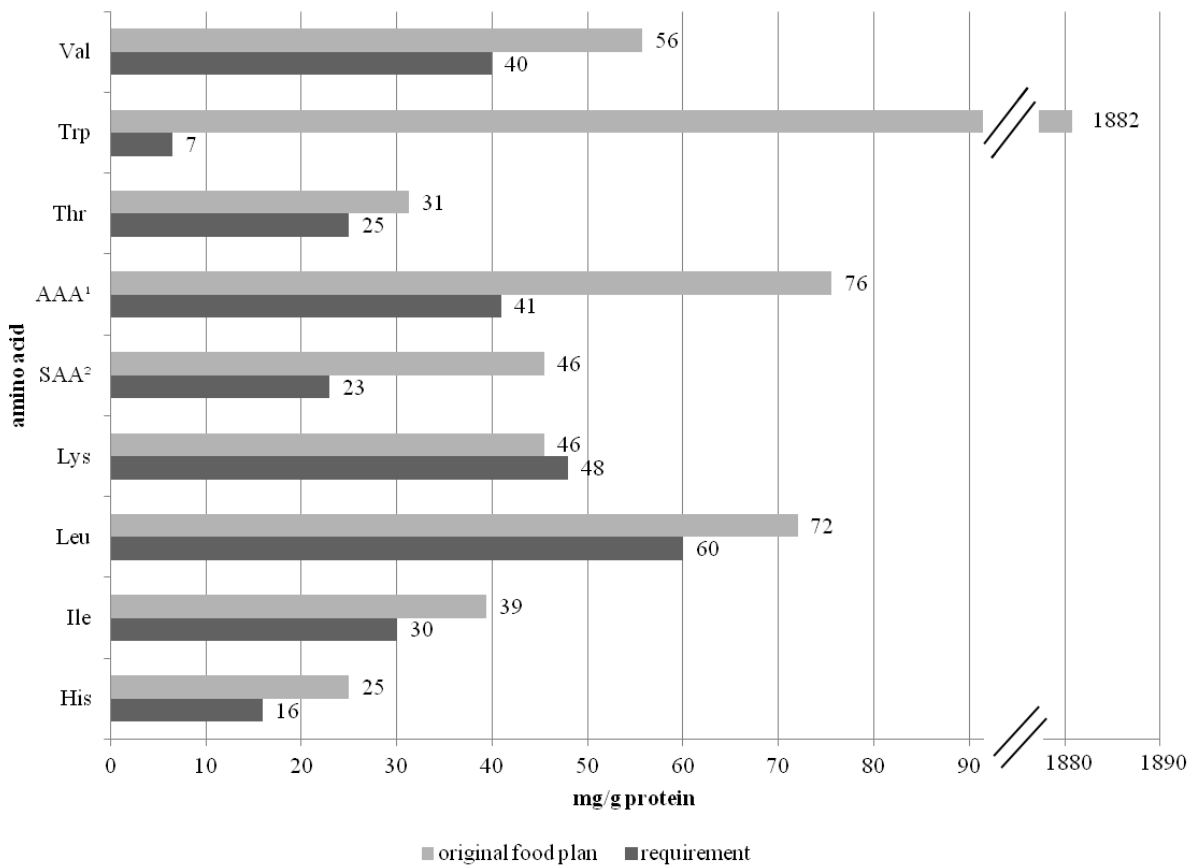
Sugar in biscuits and tea was considered critically because of the effect on blood sugar level and dental caries. Especially before study hours or as school tiffin biscuits are unsuitable because of

their high Glycemic Index (GI) (KANAREK et al. 2005 and BAKER et al. 1981). The GI is a score which indicates blood sugar effect of various food items. Food with a high GI leads to a rapid and steep increase of blood sugar level followed by a fast decline often below the normal blood sugar level. Food with low GI leads to a slow increase of blood sugar level, which then maintains constant before it returns slowly to the normal level. Carbohydrate-rich foods with smooth blood sugar effect (low GI) provide better support for cognitive processes during studying (KANAREK et al 2005).

In the beginning of the research project all children were checked by a dentist. Even though the caries indications among the orphans were considerable less than among the other children of the village who participated in the dental camp, further improvement of dental hygiene and sugar burden in the SOH would be desirable.

According to the recommendations of the WHO the amount of sugars consumed should be below 10% of total energy intake (E%) and they suggest “that a reduction to below 5E% per day would have additional benefits” (2014b). These limits apply to all mono- and disaccharides added to the food during processing, preparation and consumption. At present these recommendations are debated among the WHO and scientists. Because of the caries burden JAMES and SHEIHAM support the <5E% recommendation and even advocate sugar intakes <3E% as optimal proportion (2014). According to the estimations the children consumed 310g added sugar, which makes up 7.2.E%. This result was not alarming, nevertheless a reduction was desired.

Most of the diet's protein derived from vegetable sources, mainly rice, rice products and legumes. The biological valency of proteins derived from vegetables is generally lower than of animal products (BIESALSKI and VAUPEL 2010, p. 124). Therefore, it was questionable whether the requirement in essential and semi-essential amino acids was met. The calculated intakes of the essential amino acids and the recommendations by the WHO/FAO are given in Figure 2 (FAO/WHO/UNU 2007, p.180). The calculation showed that there was only a small deficit of 2.5mg/g protein in Lysine. All the other amino acids are consumed in sufficient amount. The tryptophan intake was remarkably high due to the high amount of legumes in the diet.



¹ = aromatic amino acid (Met + Cys)

² = sulfur amino acid (Phe + Tyr)

Figure 2: Comparison of the intake of essential and semi-essential amino acids (mg/g protein) from the original food plan and their recommendations

The amino acid intake of the eleven to fourteen year old female orphans was compared with the corresponding recommendations (FAO/WHO/UNU 2007, p.180).

At the first glance it was clear that none of the orphans suffered from overweight. Also the personal health files, containing weight and body height records, showed that overweight was not present among the SOH children. Therefore the high energy intake needed not to be seen as problematic. Possibly the high physical activity prevented the orphans from overweight. Also an overestimation of the consumption of staple foods may be the cause for the high calculated energy intake.

Figure 1 shows, that none of the investigated micronutrients is consumed in sufficient amounts. According to the calculations done in NutriSurvey the vitamin A supply of the SOH did reach 91% of the RNI of the children. Therefore the recommendation was almost met. Main sources for vitamin A were dairy products and egg. A slight improvement of the vitamin A supply was desired to reach the recommendation.

For the original food plan an average daily zinc intake of 8,5g was calculated. As shown in Figure 1, this amount would have made 82% of the recommendation. Because the bioavailability of zinc from vegetable sources is lower than from animal sources, one must consider low absorption rates (BIESLASKI 2013a, p. 42). Therefore the zinc supply of the orphans is likely to be worse than the share of the RNI indicates. Prevalent gastrointestinal and respiratory diseases of the SOH children may be associated with zinc deficiency.

The bioavailability of vegetable iron is around four times lower than of animal sourced iron (KOLETZKO, p. 33). Because the iron intake recommendation by WHO/FAO does not consider a purely vegetarian diet, the iron supply of the SOH diet should even exceed the RNI. To avoid anemia and cognitive deficits the iron intake respectively bioavailability should have been raised.

Nepal's soils are among the iodine poorest in the world (HETZEL and WELLBY 1997, p. 588). Therefore also the agricultural products of Nepal have low iodine contents. In the SOH kitchen exclusively iodized salt was used. However, the iodine content of the utilized salt was indicated and therefore not included in the NutriSurvey calculation. The examinations of SCHULZE et al. (2003, p. 972) show that iodine contents of iodized salt in Nepal vary and do not always reach the recommended value of at least 30 mg/kg (WHO, UNICEF, ICCIDD 1994, p. 29). Therefore the content in the SOH diet was utterly unknown.

Although the calculated vitamin D intake from the diet was very low (34% of RNI), high self-synthesis rates can be assumed. The orphanage is located between 27 and 28 degrees latitude, where solar radiation is relatively high and vitamin D synthesis in the skin is likely to process (ENGELSEN et al. 2005 and VitD-ez). The orphans spent usually every day some hours outside. Nevertheless actual vitamin D self-synthesis rates are influenced by many factors (e.g. clouds, time) and therefore hard to estimate. According to several studies vitamin D deficiency is not uncommon in Nepal (SCHULZE et al. 2014 and Shrestha et al. 2012).

The orphans' diet reached 74% of the calcium RNI (1200mg/day). The calcium obtained derived mainly from milk and curd. To ensure good bone mineralization an adequate calcium intake is required. More milk and dairy products should be provided to increase the calcium supply. In addition adequate vitamin D supply is essential to promote calcium absorption in the intestine.

Only 19% of the recommended vitamin B12 intake was reached with the SOH diet. According to the original food plan there was one egg consumed in one week. This egg was the only source of vitamin B12 in the SOH diet. The vitamin B 12 intake should be increased in large extends to avoid physical and mental deficit syndromes.

Legumes were the main source of folic acid in the SOH diet. The SOH children achieved 32% of the recommended folic acid intake. This result showed that folic acid intake should be raised to ensure adequate physical and cognitive development of the children.

3.3 Modification of the food supply to improve the food quality and to reach the recommendations

3.3.1 Changes in the food preparation

To improve the quality of the SOH food supply hygiene shortcomings were addressed and abolished. Unhygienic kitchen items such as cutting boards and cleaning cloth were exchanged for new ones. A plan for kitchen cleaning routine was compiled. Similar plans proved to be very effective in other sectors of the orphanage, because they lead to regular fulfillment of duties.

The team was informed about increased acrolein and trans-fatty acids formation during frying at excessive temperature. The harmful effects of these substances were explained to them. In addition staff members learned about toxicity of potatoes and tomatoes with green spots due to their solanine content.

The risk associated with consumption of mustard oil was explained to the team. It was pointed out, that it is not proven yet, whether it is really harmful to humans. Although mustard oil is a traditional component of Nepalese dishes and it is produced locally the team decided to not to use it anymore. Instead sunflower and soya oil was used.

The kitchen team got also an introduction into to the combination of nutrients. To increase the bioavailability of iron vitamin C rich food should be eaten with it. For example in orange season the kitchen team should provide the fruits with the bean soup in the afternoon. The same goes for mango, pomelo and other vitamin C rich fruits and vegetable.

3.3.2 Changes in the food plan

According to the findings of the nutrient analysis described in chapter 3.2 changes in the weekly food plan were made, in order to diversify the diet of the orphanage. Beside the nutrient values also economic and ecological factors were considered, such as price, origin of the food items and packaging waste. The strategy was mainly to exchange food with little nutritious value with more nutrient-rich food. The improved weekly food routine is shown in Table 2.

Table 2: Improved SOH food plan

The table shows the improved weekly food plan of the Shangrila Orphanage Home in Nepal. Some new food items were introduced as substitutes for less valuable foods.

Day	Morning Snack	Breakfast	School Tiffin	Home Tiffin	Dinner
Sunday	Milk + Rice Flakes	Rice + Bean Soup	Rice Flakes + Peanuts*	Puffed Rice+ Juice + Egg	Dal Bhat + Vegetable
Monday	Milk + Porridge* + Banana*	Rice + Soya Balls + Potatoes + Pickles	Bread + Jam	Rice Pudding*	Rice + Bean Soup
Tuesday	Milk + Rice Flakes	Dal Bhat + Vegetable	Egg* + Vegetable* + Rice Flakes	Rice Flakes + Potato Soup	Dal Bhat + Vegetable
Wednesday	Milk + Porridge* + Banana*	Rice + Soya Balls + Potatoes + Pickles	Puffed Rice + Chickpeas*	Chow mein	Dal Bhat + Vegetable
Thursday	Milk + Rice Flakes	Rice + Bean Soup	Rice Flakes + fried Potatoes*	Rice Flakes + Curd	Dal Bhat + Vegetable
Friday	Milk + Porridge* + Banana*	Dal Bhat + Vegetable	Rice Flakes + smashed Potatoes*	Rice Flakes + Bean Soup + Fruit	Dal Bhat + Vegetable
Saturday	Milktea + Chocolate Biscuits	Rice + Bean Soup +Milk		Polenta	Dal Bhat + Vegetable

Chow mein = fried noodles with vegetable, Dal Bhat = lentil soup with rice , * food items which were newly introduced to replace others

According to the original food plan there was a deficit in various micronutrients, especially in those which are mainly obtained by animal derived food. Furthermore the consumption of starch-rich staple food was very high. Especially the supply of six packages of biscuits for each child per week was unsatisfactory. Therefor one of the first steps was to exchange the biscuits in the food routine with more valuable foods.

For the morning instead of the biscuits porridge out of soy, maize and whole meal wheat flour was prepared with milk and served was served with smashed banana. The flour mixture contributes to a small extend to the zinc supply. The porridge has a comparably low GI and provides therefor long lasting energy. The main benefit of the banana is its vitamin A content. Moreover the porridge was a good alternative because it is cheaper than the biscuits and it reduces packaging waste. Due to the phytate content of the porridge a reduction of the calcium intake must be assumed.

For school the biscuits were substituted once a week by boiled egg, vegetable and rice flakes. The egg is very valuable because it delivers animal protein, vitamin A, folic acid, high bioavailable trace elements (zinc, iron, iodine) and vitamin B12. The vegetables, mostly carrot and cucumber, increase the vitamin A and folic acid intake. Rice flakes provide carbohydrates with a lower GI than biscuits. The second weekly biscuit package for school was exchanged by fried potatoes with rice flakes, which have a lower GI but do not contribute significantly to diversification of the diet.

In a second step Dalmut, a mixture made from crisp, nuts and spices, was substituted by various other food items. Dalmut was classified as less valuable because it is intensively spiced and contains several food additives. The proportion of nuts is relatively low. According to the study by CLADERA-OLIVERA et al. food additives can have various negative health effects on children (2012). Dalmut was exchanged by various food items.

For school Dalmut was replaced by smashed potatoes, roasted peanuts and fried chickpeas. Although potatoes do not contribute to the nutrient diversity, they do not contain food additives. Whereas chickpeas add iron and zinc to the diet. The peanuts are beneficial due to their folic acid and zinc content.

Also the doughnuts were abolished from the weekly food routine due to their high trans-fatty acid content. According to the statements of the Nepalese staff team these doughnuts are fried in very low quality fat which is seldom refreshed. The doughnuts were replaced by rice pudding which is a traditional dish in Nepal. Rice pudding is mainly valuable because of its milk content providing animal protein and calcium.

Every other week on Saturdays an instant noodle soup was prepared in the SOH kitchen, which is rich in food additives and accrues much packaging waste. Therefore the team decided to prepare every Saturday polenta instead. The polenta does not contain food additives and provides some vitamin A from the butter fat.



Picture 10: Porridge preparation

3.4 Acceptance of the modifications

All issues upcoming during the observation processes as well as from the nutrient analysis were discussed with the Nepalese team. The team was very open for the criticism and suggestions. Together substitutes for less valuable foods could be found. The project benefited a lot from the ideas and contributions by the SOH team. Most of the decisions were quickly put into action.

The kitchen team seemed to be proud on its central role in this project. Just in few parts of the implementation constraints which were related with culture and traditions were faced. In addition it was difficult to selectively increase specific nutrients, because the knowledge about nutrient content of local foods was very low.

In various workshops, the topics sugar, solanine, food additives and overheating of fat were discussed. The Nepalese team was very thankful that they became aware of these problems and they were very motivated to find ways to deal with the challenges.

The effects of sugar on blood sugar levels and mental performance as well as on dental health were also taught to the children in workshops. They were very interested in the topic and willing to reduce the amount of biscuits in the diet.

The overheating of fat was still observed several times, but did become less frequent. Excessive fat heating for frying is typical in Nepalese food preparation and maybe they must get used to the new practice.

The sugar content of the tea was still quite high after the sugar workshop. This is also related to the cultural background. Sugar is regarded as very valuable in Nepal. Especially to guests and superiors tea is served with much sugar to honor them.

Through constant communication during the implementation period the food system was permanently adapted to the needs of all parties. In general the implementation took place quite fast and successful, mainly because all people involved cooperated in the best way. Also the taste of the children was met, which is a prerequisite for the success of the project.



Picture 11: Negative effects of sugar consume on dental health was explained in a workshop



Picture 12: Sugar workshop for staff members

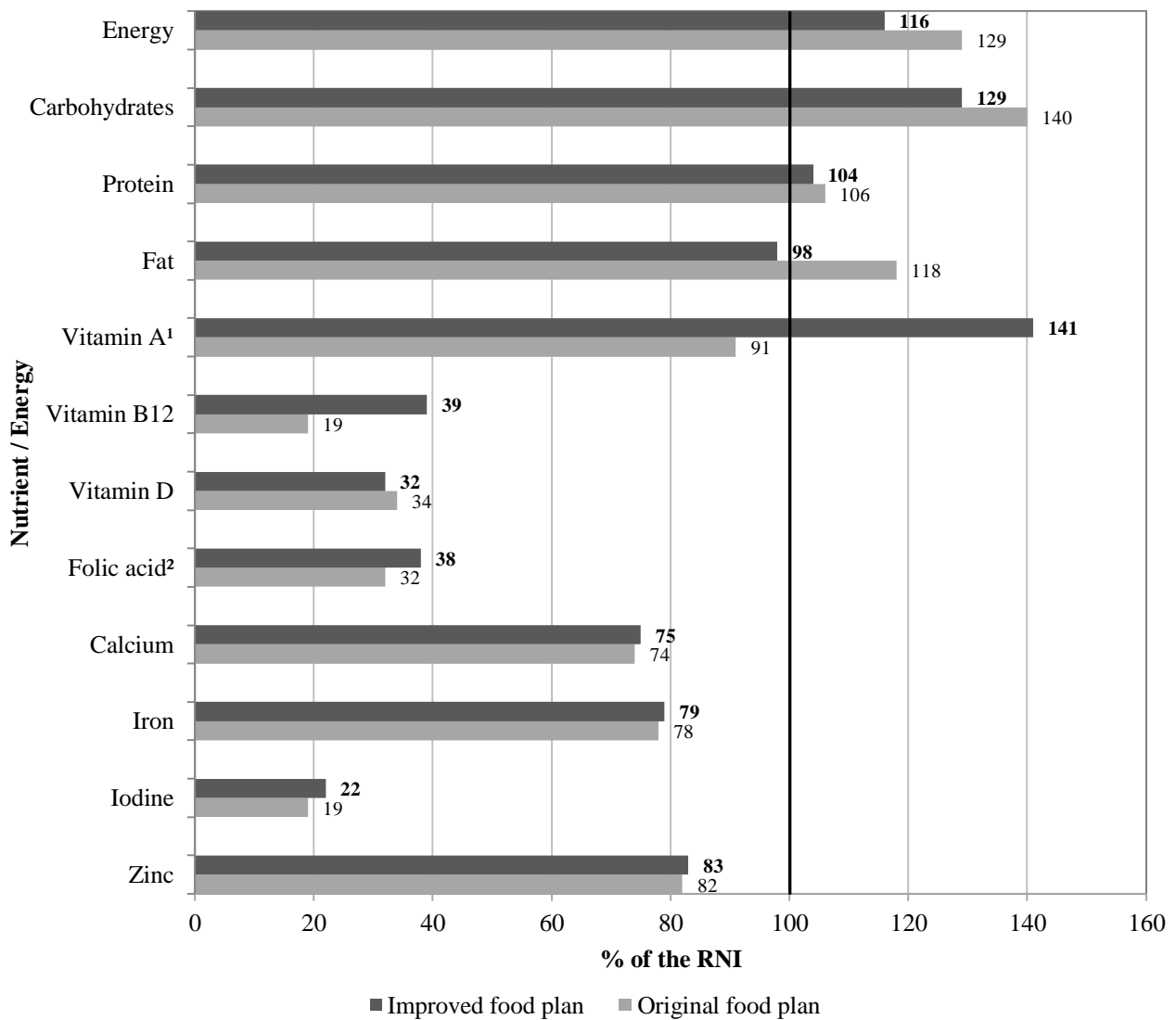
3.5 Nutrient analysis of the improved food plan

The second nutrient analysis evinces various improvements of the nutrient supply. According to the NutriSurvey calculations the weekly consumption of common sugar (saccharose) was reduced from 310g to 190g. Main changes leading to a decrease in sugar intake were the reduction in biscuits and lower sugar contents in tea. Before the improvements sugar consumption was already below the recommended limit for added sugar of 10E%. With implementation of the new food plan proportion of sugar was reduced by 2.4% from 7.2E% to 4.8E%. As explained above the WHO associates positive effects with a sugar consume below 5E%.

The protein intake could be slightly improved. Lysine is still the only limiting amino acid. Due to the food plan improvement Lysine intake could be increased from 45,5 to 47,1mg/g protein and therefore the recommendation of 48mg/g protein is almost met. All other essential and semi-essential amino acids were supplied in sufficient amounts.

Due to the use of sunflower oil the intake of poly unsaturated fatty acids (PUFA) rose from 8 to 19g/day and therefore more than doubled. The FAO recommends a PUFA intake of 6-11E% (2010, p. 15). With the original food plan the PUFA consumption reached 2.7E%. Due to the change in the oil the PUFA intake rose to 7.3E% and is now within the recommended range.

Comparing the results of the nutrient analysis of original and improved food plan, various improvements were found, as shown in Figure 3. However, the supply of most micronutrients was only slightly raised and there were still deficits present.



¹ retinol equivalents, ² total folic acid

Figure 3: Comparison of the percentages of the RNI reached with the original and the improved food plan

The graph shows the changes in the nutrient intake due to the modifications of the orphanage’s food plan. The iodine salt consumption as well as the vitamin A self-synthesis were not considered.

There was a strong increase in vitamin A intake, from 91% of RNI to 141%. Thus the vitamin A supply became much higher than the required level. The vitamin A intake was mainly increased by additional egg, carrots, and the bananas served with porridge.

Figure 3 shows that vitamin B12 intake rose by 20%. The provision of one more egg mostly contributed to the better vitamin B12 supply. Still less than 40% of RNI are reached. The vitamin B12 supply must be further increased.

Folic acid intake was raised by 6%. Additional chickpeas, egg, and vegetable could raise the supply a little bit. However, this development is insufficient and further measures need to be taken.

Marginal increases were indicated for calcium, iron and zinc supply. The only change in dairy product consumption was the implementation of rice pudding. More milk and dairy products are required to reach the recommended calcium supply.

The increase in iron intake is negligible. However, it is assumed that iron intake was raised by combining it with vitamin C rich food. The actual effect on iron absorption could not be calculated with NutriSurvey.

Also, zinc supply was not enhanced sufficiently. Corresponding to the new food plan the zinc supply of the orphanage was 17% below RNI.

Not enough nutrient dense food items were included in the food routine. In the modification of the food plan more emphasis should have been put on the micronutrient content of the newly introduced food items. More milk and dairy products are required to increase the calcium intake. More eggs would lead to further improvement of the vitamin B12, iron and folic acid intake. Higher supply of whole meal products was an option to raise the intake of zinc. The amount of vegetable and soya products consumed should be raised. This would have a positive effect on iron and folic acid supply.

4 Discussion

The project has led to significant changes in the SOH food system. However, the intake of most micronutrients was not raised sufficiently (cf. p. 18). According to the calculations the RNI of vitamin A could be met due to the changes in the food plan. The vitamin A supply in the SOH diet was mainly based on β -carotene. At present the retinol equivalent conversion factor for provitamins is debated. Although the conversion factor 6:1 for β -carotene is still internationally recognized, various studies indicate that actual absorbability of vitamin A provitamin carotenoids is lower than previously expected (WHO and FAO 2014, p. 25-26). The Food and Nutrition Board of the Institute of Medicine in the United States advocates a β -carotene conversion factor of 12:1 (NATIONAL ACADEMY OF SCIENCES 2014, p. 180). NutriSurvey uses the conversion factor 6:1. For the factor 12:1 a vitamin A supply of 70% of RNI for the original food plan and of 87% of RNI for the improved food plan was estimated. It was calculated as follows. Assuming that the orphan's vitamin A supply derived mainly from β -carotene and retinol, one can subtract the calculated retinol intake from total vitamin A intake to get the estimated amount of vitamin A derived by β -carotene. In order to apply the conversion factor this factor needs to be halved. By adding retinol intake and newly calculated vitamin A intake from β -carotene the total vitamin A intake for the conversion factor 12:1 can be estimated.

The increase in iron, calcium and zinc intake was only marginal. Also folic acid and vitamin B12 supply was still insufficient. A much more significant improvement in the supply of micronutrients was sought. More emphasis should have been put on the micronutrient supply. The improved food plan contained less sugar, was free from mustard oil and food additives but did not meet the recommendations for vitamin B12, folic acid, calcium, iron, and zinc.

The total supply of iodine and vitamin D could not be determined. The iodine content of the iodized salt was uncertain and it was questionable whether the recommended level was met (cf. p. 11). The iodine content of salt should be examined in order to ensure an appropriate iodine supply. Therefore test kits are available for assessing the iodine content of salt (CDC and WFP 2005, p. 31).

Vitamin D supply was unknown because vitamin D-self synthesis rates are difficult to estimate. Risk of vitamin D deficiency can clearly be decreased by expanding the time for the children being exposed to sun radiation.

Also the calculated iron supply was rather uncertain. The bioavailability of vegetable iron is very low. In order to improve the uptake of vegetable iron, vitamin C rich fruits were served together with meals rich in iron. The effects of bioavailability however were hard to estimate.

Comparing the nutrient intakes in SOH against the Indian RDA the supply of most micronutrients appears to be worse. For most of the micronutrients the RDA is higher than the RNI. Especially the RDA for iron is much higher, because it is “computed for a predominately vegetarian diet”. Considering the RDA for iron (27mg/d) only 47% of the recommendation was reached. Only for vitamin B12 the RDA (0,8µg) is lower than the RNI (1,0µg). The SOH diet reached 39% of the RNI but 48% of the RDA. However, the supply of both micronutrients should be increased because neither RDA nor RDA is met.

It must be considered that all calculations are based on estimated data for food intake only. Therefore the validity of these results is limited. While the food preferences among the children vary. Thus the results provide little information about the nutrient status of an individual child.

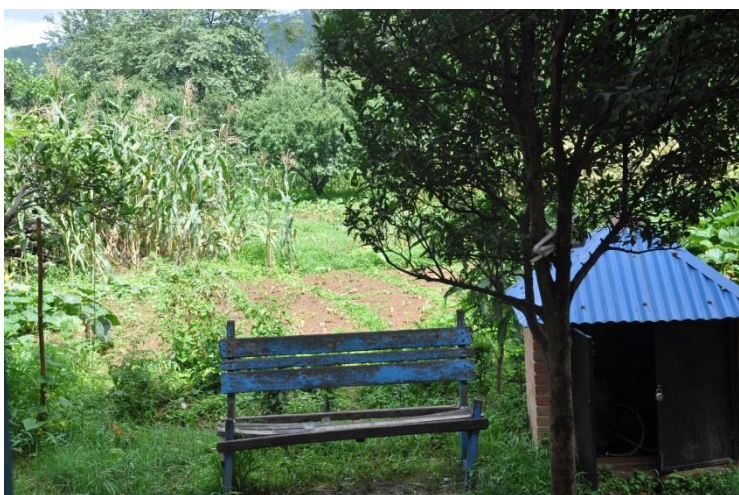
In order to evaluate the nutrient status of the individual children anthropometric assessments and biochemical analyses could be carried out. There are various anthropometric methods for finding out whether children are malnourished. For the classification these measures are often related to the children’s age. For SOH children this is critical, because the actual age from many of them is not known. Moreover malnutrition periods in the children’s earlier age can influence the results.

Biochemical analysis could provide more clarity concerning the micronutrient status. Iodine status can be assessed by measuring urinary iodine concentration (CDC and WFP 2005, p. 30). In addition to this presence of anemia should be tested. Anemia is characterized by low level of hemoglobin. It can be caused by deficits of iron, vitamin B12, folic acid or vitamin A (CDC and WFP 2005, pp. 24-25). However biochemical analyses are elaborate and expensive. Specific equipment is required and qualified personnel for carrying out these analyses. Due to cultural constraints it will become difficult to collect urine samples from the children.

In order to overcome remaining micronutrient deficits further efforts should be taken. A possible way for improving the nutrient supply is to provide food supplements. But it is favored to meet these needs with the natural diet. Therefore the food plan needs to be further diversified. One option would be to introduce meat in the food routine. This would have positive effects on the intake of iron, vitamin B12, and folic acid. But meat is expensive and inadequate cooling facilities would lead to high risk of deterioration. It is also critical that meat is not provided for ethical reason. In Order to ensure the acceptance of dietary modifications it is essential to respect religious beliefs. It is possible to reach an adequate nutrient supply with the foods included in the SOH diet by just optimizing the proportions. As elaborated above to reach a balanced diet the consumption of vegetable, fruits, eggs, soya products, milk, and dairy products must increase and the share of staple

food must be reduced. It would be preconditioned for this modification to increase the awareness of the importance of diet diversity. All the efforts made to offer a happy and healthy life for the children in the orphanage and to provide a safe future are limited to certain extent if the physical and cognitive performance are restricted due to micronutrient deficits. The modifications introduced to the original SOH food plan have proven that it is imperative to convince staff members first, as they decide on what food is provided. The SOH children usually eat what they get offered. Awareness must be developed within the SOH team for the fact that the predominant eating habits are deficient. Such a modification would change the food procurement and its preparation. Certainly the costs incurred would increase. Only if the team is able and willing to change the diet these changes will. Supporting cost calculation also is required and better financial resources must be provided for the SOH catering if necessary. Due to the far reaching consequences of malnutrition introducing these measures would be a worthwhile investment.

First, however, it is important that the already introduced improvements are retained. Good prerequisites therefore were made by creating fundamental confidence and the participatory decision making procedures. Only if concerns of the people involved and cultural conditions are taken into consideration, externally introduced changes will become sustainable. Moreover the orphanage team may seek for advice and recommendations concerning nutrition any time if required. After one year there will be a control period. If desired at that time additional measures for improvement would be taken. With these efforts even the kitchen garden could be used in a more efficient way. The kitchen garden makes the orphanage to a certain extent independent of temporary food shortages and price fluctuations. By implementing targeted management methods the garden would be farmed in a nutrition sensitive manner.



Picture 13: The SOH kitchen garden

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Results of the NutriSurvey nutrient analysis										
	energy (kJ)	Vit. A (µg)	retinol (µg)	Vit. B12 (µg)	Vit. D (µg)	tot. fol.acid (µg)	calcium (mg)	iodine (µg)	iron (mg)	zinc (mg)
Original food plan										
<i>Sunday</i>	11984	383	61	1.2	1.8	44	476	24	14	11,3
<i>Monday</i>	16215	641	189	0,0	0,0	95	900	50	22	12,2
<i>Tuesday</i>	9565	477	393	0,0	1,6	33	315	22	9	6,2
<i>Wednesday</i>	10569	659	207	0,0	0,0	59	546	25	14	8,9
<i>Thursday</i>	9516	439	412	0,1	1,6	40	345	22	9	5,4
<i>Friday</i>	11139	104	410	0,0	0,0	38	479	20	13	11,0
<i>Saturday</i>	7987	479	34	0,0	1,0	75	306	21	7	4,3
Average daily intake	10996	455	244	0,2	0,9	55	481	26	12	8,5
Improved food plan										
<i>Sunday</i>	8814	303	59	0	0,03	57	445	27	12	8,9
<i>Monday</i>	15189	650	88	0,31	1,02	91	770	33	21	9,2
<i>Tuesday</i>	7575	478	393	0	1	30	306	18	7	4,4
<i>Wednesday</i>	9637	382	207	1,2	1,8	75	413	31	12	10,3
<i>Thursday</i>	9919	374	177	0	0	51	521	33	12	10,0
<i>Friday</i>	8848	2053	207	1,2	1,8	68	421	44	11	8,9
<i>Saturday</i>	9287	690	34	0	0	87	539	26	14	8,0
Average daily intake	9896	705	166	0,4	0,8	65	488	30	13	8,5
RNI (WHO/FAO)	7920	500		1,0	2,5	170	650	135	16	10,3

Remark: Several food items that were used regularly in small amounts were added to Monday (e.g. salt, sugar, oil)

Appendix