UNIVERSITI PUTRA MALAYSIA

ANEMIA AND ASSOCIATED FACTORS AMONG SCHOOL CHILDREN IN MAKKAH PROVINCE, SAUDI ARABIA

ALTALHI ROAA OMAR M

FPSK(M) 2016 39

ANEMIA AND ASSOCIATED FACTORS AMONG SCHOOL CHILDREN IN MAKKAH PROVINCE, SAUDI ARABIA

By

ALTALHI ROAA OMAR M

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Science

August 2016

DEDICATION

This thesis is dedicated to:

- My mother Nawal Hefny my father Omar Al-Talhi and my uncle Ghazi Hefny whose without their support and encouragement, this dissertation would not be possible.
- To my Sisters Raniya Al-Talhi, Rotana Al-Talhi and my brother Rayan Al-Talhi.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

ANEMIA AND ASSOCIATED FACTORS AMONG SCHOOL CHILDREN IN MAKKAH PROVINCE, SAUDI ARABIA

By

ALTALHI ROAA OMAR M

August 2016

Chairman : Zuriati bt Ibrahim, PhD
Faculty : Medicine and Health Sciences

Anemia among children is considered as moderate public health problem in Saudi Arabia and among the most important public health problems around the world. This cross sectional study aimed to determine the prevalence of anemia and its associated factors among 7 to 9 years old schoolchildren in Makkah province of Saudi Arabia.

A questionnaire was utilised to assess the socio demographic characteristics, body weight status, food security status, dietary intake and hemoglobin level of the respondents. Weight and height of the respondents were measured and body mass index (BMI) was computed to assess the body weight status. The food security status was assessed using a 10-item questionnaire by Radimer/Cornell Hunger and food insecurity. The dietary intake was assessed using two days 24-hour dietary recall by the parents /guardian of the respondents. The dietary intakes data were analysed using Nutritionist Pro software and the mean intakes of the macro and micronutrients were compared with Dietary Reference Intake (DRI). The Hemoglobin level (Hb) was measured by automated hematology counters method. Five-ml of venipuncture blood were drawn by a trained nurse. The cut-off point for Hb<11.5 g/l was diagnose anemia. Body weight status was assessed using Anthroplus software v1.0.4 to determine BMI for age. A total of 240 primary schools students with equal distribution of boys and girls were recruited through multi stage cluster sampling.

The mean age (±SD) of the respondents was 7.98 ±0.80 years. More than half mean (54.2 %) of the respondents had families with monthly household income more than the average (> 13106 SAR). Majority of the respondents (87.9%) had 2 to 4 siblings. Furthermore, more than half of the respondent's fathers (52.1%) and mothers (55.0%) had education at tertiary level. Majority of the respondents (88.3%) had household size between four to six people. Mean for body weight, height and BMI were; 24.75 ±6.95 kg, 1.19 ±0.08 m and 17.17±3.24 kgm^{-2} respectively. Majority of the respondents (67.1%) were classified as normal, 16.7% overweight, 13.3% obese and only 2.9% thinness. The mean for total energy, carbohydrate, fat and protein intake were 1239±193 kcal, 181.09 ± 26.42g, 38.05 ± 8.88g, 40.78 ± 6.10g respectively. The

determined mean for vitamin B12, vitamin B6, vitamin A, iron, folic acid and calcium of all the respondents were 2.09 ± 0.72mg, 0.86 ± 0.23 mg, 206.16 ± 67.41mg, 9.81 ± 2.36 mg, 279.13 ± 72.82 mg, 571.25 ± 149.29 mg respectively.

The prevalence of anemia was 18% for all respondents with higher prevalence noted among girls (20.8%) as compared to boys (15.0%). A significant association was observed between anemia with vitamin B12, folic acid and protein. Most of the households (97.5%) were considered food-secured. There was significant difference ($t=2.608$, $p<0.05$) in the mean value of Hb level between boys (12.56 ± 1.05 g/l) and girls (12.23 ± 0.91 g/l). Using Binary Logistic Regressions Test, there were significant relationships ($p<0.05$) between vitamin B12 (OR=0.45, 95% CI: 0.26-0.78), folic acid (OR=0.99, 95%CI: 0.98-0.99) and protein intake (OR=1.09, 95%CI: 1.03-1.16) with anemia.

Logistic regressions model for anemia status indicated that intake of vitamin B12, folic acid and protein were the significant determinants of anemia status. High prevalence of anemia among school children in Saudi Arabia requires great attention from related authorities. Thus, implicates for a proactive planning for preventive measures and implementation of intervention program on nutrition and health that emphasise on the dietary intakes.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

ANEMIA DAN FAKTOR YANG BERKAITAN DIKALANGAN KANAK-KANAK SEKOLAH DI WILAYAH MEKAH, ARAB SAUDI

Oleh

ALTALHI ROAA OMAR M

Ogos 2016

Pengerusi : Zuriati bt Ibrahim, PhD
Fakulti : Perubatan dan Sains Kesihatan

Anemia dalam kalangan kanak-kanak dianggap sebagai masalah kesihatan awam yang sederhana di Arab Saudi dan antara masalah kesihatan awam terpenting di seluruh dunia. Kajian keratan rentas ini bertujuan untuk menentukan prevalens dan faktor yang menyumbang kepada anemia dalam kalangan kanak-kanak yang berusia antara 7-9 tahun di wilayah Mekah, Arab Saudi.

Borang soal selidik telah digunakan untuk menilai ciri-ciri sosio-demografi, status berat badan, status keselamatan makanan, pengambilan diet dan tahap hemoglobin responden. Berat badan dan ketinggian responden telah diukur dan indeks jisim badan (BMI) telah dihitung untuk menilai status berat badan. Status keselamatan makanan telah dinilai menggunakan soal selidik 10-item Kelaparan dan kekurangan makanan oleh Radimer/Cornell. Pengambilan diet dinilai menggunakan ingatan diet 24 jam selama 2-hari oleh ibu bapa responden. Data pengambilan diet dianalisis menggunakan perisian "Nutritionist Pro' dan min pengambilan makro dan mikronutrien dibandingkan dengan Pengambilan Rujukan Diet. Tahap Hemoglobin (Hb) diukur dengan kaedah automatik kaunter hematologi. Sebanyak 5ml darah punktur vena telah diambil oleh jururawat terlatih. Nilai normal untuk tahap hemoglobin Hb <11.5 g/l digunakan untuk mendiagnosis anemia. Perisian v1.0.4 *Anthroplus* telah digunakan untuk menentukan status berat badan menggunakan pengkelasan BMI-untuk-umur. Seramai 240 pelajar sekolah rendah dengan pengagihan sama rata lelaki dan perempuan telah diambil melalui persampelan kelompok pelbagai peringkat.

Purata umur responden adalah 7.98±0.80 tahun. Lebih daripada separuh (54.2%) responden mempunyai keluarga yang berpendapatan isi rumah melebihi purata bulanan (>13106 SAR). Hampir semua responden (87.9%) mempunyai bilangan adik-beradik seramai 2-4 orang. Tambahan pula, lebih separuh daripada bapa (52.1%) dan ibu (55.0%) responden adalah berpendidikan tinggi. Majoriti responden (88.3%) berada dalam saiz isi rumah antara empat hingga enam orang. Purata berat badan, ketinggian dan BMI responden adalah, 24.75±6.95 kg, 1.19±0.08m dan 17.17±3.24 kgm^{-2} masing-

masing. Majoriti responden (67.1%) telah diklasifikasikan sebagai normal, berat badan berlebihan 16.7%, 13.3% obes dan 2.9% kurus. Min bagi jumlah pengambilan tenaga, karbohidrat, dan lemak serta protein masing-masing ialah 1239±193 kcal, 181.09 ± 26.42g, 38.05 ± 8.88g, 40.78 ± 6.10g. Min yang ditentukan untuk vitamin B12, vitamin B6, vitamin A, zat besi, asid folik dan kalsium semua responden masing-masing ialah 2.09 ± 0.72mg, 0.86 ± 0.23mg, 206.16 ± 67.41mg, 9.81 ± 2.36mg, 279.13 ± 72.82mg, 571.25 ± 149.29mg.

Prevalens anemia adalah 18% untuk semua responden dengan prevalens lebih tinggi dicatatkan berlaku dalam kalangan kanak-kanak perempuan (20.8%) berbanding kanak-kanak lelaki (15.0%). Perkaitan ketara diperhatikan antara anemia dengan vitamin B12, asid folik dan protein. Kebanyakan isi rumah (97.5%) telah dianggap sekuriti makanan. Terdapat perbezaan ketara ($t=2.608$, $p<0.05$) dalam nilai min tahap Hb antara kanak-kanak lelaki (12.56 ± 1.05 g/l) dan perempuan (12.23 ± 0.91 g/l). Terdapat satu hubungan yang signifikan ($p<0.05$) antara pengambilan vitamin B12(OR=0.45, 95% CI: 0.26-0.78), asid folik (OR=0.99, 95%CI: 0.98-0.99) dan protein(OR=1.09, 95%CI: 1.03-1.16) dengan anemia menggunakan Ujian Regresi Logistik Perduaan.

Model regresi logistik bagi status anemia menunjukkan bahawa pengambilan vitamin B12, asid folik dan protein adalah penentu penting status anemia. Prevalens anemia yang tinggi dalam kalangan kanak-kanak sekolah di Arab Saudi memerlukan perhatian yang lebih daripada pihak berkuasa berkaitan. Oleh itu, ia melibatkan perancangan dan pelaksanaan proaktif program intervensi dalam pemakanan dan memberi penekanan kepada pengambilan diet.

ACKNOWLEDGEMENTS

Alhamdulillah. First and foremost, I would like to thank Allah for His Blessing and Guidance, which without them I believed I could not finished this Master's thesis. I would like to express my greatest appreciation to my supervisor Dr. Zuriati bt Ibrahim my appreciation also needs to award to my other two co-supervisors, Assoc. Prof Dr. Norhasmah Sulaiman, Professor Fahaid H Al-Hashem. I would like to thank the Ministry of Health in Saudi Arabia and school health unit in Makkah. Furthermore I would like to thank Ministry of Education in Saudi Arabia and Saudi Cultural Mission in Malaysia.

I wish to express my profound gratitude and thanks to my best friend Dr. Amani Al-Otaibi for the considerable time she spent to help me and greatly assisted in many of the topics in this thesis. Her never-ending advice support and contributions were indeed valuable. Also, I would like to thank Muhammad Faizal bin Murat to help me in many parts in this thesis.

I would like to express my sincere thanks to director of the school health department in Makkah Dr. Mansour Madabghy and also the assistant director of health school Dr. yasser Ba hakeem. Special thanks to all nurses who help me to collect the blood sample and also for the staffs of schools in Makkah who help me to collect the data on time. Also, I would like to thank the participants and their parents in my survey, who have willingly shared their precious time during the process of data collection. Last but not least, my appreciation also extends to my beloved family for their understandings, encouragements and continuous supports throughout my journey as a masters student. I present my thanks to all who shared in supporting me either directly or indirectly.

This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Zuriati bt Ibrahim, PhD
Senior Lecturer
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Norhasmah Sulaiman, PhD
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

Fahaid Al-hashem, PhD
Professor
Department of Physiology College of Medicine
King Khalid University
(Member)

_____

BUJANG KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: Altalhi, Roaa Omar M (GS33383)

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
Name of Chairman of Supervisory Committee: Zuriati bt Ibrahim, PhD

Signature: _____
Name of Member of Supervisory Committee: Norhasmah Sulaiman, PhD

Signature: _____
Name of Member of Supervisory Committee: Fahaid Al-hashem, PhD

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

BMI	Body Mass Index
BMR	Basal Metabolic Rate
DRI	Dietary Reference Intake
EI	Energy Intake
Hb	Hemoglobin
IDA	Iron Deficiency Anemia
Kcal	Kilocalorie
MLR	Multivariate Logistic Regression
RBC	Red blood cell
SAR	Saudi Arabia Riyal
USD	United States Dollar
V	Vitamin
WHO	World Health Organization
WSFS	World Summit on Food Security

CHAPTER 1

INTRODUCTION

1.1 Background

Anemia among children is considered as one of the most important public health problems in both developed and developing countries (McLean *et al.*, 2009). It is now one of the most widespread medical problems because it affects the growth, academic performance (Kemmer, Novotny, Gerber, & Ah Ping, 2009) and have a significant impact on the health and nutritional status of school children (Gari, 2008). Around 305 million children among school-aged around the world suffer from anemia (McLean *et al.*, 2009).

Anemia occurs when the number of the red blood cells is not enough to meet the body physiological requirements, and this happens when the level of hemoglobin is less than 11.0 g/dl (WHO, 2011). Anemia is known as a low hemoglobin concentration in the blood (Agho *et al.*, 2008).

The insufficient of iron intakes is the most common reason for anemia prevalence worldwide and infections that affect the hemoglobin level can also be another reason for anemia (WHO, 2011). In addition, McLean et al., (2009) showed that 50% of anemia were caused by iron deficiency. However; this ratio can vary between regions, demographic groups and conditions. Some tropical diseases affect the hemoglobin level of children living in warm areas such as malaria and leishmaniasis which causes a decline in the hemoglobin level (Al-Hashem, 2006).

Furthermore, there are other causes of lower blood Hb concentrations including cancer, HIV and micronutrient deficiencies, folate, riboflavin, copper, vitamin A and vitamin B12 (McLean *et al.*, 2009).

The prevalence of anemia reported by the World Health Organisation (WHO) among 192 Member States was 48.8%. According to WHO report (2009), the prevalence of anemia was highest in the preschool age (47.4%) while the prevalence of anemia among school children was 25.4% (McLean *et al.*, 2009). In 2013, the prevalence of anemia among school children in Riyadh region, Saudi Arabia was 22.3% (Gad *et al.*, 2013). As observed in Table 1.1 the prevalence of anemia was considered as moderate public health problems (McLean *et al.*, 2009).

Table 1.1: Public health significance of different prevalence of anemia according to (WHO)

Prevalence of anemia (%)	Public health significance
≤4.9	No public health problem
5.0-19.9	Mild public health problem
20.0-39.9	Moderate public health problem
≥40	Severe public health problem

Adapted from (McLean *et al.*, 2009)

Most of the studies conducted in Saudi Arabia focused on the iron deficiency anemia and nutritional status among children less than six years of which very limited studies were conducted among school-age children (Gari, 2008). Children of early school (aged 7-8) is a critical stage of development that forms the foundation of school children's future learning and wellbeing (Unicef, 2014). A review study indicated that school children aged 7 to 9 who were anemic in early childhood remain to have poor cognitive and motor development and school achievement into middle childhood (Grantham-McGregor & Ani, 2001). Furthermore, unhealthy eating habits such as eating few fruits and vegetables and more fast foods appear to be prevalent among school children in early years thus, nutritional problems in the school age children may carry into adulthood (Gari, 2008).

A study by Gari (2008) reported that the prevalence of anemia among female elementary school in northern Jeddah, Saudi Arabia was 35.8%. The prevalence of anemia was 11.6% by hemoglobin concentration and 15% by hemoglobin concentration and hematocrit values in Saudi high altitude area (Abou-Zeid *et al.*, 2006).

Indeed, anemia is said to be associated with many factors including sex, age, ethnic background, environmental factors, anthropometric measurements and dietary intake (Agho *et al.*, 2008). The prevalence of anemia among people living in high residential areas that are above the sea level is observed to be lower because of the increased hemoglobin concentration level among the population of these areas (WHO, 2011). Furthermore, parent's education, dietary intake and family income are the foreteller of anemia (Assefa *et al.*, 2014).

Many studies demonstrated that the socio-demographic factors are associated with anemia status among children (Assefa *et al.*, 2014; Al-Mekhlafi *et al.*, 2008; Abou-Zeid *et al.*, 2006; Abalkhail & Shawky, 2002). Body weight status was associated with anemia (Mikki *et al.*, 2011; Sudhagandhi *et al.*, 2011). Food insecurity could also be related with anemia particularly among children (Pasricha *et al.*, 2010). While dietary intake the most common factor that has association with anemia status. The major cause of anemia reported were deficiency in vitamin B12 and folate intake (Balarajan *et al.*, 2012; Milman, 2011).

Generally, several factors have been identified to be associated with anemia status among school-aged children, despite some results still being inconclusive. Those factors included socio-demographic factors (age, gender, parents' educational level, household income, number of children and household size) dietary intake (carbohydrate, protein, fats, energy, vitamin B6, vitamin B12, vitamin A, calcium, folic acid and iron), body weight status (weight, height and BMI for age) and food security. Some possible risk factors that affect anemia status have been somewhat neglected in some research. Potential associations between anemia status with dietary intake and food security have not been adequately investigated in recent research in Saudi Arabia, despite the prevalence of anemia among school-aged children becoming of concern.

Some international studies (Mohamed & Hussein, 2015; Assefa *et al.*, 2014; Kokore *et al.*, 2013; Ngui *et al.*, 2012; Mikki *et al.*, 2011) were published about anemia among children worldwide including prevalence and factors associated with it, but there is no such reliable data available on anemia in Makkah province of Saudi Arabia.

1.2 Problem Statement

Anemia is one of the most prevalent health problems among children that is associated with increased risk of morbidity and mortality. About 25% of world school age children was reported to affected with anemia (Kraemer & Zimmermann, 2007).

In Asian countries, the prevalence of anemia among school children aged 7 to 12 years old in rural peninsular Malaysia was reported to be 48.5% (Al-Mekhlafi *et al.*, 2008). In India, the prevalence of anemia among students aged 8 to 16 years was found to be 52.88% (Sudhagandhi *et al.*, 2011). While in Istanbul the prevalence of anemia among school children aged 6 to10 years was reported to be 28.9 % (Gur *et al.*, 2005).

In northern Africa in Kenitra Morocco among school students (6 to 16 years) the prevalence of anemia was 12.2% (El Hioui *et al.*, 2008), and 30.3% among school children aged 5 to 11 years in west African Abidjan (Kokore *et al.*, 2013). Therefore, anemia is considered as a major health problem in most of developing countries.

In Jeddah the western region of Saudi Arabia anemia prevalence was found to be 20.5% among 6 to 12 years school children (Abalkhail & Shawky, 2002). While in Riyadh region the prevalence of anemia among school children (5 to 12 years old) was up to 22.3% (Gad *et al.*, 2013). According to classification of anemia as a public health problem (McLean *et al.*, 2009), the prevalence of anemia among school children in Riyadh and Jeddah region is considered as a moderate public health problem. The prevalence of anemia among school children in Saudi Arabia varies between the regions because Saudi Arabia is the largest country in southwest Asia with a population (29 million people) (CDSI, 2010) of different ethnicities and different lifestyles.

Children's health such as fatigue shortens attention span, poor cognitive development, difficulty with concentration; lethargy and increased mortality were the consequences

of anemia. Anemic children usually perform poorly on reading, vocabulary and other tests hence represents a major public health problem (Agho *et al.*, 2008).

Furthermore, anemia might be as a disease per se or as a result of other disease. Symptoms of anemia such as fatigue, shortens attention span and others can all be due to failure to provide enough oxygen to the blood tissues therefore causing imbalance between the provision and oxygen consumption in tissues to occurrence (Pirker, 2010). Other symptoms of anemia are headaches, nausea, anorexia, listlessness and dimness of vision (Kemmer, Novotny, Gerber, & Ah Ping, 2009).

Considering the high prevalence of anemia among school children in Saudi Arabia and the consequences of anemia that affects growth and development of children, it is imperative to understand the risk factors to this problem. Studies had found that many factors including socio demographic, environment and social may be associated with anemia. Nevertheless, there is limited national published data focused on the association between anemia with nutritional status and dietary intake aspects. Thus, this study aimed to determine the prevalence of anemia and it's associated socio demographic, body weight status, food security and dietary intake factors.

1.3 Research question

This study aims to answer the following research questions:

1. What is the prevalence of anemia among children aged 7-9 years in Makkah?
2. What is the socio demographic characteristics, body weight status, food security status and dietary intake of the respondents?
3. Is there any difference in terms of body weight status, dietary intake and Hb level between boys and girls respondents?
4. Is there any difference in body weight status and dietary intake between anemic and non-anemic groups?
5. Is there any association between socio demographic characteristics, body weight status, dietary intake and food security with anemia among respondents?
6. What are the determinants of anemia among respondents?

1.4 Objectives

1.4.1 General objective

To determine the prevalence of anemia and its associated factors among school children age 7-9 years in Makkah, Saudi Arabia.

1.4.2 Specific objectives

i. To determine the prevalence of anemia among the respondents.
ii. To determine socio demographic profiles, body weight status, food security, and dietary intake among the respondents.
iii. To determine the difference of body weight status and dietary intake between anemic and non-anemic boys and girls**.**
iv. To determine the association between socio demographic characteristics, body weight status, food security and dietary intake with anemia among the respondents.

1.5 Null Hypotheses

Ho1: There is no significant difference of body weight status, dietary intake, Hb level between boys and girls respondents.
Ho2: There is no significant difference in terms of body weight status and dietary intake between anemic and non-anemic groups
Ho3: There is no significant association between socio demographic characteristics, body weight status, food security and dietary intake with anemia among the respondents
Ho4: There is no significant contribution of socio demographic characteristics, body weight status, food security and dietary intake with anemia status of the respondents.

1.6 Conceptual framework of the study

Figure 1.1 shows the conceptual framework of the current study. The framework of this study comprises of four group risk factors including; socio-demographic (age, gender, parents educational level, household income, number of children and household size), dietary intake (carbohydrate, protein, fats, energy, vitamin B6, vitamin B12, vitamin A, calcium, folic acid and iron), body weight status (weight, height and BMI for age) and food security may be associated with anemia through Hb level among children age 7 to 9 years in Makkah.

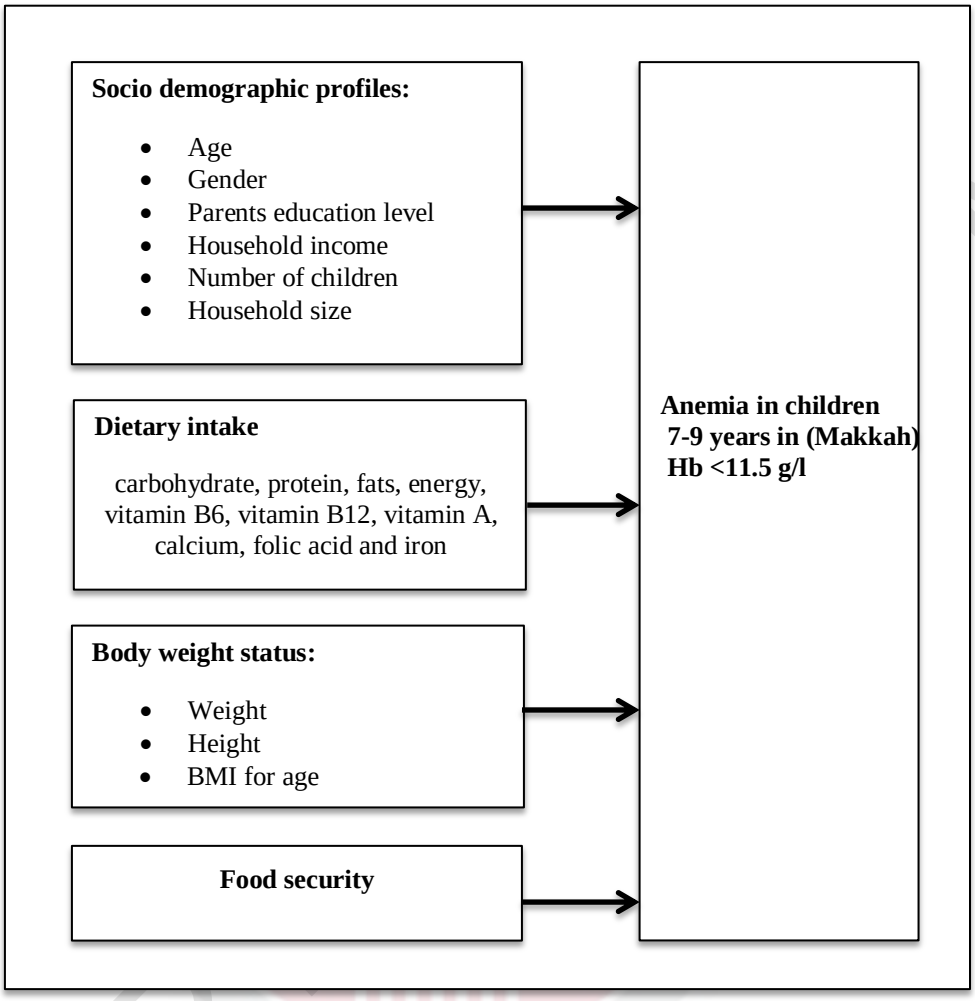

Figure 1.1: Conceptual framework

1.7 Significance of the study

The current study will contribute to the body of knowledge on factors contributing to anemia among school-aged children. The findings from this study will serve as a baseline data for future study in similar context. This study would inform the nutrition practitioners and other healthcare professional on planning the intervention program related to nutrition and anemia.

1.8 Conceptual and operational definitions

1.8.1 Anemia

Anemia is defined as the shortage in the number of red blood cells needed to meet the physiological requirement and carry oxygen (WHO, 2011). In this study, anemia was determined when the level of hemoglobin concentration is lower than 11.5 (WHO, 2011).

1.8.2 BMI for age

Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults defined as the weight in kilograms divided by the square of the height in meter's (kg/m2) (Organization, 2006). The BMI for age as index of child growth was calculated using Anthro plus software v1.0.4 (Organization, 2009) and classification of BMI for children was obtained using the Z score (WHO, 2007).

1.8.3 Dietary intake

The dietary intake assessed in this study refers to all the foods and beverages consumed by respondents that were obtained through two days 24 hour dietary recall with the respondents' parents. The macronutrients (carbohydrates, protein and fats) and the micronutrients (vitamin B6, vitamin B12, vitamin A, calcium, folic acid and iron) were analysed.

1.8.4 Food security status

Food security status was defined according to World Summit on Food Security (WSFS) ,"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life" (WSFS, 2009)(p.1). In the current study, the food security status was determined using a 10-item questionnaire by Radimer/Cornell Hunger and food insecurity. Food insecurity can affect health and nutritional status and is related to lower macro and micronutrient intakes, lower intake of fruits and vegetables and lack of diet diversity.

REFERENCES

Abalkhail, B.,Shawky, S. (2002). Prevalence of daily breakfast intake, iron deficiency anaemia and awareness of being anaemic among Saudi school students. *International journal of food sciences and nutrition, 53*(6), 519-528.

Abou-Zeid, A. H., Abdel-Fattah, M. M., Al-Shehri, A.-S. A., Hifnawy, T. M.,Al-Hassan, S.-A. A. (2006). Anemia and nutritional status of schoolchildren living at Saudi high altitude area. *Saudi medical journal, 27*(6), 862-869.

Aday, L. A.,Cornelius, L. J. (2011). *Designing and conducting health surveys: a comprehensive guide*: John Wiley & Sons.

Agho, K., Dibley, M., D'Este, C.,Gibberd, R. (2008). Factors associated with haemoglobin concentration among Timor-Leste children aged 6-59 months. *Journal of health, population, and nutrition, 26*(2), 200.

Al-Hashem, F. H. (2006). Pattern of haemoglobin among high and low altitude children of southwestern Saudi Arabia. *Journal of family and community medicine, 13*(1), 35.

Al-Mekhlafi, M. H., Surin, J., Atiya, A., Ariffin, W., Mahdy, A. M., et al. (2008). Anaemia and iron deficiency anaemia among aboriginal schoolchildren in rural Peninsular Malaysia: an update on a continuing problem. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 102*(10), 1046-1052.

Al-Shahib, W.,Marshall, R. J. (2003). The fruit of the date palm: its possible use as the best food for the future? *International journal of food sciences and nutrition, 54*(4), 247-259.

Al-Zabedi, E. M., Kaid, F. A., Sady, H., Al-Adhroey, A. H., Amran, A. A., et al. (2014). Prevalence and risk factors of iron deficiency anemia among children in Yemen. *American Journal of Health Research, 2*(5), 319-326.

Alzain, B. (2012). Anemia and nutritional status of pre-school children in north Gaza, Palestine. *International Journal of Scientific and Technology Research, 1*(11).

Arsenault, J. E., Mora-Plazas, M., Forero, Y., LÃ³pez-Arana, S., MarÃn, C., et al. (2009). Provision of a school snack is associated with vitamin B-12 status, linear growth, and morbidity in children from Bogota, Colombia. *The Journal of nutrition, 139*(9), 1744-1750.

Aspuru, K., Villa, C., Bermejo, F., Herrero, P.,LA pez, S. G. (2011). Optimal management of iron deficiency anemia due to poor dietary intake. *International journal of general medicine, 4*, 741.

Assefa, S., Mossie, A.,Hamza, L. (2014). Prevalence and severity of anemia among school children in Jimma Town, Southwest Ethiopia. *BMC hematology, 14*(1), 3.

Ayyavoo, A., Derraik, J. G., Hofman, P. L., Biggs, J.,Cutfield, W. S. (2014). Metabolic, cardiovascular and anthropometric differences between prepubertal girls and boys. *Clinical endocrinology, 81*(2), 238-243.

Badham, J., Zimmermann, M. B.,Kraemer, K. (2007). *The guidebook nutritional anemia*: Sight and Life Press Basel, Switzerland.

Balarajan, Y., Ramakrishnan, U., Ã–zaltin, E., Shankar, A. H.,Subramanian, S. (2012). Anaemia in low-income and middle-income countries. *The Lancet, 378*(9809), 2123-2135.

Baliga, M. S., Baliga, B. R. V., Kandathil, S. M., Bhat, H. P.,Vayalil, P. K. (2011). A review of the chemistry and pharmacology of the date fruits (Phoenix dactylifera L.). *Food Research International, 44*(7), 1812-1822.

Beard, J.,Stoltzfus, R. (2001). Iron-deficiency anemia: reexamining the nature and magnitude of the public health problem. *Journal of Nutrition, 131*(2S-2), 568S-579S.

Black, R., Allen, L., Bhutta, Z., Caulfield, L., de Onis, M., et al. (2008). Maternal and Child Undernutrition Study Group: Maternal and child undernutrition 1-maternal and child undernutrition: global and regional exposures and health consequences. *Lancet, 371*, 243-260.

Brug, J., van Stralen, M. M., te Velde, S. J., Chinapaw, M. J., De Bourdeaudhuij, I., et al. (2012). Differences in weight status and energy-balance related behaviors among schoolchildren across Europe: the ENERGY-project. *PloS one, 7*(4), e34742.

Cardoso, M. A., Scopel, K. z. K., Muniz, P. T., Villamor, E.,Ferreira, M. U. (2012). Underlying factors associated with anemia in Amazonian children: a population-based, cross-sectional study. *PloS one, 7*(5), e36341.

Case, A., Lubotsky, D.,Paxson, C. (2001). Economic status and health in childhood: The origins of the gradient: National Bureau of Economic Research.

CDSI. (2010). Facts About Kingdom. *Central Department of Statistics and Information (CDSI), Saudi Arabia*, from http://www.cdsi.gov.sa/english

CDSI. (2013). Household expenditure and income survey bulletin1434 H. *Central Department of Statistics and Information (CDSI), Saudi Arabia* Retrieved 12-6, 2013, from http://www.cdsi.gov.sa/english

Chellan, R.,Paul, L. (2010). Prevalence of iron-deficiency anaemia in India: Results from a large nationwide survey. *Journal of Population and Social Studies, 19*, 59-80.

Coleman-Jensen, A., Gregory, C.,Singh, A. (2014). Household Food Security in the United States in 2013.

Cooper, A. R., Page, A. S., Foster, L. J.,Qahwaji, D. (2003). Commuting to school: are children who walk more physically active? *American journal of preventive medicine, 25*(4), 273-276.

Dang, J., Arcot, J.,Shrestha, A. (2000). Folate retention in selected processed legumes. *Food Chemistry, 68*(3), 295-298.

Djokic, D., Drakulovic, M., Radojicic, Z., Radovic, L. C., Rakic, L., et al. (2010). Risk factors associated with anemia among Serbian school-age children 7-14 years old: results of the first national health survey. *Hippokratia, 14*(4), 252.

Drake, L., Maier, C., Jukes, M., Patrikios, A.,Bundy, D. (2002). School-age children: their nutrition and health. *SCN news*(25), 4-30.

Drewnowski, A. (2009). Obesity, diets, and social inequalities. *Nutrition reviews, 67*(suppl 1), S36-S39.

Education, M. o. (2013). General Administration of Education in Makkah Retrieved 20-5, 2013, from https://www.makkahedu.gov.sa/

Eicher-Miller, H. A., Mason, A. C., Weaver, C. M., McCabe, G. P.,Boushey, C. J. (2009). Food insecurity is associated with iron deficiency anemia in US adolescents. *The American journal of clinical nutrition*, ajcn. 27886.

El-Hazmi, M. A. F.,Warsy, A. S. (1999). The pattern for common anaemia among Saudi children. *Journal of tropical pediatrics, 45*(4), 221-225.

El Hioui, M., Ahami, A., Aboussaleh, Y., Rusinek, S., Dik, K., et al. (2008). Risk factors of anaemia among rural school children in Kenitra, Morocco.

Emarah, M. (2015). Makkah Al mukarrama province Retrieved 28-6, 2015, from https://www.makkah.gov.sa/page/324

FAO, I.,WFP. (2013). The State of Food Insecurity in the World, 2013. The Multiple Dimensions of Food Security: Food and Agriculture Organization of the United Nations Rome, IT.

Farghaly, N. F., Ghazali, B. M., Al-Wabel, H. M., Sadek, A. A.,Abbag, F. I. (2007). Life style and nutrition and their impact on health of Saudi school students in Abha, Southwestern region of Saudi Arabia. *Saudi medical journal, 28*(3), 415-421.

Foo, L. H., Khor, G. L., Tee, E.-S.,Prabakaran, D. (2004). Iron status and dietary iron intake of adolescents from a rural community in Sabah, Malaysia. *Asia Pacific journal of clinical nutrition, 13*(1), 48-55.

Gad, A., Al-Quaiz, J., Khoja, T., As-Sharif, A., Al-Manea, H., et al. (2013). Anemia among Primary School Children (5 -12 years) in Riyadh Region, Saudi Arabia: A Community-Based Study. *Canadian Journal of Clinical Nutrition, 1*(1), 27-34. doi: http://dx.doi.org/10.14206/canad.j.clin.nutr.2013.01.04

Gao, W., Yan, H., Dang, S.,Pei, L. (2013). Severity of anemia among children under 36 months old in Rural Western China. *PloS one, 8*(4), e62883.

Gari, M. A. (2008). Prevalence of Iron Deficiency Anemia among Female Elementary School Children in Northern Jeddah, Saudi Arabia. *Journal of King Abdulaziz University-Medical Sciences, 15*(1), 63-75.

Goldberg, G., Black, A., Jebb, S., Cole, T., Murgatroyd, P., et al. (1991). Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *European journal of clinical nutrition, 45*(12), 569-581.

Gorton, D., Bullen, C. R.,Mhurchu, C. N. (2010). Environmental influences on food security in high-income countries. *Nutrition reviews, 68*(1), 1-29.

Gowri, R. A.,Sargunam, J. H. (2005). Assessment of mental and motor abilities of school going children with anaemia. *The Indian Journal of Nutrition and Dietetics, 42*(3), 99-105.

Grantham-McGregor, S.,Ani, C. (2001). A review of studies on the effect of iron deficiency on cognitive development in children. *The Journal of nutrition, 131*(2), 649S-668S.

Gur, E., Yildiz, I., Celkan, T., Can, G., Akkus, S., et al. (2005). Prevalence of anemia and the risk factors among schoolchildren in Istanbul. *Journal of tropical pediatrics, 51*(6), 346-350.

Hall, J. E. (2010). *Guyton and Hall textbook of medical physiology*: Elsevier Health Sciences.

Halterman, J. S., Kaczorowski, J. M., Aligne, C. A., Auinger, P.,Szilagyi, P. G. (2001). Iron deficiency and cognitive achievement among school-aged children and adolescents in the United States. *Pediatrics, 107*(6), 1381-1386.

Hillman, R. S., Ault, K. A.,Rinder, H. M. (2011). *Hematology in clinical practice*: McGraw-Hill Medical.

Hoffman, J. R.,Falvo, M. J. (2004). Proteina which is best? *Journal of sports science and medicine, 3*(3), 118.

Huch, R.,Schaefer, R. (2006). *Iron Deficiency and Iron Deficiency Anemia: Pocket Atlas Special*: Georg Thieme Verlag.

Jain, S.,Kamat, D. (2008). Evaluation of microcytic anemia. *Clinical pediatrics*.

Kaur, I.,Kaur, S. (2011). A comparison of nutritional profile and prevalence of anemia among rural girls and boys. *Journal of Exercise Science and Physiotherapy, 7*(1), 11-18.

Kemmer, T. M., Novotny, R., Gerber, A. S.,Ah Ping, I. (2009). Anaemia, its correlation with overweight and growth patterns in children aged 5-10 years living in American Samoa. *Public health nutrition, 12*(05), 660-666.

Kemmer, T. M., Novotny, R., Gerber, A. S.,Ping, I. A. (2009). Anaemia, its correlation with overweight and growth patterns in children aged 5-10 years living in American Samoa. *Public health nutrition, 12*(05), 660-666.

Khatib, L. A., Obeid, O., Sibai, A.-M., Batal, M., Adra, N., et al. (2006). Folate deficiency is associated with nutritional anaemia in Lebanese women of childbearing age. *Public health nutrition, 9*(07), 921-927.

Kokore, B. A., Bleyere, M. N., Kouakou, L. a. K., Kouassi, D.,Yapo, P. A. (2013). Haematological Status and Anaemia Prevalence Among Children Aged 5 to 11 Years in School Canteens in Abidjan *Middle-East Journal of Scientific Research, 14*(4), 461-470.

Kraemer, K.,Zimmermann, M. B. (2007). *Nutritional anemia*: Sight and Life Press Basel.

Kyttala, P., Erkkola, M., Kronberg-Kippila, C., Tapanainen, H., Veijola, R., et al. (2010). Food consumption and nutrient intake in Finnish 1-6-year-old children. *Public health nutrition, 13*(6A), 947-956.

Le, H. T., Brouwer, I. D., Verhoef, H., Nguyen, K. C.,Kok, F. J. (2007). Anemia and intestinal parasite infection in school children in rural Vietnam. *Asia Pacific journal of clinical nutrition, 16*(4), 716-723.

Li, G.-M., Presnell, S. R.,Gu, L. (2003). Folate deficiency, mismatch repair-dependent apoptosis, and human disease. *The Journal of nutritional biochemistry, 14*(10), 568-575.

Luo, R., Zhang, L., Liu, C., Zhao, Q., Shi, Y., et al. (2011). Anaemia among students of rural China's elementary schools: Prevalence and correlates in Ningxia and Qinghai's poor counties. *Journal of health, population, and nutrition, 29*(5), 471.

McIntyre, L., Glanville, N. T., Officer, S., Anderson, B., Raine, K. D., et al. (2002). Food insecurity of low-income lone mothers and their children in Atlantic Canada. *Canadian Journal of Public Health/Revue Canadienne de Sante'e Publique*, 411-415.

McKillop, D. J., Pentieva, K., Daly, D., McPartlin, J. M., Hughes, J., et al. (2002). The effect of different cooking methods on folate retention in various foods that are amongst the major contributors to folate intake in the UK diet. *British Journal of Nutrition, 88*(06), 681-688.

McLean, E., Cogswell, M., Egli, I., Wojdyla, D.,de Benoist, B. (2009). Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993-2005. *Public health nutrition, 12*(04), 444-454.

Metz, J. (2008). A high prevalence of biochemical evidence of vitamin B12 or folate deficiency does not translate into a comparable prevalence of anemia. *Food and Nutrition Bulletin, 29*(Supplement 1), 74-85.

Midhet, F., Al Mohaimeed, A. R.,Sharaf, F. (2010). Dietary practices, physical activity and health education in qassim region of Saudi Arabia. *International journal of health sciences, 4*(1).

Mikki, N., Abdul-Rahim, H., Stigum, H.,Holmboe-Ottesen, G. (2011). Anaemia prevalence and associated sociodemographic and dietary factors among Palestinian adolescents in the West Bank. *EMHJ, 17*(3).

Milman, N. (2011). Anemia-still a major health problem in many parts of the world! *Annals of hematology, 90*(4), 369-377.

Mohamed, S.,Hussein, M. D. (2015). Prevalence of Thinness, Stunting and Anemia Among Rural School-aged Sudanese Children: A Cross-sectional Study. *Journal of tropical pediatrics*, fmv028.

Musaiger, A. O. (2011). Food Composition Tables for Kingdom of Bahrain *Middle East food composition tables*, from http://www.fao.org/

Musaiger, A. O., Takruri, H. R., Hassan, A. S.,Abu-Tarboush, H. (2012). Food-based dietary guidelines for the Arab Gulf countries. *Journal of nutrition and metabolism, 2012*.

Mustapha, M. R., San, L. H., Jafri, M. Z. M.,Syahreza, S. (2011). *Land Cover Classification in Makkah Area using Frequency-based Contextual Classifier.* Paper presented at the International Conference on Environment Science and Engineering IPCBEE.

NA. (2002). Dietary Reference Intakes. *Food and nutrition board,Institute of Medicine, National Academies* from https://www.iom.edu/~/media/Files/Activity%20Files/Nutrition/DRIs/5_Summary%20Table%20Tables%201-4.pdf

Ngesa, O.,Mwambi, H. (2014). Prevalence and risk factors of anaemia among children aged between 6 months and 14 years in Kenya. *journal.pone*.

Ngui, R., Lim, Y. A. L., Chong Kin, L., Sek Chuen, C.,Jaffar, S. (2012). Association between anaemia, iron deficiency anaemia, neglected parasitic infections and socioeconomic factors in rural children of West Malaysia. *PLoS Negl Trop Dis, 6*(3), e1550.

Odeh, M. M. M. (2006). *Prevalence of iron deficiency anemia among school children in Salfeet District.* National University.

Oh, S.-Y.,Hong, M. (2003). Food insecurity is associated with dietary intake and body size of Korean children from low-income families in urban areas. *European journal of clinical nutrition, 57*(12), 1598-1604.

Organization, W. H. (2006). Global database on body mass index.

Organization, W. H. (2009). AnthroPlus for personal computers. Manual: Software for assessing growth of the world's children and adolescents. Geneva: WHO, 2009.

Pasricha, S.-R., Black, J., Muthayya, S., Shet, A., Bhat, V., et al. (2010). Determinants of anemia among young children in rural India. *Pediatrics, 126*(1), e140-e149.

Perkins, S. (2006). Diagnosis of anemia. *Practical Diagnosis of Hematologic Disorders, Fourth ed. C. Kjeldsberg, ed. ASCP Press, Chicago, IL*, 1-16.

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food security, 1*(1), 5-7.

Pirker, R. (2010). *Symptoms of anemia*.

Radimer, K. L., Olson, C. M., Greene, J. C., Campbell, C. C.,Habicht, J.-P. (1992). Understanding hunger and developing indicators to assess it in women and children. *Journal of Nutrition Education, 24*(1), 36S-44S.

Santos, J. N., Rates, S. P. M., Lemos, S. M. A.,Lamounier, J. A. (2009). Consequences of anemia on language development of children from a public day care center. *Revista Paulista de Pediatria, 27*(1), 67-73.

Schechter, A. N. (2008). Hemoglobin research and the origins of molecular medicine. *Blood, 112*(10), 3927-3938.

Schmidhuber, J.,Tubiello, F. N. (2007). Global food security under climate change. *Proceedings of the National Academy of Sciences, 104*(50), 19703-19708.

Schofield, W. (1984). Predicting basal metabolic rate, new standards and review of previous work. *Human nutrition. Clinical nutrition, 39*, 5-41.

Seabra, A. C., Seabra, A., F, Mendonca, D. M., Brustad, R., Maia, J., A, et al. (2013). Psychosocial correlates of physical activity in school children aged 8-10 years. *The European Journal of Public Health, 23*(5), 794-798.

Sembulingam, K.,Sembulingam, P. (2012). *Essentials of medical physiology*: JP Medical Ltd.

Skalicky, A., Meyers, A. F., Adams, W. G., Yang, Z., Cook, J. T., et al. (2006). Child food insecurity and iron deficiency anemia in low-income infants and toddlers in the United States. *Maternal and child health journal, 10*(2), 177-185.

Skikne, B. S., Punnonen, K., Caldron, P. H., Bennett, M. T., Rehu, M., et al. (2011). Improved differential diagnosis of anemia of chronic disease and iron deficiency anemia: a prospective multicenter evaluation of soluble transferrin receptor and the sTfR/log ferritin index. *American journal of hematology, 86*(11), 923-927.

Sudhagandhi, B., Sundaresan, S., William, W.,Prema, A. (2011). Prevalence of anemia in the school children of Kattankulathur, Tamil Nadu, India. *International Journal of Nutrition, Pharmacology, Neurological Diseases, 1*(2), 184.

Tanasescu, M., Ferris, A. M., Himmelgreen, D. A., Rodriguez, N.,PA-rez-Escamilla, R. (2000). Biobehavioral factors are associated with obesity in Puerto Rican children. *The Journal of nutrition, 130*(7), 1734-1742.

Unicef. (2014). Unicef: Early Childhood Development: The key to a full and productive life Retrieved 19/09/2016, from http://www.unicef.org/dprk/ecd.pdf

Villalpando, S., Shamah-Levy, T., RamArez-Silva, C. I., MejAa-RodrAguez, F.,Rivera, J. A. (2003). Prevalence of anemia in children 1 to 12 years of age: results from a nationwide probabilistic survey in Mexico. *salud pública de méxico, 45*, 490-498.

Vogiatzoglou, A., Smith, A. D., Nurk, E., Berstad, P., Drevon, C. A., et al. (2009). Dietary sources of vitamin B-12 and their association with plasma vitamin B-12 concentrations in the general population: the Hordaland Homocysteine Study. *The American journal of clinical nutrition, 89*(4), 1078-1087.

W Moumena, M Webb, I. G., V Martina, L Phillip,Gray-Donald, K. (2012). *Prevalence of anemia and the dietary intake of children ages 5-9 in Trinidad and Tobago*. Paper presented at the 58th Annual CHRC/CARPHA Scientific Conference, Caribbean.

Whiting, S. J. (1995). The inhibitory effect of dietary calcium on iron bioavailability: a cause for concern? *Nutrition reviews, 53*(3), 77-80.

WHO. (2007). *Growth reference 5-19 years*, from http://www.who.int/growthref/who2007_bmi_for_age/en/

WHO. (2008). World malaria report 2008: World Health Organization.

WHO. (2011). Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System *World Health Organization. Geneva, Switzerland: World Health Organization*.

WHO. (2011). Serum ferritin concentrations for the assessment of iron status and iron deficiency in populations. In W. H. Organization (Ed.), (pp. 5).

WHO, F. A. O., U N U. (2004). Human energy requirements: NS.

Wrieden, W., Peace, H., Armstrong, J.,Barton, K. (2003). *A short review of dietary assessment methods used in National and Scottish Research Studies.* Paper presented at the Briefing Paper Prepared for: Working Group on Monitoring Scottish Dietary Targets Workshop. Edinburgh.

WSFS. (2009). *Declaration of the World Summit on Food Security World Summit on Food Security (WSFS)* (pp. 7).