Institut für Ernährungswissenschaft
Justus-Liebig-Universität Giessen

Improving the nutritional status of preschool children in El-Menoufia Governorate, Egypt

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eingereicht von:
Azza Mohamed Ibrahim El.Eskafy
aus Ägypten

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Dekan:	Prof. Dr. R. Herrmann
Prüfungsvorsitzende:	Prof. Dr. I. Hoffmann
1. Gutachter:	Prof. Dr. M. Krawinkel
2. Gutachterin:	Prof. Dr. M. Neuhäuser-Berthold
Prüfer:	Prof. Dr. C. Kunz
Prüferin:	Prof. Dr. U. Meier-Gräwe

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Index of Terms and Abbreviations

Anemia	Concentration of haemoglobin in the blood for children 6-59 months of age below 110 g/L
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization
Fertility rate	The number of children that would be born per woman
HAZ	Height-for-age
Hb	Haemoglobin
MCH	Mean corpuscular haemoglobin
MCHC	Mean corpuscular haemoglobin concentration
MCV	Mean corpuscular volume
Morbidity	Number of people in a population falling ill during a certain period
Mortality	Frequency of death in a population
Mortality rate	Frequency of death per 1000 live people in a given year
Obesity	Weight-for-height >+3 Z-score of the reference population
Overweight	Weight-for-height >+2 Z-score of the reference population
Prevalence	The number of cases of disease (or people with a particular characteristic), in a given population at a designated time
RBCs	Red blood cells
RDA	Recommended Dietary Allowances
SD	Standard deviation
Stunting	The process of failure to reach linear growth potential. It is defined as height-for-age <-2 Z-score of the reference population, usually as a consequence of long-term inadequate nutrition and / or poor health
Underweight	Weight-for-age <-2 Z-score of the reference population, usually as a consequence of chronic and / or acute malnutrition
Wasting	Weight-for-height <-2 Z-score of the reference population, usually as a consequence of acute starvation and / or severe diseases
WAZ	Weight-for-age

WHO	World Health Organization
WHZ	Weight-for-height
Z-score	Standard deviation of an individual's value from the median of the reference population

1. Introduction

1.1 Background

Adequate dietary intake and nutritional status among children are important for their own growth, development and function, and there is now increasing evidence that childhood nutrition also influences adult health. Thus, childhood diet needs to be taken seriously in order to improve a nation's health as well as producing bright and active children (Tomkins 2001).

Children with subclinical deficiency of micronutrients are more vulnerable to develop frequent and more severe common day-to-day infections.The first three years of life are most crucial and vulnerable to the hazards of undernutrition. All efforts should be made so that preschool children are given a balanced and nutritious home-based diet (Singh 2004).

Malnutrition, with its 2 constituents of protein-energy malnutrition and micronutrient deficiencies (iron, iodine, vitamin A and zinc), continues to be a major health burden in developing countries. It is globally the most important risk factor for illness and death, with hundreds of millions of pregnant women and young children particularly affected. In these communities, a high prevalence of poor diet and infectious diseases regularly unite into a vicious circle (Müller and Krawinkel 2005).

Malnutrition permeates all aspects of health, growth, cognition, motor and social development of young children in developing countries. More than 50% of deaths among these children can be attributed to malnutrition, most often in conjunction with serious infection. Child survival initiatives and programs have accomplished much to save the lives of children from common and preventable illnesses, but the quality of the survivor's health needs to be improved, with much more attention paid to nutrition of the preschool and school child (Neumann, Gewa and Bwibo 2004).

Estimates for the prevalence of micronutrient deficiencies in today's world are iron deficiency anemia affects two billion people, mostly women and children, blindness due to vitamin A deficiency affects 2.8 million children under 5 years of age and iodine deficiency disorders affect 740 million people (Diaz, de las Cagigas and Rodrigue 2003).

In Egypt, although indicators of child health have improved, the current rates for malnutrition in children are still unacceptably high, especially in rural Upper Egypt with a high level of stunting due to insufficient household food security, inadequate feeding and caring practices and high infection rates (WHO 2006a).

The results of nationwide nutrition surveys in Egypt suggest that the nutritional status of young children has improved during the 1995-2000 period, but the main problem among preschool children is stunting which is considered a moderate public health problem according to WHO criteria.

Regarding micronutrient deficiencies, iron deficiency is considered the most prevalent among preschool children and their mothers. According to WHO criteria, iron deficiency anemia is considered to be a moderate public health problem in Egypt. Also, vitamin A deficiency among preschoolers and their mothers is considered to be sub-clinical, mild-to-moderate, public health problem in Egypt (FAO 2003).

Clearly major health benefits could be achieved by choosing appropriate and cost-effective strategies that successfully alleviate micronutrient deficiencies in developing countries. Strategies include supplementation to those at risk, food-based strategies involving fortification of foods and dietary diversification, and public health actions to reduce infections and promote good health. The food supplementation refers to the addition of a nutritious food to a simple diet (Gibson 2004; Latham 1997 p 400).

Snacks are food eaten between meals. Eating good snacks like roasted groundnuts, oilseeds, dried fruits, coconut flesh and dates is a good way of improving a diet which may lack energy and nutrients. Provision of snacks at school could help alleviate the micronutrient malnutrition that is common in developing countries (Burgess and Glasauer 2004; Murphy et al. 2003).

1.2 Egypt and El-Menoufia

Egypt

Geography

Egypt is situated in the northeastern corner of Africa. It is bordered in the north by the Mediterranean Sea, in the east by Gaza Strip and the Red Sea, in the south by Sudan and in the west by Libya (Figure 1). The country consists of vast desert plateau interrupted by the Nile Valley and Delta (FAO 2005). The total area of Egypt is about 1 million km² (land of about 995,450 km² and water of about 6,000 km²), only 6% of the area is inhabited (WHO 2006a).

Fig. 1: Map of Egypt

The majority of the country area is desert land. Most of the cultivated land is located close to the banks of the Nile River, its main branches and canals, and in the Nile Delta. There is no forest land. The total cultivated area is about 3% of the total area of the country (FAO 2005).

The Nile traverses over 1500 km² within Egypt from Wadi Halfa in the south to the Mediterranean in the north. It divides the country into four broad regions: the Western Desert, which occupies almost tow-thirds of the total area; the Eastern Desert; the Sinai Peninsula; and the Nile Valley and Delta, which is the most densely populated region of the country (FAO 2003).

The dominant feature of the northern coastal zone is the low lying Delta of the River Nile, with its large cities, industry, agriculture and tourism. The Delta and the narrow Valley of the Nile comprises 5.5% of the area of Egypt, but has over 95% of its people and its agriculture. With the exception of small areas of cultivated land in the oases of the Western Desert, the coastlands west of the Delta and in Northern Sinai, and the rest of Egypt is desert (EEAA 1999).

Cairo is the capital of Egypt and the largest city in Africa, the Arab world and the Middle East. It is also the industrial and commercial center of Egypt (FAO 2003).

Administratively, Egypt is divided into 26 Governorates and Luxor city. The four urban Governorates (Cairo, Alexandria, Port Said and Suez) have no rural population. Each of the other 22 Governorates is subdivided into urban and rural areas. Nine of these Governorates are located in the Nile Delta (Lower Egypt), eight are located in the Nile Valley (Upper Egypt) and the remaining five Frontier Governorates are located on the eastern and western boundaries of Egypt (El-Zanaty and Way 2001).

Climate

Egypt’s climate is hot dry summer and mild winter. Rainfall is very low, irregular and unpredictable. Summer temperatures are high, reaching 38 °C to 43 °C with extremes of 49 °C in the southern and western deserts. The northern areas on the Mediterranean coast are cooler, with 32 °C as a maximum (FAO 2005).

The country is characterized by particularly good wind with excellent sites along the Red Sea and Mediterranean coasts. The climate in Egypt has been changing in phase with global change, but with lower rates of variation. There is a downward trend in maximum temperature over the Delta, over the northern part of Upper Egypt and over the extreme south of Upper Egypt (EEAA 1999).

Population

Egypt's population was estimated to be 73,911,761, according to the results of the census 2007 (CAPMAS 2007). Egypt is the second most populous country in the WHO Eastern Mediterranean Region after Pakistan. 51.2% of the Egyptians are males and 48.8% are females (WHO 2006a).

In the last 50 years, the population in Egypt has grown largely as a result of high fertility. In 1972, the birth rate was 34.5 births per 1000 population. This rate increased to 39.8 births per 1000 in 1985, then declined to 28.6 per 1000 in 1994. The fertility rates are higher in rural than in urban areas (Harmeling 1999).

In 1995-2000, the population growth rate was 1.8% and the total fertility rate was 3.4 children born per woman. In the period 1980-2000, the population increased by just over 24 million. In the period 2000-2020, on the basis of United Nations medium variant assumptions about fertility rates, it is forecast to grow by 22 million. Fertility rates are higher in Upper Egypt, especially in poor and rural regions. One third of the population and half of the poor Egyptian live in Upper Egypt. It is also the area with the highest infant mortality rates (Rivlin 2003).

57.4% of the population lives in rural areas, and 42.6% lives in urban areas. The distribution of Egypt's population by age groups is shown in figure 2 (CAPMAS 2006).

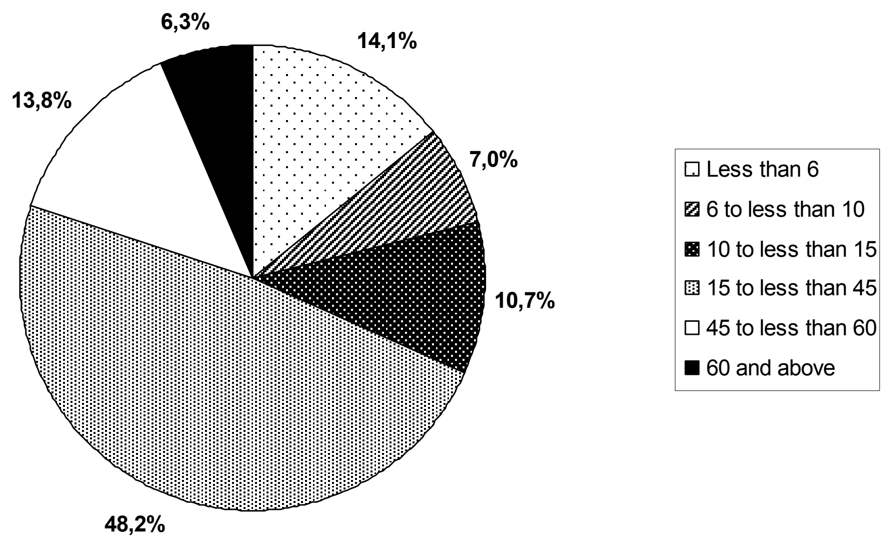

Fig. 2: Distribution of Egypt's population by age groups

The population lives in crowded conditions and the number of people living in housing units is exceptionally high everywhere. In some areas of Cairo and Alexandria, the number of persons per km^2 exceeds 100,000. In urban areas, 83% of the populations live in apartments; and in rural areas, 71% live in a free-standing house (WHO 2006a).

Overall population density is 73 inhabitants per km^2; however, with about 97% of all people living in the Nile Valley and Delta, population density reaches more than 1,165 inhabitants per km^2 in these areas, while in the desert it drops to only 1.2 inhabitants per km^2 (FAO 2005).

The official language is Arabic, but English and French are widely spoken among educated classes (FAO 2003).

Economy

Egypt is a lower middle-income country. Its economy relies mainly on four sources of income: tourism, remittances from Egyptians working aboard, revenues from the Suez Canal and oil exports. Serious macroeconomic imbalances emerged as unemployment and poverty increased. The pressing poverty has aggravated the situation of child labor. It is estimated that roughly 3-4 million children are working. By law, children under the age of 12 years may not be employed, and those between 12 and 18 years may work for a limited number of hours only and only in certain categories of jobs (WHO 2006a).

In 1997, it was estimated that 26.5% of the Egyptian population was living in poverty. The percentage was higher in rural than in urban areas. The incidence of poverty and "ultra poverty" was highest in Upper Egypt, while a larger absolute number of poor households was found in Lower Egypt because of the concentration of population there. In rural areas, about 29% of the population lives in poverty, compared to 23% of the urban inhabitants (FAO 2005).

Egypt Human Development Report/1996 illustrated that nearly 23% of the Egyptians live below the poverty line (FAO 2003), and the unemployment rate was 8.4% in 2000-2001 (WHO 2006a).

Egypt's industrial base is highly diversifies, and activities include transport vehicles, textiles, consumer electronics, consumer goods, pharmaceuticals and iron, steel and aluminum industries. The agricultural sector plays a significant role in the national economy. Almost 50% of the Egyptian population relies on agriculture for income generation and employment opportunities. It contributes to the overall food needs of the country and provides the domestic industry with agricultural raw materials (EEAA1999).

Egypt is self-sufficient in many agricultural commodities with the exception of cereals, vegetable oils and sugar; however, these exceptions make Egypt one of the largest food importers in the world (FAO 2005).

Egyptian exports include crude oil and petroleum products, cotton, textiles, chemicals and metal products (EEAA 1999).

Health status

Egypt is one of the countries of the WHO Eastern Mediterranean Region that faces a double burden of both communicable, and noncommunicable and mental health-related diseases (WHO 2006a).

Egypt has a relatively well-established network of health facilities in rural and urban areas. The major health problems in the country are mainly a function of poverty, an unsanitary environment, the inappropriate distribution of health resources among the various regions and socio-economic groups and limited financial resources. While potable water is available to almost all the urban population, unsanitary disposal of liquid and solid wastes and inadequate personal hygiene are still major sources for dissemination and prevalence of infectious diseases. The major health problems include endemic diseases such as gastrointestinal diseases, diarrhea, anemia, trachoma, chronic infections and parasitic diseases (UN-CSD, 1997).

In the mid-1990s, Egypt faced an epidemiological transition characterized by a decline in infant and child mortality due to diarrhea and respiratory infections (although rates were still high); a changing socioeconomic environment leading to dietary changes and an increasing prevalence of chronic disease risk factors such as obesity and hypertension. Under-five mortality and infant mortality rates in Egypt gradually decreased from the mid-1960s to the mid-1990s. The under-five mortality rate fell from 243 to 81 per 1000 live borns between 1967 and 1995; the infant mortality rate fell from 141 to 63 per 1000 and the neonatal mortality rate from 63 to 30 per 1000. Despite these declines, infant and child mortality rates were still unacceptably high, especially in comparison to other countries (Harmeling 1999).

The 2003 Egypt Interim Demographic and Health Survey estimated that childhood mortality is becoming increasingly concentrated in early infancy. For the five-year period before the survey, the under-five mortality rate was 46 per 1000 births, and the infant mortality rate 38 per 1000 births. More than 80% of early childhood deaths in Egypt were occurring in infants under the age of one year. Estimates of childhood mortality trends over the last 40 years (1964 to 2003) showed a substantial decrease. Overall, the probability of dying before the age of five years has fallen by about 80%, from 243 deaths per 1000 live births in the period 1964 to 1969, to 46 deaths per 1000 live births in the period 1998 to 2003 (FAO 2006).

Child nutrition in Egypt

The 2000 Egypt Demographic and Health Survey assessed the nutritional status of young children in Egypt. Measurements of height and weight were obtained for all children under age 6 years. The data on height-for-age indicated that there was considerable chronic malnutrition among Egyptian children. Overall, 19% of children under age 5 years were stunted, and 6% were severely stunted. Stunting increased rapidly with age, from only 11% among children under 6 months of age to 24% among children 12-23 months, before falling to 18% among children age 4 years and older. Levels of stunting were slightly higher for males than for females. Children in rural areas were much more likely to be stunted than urban areas (22% and 14%, respectively). Wasting was more common among children under age 2 years than among older children, and was nearly 3% of Egyptian children were wasted. 4% of children under age 5 years were underweight for their age, and low weight-for-age was more common among children 6-23 months than among older or younger children (El-Zanaty and Way 2001).

The nutritional status of young children in Egypt improved during the period between 1992 and 2003. Looking at the height-for-age measures, for example, there was a decrease in the percentage of children who were considered stunted, from 26% at the time of the 1992 Egypt Demographic and Health Survey to 16% in the 2003 Egypt Interim Demographic and Health Survey. The weight-for-height and weight-for-age measures also showed declines (El-Zanaty and Way 2004).

During the 2005 Egypt Demographic and Health Survey, 18% of the Egyptian children under age 5 years were stunted, and 6% were severely stunted. Stunting was only 13% among children less than 6 months of age, and 24% among children 18-23 months, before falling to 14% among children age 4 years or older. Wasting was more common among children under age 2 years than among older children, and overall around 4% of Egyptian children were wasted; and 6% of children were underweight for their age (El-Zanaty and Way 2006).

Regarding anemia levels among children 6-59 months, about three in ten children were suffering from some degree of anemia. The anemia was mild in many cases, however, 11% of children had a moderate level of anemia; and a small proportion (less than 1%) were classified as having severe anemia. Children under age two years were more likely to be anemic than older children. Rural children were more likely to be anemic than urban children (33% and 24%, respectively), and children in rural Upper Egypt and the Frontier Governorates had the highest anemia levels (38%) (El-Zanaty and Way 2001).

Information on anemia levels which was obtained in the 2005 Egypt Demographic and Health Survey showed that the level of anemia among children age 6-59 months was much higher in 2005 than in 2000 (49% and 30%, respectively), and rural children were more likely to be anemic than urban children (51% and 44%, respectively); and children in rural Upper Egypt had the highest anemia levels (58%) (El-Zanaty and Way 2006).

In a study to estimate the prevalence of iodine deficiency disorders (IDD) and some potential risk factors in Upper Egypt among 6,750 school children, results concluded that IDD is a severe public health problem in Upper Egypt (el-Sayed et al. 1998).

The status of vitamin A deficiency and the magnitude of the problem were assessed in Alexandria Governorate, Egypt. The prevalence of vitamin A deficiency among 1,217 preschool children aged 6-71 months was 9.3%. It was more prevalent in squatter areas (13.3%), rural areas (15.8%) and among males (10%) (el-Sayed et al. 1999).

In rural Egypt, vitamin A status was evaluated among a cohort of preschool children (mean age 43 months). The aforementioned estimates of total vitamin A intakes were 58% and 81% of the FAO/WHO recommendations among males and females, respectively (el-Arab, Khalil and Hussein 2002).

El-Menoufia

Geography and climate

El-Menoufia Governorate lies between the two blanks of the Nile, Rashid and Domiatt. It is surrounded by Kaliobia Governorate in the East, Behira Governorate in the West, Gharbia Governorate in the North and Giza and Cairo Governorates in the South (Figure 3). The capital of El-Menoufia Governorate is the city Shebin El-kom which is located in northern Egypt, and approximately 73 km from Cairo (Faculty of Computers and Information 2007).The total area of El-Menoufia Governorate is about 2,544 km^2 (Shahin 2004).

Fig.3: Sketch of the Nile Delta in Egypt

According to the results of the census 2006, the total number of the population in El-Menoufia reached 3,270,404 inhabitants, and the number of population under 6 years old is 14.29%. 20.5% of the population live in urban areas, and 79.5% live in rural areas. The raw birth rate is 24 per 1000 (CAPMAS 2006).

The climate in El-Menoufia Governorate is Mediterranean with hot rainless summers (mid-March to mid-October), and mild and frost-free winters with some rains.

The most important central and local government offices are located in Shebin El-Kom, as well as the Menoufia University. Shebin El-Kom is located in middle of El-Menoufia Governorate. The covering area of Shebin El-Kom is 187 km^2, and the district population in 1996 was estimated about 303,759 inhabitants. The cultivated area is 27,993 Feddan, and the number of holders is 32,369, i.e. less than 1 Feddan/holder (Shahin 2004).

Nutrition of the preschool children in El-Menoufia

In a previous study which was conducted in the urban areas in El-Menoufia Governorate, Egypt, between March and June 2003, the nutritional intake among the preschool children was evaluated.

Data were collected from three kindergartens. The subjects were 100 healthy children, 51 males and 49 females, aged 24-71 months from the middle income groups.

Information about sociodemographic characteristics of the family and children's dietary habits were obtained from the children's mothers. Food-frequency and 24-hour recall method were used for the assessment of food and nutrient intakes.

Results revealed that the majority of the families had 2 children (56%), and 49% of the children were the first child in their families. Illiteracy rate was 2% only among the mothers, and there were no illiterate fathers. The parent's unemployment rate was 18% for the fathers and 33% for the mothers.

76% of the children ate three main meals per day, and the habit of eating snacks was common among most children. 33% and 51% of the children give priority to semisolid and sweet foods, respectively.

Regarding to the results of food frequency questionnaire (Appendix 1, Tab. A1, page 91), the consumption of bread was daily at breakfast and supper, while the consumption of rice and noodles was weekly at lunch. The consumption of meat and poultry was higher than liver and fish. 70% of the children didn't eat legumes, and most of the fresh vegetable and fruit consumption was between the meals. Tea represented the highest portion of the beverage consumption (25%). The daily consumption of chocolates and candy was high (62% and 74%, respectively).

Results of 24-hour recall (Appendix 1, Tab. A2, page 93) indicated that the mean energy intake among all children was low (72.7%) compared to the RDA; whereas, it was 72.7% among the children aged 2-3 years and 70.3% among the children aged 4-6 years.

The mean intakes of calcium (89.3%), phosphorus (82.0%), iron (78.7%), V.B1 (80.0%), niacin (69.0%) and V.B6 (77.1%) of all children were also lower than the RDA, especially among the children aged 2-3 years.

The highest inadequate intakes were observed for zinc and vitamin A (mean intake was 50.1% and 64.2% of the RDA, respectively), and this was more pronounced in the children aged 2-3 years who had a mean intake of vitamin A of 56.7% and of zinc of 42.4% of the RDA; however, children aged 4-6 years got 67.2% for vitamin A and 55.9% for zinc of the RDA.

Most children received more than the RDA of protein, magnesium, vitamin C, vitamin B2, vitamin B12 and folate. The mean intake (%RDA) of potassium and vitamin E were sufficient.

1.3 Objectives

Based on the results of the previous studies of the nutrition situation in Egypt and El-Menoufia, the main objectives of the current study are:

1. Improve the nutritional status of the preschool children aged 24-47 months by an intervention with locally made snacks designed to provide the deficient nutrients.
2. Determine the effect of these snacks on the nutritional status of the children.
3. Evaluate the acceptability of the snacks among the children.

2. Materials and Methods

2.1 Study population

The study was conducted in the city Shebin El-Kom in northern Egypt for three months, between June and August 2005. Shebin El-Kom is one of the urban areas and the capital of El-Menoufia Governorate. The subjects were healthy preschool children aged 24-47 months from the low and middle income groups.

At the beginning of the study, some private and governmental kindergartens from low and also middle socioeconomic districts in Shebin El-Kom were selected.

The kindergartens were visited by the supervisor and the investigator to explain the main objectives of the study depending on the results of the previous study which was conducted between March and June 2003 in the same city, and to obtain the permission from the director of kindergarten.

The governmental kindergartens apologized for not participating in the study because they needed permission from a lot of Ministries such as Ministry of Health and Population and Ministry of Social Insurance and Social Affaires.

Two private kindergartens agreed to collaborate in the study. In every kindergarten, an interview was conducted by the investigator with the teachers and the mothers who have a child in the age between 24-47 months to explain the importance of nutrition for the preschool children, and a summary of the previous study in 2003.

They were informed that the study with these supplements aimed to improve the nutritional status of their children. The study procedures (with the concentration, once with the snacks in the first kindergarten and another with the beverage in the second kindergarten), and the potential benefits of the study were also explained. The questions of some mothers about the study and the supplements were answered.

Some of the children's mothers refused to participate in the study because of fear of blood samples. 45 mothers from the two kindergartens, 22 from the first kindergarten and 23 from the second, have given an oral consent.

2.2 Study design

The study was designed as a single-blind, placebo-controlled intervention for 8 weeks. Only the investigator was aware of the group allocation, and the mothers and also the teachers were informed that the snacks and the beverages were designed to improve the nutritional status of the children.

The 45 children were divided into two groups in two separate kindergartens to avoid the exchange of the snacks and beverages between the children in the two groups. The first group was the intervention group who received the snacks designed to improve the nutrient supply to the children (n = 22). The second group was the placebo group, and they received the beverages (n = 23) providing energy only.

At the beginning of the study, two lists of the children's names in the two study groups were prepared by the investigator. The list of every kindergarten was also with the teachers who participated in the work. After two weeks, 3 children (1 in the intervention group and 2 in the placebo group) were excluded from the study. The child who was in the intervention group refused to continue taking the snacks after the first week. In the placebo group, the first child refused to continue taking the beverages; and the second was absent for one week due to a holiday.

The study was completed with 42 children in the two groups (21 children in the intervention group, and 21 children in the placebo group), and a complete data set were obtained from them.

2.3 Intervention

Supplements

Based on a previous study in 2003, the habit of eating snacks between meals was common among the preschool children in El-Menoufia Governorate; and most of them gave priority to semisolid and sweet foods. Furthermore, the children had a deficiency in the nutritional intake of energy and some nutrients. Some semisolid and sweet snacks were designed from different ingredients of dried fruits and nuts, especially rich in the deficient nutrients among the children and also available in the local markets at cheap prices. The composition of the different snacks is shown in table 1.

Tab. 1: Composition of some semisolid and sweet snacks

Ingredients	Sesame snack	Peanut snack	Coconut snack
Dried apricots	20%	20%	20%
Semi dried dates (Deglet Noor)	20%	20%	20%
Sesame	30%	10%	20%
Coconut	15%	10%	30%
Peanut	10%	30%	0%
Cocoa powder	5%	10%	10%

The nutritional value of every snack was calculated by using the food composition tables (Senser and Scherz 1987; Paul and Southgate 1978; NutriSurvey 2005) and by the Microsoft Excel 2002 (Appendix 4, Tab. A3, page 98).

The snacks were tested to select the most acceptable snack regarding taste and nutritional value. The Sesame snacks had the highest nutritional value and were the most favored for the taste. These used for the children in the intervention group.

The daily serving of the snacks was 50 g. The energy and nutrient contents per 100 g and per one serving (50 g) of the Sesame snacks, and the percentage of the Recommended Dietary Allowances for one serving are shown in table 2.

The children in the placebo group received a beverage with maltodextrin to provide them only the same amount of energy content of the Sesame snack (i.e. 191 kcal per one serving). The ingredients of one serving of maltodextrin beverage are 50 g maltodextrin in 120 ml water.

Tab. 2: Energy and nutrient contents of 100 g and one serving of Sesame Snacks

	Value of 100 g	Value of one serving (50 g)	% of RDA[1]
Energy (kcal)	382.10	191.05	14.70
Protein (g)	10.80	5.40	33.80
Fat (g)	26.70	13.35	NA[2]
Carbohydrate (g)	26.50	13.25	NA[2]
Calcium (mg)	267.60	133.80	16.70
Phosphorus (mg)	306.50	153.25	19.20
Iron (mg)	5.30	2.65	26.50
Zinc (mg)	3.00	1.50	15.00
Potassium (mg)	882.10	441.05	31.50
Magnesium (mg)	180.90	90.45	113.10
Vitamin A (µg)[3]	122.00	61.00	15.30
Vitamin E (mg)	1.68	0.84	14.00
Vitamin B1 (mg)	0.30	0.15	21.40
Vitamin B2 (mg)	0.12	0.06	7.50
Niacin (mg)	4.70	2.35	26.10
Vitamin B6 (mg)	0.30	0.15	15.00
Folate (µg)	31.30	15.65	31.30

[1] Percentage of the Recommended Dietary Allowances (NRC 1989) for one serving of the Sesame snacks (50 g).

[2] NA: not available.

[3] Retinol equivalents.

Preparation of the supplements

The supplements of the intervention group (Sesame snacks) were prepared by the investigator in a private kitchen under good hygienic conditions.

The amount of all ingredients of the snacks which would be used during the intervention was calculated and bought at the beginning of the study.

The snacks were prepared every 3 days (twice a week). The dates and apricots were minced by electric mincing machine, and the peanuts were brayed to small pieces. All the components were minced together, and were made in bars. Every bar

was weighed as 50 g (one serving) by using a kitchen scale, and then was packed in tinfoil (Appendix 9, page 104).
The supplement of the placebo group was prepared by the investigator in the same place of preparing the snacks. The individual serving was prepared by weighing 50 g maltodextrin in sachet.

Intervention procedure

The snacks were distributed as one piece for every child in the first kindergarten, and the beverages were distributed by using a special glass in the second kindergarten. The distribution of snacks and beverages was daily after the breakfast for 8 weeks (6 days / wk); no intervention took place on Friday (weekend).
The distribution and consumption of snacks and beverages were supervised directly by the investigator and the teachers in kindergartens, and they recorded that in the list of children's name.
The daily attendance of the children was recorded by the teachers. The child who was absent in one day of the intervention received his/her supplement on Friday with the monitoring from the mother.

2.4 Data collection

Questionnaire-based interview

The mothers were interviewed by the investigator, either in kindergartens or in their houses, to collect information on the family sociodemographic characteristics and children's dietary habits, including information about number of children in the family, the rank of the child in siblings, educational level and employment of the parents, number of the mean meals of the child, and kind of snacks eaten by the child between the meals by using a questionnaire (Appendix 2, page 94) translated into Arabic language (the local language in Egypt).
The mothers were asked about their opinion of the snacks. Every child was also asked about his/her acceptability of the snacks.
The information of child age was obtained from the mothers when they could remember the birth date, or from the birth certificate.

Food intake

The 24-hour recall method was used to assess the usual intake of energy and nutrients for two consecutive days. In the same day of interview, the mothers were asked to recall type and quantity of all foods and beverages consumed by the child during the previous 24 hours, and they were also asked to record the food intake during the day of the interview when they could write. The mothers who could not write were interviewed again at the next day, and were asked about the child's food intake of the previous 24 hours (the second day).

The food intake data were analyzed using a computer programme (Dietary analysis for food ready to eat, Egyptian Foods, computer programme, version 1, 1995, Faculty of Home Economics, Menoufia University, Egypt). Data of the 24-hour food intake were coded and entered into this programme.

The analysis by this programme is based on food composition tables of the Egyptian National Nutrition Research Institute and on food composition tables for the Near East (FAO 1982).

The results of food intake of all children were entered in Microsoft Excel 2002 to calculate the mean intake of energy and nutrients for every group. The nutritional value of one serving of snack and beverage was added to the mean intake of energy and nutrients of intervention group and placebo group, respectively to calculate the nutrient intakes of every group during the intervention.

Anthropometric measurements

Both at baseline and after 8 weeks of the intervention, the weight and height of the children in the two groups were assessed (Appendix 3, page 97).

Height was measured with a vertical board with an attached metric rule and a horizontal headboard. The children were standing without shoes on a flat surface with feet parallel and heel together, and the head, back and heels in contact with the vertical board. The height was recorded to the nearest 0.1 cm (WHO, 1995).

Weight of children was determined by using an electronic scale (Piscover, Poland) and was recorded to the nearest 0.1 kg. The children were weighed with light indoor clothing and without shoes (WHO, 1995).

Anthropometric indices are combinations of measurements. They are essential for the interpretation of measurements. In children, the three most commonly used anthropometric indices are weight-for-height, height-for-age, and weight-for-age.

The anthropometric indices can be expressed in terms of Z-scores to compare a child or group of children with a reference population to assess their growth (WHO 1995).

Data of height and weight were entered into ENA (Emergency Nutrition Assessment) for SMART programme (October 2007, last update) and were transformed into Z-score. This programme was developed by Dr. Juergen Erhardt in cooperation with Prof. Michael Golden, and uses the WHO standards 2005.

The three anthropometric indices in children can be interpreted as stunting, underweight, wasting, overweight and obesity.

According to the World Health Organization Global Database on Child Growth and Malnutrition, stunting, underweight and wasting are defined as height-for-age Z-score (HAZ), weight-for-age Z-score (WAZ) and weight-for-height Z-score (WHZ) below -2 standard deviation (<-2 SD) of reference population, respectively. Overweight and obesity in children are defined as weight-for-height Z-score (WHZ) above +2 SD and +3 SD of reference population, respectively. The classification for assessing the severity of malnutrition by prevalence ranges among children under 5 years of age according to the WHO (Tab. 3) was used (de Onis and Bloessner 1997).

Tab. 3: Public health classification of the severity of malnutrition among children under 5 years of age

Indicator	Severity of malnutrition by prevalence ranges (%)			
	Low	Medium	High	Very high
Stunting	<20	20-29	30-39	≥40
Underweight	<10	10-19	20-29	≥30
Wasting	<5	5-9	10-14	≥15

Biochemical measurements and blood cell count

Blood samples were collected from all children in the two study groups twice, at baseline and 8 weeks after the intervention, by two trained technician from Al.Borg laboratory in the city Shebin El.Kom, Egypt.

4 ml of venous blood were collected by using sterilized plastic syringes. Immediately after collection, part of the samples was removed in tubes containing EDTA as an

anticoagulant which were prepared at the laboratory with a special code and the child name before the blood collection.

On the same day of blood collection, a complete blood cell count (haemoglobin, haematocrit, RBCs, MCV, MCH, and MCHC) was performed for the children in the two groups at baseline and after the intervention with the Cell – DYN 1700 System at Al.Borg laboratory.

The rest of the blood was allowed to clot for > 3 h., and was centrifuged at 3000 x for 5 min at the room temperature at the laboratory. The serum was deep frozen (-38 ºC), and after the intervention all serum samples were transported on dry ice to Germany for determination of ferritin level which would be used as an indicator of iron status deficiency at the beginning and after the intervention.

The serum ferritin level, before and after the intervention, of all the children in the two groups was measured within 5 months after the blood collection at the laboratory of Institute of Clinical Chemistry and Pathobiochemistry, Justus-Liebig-University, Giessen, Germany with an ADVIA Centaur® - System.

According to World Health Organization guidelines (WHO 2001), anemia among children 6-59 months was defined as a haemoglobin concentration < 110 g/L, and the classification of public health significance of anemia in populations on the basis of the prevalence of anemia is shown in table 4.

Tab. 4: Classification of public health significance of anemia in population on the basis of the prevalence on anemia

Category of public health significance	Prevalence of anemia (%)
Severe	> or = 40
Moderate	20.0-39.9
Mild	5.0-19.9
Normal	< or = 4.9

A serum ferritin level <12 ng/ml was used as the cut-off for the identification of iron depletion (WHO 2001).

2.5 Statistical analysis

Statistical analyses were performed with SPSS for Windows (version 14.0; SPSS Inc., Chicago, USA), and Microsoft Excel 2002.

Data of anthropometric measurements and indices, food intake and biochemical measurements of all the children in the two study groups were entered in Microsoft Excel 2002. Descriptive statistics for baseline and after the intervention was performed.

The same data of all children were also entered in SPSS for Windows. Data were checked for normal distribution by using the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality. A p-value of < 0.05 was considered statistically significant.

To compare the differences (the level of significance of the differences) between the intervention group and the placebo group in the anthropometric measurements and indices, food intake and biochemical measurements at baseline and also after the intervention we used the independent t-test for normally distributed data, and median test with K-independent samples for non-normally distributed data.

The level of significance of the differences between baseline and after the intervention within each group, the intervention group and the placebo group, in the anthropometric and biochemical measurements was tested by using the paired t-test for normally distributed data, and by using 2 related samples for non-normally distributed data.

3. Results

3.1 Sex and age of the children in the two study groups

The number of the children in the two study groups, intervention group and placebo group, was 42 children (21 children in every group). The mean age of the children in the intervention group was 41.2 months, and 42.9 months in the placebo group with a range from 24 to 47 months. There was no significant difference (median test, p = 0.53) between the two groups in age.

The sex distribution and the age of the children in the two study groups are shown in table 5.

Tab. 5: Sex and age of the children in the two study groups

	Boys		Girls		Age in months (both sexes) mean ± SD
	n	%	n	%	
Intervention group (n = 21)	14	66.7	7	33.3	41.2 ± 7
Placebo group (n = 21)	11	52.4	10	47.6	42.9 ± 4.9

3.2 Sociodemographic characteristics of the family

Regarding the sociodemographic characteristics of all families in the two study groups, most of the families (29 families) had two or three children; whereas, 38.1% of them had two children and 31% had three children. However, 23.8% had more than three children (four or five children), and 7.1% of the families had only one child (Appendix 5, Tab. A4, page 99).

In the two study groups and concerning the rank of child in siblings, 40.5% of the children were the first child in their families, while 30.9% of them were the second child, 23.8% were the third child, and only 4.8% were the fourth child (Appendix 5, Tab. A5, page 99).

The educational level among the mothers was lower than among the fathers. The rate of illiteracy among the mothers was higher than among the fathers (12% vs. 5%). Furthermore, 21% of the fathers completed the primary school compared to 19% of the mothers. More than the half of the mothers and the fathers completed the secondary school (57.1% and 59.5%, respectively). Graduation from university was slightly lower among the mothers than among the fathers (11.9% vs. 14.3%). Figure 4 shows the educational level of the parents in the two study groups.

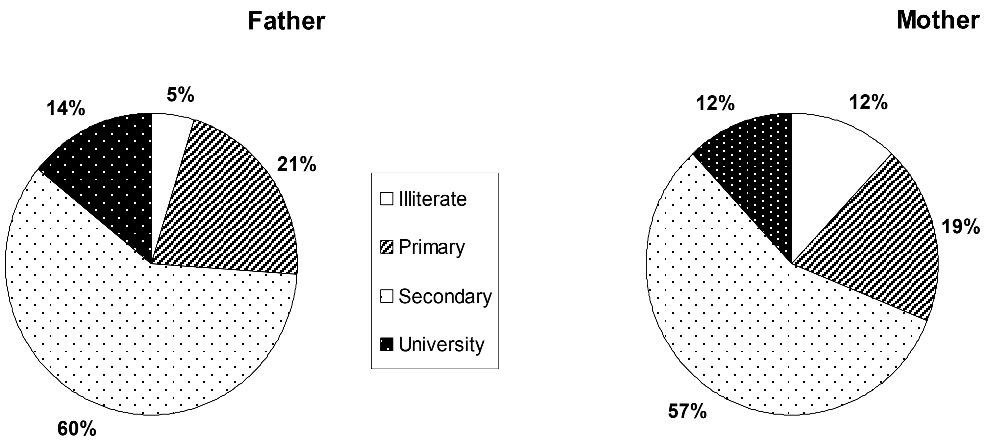

Fig. 4: The educational level of the children's parents

Regarding the employment of the parents, the unemployment rate among the fathers was 9.5%. Most of the employed fathers (57.1%) were public servants, 23.8% of them were workers in factories and 9.5% were technicians.

On the other hand, 64.3% of the mothers worked as housewives. Most of the mothers who had formal employment (16.7%) were workers in the farms, while 11.9% of them were public servants and 7.1% were teachers in a primary school.

3.3 Dietary habits of the children

88.1% of the children in the two groups ate three main meals per day, while 11.9% of the children ate only two meals (breakfast and lunch). The breakfast was eaten in the kindergarten and the other meals at home.

92.9% of the children in the two groups ate one or two snacks in addition to the two or three main meals. The most preferred snacks among the children were candies and chocolates (30.9%), however; vegetables and fruits were the lowest (7.4% and 11.1%, respectively). The types of preferred snacks are shown in figure 5.

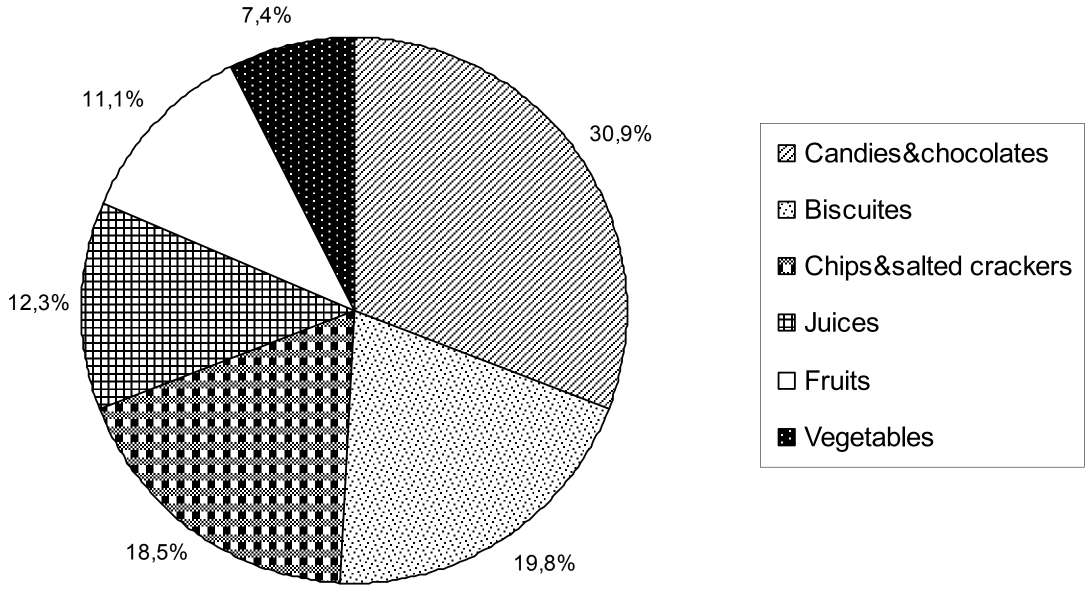

Fig. 5: Preferred snacks of the children

Regarding other dietary habits, 35.7% of the children increased the intake of sugar with the beverages; and 30.9% of them drank tea after or between the meals.
9.5% of the children liked to drink a lot of water and beverages, and only one child did not eat vegetables and fruits.

3.4 Acceptability of the Sesame snacks

The opinion of the children in the intervention group about the snacks indicated that most of them liked the snacks. 33.3% of the children said that the snacks were very good, 42.9% that they were good; however, 9.5% found the snacks were acceptable, and 14.3% were undecided. There were no children who completed the study (only one child excluded) said that the snacks were bad (Appendix 6, Tab. A6, page 100). Most of the children (76.2%) found that the snacks had a sweet and nice taste, and that was the reason for liking them; however, 23.8% of the children didn't mention the reason for liking the snacks.

Concerning the opinion of the mothers, all of them found that the snacks were good for their children for their good taste. Moreover, some of the literate mothers considered the Sesame snacks were good for their natural ingredients compared to the other snacks in the local markets. 23.8% of the mothers said that the snacks were very good, 61.9% that they were good, and 14.3% considered the snacks were acceptable (Appendix 6, Tab. A6, page 100).

3.5 The nutritional status of the children in the two study groups

The nutritional status of the children in the intervention group and the placebo group before and after the intervention is shown in table 6.

Tab. 6: The nutritional status of the children in the two study groups

	Intervention group (n = 21)		Placebo group (n = 21)	
	No	%	No	%
Stunting (HAZ < -2SD)				
Baseline	3	14.3	2	9.5
End	2	9.5	2	9.5
Wasting (WHZ < -2SD)				
Baseline	2	9.5	1	4.7
End	2	9.5	5	23.8
Underweight (WAZ < -2SD)				
Baseline	2	9.5	0	0
End	1	4.7	1	4.7
Overweight (WHZ > 2SD)				
Baseline	0	0	0	0
End	0	0	0	0
Obese (WHZ > 3SD)				
Baseline	1	4.7	0	0
End	1	4.7	0	0

In the intervention group, the prevalence of stunting and underweight was lower after the intervention than at baseline. There were three stunted children (HAZ < -2SD) and two underweight children (WAZ < -2SD) at the beginning of the study. After the intervention two stunted children and one underweight child were found. However, there was no change in the prevalence of wasting (WHZ < -2SD) before and after the intervention (Fig. 6).

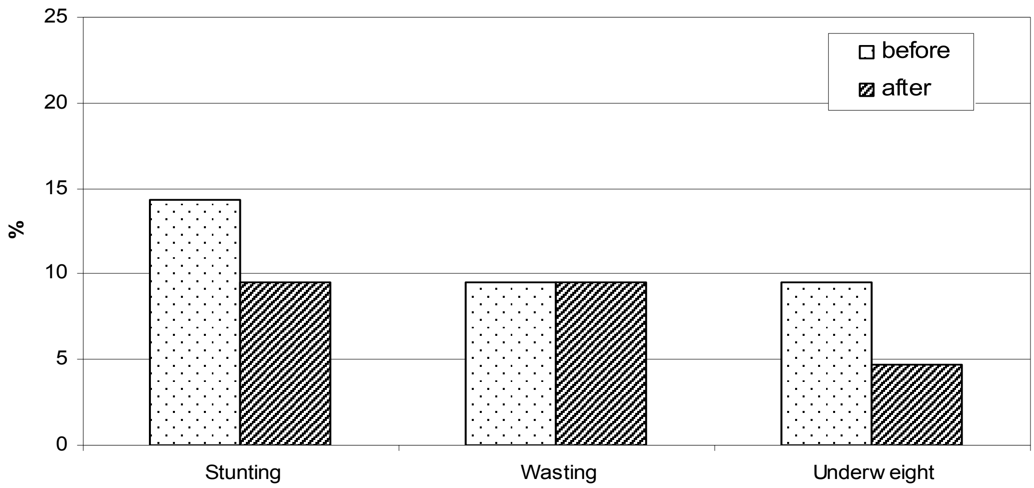

Fig. 6: The nutritional status of the children in the intervention group

Regarding the placebo group, there were no underweight children at baseline, but after the intervention one child was found underweight. Furthermore, there was no change in the prevalence of stunting before and after the intervention. The prevalence of wasting increased after the intervention compared to baseline (Fig. 7).

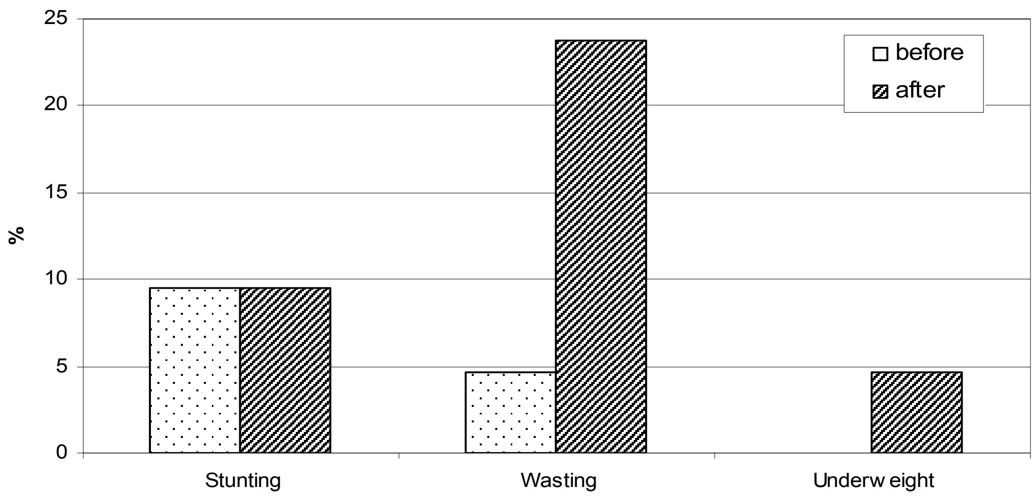

Fig. 7: The nutritional status of the children in the placebo group

Concerning overweight (WHZ > 2SD), there were no overweight children in the two study groups at baseline and after the intervention; and one child in the intervention group was obese (WHZ > 3SD).

Regarding the classification of WHO for assessing the severity of malnutrition by prevalence ranges (%) among the children under 5 years of age (de Onis and Bloessner 1997), the severity of stunting and underweight among the children in the intervention group and in the placebo group was low before and after the intervention. Concerning wasting, the severity was medium in the intervention group at baseline and also after the intervention; but it was low in the placebo group at baseline and increased to very high after the intervention (Tab. 6).

3.6 The nutritional status of boys and girls

In the intervention group, the prevalence of stunting among the boys at baseline was higher than among the girls, and it decreased after the intervention only among the boys. Whereas, there were two stunted boys and one stunted girl at baseline; and decreased to one stunted boy without any change among the girls.
The prevalence of underweight was the same among the boys and also among the girls at baseline; but it decreased only among the girls after the intervention.
Concerning the wasting, there were two wasted boys before and after the intervention; and no wasted girls were found (Appendix 7, Tab. A7, page 101).

In the placebo group, the prevalence of stunting was the same among the boys and among the girls at baseline; and there was no change after the intervention.
Regarding underweight, there were no underweight boys or girls at baseline; however, one underweight girl was found after the intervention. The prevalence of wasting was higher among the boys than among the girls at baseline and also after the intervention. Whereas, there was one wasted boy and no wasted girls at baseline, and increased to three wasted boys and two wasted girls after the intervention (Appendix 7, Tab. A8, page 101).

3.7 Anthropometric measurements and indices of the children in the two study groups

The anthropometric measurements and indices of the children in the two study groups before and after the intervention are shown in table 7.

Tab. 7: Anthropometric measurements and indices of the children in the two study groups

	Intervention group (n = 21)		Placebo group (n = 21)		Between -groups
	mean ± SD	P-value[1]	mean ± SD	P-value[1]	P-value[2]
Weight (kg)					
Baseline	14.60 ± 2.58		13.65 ± 1.11		**0.031**
End	14.82 ± 2.59	0.065	13.78 ± 1.09	0.063	0.122
Height (cm)					
Baseline	97.06 ± 4.46		95.78 ± 2.99		0.283
End	98.73 ± 4.71	**0.001**	97.12 ± 3.04	**0.001**	0.197
Height-for-age Z-score					
Baseline	-0.42 ± 1.03		-1.01 ± 0.55		**0.026**
End	-0.31 ± 0.97	0.089	-0.96 ± 0.62	0.303	**0.014**
Weight-for-height Z-score					
Baseline	-0.15 ± 1.28		-0.49 ± 1.00		0.345
End	-0.32 ± 1.25	0.069	-0.67 ± 1.15	**0.014**	0.354
Weight-for-age Z-score					
Baseline	-0.36 ± 1.09		-0.92 ± 0.62		**0.047**
End	-0.41 ± 1.04	0.268	-1.01 ± 0.67	**0.018**	**0.032**

1 The difference within every group was tested by using paired t test.

2 The difference between the two groups at baseline and also after the intervention was tested by using independent t test.

The children in the two study groups showed a significant increment in height after the intervention (paired t test, $p = 0.001$), however; there were no significant differences between the two groups (independent t test, $p = 0.197$). The increment in the mean of height was higher in the intervention group than in the placebo group (1.67 cm vs. 1.34 cm).

There was also a slight increment in weight after the intervention among the children in the intervention group and in the placebo group, with a mean weight gain of 0.22 kg and 0.13 kg, respectively. However, the difference in weight gain was not significant among the children in the intervention group (paired t test, $p = 0.065$) and also in the placebo group (paired t test, $p = 0.063$).

Furthermore, there was an increase in the mean value of HAZ after the intervention in the two study groups; and the difference between the two groups (independent t test) was significantly higher after the intervention ($p = 0.014$) than at baseline ($p = 0.026$).

The HAZ of the children, before and after the intervention, in the intervention group and the placebo group is shown in figures 8 and 9, respectively.

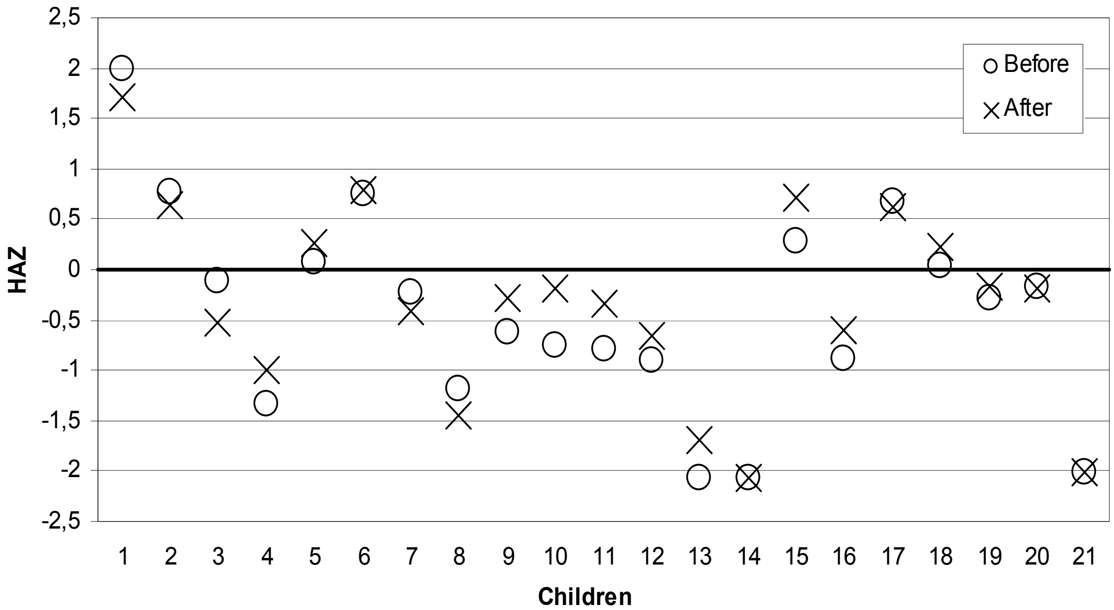

Fig. 8: HAZ of the children in the intervention group

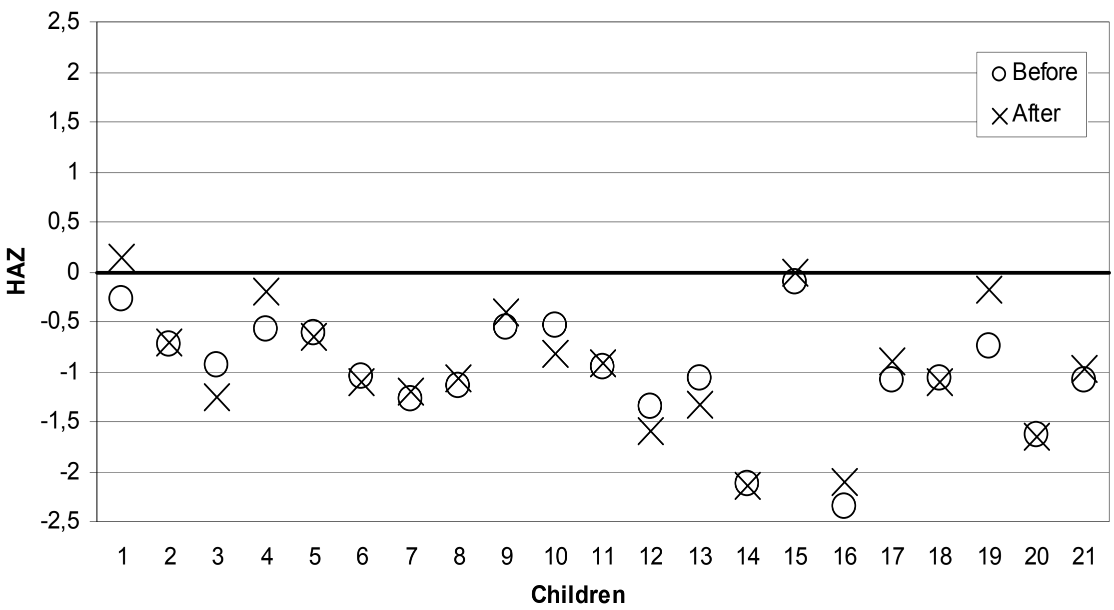

Fig. 9: HAZ of the children in the placebo group

After the intervention, 52% of the children in the intervention group had an increase in the value of HAZ compared with 47% in the placebo group. Moreover, the HAZ value decreased among 24% of the children (not stunted) in the intervention group and also in the placebo group. There was no change in the HAZ value among 24% and 29% of the children in the intervention group and in the placebo group, respectively (Fig. 10).

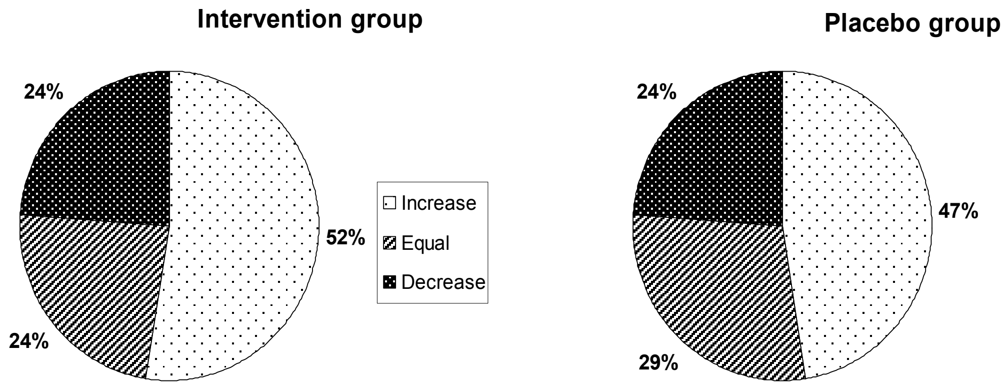

Fig. 10: Change in HAZ after the intervention in the two study groups

On the other hand, the mean value of WHZ of the children in the two study groups decreased after the intervention (Tab. 7); and there was no significant difference between the two groups (independent t test, $p = 0.354$).

This decrease in the mean WHZ after the intervention was not significant (paired t test, $p = 0.069$) within the intervention group, however; it was significant within the placebo group (paired t test, $p = 0.014$).

The WHZ of the children in the intervention group and in the placebo group before and after the intervention is shown in figures 11 and 12, respectively.

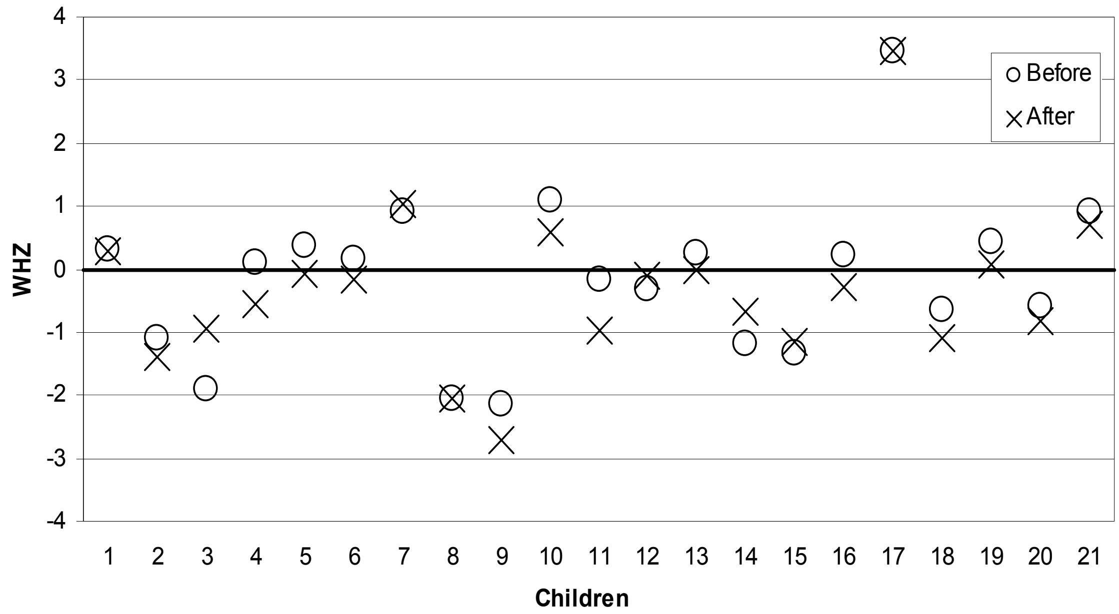

Fig. 11: WHZ of the children in the intervention group

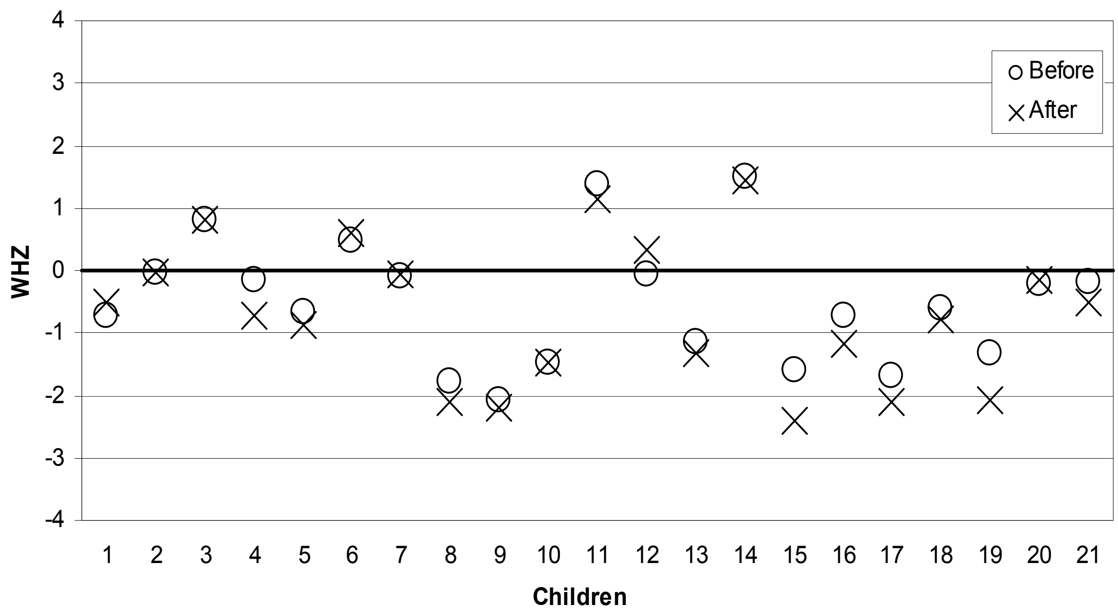

Fig. 12: WHZ of the children in the placebo group

After the intervention, 19% of the children in the intervention group had an increase in the WHZ value compared with 14% in the placebo group. The WHZ value decreased among 62% of the children in the intervention group and 5% of them were wasted, however; it decreased among 57% in the placebo group and 24% of them were wasted. 19% and 29% of the children had no change in the value of WHZ in the intervention group and in the placebo group, respectively (Fig. 13).

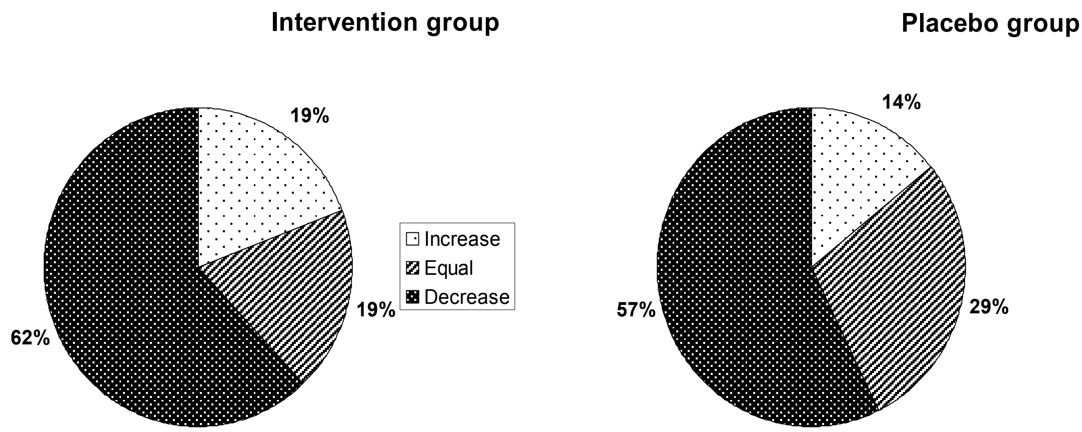

Fig. 13: Change in WHZ after the intervention in the two study groups

Regarding the WAZ, the mean value of WAZ of the children in the two study groups decreased also after the intervention, and this decrease was not significant (paired t test, p = 0.268) in the intervention group; however, it was significant (paired t test, p = 0.018) in the placebo group (Tab. 7).

The WAZ of the children, before and after the intervention, in the intervention group and in the placebo group is shown in figure 14 and 15, respectively.

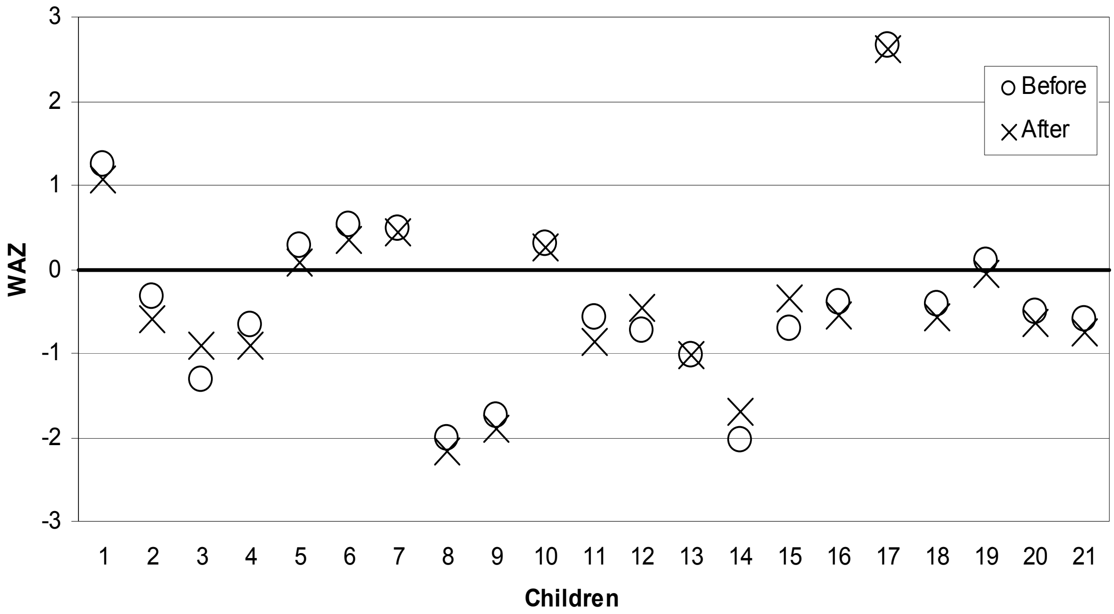

Fig. 14: WAZ of the children in the intervention group

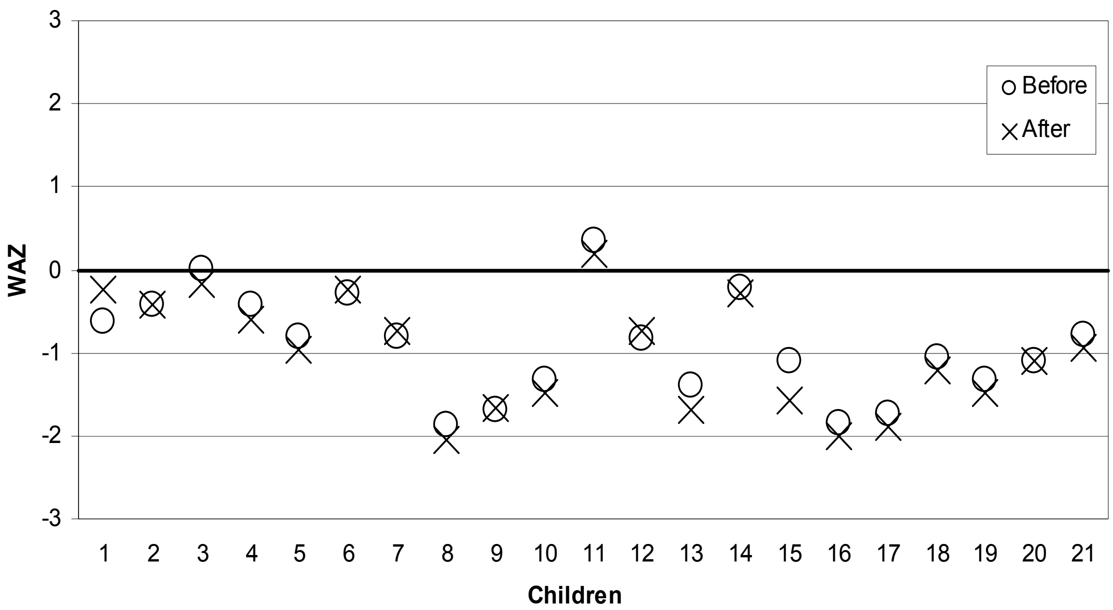

Fig. 15: WAZ of the children in the placebo group

In the intervention group, 19% of the children had an increase in the WAZ value after the intervention compared with 14% in the placebo group; and 19% of the children in the two study groups had no change in the WAZ value. Furthermore, the WAZ decreased among more children in the intervention group than in the placebo group (62% vs. 67%), and 5% of them were underweight in the two groups (Fig. 16).

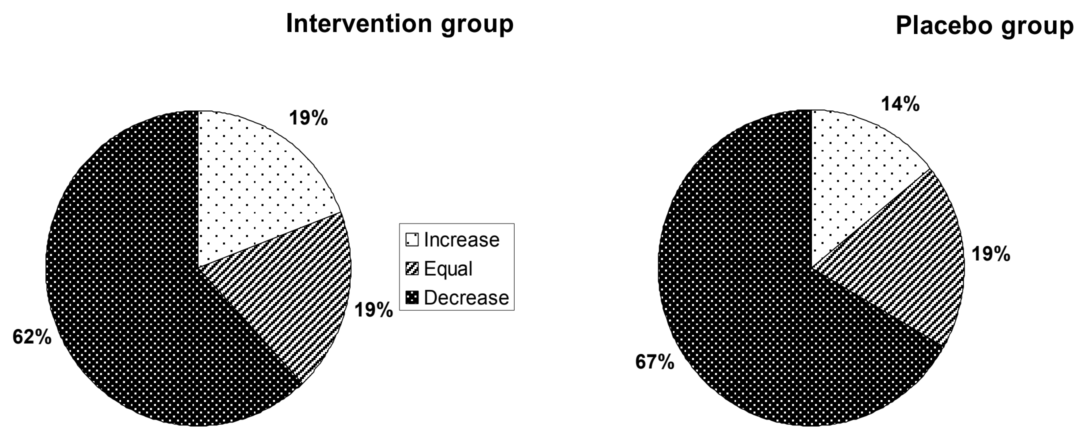

Fig. 16: Change in WAZ after the intervention in the two study groups

3.8 Anthropometric measurements and indices of boys and girls

The anthropometric measurements and indices of the boys and the girls in the intervention group before and after the intervention are shown in tables 8.

Tab. 8: Anthropometric measurements and indices of the children in the intervention group

	Boys (n = 14)		Girls (n = 7)	
	mean ± SD	P-value[1]	mean ± SD	P-value[2]
Weight (kg)				
Baseline	14.22 ± 1.41		15.34 ± 4.11	
End	14.38 ± 1.47	0.375	15.71 ± 4.04	0.219
Height (cm)				
Baseline	96.86 ± 4.27		97.46 ± 5.15	
End	98.58 ± 4.41	**0.001**	99.04 ± 5.62	**0.031**
Height-for-age Z-score				
Baseline	-0.40 ± 1.13		-0.46 ± 0.86	
End	-0.28 ± 1.05	0.180	-0.38 ± 0.85	1.000
Weight-for-height Z-score				
Baseline	-0.34 ± 0.97		0.23 ± 1.79	
End	-0.59 ± 0.95	**0.022**	0.20 ± 1.66	1.000
Weight-for-age Z-score				
Baseline	-0.47 ± 0.85		-0.13 ± 1.51	
End	-0.56 ± 0.83	0.057	-0.10 ± 1.40	0.453

[1] The difference between the boys after the intervention from baseline.

[2] The difference between the girls after the intervention from baseline.

In the intervention group, there was an increment in height after the intervention which was significantly higher among the boys ($p = 0.001$) than the girls ($p = 0.031$), and the mean height increment was 1.72 cm and 1.58 cm, respectively.

Furthermore, a slight incremental weight was found among the boys and the girls after the intervention, with a mean weight increment of 0.16 kg and 0.37 kg, respectively. The difference in weight gain either among the boys or among the girls was not significant ($p > 0.05$).

The mean value of HAZ increased also after the intervention, and it was slightly higher among the boys than the girls. The difference in HAZ was not significant among the boys (p = 0.180) and also among the girls (p = 1.000).
Concerning WHZ and WAZ, the mean value of WAZ increased slightly, but not significantly (p > 0.05), among the girls after the intervention; and there was no change in the mean value of WHZ. However, there was decrease in the mean value of WHZ and WAZ among the boys after the intervention.

Table 9 shows the anthropometric measurements and indices of the boys and the girls in the placebo group before and after the intervention.

Tab. 9: Anthropometric measurements and indices of the children in the placebo group

	Boys (n = 11)		Girls (n = 10)	
	mean ± SD	P-value[1]	mean ± SD	P-value[2]
Weight (kg)				
Baseline	13.72 ± 1.32		13.58 ± 0.88	
End	13.88 ± 1.23	0.219	13.66 ± 0.98	0.625
Height (cm)				
Baseline	95.37 ± 3.73		96.23 ± 2.00	
End	96.83 ± 3.50	**0.002**	97.45 ± 2.58	**0.016**
Height-for-age Z-score				
Baseline	-0.90 ± 0.60		-1.13 ± 0.49	
End	-0.83 ± 0.62	0.227	-1.11 ± 0.62	0.754
Weight-for-height Z-score				
Baseline	-0.45 ± 1.09		-0.54 ± 0.96	
End	-0.61 ± 1.24	0.344	-0.73 ± 1.10	0.180
Weight-for-age Z-score				
Baseline	-0.81 ± 0.73		-1.03 ± 0.49	
End	-0.88 ± 0.78	0.549	-1.15 ± 0.54	0.109

[1] The difference between the boys after the intervention from baseline.

[2] The difference between the girls after the intervention from baseline.

In the placebo group, the boys and the girls showed also an increment in height which was also significantly higher among the boys ($p = 0.002$) than the girls ($p = 0.016$) as the same in the intervention group, and the mean height increment was 1.46 cm and 1.22 cm, respectively.
There was a slight weight gain among the boys and also the girls, with a mean weight gain of 0.16 kg and 0.08 kg, respectively. However, the difference in weight gain was not significant either among the boys or among the girls.
The mean value of HAZ increased also slightly, but not significantly ($p > 0.05$), among the boys and also the girls after the intervention.
On the other hand, the mean value of WHZ and WAZ decreased among the boys and also among the girls after the intervention. The change in WHZ and WAZ among both the boys and the girls was not significant.

In the two study groups, the intervention group and the placebo group, the differences between the boys and the girls in the anthropometric measurements and indices were not significant ($p > 0.05$) at baseline and also after the intervention.

3.9 Food intake of the children in the two study groups

The usual food intake at home of the children in the two study groups was assessed by using the 24-hour recall method (averaging of two consecutive days). The nutrient intakes during the intervention were calculated by adding the nutritional value of the daily serving of the snacks and the daily serving of the beverages to the mean intake at home of the intervention group and the placebo group, respectively. Energy and nutrient intakes of the children in the intervention group and the placebo group at baseline and during the intervention are shown in tables 10 and 11, respectively.

Tab. 10: Energy and nutrient intakes per day of the children in the intervention group (n = 21)

	Intake baseline[1]		Intake during intervention[2]	
	mean ± SD	mean (%)[3]	mean ± SD	mean (%)[3]
Energy (kcal)	809.49 ± 220.5	62.3	1000.59 ± 220.5	77.0
Protein (g)	22.96 ± 5.5	143.5	28.36 ± 5.5	177.3
Calcium (mg)	251.31 ± 104.1	31.4	385.11 ± 104.1	48.1
Phosphorus (mg)	361.65 ± 109.5	45.2	514.95 ± 109.5	64.4
Iron (mg)	5.49 ± 1.5	54.9	8.14 ± 1.5	81.4
Potassium (mg)	781.92 ± 242.1	55.9	1223.0 ± 242.1	87.4
Zinc (mg)	3.04 ± 0.9	30.4	4.54 ± 0.9	45.4
Magnesium (mg)	112.98 ± 40.3	141.2	203.48 ± 40.3	254.3
Vitamin A (µg)	243.52 ± 86.2	60.9	304.52 ± 86.2	76.2
Vitamin E (mg)	8.64 ± 5.5	144.0	9.48 ± 5.5	158.0
Vitamin B1 (mg)	0.48 ± 0.2	68.6	0.63 ± 0.2	90.0
Vitamin B2 (mg)	0.9 ± 1.0	112.5	0.96 ± 1.0	120.0
Niacin (mg)	4.12 ± 1.3	45.8	6.47 ± 1.3	71.9
Vitamin B6 (mg)	0.48 ± 0.2	48.0	0.63 ± 0.2	63.0
Folate (µg)	83.6 ± 34.7	167.2	99.3 ± 34.7	198.5

[1] Intake baseline is the nutritional intake at home.

[2] Intake during intervention is the mean intake at home + the nutritional value of the daily serving of the snack (50 g).

[3] The mean intakes of nutrient in percent of the recommended dietary allowances (RDAs).

Tab. 11: Energy and nutrient intakes per day of the children in the placebo group (n = 21)

	Intake baseline[1]		Intake during intervention[2]	
	mean ± SD	mean (%)[3]	mean ± SD	mean (%)[3]
Energy (kcal)	852.3 ± 266.9	65.6	1047.3 ± 266.9	80.6
Protein (g)	26.37 ± 5.01	164.8	26.37 ± 5.01	164.8
Calcium (mg)	281.39 ± 166.1	35.2	281.39 ± 166.1	35.2
Phosphorus (mg)	428.9 ± 89.7	53.6	428.9 ± 89.7	53.6
Iron (mg)	5.68 ± 1.2	56.8	5.68 ± 1.2	56.8
Potassium (mg)	871.71 ± 226.3	62.3	871.71 ± 226.3	62.3
Zinc (mg)	3.72 ± 0.7	37.2	3.72 ± 0.7	37.2
Magnesium (mg)	126.1 ± 31.3	157.6	126.1 ± 31.3	157.6
Vitamin A (µg)	176.97 ± 82.6	44.2	176.97 ± 82.6	44.2
Vitamin E (mg)	12.1 ± 9.4	201.7	12.1 ± 9.4	201.7
Vitamin B1 (mg)	0.55 ± 0.2	78.6	0.55 ± 0.2	78.6
Vitamin B2 (mg)	0.83 ± 0.5	103.8	0.83 ± 0.5	103.8
Niacin (mg)	4.9 ± 1.2	54.4	4.9 ± 1.2	54.4
Vitamin B6 (mg)	0.5 ± 0.1	50.0	0.5 ± 0.1	50.0
Folate (µg)	97.68 ± 29.0	195.4	97.68 ± 29.0	195.4

[1] Intake baseline is the nutritional intake at home.

[2] Intake during intervention is the mean intake at home + the nutritional value of the daily serving of the beverage (195 kcal).

[3] The mean intakes of nutrient in percent of the recommended dietary allowances (RDAs).

The mean energy intake of the children in the two study groups at baseline was low compared to the recommended dietary allowances (RDAs). Furthermore, the mean energy intake of the intervention group was slightly lower than of the placebo group with a significant difference between the two groups (independent t test, $p = 0.027$). During the intervention, the mean energy intake of the two groups increased but it was still lower than the RDA; and there was a significant difference (independent t test, $p = 0.024$) between the two groups.

At baseline, inadequate micronutrient intakes were also found among the children in the two study groups for iron, phosphorus, potassium, vitamin A, vitamin B1, niacin and vitamin B6. The mean intake of these nutrients during the intervention increased significantly (independent t test, $p < 0.05$) in the intervention group compared to the placebo group which had no change in the mean intake of these nutrients, whereas; the beverage was only a source of energy.

It was observed that the mean intakes of calcium and zinc among the children in the two study groups at baseline were extremely lower than the RDA for this age.

During the intervention, the mean intake of calcium and zinc of the intervention group increased significantly (median test, $p = 0.031$ and independent t test, $p = 0.002$, respectively) compared to the placebo group which had also no change in the mean intake of calcium and zinc.

Concerning the nutritional intake of boys and girls, the mean energy and nutrient intakes at baseline was higher among the boys than among the girls in the intervention group; with exception of the mean intake of vitamin A and vitamin E which was higher among the girls than among the boys (Appendix 8, Tab. A9, page 102). In the placebo group, the mean energy and nutrient intakes at baseline was also higher among the boys than the girls; with exception of the mean intake of protein, zinc, vitamin B1 and folate (Appendix 8, Tab.A10, page 103).

3.10 Blood measurements of the two study groups

The blood measurements of the children in the two study groups, at baseline and after the intervention, are shown in table 12.

Tab. 12: Blood measurements of the children in the two study groups

	Intervention group (n = 21)		Placebo group (n = 21)		Between -groups
	mean ± SD	P-value[1]	mean ± SD	P-value[1]	P-value[2]
Haemoglobin (g/dl)					
Baseline	11.63 ± 0.83		11.93 ± 1.02		0.355
End	11.90 ± 0.90	0.143	11.90 ± 1.04	0.332	0.123
Haematocrit (%)					
Baseline	35.16 ± 2.29		35.64 ± 3.07		0.572
End	35.19 ± 2.67	0.932	35.56 ± 2.76	0.796	0.656
RBC-counts					
Baseline	4.64 ± 0.33		4.78 ± 0.42		0.121
End	4.89 ± 0.40	**0.0001**	4.98 ± 0.40	**0.001**	0.501
MCV (fl)					
Baseline	75.98 ± 7.25		75.48 ± 9.61		0.758
End	72.26 ± 7.21	**0.001**	71.95 ± 8.43	**0.001**	0.758
MCH (pg)					
Baseline	24.94 ± 2.75		25.27 ± 3.24		0.758
End	24.23 ± 2.69	**0.001**	24.11 ± 3.20	**0.001**	0.758
MCHC (g/dl)					
Baseline	33.35 ± 1.28		33.47 ± 0.65		0.695
End	33.50 ± 0.77	0.558	33.45 ± 0.82	0.910	0.832
Ferritin (ng/ml)					
Baseline	21.81 ± 9.0		22.0 ± 7.89		0.942
End	21.62 ± 7.41	0.941	22.0 ± 9.0	0.984	0.867

[1] The difference within every group was tested by using paired t test (parametric test) and 2-related samples (nonparametric test).

[2] The difference between the two groups at baseline and also after the intervention was tested by using independent t test (parametric test) and median test (nonparametric test).

After the intervention, the mean value of haemoglobin of the children in the intervention group who received the snacks increased slightly (0.27 g/dl), but not significantly (2-reated samples, p = 0.143). However there was no change in the mean value of haemoglobin in the placebo group. No significant differences were found between the two groups in the haemoglobin values at baseline (median test, p = 0.355), and also after the intervention (median test, p = 0.123).
The frequency of the haemoglobin values (in %) in the intervention group and also in the placebo group is shown in Figures 17 and 18, respectively.

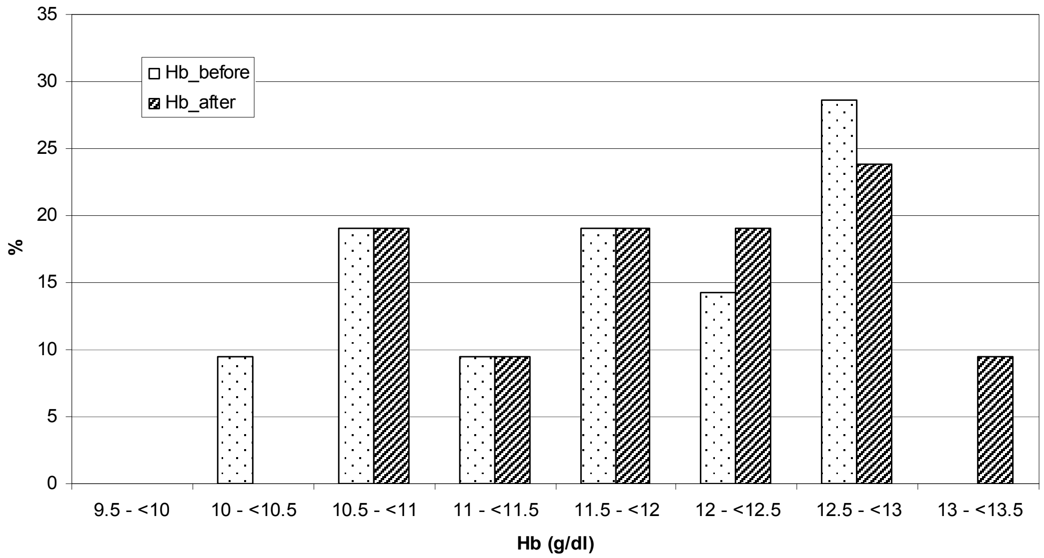

Fig. 17: Frequency (in %) of the haemoglobin values in the intervention group

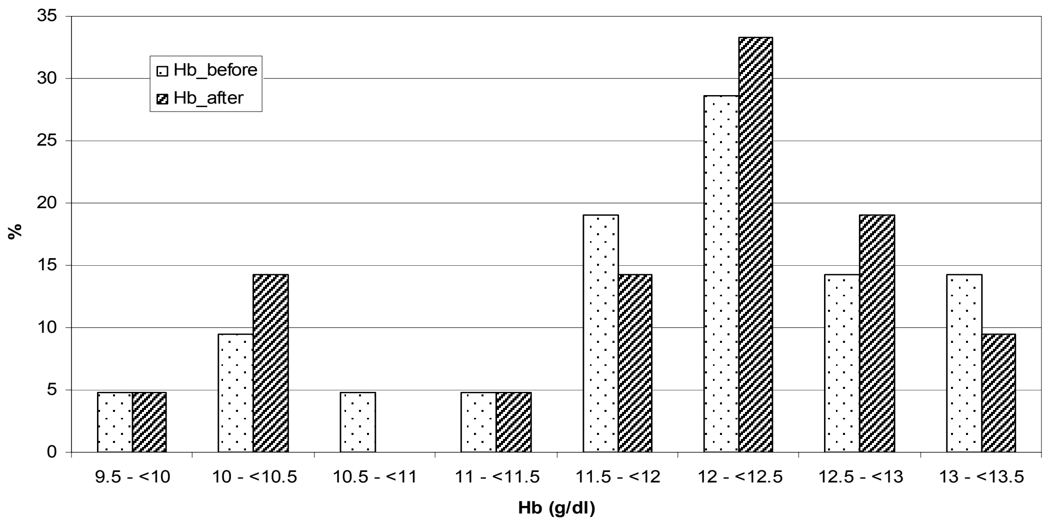

Fig. 18: Frequency (in %) of the haemoglobin values in the placebo group

According to the World Health Organization guidelines (WHO 2001), the normal haemoglobin concentration for the children aged 6 months to 5 years is 11 g/dl.

In the intervention group, the frequency of low haemoglobin level (<11 g/dl) decreased after the intervention compared to at baseline (Fig. 17); however, there was no change in the placebo group (Fig. 18).

The children in the two study groups showed a significant increase in the RBC-counts after the intervention, and it was significantly higher in the intervention group (2-related samples, $p = 0.0001$) than in the placebo group (2-related samples, $p = 0.001$). On the other hand, there was a significant decrease in the mean MCV values and MCH concentrations after the intervention (2-related samples, $p = 0.001$) within the two study groups. There was no significant difference in the haematocrit value and MCHC value after the intervention in the two groups (Tab. 12).

Regarding the ferritin level, the frequency (in %) of low ferritin level (<12 µg/l) (WHO 2001) in the intervention group decreased after the intervention compared to at baseline (4.8% vs. 14.3%). In the placebo group, the frequency of low ferritin level increased after the intervention. These results indicate that the prevalence of low ferritin level decreased after the intervention in the intervention group, but it increased in the placebo group.

The change in the mean value of ferritin after the intervention was not significant (paired t test, $p = 0.9$) in the two study groups.

The ferritin level of the children in the intervention group and in the placebo group before and after the intervention is shown in figures 19 and 20, respectively.

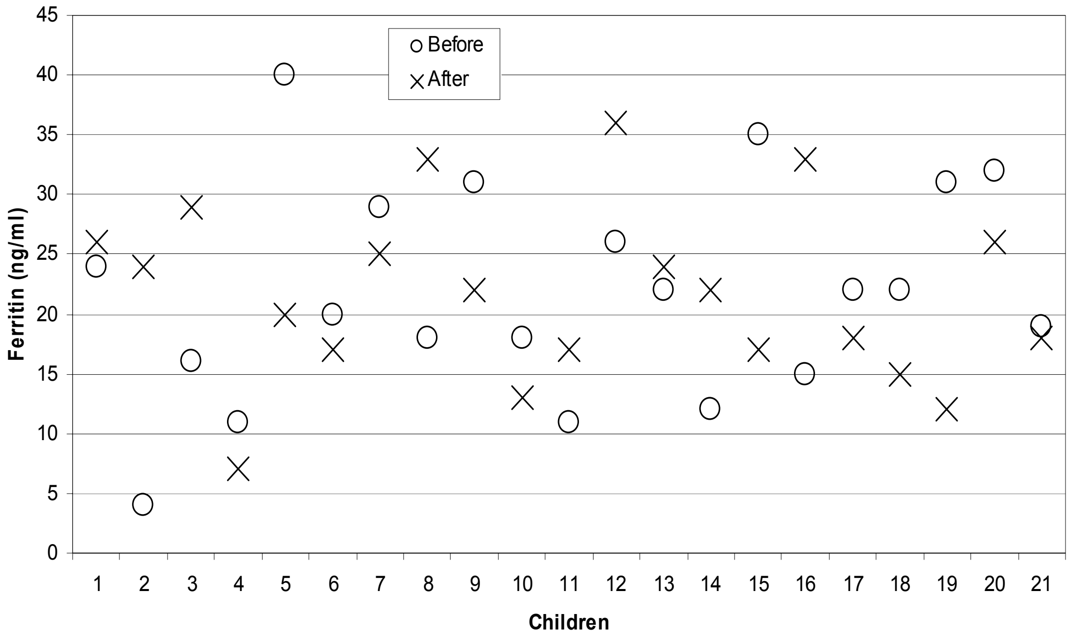

Fig. 19: Ferritin level of the children in the intervention group

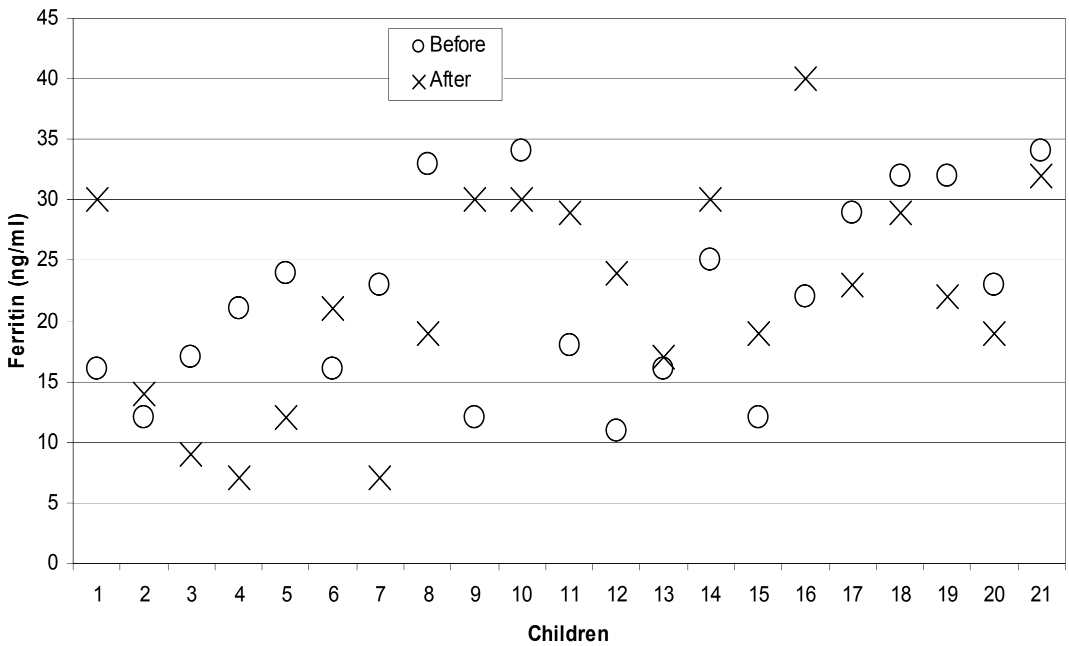

Fig. 20: Ferritin level of the children in the placebo group

3.11 Blood measurements of boys and girls

The blood measurements of the boys and the girls in the intervention group are shown in tables 13.

Tab. 13: Blood measurements of the children in the intervention group

	Boys (n = 14)		Girls (n = 7)	
	mean ± SD	P-value[1]	mean ± SD	P-value[2]
Haemoglobin (g/dl)				
Baseline	11.84 ± 0.80		11.24 ± 0.81	
End	12.02 ± 1.01	0.227	11.64 ± 0.63	0.688
Haematocrit (%)				
Baseline	35.65 ± 2.57		34.19 ± 1.22	
End	35.44 ± 3.03	0.791	34.67 ± 1.83	1.000
RBC-counts				
Baseline	4.70 ± 0.32		4.52 ± 0.33	
End	4.97 ± 0.39	**0.002**	4.74 ± 0.38	0.125
MCV (fl)				
Baseline	76.09 ± 8.13		75.76 ± 5.64	
End	71.68 ± 7.99	**0.0001**	73.43 ± 5.71	0.125
MCH (pg)				
Baseline	24.93 ± 3.00		24.96 ± 2.40	
End	24.03 ± 3.07	**0.003**	24.64 ± 1.85	0.125
MCHC (g/dl)				
Baseline	33.41 ± 1.38		33.23 ± 1.13	
End	33.47 ± 0.85	0.424	33.56 ± 0.66	0.688
Ferritin (ng/ml)				
Baseline	23.07 ± 9.97		19.29 ± 6.58	
End	21.21 ± 5.79	0.424	22.43 ± 10.45	1.000

[1] The difference between the boys after the intervention from baseline.

[2] The difference between the girls after the intervention from baseline.

After the Intervention, there was a slight increase in the mean value of haemoglobin which was higher among the girls than among the boys (0.4 g/dl vs. o.18 g/dl) in the intervention group. The change in haemoglobin value was not significant ($p > 0.05$) either among the boys or among the girls, as well as; the change in the haematocrit value and the MCHC value (Tab. 13).

Furthermore, an increase in the RBC-counts was found among the children after the intervention, and this change was significant among the boys ($p = 0.002$); however, it was not significant among the girls ($p = 0.125$).

On the other hand, the boys showed significant decrease in the mean values of MCV and MCH ($p = 0.0001$ and $p = 0.003$, respectively) after the intervention, and among the girls a decrease, but not significant ($p = 0.125$), was also found.

Concerning the ferritin level, the girls showed an increase in the mean value of ferritin after the intervention (3.14 ng/ml), however; the mean ferritin value decreased among the boys with 1.86 ng/ml. The change in ferritin value among the girls and also among the boys was not significant ($p = 0.5$).

Concerning the placebo group, the blood measurements of the boys and the girls before and after the intervention are shown in table 14.

Tab. 14: Blood measurements of the children in the placebo group

	Boys (n = 11)		Girls (n = 10)	
	mean ± SD	P-value[1]	mean ± SD	P-value[2]
Haemoglobin (g/dl)				
Baseline	11.93 ± 1.19		11.93 ± 0.85	
End	11.83 ± 0.98	**0.039**	11.99 ± 1.14	0.727
Haematocrit (%)				
Baseline	35.49 ± 3.52		35.80 ± 2.67	
End	35.33 ± 2.76	1.000	35.82 ± 2.89	1.000
RBC-counts				
Baseline	4.81 ± 0.39		4.74 ± 0.46	
End	5.00 ± 0.39	**0.001**	4.95 ± 0.44	0.344
MCV (fl)				
Baseline	74.09 ± 8.13		77.00 ± 11.27	
End	71.00 ± 7.31	**0.001**	73.00 ± 9.82	**0.002**
MCH (pg)				
Baseline	24.91 ± 2.87		25.67 ± 3.72	
End	23.78 ± 2.74	**0.001**	24.48 ± 3.76	**0.021**
MCHC (g/dl)				
Baseline	33.62 ± 0.57		33.31 ± 0.72	
End	33.46 ± 0.73	1.000	33.43 ± 0.95	0.344
Ferritin (ng/ml)				
Baseline	19.73 ± 6.72		24.5 ± 8.64	
End	23.55 ± 9.46	0.549	20.4 ± 8.64	0.344

[1] The difference between the boys after the intervention from baseline.

[2] The difference between the girls after the intervention from baseline.

There was a slight increase, but not significant ($p = 0.7$), in the mean haemoglobin value after the intervention among the girls; however, a significant decrease was found among the boys ($p = 0.03$) in the placebo group. Both the boys and the girls had no significant changes in the haematocrit value and MCHC value after the intervention (Tab. 14).

In the intervention group, both the boys and the girls in the placebo group showed an increase in the RBC-counts after the intervention, and it was significant only among the boys ($p = 0.001$). However, there was a significant decrease in the mean values of MCV and MCH among the boys and the girls after the intervention.

Contrary to the results of the intervention group, the mean value of ferritin decreased among the girls (4.1 ng/ml) in the placebo group after the intervention and increased among boys (3.82 ng/ml).

In the two study groups, the placebo group and also the intervention group, the differences between the boys and the girls in all blood measurements were not significant ($p > 0.05$) at baseline and also after the intervention.

3.12 Prevalence of anemia

Anemia was defined as a haemoglobin concentration <11g/dl for the children in the age of 6-59 months, according to the WHO guidelines (WHO 2001).
The prevalence of anemia in the two study groups before and after the intervention is shown in figure 21.

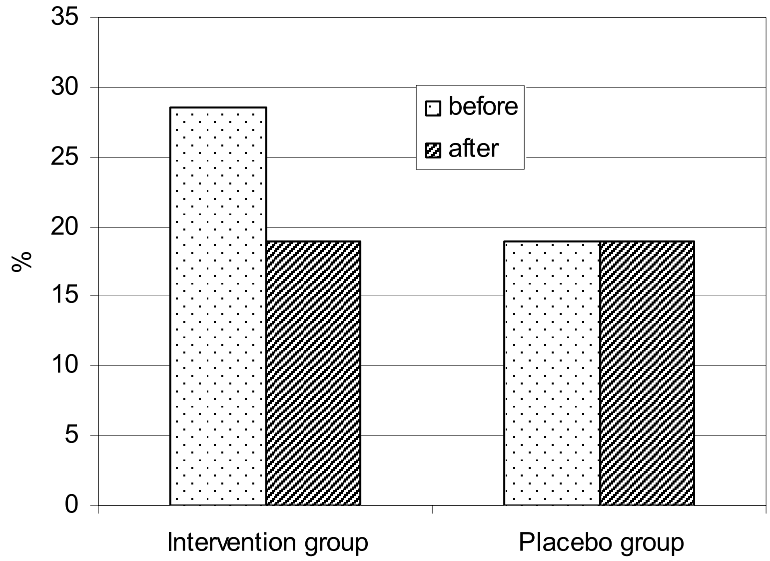

Fig. 21: Prevalence of anemia in the two study groups

According to the classification of public health significance of anemia in population from the WHO (WHO 2001), anemia was moderate at baseline in the intervention group and decreased to be mild after the intervention. In the placebo group, anemia was mild before and after the intervention without any change.
At the beginning of the study, the prevalence of anemia in the intervention group and also in the placebo group was the same among the boys and among the girls.
In the intervention group, the prevalence of anemia at baseline was 28.6% (6 anemic children) and decreased after the intervention to 19% (4 anemic children). The improvement in the prevalence of anemia was among the girls and not the boys.
In the placebo group, there was no change in the prevalence of anemia after the intervention from baseline (19%, 4 children).
After the intervention, the haemoglobin value increased among 4 anemic children in the intervention group, half of them had haemoglobin >11 g/dl, and one anemic child in the placebo group had an increase in the haemoglobin value; but lower than 11

g/dl. Furthermore, the haemoglobin value decreased among more anemic children in the placebo group than in the intervention group (two children vs. one child). The change in the haemoglobin values of the anemic children in the intervention group and the placebo group after the intervention is shown in figures 22 and 23, respectively.

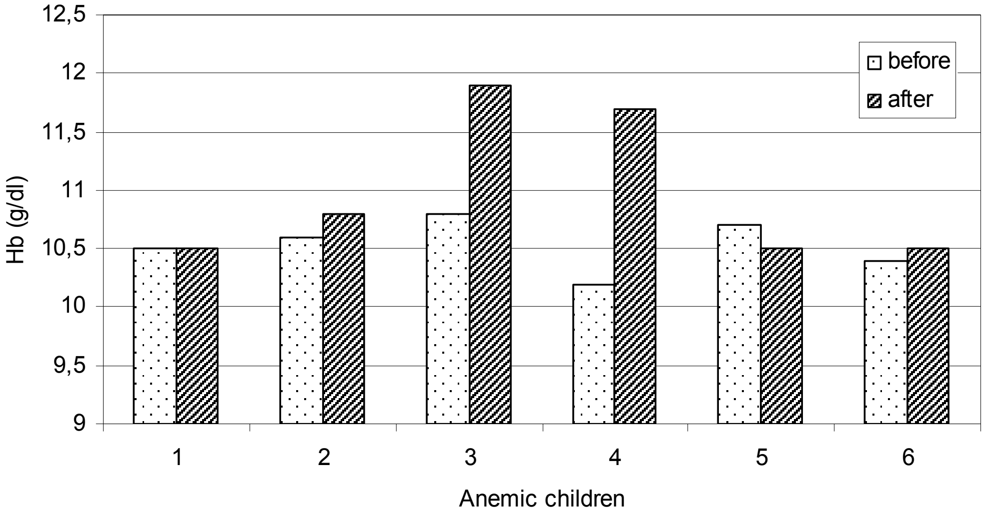

Fig. 22: Individual haemoglobin value of the anemic children in the intervention group

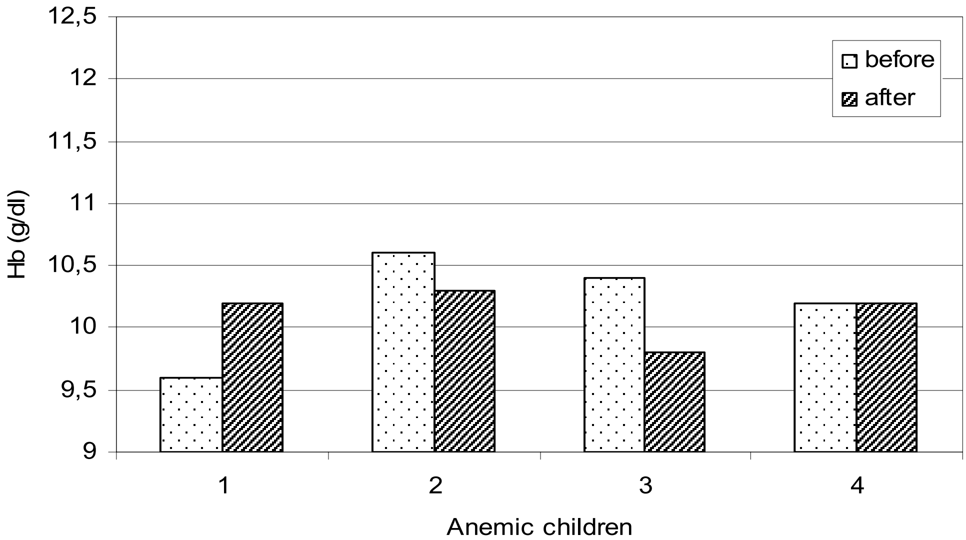

Fig. 23: Individual haemoglobin value of the anemic children in the placebo group

Regarding the ferritin levels, all the 6 anemic children in the intervention group had an increase in the ferritin level after the intervention compared to only 2 anemic children in the placebo group.

The change in the ferritin level among the anemic children in the intervention group and in the placebo group after the intervention is shown in figures 24 and 25, respectively.

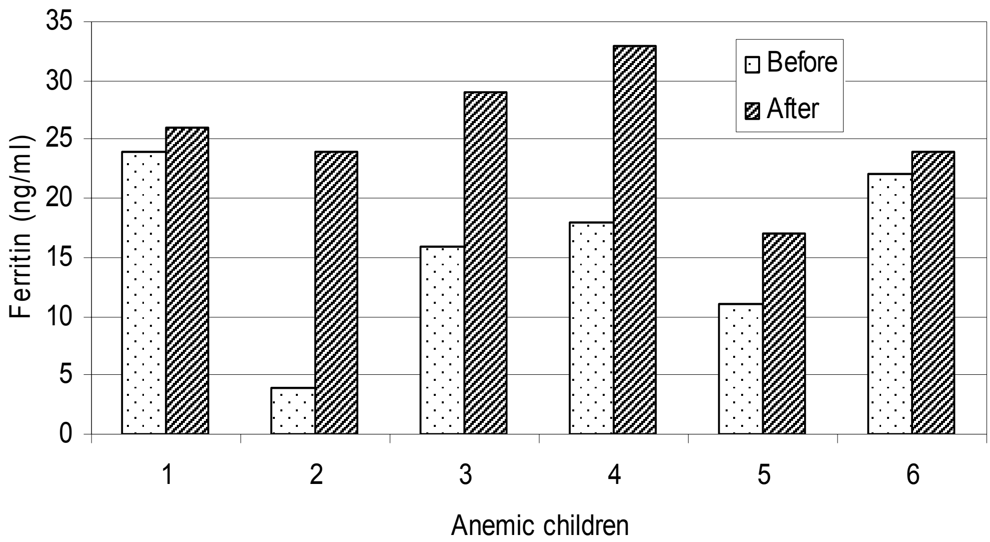

Fig. 24: Individual ferritin level of the anemic children in the intervention group

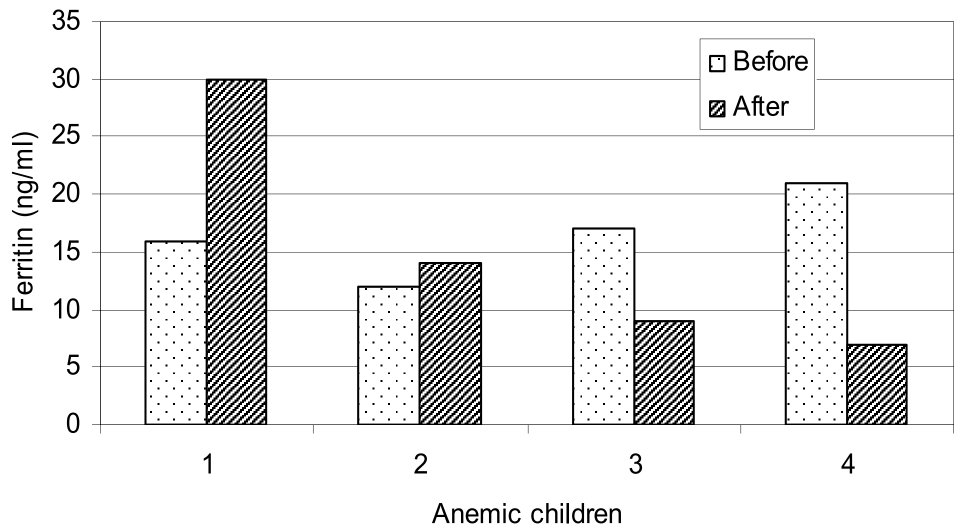

Fig. 25: Individual ferritin level of the anemic children in the placebo group

4. Discussion

4.1 Introduction

Substantial, but indirect, evidence suggest that improving nutrition in early childhood in developing countries is a long-term economic investment (Hoddinott et al. 2008). Poor nutrition can affect development prenatally from early gestation and throughout childhood. Child development is multidimensional and comprises several interrelated domains including motor, cognitive, social and emotional development (Baker-Henningham and Grantham-McGregor 2006).

The children aged 3-5 years have already stopped breastfeeding, and they must get all the nutrients they need from the family foods. Parents should make sure that the children get plenty of energy-rich and nutrient-rich foods, particularly vitamin A, iron and vitamin C to prevent anemia. The children must be given good snacks between main meals (King and Burgess 1992). It is clear that as children increase in weight and height they need more food to provide them with more energy and more of the other nutrients essential for growth and health. Parents should understand the needs of the children, and know the right foods and adequate quantities (Latham 1997). Infants and young children require vitamins and minerals not only to replace losses through metabolic turnover, but also to increase the body reserves as they grow (Bender 2003).

Children with nutritional deficiencies usually come from disadvantaged environments which may have independent effects on children's development. These children are likely to be exposed to multiple biological risks (Baker-Henningham and Grantham-McGregor 2006). An important issue is that many children in developing countries are already nutritionally depleted by the end of the first year of life, because maternal undernutrition can cause low fetal accumulation of nutrient stores and secretion of inadequate amounts of some micronutrients in breast milk. Although much is known about the role of inadequate diets in preschooler malnutrition, on a global scale the ability of households to apply this knowledge to improve the diets of their children is still limited (Allen 2006).

Over 200 million children under 5 years in developing countries are not fulfilling their developmental potential. These disadvantaged children are likely to do poorly in school and subsequently have low income (Grantham-McGregor et al. 2007).

Regular growth monitoring is an important tool for assessing the nutritional status of infants and young children, and it should be an integral part of the child health care system. Infants and young children are very vulnerable to growth faltering as a result of malnutrition (Michaelsen et al. 2003).

According to current World Health Organization estimates, more than 3 billion people worldwide, especially in developing countries, are malnourished in essential nutrients. Malnutrition imposes severe costs on a country's population due to impaired physical and cognitive abilities and reduced the ability to work (Gilani and Nasim 2007), and it has been the biggest challenge faced by developing countries in order to guarantee to children under 5 years their right of being well nourished and healthy (Monte 2000).

The nutritional problems of developing countries are conditioned by poverty, near exclusive reliance on plant sources of nutrients and high rates of infections. Common deficiency diseases include protein energy malnutrition, nutritional anemias, vitamin A deficiency, iodine deficiency disorders and possibly others (Brown and Solomons 1991).

Protein energy malnutrition is a major public health problem in the tropical and also subtropical regions of the world. It is the most common nutritional disorder affecting children in developing countries and the third most common disease of childhood in such countries (Akuyam 2007).

People of all population groups in all regions of the world can be affected by micronutrient malnutrition. Although the most server problems of micronutrient deficiencies are found in developing countries, people in developed countries also suffer from various forms of these nutritional problems (FAO 1997). Micronutrient deficiencies and infectious diseases often coexist and exhibit complex interactions leading to a vicious cycle of malnutrition and infections in developing countries, particularly among the preschool children (Bhaskaram 2002).

Many children younger than 5 years in developing countries are exposed to multiple risks, including poverty, malnutrition, poor health, and poor home environments, which affect their cognitive, motor, and social-emotional development (Grantham-McGregor et al. 2007). Malnutrition in children is the consequence of factors that are often related to poor food quality, insufficient food intake, and severe and repeated infectious diseases, or frequently some combination of the three (de Onis and

Bloessner 1997). It is still a major problem for many children under 5 years of age in developing countries, although the prevalence is decreasing, (Hoeree, Kolsteren and Roberfroid 2002).

There is increasing evidence that poor nutrition in childhood is associated with both the short-term and long-term adverse consequences such as poorer immune status, higher caries rates and poorer cognitive function and learning ability (Nelson 2000). It affects also the physical growth and development of the children, and some of these effects resulting from specific micronutrient deficiencies (Bhan, Sommerfelt and Strand 2001). Moreover, a number of studies relate early malnutrition, iron deficiency and malaria infection to poor cognitive abilities in the school age years (Jukes 2005).

Despite numerous advances and improvements in child health globally, malnutrition remains a major problem and underlies a significant proportion of child death (Bhutta 2006). Worldwide, malnutrition is a contributing cause of about half of the 10 million deaths annually; and it contributes also to a substantial proportion of the infectious disease morbidity among the children in developing countries. Epidemiological and clinical evidence has shown that in most developing countries deficiencies of specific micronutrients are partly responsible for the severity of infectious disease morbidity and mortality in malnourished children (Temple and Masta 2004). Studies indicated that 42-57% of all child deaths in developing countries are due to the potential effects of malnutrition and infectious diseases, of which over three-quarters can be attributed to mild to moderate malnutrition (Sanghvi et al. 2001).

Therefore, action is needed to reduce the burden of micronutrient malnutrition among low income populations in developing countries who are the vulnerable to deficiencies of multiple micronutrients. The normal and evolutionary manner in which to consume nutrients is in the context of foods, both snacks and meals (Briend and Solomons 2003).

In Egypt, results of the WHO Global Database on Child Growth and Malnutrition declared the nutritional status of the children under the age of 5 years based on WHO Child Growth standards. In 2005, the prevalence of stunting among the Egyptian children under the age of 5 years in the urban areas was 22%, and severe stunting was 9.3%. The rural children were more likely to be stunted and severe stunted (24.9% and 10.9%, respectively) than the urban children.

Wasting was more common among the urban children than the rural children (6.8% vs. 4.4%), and also severe wasting (3.7% vs. 1.8%). The prevalence of underweight and severe underweight (5.4% and 1.7%, respectively) was the same among the urban and rural children. The prevalence of stunting and wasting in Egypt in 2005 increased compared to the prevalence in 2003, however; there was a decrease in the prevalence of underweight in 2005 compared to 2003 (WHO 2008).

Regarding micronutrient deficiencies, iron deficiency anemia is considered the most prevalent. The groups most affected are the preschool children and their mothers. According to WHO criteria, iron deficiency anemia is considered to be a moderate public health problem in Egypt (FAO 2003).

Results of the WHO Global Database on Anemia declared that the prevalence of anemia (Hb <11 g/dl) among the children under the age of 5 years in Egypt in 2005 was 48.5%, and it was more prevalent among the children in the rural areas than the urban areas (51.3% vs. 43.7%). Moreover, the highest prevalence of anemia among the preschool children was in Upper Egypt (55.3%), which was in Lower Egypt 43%. The prevalence of anemia among the children in 2000 was 29.9%, with the highest prevalence in the rural areas (34%) and in Upper Egypt (36%), respectively. This indicates that the prevalence of anemia among the preschool children increased during the period between 2000 and 2005 (WHO 2006b).

Vitamin A deficiency was also found among the preschool children and their mothers in Egypt (FAO 2003). Regarding the WHO Global Database on Vitamin A Deficiency, the prevalence of vitamin A deficiency (serum retinol <70 µmol/l) among the preschool children in Alexandria Governorate in 1999 was 9.3%; and it was more prevalent in the rural areas than the urban areas (15.8% vs. 7.7%). In 3 Governorates in Upper Egypt (Assiut, Minia and Sohag) in 1997, the prevalence of vitamin A deficiency among the preschool children was 4.8%. It was more prevalent in the urban areas than the rural areas (5.4% vs. 4.7%) (WHO 2007).

Concerning iodine deficiency in Egypt, it was considered a public health problem; since the total goiter rate was higher than 5% among different vulnerable populations (FAO 2003). Results of the WHO Global Database on Iodine Deficiency declared that iodine deficiency in 1998 was found among 31.2% of the Egyptian school children from 3 governorates (Cairo, El-sharkia and Quena). The prevalence of iodine deficiency increased in Cairo in 2004. In a study among 99 school children, the prevalence was 60.6% as mild iodine deficiency, 27.3% as moderate deficiency and 4% as severe deficiency (WHO 2006c).

The current study aimed to improve the nutritional status of the preschool children in El-Menoufia Governorate, Egypt by an intervention with cheap and locally made snacks to provide the deficient nutrients; and to determine the effect of these snacks on the nutritional status of the children.

The anthropometric and blood measurements of the children who received the snacks were assessed before and after the intervention, the nutritional intake of them at baseline and during the intervention was also estimated, and all these data were compared with the same data of the placebo group who received a beverage with the same energy value of the snacks.

4.2 Study results

Acceptability of the snacks

The Sesame snacks were well accepted by the children in the intervention group. Most of the children found the snacks "very good" and "good" (33.3% and 42.9%, respectively), some of them said that they were acceptable and the others did not know. Some of the children could explain the reasons for liking the snacks such as the good and delicious taste, or their liking of the sweets.

The snacks were also acceptable among the mothers for their taste. Some of them, especially the mothers who were university educated, said that the snacks were good for their children for the natural ingredients of these snacks which were free of food additives. The others did not mention the reason, or said that the snacks were just as a food for the child.

In Jakarta, Indonesia; an intervention study was performed to improve the iron status of the children aged 4-6 years from low-to-middle income groups. They used iron fortified candies, and these candies were fruit-flavored, chewy and sweet. The acceptability of the candies among the children and also their mothers was evaluated. The finding of this study indicated that the candies were acceptable to the children for their orange taste, or sweet and nice taste; and were also accepted among the mothers for their iron fortification (Sari et al. 2001).

Nutrients supply can be done through supplements based on natural food, but the taste preferences of the children should be respected to ensure better acceptability.

Nutritional status of the children and maternal education

Maternal education has been accepted as one of the most important influences on the child health (Shin 2007).

In the current study, malnutrition was more prevalent among the children of illiterate mothers than among the children of literate mothers. The prevalence of malnutrition among the children of illiterate mothers was 66.7% compared to 16.7% among the children of literate mothers.

High levels of maternal education and intelligence reduce the effect of early childhood undernutrition on child development. Conversely, there are worse effects on the child development when mothers are illiterate (Baker-Henningham and Grantham-McGregor 2006).

Other studies reported an association between the nutritional status of the children and the educational level of their mothers. Results of the Demographic and Health Survey in Egypt indicated that the educational level of the mothers was inversely related to the level of stunting among the children. 23% of the stunted children are of mothers who never attended school compared to 15% being of mothers who completed the secondary level or higher (El-Zanaty and Way 2006).

In northern Tanzania, the nutritional status of the children under the age of 5 years was assessed. Again, educated mothers were less likely to have an undernourished child (Nyaruhucha et al. 2006).

Another study was conducted in three states representing three stages of development in India. The degree of stunting among the preschool children in the context of socio-economic and demographic characteristics of the children was investigated. Som, Pal and Bharati (2007) found that mother's education was important and had significant influence on children's health status.

Furthermore, Arya and Devi (1991) studied the impact of maternal literacy status on the nutritional status of preschool children in Parbhani, India. They found that the children of literate mothers had better anthropometric indicators than children of illiterate mothers, and nutrient deficiency signs were more predominant among the children of illiterate mothers.

Impact of the supplements on the nutritional status of the children

Nutritional status is the best global indicator of well-being in children, and it is also an important factor in child survival, especially in developing countries. Therefore, it is important that nutritional problems are addressed and overcome (de Onis, Frongillo and Bloessner 2000; Arokiasamy 1990).

In children, the three most commonly used anthropometric indices are weight-for-height, height-for-age, and weight-for-age (WHO 1995).

Failure to meet micronutrient requirements, a challenging environment and the inadequate provision of care are all factors responsible for stunting which affect almost 200 million children under 5 years of age. Prevention is possible by undertaking interventions at all stages of the life cycle (Branca and Ferrari 2002).

Wasting or low weight-for-height or thinness may indicate in most cases a recent and severe process of weight loss, which is often associated with acute starvation and/or severe diseases. Children may also be thin as a result of a chronic dietary deficit or disease (WHO 1995).

Underweight or low weight-for-age reflects body mass relative to chronological age. It is influenced by both the height of the child (height-for-age) and his or her weight (weight-for-height) (de Onis and Bloessner 1997).

In the current study, the anthropometric indicators of all children in the study population (the two groups) at the beginning of the study compared with the children in Egypt are shown in table 15.

Tab.15: Comparison of anthropometric indicators of the children in Egypt and the study population

Indicator	Egypt	Study population
Stunting	22,0%	11,9%
Wasting	6,8%	7,1%
Underweight	5,4%	4,8%

After the intervention, we can identify a positive effect on the nutritional status of the children (aged 24-47 months) in the intervention group. This effect was on the prevalence of stunting and underweight which decreased after the intervention, however; there was no effect on the prevalence of wasting.

On the other hand, there was no positive impact of the beverage on the nutritional status of the children in the placebo group who received the same energy supplement as the intervention group. The beverage had no effect on the prevalence of stunting. Moreover, there was a negative effect on the prevalence of wasting which increased after the intervention. After the intervention, one child was found underweight.

The children did not benefit at all from the caloric supplement in the placebo group, and the reason can not be explained with the data obtained from them.

Our results in the intervention group are in line with other studies conducted in different places. The first study was looking at stunted children (3-6 years) in Saharawi refugee camps in Algeria. A fat spread that was high in energy and protein was used as supplement for children in the unfortified group, and a vitamin-mineral mix was added to the same spread given to children in the fortified group. The linear growth of children in the fortified group was 30% faster at 3 months than in the unfortified group. Moreover, height-for-age Z-scores increased slightly in the fortified group and remained unchanged in the unfortified group, although the supplements of the fortified and unfortified groups had the same energy, protein and lipid. The investigators reported that the micronutrient fortified supplement, and not a supplement with identical macronutrients composition and without micronutrients, was effective in inducing accelerated catch-up linear growth. They reported also that this catch-up growth was achieved in children up to age 6 years (Lopriore et al. 2004).

The second study was implemented in Botswana and showed success to improve the nutritional status over the same period of time of our study (8 weeks), but with older children (6-11 years) in urban areas. Abrams et al. (2003) used a fortified beverage with 12 micronutrients for the fortified group, and an isoenergetic placebo drink for the placebo group. Growth improvement was in the fortified group more significant than in the placebo group, although both the intervention and control beverages provided the same energy. They reported that this improvement in the fortified group might be due to the increase in zinc intake (3.75 mg zinc gluconate/serving) from the fortified beverage which increased utilization of the energy provided.

Several micronutrients are required for adequate growth among children. There is a strong evidence for the contribution of zinc deficiency, which is essential for DNA and protein synthesis, to growth faltering among children; even mild to moderate zinc deficiency may affect growth. Vitamin A and iron deficiencies also have been demonstrated to cause growth faltering, however; only when the deficiency state of these nutrients is severe (Rivera et al. 2003, Wasantwisut 1997).

Therefore, findings of previous studies and the current study demonstrate that a pure energy supplement does not lead to an improved nutritional status. Micronutrients content of the snacks, particularly iron and zinc, may be the explanation for improving the nutritional status in the intervention group.

Impact of the supplements on the nutritional of boys and girls

Our study showed that the prevalence of the stunting among the boys was higher than among the girls at baseline in the intervention group. The snack had a positive effect on the stunted boys, but no effect on the stunted girls. However, the positive effect of the snacks was only on the underweight girls whose decreased after the intervention. No impact was found on the prevalence of wasting of both, boys and girls. There was no positive effect of the beverage on the nutritional status of the placebo group, neither the boys nor the girls.

The results of the intervention group are approximately similar to the results of another study implemented in Alexandria, Egypt. Ghoneim, Hassan and Amine (2004) studied the effect of an intervention programme on the nutritional status of children aged 2-5 years in 3 nurseries. All children were in one group, and received 2 meals (rich in protein, iron and vitamins) per day (breakfast and lunch) and a fruit snack in between. They found that the prevalence of stunting among boys was higher than among girls at baseline (as the same with our results), and it decreased among both after the intervention. Moreover and in line with our results, prevalence of underweight was the same among boys and girls at baseline. The intervention had an effect on underweight girls more than underweight boys. Wasting was present among boys and girls at baseline, and decreased among the both after the intervention.

Impact of the supplements on the anthropometric measurements

Indicators of poor nutritional status can provide an early sign of a child at risk. In children below the age of 5 years, measured weight and height can be compared with the weights and heights of children of the same age in a healthy reference population (Michaelsen et al. 2003).

In developing countries, height and weight are good indicators of children's health and nutritional status (Shin 2007). The increase in height is assumed to result from long-term improvements in nutritional intakes and reductions in infectious disease burdens. Nutritional supplementation in early life reduces stunting in chronically undernourished populations (Stein et al. 2003).

The current study showed that the intervention with the snacks had a positive effect on the anthropometric measurements of the children in the intervention group.

The children in the two study groups, the intervention and the placebo, showed a significant increment in height and a slight increment in weight after the intervention. Furthermore; the mean incremental height was higher in the intervention group than in the placebo group (1.67 cm vs. 1.34 cm); as well as the mean weight gain (0.22 kg vs. 0.13 kg).

Our results were in line with similar trial was implemented in rural Tanzania among older children (aged 6-11 years) and for longer period of time (6 months) compared with our study, and it showed also an improvement in the anthropometric measurements. Ash et al. (2003) used micronutrient fortified beverage and unfortified beverage for the fortified and nonfortified groups, respectively. There were mean incremental changes in weight (1.79 kg vs. 1.24 kg) and height (3.2 cm vs. 2.6 cm) which were significantly higher in the fortified group than in the nonfortified group. After the 6 months intervention, the fortified group had gained 0.55 kg more weight, and 0.57 cm more height compared with the nonfortified group.

Another study in Kenyan with food supplements had a positive impact on weight gain among school children (median age 7.1 years). The children received a local food supplementation with a meat, milk or energy supplement contained an estimated energy content of ~ 1255 kJ/serving for 23 months. The growth of the children in these three groups was evaluated, and compared with a control group without supplement. There was a statistically significant supplementation effect on weight gain of the children in the supplementation groups. Children in each of the supplementation groups gained ~0.4 kg (10%) more weight than children in the control group. No statistically significant overall effects of the supplementation were found on height, HAZ and WHZ for all groups (Grillenberger et al. 2003).

In semi-urban areas in India, another trial among healthy school children from middle income groups used a micronutrient fortified beverage. Sarma et al. (2006) evaluated the effect of this beverage on the growth of children in supplemented group compared with the children in placebo group. The fortified beverage was beneficial in promoting the growth. After 14 months of supplementation, there was a significant increase in mean increments of height, weight and WAZ in the supplemented group more than in the placebo group.

A positive effect of the snacks on the HAZ of the children in the intervention group was also found in our study. Although the children in the two groups showed an increase in the mean value of HAZ (0.11 vs. 0.05), the difference between the two groups was significantly higher after the intervention than at baseline. This confirms the results of the nutritional status, whereas; the prevalence of stunting decreased after the study in the intervention group, and did not change in the placebo group.

On the other hand, the changes in WHZ and WAZ after the intervention compared to baseline were not significant in the intervention group. However, in the placebo group; WHZ and WAZ decreased significantly, and it may be the explanation of increasing the percentages of wasting and underweight after the intervention among the children in the placebo group.

Compared with the supplementation trial in Saharawi refugee camps in Algeria among stunted children aged 3-6 years, for longer period of time, with spread fortified with vitamins and minerals. Lopriore et al. (2004) reported that the fortified spread had a positive effect on the height and weight indexes. Positive incremental height increased among children in the fortified group, reaching 2.6 cm after 3 months, compared with 2 cm in the unfortified group; as well as, HAZ increased significantly in the fortified group. In both groups, weight improved, and changes in WAZ between groups after 3 months were not significant.

Nutritional intake

Inadequate micronutrient intakes and resulting deficiencies are common among preschoolers, and have been associated with delayed child development (Allen 2006). A number of factors may influence micronutrient deficiencies in developing countries, including poor body stores at birth, dietary deficiencies and high intake of inhibitors of absorption such as phytates and increased losses from the body (Bhutta 2006).

Data from ARC (Agriculture Research Centre of the Ministry of Agriculture in Egypt) surveys conducted between 1995 and 2002 showed that the percentage of children aged 2-5 years who consumed less than 50% of the RDA of energy, calcium, zinc and vitamin A increased in 2001 compared to this percentage in 1995; and increased also slightly of iron and vitamin C (FAO 2006).

In our study, the results were in line with the results of the ARC surveys in Egypt. The energy intake among the children in the two study groups at baseline was also lower than the RDA. During the intervention, the children in the two groups showed an increase in the mean value of energy; whereas, they received the same energy value from the snack and the beverage.

Provision of adequate dietary energy is vital during the period of rapid growth in infancy and early childhood. Energy is required for tissue maintenance and growth, to generate heat and for physical activity (Michaelsen et al. 2003).

Furthermore, in the current study, inadequate micronutrient intakes were also found at baseline among the children in the two groups for phosphorus, potassium, vitamin B1, niacin and vitamin B6. During the intervention, the mean intake of these nutrients increased significantly in the intervention group who received the snacks with micronutrients. Moreover, the children in the two study groups had also inadequate iron and vitamin A intakes before the intervention; and it increased significantly in the intervention group.

Iron deficiency is one of the most common nutrition disorders and one of the leading risk factors for disability and death worldwide, affecting a large proportion of children and women in the developing world. In addition, iron deficiency is probably the only nutrient deficiency of significant prevalence in developed countries. Nutritional iron deficiency arises when physiological requirements can not be met by iron absorption from diet (Yip 2001; Zimmermann and Hurrell 2007).

In developing countries, the main causes of iron deficiency are the low iron content and bioavailability from the diet and the high prevalence of hookworm infestations. The consequences of iron deficiency are many and serious, affecting not only individual's health and life but also the development of societies and countries (Berger and Dillon 2002).

Vitamin A is required for healthy vision, for the integrity of epithelial surfaces, and for the development and differentiation of tissues. It is also essential for the normal immune response (Michaelsen et al. 2003). Vitamin A deficiency among children in developing countries remains the leading cause of preventable severe visual impairment and blindness, and is a significant contributor to severe infections and death, particularly from diarrhea and measles. Vitamin A deficiency is also likely to increase vulnerability to other illnesses in both women and children, such as iron deficiency anemia, and may be an important factor contributing to growth deficits in children (Underwood and Arthur 1996). Improved vitamin A status would be expected to prevent approximately 1-2 million deaths annually among children aged 1-4 years (Humphrey, West and Sommer 1992).

At baseline, we found also that the most insufficient intakes compared to the RDA among the children in the two study groups were the intakes of zinc and calcium.

A significant increase in the mean value of zinc and calcium was found during the intervention only in the intervntion group. It may be also an explanation of the more improvement in the nutritonal status of the intervention group compared with the placebo group.

Zinc is a constituent of many enzymes in the body, so it is important in a wide range of metabolic processes including protein and nucleic acid synthesis (Michaelsen et al. 2003). It is also an essential micronutrient for human growth, development, and it has an important role in infant and childhood infectious diseases, whereas; zinc deficiency impairs overall immune function and the resistance to infectious diseases (Fischer Walker and Black 2004). Furthermore, it has a fundamental role in cellular metabolism, with profound effects on the immune system and the intestinal mucosa. Zinc deficiency is common among the children in developing countries due to lack of intake of animal foods, high dietary phytate content, inadequate food intake and increased the fecal losses during diarrhoea. This deficiency may has adverse effects on the physical growth and neurodevelopment (Bhatnagar and Natchu 2004).

Some data suggest that zinc may detrimentally affect children's development (Hamadani et al. 2001). Furthermore, deficiencies of iron and zinc are associated with delayed development, growth faltering and increased infectious disease morbidity during infancy and childhood (Lind et al. 2004).

Calcium is essential for the structural integrity and mineralization of bones and teeth, and it plays an important role in a number of metabolic and regulatory processes. An adequate supply of calcium is vital during skeletal growth to ensure optimum bone mass (Michaelsen et al. 2003). Dietary requirements for calcium vary throughout the life stage, with greater needs during the periods of rapid growth in childhood. Inadequate dietary calcium in early life impairs bone development (Flynn 2003).

Compared with another study In Alexandria, Egypt, the dietary intake of 974 children aged 2-5 years from three day care centres was assessed. Ghoneim, Hassan and Amine (2004) reported that the most deficient nutrient was calcium (only 22.1% consumed 100% of the RDA), followed by calories (26.4%), vitamin C (39.1%) and niacin (44.8%). The least deficient nutrient was protein (98% consumed 100% of the RDA), followed by vitamin B2 (71%) and vitamin A (60.3%).

In another study, the intra-household food distribution was studies among 1470 families in 3 Governorates (Cairo, Qualyobia and Beheria) in Egypt. The results showed that the preschool and school children had lower than the recommended energy intakes, and consumed also less than the recommended of calcium. These results were more pronounced in the rural than urban communities. The investigators reported that the prevalence of malnutrition among certain sectors of population raises concern about intra-household food distribution (Shaheen and Tawfik 2000).

The results of the current study and of these previous studies in Egypt indicate that the preschool children had insufficient nutritional intake in energy and micronutrients, and providing of the snacks during the intervention could improve the nutritional intake of the children.

Impact of the supplements on the blood measurements

Biochemical indicators are sometimes useful for assessing nutritional status, and some may provide an early indication of a specific nutrient deficiency (Michaelsen et al. 2003). Determinations of haemoglobin or haematocrit levels are the most widely used in the diagnosis of anemia. These tests require quite cheap apparatus and can provide information on the absence, presence or severity of anemia; but do not provide information on the iron stores of the individual (Latham 1997).

In the current study, results of the intervention group indicate that the snacks had a positive effect on the blood measurements of the children, particularly the anemic children, after the intervention compared with the placebo group.

The children in the intervention group showed a slightly increase (0.27 g/dl), but not significant, in the mean value of haemoglobin after the intervention, compared to no change in the placebo group. Moreover, there was an increase in the RBC-counts, and it was more significant among the children in the intervention group than in the placebo group.

Serum ferritin level is the most specific biochemical test that correlates with relative total body iron stores. A low serum ferritin level reflects depleted iron stores, and hence is a precondition for iron deficiency in the absence of infection (WHO 2001).

After the intervention in the current study, no significant effect on the serum ferritin was found in the two study groups. It was observed that the ferritin level of few children (about 4 children) in the intervention group had extremely decreased after the intervention, and thus might dilute the possible intervention effects in this group.

But the snacks had a positive effect on the prevalence of low ferritin level which decreased after the intervention. At the same time, the prevalence of low ferritin level increased in the placebo group after the intervention. We can identify a positive effect of the snacks on the prevalence of low ferritin level.

A similar intervention study (double-blind, placebo-controlled) was conducted in Jakarta, Indonesia for 12 weeks among children aged 4-6 years from low to middle income groups. Sari et al. (2001) assessed the effect of iron fortified candies on the iron status of children. The children in fortified group received fortified candies with 30 mg iron weekly (the double amount of snack's iron in our study, i.e., 15.6 mg/week), and in placebo group; they received placebo candies. After the intervention, the haemogloin concentration increased significantly among all children in the fortified group than in the placebo group (10.2 g/L vs. 4 g/L), and also among the anemic subjects (12.9 g/L vs. 8.3 g/L). The serum ferritin concentration was 71% higher than at baseline in fortified group and 28% higher in placebo group.

Another trial was implemented in rural South Africa to improve the micronutrient status of school children (aged 6-11 years). The study was for longer period of time (43 weeks) compared to our study, and it was in line with our study; whereas, both studies were single-blind (only the project leader was aware of the group allocation). Faber et al. (1999) used fortified biscuits with iron, iodine and ß-carotene with an intervention group, and nonfortified biscuits with control group. A significant effect was found in the intervention group, compared with the control group, for serum ferritin, haemoglobin and hematocrit. Moreover and in line with our results, the percentage of children with low serum ferritin decreased in the intervention group, and increased in the control group.

A study conducted in Botswana to improve the nutritional status of urban school children by using a micronutrients fortified beverage with 12 micronutrients (iron was as 7.0 mg ferrous bisglycinate chelate/serving) for 8 weeks. Using the micronutrients fortified beverage declared also an improvement in haematological data. Changes in haemoglobin, mean corpuscular volume (MCV) and serum ferritin were significantly different between the fortified group and the placebo group (Abrams et al. 2003).

In North East Thailand, the efficacy of a micronutrient fortified powder on enhancing the haemoglobin status of children aged 5.5-13.4 years was assessed. The children were from the low socioeconomic status groups in rural areas. The powder either unfortified or fortified with zinc, iron, vitamin A and iodine was served with a school lunch for 31 weeks (5 days/week) to the unfortified and fortified groups, respectively. There was an evidence of a significantly higher haemoglobin concentration in the fortified group than the unfortified group. No significant improvement in serum ferritin or MCV was observed. The investigators reported that the negative findings may have arisen because the level (i.e., 5 mg/serving) and/or the form of the iron fortification may not have been adequate to significantly enhance the iron stores of the children (Winichagoon et al. 2006).

In a trial implemented in rural India among children aged 3-6 years for 13 weeks, Anand et al. (2007) used sugar candies fortified with iron and vitamin A (14 mg iron and 1000 IU vitamin A/daily dose) to improve the iron and vitamin A status. The children received full dose candy daily, full dose candy for 3 days a week, half dose candy daily or placebo. There was an increase in haemoglobin in the two full dose groups (1.15-1.18 g/dl) more than in the placebo group (0.3 g/dl), and ferritin level increased significantly only in the full dose daily group. Although this trial was for a slightly longer time compared to the current study, the increase in haemoglobin value and ferritin level was significant and higher than the same results in our study. Consideration must be given to the daily dose of iron used in the study in India which was more than the daily iron of the snacks used in our study (14 mg vs. 2.6 mg), and it might be the explanation of both results.

Regarding the anemic children in the two study groups, it was observed that using the snacks as supplements had a beneficial effect on the anemic children. The snacks had a positive effect on the haemoglobin value and the level of serum ferritin of the anemic children who showed more increase than the anemic children in the placebo group. After the intervention, the haemoglobin value increased among 4 anemic children in the intervention group compared to one anemic child in the placebo group. All the anemic children in the intervention group had an increase in the ferritin level after the intervention compared to the half anemic children in the placebo group.

Compared with a study performed in Philippines, the effect of a multiple-micronutrient-fortified fruit powder beverage on the micronutrient status of school children was determined. The study findings showed that consumption of the multiple-micronutrient-fortified beverage for 16 weeks had significant effects on iron status among deficient Filipino school children compared to placebo group who received a placebo beverage. The fortified beverage significantly improved iron status among anemic subjects that had haemoglobin levels < 11 g/dl at baseline, and the proportion of children who remained moderately to severely anemic was significantly lower among those given the fortified beverage (Solon et al. 2003).

Prevalence of anemia

Nutritional anemia refers to a condition in which the haemoglobin content of the blood is lower than normal as a result of a deficiency of one or more essential nutrients (usually iron, less frequently folate or vitamin B12) (Verster 1996).

On average, globally, 50% of the anemia is assumed to be attributable to iron deficiency. Iron deficiency ranks, globally, number 9 among 26 risk factors included in the Global Burden of Disease 2000 project, and accounts for 841,000 deaths and 35,057,000 disability-adjusted life years lost. It is also considered to be one of the most prevalent forms of malnutrition (Stoltzfus 2003). Iron deficiency anemia is estimated to affect almost 25% of the world's population (equivalent to 3.5 billion people) resulting in high economic costs by adding to the burden on healthcare services, affecting learning in school and reducing adult productivity (Caballero 2002).

Young children are the highest risk group to iron deficiency, particularly during their rapid period of growth. Anemia in infants and young children is known to have a negative impact on the motor and socioemotional development and cognitive function (Zlotkin 2004), moreover; it reduces resistance to infections and slow development of learning abilities (FAO 1997). In 2005, the prevalence of anemia among the children under 5 years of age in Egypt was 48.5% (WHO 2006b).

Compared with the current study, the prevalence of anemia among all children in the two study groups was 23.8% at the beginning of the study. The snacks had a positive effect on the prevalence of anemia in the intervention group which decreased from 28.6% at baseline to 19% after the intervention. It was observed that this decrease in the prevalence of anemia was only among the girls, whereas; the haemoglobin value and also the serum ferritin level increased among the girls more than among the boys, and this confirms the results of anemia among both, boys and girls. However, in the placebo group, no change in the prevalence of anemia was found after the intervention.

Epidemiological surveys showed that the prevalence of anemia is high in populations affected by vitamin A deficiency in developing countries. Improvement of vitamin A status has generally been shown to reduce anemia. Vitamin A appears to be involved in the pathogenesis of anemia through diverse biological mechanisms, such as the enhancement of growth and differentiation of erythrocyte progenitor cells (Semba and Bloem 2002).

In the study population, it was observed that the mean intake of vitamin A at baseline and during the intervention (60.9% and 76.2% of the RDA, respectively) among the children in the intervention group was more than in the placebo group (44.2%). Moreover, the iron intake from the snacks during the intervention increased the mean intake of iron in the intervention group more than in the placebo group (81.4% vs. 56.8% of the RDA). Therefore, this might be the reason of improving the prevalence of anemia in the intervention group more than in the placebo group.

The intervention programme performed In Alexandria, Egypt, for improving the nutritional status of children aged 2-5 years in 3 nurseries who were in one group showed also an improvement in the prevalence of anemia. The prevalence of anemic children decreased from 47.3% before the intervention to 14.2% after the intervention (Ghoneim, Hassan and Amine 2004).

At the same time, the intervention conducted in Jakarta, Indonesia had a positive effect on the prevalence of anemia. The study aimed to improve the iron status of children aged 4-6 years from low to middle income groups by using iron fortified candies with 30 mg iron weekly. The prevalence of anemia decreased from 50.9% at baseline to 8.8% after 12 weeks of intervention in the fortified group, and from 43.3% to 26.7% in the placebo group (Sari et al. 2001).

Furthermore, the trial with fortified biscuits among school children in South Africa declared that the fortified biscuits (5.9 mg iron/serving) had a positive effect on the prevalence of anemia more than the nonfortified biscuits (1.2 mg iron/serving). The prevalence of anemia after the study decreased in the intervention group (29.6% vs. 15.6%) more than in the control group (24.5% vs. 19.4%) (Faber et al. 1999).

On the other hand and regarding the relationship between the level of anemia among the children and maternal education, it was observed that all the anemic children in the two groups of the current study were of literate mothers.

Our results were contrary to the results of the Demographic and Health Survey in Egypt which indicated that children whose mothers never attended school had the highest anemia level, and children whose mothers completed at least secondary school had the lowest level (El-Zanaty and Way 2006).

Compared with another study in rural Wardha, India, the prevalence of anemia and its correlates among children aged 6-35 months were studied. The study showed that educational level of the mothers and occupation of the fathers were significantly associated with anemia (Sinha, Deshmukh and Garg 2008).

In Brazil, in the state of Pernambuco, a study was conducted to identify risk factors for anemia among children aged 6-59 months. Oliveira, Osorio and Raposo (2007) reported that the low maternal educational level was one of the risk factors for anemia among children aged 6-59 months.

In the current study, although using of the snacks during the intervention programme showed a positive effect on the nutritional status of the children; further evaluation is necessary to test the effectiveness of these snacks in long-term trials and among more subjects to estimate the probability of more positive effects on the nutritional status of the children by using the snacks in long-term trial.

Using the snacks as supplements presented some advantages such as the good acceptability among the children and their mothers and the type of the snacks as ready-to-eat snack from local and cheap ingredients. Therefore, it can be used as a supplement in a nutritional programme to improve the nutritional status of the preschool children from the low and middle income groups, or as a product in the local markets.

5. Summary

Malnutrition continues to be a major health burden in developing countries. It imposes severe costs on a country's population due to impaired physical and cognitive abilities and reduced the ability to work. It has been the biggest challenge faced by developing countries in order to guarantee to children under 5 years their right of being well nourished and healthy.

In Egypt, the data of height-for-age Z-score (HAZ) indicated that there was considerable chronic malnutrition among the Egyptian children. Regarding micronutrient deficiencies, iron deficiency is considered the most prevalent among preschool children; and iron deficiency anemia is considered a moderate public health problem. Vitamin A deficiency among preschoolers is considered to be sub-clinical, mild-to-moderate, public health problem.

In El-Menoufia Governorate, Egypt during a previous study in 2003, the habit of eating snacks between meals was common among preschool children. Furthermore, the children had a deficiency in the nutritional intake of energy, calcium, phosphorus, iron, zinc, vitamin A, vitamin B1, niacin and vitamin B6.

The main object of the current study was improving the nutritional status of preschool children from low and middle income groups in El-Menoufia Governorate, Egypt, by an intervention with locally made snacks designed from dried fruits and nuts to provide the deficient nutrients.

The study was designed as a single-blind, placebo-controlled intervention for 8 weeks. 45 children aged 24-47 months were divided into two groups in two separate kindergartens to avoid the exchange of the supplements. The first group was the intervention group who received the snacks (n = 22), and the second group was the placebo group who received the beverages (n = 23). The snack and the beverage were similar only in energy content (i.e. 191 kcal / serving). The distribution was daily (6 days / wk); no intervention took place on Friday (weekend).

Information on the family sociodemographic characteristics and children's dietary habits were obtained during an interview with the mothers who were asked besides others about their opinion of the snacks. Additionally, every child was asked about his/her acceptability of the snacks. The 24-hour recall method was used to assess the usual intake of energy and nutrients of children for two consecutive days.

Both at baseline and after 8 weeks of the intervention, the weight and height were assessed and blood samples were collected from all children in the two groups. A complete blood cell count was performed and serum ferritin level was measured.

The snacks were acceptable among the children and their mothers for their sweet and nice taste, and most children liked the snacks. The intervention study by using the snacks as supplements had a positive effect on the nutritional status of the preschool children.

In the intervention group, the prevalence of stunting and underweight was lower after the intervention than at baseline, and there was no change in the prevalence of wasting. However, there was no change in the prevalence of stunting in the placebo group and the prevalence of wasting increased during the intervention; moreover, there were no underweight children at baseline, but one child was found underweight after the intervention.

After the intervention, the children in the two study groups showed a significant increment in the mean of height which was higher in the intervention group than in the placebo group (1.67 cm vs. 1.34 cm), and also slight increment in weight (0.22 kg vs. 0.13 kg).

There was an increase in the mean value of HAZ after the intervention in the two groups, and the difference between the two groups was significantly higher after the intervention ($p = 0.014$) than at baseline ($p = 0.026$). In the intervention group, 52% of the children had an increase in HAZ compared to 47% in the placebo group.

On the other hand, the mean value of weight-for-height Z-score (WHZ) and also of weight-for-age Z-score (WAZ) of the children in the two groups were lower after the intervention compared to baseline. This decrease in WHZ and in WAZ after the intervention was not significant in the intervention group, however; it was significant in the placebo group.

Regarding the nutritional intake, there was a significant increase in the mean intakes of energy and nutrients during the intervention among the children in the intervention group, especially the deficient nutrients. However, there was no change in the nutrient intakes in the placebo group.

The blood measurements of the children in the intervention group who received the snacks, particularly the anemic children, improved after the intervention compared with the placebo group. The mean value of haemoglobin of the children in the intervention group increased slightly (0.27 g/dl). However, there was no change in the placebo group. The children in the two study groups showed a significant increase in the red blood cell counts after the intervention which was significantly higher in the intervention group (p = 0.0001) than in the placebo group (p = 0.001). Furthermore, the prevalence of low ferritin level (< 12 µg/l) in the intervention group decreased after the intervention compared to at baseline; however, it increased in the placebo group.

The prevalence of anemia among the children in the intervention group was 28.6% at baseline, and it decreased to 19% after the intervention. In the placebo group, there was no change in the prevalence of anemia after the intervention from baseline (19%). After the intervention, the haemoglobin value increased among 4 anemic children in the intervention group, half of the anemic children had haemoglobin >11 g/dl, and it increased among one anemic children in the placebo group; but lower than 11 g/dl.

It can be concluded that a supplement made from locally available food as a snack showed success in improving the nutritional status of the preschool children from low and middle income groups in Egypt. Moreover, using the snacks showed an improvement in the blood measurements, especially among the anemic children. Thus, we can identify that the snacks were effective in managing iron deficiency among the children in study population. Additionally, the snacks had some advantages such as the good acceptability among the children and the type of them as ready-to-eat snacks with no preparation required.

Zusammenfassung

Mangelernährung ist weiterhin eine der Hauptbelastungen in Entwicklungsländern. Durch sie entstehen einer Bevölkerung hohe Kosten durch reduzierte körperliche und kognitive Leistungen und dadurch verminderte Arbeitsfähigkeit. Es war diegrößte Herausforderungen für Entwicklungsländer das Recht auf Nahrung und ausreichende Ernährung und Gesundheit für Kinder unter 5 Jahren zu garantieren.

In Ägypten weisen die height-for-age Z-score Daten (HAZ) auf eine chronische Mangelernährung unter ägyptischen Kindern hin. Im Hinblick auf Mikronährstoffmangel ist bei Vorschulkindern Eisenmangel am meisten verbreitet. Eisenmangelanämie gilt als moderates Volksgesundheitsproblem. Vitamin A Mangel unter Vorschulkindern gilt als sub-klinisches, schwaches bis moderates Volksgesundheitsproblem.

Im El-Menoufia Gouvernement, Ägypten, wurde in einer frühen Studie im Jahre 2003 deutlich, dass unter Vorschulkindern der Verzehr von Zwischenmahlzeiten (Snacks) üblich war. Es konnte ein Nährstoffdefizit bei den Kindern im Hinblick auf die Gesamtenergie aus der Nahrung, Calcium, Phosphor, Eisen, Zink, Vitamin A, Vitamin B1, Niacin und Vitamin B6 festgestellt werden.

In der vorliegenden Studie war das Hauptanliegen, den Ernährungszustand von Vorschulkindern aus Haushalten mit niedrigem und mittlerem Einkommen in Ägypten durch die Gabe eines lokal hergestellten Snacks aus Trockenobst und Nüssen zu verbessern und so Nährstoffdefizite auszugleichen.

Der Aufbau der Studie war eine einfach-blinde, Placebo-kontrollierte Intervention über 8 Wochen. Fünfundvierzig Kinder im Alter von 24-47 Monaten aus 2 Kindergärten waren aufgeteilt in 2 Gruppen um ein Austauschen von Snack und Getränk zu vermeiden. Die erste Gruppe, (n=22), war die Interventionsgruppe, welche den Snack bekam. Die zweite Gruppe, (n=23), war die Placebogruppe, die mit Getränken versorgt wurde. Der Snack und das Getränk waren gleich im Hinblick auf den Energie-Gehalt (191 kcal/Snack bzw. Getränk). Die Ausgabe erfolgte täglich nach dem Frühstück an 6 Tagen pro Woche. An Freitagen fand keine Intervention statt.

Informationen über den soziodemographischen Hintergrund der Familie und die Ernährungsgewohnheiten des Kindes wurden während eines Interviews mit den Müttern aufgenommen. Sowohl die Mütter als auch jedes teilnehmende Kind wurde

über ihre/seine Einstellung und Akzeptanz zum entwickelten Snack befragt. Die 24-hour-recall-Methode wurde genutzt, um die gewöhnliche Menge an Energie- und Nährstoffaufnahme von Kindern an zwei aufeinander folgenden Tagen zu schätzen.
Zu Beginn und nach acht Wochen Intervention wurden Körpergewicht und Körpergröße gemessen und Blutproben von den Kindern der beiden Gruppen genommen. Es wurde ein Blutbild erstellt und die Serum Ferritin-Level bestimmt.
Die Snacks wurden aufgrund ihres süßen, angenehmen Geschmacks von Kindern und Müttern akzeptiert und die meisten Kinder mochten die Snacks gerne.
Die Interventionsstudie unter Vorschulkindern durch Einführung eines Snacks als Nahrungssupplement hatte positive Effekte auf den Ernährungsstatus der Kinder.
In der Interventionsgruppe war die Prävalenz für Stunting und Untergewicht niedriger nach der Intervention. Es gab keine Unterschiede in der Prävalenz von Wasting. In der Placebogruppe gab es keine Veränderung hinsichtlich der Prävalenz des Stunting, die Prävalenz des Wasting stieg während der Intervention an. Außerdem fand sich in dieser Gruppe kein Kind mit Untergewicht zu Beginn der Studie, aber nach der Intervention wurde ein Kind mit Untergewicht erfasst.
Nach der Intervention zeigten die Kinder beider Gruppen signifikanten Erhöhungen der mittleren Körpergröße, welche in der Interventionsgruppe stärker ausgeprägt war als in der Placebogruppe (1,67cm versus 1,34cm). Ebenso konnte eine leichte Erhöhung des Körpergewichts festgestellt werden (0,22 kg versus 0,13 kg).
Ein Anstieg der mittleren HAZ konnte nach der Intervention in beiden Gruppen festgestellt werden, wobei die Differenz zwischen den beiden Gruppen signifikant höher war nach Intervention (p=0,014) als bei Studienbeginn (p=0,026). Dabei ist zu berücksichtigen, dass 52% der Kinder in der Interventionsgruppe einen Anstieg der HAZ-Werte hatten, im Vergleich zu 47% der Kinder aus der Placebo Gruppe.
Auf der anderen Seite sank der Mittelwert für den Weight-for-hight Z-score (=WHZ-Wert) und den Weight-for-age Z-score (=WAZ-Wert) der Kinder in beiden Gruppen nach der Intervention. Dieser Abfall war nicht signifikant in der Interventionsgruppe aber signifikant in der Placebogruppe.
Im Hinblick auf die Nährstoffaufnahme ergab sich eine signifikante Steigerung während der Interventionsphase bei den Kindern aus der Interventionsgruppe bezüglich der im Mittel zugeführten Energiemenge und der Nährstoffe, besonders der defizitären Nährstoffe. In der Placebogruppe konnte keine Änderung in der Nährstoffaufnahme festgestellt werden.

Die biochemischen Analyseparameter der Kinder aus der Interventionsgruppe, besonders die anämischen Kinder, verbesserten sich nach Intervention im Vergleich zu den Kindern aus der Placebogruppe. Die Mittelwerte für Hämoglobin der Kinder aus der Interventionsgruppe erhöhten sich leicht (um 0,27 g/dl). In der Placebogruppe fand sich keine Änderung des mittleren Hämoglobinwertes. Die Kinder der beiden Gruppen zeigten eine signifikante Zunahme des Red-Body-Cell-counts nach der Intervention. Diese Zunahme war in der Interventionsgruppe signifikant höher (p=0,0001) als in der Placebogruppe (p=0,001).
Des Weiteren nahm die Prävalenz niedriger Ferritin-Spiegel (< 12µg/l) in der Interventionsgruppe ab, während sie in der Placebogruppe zunahm.
Die Prävalenz für Anämie unter den Kindern der Interventionsgruppe betrug 28,6% vor Studienbeginn und sank nach Intervention auf 19% ab. In der Placebogruppe ergab sich kein Unterschied in der Prävalenz der Anämie (19%) nach der Intervention mit dem Getränk. Der Hämoglobinwert stieg in der Interventionsgruppe nach Verabreichung des Snacks bei vier anämischen Kindern. Die Hälfte von ihnen hatte nach Intervention Hämoglobinwerte > 11 g/l. Eines der anämischen Kinder in der Placebogruppe wies nach Intervention mit dem Getränk einen Anstieg des Hämoglobinwertes auf, der Hämoglobinwert lag allerdings unter 11 g/l.
Zusammenfassend kann gesagt werden, dass ein Nahrungsergänzungsmittel, verabreicht als Snack, hergestellt aus lokal erhältlichen Lebensmitteln, geeignet ist den Ernährungsstatus von Vorschulkindern aus niedrigen und mittleren Einkommensklassen in Ägypten zu verbessern. Darüber hinaus verbesserten sich unter Verwendung des Snacks die Blutwerte der Kinder, insbesondere der anämischen Kinder. Die Snacks waren folglich wirksam in der Behandlung von Eisenmangel bei den Kindern aus der Studienpopulation. Zusätzlich boten die Snacks Vorteile wie gute Akzeptanz unter den Kindern und hinsichtlich der Form der Bereitstellung als fertiges Nahrungsmittel ohne weitere Zubereitung.

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7. Appendix **page**

Appendix 1: Results of the previous study in El-Menoufia Governorate, Egypt (March-June, 2003)

Tab. A1: Results of the food frequency questionnaire of the children (n = 100)

Foods & Beverages	Daily (%)	Weekly (%)	Monthly (%)	don't eat (%)
White bread	70.0	17.0	-	13.0
Whole grain bread	46.0	32.0	1.0	21.0
Rice	-	85.0	-	15.0
Noodles	-	90.0	2.0	8.0
Potatoes	5.0	74.0	-	21.0
Fats	36.0	4.0	-	60.0
Oils	69.0	4.0	-	27.0
Meat	-	84.0	4.0	12.0
Liver	-	19.0	39.0	42.0
Poultry	-	88.0	4.0	8.0
Fresh fish	-	39.0	41.0	20.0
Canned fish	-	8.0	11.0	81.0
Milk	35.0	25.0	-	40.0
Yoghurt	29.0	29.0	-	42.0
Cheese	20.0	45.0	2.0	33.0
Eggs	34.0	45.0	1.0	20.0
Legumes	-	4.0	26.0	70.0
Cooked vegetables	-	32.0	20.0	48.0
Fresh vegetables	28.0	27.0	2.0	43.0
Orange	30.0	53.0	-	17.0
Mandarin	17.0	48.0	-	35.0
Banana	-	63.0	14.0	23.0
Apricot	-	21.0	23.0	56.0

Tab. A1: Results of the food frequency questionnaire of the children (continued)

Foods & Beverages	Daily (%)	Weekly (%)	Monthly (%)	don't eat (%)
Watermelon	-	67.0	5.0	28.0
Dates	-	36.0	7.0	57.0
Apple	-	27.0	31.0	40.0
Guava	6.0	55.0	-	39.0
Grape	-	46.0	4.0	50.0
Strawberry	-	62.0	1.0	37.0
Peach	-	23.0	18.0	59.0
Mango	-	31.0	18.0	51.0
Soda beverages	16.0	35.0	7.0	42.0
Fresh fruit juices	19.0	33.0	3.0	45.0
Canned juices	2.0	17.0	11.0	70.0
Tea	25.0	6.0	-	69.0
Ice cream	7.0	36.0	2.0	55.0
Biscuits	63.0	7.0	-	30.0
Chocolates	62.0	12.0	-	26.0
Candy & Gum	74.0	5.0	-	21.0
Sugar	64.0	3.0	-	33.0
Honey	9.0	19.0	4.0	68.0
Jam	16.0	12.0	3.0	69.0
Chips	61.0	10.0	-	29.0
Salted crackers	65.0	15.0	-	20.0

Tab. A2: Energy and nutrient intakes per day of the children (n = 100)

Nutrient	Median	Mean	Min.	Max.	Mean (%RDA)
Energy (kcal)	1103.2	1127.3	411.8	2415.0	72.7
Protein (g)	39.1	39.9	11.3	64.8	199.3
Calcium (mg)	497.2	714.6	137.6	3708.1	89.3
Phosphorus (mg)	639.4	656.3	293.4	1154.3	82.0
Iron (mg)	7.4	7.9	2.4	22.7	78.7
Potassium (mg)	1266.4	1324.5	553.3	2610.0	92.0
Zinc (mg)	5.0	5.0	1.7	9.4	50.1
Magnesium (mg)	138.1	140.3	62.6	287.3	140.3
Vitamin A (µg)	215.4	289.1	65.9	1330.2	64.2
Vitamin C (mg)	57.8	62.7	1.0	195.1	147.4
Vitamin D (µg)	0.8	1.3	0	26.1	13.0
Vitamin E (mg)	5.8	8.5	0.6	205.0	98.1
Vitamin B1 (mg)	0.6	0.6	0.1	1.7	80.0
Vitamin B2 (mg)	1.1	1.4	0.2	4.9	139.8
Niacin (mg)	6.9	7.2	2.2	15.0	69.0
Vitamin B6 (mg)	0.7	0.8	0.1	1.9	77.1
Vitamin B12(µg)	1.7	1.8	0.4	5.7	194.9
Folate (µg)	109.5	114.3	37.9	230.0	182.9

Appendix 2: Questionnaire for family and child

1. Child code --

2. Child name --

3. Child sex

a) Boy ----

b) Girl ----

4. Child age (birth date)

Day ---- Month ---- Year ----

5. Number of the children in the family

a) One ---- b) Two ----

c) Three ---- d) More than three ----

6. Rank of the child in siblings

a) First ---- b) Second ----

c) Third ---- d) Other ----

7. Educational level of the father

a) Illiterate ---- b) Primary ----

c) Secondary ---- d) University ----

e) Post graduate ----

8. Educational level of the mother

a) Illiterate ---- b) Primary ----

c) Secondary ---- d) University ----

e) Post graduate ----

9. Father Employment

a) No employment ----

b) Public servant ----

c) Industrial worker ----

d) Farmer ----

e) Technician ----

f) Teacher ----

g) Others ----

10. Mother Employment

a) No employment ----

b) Housewife ----

c) Public servant ----

d) Industrial worker ----

e) Technician ----

f) Farmer ----

g) Teacher ----

h) Others ----

11. Does the child eat the three main meals?

a) Yes ----

b) No ----

If no, how many meals does the child eat?

a) 1 ---- b) 2 ----

c) 4 ---- d) 5 ----

12. Does the child eat snacks between meals?

a) Yes ----

b) No ----

If yes, which snacks are preferred?

a) Chips & salted crackers ----

b) Candy & chocolates ----

c) Vegetables ----

d) Fruits ----

e) Biscuits ----

f) Juices ----

g) Others ----

13. Are there food habits of the child?

a) Yes ----

b) No ----

If yes, which habits?

a) Excess of sugar intake ----

b) Excess of salt intake ----

c) Drink tea between meals ----

d) Don’t eat breakfast ----

e) Don’t eat vegetables ----

f) Don’ t eat fruits ----

g) Others ----

14. Mother's opinion about the snacks (intervention group)

a) Very good ----

b) Good ----

c) Acceptable ----

d) Bad ----

e) Very bad ----

f) Does not know ----

15. Child's opinion about the snacks (intervention group)

a) Very good ----

b) Good ----

c) Acceptable ----

d) Bad ----

e) Very bad ----

f) Does not know ----

Appendix 3: Anthropometric measurements

1. Child code --

2. Child name ---

3. Height, baseline, in cm ----

4. Weight, baseline, in kg ----

5. Height, after the intervention, in cm ----

6. Weight, after the intervention, in kg ----

Appendix 4: Energy and nutrient contents of the snacks

Tab. A3: Energy and nutrient contents of 100 g of the different snacks

Nutrient	Sesame snack	Peanut snack	Coconut snack
Energy (kcal)	382.1	387.1	337.4
Protein (g)	10.8	13.4	7.8
Fat (g)	26.7	25.9	23.3
Carbohydrate (g)	26.5	26.6	25.7
Calcium (mg)	267.6	138.1	195
Phosphorus (mg)	306.5	294.9	251.4
Iron (mg)	5.3	4.15	4.97
Zinc (mg)	3.0	2.23	2.21
Potassium (mg)	882.1	998.9	899.6
Magnesium (mg)	180.9	171.3	161.8
Vitamin A (µg) [3]	122.0	121.8	121.9
Vitamin E (mg)	1.68	2.76	0.75
Vitamin B1 (mg)	0.3	0.2	0.22
Vitamin B2 (mg)	0.12	0.11	0.1
Niacin (mg)	4.7	6.22	2.77
Vitamin B6 (mg)	0.3	0.25	0.19
Folate (µg)	31.3	29.7	26.4

Appendix 5: Sociodemographic characteristics of the family

Tab. A4: Number of the children in the family

Number of children	Families	
	No	(%)
Only 1 child	3	7.1
2 children	16	38.1
3 children	13	31.0
More than 3 children	10	23.8
Total	42	100.0

Tab. A5: Rank of the child in siblings

Rank of child	Children	
	No	(%)
First child	17	40.5
Second child	13	30.9
Third child	10	23.8
Fourth child	2	4.8
Total	42	100.0

Appendix 6: Acceptability of the snacks

Tab. A6: Acceptability of the snacks

	Mother		Child	
	N	%	N	%
Very good	5	23.8	7	33.3
Good	13	61.9	9	42.9
Acceptable	3	14.3	2	9.5
Bad	0	0	0	0
Very bad	0	0	0	0
Does not know	0	0	3	14.3

Appendix 7: The nutritional status of the two study groups

Tab. A7: The nutritional status of the children in the intervention group

	Boys (n = 14)		Girls (n = 7)	
	No	%	No	%
Stunting (HAZ < -2SD)				
Baseline	2	14.3	1	14.3
End	1	7.1	1	14.3
Wasting (WHZ < -2SD)				
Baseline	2	14.3	0	0
End	2	14.3	0	0
Underweight (WAZ < -2SD)				
Baseline	1	7.1	1	14.3
End	1	7.1	0	0
Overweight (WHZ > 2SD)				
Baseline	0	0	0	0
End	0	0	0	0
Obese (WHZ > 3SD)				
Baseline	0	0	1	7.1
End	0	0	1	7.1

Tab. A8: The nutritional status of the children in the placebo group

	Boys (n = 11)		Girls (n = 10)	
	No	%	No	%
Stunting (HAZ < -2SD)				
Baseline	1	9.1	1	10
End	1	9.1	1	10
Wasting (WHZ < -2SD)				
Baseline	1	9.1	0	0
End	3	27.3	2	20
Underweight (WAZ < -2SD)				
Baseline	0	0	0	0
End	0	0	1	10
Overweight (WHZ > 2SD)				
Baseline	0	0	0	0
End	0	0	0	0
Obese (WHZ > 3SD)				
Baseline	0	0	0	0
End	0	0	0	0

Appendix 8: The nutritional intake of the two groups at baseline

Tab. A9: Energy and nutrient intakes per day of the children in the intervention group at baseline

	Boys (n = 14)		Girls (n = 7)	
	mean ± SD	mean (%)[1]	mean ± SD	mean (%)[1]
Energy (kcal)	824.58 ± 274.6	63.4	777.88 ± 293.6	59.8
Protein (g)	23.42 ± 5.5	146.4	22.04 ± 5.6	137.7
Calcium (mg)	265.4 ± 119.6	33.2	223.1 ± 61.3	27.9
Phosphorus (mg)	369.96 ± 114.8	46.2	345.03 ± 104.4	43.1
Iron (mg)	5.8 ± 1.5	58.0	4.85 ± 1.5	48.5
Potassium (mg)	814.4 ± 249.6	58.2	716.96 ± 230.1	51.2
Zinc (mg)	3.24 ± 0.9	32.4	2.63 ± 0.7	26.3
Magnesium (mg)	122.19 ± 42.6	152.7	94.55 ± 29.8	118.2
Vitamin A (µg)	242.48 ± 83.7	60.6	245.6 ± 97.7	61.4
Vitamin E (mg)	8.38 ± 5.4	139.7	9.17 ± 6.1	152.8
Vitamin B1 (mg)	0.5 ± 0.2	71.4	0.45 ± 0.1	64.3
Vitamin B2 (mg)	1.04 ± 1.2	130.0	0.61 ± 0.2	76.2
Niacin (mg)	4.32 ± 1.5	48.0	3.73 ± 0.9	41.4
Vitamin B6 (mg)	0.51 ± 0.1	51.0	0.41 ± 0.1	41.0
Folate (µg)	86.39 ± 40.6	172.8	78.02 ± 19.5	156.0

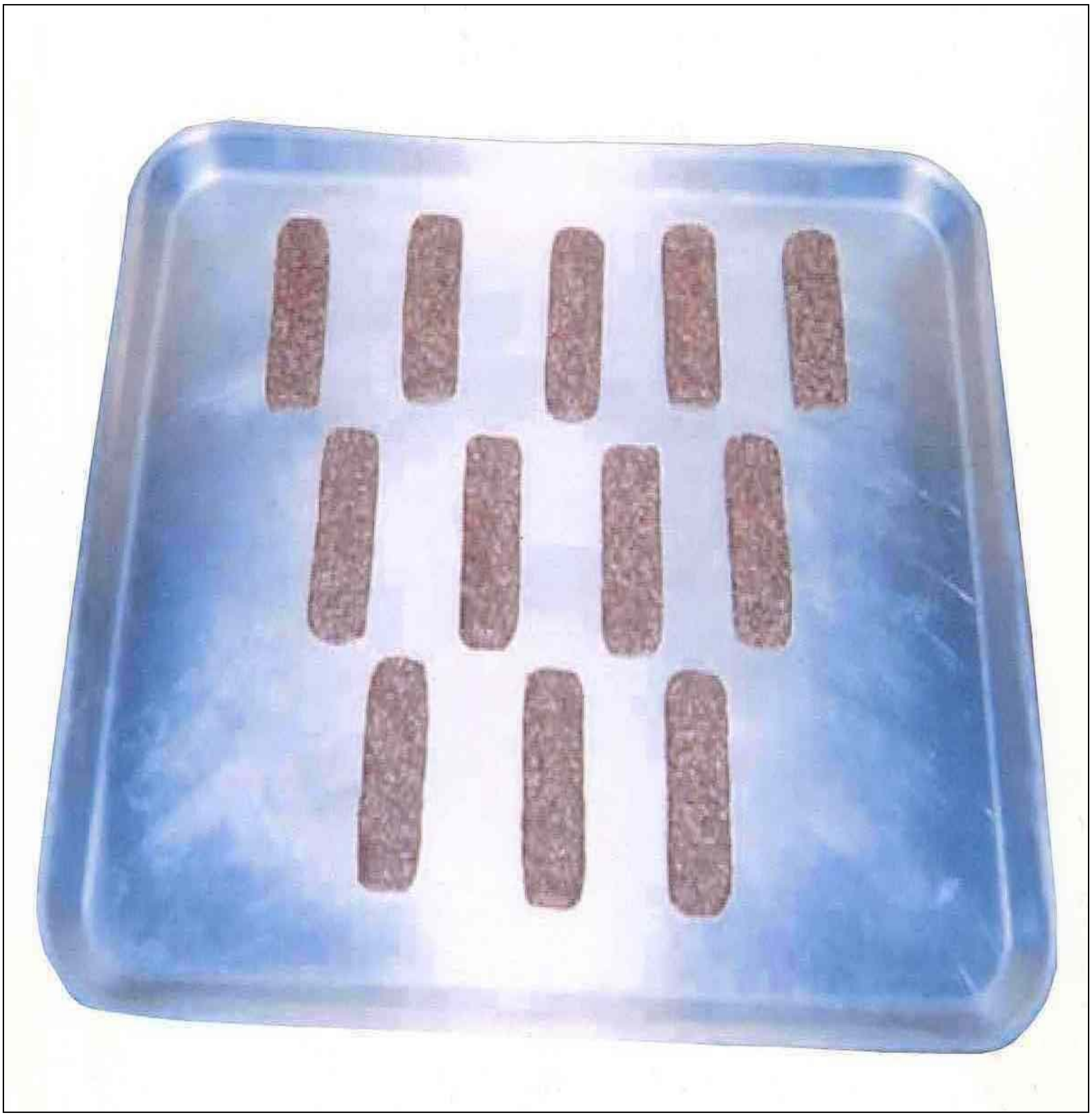
[1] The mean intakes of nutrient in percent of the recommended dietary allowances (RDAs).

Tab. A10: Energy and nutrient intakes per day of the children in the placebo group at baseline

	Boys (n = 11)		Girls (n = 10)	
	mean ± SD	mean (%)[1]	mean ± SD	mean (%)[1]
Energy (kcal)	900.76 ± 188.3	69.3	799.07 ± 169.8	61.5
Protein (g)	25.68 ± 4.7	160.5	27.13 ± 5.5	169.6
Calcium (mg)	298.5 ± 142.1	37.3	262.57 ± 195.3	32.8
Phosphorus (mg)	432.71 ± 117	54.1	424.71 ± 51.5	53.1
Iron (mg)	5.81 ± 1.3	58.1	5.54 ± 1.0	55.4
Potassium (mg)	944.13 ± 222.1	67.4	792.05 ± 213.3	56.6
Zinc (mg)	3.64 ± 0.7	36.4	3.8 ± 0.6	38.0
Magnesium (mg)	126.47 ± 37.4	158.1	125.69 ± 24.9	157.1
Vitamin A (µg)	201.79 ± 91.1	50.4	149.67 ± 66	37.4
Vitamin E (mg)	13.99 ± 10.4	233.2	10.02 ± 8.3	167.0
Vitamin B1 (mg)	0.54 ± 0.3	77.1	0.57 ± 0.2	81.4
Vitamin B2 (mg)	0.72 ± 0.4	90.0	0.96 ± 0.6	120.0
Niacin (mg)	5.15 ± 1.1	57.2	4.63 ± 1.3	51.4
Vitamin B6 (mg)	0.51 ± 0.2	51.0	0.49 ± 0.1	49.0
Folate (µg)	95.84 ± 32	191.7	99.7 ± 26.8	199.4

[1] The mean intakes of nutrient in percent of the recommended dietary allowances (RDAs).

Appendix 9: Sesame snacks



Sesame snacks

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Azza El.Eskafy

Erklärung

Ich erkläre, dass ich die vorliegende Arbeit selbstständig verfasst und keine anderen als die angegebenen Hilfsmittel verwendet habe. Die Stellen, die anderen Werken wörtlich oder sinngemäß entnommen sind, sind als solche kenntlich gemacht. Ich versichere weiterhin, dass die Arbeit in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen hat.

Giessen, Juni 2008

Azza El.Eskafy