

Research article

Body mass index and consumption pattern of different food products in thalassemia and healthy children of the Sargodha district of Pakistan

Zamar Zahra, Sarfraz Hussain*, Muhammad Nadeem, Saqib Jabbar, Tahir Mahmood Qureshi, Muhammad Umar Nasir, Syeda Mahvish Zahra, Farhat Rashid

Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Pakistan

Abstract

The aim of the present study was to determine and compare the health status of thalassemia and healthy children, to measure the adiposity in the body and eating habits of children and to check the influence of diet on the body using 24 hour dietary recalls technique. The nutritional status of the children was determined by anthropometric measurements and compared by calculating body weight, height, body mass index (BMI) and by conducting 24 hours recall method. In this study, the cumulative comparison (both boys & girls) of body mass index (BMI) between thalassemia and healthy children was highly significant ($P < 0.001$) as well as individually by gender (boys and girls) was also highly significant ($P < 0.001$). It was concluded from the consumption pattern of different food products in thalassemia and healthy children the parents or their caretakers must take positive steps to improve the quality of life of thalassemia children. Also, parents or their caretakers of thalassemia children need guidance in selecting food, clothing and education for their future. Finally, the parents or caretakers must watch their child's growth and development critically.

Keywords: Body mass index, Thalassemia children, dietary recall technique, Sargodha district

Received December 14, 2014 Revised February 10, 2015 Published online first March 15, 2015

*Corresponding author Sarfraz Hussain Email sarfrazuaf2002@yahoo.co.uk



To cite this manuscript: Zahra Z, Hussain S, Nadeem M, Jabbar S, Qureshi TM, Nasir MU, Zahra SM, Rahid F. Body mass index and consumption pattern of different food products in thalassemia and healthy children of the Sargodha district of Pakistan. Sci Lett 2015; 3(2):46-53.

Introduction

Food provides not only the energy for work, but also essential nutrients like minerals and vitamins, which are needed for proper body functions [1]. Nutrition has a direct link with the body for its sound functioning. Food comprises of different chemical components that human need to survive, such as proteins, carbohydrates, fats, vitamins, and minerals. These nutrients have multiple tasks to perform like, building the immune system, maintain health of body tissues, etc. However, requirements for these nutrients vary from body to body. Micro nutrients specifically minerals are very important to sustain healthy life as their deficiency can cause serious problems [2].

Malnutrition is the condition that develops, when the body does not get the right amount of vitamins, minerals and other nutrients required to maintain healthy tissue and organ function [3]. One of the most important global risk factors for illness and death is malnutrition, which contributes to more than half of death of the world's children. During the year 2001, 54% children's death was associated with the child malnutrition in developing countries. Overpopulation is the main factor responsible for under/poor grade food production, which is more common in developing countries and result in malnutrition [4].

According to Food and Agriculture Organization of the United Nations (FAO), about 925 million people are being suffered from the problem of malnutrition and its numbers are increasing day by day. Globally, children are the most perceptible victims of malnutrition. Each

year, malnutrition is causing the death of about 10.9 million children [5].

Malnutrition also affects already diseased patients as growth abnormality is the most common attribute seen in children of thalassemia disease. In children with thalassaemia disease, growth associated disturbances are caused due to under-nutrition. The factors of malnutrition were caused by inadequate nutrient intake, as indicated by the aptitude to gain weight suitably when provided with nutrition support, and by the nonexistence of intestinal mal-absorption [6].

Thalassemia is the most prevalent genetic blood disorder in the world, recognized by The World Health Organization (WHO). It is found in more than 60 countries with a carrier population of 150 million. Approximately 250 million people worldwide are heterozygotes for β -thalassemia and at least 2,000,000 affected homozygotes are born annually, while, some other reports have shown 3 - 10% of the world's population carries a thalassemic gene [7].

In Pakistan β -thalassemia is more prevalent than other forms of thalassemiias. Like α -thalassemia and β -thalassemia and hereditary persistence of fetal hemoglobin are extremely uncommon. Gene frequency of β -thalassemia in Pakistan is about 6% with a population of 140 million, there are over 8 million carriers of β -thalassemia gene intermarriages and first cousin marriages have resulted in a high prevalence of homozygous β -thalassemia (β -thalassemia disease) [8]. At present, the projected figure of β -thalassemia major patients in Pakistan is 121,000. This causes severe

hemolytic anemia in the fetus, marked hepatosplenomegaly, marked cardio-megaly, severe anemia, edema and heart failure resulting in intra-uterine death of the fetus [8]. Therefore, the aim of the present study was to determine and compare the health status of thalassemia children and healthy children, to measure the adiposity in the body and eating habits of children and also to check the influence of diet on the body using 24 hour dietary recalls technique.

Materials and methods

Nutritional status

The nutritional status of the children was determined by anthropometric measurements and compared by calculating body weight, body height, body mass index and by conducting 24 hours recall method.

Selection of sample

Samples for BMI measurements and for 24 hours recall technique were collected from thalassemia centers, few schools and children parks in Sargodha. A sample size of 90 thalassemia children as well as 90 healthy children (46 boys, 44 girls) was taken by convenient sampling method from the above mentioned places of Sargodha. Keeping in view the type of study, data availability, cost and time span, kind of data analysis, resources available, practical evidences and the sensitivity of the issue of the diseased children, Sargodha city was selected among the district. The samples were selected irrespective of sex. The age group of children was ranged mainly from 2-15 years.

Personal information

According to the instructions of the World Health Organization for anthropometric measurements name, sex, age, contact number, E-mail address, postal address and other necessary information of the children were recorded for any further inquiry and detailed information.

Data collection techniques

In this study, the tools body mass index (BMI calculator for children) and dietary intake (24 hour recall method) were selected for assessing the BMI and nutritional status of thalassemia children with healthy children of 2 to 15 years of age.

Body mass index (BMI) measurement

For calculating body mass index (BMI), child body mass index calculator was used [9] and according to this method person's weight and height of the individuals

were calculated and to calculate BMI, a method for the calculation of BMI was adopted given as under:

Weight measurement

Following things were used for the measurement of weight, i.e. eraser, pencil, beam scale, level wooden board, magnifying glass, spirit leveler [10]. A well balanced level place was selected for the installation of weighing balance. The weighing machine was placed on the clean cemented floor for accurate and reliable results. For this reason a spirit leveler was used to check the level of floor surface and then the weighing machine was placed on a smooth surface. Spirit leveler was placed over the center of the machine to confirm the level of weighing machine, along the line mentioned in the balance. It was made sure that the weighing machine reading was zero before weighing. At the start of each weight measurement session, a standard 2-kg mass was used to check that either the beam scale was working properly or not.

To minimize error, children were advised to take off everything except briefs or panties. So weight with minimal clothing was made possible. Children were also instructed to empty pockets of panties. Children were asked to stand upright on the weighing machine with both feet parallel and look straight. Children were also asked to breath in deep and hold breath until weighing readings were recorded.

Sources of error

During measurement, it was made possible to minimize sources of errors, i.e. heavy and light clothing, shoes and socks (if not removed), shaking child, zero error, unequal weight on both feet, child holding on to something, breathing, heels up and down, recording at different times of the day, wet body after bath, body not clean, pockets holding heavy things, looking down to read weight measurements, measuring before and after heavy meal intake, after disturbed sleep, weight of watch, ornament and eye glasses (if not removed), level of surface on which machine was placed [10].

Standing height

The following things were used for measurement of standing height; Stadiometer, mounting tape, eraser, magnifying glass, lead pencil, vertical board, spirit leveler [10]. Children were asked to stand erect on the floor board of the stadiometer with his/her back to the vertical backboard of the stadiometer. The weight of the participant was evenly distributed on both feet. The heels of the feet were placed together with both heels touching the base of the vertical board. The feet were pointed slightly outward at a 60 degree angle. If the

children had knock knees, the feet were separated so that the inside of the knees was in contact but not overlapping. The buttocks and head were positioned in contact with the vertical backboard. For the children who could not place their heels, buttocks and the posterior aspect of the head against the backboard while maintaining normal stature were positioned so that only heels and buttocks were in contact with the vertical board, and the body was positioned vertically above the waist. The arms hanged freely by the sides of the trunk with palms facing the thighs. The children were asked to inhale deeply and stand fully erect without altering the position of the heels. Hair ornaments, buns, braids, etc. were removed to obtain an accurate measurement. The height was measured with the measuring tape mounted on the wall.

Sources of error

All possible sources of errors were kept in mind to overcome measurement errors. The possible sources of errors were i.e. carpet (in faculty offices), uneven floor (mud) during field studies, head not straight (tilted either forward or level of surface in laboratory backward), hair on the head, shrinking neck muscles, scarf (if not removed), socks and shoes (if not removed), breathing, subject flexing knees, heels lifted up, toes lifted up, feet with mud, measuring time not same (morning, evening and weak muscles of hips and legs), children not standing still, not putting equal weight on both feet, children not looking straight, subject holding on to something, height measured after strenuous exercise [10].

Calculation of body mass index (BMI)

After calculating children's weight (kg) and height (m), BMI was calculated using following formula.

$$\text{BMI} = \text{weight (Kg)} / \text{height (m)} \times \text{Height (m)}$$

Hour dietary recall method for nutritional assessment

For nutritional assessment of thalassemia and healthy children of 2 to 15 years of age, 24 hour recall interview method was used. For the collection of 24 hour dietary recall information performa, led pencil, eraser, table, file were used. In this technique the children as well as their parents were interviewed about every food item and its amount that a child ate during last 24 hours. Duplicate readings were recorded for more accurate and reliable results. The interview was conducted in Urdu language as to assist children and their guardians to understand easily [11].

Statistical analysis

The data obtained after conducting the procedures was subjected to statistical analysis. To check the level

of significance, t-test of independence using SPSS was applied and to compare the BMI of thalassemia and healthy children and eating pattern was presented graphically by using Microsoft Excel 2007.

Results and discussion

Comparison of body mass index (BMI) between thalassemia and healthy children

The comparison of BMI between thalassemia and healthy children is given in Figure 1. There were 90 observations in our study, including 46 boys and 44 girls. Cumulative comparison (both boys & girls) was highly significant ($P < 0.001$) as well as individually by gender (boys & girls) was also highly significant ($P < 0.001$) in this study. The results showed many probabilities. Thalassemia is a disease with many complications like multiple endocrinopathies, iron deposits in major organs and maybe it was the reason of low body mass index in thalassemia children. In case of healthy children, their immune system was very strong which might be the reason of their normal body mass index. The recommended interpretations for comparison of BMI are given in Table 1.

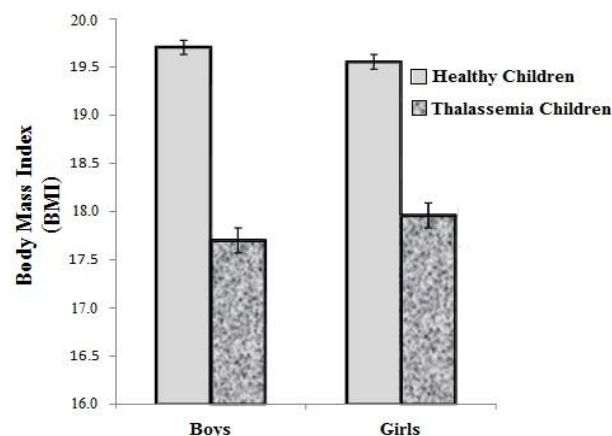


Figure 1: Comparison of body mass index (BMI) between thalassemia and healthy children

Table 1: Recommended interpretation for comparison of body mass index (BMI).

Interpretation of the Results	
BMI Range	Interpretation
<18.5	Underweight
18.5 to 24.9	Normal
25 to 29.9	Overweight
30 or more	Obese

Consumption of dairy products in thalassemia and healthy children

In Pakistan major blood group in the Indo-Pak subcontinent is "B" which likes dairy products most. Dairy products are important and major food group items and play vital role in the development of body,

especially bones and teeth. Dairy items provide a good source of energy and also a rich source of calcium and many other vitamins [12].

In thalassemia children, consumption pattern of dairy products is shown in Figure 1a. According to this pattern highest consumption of milk was seen among all other dairy products, 62% children took one serving of milk and 19% children took one serving of lassi (a by-product of milk). One serving of yogurt and butter was consumed by 56% and 61% children, respectively. None of the children were taking two or three servings of dairy products. Thalassemia disease complications show the losses of large amount of calcium. An overall dairy consumption pattern of diseased children were not satisfactory. This pattern was, according to the food consumed by children in last 24 hours of the time period.

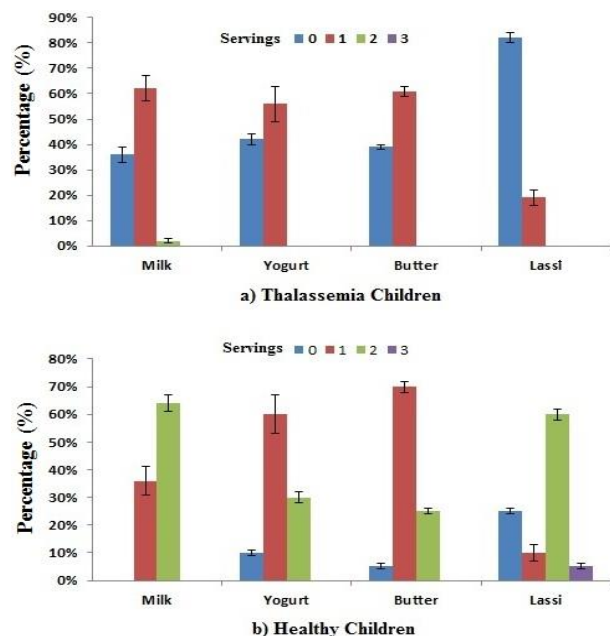


Figure 2: Consumption of dairy products in thalassemia and healthy children.

Consumption of dairy products of healthy children is shown in Figure 2b. Milk consumption was highest even with two servings which was 64% and the lowest consumption were seen of yoghurt, which was consumed by 30% children. Overall consumption of dairy products in healthy children in a period of 24 hours was good.

Consumption of meat products in thalassemia and healthy children

Animal foods contain high-quality or complete protein, which means they supply all the amino acids that are essential for the body need to build up the protein and also help to support proper body functions.

Besides protein, foods from this group, supply various amounts of other key nutrients, including iron, zinc, magnesium, vitamin E, and B vitamins (thiamin, niacin, and vitamins B₆ and B₁₂). On the downside, some of the foods in this group contain higher amounts of fat, saturated fat, and some cholesterol [13].

Figure 3a shows the consumption of meat products in thalassemia children. Consumption patterns of meat products showed that 79% diseased children took one serving of mutton, while, 18% took two serving of mutton. One serving of poultry was consumed by 86% children, while, 14% took two servings. 75% sick children took one serving of egg, while, 25% took two servings. The lowest consumption of fish showed that 96% did not take even a single serving of fish, while, 4% took one serving, which may be due to the reason that it is a seasonal food item and most of the children did not develop a taste for it. Overall consumption of meat products in a period of 24 hours was good in diseased children. In thalassemia iron deposits occurred in different organs in the body that’s why meat products cause harm to them as it contain iron as a micronutrient.

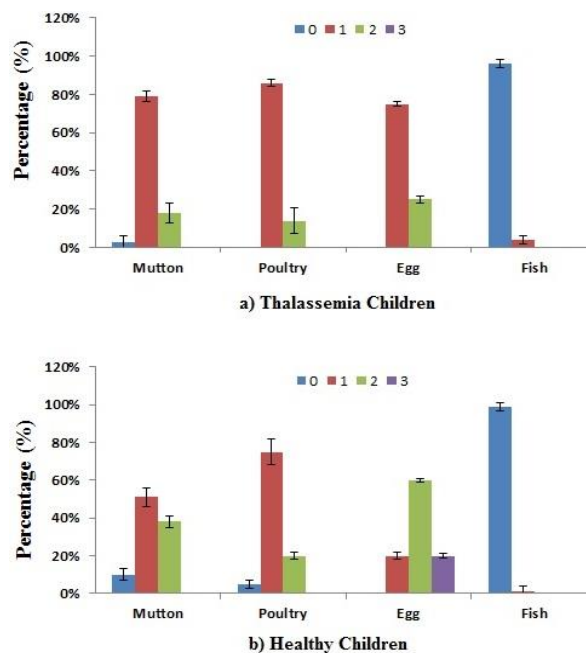


Figure 3: Consumption of meat products in thalassemia and healthy children.

Figure 3b shows the consumption of meat products in healthy children showed that 51% healthy children took one serving of mutton, while, 38% took two servings of mutton. One serving of poultry was consumed by 75% children, while, 20% children took two servings. 20% healthy children took one serving of egg, while, 60% took two servings and 20% children took three servings of egg. The consumption of fish showed that 99% children did not take even a serving of

fish while 1% took one serving which may be because fish is a seasonal item and most of the children do not develop a taste for it or may be due to the reason that fish meat has spines in it. Overall consumption of meat product in a period of 24 hours was good in healthy children.

Consumption of fruits/vegetables in thalassemia and healthy children

Foods such as fruits and vegetables do not only contain vitamins and minerals, but also other naturally occurring substances that may help protect the body from chronic diseases. There is no doubt that a diet with plenty of fruits and vegetables offers a whole host of health benefits, including protection from heart disease, stroke, high blood pressure, some types of cancer, eye disease, and gastrointestinal troubles. Eating healthy can be a part of an alternative treatment against illness. In addition, fruits and vegetables can even help beat back the effects of aging. Some fruits and vegetables are good natural sources of vitamin A, while, others rich in vitamin C, folate and potassium. Almost all are naturally low in fat and calories, none have cholesterol, and many are great sources of fiber. Fruits and vegetables also add wonderful flavors, textures, and colors to the diet [14].

Figure 4a shows the consumption of fruits and vegetable products in thalassemia children. Consumption patterns of these products showed that 87% diseased children took one serving, while 11% took two serving of mangoes. One serving of bananas was consumed by 83% children while 4% took two servings. 62% sick children took one serving of apples while 18% took two servings. The consumption of vegetables showed that 45% did not take even a serving of vegetables while 55% took one serving which may be because most of the children do not like vegetables. Overall consumption of fruits and vegetables products in a period of 24 hours was average in diseased children.

Figure 4b shows the consumption of fruits and vegetable products in healthy children. Consumption patterns of these products showed that 75% healthy children took one serving, while 15% took two serving of mangoes. One serving of bananas was consumed by 10% children while 60% took two servings and 30% healthy children took three servings. 22% healthy children took one serving of apples while 55% took two servings and 15% children took three servings of apples. The consumption of vegetables showed that 10% did not take even a serving of vegetables while 10% took one serving and 80% healthy children took three servings of vegetables. Overall consumption of fruits

and vegetables products in a period of 24 hours was above average in healthy children.

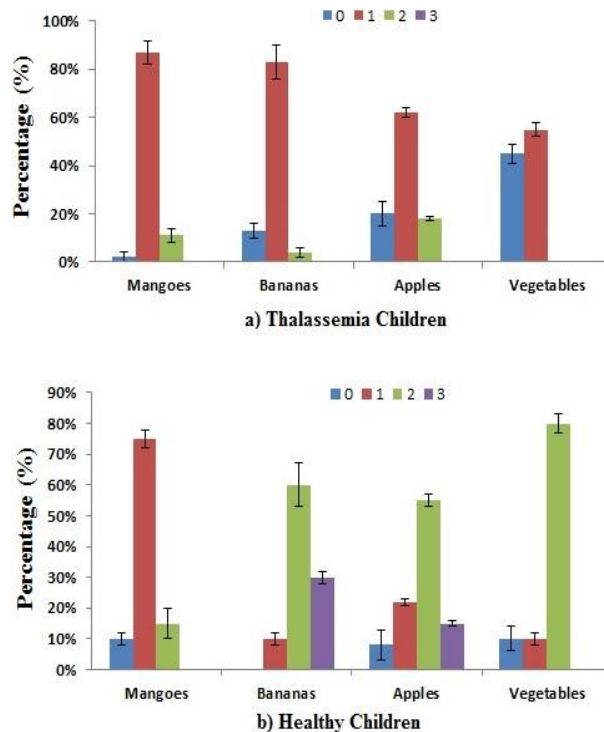


Figure 4: Consumption of Fruits/Vegetables in Thalassemia and Healthy Children

Consumption of cereal products in thalassemia and healthy children

Cereals are one of the most popular members of the complex carbohydrate food group. In their natural form (as in whole grain), they are a rich source of vitamins, minerals, carbohydrates, fats and oils and proteins. However, when refined by the removal of the bran and germ, the remaining endocarp is mostly carbohydrate and lacks the majority of the other nutrient, but now more than 90% of all commercial cereals are fortified with various vitamins and minerals, especially iron, niacin, riboflavin, thiamine, and perhaps calcium [15].

Figure 5a shows the consumption of cereal products in thalassemia children. Consumption patterns of these products showed that 31% diseased children took one serving, while 26% took two serving of chapati. One serving of paratha was consumed by 26% children while 74% did not take any servings of paratha. 67% sick children took one serving of rice while 4% took two servings. The lowest consumption of daal was observed among all other cereal products as 77% did not take even a serving of daal while 23% took one serving which may be because most of the children do not like daal. Overall consumption of cereal products in a period of 24 hours was not good in diseased children.

Figure 5b shows the consumption of cereal products in healthy children. Consumption patterns of these products showed that 70% healthy children took one serving, while 20% took two serving of chapatti and 10% children took three servings of chapatti. One serving of paratha was consumed by 60% children while 25% took two servings of paratha. 65% healthy children took one serving of rice while 25% took two servings. The consumption of daal showed that 55% took one serving of daal while 45% took two servings. Overall consumption of cereal products in a period of 24 hours was good in healthy children.

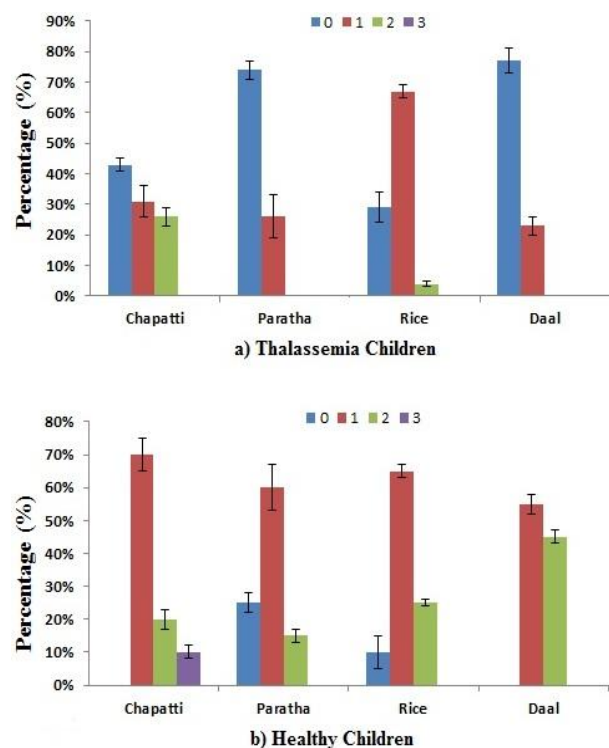


Figure 5: Consumption of Cereal Products in Thalassemia and Healthy Children

Consumption of beverages in thalassemia and healthy children

Beverages are the important food group. The beverages include fruit juices and carbonated drinks, which are also called soft drinks or fizzy drinks. Fruit juices provide powerful health benefits. Drinking fresh juice is a well-known method to bring the necessary vitamins and minerals in the body so that health would profit most from nature’s bounty. While on the other hand carbonated beverage is acidic and it obstructs the absorption of calcium that can make the bones weak. Losing calcium in young age is a bad sign, as the bones may not support the body weight and make the body feel tired all the time. Acid based

drinks also cause tooth decay and cavities. The discoloration of teeth can also be blamed on carbonated drinks due to its high sugar content [16].

Figure 6a shows the consumption of beverages in thalassemia children. Consumption patterns of these beverages showed that only 7% diseased children took one serving, while the rest of 93% did not take any serving of fruit juices. One serving of carbonated drink was consumed by 76% children, while, 23% took two servings and 1% took 3 servings of carbonated beverages. Overall consumption of beverages in a period of 24 hours was not good in diseased children as most of the children have their liking towards carbonated beverages which is dangerous for health and especially in a disease like thalassemia, already calcium losses are very high due to iron overload and other complications.

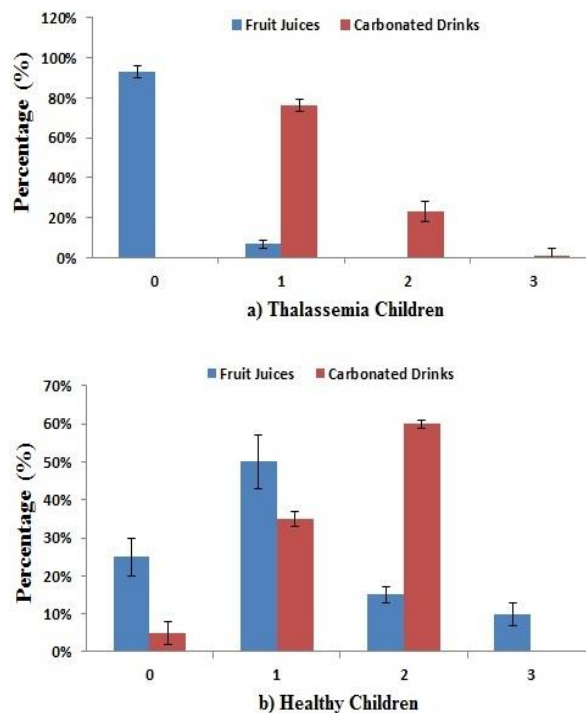


Figure 6: Consumption of beverages in thalassemia and healthy Children.

Figure 6b shows the consumption of beverages in healthy children. Consumption patterns of these beverages showed that only 50% healthy children took one serving, while, 15% took two servings of fruit juices and 10% children even took three servings of fruit juices. One serving of carbonated drink was consumed by 35% healthy children while 60% took two servings of carbonated beverages. Overall consumption of beverages in a period of 24 hours was good in vigorous children as most of the children have their liking towards fruit juices which is good for better nutrition.

Consumption of snack foods in thalassemia and healthy children

Due to the presence of a wide variety of additives and preservatives, there are chances of many health related risks by eating unhealthy snacks too often. These additives are synthetic product and body cannot digest them. Artificial colors are other very dangerous ingredients of these foods. Fast food as they have zero caloric value: no vitamins, minerals, protein or fiber. These make them weaken to every organ of the body [17, 18].

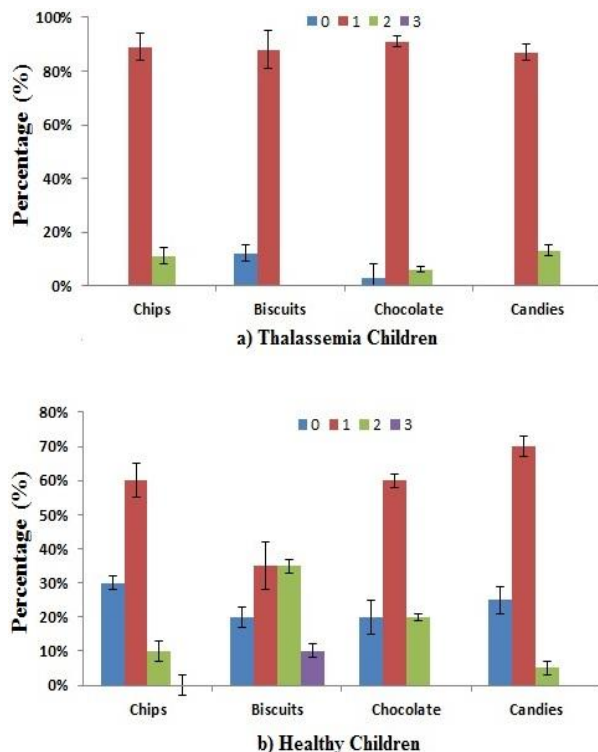


Figure 7: Consumption of snack foods in thalassemia and healthy children.

Figure 7a shows the consumption of snack foods in thalassemia children. Consumption patterns of these foods showed that 89% diseased child took one serving, while the rest of 11% took two servings of chips. One serving of biscuits was consumed by 88% children. 91% children took one serving and 6% took 2 servings of chocolates. 87% children took one serving of candies and 13% took two servings of candies. Overall consumption of snack foods in a period of 24 hours was not good in diseased children as most of the children have their strong liking towards snack foods which is dangerous for health and especially in a disease like thalassemia, already disease complications cause harm to health and these snack food item add more it.

Figure 7b shows the consumption of snack foods

in healthy children. Consumption patterns of these foods showed that 60% of well children took one serving, while the 10% took two servings of chips. One serving of biscuits was consumed by 35% children, 35% children took two servings and 10% even took three servings of biscuits. 60% children took one serving and 20% took two servings of chocolates. 70% children took one serving of candies and 5% took two servings of candies. Overall consumption of snack foods in a period of 24 hours was not good in healthy children as most of the children have their strong liking towards snack foods which is dangerous for health.

Conclusions

Thalassemia children are passed through a series of phases that psychologically and physically affect their growth patterns. Parents and their caretakers must take positive steps to improve the quality of life of thalassemia children. Parents are their guards and caretakers of children need guidance in selecting food, clothing and education for their future. The parents must watch their child's growth and development critically. Following steps should be taken to maintain a good health. Children should be evaluated annually by a registered dietitian regarding adequate dietary intake of calcium, vitamin D, folate, trace minerals (copper, zinc, and selenium) and antioxidant vitamins (E and C). Recommendations for dietary supplementation should be made as indicated by nutritional history, complications of the disease and their growth status. Typically multivitamin supplementation without iron is suggested. Vitamin D supplementation (50,000 IU once a week until levels normalize) is recommended for patients. Calcium supplementation should be encouraged if dietary intake is insufficient. Counseling should be offered for children with special dietary needs. These include patients with diabetes or lactose intolerance, those who practice vegetarianism, or those on oral chelators. Children should be given homemade lunches instead of money to buy food from shops and carts. The children adapt the dietary preferences and patterns expressed by parents. So parents should also modify their food patterns that can improve health of their children. The food cooked at home did not satisfy the child in quality and quantity. So it should be improved and must be cooked according to food groups that are needed for their children. The media (T.V, press, radio) can be an instrument in bringing about the required change in attitude. The issue of malnutrition among thalassemia children should be given importance. Sanitation and hygiene in homes and thalassemia centers should be provided to minimize the chances of infection.

Acknowledgement

The authors of this research work duly acknowledge the help and support of faculty and staff for providing help and support to carry out this research at Institute of Food Science and Nutrition, University of Sargodha (UOS), Sargodha.

References

- [1] Jegtvig S. Do you know what you need to eat? http://nutrition.about.com/od/nutrition101/a/why_nutrition.htm. 2007.
- [2] Schmidt S. What are nutrients ? <http://www.wisegeek.com/what-are-nutrients.htm>. 2010.
- [3] Shashidhar RH. Malnutrition (background). [medicine.medscape.com/article/985140-overview#a0101](http://www.medscape.com/article/985140-overview#a0101). 2011.
- [4] Anonymous. History highlights of nutrition. <http://nutrition/History%20Highlight%20of%20Nutrition.htm>. 2011.
- [5] Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? *Lancet* 2003;361: 2226-34.
- [6] Fuchs GJ, Tienboon P, Linpisam S, Nimsakul S, Leelapat P. Nutritional factors and thalassaemia major. *Arch Dis Child* 1996;74: 224-7.
- [7] Pemde HK, Chandra J, Gupta D, Singh V, Sharma R, Dutta AK. Physical growth in children with transfusion-dependent thalassaemia. *Pediatr. Health, Med. Therapeutic*. 2011;2: 13-9
- [8] Moin. Introduction to Thalassaemia. [thalassaemia/Introduction%20to%20ThalassaemiaPakHematology.htm](http://www.thalassaemia.org/Introduction%20to%20ThalassaemiaPakHematology.htm). 2010.
- [9] Nelson WE, Behrman RE, Kliegman RM, Arvin AM. 1996. *Nelson Textbook of Pediatrics*. ed. WB Saunders, pp. 63-7: Saunders Company.
- [10] Kamal AS. The NGDS Pilot Project, University of Karachi, Pakistan, Karachi, 75270. 2010.
- [11] Buzzard IM, Faucett CL, Jeffery RW, McBane L, McGovern P. World health organization. Physical status, the use and interpretation of anthropometry, WHO technical report series 854, Geneva, Switzerland. 1996.
- [12] Lanou AJ, Berkow SE, Barnard ND. Calcium, dairy products, and bone health in children and young adults: a reevaluation of the evidence. *Pediatr* 2005;115: 736-43.
- [13] Biesalski HK. Meat as a component of a healthy diet-are there any risks or benefits if meat is avoided in the diet? *Meat Sci* 2005;70: 509-24.
- [14] Liu RH. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *Am J Clin Nutr* 2003;78: 517S-20S.
- [15] Hoseney RC. Principles of cereal science and technology. American Association of Cereal Chemists (AACC); 1994.
- [16] Wyshak G. Teenaged girls, carbonated beverage consumption, and bone fractures. *Arch Pediatric Adolesc med* 2000;154: 610-3.
- [17] Boris M, Mandel FS. Foods and additives are common causes of the attention deficit hyperactive disorder in children. *Ann Allergy* 1994;72: 462-7.
- [18] Tuorma TE. The adverse effects of food additives on health: a review of the literature with a special emphasis on childhood hyperactivity. *J Orthomol Med*. 1994;9: 225.