NUTRITION, LIFESTYLE AND DIABETES-RISK OF SCHOOL CHILDREN IN DERNA, LIBYA

TAWFEG A. A. ELHISADI

INAUGURAL-DISSERTATION
zur Erlangung des Doktorgrades
im Fachbereich
Agrarwissenschaften, Ökotrophologie
und Umweltmanagement
der Justus-Liebig-Universität Giessen

édition scientifique
VVB LAUFERSWEILER VERLAG

Das Werk ist in allen seinen Teilen urheberrechtlich geschützt.

Jede Verwertung ist ohne schriftliche Zustimmung des Autors oder des Verlages unzulässig. Das gilt insbesondere für Vervielfältigungen, Übersetzungen, Mikroverfilmungen und die Einspeicherung in und Verarbeitung durch elektronische Systeme.

1. Auflage 2009

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Author or the Publishers.

1st Edition 2009

© 2009 by VVB LAUFERSWEILER VERLAG, Giessen
Printed in Germany

édition scientifique
VVB LAUFERSWEILER VERLAG

STAUFENBERGRING 15, D-35396 GIESSEN
Tel: 0641-5599888 Fax: 0641-5599890
email: redaktion@doktorverlag.de

www.doktorverlag.de

Institut für Ernährungswissenschaft

Justus-Liebig-Universität Giessen

Nutrition, Lifestyle and Diabetes-risk of School Children in Derna, Libya

INAUGURAL-DISSERTATION

zur Erlangung des Doktorgrades im Fachbereich

Agrarwissenschaften, Ökotrophologie und Umweltmanagement

der Justus-Liebig-Universität Giessen

eingereicht von

Tawfeg A. A. Elhisadi

aus Libyen

Giessen 2009

Dekanin:	Prof. Dr. I. U. Leonhäuser
Prüfungsvorsitzende:	Prof. Dr. A. Evers
1. Gutachter:	Prof. Dr. M. Krawinkel
2. Gutachter	Prof. Dr. I. Hoffmann
Prüferin:	Prof. Dr. U. Meier-Gräwe
Prüferin:	Prof. Dr. M. Neuhäuse-Berthold

Tag der Disputation: 24.07.2009

Table of contents

Page

Index of figures II

Index of tables III

Abbreviation IV

Symbol IV

1. **Introduction** 1

2. **Literature review** 5

3. **Material and Methods** 10

4. **Results** 15

4.1. Anthropometric Measurements 15

4.2. Dietary Intake (24-h recalls) 24

4.3. Physical activities and television viewing 26

4.4. Height, weight and BMI increment within one year 29

4.5. Nutrition status compared to different references 35

5. **Discussion** 41

5.1. Anthropometric measurements 41

5.2. Dietary Intake (24-h recalls) 47

5.3. Physical activities and television viewing 54

5.4. Height, weight and BMI increment within one year 55

5.5. Nutrition status compared to different references 57

5.6. Diabetes mellitus 62

6. **Recommendation** 64

7. **Summary** 66

Zusammenfassung 69

8. **References** 73

9. **Appendix** 80

Erklärung 94

Acknowledgements 95

Index of figures

			Page
Fig.	1.	Map of work area (Derna municipality)	5
Fig.	2.	Mean weight of boys aged 6 to 9 years.	15
Fig.	3.	Mean weight of girls children aged 6 to 9 years	16
Fig.	4.	Mean weight, urban and & rural districts	17
Fig.	5.	Weight for age, (2000 CDC)	18
Fig.	6.	Mean height of boys aged 6 to 9 years	19
Fig.	7.	Mean height of girls aged 6 to 9 years	20
Fig.	8.	Mean height, urban & rural districts	20
Fig.	9.	Height-for-age, means ±SD (ref. CDC 2000)	21
Fig.	10.	Mean BMI of boys children aged 6 to 9 years	22
Fig.	11.	Mean BMI of girls children aged 6 to 9 years	22
Fig.	12.	Mean BMI (± SD), urban & rural districts	23
Fig.	13.	Comparison of BMI, age groups, boys and girls	23
Fig.	14.	Mean daily intake of boys	25
Fig.	15.	Mean daily intake of girls	25
Fig.	16.	Comparison of the nutrient intake	26
Fig.	17.	Time spent for various activities by boys	27
Fig.	18.	Time spent for various activities by girls	28
Fig.	19.	Comparison of time spent for various activities, boys & girls	28
Fig.	20.	Increment of weight gain within one year among boys	30
Fig.	21.	Increment of height gain within one year, boys	30
Fig.	22.	Increment of BMI gain within one year, boys	31
Fig.	23.	Increment of weight gain within one year, girls	31
Fig.	24.	Increment of height gain within one year, girls	32
Fig.	25.	Increment of BMI gain within one year, girls	32
Fig.	26.	Comparison of height gain (within one year , boys & girls	33
Fig.	27.	Comparison of weight gain (kg) increment, boys & girls	33
Fig.	28.	Comparison of BMI gain (kg/m^2) increment, boys & girls	34
Fig.	29.	Height for age, girls (WHO 2007 & CDC 2000)	36
Fig.	30.	Height for age, boys (WHO 2007 & CDC 2000)	37
Fig.	31.	Weight for age, girls (WHO 2007 & CDC 2000)	37
Fig.	32.	Weight for age, boys, (WHO 2007 & CDC 2000)	38
Fig.	33.	BMI for age, girls (WHO 2007 & CDC 2000)	38
Fig.	34.	BMI for age, boys (WHO 2007 & CDC 2000)	39
Fig.	35.	Comparison <-2SD, (CDC 2000 & WHO 2007),boys & girls	39
Fig.	36.	Comparison >+2SD (CDC 2000 & WHO 2007)	40

Fig. 37. Underweight & overweight, Libyan & Qatari boys 42
Fig. 38. Underweight & overweight, Libyan & Qatari girls 42
Fig. 39. Underweight & overweight, Libyan & Saudi children 43
Fig. 40. Underweight & overweight, Libyan & Kuwaiti boys 44
Fig. 41. Underweight & overweight, Libyan & Kuwaiti girls 44
Fig. 42. Comparison of mean carbohydrate & fat intake 49
Fig. 43. Energy & macronutrient intake, Libyan children, % of RDA 49
Fig. 44. Intake of vitamins in percent of RDA 50
Fig. 45. Comparison, height increment, 1989 & 2006 studies 57
Fig. 46. Comparison, z-score for w/a, boys & girls, (WHO 2007) 59
Fig. 47. Comparison z-score for h/a, boys & girls) (WHO 2007) 59
Fig. 48. Comparison z-score for w/h, boys & girls (WHO 2007) 60
Fig. 49. Underweight & overweight, Libyan, Qatari, & Kuwaiti boys 61
Fig. 50. Underweight & overweight, Libyan, Qatari & Kuwaiti girls 61
Fig. 51. Derna Municipality - Libya 80

Index of Tables

Tab.1: Age and sex of the study children 81
Tab.2: Mean weight ±SD, both sexes, aged 6 to 9 years 81
Tab.3: Weight/age, boys & girls, means ±SD (CDC 2000) 82
Tab.4: Underweight & overweight, rural & urban (CDC 2000) 82
Tab.5: Mean height ±SD, both sexes, aged 6 to 9 years 83
Tab.6: Height/age, boys & girls, means ±SD (CDC 2000) n 83
Tab.7: Stunting in rural & urban children (CDC 2000) 84
Tab.8: Mean BMI ±SD, both sexes, aged 6 to 9 years 85
Tab.9: Macronutrient composition of the diet at different classes. 86
Tab.10: Trend, energy intake, Middle East Countries, 1971-97 87
Tab.11: Twenty-four-hour dietary recall data, boys and girls 88
Tab.12: Mean daily activity hours, boys 89
Tab.13: Mean daily activity hours, girls 89
Tab.14: Anthropometric data change within one year, boys 90
Tab.15: Anthropometric data change within one year, girls 90
Tab.16: Pooled data: HAZ, girls, (WHO 2007 & CDC 2000) 91
Tab.17: Pooled data: HAZ, boys (WHO 2007 & CDC 2000) 91
Tab.18: Pooled data: WAZ, girls (WHO 2007 & CDC 2000) 92

Tab.19: Pooled data: WAZ, boys (WHO 2007 & CDC 2000) 92
Tab.20: Pooled data: BMIZ, girls(WHO 2007 & CDC 2000) 93
Tab.21: Pooled data: BMIZ, boys (WHO 2007 & CDC 2000) 93
Tab.22: Overweight & underweight, (WHO 2007 & CDC 2000) 93

Index of terms and abbreviations

w/a	Weight for Age
h/a	Height for Age
CHD	Coronary Heart Disease
NCHS	National Center for Health Statistics
CDC	Center for Disease Control and Prevention
BMI	Body Mass Index
WHO	World Health Organization
NHANES	National Health and Nutritional Examination Survey
NHMR	National Health and Medical Research Council
RDA	Recommended Dietary Allowances
NRC	National Research Council
PHV	peak height velocity
PWV	peak weight velocity
ENA	Emergency nutrition assessment

Symbols

Kg	kilogram
g	grams
Kcal	kilocalorie
SD	Standard deviation

1. Introduction

1.1. Aim of the study

Due to lack of anthropometric data of schoolchildren and adolescents in Libya (1), this study is the first documentation of the growth of elementary school children in Derna and the surrounding area. It was initiated to:

- Present data that can serve as a growth reference for local school children.
- Assess the growth pattern and nutritional status of children by using anthropometric indices of height, weight and BMI with age and comparing them with the 2000 Centers of Disease Control (CDC) and 2007 World Health Organization (WHO) references.
- Investigate the prevalence of overweight, underweight and stunted children among Libyans aged 6-9 years.
- **1.2. Location**

The Libyan Arab Jamahiriya, situated in North Africa, it is extends over 1,759,540 square kilometers. It is the 17th largest nation in the world by size. It is bound to the north by the Mediterranean Sea, the west by Tunisia and Algeria, the Southwest by Niger, the south by Chad and Sudan and the east by Egypt. The population is relatively young, mostly urban and concentrated on the coastal area. At 1770 kilometers, Libya's coastline is the longest of any African country bordering the Mediterranean (2).

1.3. Population Indicators

The Libyan total population is about 5,765,563 (est. July 2005). The Libyan population is relatively young, with 33% under 15 years of age. Over the last 30 years, Libya's population has grown rates of about 2-3 % per year. However, population growth takes place only on the urban areas while the rural population shows a slight decline. Average population density varies from 150 inhabitants/km² in the northern regions to less than 1 inhabitant/km² in the rest of the country. About 75% of the population is concentrated in 1.5% of the country, mainly in the coastal areas; the population is essentially urban (2)

1.4. Climate

The climate is mostly dry and desert-like in nature. However, the northern regions enjoy a milder Mediterranean climate. The Mediterranean coastal strip has dry summers and relatively wet winters. Annual rainfall is extremely low, with about 93% of the land surface receiving less than 100mm/year. The highest rainfall occurs in the northern Tripoli region (Jabal Nafusah and Jifarah Plain) and in the northern Benghazi region (Jabal al Akhdar). These two areas are the only ones where the average annual rainfall exceeds the minimum value considered necessary to sustain rain-fed agriculture (250-300 mm). Average annual rainfall for the country as a whole is 26 mm (2).

1.5. Libyan Foods

Libyan cuisine is a mixture of Arabic and Mediterranean with a strong Italian influence. A famous local dish is Couscous, which is a boiled cereal (traditionally millet, now fairly often wheat). Couscous is used as a base for meat and potatoes. The meat is usually mutton, but chicken is served occasionally. Lamb, in various forms, is the most widely eaten meat dish though in recent times beef has become more common. Meals in Libya often end with fruit. No alcohol is drunk in Libya. There is a considerable production of local mineral water of high quality as well as soft drinks and local and imported fruit juices. Milk is consumed mainly for breakfast, with increased consumption in the month of Ramadan. Usually, there are three meals a day. Breakfast is usually a light meal –tea with milk and bread with cheese, honey or eggs. Lunch is the main meal for most people; the lunch in Libya is between 2:00 and 3:30 p.m. The dinner in Libya is usually soup, pasta, or macaroni. Libyan prefers to eat at home, except on Fridays, when they enjoy family beachside picnics. Libyan tea is a thick beverage served in a small glass; green tea is very popular in Libya, often accompanied by mint or peanuts. People drink tea hot with cream. Libyan coffee is thick, black and sweet.

1.6. Education

In Libya, education is free to everyone from elementary school right up to university and post-graduate education, both in Libya and abroad. Pre-university education is divided into elementary, intermediate, and secondary education. Schools are

everywhere. According to the education system in Libya, it is mandatory that all children at age 72 months should be enrolled in elementary schools and hence these schools represent the population of children at this age. The rate of attendance in elementary, secondary and high school is about 92% (3). In Derna, first to third classes last between 14:00 to 17:00 pm and fourth class lasts from 8:00 am to 13:00 pm. There is a dearth of information relating to the anthropometric evaluation of school children in Libya. Although these studies are worth mentioning, most of them focused on Tripoli and Benghazi, and it is important to note that no extensive growth study except Tripoli and Benghazi has been published.

1.7. Economy

Libyan's economy, which remains largely state controlled and heavily dependent on the oil sector, grew solidly in 2003/2004, reflecting favorable developments in world oil markets (4). The oil sector contributes practically all export earnings and about 25% of the GDP. The non-oil manufacturing and construction sectors have expanded from processing mostly agricultural products to including the production of petrochemicals, iron, steel, and aluminum (FAO, 2005a). The public sector plays a dominant role: to absorb the labour force resulting from to the growth of the working-age population. This is needed because the government increased public sector employment. The country is in isolation, resulting in part from the United Nation' sanctions imposed until April 1999 has hampered economic development (5). Oil earning constituted about 95% of the Libyan exports' value and 60% of budgetary revenue in 1997-2002. Animal production contributes approximately 30% of the total agricultural production, providing meat, milk, dairy products and eggs. Wheat and barley are the most important cereal crops in Libya. All agricultural development plans since 1970 have invested considerable effort in their development in order to increase production to achieve self–sufficiency and food security (6).

1.8. Municipalities

Derna is one of the municipalities of Libya. It is located in the northeast of the country. It is about 300 Km east of Benghazi, the second largest city in Libya. Derna has a shoreline on the Mediterranean Sea. On land, it borders the following municipalities: Al-Qubah- east and south, Al-jabal alakhtar municipality on the west,

and Mediterranean Sea on the north. Derna is divided into eight administrative areas: Aljibila area (4 primary schools), Bomansour area (7 primary schools), Saheel area (6 primary schools), Makar area (7 primary schools), Karsa area (2 primary schools), Raselhilal area (2 primary schools), fataih area (3 primary schools) and Al bilad area (0 schools). The overall Population of Derna is 105,932 (2005 census) and the area is 4908 km² (Derna municipality, unpublished report, 2005). Figure 1 shows the relative regional population distribution (map of work area).

1.9. Nutritional status for schoolchildren was assessed to:

- Describe dietary habits of Libyan children attending primary school in Derna and the surrounding area.
- Determine the extent to which children are meeting the dietary recommendation.
- Identify major food intake patterns and assess nutrient intakes associated with those patterns.
- Define the nutritional quality of the Libyan diet.
- Provide a basis for strategies to improve dietary consumption and to maximize health and minimize diet-related diseases in Libya.
- Look at lifestyle factors related to nutrition and physical activities which may influence on children and adolescents.
- Assess the risk factors for diabetes such as dietary habits, physical activity and body mass index (BMI) amongst school children.
- Develop a source reference for school children in Libya.

2. Literature review

The age of 6-10 years is a period of growth and at this stage, the foundation for adulthood is laid down. Hence, the nutritional deprivation during this period may influence the adult size and capabilities of the individual at later stages of life (7). Diabetes mellitus is a chronic disease which needs continuous medical care to prevent long-term complications. More than 135 million people worldwide have diabetes and their number is expected to reach approximately 300 million by 2025.

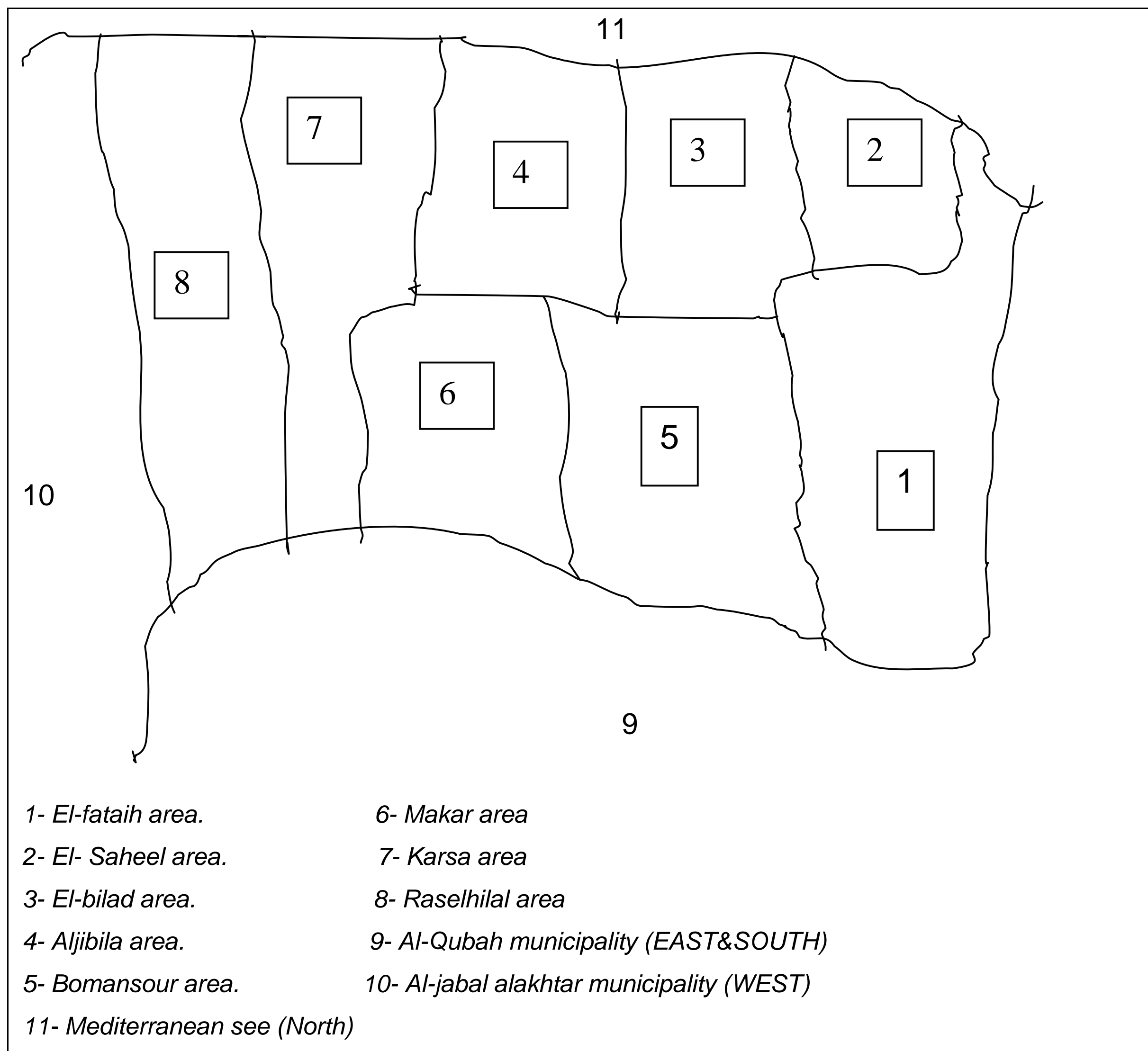

Figure1: Map of work area (Derna city)

Approximately 10% off all cases would have type I diabetes and 90% would have type II diabetes. With 1.7 children *per* 1000 afflicted with the disease, diabetes is second only to asthma in the prevalence of chronic childhood illnesses in the United States. In Libya, a survey carried out in 1998/1999 reported that diabetes is emerging as an important public health problem with a prevalence slightly higher in urban than in rural areas (14.5 vs. 13.5%). Associated risk factors with diabetes and glucose tolerance were age, family history of diabetes, hypertension, and hypercholestolaemia (8). In developing countries, diseases related to environmental sanitation, poverty, nutrition, and metabolic disorders were the known major morbidity and mortality problems in the past (9). Recently, some of these countries have witnessed a revolutionary change in their socioeconomic development and, consequently, there is an abundant supply of food, available health services, and an adoption of lifestyle similar to those found in urban cities of developed countries (10, 11). The nutritional habits of the people of the Arabian countries, including Libya, have changed dramatically during the past 30 years as results of the increase in income from oil revenue. The consumption of traditional foods such as rice, fish, dates and vegetables has gradually decreased and the meal patterns have become diversified with more intakes of meat, chicken, eggs, milk, fats, sugar and canned foods (12). Nutritional status is defined as the nutritional state of individual, or community (13). Several methods have been used for estimating dietary intake, including the direct weighing of foods consumed, food diaries, general dietary histories and 24-h dietary recall.

However, food weighing is accurate only for small samples, food diaries may lead to changes in dietary habits, and general histories may be affected by recall bias. Of the above-cited methods, the most widely used has been the 24-h recall due to its practicability; however, these methods may be affected by a number of different measurement errors. Food intake and morbidity are the two main proximal determinants of childhood malnutrition; intake is usually assessed through the 24-h recall method (14). The excess need for food and the great change in the life style and nutritional habits especially in the primary school children has put them at higher risk of malnutrition (15). Malnutrition continues to be a major public health problem

throughout the developing world, particular in southern Asia and sub-Saharan Africa (16). Malnutrition is a major public health problem that affects million of children worldwide (17). The two main forms of malnutrition among children worldwide are anemia and stunting (h/a <-2 standard deviations (SD) below the CDC international growth reference). In 2000, 32.5% of children under 5 in developing countries were stunted (18). In a study carried out in the Sahara, the prevalence of stunting was already 22% in the 0- to 6-month age group, and it increased up to 56% in the fourth year of life (36-48 months). This indicates that the process had been continuing on up to four years of age (19). Factors that contribute to the malnutrition are low socioeconomic status, low health and nutritional awareness, inadequate access to health services, limited availability of a variety of foods, food insecurity in rural areas, recurrent diarrhea, and respiratory infections (20). Childhood nutrition is known to have a considerable impact on children's health. Protein and fat are the two most important macronutrients with high impact on children's growth and energy provision (21). Growth failure may be caused by inadequate intakes of one or more nutrients including energy, protein, or micronutrients such as iron, zinc and vitamins A, C, or D. For some of these nutrients, such as zinc and phosphorus, the sign of deficiency during childhood is specifically growth retardation (22). Assessing the nutritional status of groups of children is an essential part of monitoring the health of a community (23). Often coexisting in developing countries with under-nutrition is obesity. Obesity is a complex condition with serious social and psychological dimensions, affecting virtually all ages and socioeconomics groups. Malnutrition and other childhood diseases during the growth period can result in moderate to severe stunting (h/a <-2 SD) (24). Overweight and obesity are well-known risk factors for a wide range of chronic noncommunicable diseases (25). Several reports show increasing rates of obesity in developed countries, whereas the extent of the problem in developing countries remains unknown (26). Childhood obesity is an increasing public health problem. Researchers showed an association between obesity in childhood and high prevalence of blood pressure, diabetes, respiratory disease and orthopedic and psychosocial disorders (27, 28). Many studies have shown that obesity increases the risk of coronary heart disease (CHD), hypertension, type II

diabetes, and gallbladder disease (29, 30). Obesity at an early age may constitute risk factors for development of morbid conditions later on life (31), which is less malleable to intervention than obesity in adults (32). Overweight describes excess of body weight. Body weight is reasonably correlated with body fat but is also highly correlated with height, which is weakly correlated with body fat. Therefore, weight adjusts for height is a far more useful index with which to assess overweight and is a reasonable indicator of fatness. Weights adjust with height squared, or body mass index (BMI, in kg/m^2), is now used widely to determine if an adult is overweight (33). BMI in childhood changes substantially with age. At birth the median is as low as 13 kg/m^2, increased to 17 kg/m^2 at age 1, decreases to 15.5 kg/m^2 at age 6, then increases to 21 kg/m^2 at age 20 (34). In many studies, BMI is the single measure used to estimate the prevalence of overweight in children. Although BMI-for-age is a simple measure, height and weight do not grow linearly throughout childhood, and a given BMI may predict a different body composition at different age (35). Anthropometric parameters are important indicators of health and nutritional status of children (36). The analysis of anthropometric indices weight-for-age (w/a) and height-for-age (h/a) for each sex group provides sensitive indicators of health and nutritional status of a given population. It is widely accepted that for practical purposes, anthropometry is the most useful tool for assessing the nutrition status of children (37). Anthropometric measurements should be reported in relation to international reference values. For this purpose it was recommended that the reference population defined by the United States (US), the National Center for Health Statistics-Center for Disease Control (NCHS-CDC) should be used (38). The NCHS growth chart are used in many parts of the world, in 1985, the NCHS began a process to revise the 1977 NCHS chart using improved statistical procedures and incorporated additional data from the second and third National Health and Nutritional Examination Survey (NHANES) (39). In May 2000 the U.S. CDC released new growth chart to replace the 1977 NCHS reference. Anthropometric studies can provide reliable information needed by both nutrition planners and administrations. Growth pattern as determined from height, weight and other anthropometric measurements reflects the nutrition status of population's health when compared with the reference (40). Weight-for-age

(w/a) is the most widely used indicator of child nutritional status in developing countries. The (w/a) of children relative to the “international growth reference” established by the US CDC chart declares that Children who fall below -2 standard deviations are classified as moderately to severely undernourished. In developing countries 30%-50% of children fall into this category (41). Although many countries have charted their growth reference standard, in Libya, such studies were few (42). Health and nutritional problems during childhood are the result of a wide range of factors like insufficient food intake (43) and/or several repeated infections, particularly affecting the low income group (44). A healthy child is not only a child with no clinically apparent illnesses, but a child with adequate physical development, both in terms of achieved size and acquired motor skills and with adequate neurological, psychological and emotional development (45). Several studies suggest that an active lifestyle during childhood and adolescence can play an important role in optimizing growth and development (46, 47). The condition of being Overweight has been associated with an increase in sedentary activities, such as watching television. In Third NHANES, children interviewed between 1988 and 1994 and reporting watching ≥4 hours of television had on average higher BMI than children who reported watching <2 hours of television ($p<0.001$). Watching television has been positively associated with excess body weight among both children and adults (48). The CDC recently recommended comprehensive school and community programs to promote physical activity among children and adolescents. The goals is to increase knowledge about activity, and exercise, develop behavioral and motor skills that promote lifelong activity, and encourage physical activity outside (49). Physical activity is also important for physical growth and development of skills during childhood. Health in later life is supported since physical activity patterns developed in early life carry on to adulthood. Physical activity guidelines for children and adolescents recommend 1 hour of moderate to vigorous physical activity every day for 5-18 year old (50). Television viewing is a highly prevalent sedentary activity in the United States; on average Americans watch at least 4 hours of television each day (51), and television viewing is the most time-consuming activity nationally, after work and sleep (52).

3. Material and methods

3.1. Study population

Libyan has three school levels before university: elementary school (6 years), intermediate school (3 years), and secondary school (3 years). The list of elementary schools in Derna municipality was obtained from the Ministry of Education in Derna. The total number of elementary public schools was 31 at the time of study, with 24 schools in the urban community and 7 schools in rural community. At the start of school year 2005/2006 in September, the number of students registered in the primary schools of age group 6-9 years (72-108 months) in Derna municipality was 7,527 from first to fourth class (Derna Ministry of Education, unpublished report, 2005). Elementary schools contained 363 classes. These classes were divided into the first level which contained 93 classes, the second level which included 86 classes, the third level which included 92, and the fourth level which included 92 classes. Permission for the study was obtained from the Ministry of Education in Libya. Most of the schools in Derna are combine-sex schools from class one to class three. Therefore, an equal number of boys and girls were represented. A cross-sectional study was carried out to asses the anthropometric measurements among elementary school children aged 6-9 years. This cross-sectional study reports on the findings of a very large scale sample. It was conducted between school year 2005/2006 for first measurements and 2006/2007 for the second measurements. A cross-sectional growth survey was conducted using a multistage stratified random sampling from 31 schools, as clusters, selected systematically from all elementary schools. The children were selected from each school from school records by a random sampling. A class list of boys and girls was used to obtain samples. The selection procedures allowed representation of about 50% of the target population in the class. The target sample size included 3,879 students that were randomly selected from the Derna and the surrounding area as defined previously. Only Libyan children were included in the survey so, therefore, all were of the same ethnicity. The number of boys was 1,937 (49.9%) and the number of girls was 1,942 (50.1%). This constitutes approximately 51.5% of the target population registered in the primary school from 6-9 years. The minimum number of children in each age category was

430. Table 1 represents the distribution of children according to age and sex. This age range was chosen for practical and physiological reasons. By age 6 years the adiposity rebound occurs, following the nadir of the BMI curve. This age range is also likely a favorable period for prevention strategies (53). Weight and height measurements were repeated in the same population after one year. All measurements were performed at the school's premises.

3.2. Measurements

Children were weighed on an electronic personal scale without shoes in single layer of indoor clothing. Each child's was measured to 100 g. To minimize errors in measurement, weighing scales were checked before each session as the unloaded scale registers zero. Height measured to the nearest 0.1 cm with a portable stadiometer. For measuring height, we fixed a calibrated ruler to the wall. The students stood straight, bare-footed with heels with their back, heads and shoulder touching the ruler. The horizontal indicator of the stadiometer was then lowered until it was firmly touching the peak of the head. Height was measured in centimeters and later converted to meters. The weight and height were converted to nutritional indices according to (w/a) and (h/a) based on the percentage of reference median used in the 2000 US CDC standard. This has been recommended by US Center for Disease Control and Prevention as an international reference standard. The source of reference population to which comparisons were made was the 2000 CDC data as recommended by Nutrition Unit of the World Health Organization (WHO) (54). BMI was calculated by divided the weight, measured in kilograms, by the square of height, measured in meter (kg/m^2). The formula is: BMI (kg/m^2) = weight (kg) / [Height (m)]^2. Overweight is defined as body mass index for age z-score >+2SD. Underweight is defined as weight-for-age (w/a) was classified with z-score <-2SD. Stunting is defined as height-for-age (h/a) with z-score <-2SD. The BMI was calculated for each age and gender. Data analysis was performed using the Nutrisurvey® program (2005). The diet survey was conducted using a questionnaire in Arabic language, including the 24-hour-recall as well as food frequency questionnaire (FFQ) which consisted of listing all food and beverages consumed during the previous 24 h. The questionnaire contained a list of different food items and enough space for adding food that was

consumed at school and home, but not listed. The food groups were defined as cereal products (bread, rice, pasta, macaroni, etc), milk and milk products; meat (red meat and poultry), fish, eggs, fat and fat products (butter, margarine, mayonnaise, and oil), vegetables, fruits and sweets (chocolate, ice cream, and cakes). The portion sizes were either typical or natural portions (e.g. slice, piece, cup, glass, etc.) The questionnaire also inquired about physical activities for the day. The questionnaire was distributed and explained to the students by their class teachers. The students were asked to pass on the questionnaire to their parents were also conducted. Each participant recorded everything they ate and drank and returned the questionnaire the next day. A total of 550 school children aged 6-9 year-old (boys and girls) were selected from the first to fourth class primary school from seven different regions of Derna, for assessment food intake through the 24-h recall. When any discrepancy was suspected or incomplete answers or the questionnaire was not returned by any subjects, the subject was excluded from the study. It was for this reason that 43 (7.8%) subjects in this study were excluded from further analyses. The total number of questionnaires analyzed for physical activities and 24-h recall was 507 participants. Mean energy, macronutrient and selected micronutrient intakes were determined for meals consumed at home as well as at school. The questionnaire included: student's name, age, family income, region, physical activity hours (play, TV watching, sleep hours, study hours and video games) dietary intake by means of 24-hr recall, and food frequency. Anthropometric measurements and nutrient content in foods were analyzed using Nutrisurvey®. This software was designed for by the Group on International Nutrition of the University of Hohenheim/Stuttgart in cooperation with the German Agency for Technical Cooperation (GTZ). The software is based on the *Guidelines for Nutrition Baseline Survey in Communities* published by GTZ. The purpose of the program is to integrate all steps of nutrition base line survey into a single program. The program contains a standard Nutrition Baseline questionnaire which can be easily customized for the specific site, a function for printing out the questionnaire, a data entry unit which controls the data being entered, a specially adapted plausibility check, a report function, and a graphics section. The report function produces the full set of descriptive statistics of a baseline survey. The

graphics section contains standard graphs and additional graphics for the anthropometric indices with comparison to the 2000 CDC standard. The anthropometric indices (height-for-age, weight-for-age and weight-for-height was calculated as z-score). The prevalence of stunted, wasted, underweight and overweight of children is calculated automatically. For further statistical evaluation, the data can be exported to SPSS or other statistical program. The data for boys were compiled separately from those of girls and statistical analyses were performed using Microsoft Excel and statistics package for social science (SPSS). Descriptive statistics was carried out where frequencies were calculated for all questions. Comparisons between sexes and place of residence (urban and rural) were also done. The chi-squared (X^2) test to compare proportions and *t*-test to compare means were calculated. $p<0.05$ was used for the level of significance for height-for-age, weight-for-age and BMI for boys and girls. Data were then compared with the 2000 CDC recommended standard. Nutritional status condition was calculated using cut-off points for height-for-age and weight-for-age. The cut-off points can be set using z-score, percentile, or percentage of the mean (±SD). Low height-for-age and low weight-for-age as established by <-2 SD for group of children. This study also compared the 2007 WHO update reference. (In April 2006 the WHO released new standards for assessing the growth and development of children from birth to 5 years. In 2007, the WHO merged the data from 1977 NCHS with data from under five growth standard to smooth transition between two samples as a growth reference for school-aged children and adolescents.) Growth performance of school children was assessed according to both references.

3.3. Data analysis

The data utilized for this study were collected by visiting 31 elementary public schools of seven different zones in Derna municipality. The Statistical Packages for the Social Sciences (SPSS), version 13.0, PC windows was used for data analysis. Mean, median and standard deviation (SD) of the anthropometric data obtained from 6-9 years-old children were calculated for each age group. The descriptive statistics and X^2 test were used to assess the association between categorical variables. The

student's *t*-test was used to compare the mean weights, heights and BMIs of boys and girls. A *p* -value of ≤0.05 was the criterion of statistical significant. The same data of all children were also entered in Microsoft Excel 2003. Graphs were drawn using Microsoft Excel program. The statistical software Nutrisurvey® program (2005) was used to process the data. The anthropometric indices (h/a), (w/a) and BMI-for-age were calculated and compared with 2000 CDC reference population and SPSS package was used to calculate weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ) and body mass index z-scores (BMIZ) as was used in the 2007 WHO reference. The mean and standard deviation of z-score of height, weight and BMI and the percentage of underweight, stunted, and overweight children were calculated for each reference. The weight and height were converted to nutritional indices- (w/a), (h/a), and BMI- based on percentage of reference median using the US 2000 CDC and 2007 WHO reference. The mean values of food and nutrients intakes of children were calculated separately for each age group. The z-score was used to classify children into categories of nutritional status. Stunted children are defined as those that fall below -2 SD for height-for-age. Underweight children are defined as those who fall below -2 SD for weight-for-age. The age groups were defined as follows: the six-year (72 months) group included 6.0 years to 6.99 years and the seven-year (84 months) group included 7.0 years to 7.99 years, and so on.

4. Results

Nutritional status, especially in children, has been widely and successfully assessed by anthropometric measures in both developing and developed countries. Height and weight are the most commonly used measures, not only because they are rapid and inexpensive to obtain, but also because they are easy to use. The anthropometric data (weight and height) was entered and analyzed using Nutrisurvey and Emergency Nutrition Assessment (ENA) 2008. Weight and Height were measured and used to calculate the anthropometric indicators (w/a) and (h/a). These indicators were compared with 2000 CDC reference population and 2007 WHO.

4.1. Anthropometric measurements

4.1.1. Weight for age (w/a)

Weight-for-age reflects of body weight relative to age and is influenced by recent in health or nutritional status. This study was the first that estimated prevalence rates of overweight and underweight children among a representative sample of school children from urban and rural areas in Derna, Libya. The study analyzed the data of 3,879 students, with 49.9% boys and 50.1% girls. The range for the weight of boys was 12.40 to 59.40 kg with a mean of 25.00 kg (± 5.6). The mean weight of boys aged 72, 84, 96 and 108 months were 21.1±3.5, 23.8 ± 4.0, 26.4 ± 5.1 and 29.7 ± 6.0 kg respectively, as shown in figure 2.

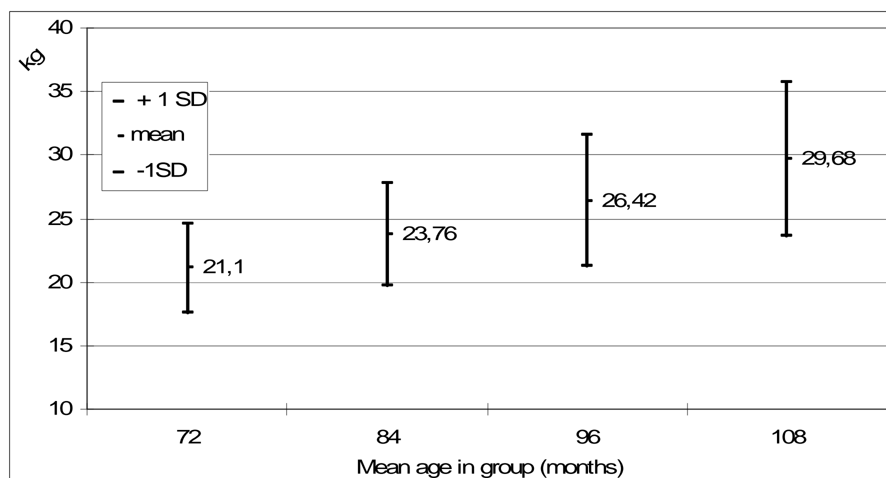

Figure 2: Mean values of weight of boys children aged 6 to 9 years.

The range of the values for weight for girls was 13.70 to 59.20 kg with a mean of 24.60 kg (± 5.7). The mean weight of girls aged 72, 84, 96, and108 months were 20.9 ± 3.3, 23.2 ± 4.2, 26.1 ± 4.9 and 29.2 ± 6.4 kg respectively, as shown in figure 3.

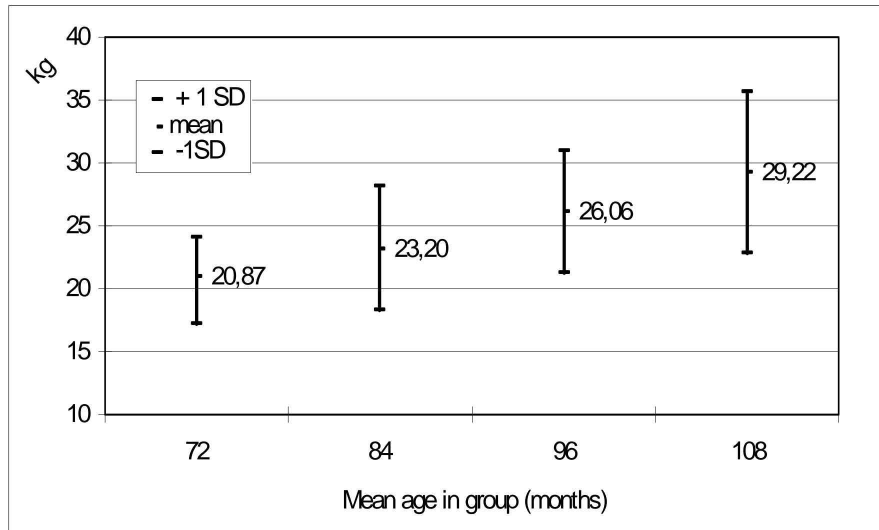

Figure 3: Mean values of weight of girls children aged 6 to 9 years.

The weights of boys were significantly higher than that of girls in all age groups (p=0.03). The mean weight for urban children and rural children (both sexes) was 24.8 and 24.4 kg respectively. The mean weights for urban and rural boys were 25.0 and 24.9 respectively, while the values of mean weight for urban and rural girls were 24.7 and 24.0 respectively, as shown in figure 4. There is a gradual and a steady increase in weight with increasing age. This study shows the distribution of weight for age (w/a) on the 2000 CDC. Table 2 reveals the sample size and their mean weight with corresponding standard deviation (±SD) of the population samples classified by age and sex.

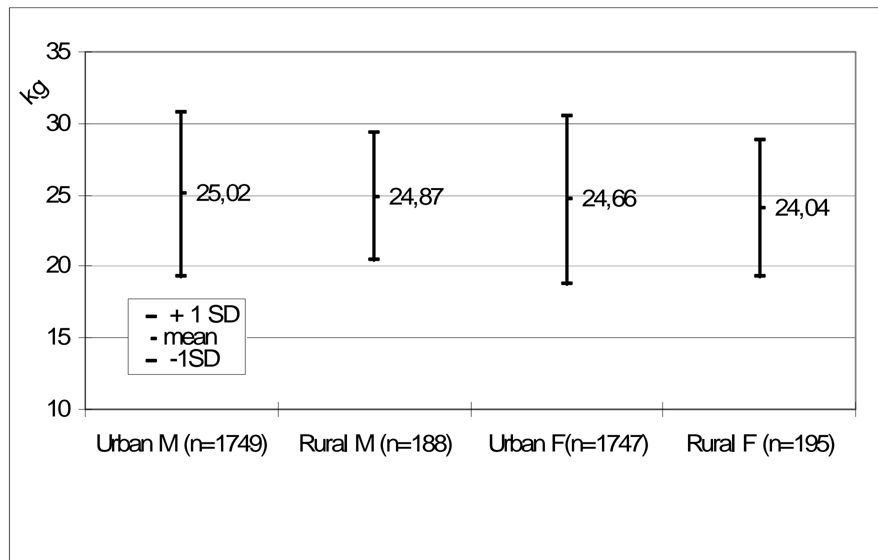

Figure 4: Mean of anthropometric variable of weight (± SD) of school children in urban and rural districts.

Table 3 shows the comparison of prevalence of underweight (<-2 SD) and overweight (>+2 SD) of (w/a) among two groups compared with 2000 CDC. There were 2.6% of children both sexes below -2 SD of the CDC median reference value for (w/a), which is indicator of undernutrition, and 3.2% for boys and 2.1% for girls were above the cut-off point of +2 SD, which indicates overweight, with values slightly higher for boys than for girls, as shown in figure 5. Table 4 reveals to the nutritional status (w/a) of girls and boys in two zones (rural and urban) according to 2000 CDC reference population.

The children with a Z-score outside the range from -6 to +6 SD were excluded from the analysis.

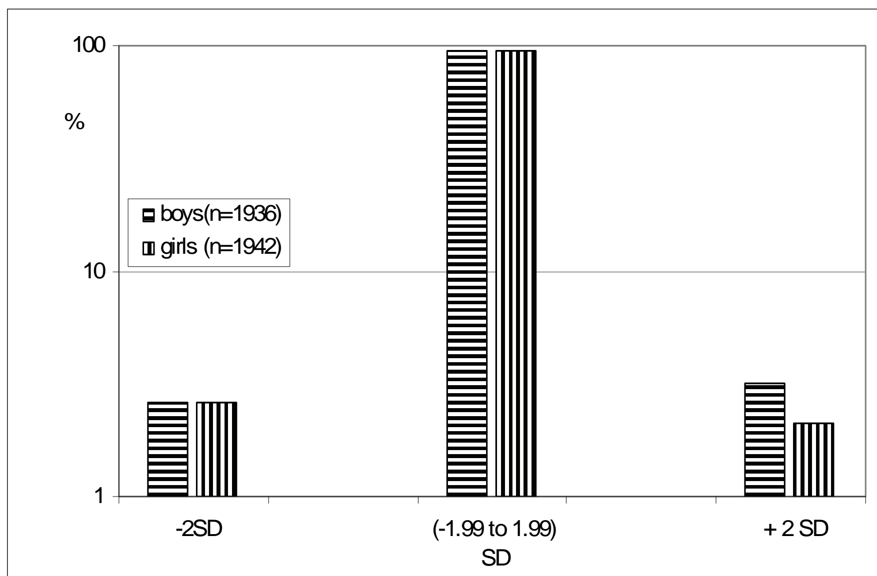

Figure 5: Weight for age of children in each groups expressed as ±SD reference values as based 2000 CDC.

4.1.2. Height for age (h/a)

Height and weight are important indicators of the health and nutritional status of children and adolescents. Waterlow *et al.* recommended that, for the assessment of nutritional status in cross-sectional studies, primary reliance should be placed on height-for-age as an indicator of the past state of nutrition and weight-for-age as an indicator of the present state of nutrition (55). The values of mean height range for boys were 103 to 160 cm with a mean of 123.8 cm (±8.2). The mean height of boys aged 72, 84, 96 and 108 months were 115.0 ± 5.0, 121.80 ± 5.4, 127.2 ± 5.5 and 132.2 cm ± 5.9 respectively, as shown in figure 6.

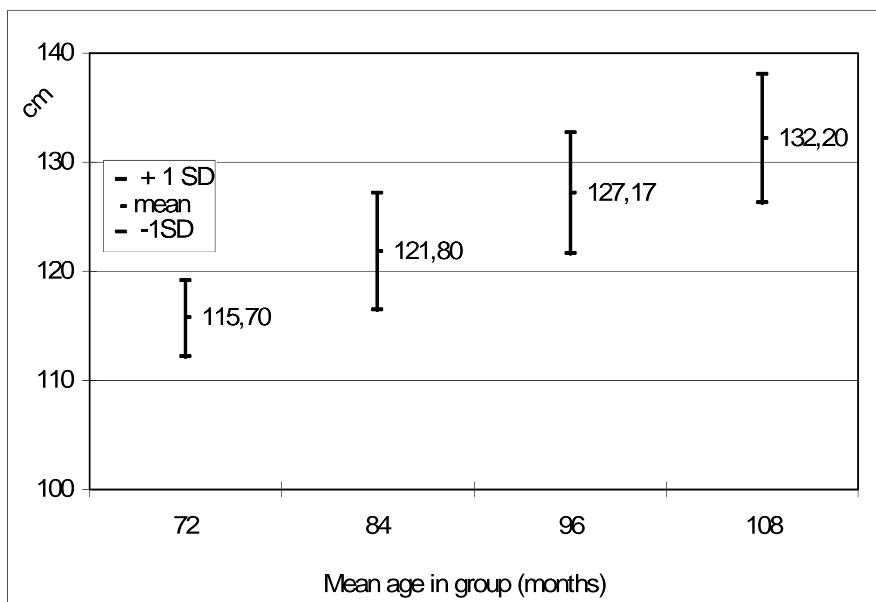

Figure 6: Mean values of height of boys children aged 6 to 9 years.

The height ranges of girls were 102 to 153 cm with mean value of 122.9 ± 8.2 cm. The mean height of girls aged 72. 84, 96, and 108 months were 115.7 ± 5.6, 120.4 ± 5.4, 126.0 ± 5.7 and 131.3 cm ± 6.1 respectively, as shown in figure 7. Table 5 gives the number of boys and girls in different age groups and their mean height with corresponding standard deviation (± SD). The range of the boys' heights is between 115.70 and 132.20 cm and the range of the girls' heights is between 115.68 and 131.35 cm. The heights of boys were significantly higher than that of girls in all age groups (p= 0.001). There is a gradual and a steady increase in height with increasing age.

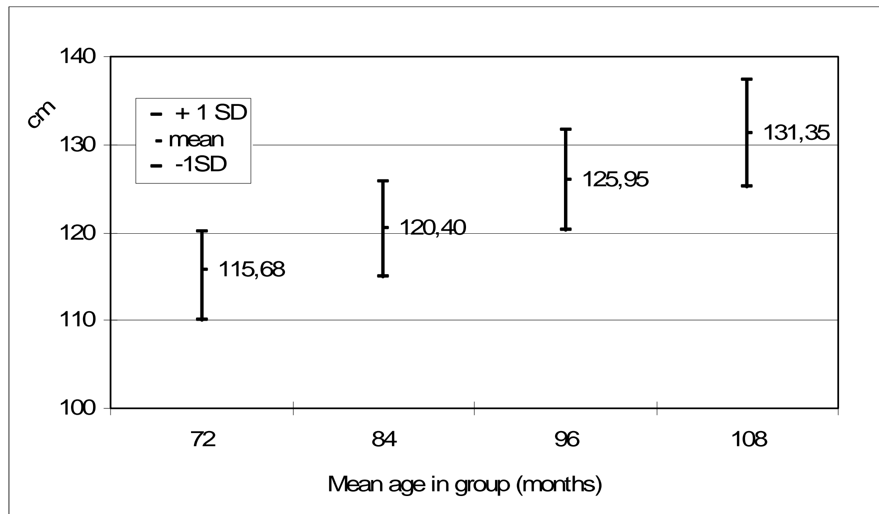

Figure 7: Mean values of height of girls children aged 6 to 9 years**.**

The mean height of urban boys was 123.8 and the mean height for rural boys was 123.5cm. The mean heights of urban and rural girls were 122.9 and 122.5 cm, respectively. The mean heights for urban children and rural children, both sexes, were 123.4 and 123.0 cm, respectively. These results showed that there was no statistical difference between the two communities ($p < 0.4$), as shown in figure 8.

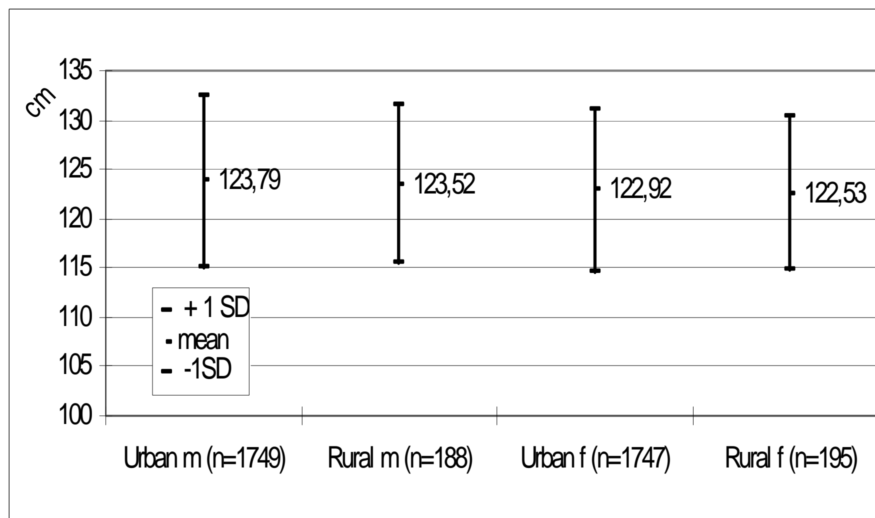

Figure 8: Mean of anthropometrics variable of height (± SD) of schoolchildren in urban and rural districts.

The prevalence of stunting (h/a) among two groups compared with CDC reference are given in table 6. There were 2.1% of boys below -2 SD of the CDC 2000 median reference value for h/a, which is indicator of stunting. 3.0% of girls were below the cut-off point of -2 SD, of the CDC 2000 median reference value for h/a. The prevalence of stunting among girls was higher than that among boys, although we could not find a statistically significant difference in stunting prevalence between boys and girls (p= 0.75), as shown in figure 9. Table 7 reveals to the nutritional status (h/a) of girls and boys in two zones (rural and urban) according to 2000 CDC reference population.

The children with a z-score outside the range from -6 to +6 were excluded from the analysis.

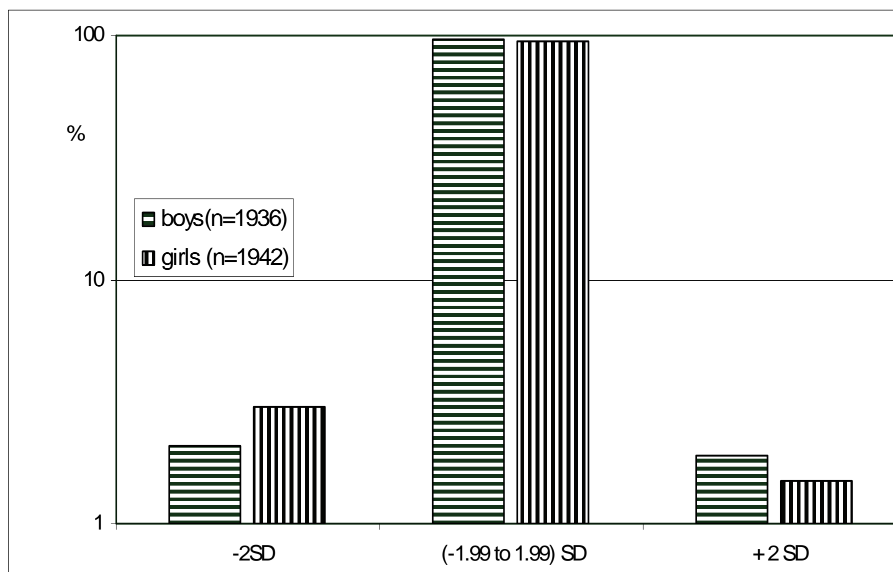

Figure 9: Height-for-age of children in each groups expressed as ±SD reference values from 2000 CDC reference.

4.1.3. BMI for age

The BMI now appears to be a widely accepted index for classifying adiposity in adults. The BMI was calculated for each age and gender, and the values were compared with the CDC reference population. The highest prevalence values of BMI were observed at the fourth class at different age and sex groups. The values of BMI

ranged between 8.08 to 37.70 kg/m² for boys with a mean value of 16.3 kg/m² (± 2.8). The mean BMIs of boys aged 72, 84, 96 and 108 months were 15.7 ± 1.73, 16.0 1.9, 16.2 ± 2.3 and 16.9± 2.7 kg/m², respectively, as shown in figure 10.

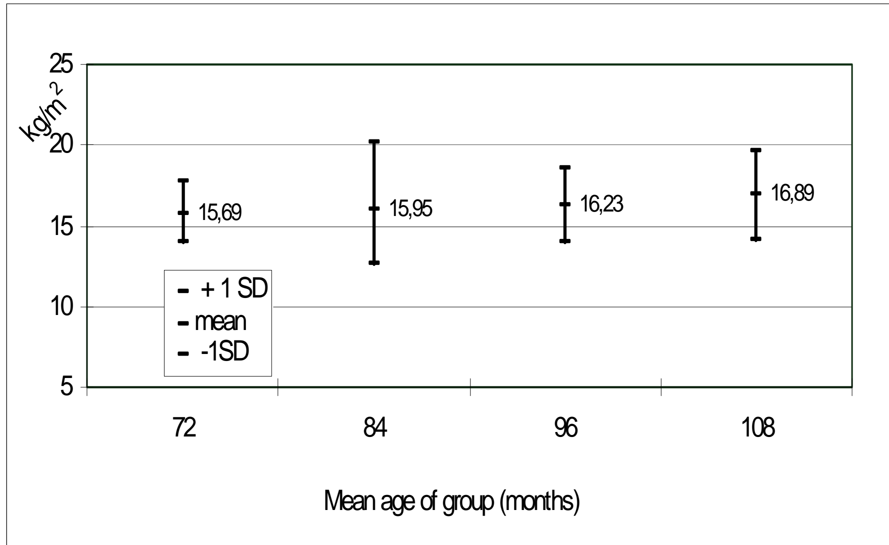

Figure 10: Mean values of BMI of boys children aged 6 to 9 years.

The BMI values ranged between 11.20 to 29.64 kg/m² for girls, with a mean value of 16.2± 2.5 kg/m². The mean BMI of girls aged 72. 84, 96, and 108 months were 15.5 ± 1.5, 15.9 ± 2.1, 16.4 ± 2.3 and 16.8 ± 2.7 kg/m², respectively, as shown in figure 11.

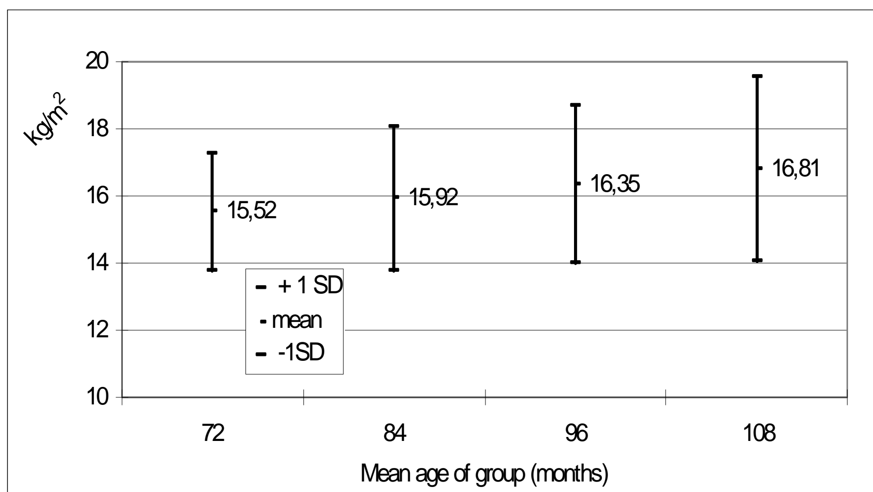

Figure11: Mean values of BMI of girls children aged 6 to 9 years.

The mean and standard deviation (± SD) of boys and girls are shown in table 8. The mean values BMIs of boys range between 15.69 and 16.89 kg/m² and for girls the BMIs range between 15.52 and 16.81 kg/m². The mean values for BMI for urban children and rural children were 16.3 ± 2.7 and 16.0 kg/m² ± 1.8, respectively.

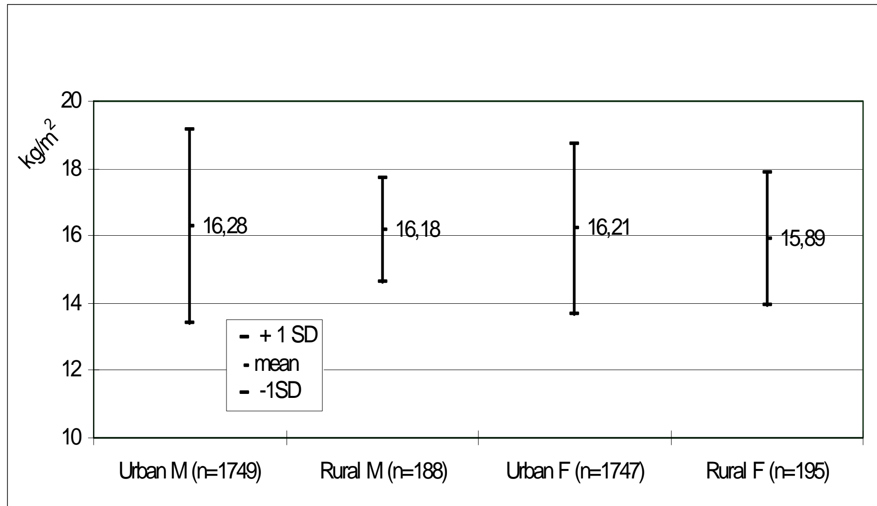

Figure 12: Mean of anthropometric variable of BMI (± SD) of school children in urban and rural districts.

The ranges of BMI for urban boys were 16.3 kg/m² ± 2.9, while rural boys were 16.2 kg/m² ± 1.6. The mean BMI for urban girls was 16.2 kg/m² ± 2.5, while the mean BMI for rural girls was 15.9 kg/m² ± 2.0, as shown in fig 12. These results showed that there was statistical difference between the two communities ($p < 0.04$).

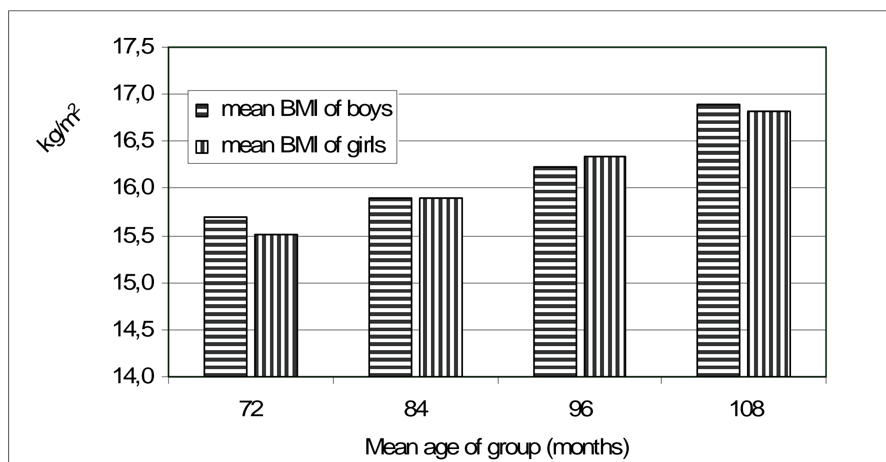

Figure 13: The comparison of BMI at different age groups between boys and girls.

The BMIs for boys were higher than that for girls in all age groups, except that the BMI was higher among girls (16.35 kg/m²) than boys (16.23 kg/m²) at the age 8 years, though the difference was not statistically significant ($p< 0.4$). This is shown in figure 13.

4.2. Dietary Intake (24- h recalls**)**

The distribution of children in terms of nutritional intake versus the recommended dietary allowance (RDA) is summarized in Table 9. The common eating patterns of the children from both regions included a breakfasted on cheese, eggs or tuna and bread with tea or coffee with milk. Lunch included family dishes, such as couscous, macaroni, rice, vegetable soup or bazeen (very popular in rural area especially in western Libya). The predominant component of the evening meal was light foods including eggs, tuna, salad, jam, and milk with dates. Large family often had macaroni for dinner. Meat was eaten an average 4-5 times a week, consumption of poultry (the least expensive meat) was high in both regions. Fruit and vegetable consumption depended on the season and family income. Energy intake expresses as a percentage of RDA of all children was 76% of RDA (± 5.8). The average intake for boys was 79% and for girls was 73%. For both groups, lunch was the most important meal and source of kilocalories and proteins for children. There was a higher intake of proteins at lunch time than at both breakfast and supper. Figures 14 and 15 reveal the average daily intake of nutrients of boys and girls respectively.

The average daily intake of total protein was 226% (± 25.4). Protein intake was higher in boys than girls- 248% and 204% respectively. In boys, the average daily intake of vitamins such as vitamin A, C, B_1, B_2, $B_{6,}$ and E, folate and carotene were 65, 63, 55, 91, 153, 54, 19 and 101%, respectively, whilst in girls, the average daily intake of vitamins A, C, B_1, B_2, B_6, and E, folate and carotene 58, 72, 53, 74, 145, 57, 16 and 158%, respectively. The school children in this study, both sexes, reported an average daily vitamins B_6 and carotene intake of 149% (± 9.6) and 129% (± 52.2), respectively. The average intakes of vitamin E and folate were 56 and 17% respectively, of both genders, as shown in figure 16.

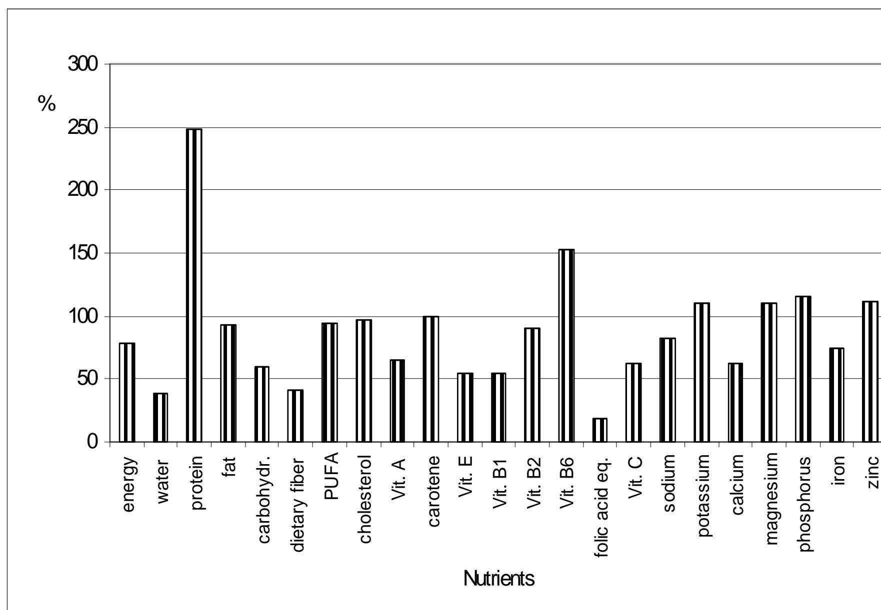

Figure 14: The average daily intake during 24-h recalls of boys in percent of RDA.

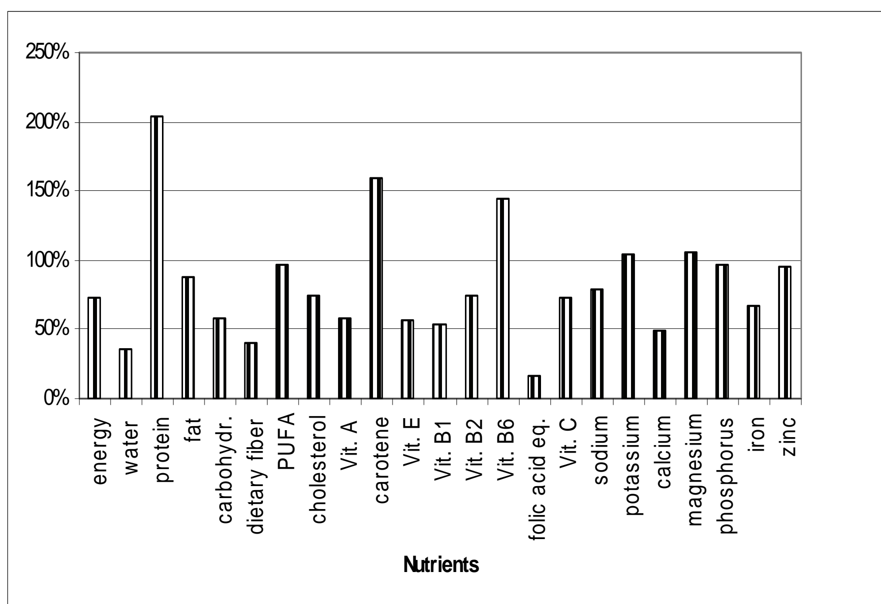

Figure 15: The average daily intake during 24- h recalls of girls in percent of RDA.

In girls the dietary fat intakes of first, second, third and fourth classes were 84, 89, 78 and 104%, respectively. The average intake of total fat in percent of RDA was 91% (SD=9), the average intake was found to be 94 and 89% for boys and girls, respectively.

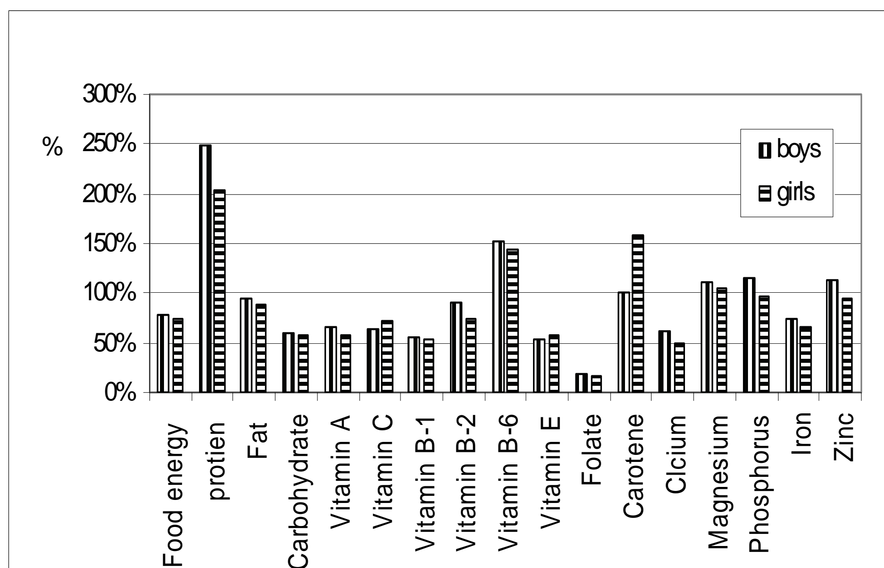

Figure 16: Comparison of the average daily nutrients intake among boys and girls in percent of RDA.

Daily intakes of minerals magnesium, phosphorus, and zinc are reported to be 108% (± 7.4), 107% (± 11.6), and 104% (± 11.2) as a percentage of RDA, respectively. The average daily intake of minerals calcium and iron for children were 56% (± 7.9) and 70% (± 6.0), respectively; calcium and iron were insufficient as a percentage of RDA. In this study average daily fiber intake was 10.0 g (± 7.9). Consumption of fiber was greater among boys (10.25g) than girls (9.94g). The average intake of zinc was 113 and 95% for boys and girls, respectively. Other dietary components such as cholesterol and sodium consumed an average 291 mg and 1991 mg for boys and 225 mg and 1932 mg for girls.

4.3. Physical activity and Television Viewing (Classification of daily activities):

Participation in vigorous activity and television watching habits and their relationship to body weight and fatness in Derna children aged 6-9 years were assessed. Classification of physical activity was assessed by a physical activity questionnaire; the questionnaire was designed to assess activity during the previous 24 hours. Questionnaires were distributed to children in their classrooms. A total of 507

participants (255 boys and 252 girls) were examined as a part of this survey. Daily physical activity is based on the belief that healthy students are better able to learn and that school communities provide supportive environments for students to develop positive habits needed for a health, active style. Participants were asked how many times per day they spent for each of the following categories: watched television, exercised (walking, running, played football, etc.), slept, studied, played video games, and sat at home engaged in other activities. The questionnaires were completed by the students' parents. This study revealed that the mean daily hours of television watching, play outside, studying, sleeping, and playing video games was 3.2 hrs/day for boys and 3.9 hours/day for girls, 4.86 for boys and 3.93 for girls, 2.93 for boys and 3.20 for girls, 10.33 for boys and 10.33 for girls, and 2.70 for boys and 2.68 for girls, respectively, as shown in figures 17 and 18. Among boys the minimum spent hours on average daily of television watching was 2.6 hours in fourth class, and maximum spent hours was 3.5 hours in first class (SD= 0.41).

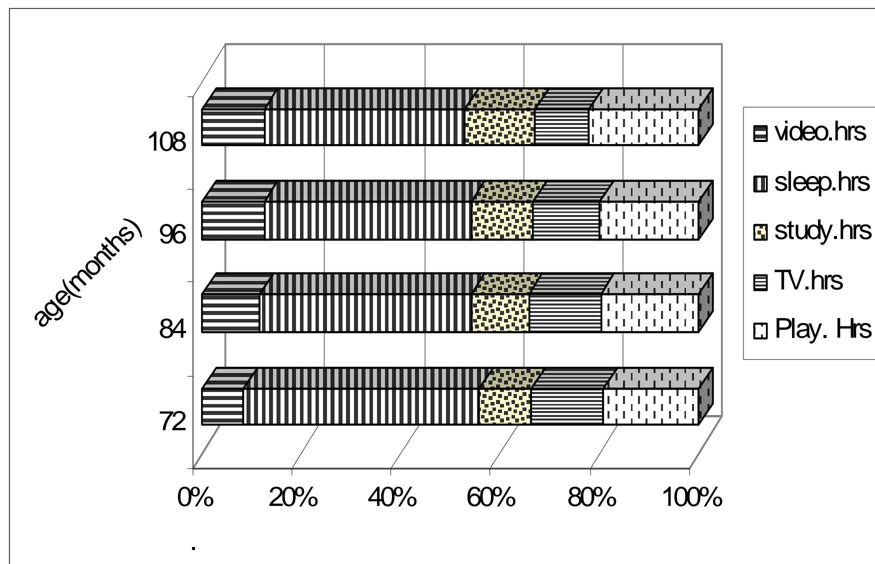

Figure 17: Percentage of time spent on average a day among boys.

Among girls the minimum time spent on average watching television was 3.5 hours in first class and maximum time watching television was in third class at 4.51 hours (± 0.43*).*

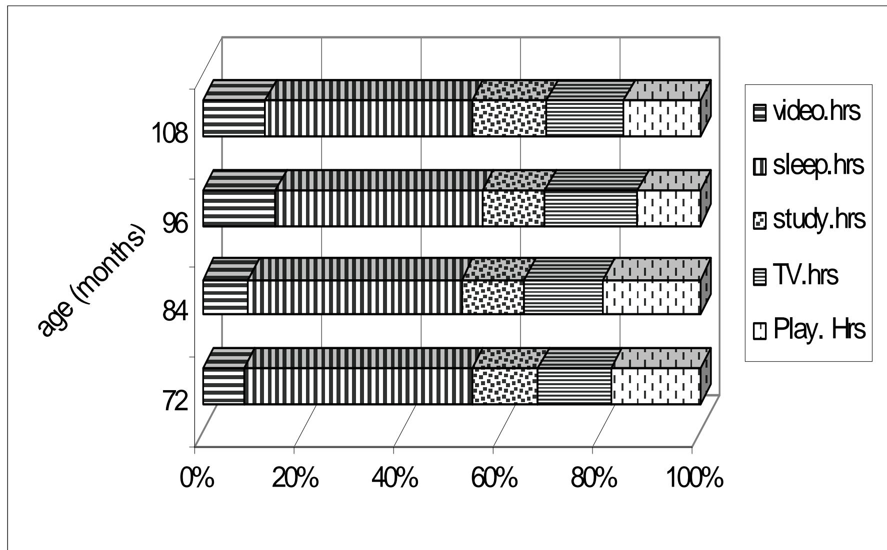

Figure 18: Percentage of time spent on average a day among girls.

The minimum spent hours of physical activity among boys was 4.6 hours in first class and maximum was 5.3 hours in fourth class (± 0.30). The minimum spent hours of physical activity among girls was 3.00 in third class, and maximum was 4.70 hours in second class (± 0.74). as shown in figure 19.

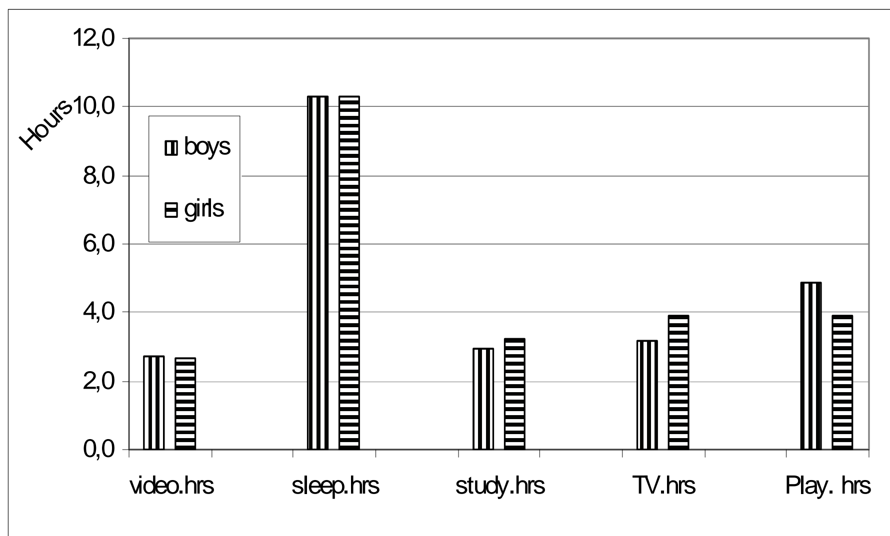

Figure 19: Comparison of physical activity variable among school-age children.

Among boys, physical activity increased from 19.2% at age 72 months (first class) to 22.1% of total daily hours at age 108 months (fourth class). Watching television decreased from 14.6% of total daily hours at age 72 months (first class) to 10.8% at age 108 months (fourth class). Among girls, physical activity decreased from 19.6% of total daily hours at age 84 months (second class) to 12.5% at age 96 months (third class), while watching television increased from 14.6% at age 72 months (first class) to 18.8% of total daily hours at age 96 months (third class). The highest television watching among girls was 4.5 hours spent on average a day at age 96 months (third class), while the lowest physical activity was 3.0 spent hours on average daily at the same age. On other hand, among boys the lowest television watching was 2.6 spent hours on average a day at age 108 months (fourth class) While the highest physical activity was 5.3 spent hours on average a day at the same age. The highest sleeping hours was observed at 72 months of age and decreased as age increased for both genders.

4.4. Height, weight and BMI increment within one year

Children between 6 and 10 are more independent and physically active than they were in the preschool years. Strength and muscle coordination improve rapidly in these years. A child's physical growth refers to the increases in height and weight and other body changes that occur as a child matures. In the 2005/2006 school year, 3,879 school children aged 6-9 years were enrolled for anthropometric measurements of height and weight and, from those measurements, their BMIs were calculated. Secondary measurements were undertaken on 809 children in the 2006/2007 school year with 366 boys and 443 girls that were randomly selected from the eight regions in Derna municipality. All students were measured a second time almost exactly one year after the first measurement. The average weight of boys within one year was 28.8 kg (± 3.91), as shown in figure 20.

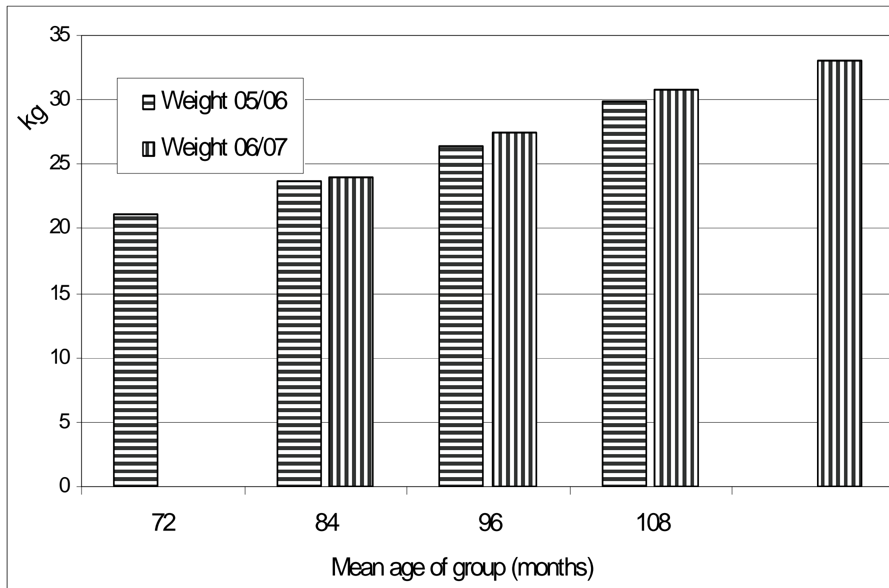

Figure 20: Weight increment (kg) within one year among boys.

The average value of height of boys within one year was 130.1 cm (± 6.5), as shown in figure 21.

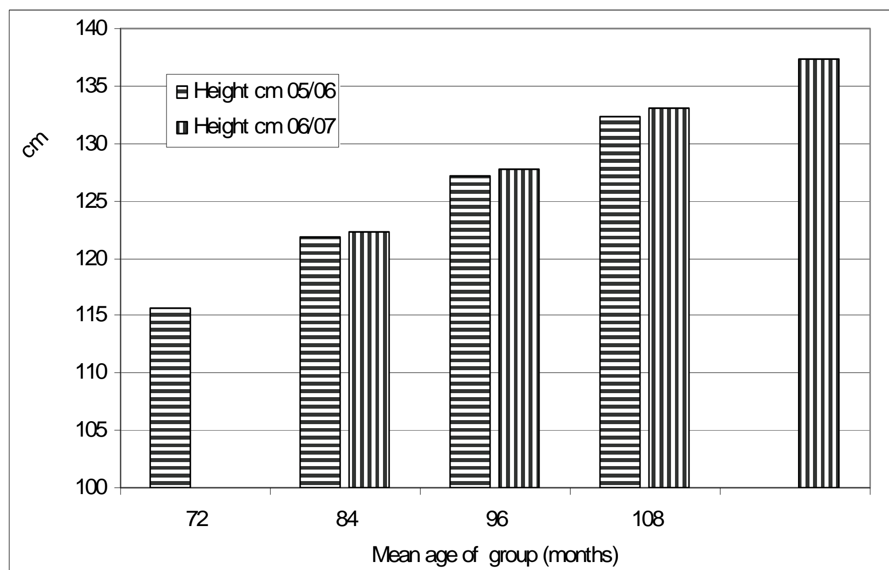

Figure 21: height increment (cm) within one year among boys.

The average value of BMI of boys within one year was 16.8 kg/m², as shown in figure 22.

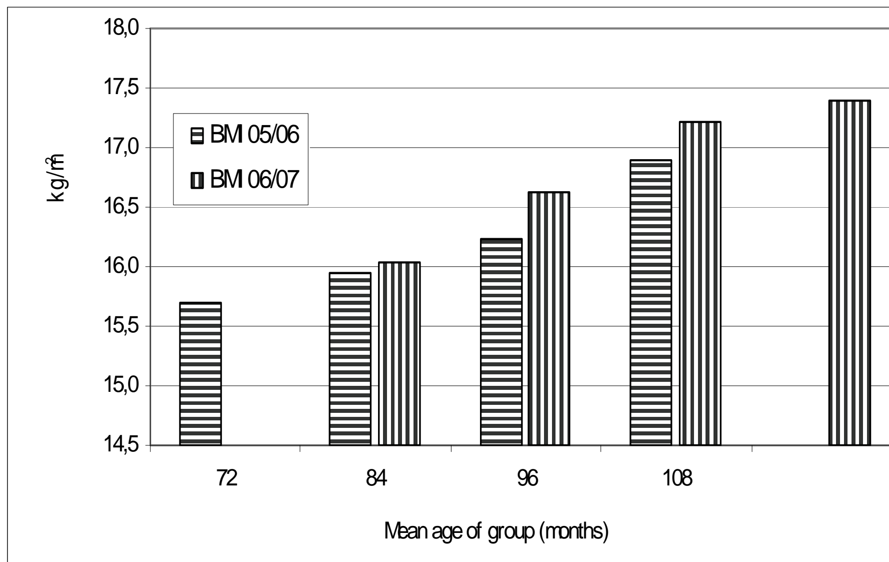

Figure 22: BMI increment (kg/m²) within one year among boys.

The average increase in weight of girls within one year was 28.5 kg (± 4.1), as shown in figure 23.

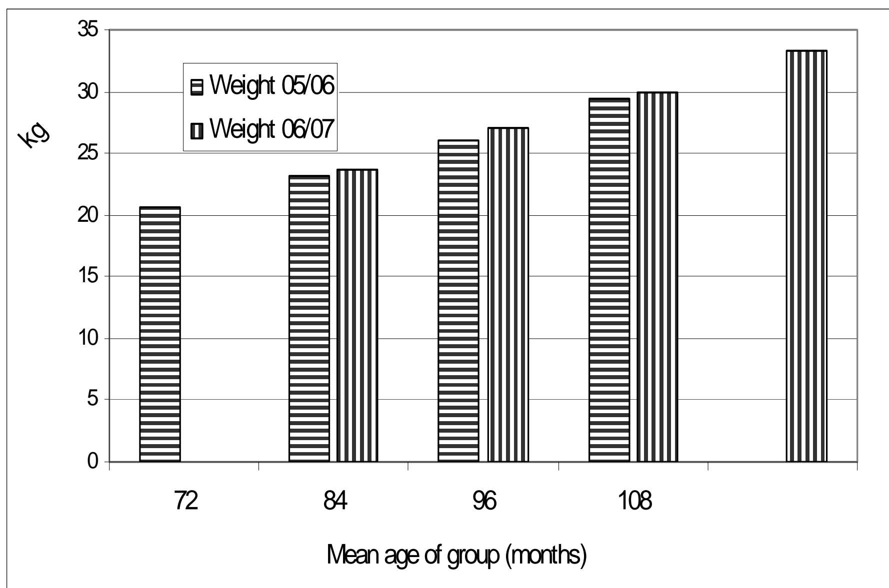

Figure 23: weight increment (kg) within one year among girls.

The average value of height of girls was 129.39 cm (± 6.6), as shown in figure 24.

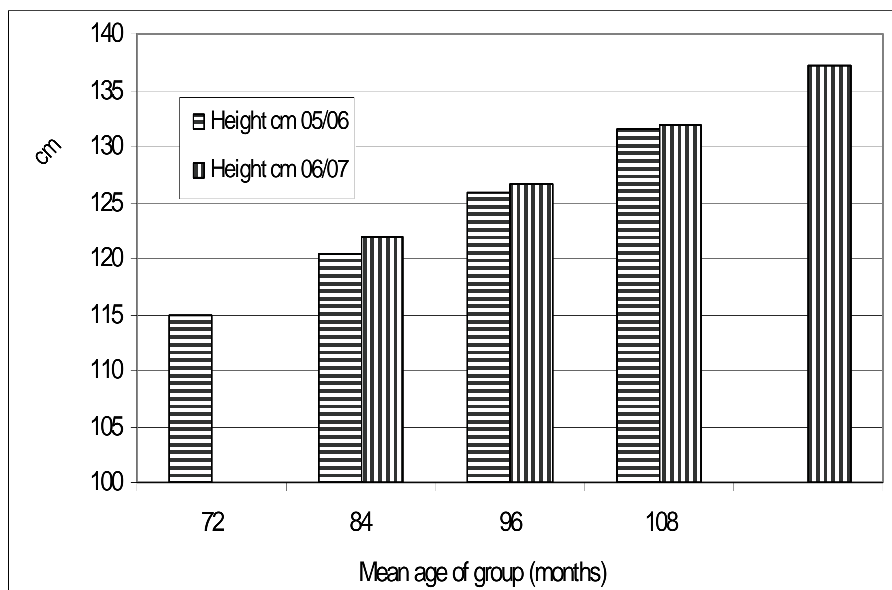

Figure 24: height increment (cm) within one year among girls.

The average value of BMI of girls was 16.90 kg/m². These results showed that there was no evidence of a statistical significant difference between the sexes (p=0.33).

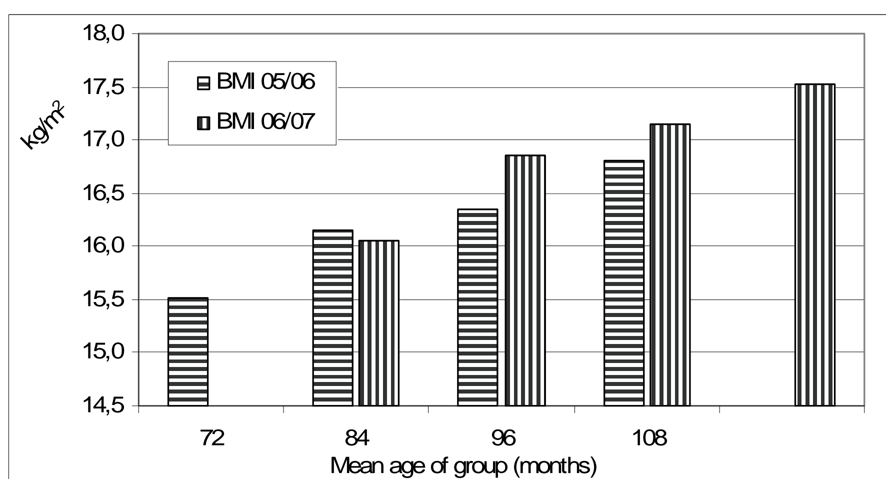

Figure 25: BMI increment (kg/m²) within one year among girls.

The increases in height within one year of boys were 6.58, 5.82, 5.88, and 5.13 cm with increasing age, respectively, and the average was 5.85 cm/year (± 0.59). Among girls, the increases in height in one year were 6.20, 6.14, 5.87 and 5.97 cm with

increasing age, respectively, and the average was 6.04 cm/yearly (±0.15), as shown in figure 26.

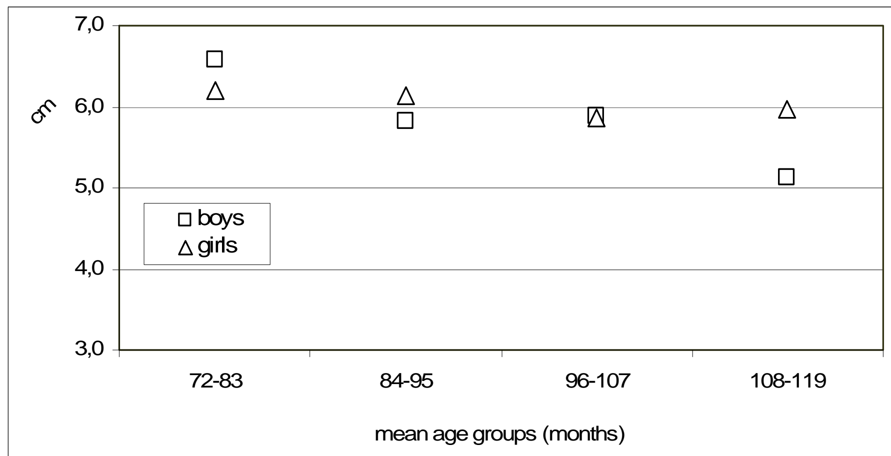

Figure 26: Comparison of height (cm) increment within one year among boys and girls at different age.

The increases in weight within one year among boys were 2.95, 3.48, 4.36 and 3.30 kg with increasing age, respectively, and the average increase was 3.52 kg/yearly (±0.60). Among girls, the increases in weights were 2.82, 3.92, 3.89 and 4.11 kg with increasing age, respectively, and the average was 3.69 kg/yearly (±0.58), as shown in figure 27.

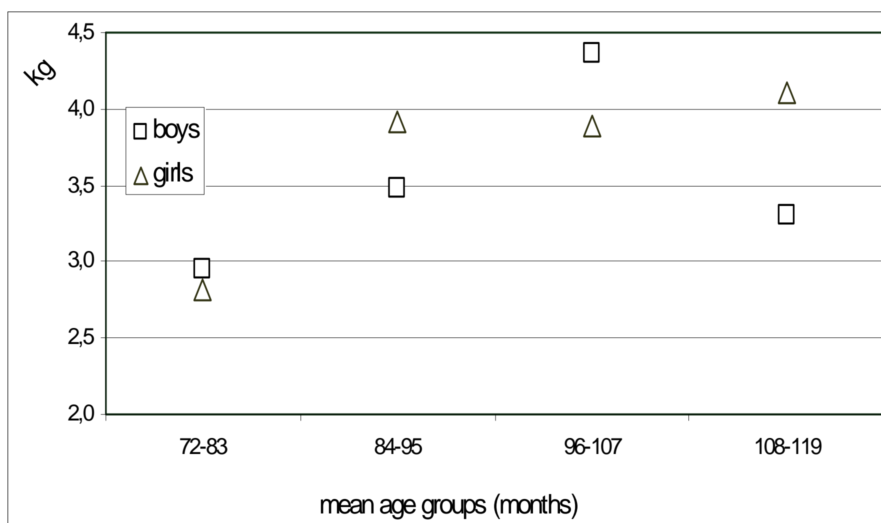

Figure 27: Comparison of weight (kg) increment within one year among boys and girls at different age.

The increases in BMI within one year among boys were 0.34, 0.67, 0.99 and 0.50 kg/m² with increasing age. The average value was 0.63 kg/m² (±0.27). Among girls the increases in BMI were 0.53, 0.93, 0.80, and 0.72 kg/m² with increasing age and the average increase was 0.75 kg/m² (± 0.16), as shown in figure 28. The highest gain in standing height in boys (peak height velocity, PHV) was 6.58 cm/year and it was between 6 and 7 years, while in girls the highest gain was 6.20 cm/year at the same age group. The lowest height increase in boys was 5.13 cm/year; it was between 9 and 10 years, while in girls it was 5.87 cm/year at the ages of 8 and 9 years.

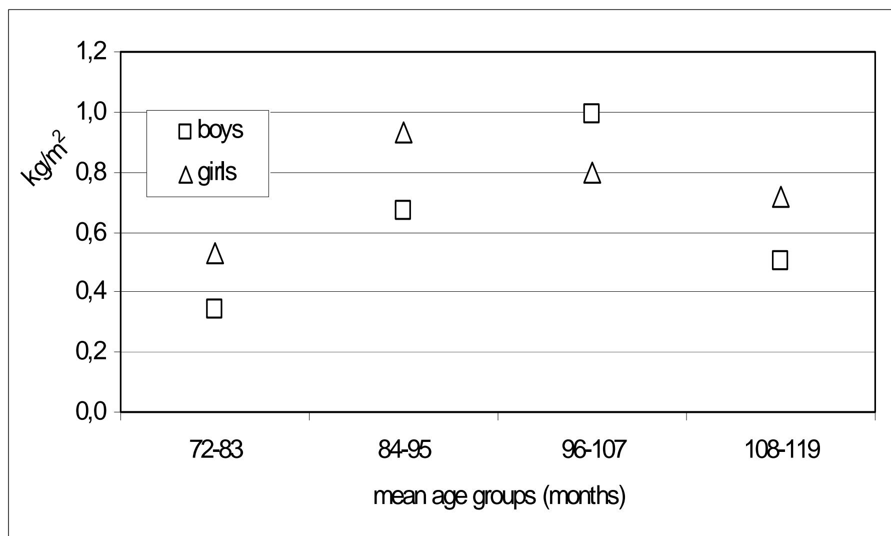

Figure 28: Comparison of BMI (kg/m²) increment within one year among boys and girls at different age.

The average rate of increase in standing height in boys was 5.85 cm/year while in girls it was 6.04 cm/year, the average rate was higher among girls than boys within one year, although there is no statistical significant (p<0.16). The highest gain in weight among boys (peak weight velocity, PWV) was 4.36 kg, between the ages of 8 and 9 years, while in girls the highest increase in weight was 4.11 kg between 9 and 10 years. The average weight gain within one year was higher among girls (3.69 kg) than boys (3.52 kg) but there was not statistical significant (p>0.05). The highest increment of BMI among boys was 0.99 kg/m² between 8 and 9 years while among girls the highest increase in BMI was 0.93 kg/m² between 7 and 8 years. The average

BMI increment within one year was higher among girls (0.75 kg/m²) than boys (0.63 kg/m²). Anthropometric measurements within one year are presented in table 14 for boys and table 15 for girls.

4.5. Nutrition status of Derna school children as based on the 2000 CDC reference compared with the 2007 WHO reference:

In May 2000, the Centres for Disease Control and Prevention (CDC) released a revision of the NCHS 1977 childhood growth reference. In April 2006, the WHO released new child growth standard for infants and children up to the age of 5 years to replace the NCHS growth reference. The 2000 CDC growth charts are commonly used to asses the nutritional status of children in nutritional surveys all over the world (56). Data from the 1977 NCHS/WHO growth reference (1-24 years) were merged with data from the under-five growth standard to smooth transition between the two samples. The new curves 2007 WHO curves are closely aligned with the WHO child growth standards at 5 years (57). Both sets of curve, the 2000 CDC and the 2007 WHO, cover the same indicators, weight-for-age, height-for-age and BMI-for-age. Weight, height and BMI measurements were obtained from a pooled cross sectional sample from 3,879 school children, weight-for-age, height-for-age and BMI-for age were computed for each child and compared to the 2000 CDC reference. This study compared and evaluated the differences sample between the 2000 CDC and the 2007 WHO as reference indicators. SPSS macro package was used to calculate (h/a), (w/a), and BMI z-scores based on 2007 WHO reference data. Mean, standard deviation (± SD), and paired samples test were calculated. A *p*-value of ≤0.05 was the criterion of statistical significant. ENA programme (2008) was used to calculate (w/a), (h/a), and (w/h) and these data were compared to the SPSS data. The data were similar using both methods; w/h is the nearly identical to the z-score for BMI. Therefore, this value is used for the MBIZ. Height- and weight- based anthropometric indicators are used worldwide to characterize the nutritional status of population. The percent (%) classified as underweight, stunted, and overweight were then calculated. Children were considered stunted or underweight if their corresponding z-score was at least <-2 SD below the mean of the reference population, and overweight if their z-

score was >+2 SD over the mean of the reference population. The SD of z-score can be used as quality indicators for anthropometric data. In 2007, the WHO published new growth standards to assess the SD of height- and weight based z- score indicators. The height for age (HAZ) of girls based on the 2000 CDC and WHO 2007 classification was normal for 95.5 and 95% with the rest being stunted, 3.0 and 2.7%, respectively. Girls in the WHO 2007 standard were taller (>+2 SD) than those in the 2000 CDC reference, 2.3 and 1.5%, respectively, as shown in figure 29.

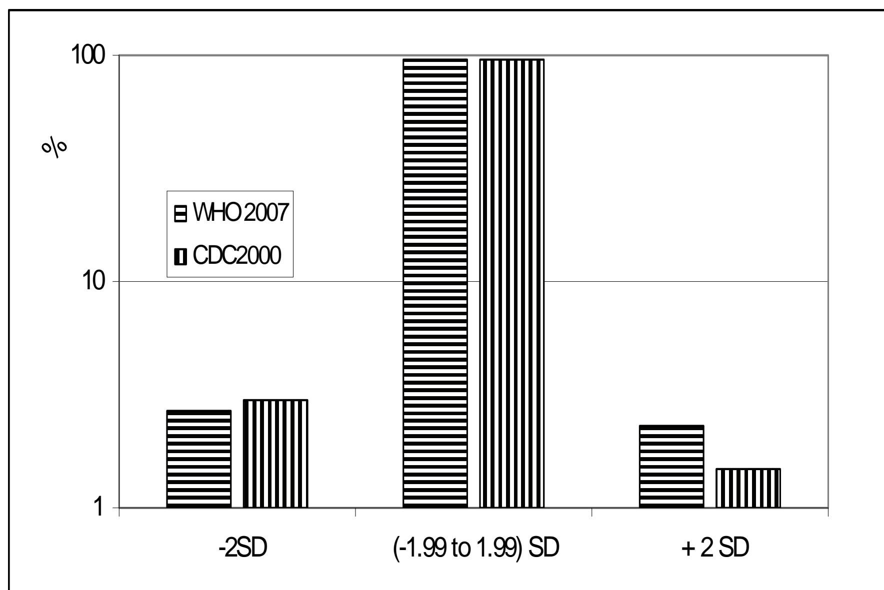

Figure 29: Height for age of girls (HAZ %) on the basis of WHO 2007 and CDC 2000.

HAZ for boys when compared to the 2000 CDC and 2007 WHO show that 96.0% and 95.7%, respectively, fall below -2 SD with 2.1 and 1.9%, respectively, being stunted. Compared to the 2007 WHO reference boys were found classified as taller than compared to the 2000 CDC - 2.4 and 1.9% respectively, as shown in figure 30.

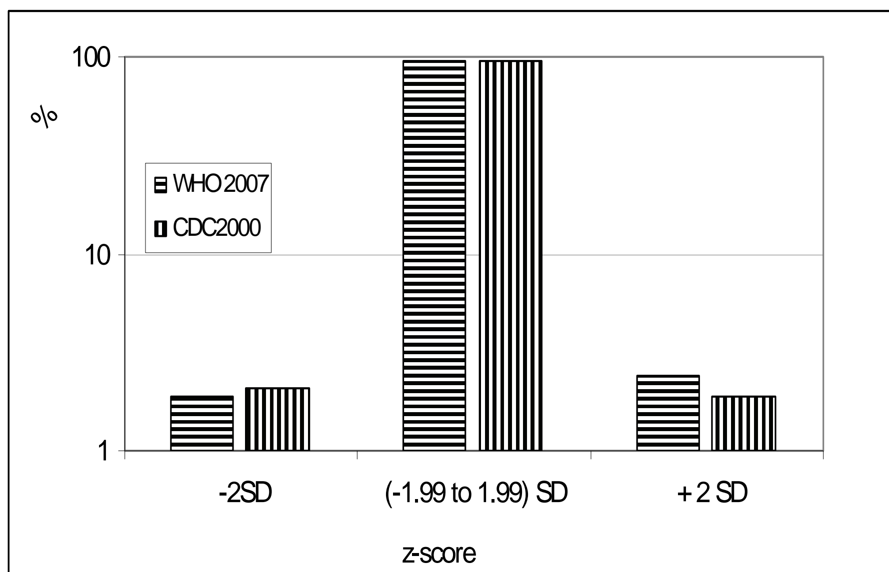

Figure 30: Height for age of boys (HAZ) on the basis of 2007 WHO and 2000 CDC references.

The nutritional status weight for age (WAZ) was 95.3% and 94% for girls when compared to the 2000 CDC and 2007 WHO references, respectively (±2.00), 2.6 and 2.0% being underweight (<-2 SD), respectively, and 2.1 and 4.0% being overweight, respectively, as shown in figure 31.

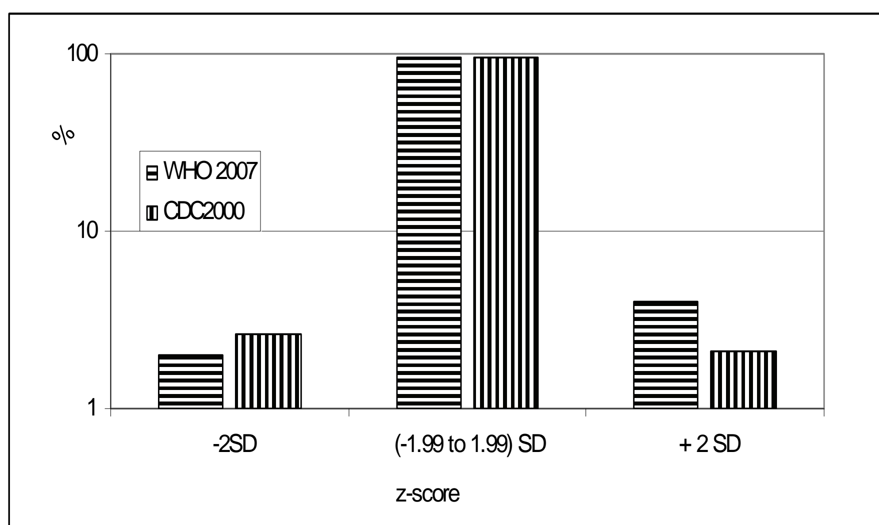

Figure 31: Weight for age of girls on the basis of 2007 WHO and 2000 CDC references.

WAZ for boys compared to the 2000 CDC and 2007 WHO references were 94.2 and 93.2% respectively. The higher prevalence of overweight children was observed when using the 2007 WHO reference (5.1%) vs. the 2000 CDC reference (3.2%). The lower prevalence of underweight children was observed when using the WHO (1.7%) as a basis vs. the CDC (2.6%) as shown in figure 32.

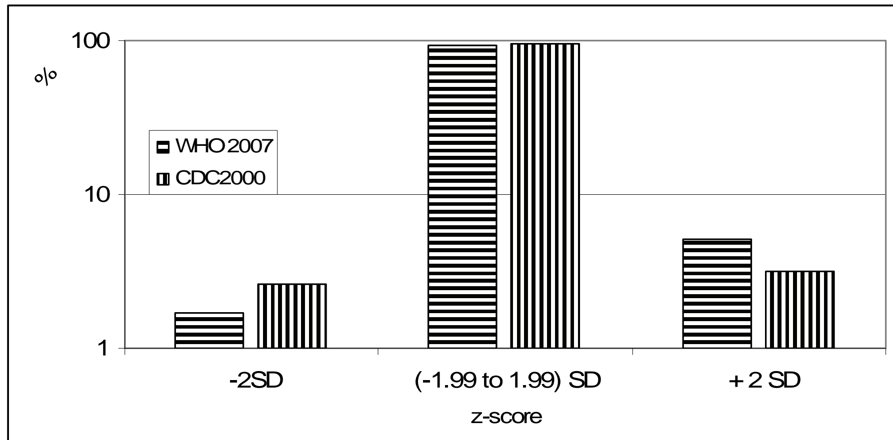

Figure 32: Weight for age of boys on the basis of 2007 WHO and 2000 CDC references.

According to the BMI z-score for girls, most of the BMI z-score (93.8 and 95.1%) fall between ±2 SD as based 2007 WHO and 2000 CDC references, with 1.1 and 2.5% being deemed thin and 5.3 and 2.4% obese, respectively, as shown in figure 33.

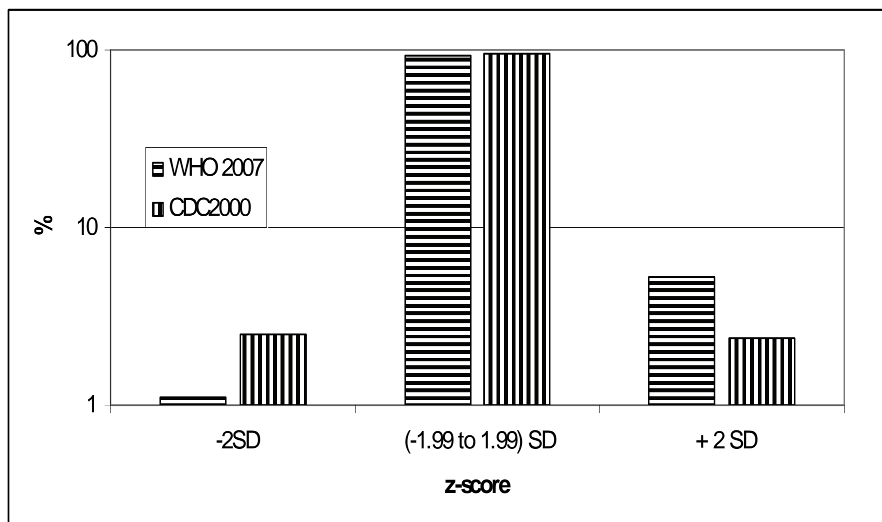

Figure 33: BMI for age of girls on the basis of 2007 WHO and 2000 CDC.

In boys, these results show that the great majority fall between ±2 SD- 93.8 and 93.7%- as based on WHO and CDC respectively. The prevalence of thinness was observed to be lower based on the 2007 WHO vs. the 2000 CDC (1.8 and 3.3%, respectively). Obesity was higher according to 2007 WHO reference than 2000 CDC- 4.4 and 3.0%, respectively, as shown in figure 34.

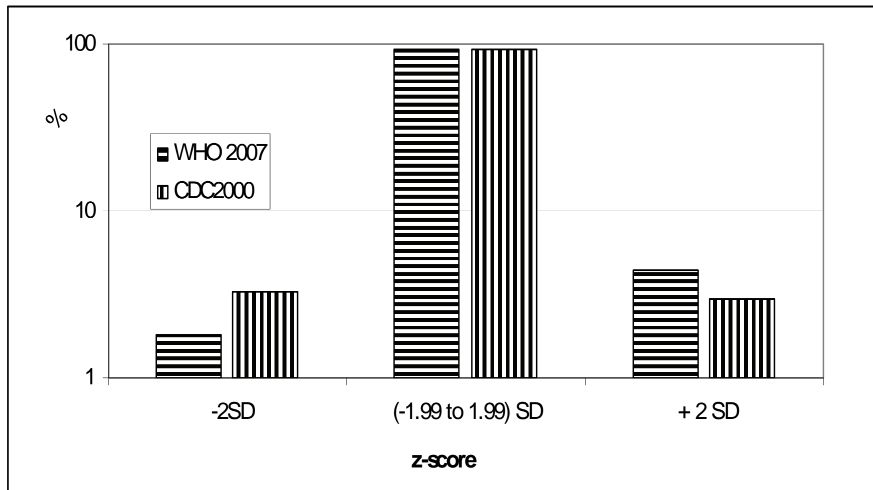

Figure 34: BMI for age of boys on the basis of 2007 WHO and 2000 CDC.

These results were observed also in students with identified birth dates. The sample

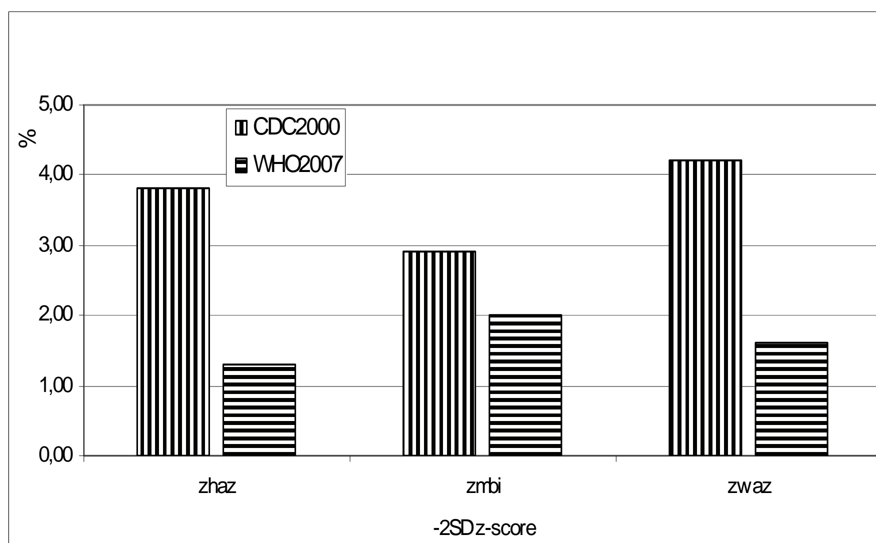

Figure 35: Comparison of <-2sd (%) between 2000 CDC and 2007 WHO of identified birth date of boys and girl.

size included 679 students, 338 boys and 359 girls. The data show that underweight, stunting and thinness (<-2SD) were higher (mean HAZ 3.8, BMIZ 2.9 and WAZ 4.2%) as based on the 2000 CDC reference vs. the 2007 WHO reference (HAZ 1.3, BMIZ 2.0 and WAZ 1.6%), as shown in figure 35.
These results show the higher prevalence of overweight children (>+2 SD) as based on 2007 WHO (HAZ 2.4, BMIZ 2.9 and WAZ 3.6%) vs. the 2000 CDC (HAZ 0.42, BMIZ 2.12 and WAZ 2.12), as shown in figure 36.
Use of the 2000 CDC reference shows a higher percentage of cases classified as stunted and underweight (<-2 SD) than 2007 WHO. There was a statistically significant between the 2000 CDC and the 2007 WHO ($p<0.05$) and no statistical difference between boys and girls as based on 2007 WHO reference ($p>0.05$).

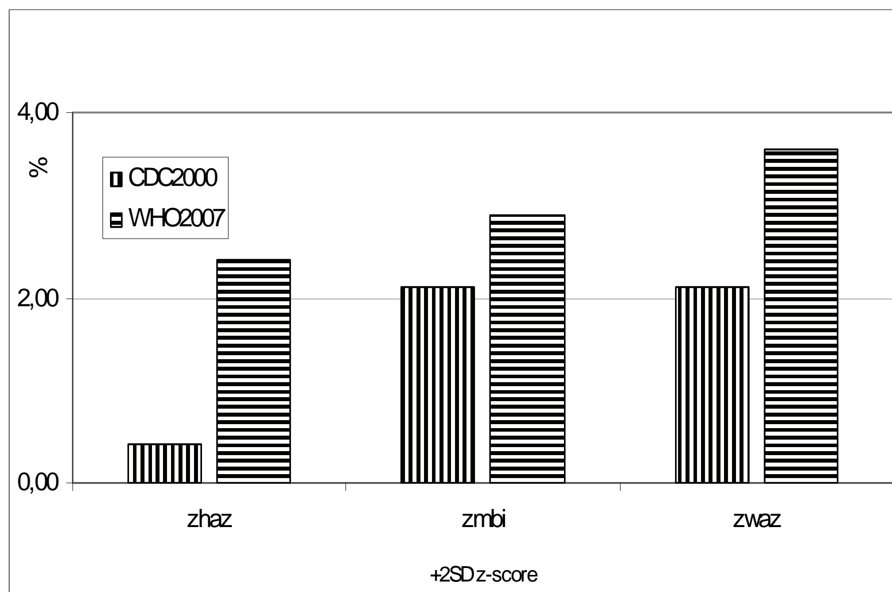

Figure 36: Comparison of >+2sd (%) between CDC 2000 and WHO 2007 of identified birth date of boys and girls.

5. Discussion

5.1. Anthropometric measurements

5.1.1. Weight for age (w/a)

In this study, it was found that the mean weight of boys, 25.0 kg, (± 5.6), was significantly higher than that of girls, 24.6 kg (*p*= 0.03). The current study showed that boys were heavier than girls at all different age groups. The mean values for weight increased with increasing age. The mean weights for urban children and rural children of both sexes were 24.8 and 24.4 kg, respectively. Urban boys (25.0 kg) and girls (24.7 kg) were slightly heavier than their counterparts in rural areas, with rural boys averaging 24.9 kg and girls, 24.0 kg. These results were not statistically significant between two communities (*p*= 0.1).

In this study, the majority of the school children aged 6-9 years of boys and girls have a weight/age that fall between ± 2.00 SD of the 2000 CDC reference population (94.2% and 95.3% respectively). The prevalence of overweight was higher for boys (3.2%) than girls (2.1%) in both urban and rural children but did not reach statistical significance (*p*= 0.7). The overall prevalence of underweight was same among the two sexes (2.6% in boys and girls), and slightly higher in urban (2.7%) than in rural children (1.3%). However, the difference was not statistical significant (p>0.1). The prevalence of underweight children was highest among urban girls (2.8%), while the lowest prevalence was found among rural girls (1.0%). The overall prevalence of overweight children was 2.7% (104 of 3,879 school children). The prevalence of overweight children was higher in urban children (2.8%) when compared with rural children (1.8%); thought the difference was not statistically significant (p> 0.3). The prevalence of overweight children was highest among urban boys (3.4%), while the lowest prevalence was found among rural boys (1.6%).

These results show that at all age groups, the mean weight is comparatively higher in boys than in girls. The prevalence of overweight and underweight children was higher among urban children than rural children. In this study, the overall prevalence rates of underweight and overweight among Derna schoolchildren were low when compared with the previous reports of Qatari school children and adolescents aged 6 to 18 years (58). These showed that 4.4% of boys and 4.6% of girls were underweight and

4.7% of boys and 5.5% of girls were overweight, figure 37 and 38 reveal the comparison of underweight and overweight between Libyan children and Qatari children.

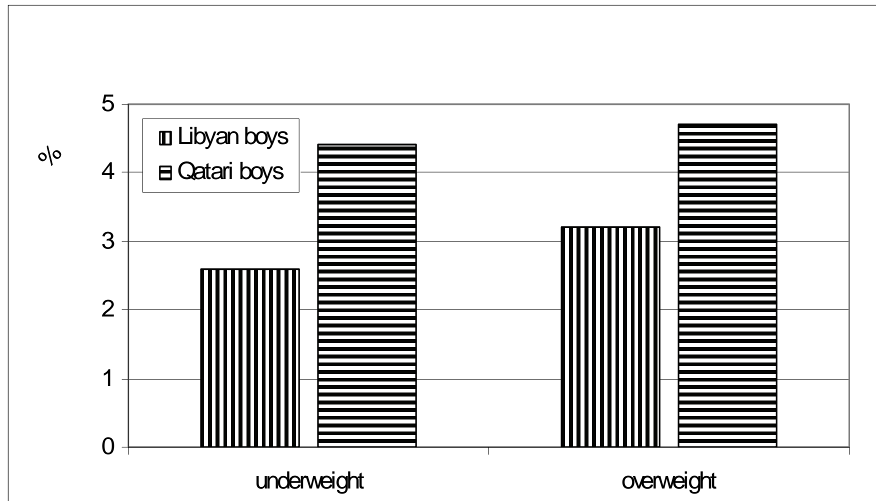

Figure 37: Comparison of underweight and overweight between Libyan and Qatari boys (Ref. 58).

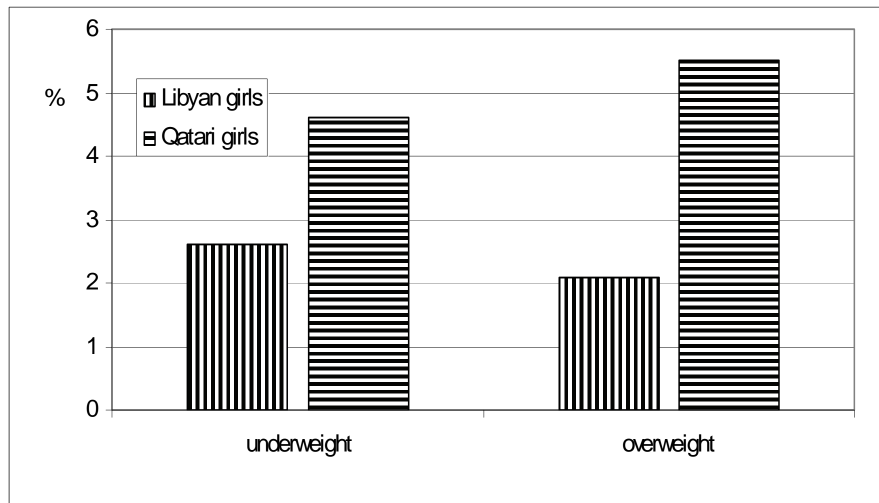

Figure 38: Comparison of underweight and overweight between Libyan and Qatari girls (Ref. 58).

Another study of Saudi Arabian male children aged 6 to 11 years (59), found that 5.2% were underweight and 6.6 were overweight figure 39 reveals the comparison of underweight and overweight between Libyan and Saudi children. A report from the

United Arab Emirates on 4,381 children aged 5 to 17 years showed that the overall prevalence of overweight children was 21.1% and 13.7% being obese (60).

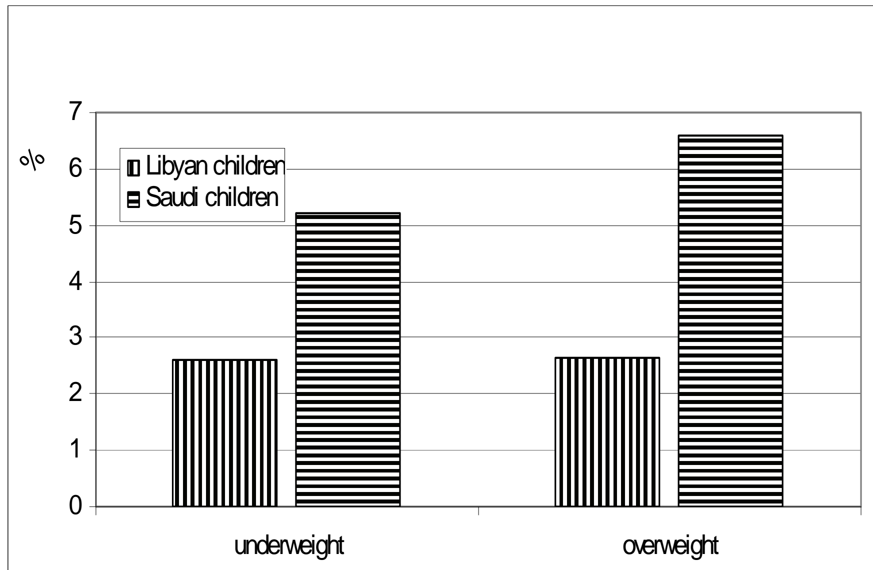

Figure 39: Comparison of underweight and overweight between Libyan and Saudi children (Ref 59).

The Derna study revealed that the prevalence of underweight and overweight children was low when compared with children in Kuwaiti elementary school aged 6-10 years (61) 15.7% of Kuwaiti boys and 13.8% of Kuwaiti girls are reported to be obese as shown in figures 40 and 41. The prevalence of underweight children was similarly among the two sexes (3.7% in boys and 3.8% in girls). Therefore, Libyan children in Derna could generally be described as having the great majority of school children aged 6-9 years fall between ± 2.00 SD score of weight for age [(w/a) = 94.2% and 95.3% for boys and girls, respectively].

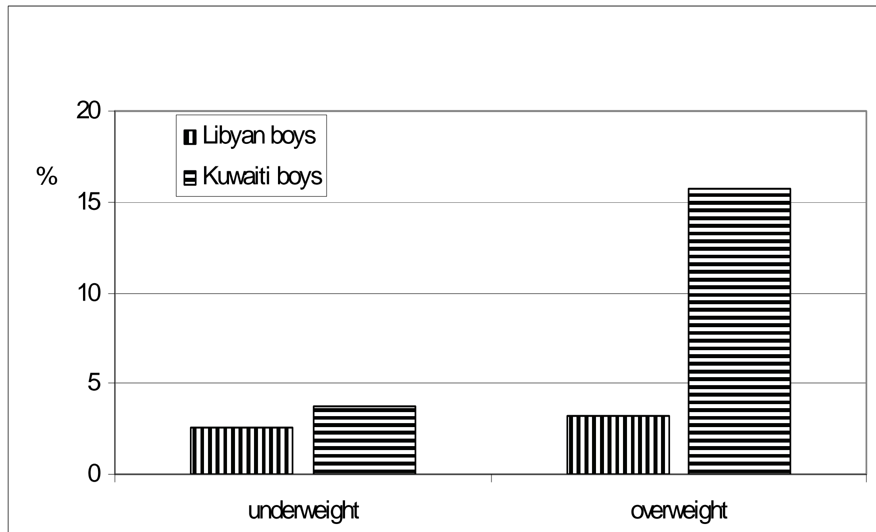

Figure 40: Comparison of underweight and overweight between Libyan and Kuwaiti boys (Ref. 61).

Weight-for-age is the most widely used indicator of child nutritional status in developing countries. This shows a positive indication that Derna had a low prevalence of underweight and overweight school children.

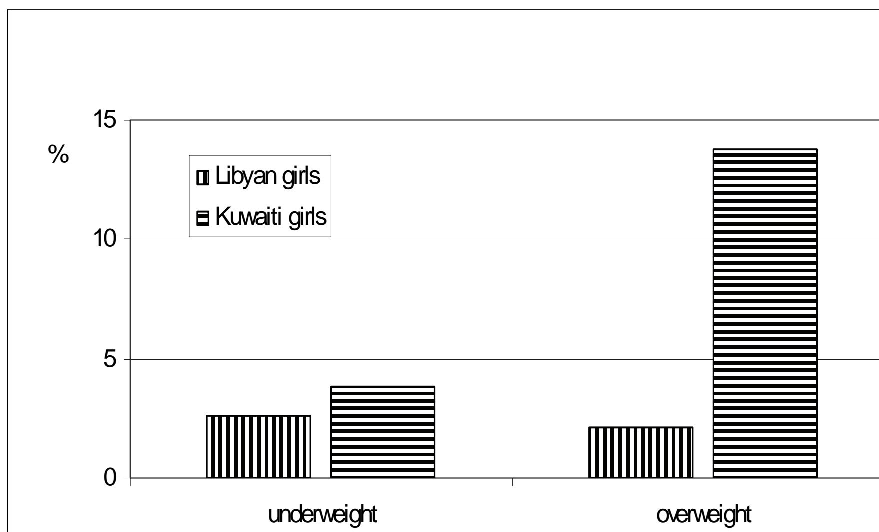

Figure 41: Comparison of underweight and overweight between Libyan and Kuwaiti girls (Ref. 61).

This low percentage is quite satisfactory compared with that found in others studies undertaken in Gulf countries. The observation of low prevalence of undernourished in Libyan children could be attributed to improved nutrition, probably associated with economic improvements. The overall prevalence of overweight children was 2.7%; this percent age is satisfactory. This observed low number of overweight children was reported previously for Gulf Countries such as Saudi Arabia, Kuwait and United Arab Emirates and may be attributed to a higher participation in physical activities. In this study, the nutritional status (w/a) showed that about 94.2% and 95.3% of boys and girls children, respectively, fall between ± 2.00 SD, of the 2000 CDC reference population indicator of the present state. This probably accounted for the better nutrition and more physical activities of the children in urban and rural districts in Derna municipality.

5.1.2. Height for age (h/a)

The mean height of boys, 123.8 ± 8.2 cm, was significantly higher than that of girls 122.9 ± 8.2 cm (p<0.001). The prevalence of stunting among boys and girls was 2.1 and 3.0%, respectively, giving an overall prevalence of stunting as 2.6% (100 of 3,789 schoolchildren). The prevalence of stunting was not significant among boys and girls aged 6-9 years in Derna school children (p= 0.8). The prevalence of stunting was higher in rural children, 2.9%, when compared with urban children, 2.5%, though the difference was not statistically significant (p< 0.75). The prevalence of stunting was highest in rural boys (3.7%), while the lowest was in urban boys (2.0%). Urban boys and girls were taller than their counterparts in rural areas. In generally, school children aged 6-9 could be described as having the great majority fall between ± 2.00 SD of height for age (h/a) at 96.0% and 95.5% for boys and girls, respectively. The children in our sample are growing similarly to those in the 2000 CDC reference population. Development of health service, nutritional habits, and physical activities may contribute of low prevalence of stunting among school children. Stunting is frequently found to be associated with poor overall economic conditions, chronic or repeated infections, as well as inadequate nutrient intake (62, 63). The present study revealed that the prevalence of stunting (h/a) was low among

boys in comparison with a previous studies by Al-Nuaim. Al-Nuaim's study revealed the highest prevalence of stunting among Saudi Arabia boys children aged 6- 11 years was 18.1% at 9 years of age (59). A Previous study conducted in Delhi on children (6-9 years) in 2004 has reported the prevalence of stunting to be 45.1% in children (64).

5.1.3. BMI for age

BMI is an inexpensive and easy method of screening for nutritional status categories that may relate to health problems. BMI was calculated by dividing weight (kg) by height in (m) to a square (m^2). There is a gradual and a steady increase in BMI with increasing age; the mean BMI continued to increase when age of children increased. There was no evidence of statistical significant observed in the BMI among boys and girls (p=0.3). The mean value of BMI of boys and girls was 16.3 and 16.2 kg/m^2, respectively.

Our finding was that the mean BMI of girls at age 8 years (16.4 kg/m^2) was slightly higher than that of boys (16.2 kg/m^2) of the same age, though the difference was not statistically significant (p<0.4). This change at 96 months (third class) may be difficult to explain, but the study results revealed that girls at this age spent more time watching television and decreased physical activity than other children at different age groups. This factor may have promoted change toward a sedentary lifestyle and food energy intake exceeding expenditure, resulting in the conversion of excess energy into fat.

The analysis of the association between BMI and physical activity in children revealed that as the amount of physical activity increased the BMI decreased. Similar findings have been reported earlier (65, 66). A slightly higher mean BMI was observed among urban girls (16.2 kg/m^2) when compared to rural girls (15.9 kg/m^2). The comparison of the BMI at different age groups in urban and rural areas revealed a higher BMI among urban children (16.3 kg/m^2) than rural children (16.0 kg/m^2). The differences were statistical significant (p=0.04). These results may be due to modernization. It has been shown that modernization is associated with a higher BMI among urban children because it is associated with a decrease in physical activity as

a result of increased dependence on effort-saving devices, like cars and other equipment, e.g. electronic games. This study showed that the prevalence of obesity was 3.0% and 2.3% of boys and girls of two communities respectively. Boys tended to have higher BMI than girls. These percentages were lower than those observed among the Kuwaiti children aged 6-9 years (8.1% for boys and 8.8% for girls) (67).
This data obtained are useful for monitoring obesity in school children in Derna as well as being useful references data for this country in other regions. The overall prevalence of obesity (BMI-for-age >2 SD) in school children was lower according to 2000 CDC.

5.2. Dietary Intake (24- h recalls**)**

A varied and balance diet is essential to good health. Poor nutrition contributes to at least 30 percent of deaths from coronary heart disease (68). Data on 24-hour food intakes for 507 (255 boys and 252 girls) children were obtained to determine the intake of energy, protein, total fat, carbohydrate, calcium, iron, zinc, folate, magnesium, sodium, fiber, water soluble vitamins and fat soluble vitamins. After determining group estimates of energy and nutrients intake, mean intake was compared to the recommended daily allowance (RDA) of the National Research Council (NRC) of the USA. A distinction was made between the time the children were in school and when they were at home. Differences in nutrient intake were analyzed using SPSS. A p-value of <0.05 was considered to be statistically significant. When Libyan school children's foods were compared to RDA in the present study, the difference between boys and girls in fat intake was not statistically significant ($p=0.5$), the average daily intake of total fat was 94% for boys and 89% for girls. This study found that the meals served provided 91% (± 9) of the RDA of total fat for all children. Fat intake in Libya is primarily from vegetable oil, which is utilized in the preparation of almost all mixed dishes. Fat is a necessary nutrient in a child's diet, it helps provide extra calories and needed nutrients for active and growing children (69). Daily per capita fat supplies showed an impressive increase in most of Arab Middle East countries, ranging from 13.6% in Sudan, 43.2% in Libya to 143.3% in Saudi Arabia. Table 10 reveals to daily per capita dietary energy in the Arab Middle

Eastern countries, 1971-1997 (70). Total food consumption should have no more than 35% of its calories from fat according to the RDA.

The mean protein intake of boys was significantly higher than that which girls-248% and 204% respectively. The average daily intake of protein was 226% (SD = 25.4) of the RDA. School children consumed an average of nearly 2.5 times the RDA and there was a statistical significant difference between boys and girls (p=0.001). This study revealed that the diet exceeded recommendations for protein intake about 2.5 times more than the RDA. The main sources of protein were eggs and meat. Lamb, beef and poultry in various forms are the most widely eaten meat dishes in Libyan cuisine. The highest average daily food energy and protein intake was more likely to be found in third class boys, 85% of the RDA for energy and 260% of the RDA for protein respectively. The highest daily fat intake was more likely to be found in fourth class girls (104% of the RDA). Among the food groups protein and fat play an important role not in providing the required energy only but also in the normally growth process (71). Comparison of mean carbohydrate and fat intake of boys and girls according to 24- h recalls are shown in figure 42. According to the literature, protein-energy malnutrition is not a common problem in this country (72). This is confirmed by our findings indicating that the diets of school children aged 6-9 years old exceed intake recommendations for protein. Therefore, low dietary intakes of saturated fatty acid are recommended for healthy children and adolescents to reduce the long-term risk of heart disease. The food energy portion of carbohydrates (59% of RDA) was extremely low.

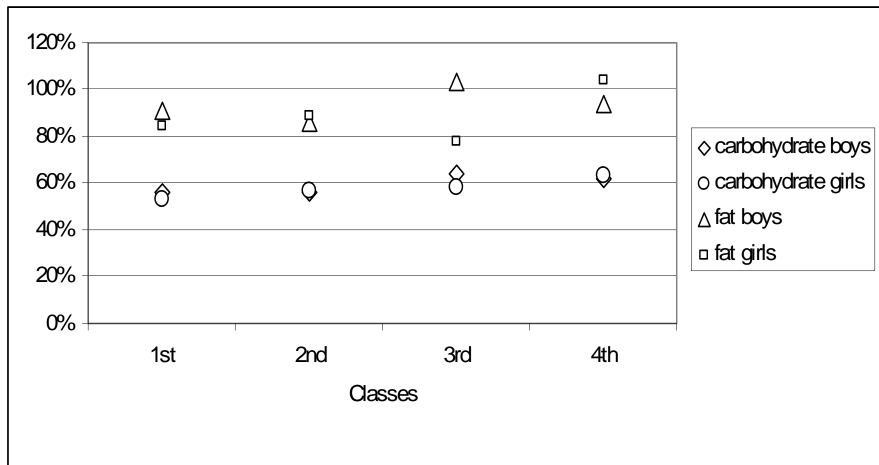

Figure 42: Comparison of mean carbohydrate and fat consumption of boys and girls in percent of RDA according to 24- h recalls.

Energy, macronutrients and micronutrients intake of the children during 24-h recall are shown in figure 43 and table 11. Although there is a great deal of evidence that suggests the RDAs are often far too low for optimal health. Unfortunately, the typical children's diet is low in important minerals such as iron (70%), a particularly important mineral.

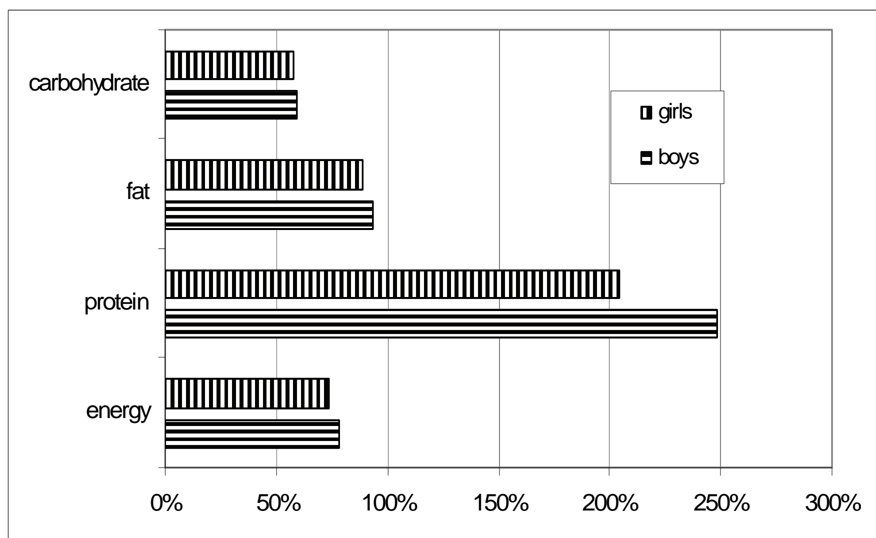

Figure 43: Energy, protein, fat and carbohydrate intake of Libyan school children in percent of RDA.

Iron helps to keep red blood cells healthy. In this study insufficient iron can lead to iron-deficiency anemia, which is particularly common among young girls. Iron deficiency is due to a combination of dietary factors: low iron intake and high consumption of whole grains rich in phytates, the low consumption of food rich in vitamin C and frequent consumption of tea. Tea inhibits absorption of iron and is widely consumed in this area, particularly after a heavy lunch. To help absorb the iron more effectively, it is recommended to combine iron-containing foods with vitamin C-rich foods such as citrus fruits, fruit juice, tomatoes and green leafy vegetables. Children need an adequate supply of nutrients such as iron to prevent iron deficiency and anaemia. In this study, both sexes consumed 61, 68, 54 and 82% of vitamins A, C, B_1, B_2, and E, of the RDA, respectively. Only 17% of the RDA was consumed for folate but 149% of the RDA was consumed for vitamin B_6 and 130% of the RDA was consumed for carotene (nearly 1.5 times in percent of the RDA), as shown in figure 44.

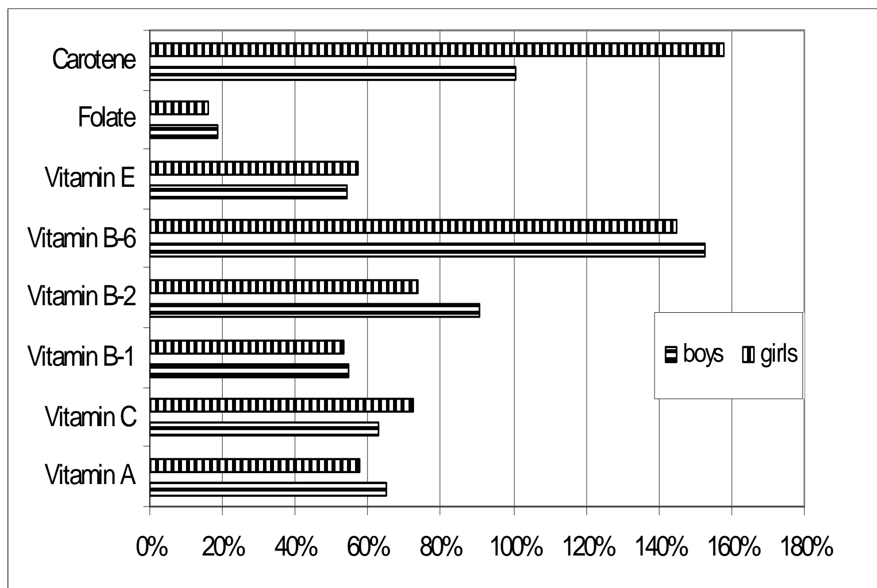

Figure 44: Vitamins intakes in percent of RDA.

In this study calcium intake (56%) was insufficient in all children according to RDA. Calcium is important for healthy bone development. Insufficient calcium intake during childhood is associated with low bone density and an increased risk for osteoporosis

later in life. Good sources include dairy products such as milk, cheese, yoghurt, green leafy vegetables; and cereals. These foods should be consumed when available. In this study the mean daily energy intakes in all groups were below 100% RDA (76% ± 5.8). There was no significant difference observed between energy intake of boys and girls (79% and 73% respectively). When compared with the previous reports of Saudi children, the daily energy intake was 64% of the RDA whereas the protein intake was 139% (73). Another report from Cairo revealed that the average intake of fat was 31% of dietary energy for children (74). The majority of girls and boys in this study reported eating adequate amounts of minerals such as zinc (104%), phosphorus (106%) and magnesium (108%) as a percent of RDA. In this study the mean daily intakes of cholesterol (258mg) and sodium (1962mg) were healthy according to the NRC. The NRC recommends that children should consume ≤ 300 mg of cholesterol and ≤ 2400 mg of sodium. In this study the mean daily fiber intake was 10.0 g. Boys consumed an average of 10.25 and girls consumed an average of 9.94 g of fiber. These values are generally low among this population of children when compared with the RDA (25.0g) and other previous studies. In Saudi Arabia Zahran and Zahran found that the average daily consumption of fiber was almost equal among both sexes (13.2 and 13.4 g for boys and girls respectively) (75). This study concluded that boys and girls students had on average dietary fiber intake; they seemed to base food selection on palatability and not healthfulness. In Germany, fat contributes an average 41% of daily energy intake, whereas the mean contributions of protein and carbohydrates were 15% and 44% of daily energy, respectively. The average daily intake of dietary fiber of primary school children aged 6–11 y in Munich is 16.3 g ± 1.4 (76). In Derna study we found some nutrients were below recommendation for children such as iron, calcium, as well as fat soluble vitamins such as vitamins A (61%) and E (56%), water soluble vitamins such as vitamins C (68%), B_1 (54%), and folic acid (17%). Vitamins B_6 (150%), carotene (130%) and vitamin B_2 (82%) were exceptions. Dietary quality deficiencies were evident for calcium, iron and fat soluble vitamins, A and E. Fat soluble vitamins dissolve in fat before they are absorbed in the blood stream to carry out their functions. These vitamins are stored in the liver. Because they are stored, they are

not needed every day in the diet. In contrast, water-soluble vitamins such as the B-complex group and vitamin C dissolve in water and are not stored. They are eliminated in urine. We need a continuous supply of them in our diets. A low-fiber intake was similar to that of others studies (77, 78). Low fiber and increased fat consumption may come from eating snacks between meals. The main food contributors to fat intake in these children's diets were deep fried chips. Young people who eat fast foods have higher intakes of fat and lower intake of fiber (79). Additionally, foods in the region are becoming increasingly processed with the result that grain products tend to be refined and thus lose their fiber content. A further decrease in fiber intake takes place with a decrease in the consumption of whole grain. For example, sorghum and millet which are usually unrefined (and therefore keep much of their fiber) are becoming less important, and are being replaced by refined wheat flour (white bread). Of particular concern in this study was that fiber consumption was not derived from fresh fruit or vegetables, but from grain products such as cereals, pasta and bread. This survey observed low consumption of fruits and vegetables. Low fiber intake may due to the lack of information on the fiber content of several foods consumed. Two broad categories for each macronutrient were defined in comparison to RDA. According this, children who receive more than 75% of RDA are normal in macronutrient intake and children who receive less than 75% of RDA have macronutrient deficiency. The people who consume less than 70 percent of an RDA are at risk for developing nutritional deficiency (80). In this study none of the children had a problem with macronutrients intake. This study revealed that the lunch time was frequently skipped by school children because children go to school at 13:00 p.m. This is important because lunch is the most important meal in Libya and the greatest source of kilocalories. This means that the lunch time may contribute significantly to the total daily nutrient intake and play a vital role in improving the nutritional status of school children. The quality of the children's lunch affects the dietary intake of a variety of essential nutrients such as some vitamins among primary school children. The dietary habits of school children are characterized by low intake of fresh fruits, vegetables, and fish. Actually, intake in this age group is closed to zero. But, unfortunately, they show a high intake of carbonated

beverages and fast foods. Fast food restaurants are more prevalent in schools and some neighborhoods. These snacks include high-fat such as cheeseburgers, minced meat and chips. High fat intake in the children's diet was not recommended in a daily dietary pattern. It is probable that the high consumption of foods rich in fats and sedentary lifestyle among children played an important role in the increase of many chronic diseases, including CHD, stroke, diabetes, hypertension and certain types of cancer. Furthermore, a preference for a high-fat diet established in children may be hard to change later in life and may be a risk indicator for features of metabolic syndrome (81). A reduction in the consumption of fat (especially saturated fat) and cholesterol was highly recommended. Foods that are relatively low in these substances, such as vegetables, fruits, whole grain foods, fish; poultry, lean meats and low-fat dairy products should be chosen. Increased consumption of foods high in calcium and iron is recommended for all. Data reported in this study showed that there is a shift in dietary habits from a traditional Mediterranean diet to industrial food. The main recommendations are maintaining body weight, consumption complex carbohydrates, keeping dietary cholesterol less than 200-300 mg/day, reducing of fat intake, eating fish once per week, and increasing consumption of antioxidants. A balance diet full of essential vitamins and minerals will help a child reach his or her full growth potential. To ensure improved dietary habits among children, we suggest that nutritional intervention strategies should encompass both school and family life with educational and practical strategies in place that may help diminish this serious problem. The RDAs for most dietary components are set such that the recommended amount is sufficient to meet the needs of most healthy individual. However, nutritional requirements of individual vary greatly, and many persons are perfectly healthy even if they consume much less of a nutrient than suggested by the RDA. Thus, a usual intake below the RDA does not necessarily signal a nutrient deficiency. This study recommended the importance of nutrition education to school children on hygienic food preparation and nutrition. The dietary intake data for this study are taken from just a single, 24-h dietary recall interview that covered a school day. A student's intake of specific nutrients may vary considerably from one day to the next being high one day and low another and still constitute an adequate intake over a period of time.

5.3. Physical activity and Television Viewing (Classification of daily activities):

In this study 507 (255 boys and 252 girls) school children aged 6-9 years were included to determine the form and extent of daily physical activities. Time spent watching television represented about 13.0% and 16.2% of time they spent on average, each day, of boys and girls respectively. The time spent of physical activity represented about 20% and 16.4% of the time spent on average a day of boys and girls respectively. Girls spend more time watching television than boys. The mean highest time watching television was found among age 96 months of girls (4.5 hours/day). The mean lowest time watching television was found among age 108 months of boys (2.6 hours/day). Girls who watched 4 or more hours of television on the day preceding the survey were more likely to be overweight (82). Our finding was that at age 96 months, BMI of girls (16.4 kg/m²) was slightly higher than boys (16.2 kg/m²) of same age. Children who watched the most television had greater BMI than those who watched less hours per day. Television may reduce time spent in activity with higher energy expenditure. Our data corroborate findings of Carlos and coauthors showing that television watching was associated with increased skinfold thickness and BMI among youths (83). Tables12 and 13 show the results of an analysis of environmental variables for boys and girls. The average daily study hours of boys and girls was about 12.0% and 13.9%, respectively. Girls spent more time studying (3.3 hours/day ± 0.28) and engaged more time watching TV (3.9 hours/day ± 0.22) but had the same sleeping hours (10.3 hours/day ± 0.75) and play outside (3.9 hours/day ±0.63) than boys. Boys had more physical activity (4.9 hours/day ± 0.31) than girls, but less television watching (3.2 hrs/day ± 0.42). Boys spent less time studying (2.9 hours/day ± 0.37) than girls. Boys and girls similarly spent time playing video games (2.7 and 2.6 hours/day, respectively). The amount of physical activities in boys increases with age. Boys in all age groups were more likely than girls to exercise four or more hours a day. Physical activity level represented engaging in light to moderate activities such as brisk walking, running and football playing. Boys may be moving away from casual exercise with friends after school, such as riding bike. In contrast, girls spend a large part of their time in the home,

especially at age 9 years. The decreased of physical activities of girls may explain the increased amount of time given to other leisure activities especially watching television and studying. Television viewing decreased with increasing age among boys. The time spent for sleeping represented about 43% of boys and girls. Sleeping time peaked for boys and girls at age 72 months (firs class), 11.40 hours/day and 11.00 hours/day respectively; there was a clear decline of sleeping time with increasing age in both sexes. Girls reported slightly lower rates on most physical activity measures than boys. Girls should be actively encouraged to reduce the amount of time spent in sedentary activities. Reducing television watching may be a way to reduce and prevent overweight among children. Physical activity in the hot climate may contribute to prevent the prevalence of obesity and overweight between target samples. The level of physical activity in our study may be optimistically high (>4 hours/daily) because children who lived in Derna city (Mediterranean coast) were surveyed during September (temperature between 18-25C°) when physical activity is known to be its peak. Schools provide more friendly environments for physical activity. The large increase in activity levels of school children may be attributed to the favorable weather condition in north Libya. School children obtained more physical activity on average here probably than in other seasons (e.g. winter).

5.4. Height, weight and BMI increment within one year

Comparison of height increase within one year in boys and girls revealed that the average height gain was higher among girls than boys at different age groups, except from age 8 to 9 there was a similarly increment among the two genders (5.88 in boys and 5.87cm in girls). Table 14 and 15 reveal that anthropometric measurements within one year of boys and girls. The average Weight increments among girls were larger than boys at age group 7 to 8 years and 9 to10 years. Among boys the average weight increments were larger than girls at age 6 to 7 years and 8 to 9 years. Overall, the girls had a larger weight gain than boys (3.69 and 3.52 kg/year, respectively). Our results revealed that the average value of increment height gain within one year was clearly higher among girls than boys at 6.04 and 5.85 cm/year, respectively. This study was compared with a 1989 study in Libya by Shamssin.

Shamssin's study showed that girls increase in standing height 5.66 cm/year while boys increase about 5.35 cm/year (84). School children in this study, were higher in standing height than Libyan children in the 1989 Shamssin study, as shown in Figure 45. The data reported here and in 1989 strongly indicate that improvements have occurred in the growth patterns and nutritional status of Libyan children in the two past decades. (Maybe this is because Shamssin' study was conducted during the country's isolation and hampered economic development. Libya was experiencing a peak of political and economic difficulties due to UN sanctions). The children in our study were taller than school children in 1989. The highest gain in weight in boys (peak weight velocity, PWV) was 4.36 kg/year and it was between 8-9 years, while in girls the highest weight gain was 4.11 kg/year between 9 and 10 years. The average rate in weight in boys was 3.52 kg/year, while in girls it was 3.69 kg/year. This study revealed that the average weight gain was higher among girls than boys, there was no statistical significant ($p>0.4$). The peak gain in BMI in boys was 0.99 kg/m²/year between 8 and 9 years, and in girls the highest increase in BMI was 0.93 kg/m²/year and occurred between 7 and 8 years of age. The average increase in BMI within one year was higher in girls than boys, 0.75 vs. 0.63 kg/m²/year. In general, the BMI of boys appears to be lower than girls. Moreover, boys lose fat during puberty faster than girls and girls still store more fat during the spurt of height than boys. Also, the fat deposition among girls continues throughout puberty. The differences in BMI between the sexes may further be explained by the differences in the level of physical activity between them; boys tend to be more physical active than girls. These results showed that there was no statistical significance between the two genders ($p > 0.5$). The average increase of standing height was higher among girls than boys, probably because of their earlier growth spurt and there was no statistical significant ($p > 0.2$). Our results may reveal that girls became taller and heaver earlier than boys within one year, and reach puberty earlier than boys. We observed that growth velocity within one year was higher in girls than in boys. These results confirm results from Shamssain's studies (1989) that adolescent growth spurt, which is evidenced as a sharp increase in velocity, occurred in girls at the age of around 10

years while in boys it occurred around 15 years. This study focused on childhood period and can be consider a basis for further studies during adolescent period.

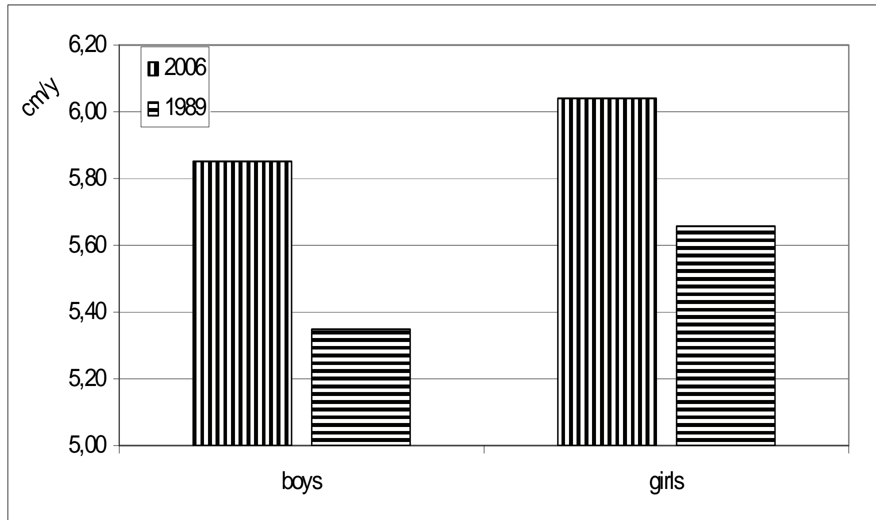

Figure 45: Comparison of increment height within one year (cm/y) between Shamssin 1989 and a 2006 study (Ref. 83).

5.5. Nutrition status of Derna school children as based CDC 2000 compared with 2007 WHO reference:

The results revealed the main finding that the 2000 CDC sample show a higher prevalence of underweight, stunting and thinness (<-2 SD), while the 2007 WHO reference sample indicated a higher prevalence of overweight and taller (>+2 SD). Estimates of overweight and obesity (BMI-for-age) increase substantially when the 2007 WHO standard is used. These results are consistent with de Ones, *et al.* (2007) who reported that the CDC reference deems children to be heavier, based on the -2 SD cut-off point. Also, the prevalence of underweight children will be higher during the first 6 months of life when based on the 2007 WHO standard and lower thereafter throughout childhood (85). The distribution of z-score of weight for age, height for age and weight for height of both sexes according to the 2007 WHO fall between ± 2.00 SD as shown in figure 46, 47 and 48. Stunting was higher according to the 2000 CDC reference than the 2007 WHO reference resulting in 3.0 and 2.7%, respectively, for girls and 2.1 and 1.9 of boys as shown tables 16 and 17. Prevalence of underweight

children was lower as based on the 2007 WHO vs. the 2000 CDC for both sexes, 2.0 vs. 2.6% for girls and 1.7 vs. 2.6% for boys, respectively, of pooled data as shown tables 18 and 19. Weight for height is nearly to BMI z-score; therefore we used the BMIZ value. The prevalence of obesity children was lower as based on the 2000 CDC vs. the 2007 WHO for girls 5.3 and 2.4%, for boys 4.4 and 3.0%, respectively, as shown in tables 20 and 21. These results showed lower rates of undernutrition, thinness and stunting (<-2 SD) and higher rates of overweight, obesity and taller (>+2 SD) as based on the 2007 WHO growth standard compared with the 2000 CDC reference. This study showed that Libyan children in Derna municipality are considered to have a low prevalence of stunting (h/a) for girls and boys based on the newly published WHO reference. Therefore, school children aged 6-9 years could generally be described as having the great majority fall between ± 2.00 SD score of weight-for-age and height-for-age (94 and 95%, respectively) as based on the 2007 WHO. Identified birth date children included 679 students with 338 boys and 359 girls. The data show that underweight, stunted and thinness (<-2SD) were higher (HAZ 3.8, BMIZ 2.9 and WAZ 4.2%) as based on the 2000 CDC reference vs. the 2007 WHO reference (HAZ 1.3, BMIZ 2.0 and WAZ 1.6%), as shown in figure 22. On other hand, the prevalence of HAZ, WAZ, and BMIZ was higher according to WHO vs. CDC reference. The growth and nutritional status of Derna children were satisfactory; the present study is a good indicator of the health and nutritional status of Derna school children. It also provides a useful guide to the health status of the community as a whole.

Figure 46: Comparison of the distribution of z-score for weight-for-age of Libyan children (boys and girls) aged 6-9 years based on the 2007 WHO growth standard.

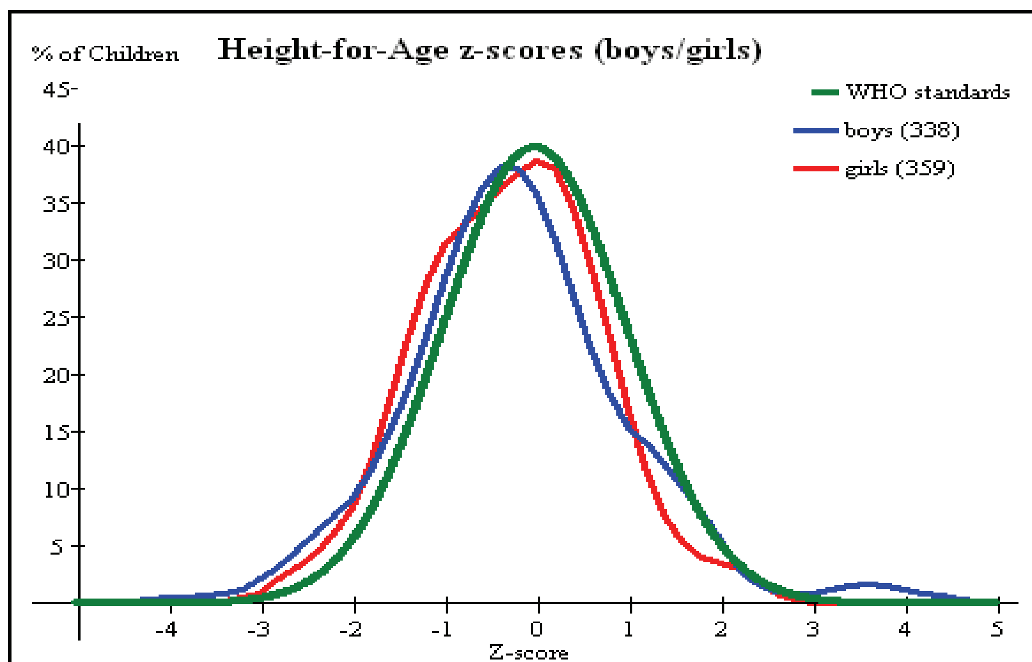

Figure 47: Comparison of the distribution of z-score for height-for-age of Libyan children (boys and girls) aged 6-9 years based on the 2007 WHO growth standard.

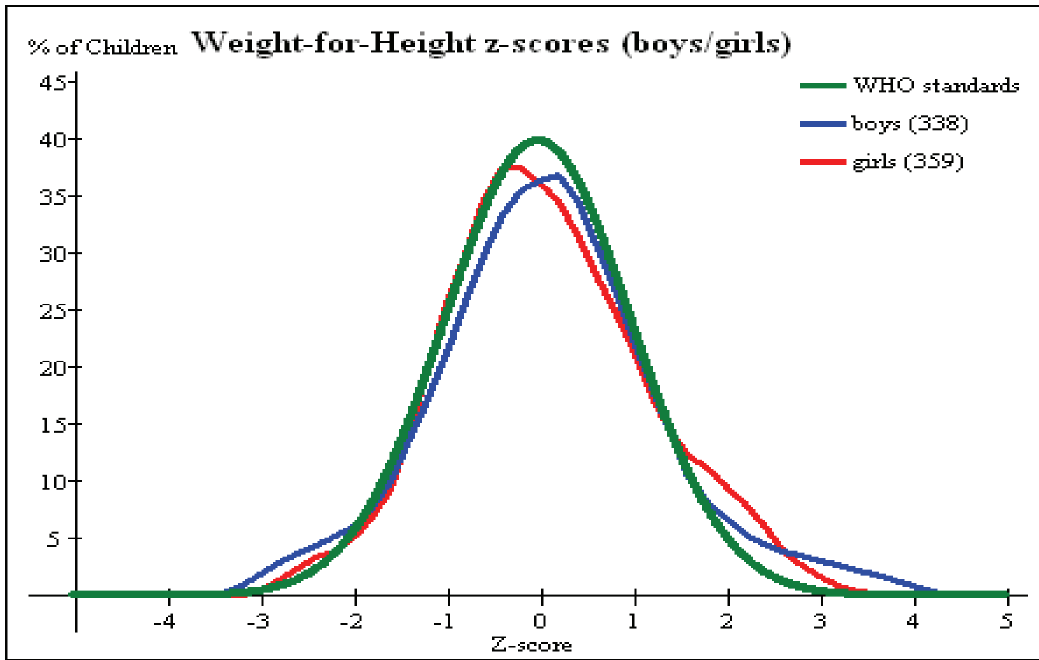

Fig. 48: Comparison of the distribution of z-score for weight-for-height of Libyan children (boys and girls) aged 6-9 years based on the 2007 WHO growth standard.

In general, our results were strongly indicated that improvements have occurred in the growth patterns and nutritional status in this part of country in the two past decades. The nutritional status of Libyan children has improved as a result of the policy of development adopted throughout the country in recent decades, as compared with finding from other Arab countries as shown in Figures 49 and 50.

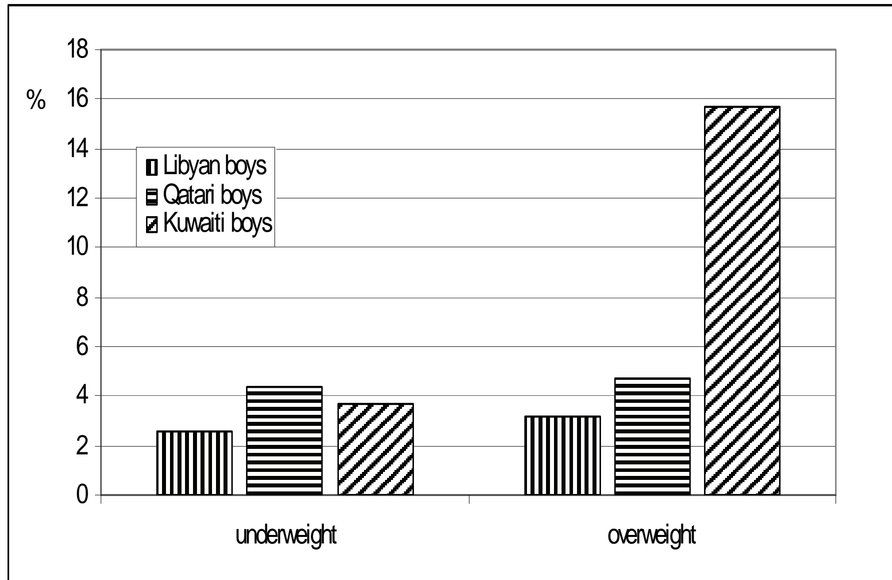

Fig. 49: Comparison of underweight and overweight between Libyan, Qatari, and Kuwaiti boys (Ref.58 and 61).

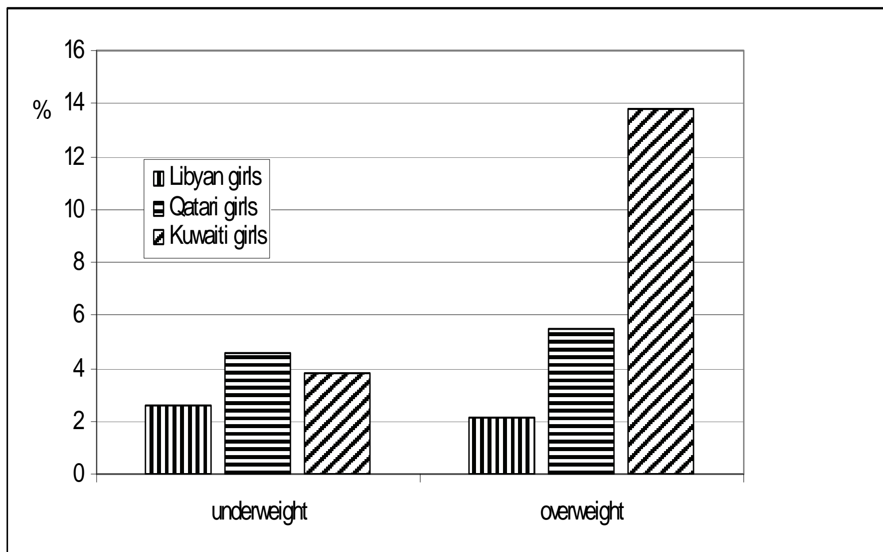

Fig. 50: Comparison of underweight and overweight between Libyan, Qatari, and Kuwaiti girls (Ref.58 and 61).

5.6. Diabetes mellitus

Life style and obesity are among the principal environmental factors that enhance the risk of the developing diabetes. The most common forms of diabetes are type II diabetes. This type of diabetes is associated with older age, obesity, family history, physical inactivity. Type II diabetes is increasingly being diagnosed in children and adolescents. In addition to anthropometric measurements, dietary intake and physical activities, this study focused on the determination of the prevalence of diabetes incidence among 6-9 years old school children in Derna municipality. Diabetes is a major health problem in this country. Report shows that the prevalence of diabetes in Benghazi is 14.1%, the annual average incidence of type I (type I diabetes is an autoimmune disease) among 0-14-year-old is 7.8 per 100,000. This accounts for 22% of all medical admissions to a teaching hospital in Benghazi (86). Another study from Benghazi revealed an incidence of type II diabetes (0-34 years at onset) of 19.6 and 35.3 per 100.000 individuals for males and females, respectively (87).

Derna diabetes center is the only outpatient diabetes clinic in Derna. The center provides oral hypoglycemic drugs, insulin, and insulin syringes free of charge. However, there is neither a dietitian nor an education program for patients. A total of 6577 diabetic patients were on the register at the end of 2007, representing about 6.25% of total inhabitants (105,932). 35 children had type I diabetes among 0-14 years olds. Childhood diabetes mellitus (type I) in Derna constituted 0.53 per cent of the total clinic population. The anthropometric measurements between the 2005/2006 and 2006/2007 school years showed the prevalence of Diabetes mellitus (type I) among students aged 6-9 years registered in the primary schools. 7,527 students from first to fourth classes were included in the survey. The study showed that only 9 children (6 boys and 3 girls) were affected by diabetes mellitus, all of them having type I diabetes. This represents 0.12% of total target sample and about 0.14 percent of the total clinic population of 6577 patients. All patients (9 cases) with type I diabetes were taking insulin. All registered patients have files. In this survey the overall prevalence of type I diabetes in the age group 6-9 years was low (120 per 100,000) when compared with previous study of Kuwait children. Kuwaiti children showed that the prevalence rate of type I diabetes in the age group 6-9 years was

182.6 per 100,000 (88). Another study of Kuwaiti children revealed an incidence of type II was 34.9 per 100.000 children aged 6-18 years (89). Family history of diabetes was positive in 44.4% (4 from 9 diabetic's children) of patients with insulin-dependent diabetes mellitus (IDDM). All patients with diabetes mellitus were not overweight, and all of them were from an urban community. Noninsulin-dependent diabetes mellitus (NIDDM) was investigated in this survey and there was no incidence of NIDDM in school children aged 6-9 years. It is evident that after the control of endemic diseases in Libyan Arab Jamahiriya (tuberculosis, schistosomiasis, malaria, trachoma and leprosy), diabetes mellitus is emerging as a health problem. Diabetes mellitus is considered a priority in health planning in the country (90). The survey shows a low prevalence of diabetes mellitus compared with Kuwaiti children at the same age. This may result Low diabetes risk factors such as obesity. Childhood obesity can increase the risk of a child developing a range of disorders in later life such as diabetes or heart disease. Improvements to create healthy lifestyle such as healthy dietary habits and physical activity in childhood and improvements in care for this major health problem can help prevent diabetes. A dietitian who is knowledgeable about Libyan food and eating habits should be available daily in diabetes center. Studying the effect of diet in humans is far more difficult than in animal models for the obvious reason that the human diet is usually not controlled for extended periods of time, let alone from birth. Studies of the effect of cow's milk, human breast milk, *N*-nitroso compounds, gluten, bovine serum albumin, fat, and protein on the development of IDDM are numerous, but none of these factors proven to play a direct role in the disease process (91).

In summary, this study shows a low rate of obesity and increasing of physical activity among school children aged 6-9 years which can reduce the risk of type II in this group, physical activity, and weight control are critical factors in type II diabetes prevention in children.

6. Recommendation

Schools and communities need to provide physical activity programs that meet the needs and interests of all children. Dietitians can serve as advisors for schools and communities to ensure that such programs are safe and enjoyable and provide activity for all children. Dietitians need to educate parents about the complications of being overweight and encourage family to make changes that include increases in physical activity of the overweight children, limiting television watching and development of healthy eating habits. Schools also play an important role in teaching healthy eating and exercise behaviors. It is important consolidate nutrition education, to enhance nutrition awareness in order to improve the nutritional status of the population. It is also of vital importance to carry out a national nutrition survey and to establish a nutrition information system. Total food should include no more than 35% of its calories from fat and 10% calories from saturated fat. There is no need to limit the consumption of monounsaturated fatty acids such as in olive oil in children with normal body weights because monounsaturated fatty acids do not raise LDL cholesterol (92). Food should have no more than 35% sugar by weight. One can conduct surveillance to monitor the prevalence of overweight based on Body Mass Index (BMI) and chronic diseases associated with overweight in children. Research can also be promoted to determine the effectiveness of programs targeted at improving nutrition and increasing activity in the country. The best nutrition advice to keep children healthy includes:

- Eat a variety of foods.
- Balance the food you eat with physical activity.
- Encourage children to adopt a lifestyle involving aerobic form of exercise.
- Choose a diet with plenty of grain products, vegetables and fruits.
- Choose a diet low in fat, saturated fat, and cholesterol.
- Choose a diet moderate in sugars and salt.
- Choose a diet that provides enough calcium and iron to meet their growing body's requirements.

- Increase the consumption of whole grain foods and cereal products rather than the refined varieties.

Promote joint/shared use of facilities among school, parks, libraries, health care clinics to increase opportunities for physical activity and health eating in community setting. Increase space allocated for physical education activity, and increase funding for adequate physical education equipment in schools. Reversing the trends of physical inactivity and unhealthy eating requires a comprehensive approach in order to change social norm, eliminate negative environmental factors, and assist individuals and families with the behavior changes that ultimately must occur. Encourage television station to offer programs on nutrition and healthy cooking as well as physical activity. Nutrition education programs should focus on the prevention of heart disease, obesity, diabetes, dental caries and cancer. Create high school academies focusing on nutrition and physical activity. Encourage colleges and universities to promote college credit opportunities for students who work with schools communities in the areas of nutrition and physical education. Promote health education mentoring programs focusing on nutrition and physical activity for high school student to work with elementary students. Ensure that cafeteria meals include a variety of appealing and nutritional choice, including choices of fruits, vegetables, whole grain and low-fat dairy products. Ensure that cafeterias are clean, safe and pleasant. Improve the health and medical school curriculum by introducing more information on prevention and management of nutritional disorders associated with affluence. This study provided some baseline data for future research and for the use of policy makers. It also clearly supports the need for effective dietary education for adolescents, and even for children. These data can be useful for further research and investigation into overweight, underweight and stunted children and adolescents in Libyan Arab Jamahiriya. The present study may be used as a source of reference for the Libyan population.

7. Summary

The Libyan Arab Jamahiriya, situated in North Africa, it is extends over 1,759,540 square kilometers. It is the 17th largest nation in the world by size. The Libyan total population is about 5,765,563 (est. July 2005). Derna city is one of the municipalities of Libya. It is located in the northeast of the country as shown Figure 49. The overall Population of Derna is 105,932 (2005 census) and the area is 4908 km^2. The total number of elementary public schools in Derna city was 31 at the time of study, with 24 urban schools and 7 rural schools. Height and weight are important indicators of the health and nutritional status of children and adolescents. Waterlow *et al.* recommend that, for the assessment of nutritional status in cross-sectional studies, primary reliance should be placed on (h/a) as an indicator of the past state of nutrition and (w/a) as an indicator of the present state of nutrition. This study was carried out in the 2005/2006 school year starting in September to 2006/2007 school year. 3,879 school children age 6-9 years were included. Our study (at the first year measurements) revealed that the weight patterns boys were significantly higher than girls at all age groups, ($p<0.03$). The boys were significantly taller than that of girls at all age group ($p<0.001$). The mean values of weight, height and BMI increased with age for both sexes at all age groups. Significant differences in mean weight ($p<0.03$), and height ($p<0.001$), were found between boys and girls. These results show that at all age groups, BMI are comparatively higher in boys than in girls, while we could not find a statistical significant difference ($p<0.3$). One except was higher among girls (16.4 kg/m^2) than boys (16.2 kg/m^2) at the age 96 months, though the difference was not statistically significant ($p< 0.4$). The mean weight for urban children and rural children was 24.8 and 24.4, respectively. The mean height for urban children and rural children was 123.4 and 123.0 cm, respectively: These results showed that there was no statistically significant difference between the two communities ($p<0.1$ and $p<0.4$, respectively). Significant differences were found in mean BMI between urban and rural children- 16.25 and 16.04 kg/m^2, respectively ($p<0.04$). The comparison of the nutritional status (w/a) at different age groups in urban and rural areas revealed higher prevalence of underweight and overweight children in urban communities compared to rural communities. However, the difference was not

statistically significant (*p*>0.1 and *p*>0.3, respectively). The prevalence of stunting was higher among rural children (2.9%) than urban children (2.5%); these results showed no evidence of statistical difference between the two communities (*p*>0.7). All the means of the anthropometric parameters (weight, height and BMI) in urban children were slightly higher than those of rural; the results obtained for school children in rural areas could have been skewed due to the small size in each age group of children. Therefore, Libyan children in Derna could generally be described as having the great majority of school children aged 6-9 years fall between ± 2.00 SD of height for age (h/a) 96.0% and 95.5% for boys and girls, respectively, and weight for age (w/a) 94.2% and 95.3% for boys and girls, respectively. The children in our sample are growing according to 2000 CDC reference population. This shows a positive indication that school children in Derna had a low prevalence rate of underweight, overweight and stunted children when compared with that found in others studies undertaken in Gulf countries. Comparisons among countries are difficult, because different reference values for the definition of overweight and underweight have been used. Our study compared previous studies used the same reference values (the 2000 CDC reference population). The overall prevalence of undernutrition, overweight and stunting among the school children study were low. This result could be attributed to socioeconomics and living conditions that are under development in the country. According to the 2007 WHO classification of severity of malnutrition among children, the overall age- and sex-combined rates of underweight and stunting were low. The rates of undernutrition in the present study were lower than those reported among similar aged school children of Gulf countries. The average Weight increase within one year (at the second year measurements) showed that girls had larger weight gains than boys. The average increase of standing height was higher among girls than boys. The results revealed that girls became taller and heaver earlier than boys. There were some differences in nutritional status between the 2000 CDC and 2007 WHO references. The results revealed the main finding that the 2000 CDC reference arrives at a higher prevalence of underweight, stunting and thinness (<-2 SD), while the 2007 WHO reference declares a higher prevalence of overweight and taller (>+2 SD). The physical activity

levels were higher for boys than for girls with average ranging from 4.60 to 5.30 hours /day, while among girls physical activity average ranged from 3.00 to 4.70 hours/day. Boys were more active than girls but the difference was not statistically significant ($p>0.1$). Girls spent more time watching television than boys with the average ranging from 3.50 to 4.51 hours/day, while boys' television watching hours ranged from 2.60 to 3.50 hours/day. Boys spent more time engaging in physical activity (20.0% of their time) and spent less time television watching (13.0%). Girls spent 16.4% of their daily time doing physical activity and 16.2% of their time television watching. Boys spent more time physical activity (20.1%) and spent less time in sedentary activities such as television watching (13.3%) than girls. In this study the mean daily energy intakes in all children were below 100% of RDA (76% of RDA). Total energy intake showed no significant correlation with anthropometric factors in all children. Students consumed an average of nearly 2.5 times the RDA for protein. Importantly, the proportion of girls whose records indicate a deficiency in calcium was 49%. Adequate calcification of the skeleton during the growing years is necessary to prevent osteoporosis in older women. Overall, the diets of the school children described here show excessive intakes of protein and deficiencies in other particular nutrients. One further point that these data are based on one 24-h recall per individual and, due to day-to-day variability in the diet, this may not necessarily represent any one person. According to BMI, the population was considered as non-obese. In this survey the overall prevalence rates of type I diabetes mellitus in the age group 6-9 years were low (120 per 100,000) when compared with a previous study of Kuwait children (182.6 per 100,000). In this survey there was no incidence rate of NIDDM in school children.

Zusammenfassung

Libyen, das *Libysch-Arabische Dschamahirija* (amtliche Bezeichnung), ist ein in Nordafrika gelegener Staat, welcher sich über 1.759.540 Quadratkilometer erstreckt. Es ist größenmäßig die 17. größte Nation der Welt. Die libysche Gesamtbevölkerung beträgt ca. 5.765.563 (Juli 2005) Einwohner. Eines der Stadtgebiete Libyens ist Derna City. Es ist, wie in Abb. 49 dargestellt, im Nordosten des Landes gelegen. Die Gesamtbevölkerung von Derna zählt 105.932 Einwohner (Volkszählung 2005) auf einer Fläche von 4980km². Zum Zeitpunkt der Studie umfasste die Gesamtzahl an öffentlichen Grundschulen in Derna City 31 Schulen, davon 24 städtische und 7 ländliche Schulen.

Die Körpergröße und das Körpergewicht stellen wichtige Indikatoren für die Gesundheit und den Ernährungsstatus von Kindern und Jugendlichen dar. *Waterlow* et al. empfehlen, zur Bestimmung des Ernährungsstatus im Rahmen einer Querschnittsstudie, das Hauptaugenmerk auf das Verhältnis von Körpergröße/Körpergewicht (weight-for-hight ratio) als Indikator des zurückliegenden Ernährungsstatus zu legen und als Indikator des aktuellen Ernährungsstatus das Verhältnis von Körpergewicht/Lebensalter (weight-for-age ratio) zu ermitteln. Die vorliegende Studie wurde zwischen September des Schuljahres 2005/2006 und dem Schuljahr 2006/2007 durchgeführt. Es wurden 3879 Schulkinder im Alter von 6 bis 9 Jahren in die Studie eingeschlossen.

Unsere Studie zeigte (im ersten Jahr der Messungen), dass das Körpergewicht der Jungen signifikant höher lag im Vergleich zum Körpergewicht der Mädchen aller Altersgruppen ($p<0,03$). Die Jungen waren signifikant größer als die Mädchen in den verschiedenen Altergruppen ($p<0,001$). Mit steigendem Lebensalter konnte bei beiden Geschlechtern in allen Altersgruppen ein Anstieg des Mittelwertes für das Körpergewicht, die Körpergröße und den BMI festgestellt werden. Sowohl das mittlere Körpergewicht ($p<0,03$) als auch die mittlere Körpergröße ($p<0,001$) zeigten signifikante Unterschiede zwischen Mädchen und Jungen. Diese Ergebnisse zeigen, dass der BMI bei den Jungen in allen Altersgruppen gegenüber dem der Mädchen vergleichsweise hoch ist, wobei kein statistisch signifikanter Unterschied ($p<0,3$) festgestellt werden konnte. Lediglich die Mädchen in der Gruppe der Kinder im Alter

von 96 Monaten wiesen einen höheren BMI-Wert (16,4kg/m²) im Vergleich der Jungen (16,2kg/m²) auf. Dieser Unterschied war jedoch nicht statistisch signifikant ($p<0,4$). Die mittlere Körpergröße der Kinder aus städtischen und ländlichen Regionen betrug 123,4 und 123,0cm. Diese Ergebnisse zeigen, dass kein statistisch signifikanter Unterschied zwischen den beiden Bevölkerungsgruppen besteht ($p<0,1$ und $p<0,4$). Es wurden signifikante Unterschiede ($p<0,04$) für den mittleren BMI zwischen den Kindern in städtischen und ländlichen Regionen festgestellt (16,25 und 16,04kg/m²). Der Vergleich des Ernährungsstatus (Körpergewicht/Lebensalter) der verschiedenen Altersgruppen in städtischen und ländlichen Gebieten deutet auf eine höhere Prävalenz für Unter-/ und Übergewicht bei Kindern in der Gruppe der Teilnehmer aus städtischen Gebieten vergleichen mit jenen aus ländlichen Gebieten hin. Der Unterschied war jedoch nicht statistisch signifikant ($p>0,1$ und $p>0,3$).
Die Prävalenz einer Wachstumsretardierung ("stunting") lag unter den Kindern aus städtischen Regionen höher (2,9%) als bei den Kindern aus ländlichen Regionen (2,5%); die Ergebnisse zeigen keinen statistisch signifikanten Unterschied zwischen den Teilnehmern der beiden Regionen ($p>0,7$). Die bei den Kindern in den städtischen Regionen gemessenen Mittelwerte für die anthropometrischen Parameter (Körpergewicht, Körpergröße und BMI) lagen alle geringfügig oberhalb der Werte der Kinder aus ländlichen Gebieten; die für die Schulkinder aus ländlichen Gebieten ermittelten Ergebnisse könnten aufgrund der geringen Größe der verschiedenen Altersgruppen der Kinder verzerrt sein. Somit kann im allgemeinen davon ausgegangen werden, dass die aus Derna stammenden libyschen Schulkinder im Alter von 6-9 Jahren mit einem Anteil von 96,0% der Jungen und 95,5% der Mädchen für das Verhältnis von Körpergröße/Lebensalter (h/a) und einem Anteil von 94,2% und 95,3% der Jungen und Mädchen für Verhältnis von Körpergewicht/Lebensalter (w/a), vorwiegend unterhalb ± 2.00 SD liegen.
Die Kinder der vorliegenden Studie weisen ein im Vergleich zu der CDC 2000 Referenzpopulation vergleichbares Wachstum auf. Dies zeigt, dass die Schulkinder in Derna eine geringe Prävalenzrate für Untergewicht, Übergewicht sowie für das Auftreten einer Wachstumsretardierung aufweisen, im Vergleich zu den Daten anderer, in Golfstaaten durchgeführten Studien.

Ein Vergleich zwischen verschiedenen Ländern ist, aufgrund der Verwendung unterschiedlicher Referenzwerte für die Definition von Über- und Untergewicht schwierig. Die vorliegende Studie stellt einen Vergleich mit früheren Untersuchungen her, in welchen dieselben Referenzwerte verwendet wurden (Referenzpopulation CDC 2000). Es wurde eine geringe Gesamtprävalenz für eine Wachstumsretardierung sowie für Unter- und Übergewicht bei Schulkindern festegestellt. Diese Ergebnisse können auf die sozioökonomischen Lebensbedingungen des Landes zurückgeführt werden. Entsprechend der von der WHO im Jahre 2007 aufgestellten Klassifikation für die Schwere einer Unterernährung bei Kindern, konnte ein geringer Anteil einer alters- und geschlechtsspezifischen Wachstumsverzögerung und an Untergewicht festgestellt werden. Der Grad der Unterernährung lag in der vorliegenden Studie niedriger als in Berichten für Schulkinder vergleichbaren Alters in den Golfstaaten. Das Durchschnittsgewicht stieg innerhalb eines Jahres (im zweiten Messjahr) an, wobei die Mädchen ein höheres Körpergewicht aufwiesen als die Jungen. Die Ergebnisse zeigen, dass Mädchen größer und schwerer werden als Jungen. Es konnten einige Unterschiede hinsichtlich des Ernährungsstatus zwischen den Werten der CDC 2000 und WHO 2007 beobachtet werden.
Die Ergebnisse deutend darauf hin, dass die CDC 2000 eine höhere Prävalenz für Untergewicht, Schlankheit und einer Wachstumsverzögerung (<-2 SD) angeben, wohingegen die WHO 2007 eine höhere Prävelanz für ein höheres Längenwachstum und Übergewicht angeben (>+2 SD). Der Aktivitätsfaktor (Physical Activity Level, PAL) war bei den Jungen höher als bei den Mädchen. Die Spanne der Mittelwerte reichte bei den Jungen von 4,60 bis 5,30 Stunden/Tag, bei den Mädchen von 3,00 bis 4,70 Stunden/Tag. Bei den Jungen konnte eine höhere körperliche Aktivität als bei den Mädchen festgestellt werden. Der Unterschied war jedoch nicht statistisch signifikant (p>0,1). Im Vergleich mit den männlichen Teilnehmern verbrachten die Mädchen mehr Zeit damit fern zu sehen. Der Mittelwert reichte bei den Mädchen von 3,50 bis 4,51 Stunden/Tag. Demgegenüber sahen die Jungen im Mittel zwischen 2,60 und 3,50 Stunden/Tag fern. Die Jungen verbrachten mehr ihrer Zeit mit körperlicher Aktivität (20,0% ihrer Zeit) und weniger mit fernsehen (13,0%). Die

Mädchen verbrachten 16,4% ihrer Zeit täglich mit körperlicher Aktivität und 16,2% ihrer Zeit mit fernsehen. Die Jungen verbrachten, im Vergleich der Mädchen, mehr Zeit mit körperlicher Aktivität (20,1%) als mit sitzenden Tätigkeiten wie fernsehen (13,3%). Die mittlere tägliche Energiezufuhr lag in der vorliegenden Untersuchung bei allen Kindern unter 100% der RDA (76% der RDA). Es wurde keine signifikante Korrelation zwischen der Energiezufuhr und den anthropometrischen Faktoren bei den Kindern festegestellt. Die Teilnehmer verzehrten ungefähr das 2,5-fache der RDA an Protein. Der Anteil der Mädchen, deren Ernährungsprotokoll auf einen Kalziummangel hindeutete betrug 49%. Vor allem im Wachstumsalter ist eine ausreichende Kalzifizierung des Knochengerüsts zur Prävention einer Osteoporose bei älteren Frauen von besonderer Bedeutung.

Insgesamt deuten die hier beschriebenen Ernährungsweisen der Schulkinder auf eine exzessive Proteinzufuhr und eine mangelhafte Zufuhr einzelner anderer Nährstoffe hin. Die vorliegenden Daten wurden anhand eines 24-h-Recall erhoben. Vor dem Hintergrund der täglichen Schwankungen der Ernährung stellen diese Ergebnisse nicht notwendigerweise eine Aussage über die einzelnen Personen dar. Entsprechend der BMI-Werte können die Teilnehmer als nicht-fettleibig betrachtet werden.

Die gesamte Prävalentrate für Diabetes mellitus Typ I war in der vorliegenden Erhebung in der Altersgruppe der 6 bis 9-jährigen gering (120 von 100.000) verglichen mit einer früheren Studie kuwaitischer Kinder (182,6 von 100.000). In der vorliegenden Untersuchung konnte bei Schulkindern kein NIDDM festgestellt werden (Inzidenzrate).

8. References:

1. FAO (2005a). Nutrition Country Profiles-Libyan Arab Jamahiriya-Food and Nutrition Division Food and Agriculture Organizations. Rome.

   ftp://ftp.fao.org/es/esn/nutrition/ncp/lby.pdf (acc. 5/11/08)

2. FAO (2005b). AQUASTAT country profile: Libyan Arab Jamahiriya. Land and Water Division. Food and Agriculture Organizations. Rome.

   http://www.fao.org/nr/water/aquastat/countries/libya/index.stm (acc. 5/11/08)

3. UNICEF. 2004. The state of the world's children 2004. United Nations Children's Fund, Oxford University Press, New York.

4. IMF. 2005. Liby's oil-driven economy needs to form and diversify. IMF Survey, 34(5):68. International Monetary Fund. Washington D.C.

   http://www.imf.org/external/pubs/ft/survey/2005/032105.pdf (acc. 5/11/08)

5. IMF. 2003. The Socialist People's Libyan Arab Jamahiriya: 2003 Article IV Consultation-Staff Report; Staff Statement; and public Information Notice on the Executive Board Disscussion. IMF Countary Report No. 03/327. October 2003. International Monetary Fund. Washington D.C.

   http://www.imf.org/external/pubs/ft/scr/2003/cr03327.pdf (acc. 5/11/08)

6. FAO: Suppot to NEPAD–CAADP implementation. Food Security Scheme (Wheat, Dates & Olives, Seed Production). Volum II of V. 2006.

   (ftp://ftp.fao.org/docrep/fao/009/ag390e/ag390e00.pdf (acc. 5/11/08)

7. Sankhala A, Sankhla AK, and et al. Impact of intervention feeding trial on nutritional status of 6-10 years old malnourished children. Anthropologist. 2004; 6(3); 185-189.

8. Belahsan R and Rguibi M, Population health and Mediterranean diet in southern Mediterranean countries, Public health nutr. 2006;9(8A);1139-1135.

9. Sevenius F, Fougerouse D, Health and nutritional status in rural Saudi Arabia. Saudi Med J 1981;2(suppl.1):10-22.

10. Sbai ZA. Health in Saudi Arabia. King Abdulaziz City for Science and technology. Riyadh, King Saud University press; 1987.

11. Al-Mazrou Y, Al-Sheri S, Rao M. Princibles and practice of primary health care. Kingdom of Saudi Arabia, Ministry of health; General Directorate of Health Centers, 1990.

12. Abdulrahman O., Nutritional disorders associated with affluence in Bahrin. Family practice; 1990 ;(7); No.1; 9-13.

13. Obsigun A.A hand book of bublic health nutrition for developing countries. Lagos: Akin Osibogun consultants, 1998:48-65.

14. Olinto MT, Victora CG, and et al. Twenty-four-hour recall overestimates the dietary intake of malnourished children.Community and international Nutrition.1994; 380-384.

15. Ralf,E.,D. Mc Donald and R. Avery, 2000. Dentistry for the child and adolescent, Mosby, London.

16. Müller O, Krawinkel M. Malnutrition and health in developing countries. CMAJ, 2005; 173(3):279-286.

17. Beaton, GH, and et al Source of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. Am J Clin Nutr. 1979; 32:2546-2559.

18. ACC/SCN (United Nation Administrative Committee on Coordination/Sub-Committee on Nutrition): Fourth report on the World Nutrition Situation: Nutrition throughout the Life Cycle 2000.

19. Branca F: Nutritional surveillance and immediate food needs among Saharawi refugees. ECHO-CISP, 2997.

20. Sarraf Z, Goldberg D, Shahbazi M, and et al. Nutrional status of schoolchildren in rural Iran. British Journal of Nutrition.2005; 94:390-396.

21. Pourhashem SJ, Motlagh MG, and et al. Nutritional assessment of macronutrients in primary school children and its association with anthropometric indices and oral health. Pakistan Journal of Nutrition. 2007; 6:687-692.

22. Golden MH: The role of individual nutrient deficiencies in growth retardation of children as exemplified by zinc and protein; in Waterlow JC (ed): Linear Growth Retardation in Less Developed Countries. New York, Raven Press, 1988,pp 143-163.

23. Rabasa AI, Omatara BA, Padomu MKO. Assessment of nutritional status of children in a Sub-Saharan rural community with reference to anthropometry. Sahel Med J 1989; 1:15-8.

24. Gallo, A.M., Building strong bones in childhood and adolescence: reducing the risk of fractures in later life. Pediatr. Nurs.1996; 22:369-370.

25. AL-hourani H.M. Henry C. J. and Lightowler H. J. Prevalence of overweight among adolescent females in the United Arab Emirates. 2003: Am J of Hum Biol., 15:758-764.

26. De Onis M. Blössner M. Prevalence and trends of overweight among preschool children in developing countries. Am J Clin Nutr 2000; 72:1032-9.

27. Gutin B. Basch C. Shea S. et al. Blood pressure, fitness, and fatness in 5-and 6-year old children. JAMA 1990; 264:1123-7.

28. Parra A, Schultz RB, Graystone JE, Cheek DB. Correlative studies in obese children and adolescents concerning body composition and plasma insulin and growth hormone levels. Pedait Res 1971 ; 5 :605-13.

29. Manson J, Colditz G, Stampfer M, et al. A prospective study of obesity and risk of coronary artery disease in women. N Engl J med 1990; 322:882-889.

30. Hanefield M, Maccini M. Obesity in athrosclerosis, biology and clinical science. Ed. Anders G.O. Edinburgh, Chrchill Livingstone, 1987.

31. Gran SM &La Vella M. Two-decade follow-up of fatness in early childhood. Am.J.Dis.Child. 1983; 139:181-185.

32. Stunkard AJ & Penick SB. Behavior modification in the treatment of obesity: the problem of maintaining weight loss. Arch.Gen.Phychiar. 1979; 36:801-806.

33. Bell M.C. Workshop on childhood obesity:summary of the discussion. Am J Clin Nutr.1999; 70:173S-5S.

34. Cola T.J. Bellizzi M.C. and et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ.2000; 320:1-6.

35. Daniels SR; Khoury PR,Morrison JA. The utility of body mass index as a measure of body fatness in children and adolescents: difference by race and gender. Pedaitrics. 1997; 99:804-7.

36. Verwied JS, Sönnichsen A, Weineck J, Koletzko B. Height and weight of German primary school children in the family intervention trial (FIT) erlangen. Eur J Nutr 2003; 42:165-170.

37. WHO. Use and interpretation of anthropometric indicators of nutritional status. Bulleun of the WHO. 1986; 64(6): 929-941.

38. U:S. Food and Nutrition Board. Comparison of body weight and body heights of groups of children. Atlanta, GA, U.S. Department of Health, Education and Welfare, 1974.

39. National Center for Health Statistics growth chart: United State, 2000(revised). Hyattsville,MD: National center for Health Statistics, 2000;1-28(Vital and health statistics no.314.

40. Kamal AA, Bener A, Ahmed MA, AL-Mulla K. Growth pattern of Qatari preschool. CMJ. 2004; 45(4):461-465.

41. Potera C. Children’s health: the obesite of obesity: undernutrition overwhelms the world’s children. Environ Health Perspect. 2004:122(14):A802.

42. AL-Sharbati MM, Younan AA, Sudani OH. Growth pattern of primary schoolchildren in Benghazi, Libya. SQU J for Scientific research.2001; I: 45-49.

43. Subha R. Growth pattern of children of two social groups: a one-year longitudinal study. J Hum Ecol. 2004; 15(1):31-39.

44. Steinhoff MC, Hilder AS, and et al. prevalence of malnutrition in Indian pre-school children: A survey of wasting and stunting in rural Tamilnadu. Bulletin of World Health Organization,1986;64:457.

45. Branca F, Ferrari M. Impact of micronutrien deficiencies on growth: the stunting syndrome. Ann of Nutr Metab .2002;46(suppl1):8-17.

46. US Department of Health and Human Services Physical Activity: A report of the Surgeon General. Atlanta, Ga: US Dep of Health and Human Services, Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion;1996.

47. Cooper DM. Evidence for and mechanisms of exercise modulation of growth. Med. Sci. Sports Exerc. 1994; 26:733-749.

48. Anderson RE, Crespo CJ, Bartlett SJ, Cheskin LJ, Pratt M. Relationship of physical activity and television watching with body weight and level of fatness among children: results from the Third National Health and Nutrition Examination Survey. JAMA: 1998; 279:938-942.

49. Centers for Disease Control and prevention. Guidelines for school and community programs to promote lifelong physical activity among young people. MMWR Morb Mortal Wkly Rep. 1977; 46(No.RR-6):1-36.

50. DoHA (Department of health and Ageing) 2004a. Active kids are healthy kids. Australia's physical activity recommendations for 5-12 year olds. Canberra: Commonwealth of Australia), (DoHA 2004b. Get out and get active. Australia's physical activity recommendations for 12-18 year old. Canberra: Commonwealth of Australia.

51. Nielson Media Research. 2000 Report on Television: The First Fifty Years. New York, NY: Nielson Media Research; 2000.

52. Williams CD, Sallis JF, Cafas KJ, Burke R. Psychosocial and demographic correlates of television viewing. Am J Health Promot. 1999; 13:207-214.

53. Padez C. Fernandes T. Et al. Prevalence of overweight and obesity in 7-9-year-old Portuguese children Portuguese children: Trends in body mass index from 1970-2002. Am J of Hum. Biol.2004; 16:670-678.

54. World Health Organization. Global nutritional indicators. Anthropometric indicators update 1989. Geneva: Nutritional Unit, WHO, 1989; 89:56-62.

55. Waterlow JC, Buzina R, Keller W,Lane JM, Nichaman MZ, Tanner JM. The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. Bull World Health Organ 1977; 55:489-98.

56. Schwartz N. G. and et al. WHO 2006 child growth standards: implications for the prevalence of stunting and underweight-for-age in both a birth cohort of Gabonese children in comparison to the CDC 2000 growth charts and NCHS 1978 growth references. Public health nutrition: 2007; 11(7), 714-719).

57. De Onis M. and et al. Development of a WHO growth reference for school-aged children and adolescents. Bulletin of the World Health Organization, 2007;85:660-66.

58. Bener A and Kamal.A A. Growth pattern of Qatari school children and adolescents aged 6-18 years. J Health Popul Nutr. 2005; 3:250-258.

59. Al-Nuaim A and Bamgboye EA. Comparison of the anthropometry of Saudi Arabian male children aged 6-11 years with the CDC 2000 reference population. Med Principles Pract 1998; 7: 96-103.

60. M. Malik and A. Bakir. Prevalenve of overweight and obesity among children in the United Arab Emirates. J compilation 2006 the international association for the study of obesity. Obesity reviews 8, 15-20.

61. Al-Isa AN and Mousa.MA. Nutritiona status of Kuwaiti elementary school children aged 6-10 years: comparison with the CDC 2000 reference population. International J of Food Sciences and Nutrition. 2000; 51: 221-228.

62. Aminorroaya A, Amini M, Naghadi H, and Zadeh A H. Growth Charts of Heights and Weights of Male Children and Adolescents of Isfahan Iran. J Health Popul Nutr. 2003:21(4):341-346.

63. Waterlow JC, Buzina R, Keller W,Lane JM, Nichaman MZ, Tanner JM. The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. Bull World Health Organ 1977; 55:489-98.

64. Kapil U,. Sethi V. Prevalence of undernutrition among children (6-9 years) in Delhi. Indian Pediatrics, 2004; 41:628-629.

65. Moayrei H, Bidad K, Zadhoush S, Gholami N, Anari S. Increasing prevalence of iron deficiency in overweight and obese children and adolescents (Tehran adolescent obesity study). Eur J Pediatr. 2006;165:813-814.

66. Kelishadi R, Pour MH, Bashardoust N. Obesity and associated modifiable environmental factors in Iranian adolescents: Isfahan health heart program-heart health promotion from childhood. Pediatr Int. 2003;45:435-42.

67. Al-Mousa Z, Parkash P. Prevalence of overweight and obesity among Kuwaiti children and adolescents. Nutrition Unit, Ministry of Health, Kuwait http://www.bahrainmedicalbulletin.com/september_2000/Obesity_Kuwaiti.pdf (acc. 09/03/2009)

68. Peterson S, and Rayner R. Cornary heart disease statistics. British Heart Foundation Statistics Database 2003.London: British Heart Foundation.

69. Devaney BL, Gorden AR, Burghardt JA. Dietary intake of students. Am Soci for Clin Nutr.1995; 61:205S-12S.

70. Musaiger AO., Diet and prevention of coronary heart disease in The Arab Middle East Countries. Med Princ Pract 2002;11:9-16.

71. Mahan K, and S-Escott-Stamp. Kerause's Food, Nutrition and diet therapy.2004; London, Mosby Co.

72. Lombeck I. Al-Zubaidy IM., Kasperek K., Feinendegen LE. and Bremer HJ. Zinc status in Libya Children-a pilot study Z-Ernährungswiss.1993; 22:1-5.

73. Khan, MA, Al-Kanhal, MA. Dietary energy and rotein requirements for Saudi Arabia: a methodological approach. Eastern Mediterranean Health Journal.1998;1:68-75.

74. Galal, MO. The nutrition transition in Egypt: obesity, undernutrition and the food consumption contex. Pub Health Nutr; 2002; 5(1A), 141-148.

75. Zahran AA., Zahran NA: The effect of iron and vitamin C intake on hemoglobin levels of Saudi elderly. Res Bull Hom Econ Manoufia Univ 1994; 4:33-34

76. Koletzko B., Dokoupil K. and et al. Dietary fat intakes in infants and primary school children in Germany. 2000 Am J of Clin Nutr Vol. 72, No. 5, 1392S-1398S.

77. Krebs-Smith SM, Ballard-Barbash R, Cleveland LE, Cook DA, Kahle LL. Characterizing food-intake patterns of American adults. Am J Clin Nutr. 1997; 65(suppl):1264S-1268S.

78. Fulgoni VL, Mackey MA, Total dietary fiber in children's diet. Ann NY Acad Sci. 1991;623:369-379

79. Lin B, Guthrie J, and Frazao E. Popularity of dining out presents barriers to dietary improvements', Food Reviews; 1998:21:2-10

80. Pourhashem, S. J. Motlag, M. G. Khaniki. G. R. and Golestan. B. Nutritional assessment of macronutrients in primary school children and its association with anthropometric indices and oral health. Pakistan Journal of Nutrition. 2007;6:687-692.

81. Roers, Emmett P. and Alspac. Fat content of the diet among pre-school children in Britain; relationship with food and nutrient intakes. Eur J of Clin Nutr, 2002; 56,252-263.

82. Dowda M, Barbara E, and et al. Environmental Influences, Physical Activity, and Weight Status in 8-to 16-year-Olds. Arch pediatric Adolesc Med. 2001; 155:711-717.

83. Carlos J, Crespo, DRPH, MA and et al . Television watching, energy intake, and obesity in US children. Arch Pediatr Adolesc Med 2001;155:360-365.

84. Shamssain M. Growth rate and anthropometry of a Libya population. Trop Pediat J. 1989; vol35:306-311.

85. De Ones's and et al, Comparison of the WHO child growth standard and CDC 2000 growth chart. J. Nutr. 137:144-148, 2007).

86. Roaeid RB, Kablan A. Profile of diabetes health care at Benghazi diabetes centre, Libya Arab Jamahiriya. La Revue de Sante de le Mediterranee orlentale. 2007; 13:168-176.

87. Kadiki OA, Reddy MR, Marzouk AA: Incidence of insulin-dependent diabetes (IDDM) and non-insulin-dependent diabetes (NIDDM) (0-34 years at onset) in Benghazi, Libya. Diabetes Res Clin Pract 1996;32:165-173.

88. Mousa M.AA, Alsaeid M, Abdella N, Refai TM, Al-Sheikh N, Gomez JE. Prevalnce of type 1 diabetes among 6-to 18- year-old Kuwaiti children. Med.Princ.Pract. 2005;14:87-91.

89. Moussa M. AA, Alsaeid M, Abdella N; Refai TM; Al-Sheikh N, Gomez JE. Prevalnce of type 2 Diabetes Mellitus among Kuwaiti Children and Adolescents. Med. Princ. Pract. 2008;17:270-275.

90. Kadiki OA, Roaed RBM. Epidemiological and clinical pattern of diabetes mellitus in Benghazi, Libyan Arab Jamahiriya. Eastern Med Health J.1999; 5:1-5.

91. Meredith R. Kraine and Roland M. Tisch. The role of environmental factors in insulin-dependent diabetes mellitus: An unresolved issue. Environmental Health Perspectives. 1999 ;(107)777-781.

92. Commission of the European Communities. Commission directive 96/4/EU amending Directive 91/321/EEC on infant formulae and follow on formulae. Off J Eur Comm 1996; L49/12.1996; L49/12.

9. APPENDIX

Fig. 51: Derna Municipality- Libya

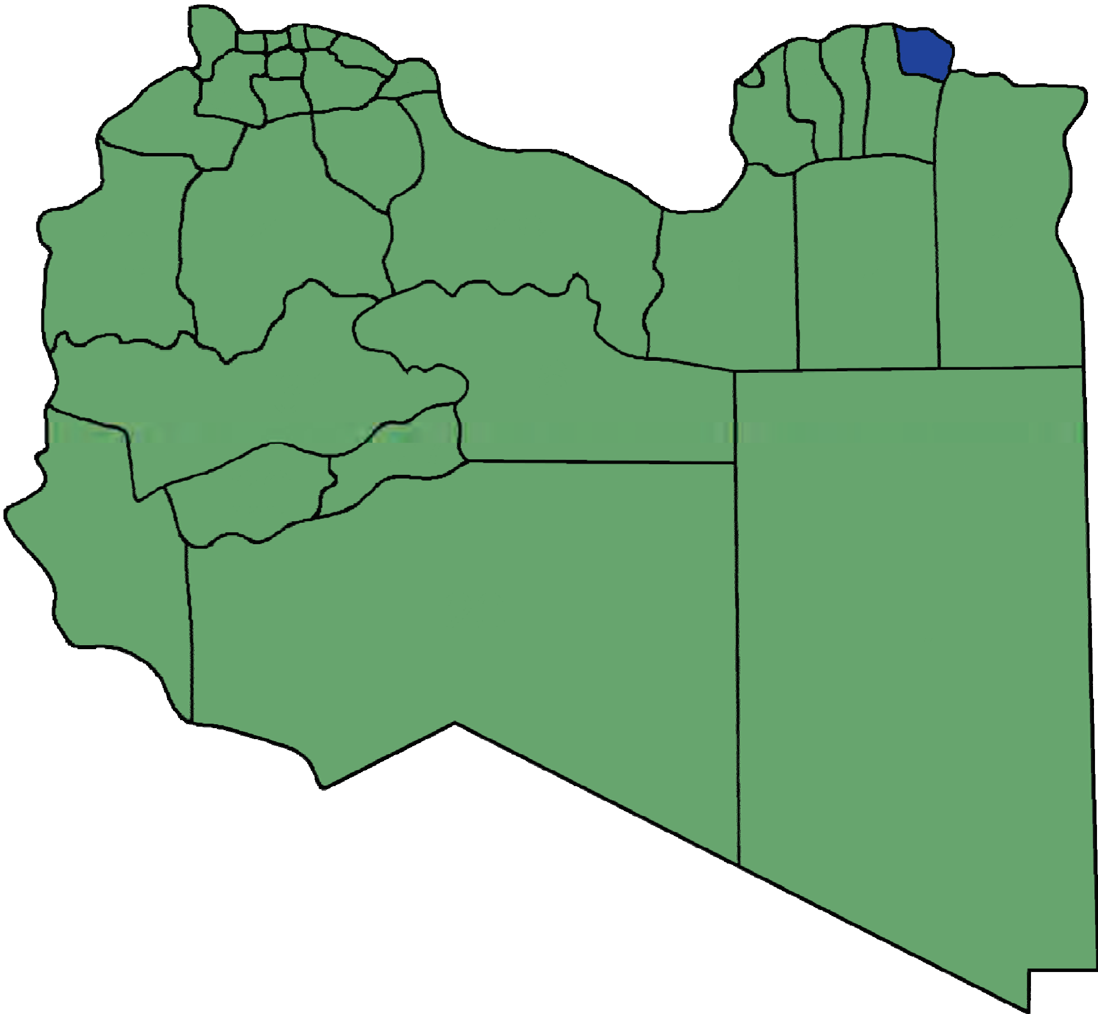

Table 1: Distribution of children according to age and sex.

Age (months)	Boys		Girls		Total	
	n	%	n	%	n	%
72-83	529	13.6	500	12.9	1,029	26.5
84-95	498	12.8	512	13.2	1,010	26.0
95-105	480	12.4	486	12.5	966	25.0
106-119	430	11.1	444	11.4	874	22.5
Total	1937	49.9	1942	50.0	3,879	100

Table 2: Mean of anthropometric of weight, (±SD) for schoolchildren (both sexes) aged 6 to 9 years.

Mean Age of Group (months)	Sex	No.	Mean	+1SD	-1SD
72-83	M F	529 500	21.10 20.61	24.57 24.09	17.63 17.13
84-95	M F	498 512	23.76 23.20	27.77 28.06	19.75 18.34
96-107	M F	480 486	26.42 26.06	31.53 30.92	21.31 21.20
108-119	M F	430 444	29.68 29.22	35.70 35.62	23.68 22.82

Table 3: Percentage (w/a) of boys and girls (±SD) of the CDC 2000 reference population.

Sex	No. (%) of children* <-2SD	No. (%) of children* -2 to +2 SD	No. (%) of children* >+2SD
Boys (n= 1937)	50 (2.6%)	1,824 (94.2%)	63 (3.2%)
Girls (n= 1942)	51 (2.6%)	1,850 (95.3%)	41 (2.1%)

*Z score outside of -6 to +6 was excluded from analyses.

Table 4: Prevalence of underweight and overweight in rural and urban school children compared with CDC 2000.

Weight-for-age (%)	Rural			Urban		
Z –scor (%)	Girls	Boys	Total	Girls	Boys	Total
<-2 (%)	2 (1.0)	3 (1.6)	5 (1.3)	49 (2.8)	47 (2.7)	96 (2.7)
-2 to +2 (%)	189 (97)	182 (96.8)	371 (96.9)	1,661 (95.1)	1,642 (93.9)	3,303 (94.5)
> +2 (%)	4 (2.0)	3 (1.6)	7 (1.8)	37 (2.1)	60 (3.4)	97 (2.8)
Total (%)	195 (100)	188 (100)	383 (100)	1747 (100)	1,749 (100)	3,496 (100)

Table 5: Mean of anthropometric of height, (±SD) for schoolchildren aged 6 to 9 years.

Mean Age of Group (months)	Sex	No.	Mean	+1SD	-1SD
72-83	M	529	115.70	122.22	108.82
	F	500	115.68	120.02	109.98
84-95	M	498	121.80	127.20	116.40
	F	512	120.40	125.79	115.01
96-107	M	480	127.20	132.67	121.67
	F	486	125.95	131.66	120.24
108-119	M	430	132.20	138.10	126.30
	F	444	131.35	137.42	125.28

Table 6: Percentage (h/a) of boys and girls (±SD) of the CDC 2000 reference population.

Sex	No. (%) of children* <-2SD	No. (%) of children* -2 to +2 SD	No. (%) of children* >+2SD
Boys(n=1937)	41 (2.1%)	1,859 (96.0%)	37 (1.9%)
Girls (n=1942)	59 (3.0%)	1,854 (95.5%)	29 (1.5%)

*Z score outside of -6 to +6 was excluded from analyses.

Table 7: Prevalence of stunted (h/a) in rural and urban school children compared with the 2000 CDC.

Height-for-age (%)	Rural			Urban		
Z -score	girls	boys	Total	girls	boys	Total
< -2 (%)	4 (2.1)	7 (3.7)	11 (2.9)	55 (3.1)	34 (2.0)	89 (2.5)
-2 to +2 (%)	188 (96.4)	177 (94.2)	365 (95.3)	1,666 (95.4)	1,682 (96.1)	3,348 (95.8)
> 2 (%)	3 (1.5)	4 (2.1)	7 (1.8)	26 (1.5)	33 (1.9)	59 (1.7)
Total (%)	195 (100)	188 (100)	383 (100)	1,747 (100)	1,749 (100)	3,496 (100)

Table 8: Mean of anthropometric of BMI, (±SD) for schoolchildren aged 6 to 9 years.

Age (months)	Sex	No.	+1SD	Mean	-1SD
72-93	M	529	17.7	15.69	13.95
	F	500	17.27	15.52	13.75
84-95	M	498	20.18	15.95	12.62
	F	512	18.99	15.92	13.33
96-107	M	480	18.49	16.23	13.97
	F	486	18.69	16.35	14.01
108-119	M	430	19.62	16.89	14.19
	F	444	19.54	16.81	14.08

Table 9 Macronutrients composition of the diet (percent daily energy) at different classes.

		Boys					Girls					Total
Dietary components	Target	1st class n=69	2nd class n=69	3th class n=65	4th class n=59	**total boys** n=262	1st class n=64	2nd class n=54	3th class n=68	4th class n=59	**total girls** n=245	n=507
Macrontrients												
Food energy (% of the RDA)	100	75%	74%	85%	80%	79%	68%	73%	71%	82%	73%	76%
protien (% of the RDA)	15	247%	239%	260%	246%	248%	193%	203%	200%	219%	204%	226%
Fat (% of energy)	≤30	91%	86%	103%	94%	94%	84%	89%	78%	104%	89%	91%
Carbohydrate (% of energy)	>55	56%	56%	64%	62%	60%	53%	57%	58%	63%	58%	59%
Vitamins (% of the RDA)												
Vitamin A	100	61%	66%	71%	62%	65%	58%	59%	57%	58%	58%	61%
Vitamin C	100	53%	67%	64%	68%	63%	66%	67%	74%	82%	72%	68%
Vitamin B-1	100	49%	53%	61%	55%	55%	48%	53%	53%	60%	53%	54%
Vitamin B-2	100	87%	90%	92%	94%	91%	71%	70%	72%	81%	74%	82%
Vitamin B-6	100	149%	148%	160%	154%	153%	129%	148%	144%	158%	145%	149%
Vitamin E	100	50%	53%	60%	53%	54%	47%	65%	50%	67%	57%	56%
Folate	100	18%	19%	18%	19%	19%	16%	16%	16%	17%	16%	17%
Carotene	100	89%	106%	97%	111%	101%	109%	139%	132%	252%	158%	129%
Minerals (% of the RDA)												
Clcium	100	59%	59%	64%	67%	62%	49%	45%	48%	54%	49%	56%
Magnesium	100	103%	110%	117%	113%	111%	96%	103%	104%	116%	105%	108%
Phosphorus	100	111%	112%	123%	118%	116%	93%	93%	95%	105%	97%	106%
Iron	100	69%	76%	79%	75%	75%	61%	65%	67%	71%	66%	70%
Zinc	100	105%	108%	122%	115%	113%	89%	93%	96%	102%	95%	104%
Other dietary components (mg)												
Cholesterol	≤300	315	288	285	276	291	240	228	180	252	225	258
Sodium	≤2400	1872	1896	2136	2061	1991	1848	2088	1800	1992	1932	1962
Dietary fiber	2500	900	1075	1125	1000	1025	900	1025	1000	1050	994	1010

Table10: Trend in daily per capita dietary energy in the Arab Middle Eastern Countries, 1971-1997.

Country	Calories (kcal)		
	1971	1997	% increase
Egypt	2.351	3.287	39.8
Iraq	2.258	2.619	16.0
Jordan	2.536	3.014	23.7
Kuwait	2.637	3.096	17.4
Lebanon	2.356	3.277	39.1
Libya	**2.457**	**3.289**	**33.9**
Saudi Arabia	1.876	2.783	48.3
Sudan	2.18	2.395	10.0
Syria	2.342	3.351	43.0

Table11: Twenty-four-hour dietary intakes of boys and girls.

Dietary Intake	Target 24-h recall	boys (n=262)	girls (n=245)	All students (n=507) % (SD)
Food energy (% of the RDA)	100	79%	73%	76 (5.8)
protein (% of the RDA)	15	248%	204%	226 (25.4)
Fat (% of food energy)	≤30	94%	89%	91 (9.0)
Carbohydrate (% of food energy)	>55	60%	58%	59 (3.9)
Vitamins (% of the RDA)				
Vitamin A	100	65%	58%	61 (4.8)
Vitamin C	100	63%	72%	68 (8.2)
Vitamin B-1	100	55%	53%	54 (4.6)
Vitamin B-2	100	91%	74%	82 (9.9)
Vitamin B-6	100	153%	145%	150 (9.6)
Vitamin E	100	54%	57%	56 (7.4)
Folate	100	19%	16%	17 (1.3)
Carotene	100	101%	158%	130 (52.2)
Minerals (% of the RDA)				
Clcium	100	62%	49%	56 (7.9)
Magnesium	100	111%	105%	108 (7.4)
Phosphorus	100	116%	97%	107 (11.6)
Iron	100	75%	66%	70 (6.0)
Zinc	100	113%	95%	104 (11.2)
Other dietary compents (mg)				
Cholesterol	≤300	291	225	258 (42.3)
Sodium	≤2400	1,991	1,932	1,962 (141.5)
Dietary fiber	2500	1025	994	1010 (79.0)

Table12: Average of daily activities among boys in hours.

Age (months)	video.hrs	sleep.hrs	study.hrs	TV.hrs	Play. Hrs	total
72-84	2.00	11.40	2.50	3.50	4.60	24.00
84-95	2.80	10.20	2.80	3.46	4.74	24.00
96-107	3.00	10.00	3.00	3.20	4.80	24.00
108-119	3.00	9.70	3.40	2.60	5.30	24.00
hours	2.70	10.33	2.93	3.19	4.86	24.00
%	11.25	43.02	12.2	13.3	20.25	100.00

Table13: The average of spent daily hours among girls (classification of daily activities).

Age (months)	video.hrs	sleep.hrs	study.hrs	TV.hrs	Play. Hrs	total
72-84	2.00	11.00	3.20	3.50	4.30	24.0
84-95	2.20	10.30	3.00	3.80	4.7	24.0
96-107	3.0	10.0	3.50	4.51	3.00	24.0
108-119	3.00	10.00	3.60	3.70	3.70	24.0
hours	2.55	10.33	3.33	3.88	3.93	24.0
%	10.63	43.01	13.85	16.16	16.35	100.00

Table14: Anthropometric measurements within one year of boys.

mean age of group of boys (months)	Weight (kg) 05/06	Weight (kg) 06/07	Height (cm) 05/06	Height (cm) 06/07	BMI (kg/m²) 05/06	BMI (kg/m²) 06/07
72-83	21.10		115.70		15.69	
84-95	23.76	24.05	121.80	122.28	15.95	16.03
96-107	26.42	27.24	127.17	127.62	16.23	16.62
108-119	29.68	30.78	132.20	133.05	16.89	17.22
> 120		32.98		137.33		17.39

Table15: Anthropometric measurements within one year among of girls.

mean age of group of girls (months)	Weight (kg) 05/06	Weight (kg) 06/07	Height (cm) 05/06	Height (cm) 06/07	BMI (kg/m²) 05/06	BMI (kg/m²) 06/07
72-83	20.61		115.68		15.52	
84-95	23.20	23.69	120.4	121.88	15.92	16.05
96-107	26.06	27.12	125.95	126.54	16.35	16.85
108-119	29.22	29.95	131.35	131.82	16.81	17.15
> 120		33.33		137.32		17.53

Table 16: Pooled data: Percentage of (%) HAZ for girls expressed as ±SD reference (the 2007 WHO and the 2000 CDC).

Reference	No. (%) of girls < -2SD	No. (%) of girls -1.99 to +1.99 SD	No. (%) of boys >+2SD
WHO 2007	52 (2.7%)	1,846 (95%)	44(2.3%)
CDC 2000	59 (3.0%)	1,854 (95.5%)	29 (1.5%)

Table 17: Pooled data: Percentage of (%) HAZ for boys expressed as ±SD reference (the 2007 WHO and the 2000 CDC).

Reference	No. (%) of boys < -2SD	No. (%) of boys -1.99 to +1.99 SD	No. (%) of boys >+2SD
WHO 2007	37 (1.9%)	1,853 (95.7)	47 (2.4%)
CDC 2000	41 (2.1%)	1,859 (96.0%)	37 (1.9%)

Table 18: Pooled data: Percentage of (%) WAZ for girls expressed as ±SD reference (the 2007 WHO and the 2000 CDC).

Reference	No. (%) of girls with SD score* < -2SD	No. (%) of girls With SD score -1.99 to +1.99 SD	No. (%) of boys with SD score* >+2SD
WHO 2007	37 (2.0%)	1,829 (94%)	76(4.0%)
CDC 2000	51 (2.6%)	1,850 (95.3%)	41 (2.1%)

Table 19: Pooled data: Percentage of (%) WAZ for boys expressed as ±SD reference (the 2007 WHO and the 2000 CDC).

Reference	No. (%) of boys with SD score* < -2SD	No. (%) of boys With SD score -1.99 to +1.99 SD	No. (%) of boys with SD score* >+2SD
WHO 2007	33 (1.7)	1,805 (93.2)	99 (5.1)
CDC 2000	50 (2.6%)	1,824 (94.2%)	63 (3.2%)

Table 20: Pooled data: Percentage of (%) MBIZ for girls expressed as ±SD reference (the 2007 WHO and the 2000 CDC).

Reference	No. (%) of girls < -2SD (Thinness)	No. (%) of girls -1.99 to +1.99 SD	No. (%) of girls >+2SD
WHO 2007	22 (1.1)	1,818 (93.6%)	102 (5.3)
CDC 2000	48 (2.5)	1,842 (95.1)	47 (2.4)

Table 21: Pooled data: Percentage of (%) BMIZ for boys expressed as ±SD reference (the 2007 WHO and the 2000 CDC).

Reference	No. (%) of boys < -2SD (Thinness)	No. (%) of boys -1.99 to +1.99 SD	No. (%) of boys >+2SD
WHO 2007	35 (1.8)	1,817 (93.8)	85 (4.4)
CDC 2000	64 (3.3%)	1,815 (93.7%)	58 (3.0%)

Table 22: Comparison of (>+2sd) and (<-2sd) (%) between CDC 2000 and WHO 2007 of identified birth date of boys and girls.

z-score	CDC 2000 (%)		WHO 2007 (%)	
	(>+2sd)	(<-2sd)	(>+2sd)	(<-2sd)
zhaz	0,42	3,8	2,4	1.31
Zmbi	2,12	2,9	2.9	2,0
zwaz	2,12	4,2	3,6	1,6

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.

Declaration

I herewith declare that I have prepared the present dissertation myself and without any means or help besides the mentioned ones.
Copied citations from other work are marked as such.
I declare that I haven't presented this dissertation to any other academic or governmental examination institution.

Giessen, July 2009

Tawfeg A.A. Elhisadi

Acknowledgements

- I would like to thanks my supervisor Prof. Dr. Michael B. Krawinkel for his countless advice, helpful comments as well as useful suggestion and valuable remarks. He quickly became for me the role model of a successful researcher in the field.
- We express our sincere thanks to the authorities concerned at the Ministry of Education in Libya who kindly issued their approval to do this study.
- We are indebted to the children, parents and teachers who participated and helped in obtaining these data.
- I am also expressing our thanks to doctors and nurses from Derna Diabetes Center.
- My thanks and appreciation goes to my co-supervisor Prof. Dr. Ingrid Hoffmann for her essential assistance.
- I am grateful to thanks Ms. Irmgard Jordan for her guidance in statistical analysis and Dr. Tsige-Yohannes for his support.
- I warmly thank Dr. Juergen Erhardt for his excellent advice during data analysis by ENA program.
- During this work I have collaborated with many colleagues for whom I have great regard, and I wish to extend my warmest thanks to all those who have helped me with my work in the Institute for Nutritional Sciences in Giessen for being the surrogate family during the time I stayed there.
- Finally, I owe my loving thanks to my wife Amal, my sons Awad, Rowid, Saja and Assim. They have lost a lot due to my research abroad. Without their encouragement and understanding it would have been impossible for me to finish this work. My special gratitude is due to my mother, my friends and my sisters and their families for their loving support.

édition scientifique
VVB LAUFERSWEILER VERLAG

VVB LAUFERSWEILER VERLAG
STAUFENBERGRING 15
D-35396 GIESSEN

Tel: 0641-5599888 Fax: -5599890
redaktion@doktorverlag.de
www.doktorverlag.de

ISBN 3-8359-5510-1

© Jose Manuel Gelpi - Fotolia.com
© KaYann - Fotolia.com