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Al-Quds University**



**Risk Factors Associated with Vitamin D Insufficiency  
among adolescents in Gaza Strip**

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among Adolescents in Gaza Strip**

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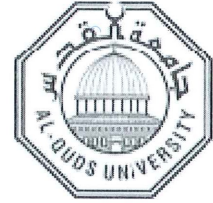
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**Al-Quds University**  
**Deanship of Graduate Studies**  
**School of Public Health**



**Thesis Approval**

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in Gaza Strip**


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**Jerusalem – Palestine**

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## **Dedication**

To my mother who supported me at all times during my life, she is the best source of motivation and inspiration.

To my brothers and sisters “Shireen, Shadi, Dalia, Ghada, Mahmoud and Saif”

To my manager “Dr. Hossam El-Helou” and my colleagues who encouraged me all the time

To my friends

I dedicate this research for all of them...

Thank you all for your endless support

**Samar Ali Abd El-Rahman**

## **Declaration**

I certify that this thesis submitted for the degree of Master, is the result of my own research, except where otherwise acknowledged, and this study (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed:

Samar Ali Abd El-Rahman

.../.../....

## **Acknowledgment**

I would like to express my deep gratitude to everyone who contributed to the success of this work, unless their help and assistance it would not have been completed.

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Words could not pay their dues, to my mother for her endless love and support, who encouraged me to join public health school and supported me throughout academic and professional life. Thank you for your trust. You have been my ideal.

Finally, my appreciation is presented to all who provide me an advice, support, information, or encouragement in order to complete my master study.

With respect

**Samar Abd El-Rahman**

## **Abstract**

In the past few years it was noticed that vitamin D level has got a growing interest as it is known to have an important role in the overall human body health and protect from many diseases such as osteomalacia, osteoporosis, cancer and cardiovascular diseases. Most of determinants of vitamin D deficiency are modifiable and can be prevented by lifestyle improvement.

The aim of study was to identify the possible risk factors for vitamin D insufficiency among adolescents in Gaza Strip to prevent adverse health outcomes and diseases and to suggest methods for prevention and management of vitamin D insufficiency. Mixed approach was used where a cross-sectional study based on collected data by Ard El-Insan in which 150 adolescents of ages between 12-17 years were selected to be tested for vitamin D levels, those 150 students were included in this study and their characteristics including: socio-demographic characteristics, nutritional habits, BMI, and micronutrients levels. In addition to five focus groups discussions (FGDs) were made to investigate other determinants such as sunlight exposure, type of dressing, physical activity and diet.

The prevalence of vitamin D insufficiency was 43.3% among study sample and adolescent females were at more risk for having insufficient vitamin D level as 54% of females and 11% of males who participated in the study had insufficient vitamin D level. Only 14% of adolescents who consumes large amounts of milk had low vitamin D level but 51% of adolescents consuming low amounts of milk had low vitamin D level. Also, 31.5% of anemic adolescent males and 80% of anemic adolescent females had low vitamin D levels. FGDs revealed that adolescents do not have enough information about vitamin D, its importance for health, consequences of vitamin D deficiency and methods of prevention.

Finally, the study concluded that vitamin D deficiency is undiagnosed and is an epidemic problem among adolescents in the Gaza Strip. The study resulted in some modifiable risk factors for vitamin D insufficiency that can be prevented such as: poor diet intake of vitamin D that can be modified by increasing the consumption of types of foods containing vitamin D (milk, egg and fatty fish), being anemic, indoor activities, low skin exposure to sunlight, covering the whole body during sunlight exposure and weak knowledge about vitamin D. Therefore, it may be beneficial to increase health awareness among children and to encourage them to eat healthy diet, play outdoor activities in order to be exposed to sunlight. Moreover, it is important to educate parents about healthy diet and importance of sunlight exposure for children for short periods of time (15-30 minutes) at least two or three times per week without sun protection that will provide them with their vitamin D requirement. Supplementation with 400 IU of vitamin D for infants and children daily is recommended.

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## List of Abbreviation

25-OHD	Total Hydroxyl Vitamin D
AI	Adequate Intake
BMI	Body Mass Index
CDC	Center for Disease Control
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
DRI	Daily Reference Intake
FGDs	Focus Groups Discussions
Hgb	Hemoglobin
MOH	Ministry of Health
NGOs	Non-Governmental Organizations
PCBS	Palestinian Central Bureau of Statistics
PHPT	Primary Hyperparathyroidism
SPSS	Statistical Package for Social Science

# Chapter One

## Introduction

### 1.1 Introduction

Vitamin D insufficiency is a common health problem for different age groups globally. It is thought that calcium and vitamin D insufficiency related to genetic or environmental factors. Although sunshine is very common in the Middle East, vitamin D insufficiency and osteomalacia is widespread in many of the regions. The most vulnerable people are at high risk of getting low vitamin D level are infants, adolescent females and pregnant women (Boucher, 2012).

Optimum vitamin D level is obtained after exposure to intense sunlight directly on skin, which leads to optimal serum 25(OH) D level of 50-70ng/dl. Vitamin D level may differ throughout the year, reaching the peak serum 25 (OH) D levels after the summer and the lowest serum 25(OH) D concentrations after winter. In some studies vitamin D insufficiency was considered as vitamin D level do not exceed 24ng/mL of serum 25(OH)D and this problem has some risk factors such as: limited sunlight exposure; presence of barriers to sunlight such as glass, plastic, clothes or sunscreen; and poor vitamin D diet (Kauffman, 2009). Factors such as gender, and greater physical activity levels are associated with greater differences in serum 25(OH) D concentrations in winter and summer (Tangpricha & Khazai, 2016).

There are common daily factors affecting vitamin D levels, which play a role in increased risk of metabolic syndrome in children. For example, increased use of TV, video or computers, less physical activity, low sun exposure, low levels of milk consumption and high levels of soft drink consumption can increase the risk of developing vitamin D insufficiency in children aged 1–18 years (Alaklabi & Alsharairi, 2018).

Many changes have been occurred to the Palestinian community in the recent years affecting sunlight exposure and subsequently vitamin D levels especially in housing conditions. The crowded refugee camps and the spread of high buildings are responsible for low sunlight exposure and small space for children playing, also overcrowding contributes to air pollution which may affect the amount of sunlight that reach to children.



In addition, adolescents tend to eat unhealthy food without any concerns to nutritional value of their food and usually it is poor of vitamin D.

Vitamin D insufficiency is a preventable health problem which can be avoided with adequate nutritional intake of vitamin D and sunlight exposure. Despite this knowledge, cases of rickets in infants due to low vitamin D intake and limited exposure to sunlight are still reported. Vitamin D insufficiency may lead to many preventable adverse health outcomes which may have high cost for treatment and admission including: prevention of bone fractures, decreased risk of cardiovascular mortality, renal diseases and diabetes mellitus type II, prevention of cancer, multiple sclerosis, allergy and asthma, infections and mental illness, and lower risk of musculoskeletal pain.

## **1.2 Problem Statement**

Vitamin D insufficiency is associated with adverse health outcomes, including impaired bone growth, gingival inflammation and increased risk for autoimmune disease. Vitamin D insufficiency is a health-threatening problem that has become very common in Gaza Strip these days. It is increasing in frequency because it is being recognized in its different manifestations but mainly because vitamin D and calcium supplementation is not considered as essential for people at high risk. Even in sunshine countries it is also very common so it is very important to move toward a national campaign to promote awareness of the risks of nutritional osteomalacia, particularly among populations at risk to help prevent the consequences that follow vitamin D insufficiency and its burden socially, financially and on health.

Vitamin D insufficiency is associated with many diseases other than those related to skeletal body and it is very common in Gaza and many new cases are still recorded. No information is available on exact prevalence of vitamin D deficiency and related risk factors among adolescents in Gaza Strip. Therefore, it is essential to focus on the problem of vitamin D deficiency among adolescents concerning possible risk factors affecting vitamin D level using the available data from the 'Ard El-Insan' Association-Gaza in addition to other methods of data collection.

### **1.3 Research Justification**

No information describing the problem of osteomalacia among adolescents in the Gaza Strip. A little information is available about nutritional osteomalacia and associated risk factors during adolescence. Even in recent studies there is no information about vitamin D status and its risk factors among adolescents.

Low serum 25(OH) D levels may lead to some preventable bone problems. If not treated, the possibility of bone fractures is increased and the bones are exposed to the risk of deformities, osteoporosis and increased liability to diabetes Mellitus (type I), heart diseases and cancer.

Adolescents are at high risk of having vitamin D insufficiency due to high need of nutrients and energy during this stage of life. It is very common that dietary habits among adolescents is very bad as they don't consume enough amounts of nutritious foods containing vitamin D and as a result it may lead to osteomalacia, delayed sexual maturation and slow linear growth. To some extent, adolescents consume diets that are inadequate in several vitamins and minerals, including folate, vitamins A, D and E, iron, zinc, magnesium and calcium. The recommended daily reference intake (DRI) of vitamin D for both male and female adolescents is 5 $\mu$ g/d (Story & Stang, 2005<sup>a</sup>).

However, there is limited studies focusing on vitamin D insufficiency concerning adolescents so, this is an attempt to study the problem of vitamin D deficiency and its interactions with housing conditions, socioeconomic factors and other determinants.

### **1.4 Research Objectives**

The general objective of this study is to identify the possible risk factors for vitamin D insufficiency among adolescents in Gaza Strip to help prevent many adverse health outcomes and diseases and to suggest recommendations for prevention and management of vitamin D insufficiency.

#### **1.4.1 Specific Objectives**

1. To examine the association between vitamin D insufficiency and socio-demographic characteristics of adolescents.

2. To estimate the effect of lifestyle factors of adolescents including: Nutritional intake of vitamin D, sunlight exposure, type of dressing of female adolescents and physical activity on vitamin D level.
3. To examine the relationship between body mass index (BMI) and vitamin D deficiency.
4. To examine the association between vitamin D insufficiency and other micronutrient deficiencies.

## **1.5 Research Questions**

1. What are the risk factors of vitamin D deficiency among Gaza adolescents?
2. What is the effect of socio-economic status, total income, parent's education level and occupation on vitamin D level?
3. Were adolescents with low vitamin D levels exposed to sunlight directly?
4. Does the type of dressing affect vitamin D levels among female adolescents?
5. Does BMI of adolescents affect vitamin D level?
6. Is vitamin D level affected by other micronutrients deficiencies?
7. What is the effect of physical activity on vitamin D insufficiency?

## **1.6 Context of the Study**

### **1.6.1 Socio-Demographic Context**

Palestine's total area is about 27,000 Km<sup>2</sup> which is divided due to Israeli occupation. Palestinian territory is divided into three areas separated geographically (annex,1); the West Bank (WB) with area of about 5.655 Km<sup>2</sup>, Gaza Strip with area of about 365 Km<sup>2</sup> and east Jerusalem. The total Palestinians population was 4.78 million (2.88 in WB and 1.89 in GS).

Palestinian society is young with 47% of the population aged below 17 years at the end of 2017. During 2017 there were about 2.394 million males in State of Palestine compared to 2.311 females (PCBS, 2017<sup>a</sup>).

### **1.6.2 Economic Context**

The Palestinian economy is not stable to be sufficient for creation of decent and productive jobs, reduce poverty and provide economic security on an equal basis for all social groups in the population. Gross Domestic Product (GDP) is estimated about 7719.3\$ and the unemployment rate is very high that reached a rate of 48.2% in Gaza Strip and 13.2% in West Bank (PCBS, 2017<sup>a</sup>). Due to blockade of the strip, the poverty rate has been higher in GS than in WB (13.9% in WB and 53.3% in GS) and 29.2% of individuals were below the national poverty line (PCBS, 2017<sup>b</sup>). In addition, nutrition of children is very bad due to high rates of food insecurity as over 68% of households in Gaza Strip are severely or moderately food insecure despite the fact that 69% of households receive food aids or other cash transfers from Palestinian or international organizations (OCHA, 2018)

There are 465,167 employed persons in economic enterprises distributed as follows: internal trade activities 39.8%, services 33.0%, industry 21.2%, construction 2.4%, information and communications 1.9%, and transportation and storage 17% (PCBS, 2015).

### **1.6.3 Housing Conditions of Palestinian Adolescents**

Most of Palestinian's refugees live in over-crowded camps or in cities with high buildings and small free spaces for playing and socialization. The mean household size in Palestine is 5.1 members per unit (PCBS, 2017<sup>b</sup>). This means that a number of children in the household of 2.4 and of 3.1 adult (over 15 years of age). As a result, it is common as a multigenerational household, which may extend to grandparents living with their children, grandchildren, aunts and uncles residing with the household head. Along with the care of parents this type of housing conditions affects adolescent's nutrition, activity and overall health. (Courbage & Abu Hamad et al., 2016)

### **1.6.4 Health Care System**

Palestinian health care system is complex of different health organizations including; governmental, non-governmental organizations (NGOs), United Nations Relief and Works Agency (UNRWA) clinics, and private health institutions that provide health services to people living in West Bank and Gaza Strip. Ministry of Health (MOH), UNRWA and NGOs are the main health providers in Gaza Strip. Health sector is affected by political conflict, closures and financial disturbances according to the data of World Bank's Public

Expenditure as the negative socio-economic impact of the political conflict has affected access to health care and is undermining progress in health status (MOH, 2012). The main responsibility of MOH is administration and regulation of the whole Palestinian health system and also it is considered as the main provider of health services (MOH, 2008)

### **1.6.5 Child Care**

Children from birth until one year of age receive Vitamin A and D supplementation drops at Maternal Child Health clinics of the MOH. On the other hand this service is not available at UNRWA clinics. About 47.9% of children less than one year of age have received vitamin A/D during 2004. Receiving vitamin A/D increased by 22.6% in 2004 (PCBS, 2013)

### **1.6.6 School Health Program**

The primary responsibilities of school health are to prevent illness and to promote and maintain the health of the school community. The existing UNRWA's School Health Program serves a group of health services in cooperation between Health and Education Ministries. Services provided by UNRWA are: medical examination for newly registered students, immunization, screening programs for hearing, vision, dental examination, in addition to the supplementation with vitamin A and drugs used for de-worming. UNRWA does not include vitamin D as a supplement in its health programs although it confirmed that vitamin D is essential for children (UNRWA, 2016).

Health services in governmental schools include: screening programs for tuberculosis, scoliosis, hearing and vision, immunization programs, monitoring of height, weight and dental health. In addition it provides emergency care, health counseling and referrals. However there is no information available on the nutritional status of adolescents or children from school grades other than first grade (MOH, 2005)

### **1.6.7 'Ard El-Insan' Benevolent Association**

The association was established since 1984. It is the leading association specialized in the field of common childhood diseases, nutrition and community health in the Gaza Strip. The health team of the association conducts research and studies on the health and nutrition status of children under five years of age. The main interest focusses on prevalence rates of growth impairment among children, evaluation of the habits and practices of the

Palestinian family with regard to breastfeeding, food, Diarrhea, food habits and their impact on health and the prevalence and risk factors for osteomalacia among children (Ard El-Insan Association, 2015).

## **1.7 Operational Definitions**

### **1.7.1 Vitamin D Deficiency**

Vitamin D deficiency exists when the concentration of 25-hydroxy-vitamin D (25-OHD) in the blood serum occurs at 12ng/ml (nanograms/milliliter), or less. The normal concentration of 25-hydroxy-vitamin D in the blood serum is 25-50 ng/ml (Gale, 2008).

### **1.7.2 Vitamin D Insufficiency**

It is defined as serum 25-hydroxy-vitamin D (25-OH) D below 20 ng/ml (50 nmol/liter) (WHO, 2003).

### **1.7.3 Rickets**

Rickets is a disease of growing bone seen in children and adolescents due to deficiency in calcium, phosphate and/or vitamin D, leading to inadequate mineralization of osteoid tissue in the growth plate and bone matrix (Acar, Demir, & Shi, 2017).

### **1.7.4 Adolescence**

It is separated in to two stages:

#### **1.7.4 (a) Early Adolescence**

Stretch between the ages of 10 and 14. It is at this stage that physical changes generally commence, usually beginning with a growth spurt and soon followed by the development of the sex organs and secondary sexual characteristics (UNICEF, 2011)

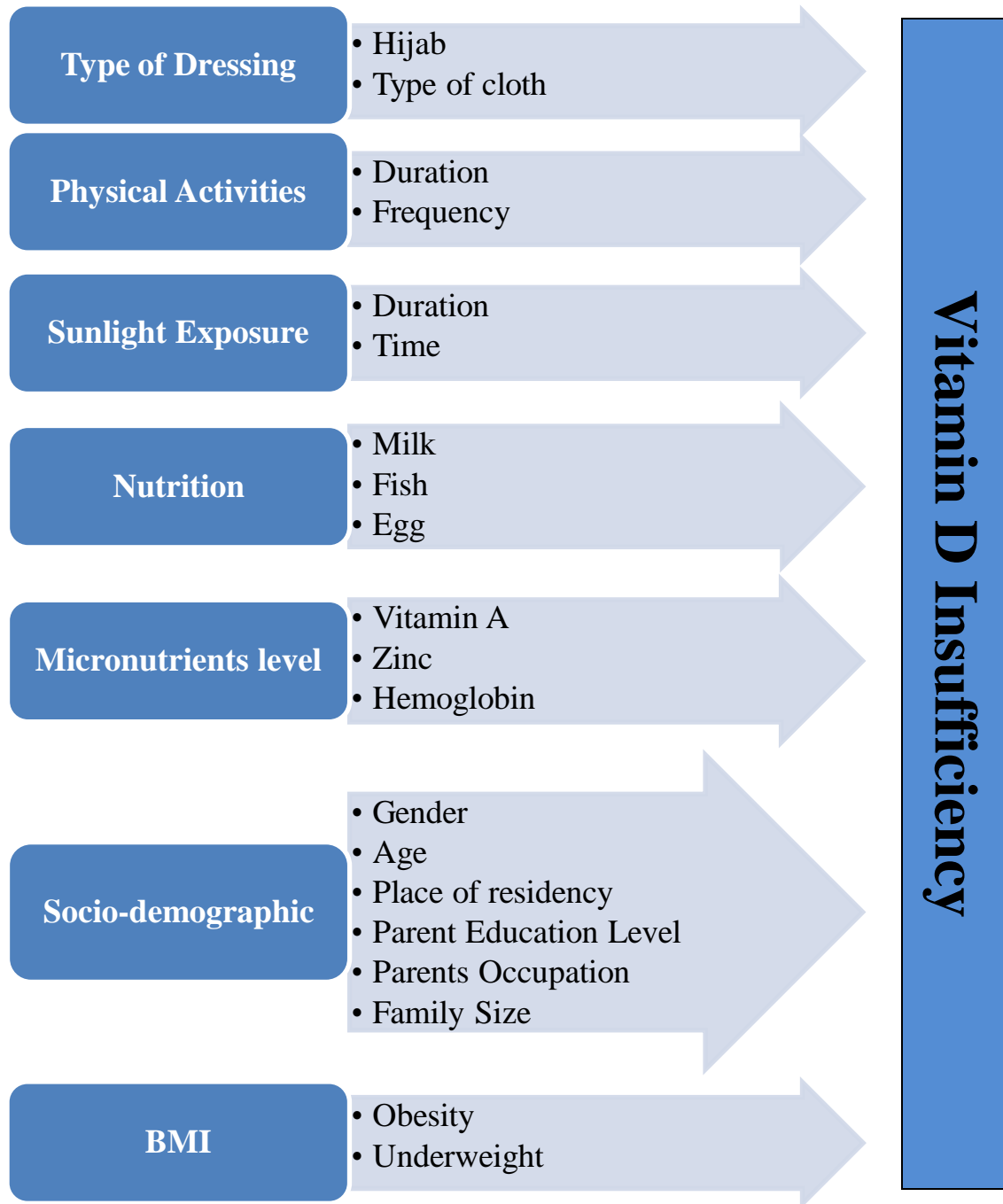
#### **1.7.4 (b) Late Adolescence**

It encompasses the latter part of the teenage years, broadly between the ages of 15 and 19. The major physical changes have usually occurred by now, although the body is still developing. The brain continues to develop and reorganize itself and the capacity for analytical and reflective thought is greatly enhanced (UNICEF, 2011)

## Chapter Two

### Literature Review

#### 2.1 Conceptual Framework



**Figure 2.1 Diagram of conceptual framework (self-developed)**

For this study the drawn conceptual framework describes the main determinants of vitamin D insufficiency and this includes:

### **2.1.1 Vitamin D Insufficiency**

Vitamin D insufficiency is very common in the Middle East region of the world despite high levels of sunshine and UV radiation throughout the year. It is common in both Turkey and Jordan that there is a strong relationship between type of dressing and vitamin D deficiency which in part may explain the low serum levels of 25(OH) D seen in these regions.

### **2.1.2 Socio-demographic Characters**

In this study, six variables of socio-demographic characteristics were tested including: Age, gender, place of residency, parents' education level, parents' occupation status and family size. Good care at household level ensures that food and health care resources provided to individual members result in optimal survival, growth and development. Low economic status of the families with adolescents could limit their food choices and hence nutrient density of their diets. Lower educational level, being unemployed and lower socioeconomic status of the families are important risk factors for adolescent health.

Adolescents who live in urban areas are more likely to suffer from osteomalacia than those living in rural areas due to less sunlight exposure this may be because they spent most of their time indoors and therefore compromised vitamin D absorption through the skin. Osteomalacia is strongly correlated with the family size (Muriuki, 2005)

### **2.1.3 Type of Dressing**

Clothing type may affect the extent of sunlight exposure and subsequently the amount of vitamin D absorbed by the skin. Whole body cover by clothes as noted in most of Muslim cultures prevents adequate sun exposure. Covering the skin and cultural practice which is associated with an increase in body surface area covered with clothing may reduce production of vitamin D in skin and subsequently is a risk factor for vitamin D deficiency (El-Sonbaty & Abdul-Ghaffar, 1996).

### **2.1.4 Nutritional Intake of Vitamin D**

Vitamin D deficiency is known to be a condition that is preventable with adequate nutritional intake of vitamin D. Low dietary vitamin D has been thought to cause nutritional osteomalacia amongst other combination of factor. Vitamin D is essential in



calcium homeostasis and calcium absorption by helping to make the necessary calcium-binding protein. An average DRI recommended amount of vitamin D from the food for adolescents is 600 IU/day.

Vitamin D deficiency results often due to limited amounts in most foods except in fish and egg yolks of chicken fed vitamin D rich feeds. Feeding practices may lead to inadequate calcium and vitamin D absorption in the body. The situation is further aggravated by diets already low in calcium and vitamin D. Nutritional osteomalacia was largely eliminated in developed countries through preventive measures of fortification of cow's milk (Muriuki, 2005).

### **2.1.5 Body Mass Index (BMI)**

Body Mass Index (BMI) is a measure of weight proportionate to height. It is considered as a useful measurement of the amount of body fat. According to Center for Disease Control definition it can be defined as a person's weight in kilograms divided by the square of height in meters. For children and teens, BMI is age- and sex-specific and is often referred to as BMI-for-age (CDC, 2015).

Adolescence is characterized by overeating, along with a sedentary lifestyle, which may contribute to obesity. Also eating a diet with a high content of calories come from sugary, high-fat, refined foods promotes weight gain. In addition to inactivity, such as lack of regular exercise, watching television or sitting at a computer, contributes to obesity in adolescents and makes it difficult to maintain weight loss. As a result 25(OH) D levels are low in obese individuals as vitamin D is sequestered in fat, so obese individuals require more vitamin D supplementations (Sahay M. & Sahay R., 2012).

### **2.1.6 Sunlight Exposure**

Sunlight is the major source of vitamin D by absorption across the skin. It is estimated that sunlight exposure is decreased in winter when comparing with summer because in winter, the sun is covered by clouds and as a result sunlight is decreased which may lead to vitamin D deficiency. In addition, the water vapor and air pollution may decrease sunlight reaching the earth so it is expected to affect vitamin D level leading to vitamin D deficiency and its associated diseases. Adolescents had unbalanced lifestyle that limits their time spent outdoors and practicing outdoor activities. In addition to the cultural

aspects that limit the lifestyles of adolescent females including outdoor activities and type of dressing that covers the whole body when being outdoors (Sahay M. & Sahay R., 2012)

## **2.2 Literature Review**

### **2.2.1 Introduction**

During the past few years, vitamin D has a big interest in medical research. It remains an area of argument among researchers about the optimal serum 25(OH)D level and the daily dietary requirement for different ages. During adolescence, both males and females' nutritional requirements are increased to compensate the rate of growth as it reaches the peak during adolescence so the nutritional need among adolescents may be twice as high as other ages (Story & Stang, 2005<sup>a</sup>).

### **2.2.2 Prevalence of Vitamin D in Gaza Strip**

Vitamin D insufficiency is a very serious problem facing children in Palestine especially those of ages 12-19 years (adolescence stage). Also the prevalence of Vitamin D deficiency associated with osteomalacia is rapidly increasing. It is often underreported due to weak diagnostic criteria in primary health care centers in Gaza Strip. The Middle East, despite its abundant sunshine, registers some of the lowest levels of vitamin D in the world. This is in large part explained by limited sun exposure due to cultural practices, skin pigmentation, shortage of vitamin D supplementation and prolonged breastfeeding without vitamin D supplementation.

A large proportion of adolescent girls, up to 70% in Iran and 80% in Saudi, 32% in Lebanese and between 9% and 12% in Lebanese adolescent boys had 25(OH) D levels below 25 nmol/l (Fuleihan, 2010).

Although there is limited data in Palestine about vitamin D status among adolescents, there is a Palestinian Micronutrient Survey for adolescents (15-18) years. 4% from the Gaza Strip having sufficient status as opposed to about 56% and 39.7% of the Palestine shows a strong sex difference of vitamin D levels with only 1.5% of girls from the West Bank and about boys from the West Bank and the Gaza Strip. Marked deficiency was virtually absent in the boys but affected about 40% and 25% of adolescent girls in the West Bank and Gaza Strip, respectively (Elmadfa et al., 2013).

### **2.2.3 Sources of Vitamin D**

Vitamin D is very rare in natural unfortified foods. Vitamin D is present in the flesh of fatty fish and oils of fish including cod and tuna liver oil. Several foods are fortified with vitamin D including milk, some cereals and some bread products. It is common that meats from poultry, pork and beef contain small amounts of vitamin D that probably comes from the vitamin D that was fortified in the animal fed (Holick, 2008).

### **2.2.4 Absorption of Vitamin D**

Vitamin D is fat-soluble in nature; dietary vitamin D (either D<sub>2</sub> or D<sub>3</sub>) is absorbed with other dietary fats in the small intestine. Presence of fat is the main factor affecting the absorption of vitamin D which stimulates the release of pancreatic lipase and bile acids which is responsible for emulsification of lipids and then triglycerides are degraded into mono-glycerides and fatty acids then bile acids build lipid-containing micelles, which diffuse into enterocytes then vitamin D along with other lipids are packaged into chylomicrons and reach the circulation by the lymphatic but a small fraction reaches the liver by the portal system. Finally vitamin D is absorbed into adipose tissue and skeletal muscle resulting in disappearance of vitamin D from plasma explaining the relationship between obesity and low 25(OH) D levels (Del Valle et al., 2011).

### **2.2.5 Vitamin D Production**

Vitamin D<sub>3</sub> (cholecalciferol) is produced from 7-dehydrocholesterol (7-DHC) by a two-step process by UV light radiation during sunlight exposure, forming pre-vitamin D<sub>3</sub> that quickly isomerizes to the active vitamin D<sub>3</sub> in a thermo-sensitive process. Many factors may contribute to the rate of vitamin D<sub>3</sub> production such as, intensity and duration of sunlight exposure, use of sunscreen and type of dressing that may impede the exposure to sunlight and subsequently limit the production of vitamin D<sub>3</sub>. The intensity of UVB from sunlight varies according to season so vitamin D<sub>3</sub> level varies throughout the year and thus vitamin D deficiency and osteomalacia is more common during winter. Vitamin D can also be obtained from the diet. Vitamin D is rarely found in most types of food except fatty fish that contain little amount of vitamin D<sub>3</sub> (Bikle, 2014). Some types of food are fortified with vitamin D<sub>2</sub> but they are not found in Gaza Strip.

### **2.2.6 Vitamin D Metabolism**

Vitamin D has two forms, vitamin D2 (ergocalciferol) and Vitamin D3 (cholecalciferol). The main stages of vitamin D metabolism are: 25-hydroxylation, 1 $\alpha$ -hydroxylation, and 24-hydroxylation performed by cytochrome P450 mixed-function oxidases (CYPs). The enzymes used in the process of vitamin D metabolism are found either in the endoplasmic reticulum (ER) or in the mitochondria (Bikle, 2014).

Both forms of vitamin D are converted to 25-hydroxyvitamin [25(OH) D] in the liver. In the kidney, vitamin D is activated to the active form by hydroxylation of 25(OH) D to 1, 25-dihydroxyvitamin D 1,25(OH)<sub>2</sub>D which in turn act on the duodenum to increase calcium absorption. It also acts on bone cells, both osteoblasts and osteoclasts, to mobilize calcium (Thacher & Clarke, 2011).

### **2.2.7 Socio-economic effect on Adolescent's Nutrition**

Dietary habits had been changed to be with a western style which is known with its high content of cholesterol, fat, sugars and sodium with low amounts of fibers. Other nutritional changes may be attributed to low economic status of most of Palestinians due to political conflict and siege which in turn affect the accessibility to healthy food (Abu dayya et al, 2009).

During adolescence, it is common to skip meals particularly among adolescents with low economic status. Also the type of consumed food, which had a great effect on their health, is affected by low economic status due to lack of ability to purchase healthy and nutritious food such as, milk products, meat, fish, fruits and vegetables (Story & Stang, 2005<sup>b</sup>)

### **2.2.8 Change in Food Habits**

Healthy nutrition can play a role in the prevention of several chronic diseases, including obesity, coronary heart disease, and certain types of cancer, stroke, and type 2 DM. To help prevent diet-related chronic diseases, it is proposed that healthy eating behaviors should be established in childhood and maintained during adolescence.

Energy and nutrient requirements are increased extremely along with other factors that may affect adolescents' food habits and nutrient intake and thus, nutritional status. These factors, including the need for independence, increased activity, and greater time spent at

school and/or work activities, contribute to the unhealthy eating behaviors that are common during adolescence.

The majority of adolescents ate fewer servings of five major food groups (grains, vegetables, fruits, dairy, meat/meat substitutes) than the recommended pyramid. The change of cognitive, physical, social, and lifestyle accompanied with adolescence can create great changes in their eating patterns. Teens as a group tends to eat a lot of snacks, miss meals, eat out of home, depend basically on fast foods (especially among females) more frequently than younger children (Story & Stang, 2005<sup>b</sup>)

### **2.2.9 Sunlight Exposure and Vitamin D Deficiency**

Sunlight exposure is important as UV light penetrate the skin to be absorbed by DNA, RNA, proteins and 7-dehydrocholesterol. Immediately after exposure, Vitamin D<sub>3</sub> remains in the skin even if the skin is washed by soap and water (Wacker & Holick, 2013).

A major factor that impeded sunlight exposure is the increased use of public transportation which in turn limited outdoor activity time. In addition, air pollution may contribute in limitation of sunlight and decrease in photosynthesis of vitamin D (Lee & Park et al, 2012). Air pollutants; including nitrous oxide and ozone is common and are responsible of absorption of UVB radiation and therefore reduce the photosynthesis of vitamin D<sub>3</sub> in the skin by sunlight (Wacker & Holick, 2013). On the other hand, some researches revealed that adequate sunlight exposure is not enough to have normal vitamin D (Binkley et al., 2007).

### **2.2.10 Effect of Sunscreen Use**

Low sunlight exposure is associated with vitamin D deficiency as vitamin D<sub>3</sub> produced by sunlight is considered as the major source of vitamin D; it provides the body by about 90% of its daily need. The use of sunscreen or any type of sun protection method is widely used these days due to its effect on skin aging, pigmentation and cancer (Lee & Park et al, 2012).

Sunscreen impedes the absorption of sunlight by skin as the use of sunscreen with (SPF 30) will absorb 95-98% of sunlight and therefore reduce the capacity of skin to produce vitamin D<sub>3</sub> by 95-98% (Wacker & Holick, 2013).

### **2.2.11 Vitamin D Supplementation**

Maternal vitamin D concentrations largely determine the vitamin D status of the fetus and newborn infant and affect their lifelong health. However, vitamin D deficiency is not limited to infancy and early childhood but covers the life span, with periods of vulnerability that mirror periods of accelerated growth or physiologic change.

Vitamin D–fortified milk will provide 400 IU of vitamin D per day, but in the adolescent population, the intake of vitamin D–fortified milk is much less so it is recommended to supplement all adolescents with at least 400 IU/day to prevent osteomalacia and vitamin D deficiency (Wagner & Greer, 2008). There is no agreed policy of vitamin D supplementation for adolescents in our country neither within primary care facilities nor UNRWA services.

### **2.2.12 Effect of Dressing Differences on Vitamin D Level**

The majority of Girls in Gaza wears hijab (covering all the body and hair) after puberty according to religious concerns. For this reason, vitamin D deficiency is more common among females than males in many of the Muslim countries. Health care providers should educate mothers and care givers on possible ways to integrate health and culture to fight against low vitamin D levels and its consequences (Meltzer, 2007).

In the Middle East it is common that women cover most of their body due to cultural and religious aspects. Women's dress styles differs by the percentage of covered surface of skin as it ranges from those who cover the whole body by clothes including hands and face which is known as Niqab, to styles that do not cover the whole body as the hands and face are excluded which is known as Hijab, to western-type dress styles. Women wearing Niqab or Hijab are at higher risk of having low vitamin D levels because they continue doing so during their working hours and other outdoor activities, but usually free themselves from these dresses inside their homes (Mishal, 2001).

### **2.2.13 Body Mass Index Effect on Vitamin D level**

Overweight and obesity have been considered the sixth most contributing predisposing factors to the overall burden of disease worldwide (Ghrayeb et al., 2013). The proportion of adolescents who are overweight or obese is rapidly increasing worldwide. Adolescence is a vulnerable period for the development of obesity and also appears to be a critical

period for establishing risk factors for some chronic diseases in adulthood. The prevalence of overweight and obesity among adolescents in Arab countries ranges from 18% to 44% (Musaiger et al., 2012).

Being overweight and obese increase the risk of serious health problems, since these conditions are risk factors for many diseases such as heart diseases, DM type II and cancer. Excess body weight may contribute to vitamin D insufficiency since body fat act as a reservoir for vitamin D which is fat soluble vitamin causing sequestration of vitamin D within body fat reducing its bioavailability.

Researches had revealed that there is a negative association between serum 25 (OH) D level and BMI since the vitamin D level may be increased after weight loss among obese and overweight individuals (Lagunova et al., 2009).

The prevalence of overweight and obesity among adolescents is relatively high in Palestine, as the national nutritional survey revealed that obesity and overweight were 22.1% among male adolescents and 23.1% among female adolescents. Vitamin D deficiency was associated with excess body weight due to vitamin D mal-absorption or the sequestration of the vitamin in adipose tissue, which may therefore affect the bioavailability of fat-soluble vitamin D in obese individuals (Lagunova et al., 2009)

#### **2.2.14 Physical Activity**

Physical activity has multiple advantages to the body and overall health but it is affected by many social, physical, environmental, economic, demographic and psychological factors which may enhance or impede regular physical activity. Outdoor activities allow sunlight exposure and therefore increase the photosynthesis of vitamin D which enhances the health of bone tissue through mineralization (Fernandes et al., 2017).

The national nutritional survey (2013) revealed that the distribution of physical activity among adolescent in Gaza Strip as it was divided as follows: Among male adolescents, 23% live sedentary life, 41.1% are low active and 35.9% are active but among females, 54.4% live sedentary life, 40.9% are low active and 4.7 are active. Given that sedentary life was defined as never do any outdoor activity, low active was defined as doing any type of outdoor activity for 30-60 minutes and active was defined as doing outdoor activity for 60 minutes or more.

### **2.2.15 Association between Vitamin D Level and Zinc Level**

Zinc plays an important role in the human body; for instance, it is used in the process of insulin synthesis. Zinc is a trace element, which after Iron, has the highest amount in the body. It is mainly accumulated in the muscles but can also be found in the blood cells, retina, bones, skin, kidneys, liver and the pancreas. Vitamin D insufficiency is probably due to inadequate exposure to sunlight. In addition, it seems inappropriate diet and lack of absorbable Zn in our foods lead to Zn deficiency in our schoolchildren (Shams et al., 2016)

### **2.2.16 Association between Vitamin D Level and Hgb Level**

Association between vitamin D deficiency and Hgb level was estimated by many researchers as increased anemia in patients with chronic anemia may result in low levels of vitamin D. This association was examined only in patients with end stage renal failure, heart failure, and anemia of other chronic diseases or in a chronic inflammatory disease. Erythropoietin sensitivity may be increased by Vitamin D due to the increase in erythroid precursor proliferation. In addition, vitamin D can suppress pro-inflammatory cytokines, which leads to decrease in anemia resulting from chronic inflammation (Seelaboyina et al., 2013).

### **2.2.17 Association between Vitamin D Level and Vitamin A Level**

Vitamin A (retinol) is very important for cell differentiation and signaling of vitamin D pathway. A heterodimer complex with retinoid x receptor should be formed by Vitamin D for the regulation of gene transcription. Active vitamin A metabolite along with the ligand of retinoid x receptor assists vitamin D receptor signaling process and plays a role in suppression of the degradation of circulating vitamin D. Vitamin A active metabolites concentration may be elevated due to supplementation with vitamin A and the first has a strong affinity to retinoid x receptor resulting in the formation of RXR-RXR homo-dimer and interrupt dimerization of RXR-VDR and vitamin D receptor transcription (Cheng et al., 2014).

### **2.2.18 Importance of Vitamin D for Bone Health**

Vitamin D is an essential element that plays a critically important role in the growth, development, building of the skeleton. Also, it exhibits an important role in maintaining a healthy skeleton for adults. Vitamin D deficiency in children results in osteomalacia. When



an adolescent becomes vitamin D insufficient, the intestinal calcium absorption decreases about 15% (DeHaven, 2014)

### **2.2.19 Consequences of Vitamin D Deficiency**

Vitamin D deficiency is associated with the etiology of many health problems worldwide. These include CVD, immune deficiency, and various types of cancers, dementia, bone health diseases, psoriasis, DM, hypertension, myopathies, multiple sclerosis, mental illness, and autoimmune disease. Low level of serum 25 (OH) D is associated with poorer physical performance (DeHaven, 2014)

### **2.2.20 Insulin Resistance**

There is a great correlation between vitamin D level and glucose homeostasis. Possible role for either altered vitamin D status and its metabolites or altered insulin sensitivity in the pathogenesis of each disease. Vitamin D deficiency impairs insulin secretion of pancreatic  $\beta$ -cells and increases insulin resistance in target tissues, both of which play critical roles in type 2 DM development (Wang, 2009).

Vitamin D level has a big role in altering the function of pancreatic  $\beta$ -cells, insulin sensitivity, and systemic inflammation which may lead to development of abnormal glucose tolerance and type II DM. Vitamin D is responsible for insulin response to glucose load and thus vitamin D deficiency treatment can help in prevention of type II DM.

### **2.2.21 Persons at Risk of Developing Vitamin D Deficiency**

People who avoid sun exposure are at higher risk for developing of vitamin D deficiency and its associated diseases. Also individuals with some diseases such as systemic lupus usually avoid sun exposure as it leads to irritations and skin rashes. In addition to people who use sunscreen, particularly in proper amounts to protect from skin cancer and photo aging are at risk for vitamin. Obese individuals have low levels of 25(OH) D levels. At first this was thought to be related to short time of sunlight exposure but when obese persons who are exposed to sunlight for long periods of time were evaluated, they too have lower vitamin D levels, so it was then attributed to sequestering of vitamin D in fat. Chronic kidney diseased individuals and those on dialysis have lower vitamin D levels. This is because they live mostly indoors in addition, they have impaired production of the active form of the vitamin (DeHaven, 2014)

### **2.2.22 Rickets**

Rickets is an example of bone diseases that results from severe vitamin D deficiency. Vitamin D insufficiency results in impeded dietary calcium and phosphorus absorption as only 10-15% of calcium and 50-60% of phosphorus are absorbed which may lead to increases risk of getting rickets (Holick, 2006).

Rickets is common among infants, toddlers and adolescents due to high growth rates among those ages. During adolescence, rickets appears slowly and progressively among adolescents, so it is not very common as the clinical signs are not obvious and needs high index of suspicion (Narchi, El Jamil & Kulaylat, 2001)

Adolescents who consume inadequate food containing vitamin D and those who receive little sunlight exposure are at higher risk of getting vitamin D deficiency and rickets. Milk fortification with vitamin D is recommended to prevent vitamin D deficiency and associated diseases. Vitamin D deficiency along with other factors including; genetic and environmental factors; increase the risk of getting rickets (Glass et al., 1982).

### **2.2.23 Osteoporosis**

Osteoporosis is a common disease that affects millions of people around the world. It is characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to enhanced bone fragility and consequent increase in fracture risk. About 1.66 million hip fractures occur each year worldwide, that the incidence is set to increase 4-fold by the year 2050 (Prentice, 2004).

Vitamin D deficiency in adults causes secondary hyperparathyroidism that can precipitate and exacerbate osteoporosis. Osteoporosis is the process giving rise to porous bones, or the resultant diminution of bone mass (Kanis et al., 1994)

### **2.2.24 Osteomalacia**

Osteomalacia is known to be the failure of mineralization of organic osteoid with calcium and phosphorous. Although osteomalacia is characteristic of rickets, the term osteomalacia is used to describe bone diseases in adults. The main clinical manifestation for osteomalacia is bone pain especially between the joints which may be confused with arthritis or fibromyalgia. On the other hand, arthritis causes predominantly joint pain and fibromyalgia causes more diffuse muscle and soft tissue pain (Thacher, 2011)

### **2.2.25 Primary Hyperparathyroidism (PHPT)**

Vitamin D deficiency is directly correlated with PHPT as vitamin D deficiency leads to increase of PHPT severity. In recent studies, it was noticed that PHPT is more common among areas of high prevalence of vitamin D deficiency. In addition, vitamin D deficiency is common among those with PHPT than other populations but there is no studies were performed to confirm the causality association between PHPT and vitamin D deficiency. Vitamin D deficiency triggers parathyroid gland causing hyperplasia and adenoma growth. Also, it may accelerate the growth of preexisting adenoma. The exact mechanism of association between PHPT and vitamin D deficiency is not well known but it may be explained as PHPT can inhibit the production of 25 (OH) D in the liver or it may increase the conversion of 25 (OH) D to 1, 25(OH) D in the kidney. It is estimated that PHPT may significantly shorten the half-life of 25(OH) D and increase the hepatic inactivation causing increase in metabolic clearance of 25(OH) D. Another indirect effect of PHPT of decreasing the bioavailability of vitamin D is explained by its effect on body weight (Silverberg, 2007)

### **2.2.26 Association between vitamin D deficiency and sleep disorders**

Although, the association between sleep disorders and vitamin D level is not well known but it is expected that vitamin D receptors are distributed in brain, hypothalamus, substantia nigra, midbrain central gray, prefrontal cortex and raphe nuclei which are responsible for the regulation of sleep-wake cycle, which means that the risk of sleep disorders is increased by the decrease of vitamin D levels may be due to chronic nonspecific pain associated with the increase of inflammation markers indicating obstructive sleep apnea and low serum vitamin D level. Some studies indicated that Vitamin D plays an important role in the alteration of immune regulation causing a decrease in the release of inflammatory modulators such as; prostaglandin D<sub>2</sub>, cytokine and tumor necrosis factor alpha that regulate sleep. This relationship still needs more investigation to understand the exact mechanism of vitamin D effect in the regulation of sleep and sleep disorders (Gao et al., 2018)

### **2.2.27 Relationship between vitamin D deficiency and cognitive impairment**

Vitamin D receptors are found in neurons and glial cells in many areas of brain including those responsible for cognition. Recent studies revealed that vitamin D deficiency may

contribute in cognitive dysfunction and neurodegenerative processes involved in Alzheimer disease. Vitamin D is very important in the prevention of neuro-degeneration by antioxidant effect, regulation of immune function and calcium homeostasis. The mechanism of vitamin D role in neuro-degeneration is not clear but it may be through its role in the production of nitric oxide which in high levels may participate in the neuro-degenerative process (Chen, 2018)

### **2.2.28 Prevention of Vitamin D Deficiency**

Adolescents are at increased risk of developing osteomalacia and vitamin D deficiency, especially those with decreased sunlight exposure, chronic diseases characterized by fat mal-absorption, and those who require anticonvulsant medications, which increase the activity of CYP 450 and other enzymes leading to catabolism of vitamin D, so they may need higher doses than 400 IU/day of vitamin D.

It is important to ensure dietary vitamin D and calcium consumption to achieve optimal bone formation and modeling. A dietary history is essential in assessing the adequacy of dietary intake for various vitamins, minerals, and nutrients, including vitamin D and calcium (Wagner & Greer, 20)

## **Chapter Three**

### **Methodology**

#### **3.1 Study Design**

Type of study used is a mixed method that uses a combination between quantitative and qualitative methods to estimate the associated determinants for vitamin D insufficiency among adolescents (12-17 years old) in the Gaza strip. This type of study was chosen because it is the most appropriate type for small sample size in addition it is useful for estimation of determinants of vitamin D deficiency.

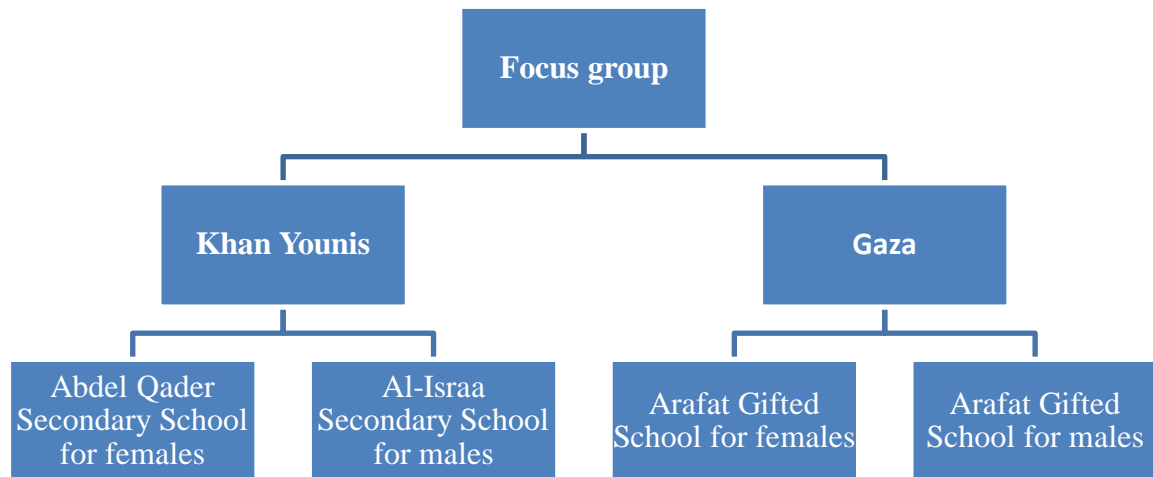
#### **3.2 Study Setting**

##### **3.2.1 Quantitative**

Quantitative part was a secondary analysis for data collected from preparatory and secondary governmental and private schools in all of the Gaza Strip Governorates, through questionnaire prepared Ard El-Insan Benevolent.

##### **3.2.2 Qualitative**

FGD was used to collect qualitative data from adolescents. Five FGDs were conducted; the first FGDs was conducted in the School of Public Health with twelve students, then four FGDs were conducted in secondary governmental schools with adolescents as two governorates, Khan Younis and Gaza, were selected and from each governorate one male school and one female school were selected and the following scheme (Figure 3.1) explains the details of FGDs.



**Figure 3.1 Outline for focus groups discussions**

### **3.3 Study Population**

#### **3.3.1 Quantitative**

The study targets all adolescents aged 12-17 years of age from both genders (males and females) who are enrolled in the schools in Gaza Strip during the academic year 2015-2016. Study population is about 248,823 students (232,186 students in Governmental schools and 16,637 students in Private schools). The age group of adolescents was purposively chosen because osteomalacia affects mainly this age group in early life.

#### **3.3.2 Qualitative**

Study population for the qualitative part was adolescent students enrolled in governmental secondary schools in Khan Younis and Gaza governorates.

### **3.4 Eligibility Criteria**

#### **3.4.1 Quantitative**

##### **1. Inclusion Criteria**

- All adolescents of age group (12-17) years who were enrolled in governmental and private schools in the Gaza strip.
- Both genders are included.

- All adolescents whom their parents signed the consent form and agreed upon participating their children in the study.
- All adolescents who agreed verbally to participate in the study.

## **2. Exclusion Criteria**

- All adolescents of age group (12-17) years who are not enrolled in governmental or private schools in the Gaza strip.
- All adolescents with different types of disability.
- All adolescents whom their parents rejected to sign the consent form.
- Children diagnosed with vitamin D insufficiency before setting of study.
- Children who are not registered in student list during the period of sampling.

### **3.4.2 Qualitative**

#### **1. Inclusion Criteria**

- All students of ages (12-17) who were enrolled in governmental secondary schools.
- Students living in Gaza Strip during all his childhood period.
- Students who agreed to participate in the FGDs and signed the consent form.

#### **2. Exclusion Criteria**

- All adolescents with different types of disability.
- Children who lived their childhood out of Gaza Strip.
- Students who rejected to participate in the FGDs.

### **3.5 Study Period**

The study was started after having a letter of approval from the university and obtaining the ethical approval from Helsinki committee to conduct the research see (annex, 2). The study was performed in the years 2018-2019; it was started in February 2018 and completed in March 2019. The tool was approved by the supervisor and data collection started in May 2018. Abstraction of the questionnaire and data was done from Ard El-Insan institution data during June to. Analysis of quantitative data started in November 2018 and findings were extracted in December 2018. Qualitative data collection and analysis was done in March 2019 which took two weeks then the final draft was handed on 30 March 2019.

## **3.6 Sample size and sampling process**

### **3.6.1 Sample size**

#### **➤ *Quantitative***

The sample consists of 150 students from different governmental and private schools in all governorates of Gaza Strip.

#### **➤ *Qualitative***

The qualitative part consisted of five FGDs with 60 participants including 48 adolescents and 12 public health students who accepted to participate in FGDs. This method was used to get more information about lifestyle of adolescents including (sunlight exposure, type of dressing, diet and physical activity). The qualitative part carried out after quantitative part to complete the required data variables to predict the possible risk factors affecting vitamin D insufficiency.

### **3.6.2 Sampling Process**

#### **– Quantitative**

The study sample was chosen from Ard El-Insan study list of 378 individuals who were included in the study of adolescence quality of life, 150 individuals were selected to participate in the study that completed vitamin D level analysis. The selected sample was a purposive sample included all those who were previously tested for some micronutrients including vitamin D, vitamin A, Hgb and zinc levels in Palestinian Medical Relief Society laboratories in the Gaza Strip.

Out of 42 variables of Ard El-Insan study questionnaire, 29 variables were selected to estimate the possible determinants for vitamin D insufficiency. A new data set was constructed for those who completed and answered the relevant questions to vitamin D status.

#### **– Qualitative**

Study sample for FGDs was selected from Gaza and South Gaza as two schools were selected from each governorate taking into account the gender variable as one of the two schools was for males and the other was for females to participate in FGDs and



participants from each school were purposively selected and asked to participate in the FGD voluntary.

### **3.7 Study Instruments**

#### **3.7.1 Quantitative Part**

Interviewer administered questionnaire was abstracted from Ard El-Insan questionnaire used for the study of the quality of life of adolescents to collect quantitative data related to socio-demographic characteristics, anthropometric measurements, nutrition, micronutrients level and physical activity for adolescent students. Abstracted items were selected according to relation to study objectives (annex, 3) it was reviewed and approved by public health and research experts to increase the validity of the content. The research in questionnaire consisted of **four sections** as follows:

**Section (1): Personal information including:** Age, gender, place of residency, ownership status of house, academic achievement in the previous semester, father's education level, mother's education level, father's occupation status, mother's occupation status and family size.

**Section (2): Nutrition information including:** Education about healthy nutrition, number of meals taken per day, skipping of breakfast status and frequency, meals taken with family, amount of consumed food (milk, egg, fish, cereals, vegetables and fruits).

**Section (3): Physical activity information including:** method used for going to school and duration of walking if it is used, using stairs and number of floors and frequency per day.

**Section (4): Anthropometric measurements and micronutrients level including:** Weight, height, BMI and the level of the following micronutrients (vitamin D, Hgb, iron, vitamin A and zinc).

#### **3.7.2 Qualitative instrument**

Open-ended (semi-structured) questions were designed to be used during the FGDs based on the initial findings of quantitative data, and list of questions and informed consent were developed see (annex, 4&5). FGDs seek participants' views and opinions about the themes of the concept of vitamin D insufficiency, importance of vitamin D in body,

diseases associated with vitamin D deficiency, people at risk of getting vitamin D insufficiency, sunlight exposure and its association with vitamin D insufficiency taking into account the best time and duration for sunlight exposure, importance of healthy diet in preserving optimal vitamin D level and specific types of food containing vitamin D, physical activity and its effect on vitamin D level taking into account the duration and frequency per week and effect of type of dressing on vitamin D level especially for females.

### **3.8 Ethical and administrative considerations**

#### **3.8.1 Ethical Approval**

- An official letter of approval to conduct the research was obtained from the Helsinki Committee-Gaza Strip (Ethical committee)
- Consent form was signed by the adolescents.
- Every participant in the study received a complete explanation about the research purposes and confidentiality of information.
- Every participant in the study knew that participation in the research is optional.
- All the relevant ethical concepts were considered: Considering adolescents' privacy and respect of truth.
- Anonymity and confidentiality were maintained.

#### **3.8.2 Administrative Approval**

- Official approval was obtained from the Ministry of education and higher education to conduct the study on the adolescent students in governmental and private schools.
- A permission letter was obtained from Human Resources Development Department to apply the research on adolescents.

#### **3.8.3 Technical Approval**

Permission to conduct the study was obtained from Public Health School, Al-Quds University.

### **3.8.4 Informed Consent**

During both, quantitative and qualitative part of the study, and prior to interview, participants were given clear written statements, see (annex, 5), and the purpose of study was fully explained and they were told that their names would not be used in data analysis and instead questionnaire identification number would be used. In addition, they were informed that results of the study would be shared to any interested participant. The participation in research was voluntary with a given signed written consents. The researcher ensured confidentiality of all information obtained by using it only for purpose of study.

### **3.9 Data Collection**

#### **3.9.1 Quantitative**

For quantitative part, the main instrument of data collection was an interviewer-administered structured questionnaire which was constructed to abstract data related to vitamin D insufficiency from Ard El-Insan questionnaire of the study about “adolescent’s quality of life in the Gaza Strip: nutritional and psychological risk factors” used to collect social demographic, social economic characteristics, dietary patterns, history of co-morbidities and physical activity”. Blood test for vitamin D, vitamin A, Iron and Zinc levels, anthropometric measurements comprising height and weight were made.

#### **3.9.2 Qualitative part**

This part of data collection was conducted by five FGDs in The School of Public Health, and schools of Gaza and South Gaza governorates. Two FGDs were made in each governorate one of them was in male school and the other was in female school. FGDs included many variables such as sunlight exposure with its multiple circumstances, physical activity (type, duration, frequency and place), diet (type, quantity, number of meals) and the type of dressing for females (wearing hijab or not). Each FGDs lasted for 120 minutes in average and included about 12 participants with various characteristics to ensure they represent adolescents living in Gaza Strip from different socio-economic conditions. During the focus group, study aim and objectives were explained to participants. Notes were taken to write the information about adolescents needed from the focus group for further analysis to ensure the best quality of collected data.

### **3.10 Scientific Rigor and trustworthiness**

#### **3.10.1 Quantitative**

- **Validity**

- a. Face Validity**

It is very important to check the face validity for the instrument of the study to increase the response rate to the questionnaire. In our study the face validity was checked twice; the first was during the pilot study done by Ard El-Insan study as the participants were asked about the structure of the questions, its shape, and typing clearance, the second was established through a panel of two experts competent in the field of child nutrition. Experts were requested to assess the relevance of the content used in the data collection, examine the questionnaire individually and provide feedback and their recommendations were incorporated in the final data collection instruments.

- b. Content Validity**

Content validity is subjective estimation of measurement based on judgment rather than statistical analysis, in order to validate the instrument used. It was done before data collection, by sending the questionnaires to experts with covering letter and paper containing instruction about the study, over all aim, objective, field of study and other relevant information.

The questionnaires were sent to 10 experts from different backgrounds including nurses, doctors, expert in management, university lecturers, psychologist, and researchers see (annex, 6). They were asked to estimate the questionnaires in term of relevancy to the study, clarity, and completeness of each item. Feedback was obtained from 6 experts, and modifications were made considerably in accordance with their opinions.

- Reliability**

Triangulation is used to insure the accuracy of data collection and more understanding of vitamin D insufficiency determinants. Data collectors were well trained and received detailed instructions to ensure standardization to control data entry errors in addition to checking and verification of questionnaires and data entry after each data collection day, and as a result errors identification, correction and prevention were more feasible.

### **3.10.2 Qualitative part**

For qualitative part, the following was done to increase the validity of the study:

- Focus groups concerned whether another focus group, of similar but different people, had given similar answers.
- The moderator who conducted all the focus groups discussions was the same so there was no bias in data collection and was well-trained
- Questions were relatively specific and were consulted by the supervisor to ensure convenience and relevance of questions.
- Then, a member check was done to assure accuracy and transparency of the transcripts during the interviews.
- The interview was written for re-check to ensure accuracy of collected data.
- Recording the interviews enhanced tracking up facts and to re-check the accuracy of the transcripts.
- Ethical recruiting was obtained.
- Respondent validation technique was used to check the validity of focus group by testing initial results with participants to see if they still ring true.
- Finally, all the transcripts and recordings were kept for tracking the information by others at any time.

### **3.11 Statistical Analysis**

#### **3.11.1 Quantitative**

Data entry and analysis were obtained using Statistical Package of Social Science (SPSS) program. Data revision and cleaning were made then the data was entered to the SPSS program.

1. First, frequency tables was made to show the distribution of students according to socio-demographic characteristics including (Age, Gender, Place of residency, Parents' education level, Parents' occupation status and Family size).
2. Frequency tables were made to show the distribution of study sample according to nutritional habits and amount consumed of: milk, egg and fish.
3. Frequency table was constructed to show the distribution of study sample according to BMI.

4. Frequency tables for different micronutrient levels among study sample including: vitamin D, vitamin A, Hgb and zinc.
5. Cross tabulation was made using chi square test to show the association between vitamin D insufficiency and different categorical variables including: socio-demographic characteristics, nutritional habits, obesity and other micronutrients' levels.
6. Independent t-test was used to test the relationship between vitamin D insufficiency and different categorical variables of two categories such as: age, gender, family size, milk consumption, egg consumption, fish consumption, vitamin A, Hgb and zinc and to get the mean difference of vitamin D level among different categories of each variable.
7. One-Way ANOVA test was used to test the relationship between vitamin D insufficiency and categorical variables of three categories such as: place of residency, parents' education level, parents' occupation status and BMI and to get the mean difference in vitamin D level among different categories of each variable.

### **3.11.2 Qualitative**

Findings from focus groups discussion were taken from open-ended questions asked during discussion with students and health providers. Debriefing reports for the focus groups were done immediately after the end of each FGDs. Also objective considerations of non-prompted intimations, group dynamics, and non-verbal cues were noted and considered. Open coding thematic analysis method was used to analyze the transcripts of the focus groups and relevant qualitative data were extracted and the main findings were obtained from the transcripts of the interview then related ideas were categorized and finally comparison and integration between quantitative and qualitative findings was done to create rich items for discussion.

### **3.12 Limitations of the Study**

- Due to limited budget for analysis the sample was quite small and limited numbers of students were tested for vitamin D level, but this problem was controlled by using focus groups discussions.
- UNRWA schools were not included in the study, so the sample was collected from governmental and private schools only.

- Lack of local studies focusing on adolescent's nutrition and vitamin D levels.
- Data analysis and focus groups discussions were made by the researcher herself only, so it took much time.
- Contextual limitations including the cut of electricity and limited access to international publications.

## Chapter Four

### Results and Discussion

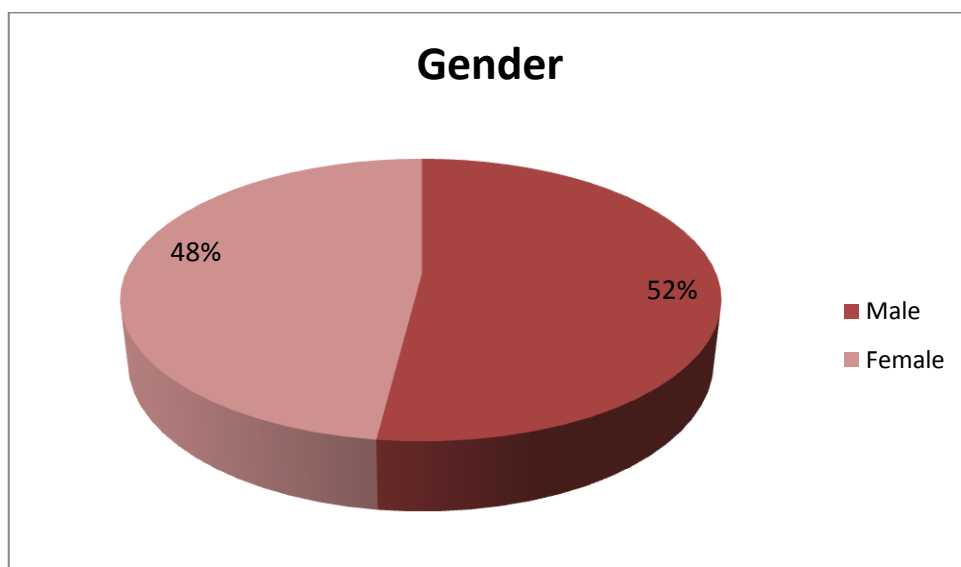
This chapter presents the results of the statistical analysis of data that was collected through a structured questionnaire. Data analysis was performed using SPSS, version 22 computer software. Descriptive statistics presented the socio-demographical characteristics of the participants as well as the distribution of vitamin D insufficiency among participants according to different variables such as socio-demographic characteristics, BMI, Hgb level, sunlight exposure and physical activity. The statistically significance test used in the study was chi square and t-test.

#### 4.1 Distribution of Study Sample According to Socio-Demographic Characteristics

Adolescents of the study sample were asked about socio-demographic characteristics including gender, age, place of residency, parent's education level, parents' occupation status and family size to test their effect on vitamin D level. Distribution of socio-demographic characteristics among study sample is illustrated in table 4.1.

##### 4.1.1 Gender

Table 4.1 shows the distribution of adolescents according to gender. The final sample consisted of 150 participants who had dietary interview and serum 25(OH) D data. Of those 52% ( $n=78$ ) were male and 48% ( $n=72$ ) were females as shown in Figure 4.1.

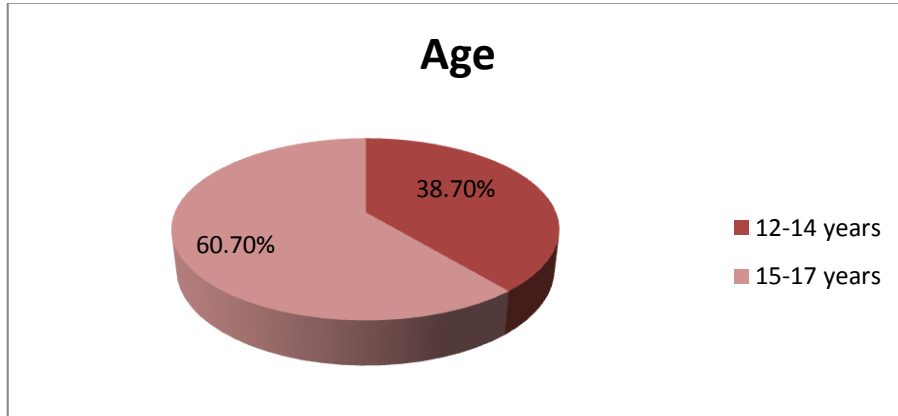


**Figure 4.1 Distribution of study sample according to gender**



#### 4.1.2 Age

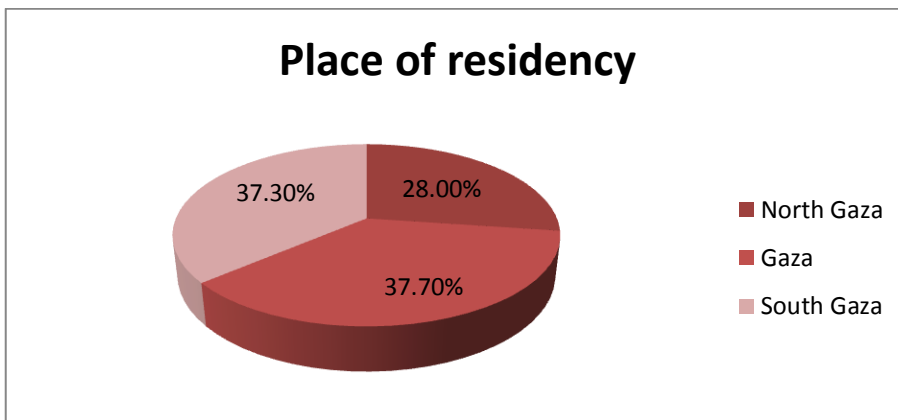
Table 4.1 shows the distribution of adolescents according to age groups. Children were distributed across age groups: 12-14 (38.7%,  $n=58$ ) and 15-17 (60.7%,  $n=91$ ) as shown in Figure 4.2.



**Figure 4.2 Distribution of study sample according to age**

#### 4.1.3 Place of Residency

Table 4.1 shows that the largest percent of the population (37.3%,  $n=56$ ) were from South Gaza, followed by (34.7%,  $n=52$ ) were from the Gaza and the smallest percent of population (28%,  $n=42$ ) were from North Gaza as shown below in Figure 4.3, so South Gaza was the Largest because it represents three governorates: Deir El-Balah, Khan Younis and Rafah. This sample was selected from governmental schools as the children were selected randomly.



**Figure 4.3 Distribution of study sample according to place of residency**

**Table 4.1 Distribution of study sample according to socio-demographic characteristics**

<b>Characteristic</b>	<b>N</b>	<b>%</b>
<b>Gender</b>		
Male	78	52%
Female	72	48%
<b>Age in years</b>		
12-14	58	38.7%
15-17	91	60.7%
<b>Place of residency</b>		
North Gaza	42	28%
Gaza	52	34.7%
South Gaza	56	37.3%
<b>Mother's education</b>		
Primary	44	29.3%
Secondary	55	36.7%
High education	49	32.7%
<b>Father's education</b>		
Primary	37	24.7%
Secondary	75	50%
High education	38	25.3%
<b>Mother's work</b>		
Employed	17	11.3%
Unemployed	131	87.3%
Dead	2	1.3%
<b>Father's work</b>		
Employed	109	72.7%
Unemployed	29	18.7%
Dead	13	8.7%
<b>Family size</b>		
≤ 7 members	70	46.7%
≥ 8 members	80	53.3%

#### 4.1.4 Parents Education Level

Table 4.1 shows the results of the analysis of the educational status of adolescents' parents. The study revealed that (32.7%,  $n=49$ ) of the fathers had high education level, (36.7%,  $n=55$ ) had secondary education level and (29.3%,  $n=44$ ) had primary education level. On the other hand, (25.3%,  $n=38$ ) of the mothers, (50%,  $n=75$ ) had secondary education level and (24.7%,  $n=37$ ) had primary education level as shown in Figure 4.4.

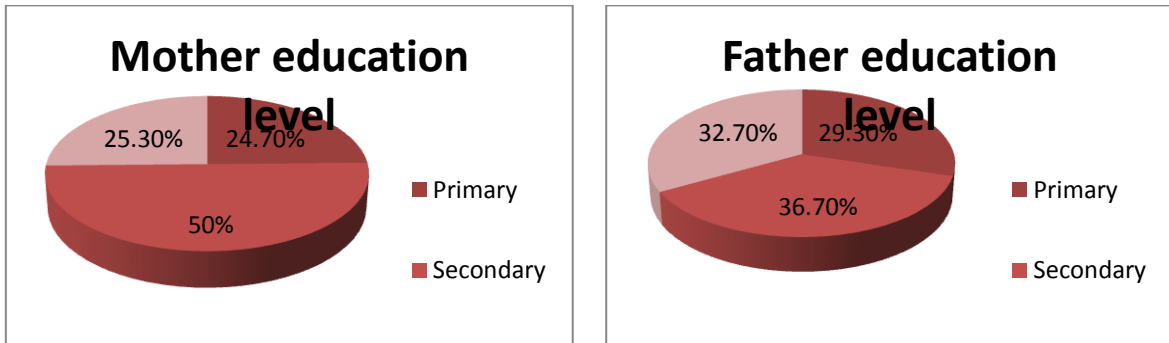


Figure 4.4 Distribution of study sample according to parents' education level

#### 4.1.5 Parents Occupation Status

Table 4.1 shows the occupancy of parents as (87.3 %,  $n=131$ ) of mothers were unemployed, (11.3%,  $n=17$ ) were employed and (1.3%,  $n=2$ ) were dead. In contrast, (18.7%,  $n=28$ ) of the fathers were unemployed, (72.7%,  $n=109$ ) were employed, and (8.7%,  $n=13$ ) were dead as shown in Figure 4.5. The result of this study did not come in accordance with the results of PCBS (2017) may be because the sample chosen for the study was not representative for the whole Palestinian population.

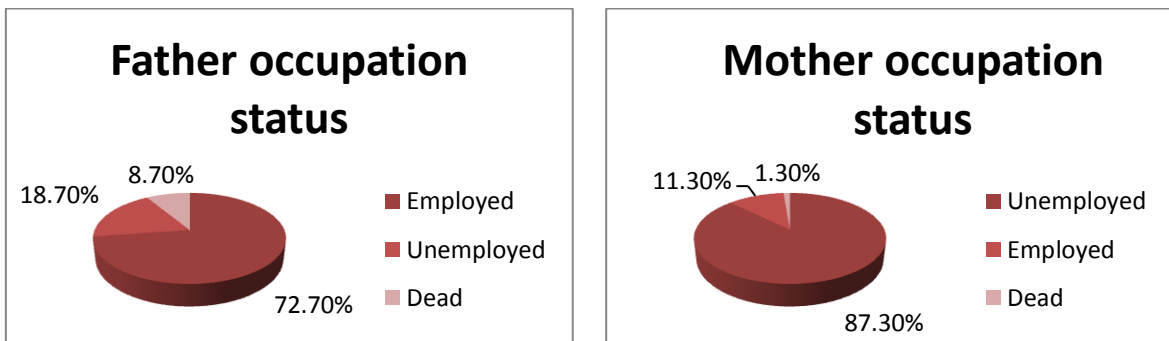
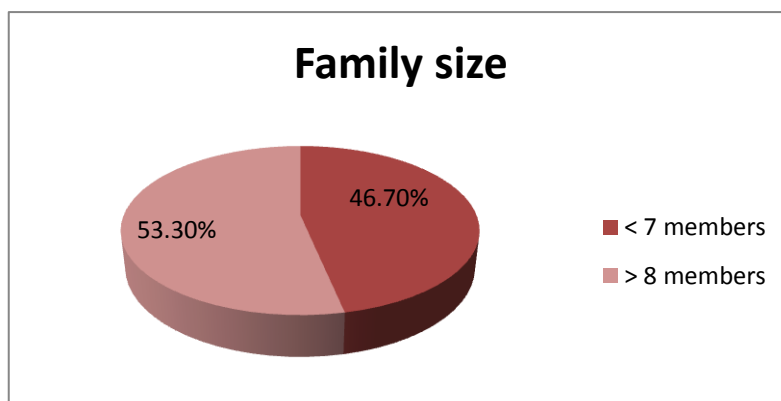


Figure 4.5 Distribution of study sample according to parents' occupation status

#### 4.1.6 Family Size

Table 4.1 shows the distribution of adolescents according to family size. In this study, the family size of children was divided into two groups as (n=70, 46.7%) of children are living in houses with family size less than 7 members in the same house and (n=80, 53.3%) of children are living in houses with family size more than 8 members in in the same house as shown below in Figure 4.6.



**Figure 4.6 Distribution of study sample according to family size**

#### 4.2 Nutrition of Adolescents in the Study Sample

During the study of Ard El-Insan, adolescents were asked about their nutritional habits for different types of food and but this study three types of food were chosen to be tested for its effect on vitamin D level, milk, egg and fish.

##### 4.2.1 Milk Consumption

Table 4.2 shows that (n= 50, 33.3%) of adolescents in the study sample were used to drink high amounts of milk and (n= 100, 66.7%) of adolescents were used to drink low amounts of milk and none of the participants never consume milk. Responses were taken as follows: high consumption = several times per day/week, low consumption = 1-2 times per month and never consume.

##### 4.2.2 Egg Consumption

Table 4.2 shows that consumption of egg was very high among adolescents in the study sample as (n= 116, 77.3%) of study sample were used to consume high amounts of eggs and about (n= 34, 22.7%) of adolescents were used to consume low amounts of eggs.

Responses were taken as follows: high consumption = several times per day/week, low consumption = 1-2 times per month and never consume.

#### 4.2.3 Fish Consumption

Table 4.2 show that eating fish is a protective measure for preserving normal level of vitamin D but in this study adolescents who are used to eat high amounts of fish were (n= 61, 40.7%) and those who were used to eat low amounts of fish were (n=89, 59.3%). Responses were taken as follows: high consumption = several times per day/week, low consumption = 1-2 times per month and never consume.

**Table 4.2 Nutrition of adolescents in the study sample**

Food consumption		N	%
<b>Milk</b>	High	50	33.3%
	Low	100	66.7%
<b>Egg</b>	High	116	77.3%
	Low	34	22.7%
<b>Fish</b>	High	61	40.7%
	Low	89	59.3%

#### 4.3 Distribution of Study Sample According to BMI

BMI is a very important variable which is associated with vitamin D deficiency as vitamin D is sequestered in fat, so obese individuals require more vitamin D supplementations (Sahay M. & Sahay R., 2012). Table 4.3 shows that about (n=35, 23.3%) of study sample were underweight, (n=84, 56%) of study sample were with normal BMI and (n=31, 20.7%) were obese.

**Table 4.3 Distribution of study sample according to BMI**

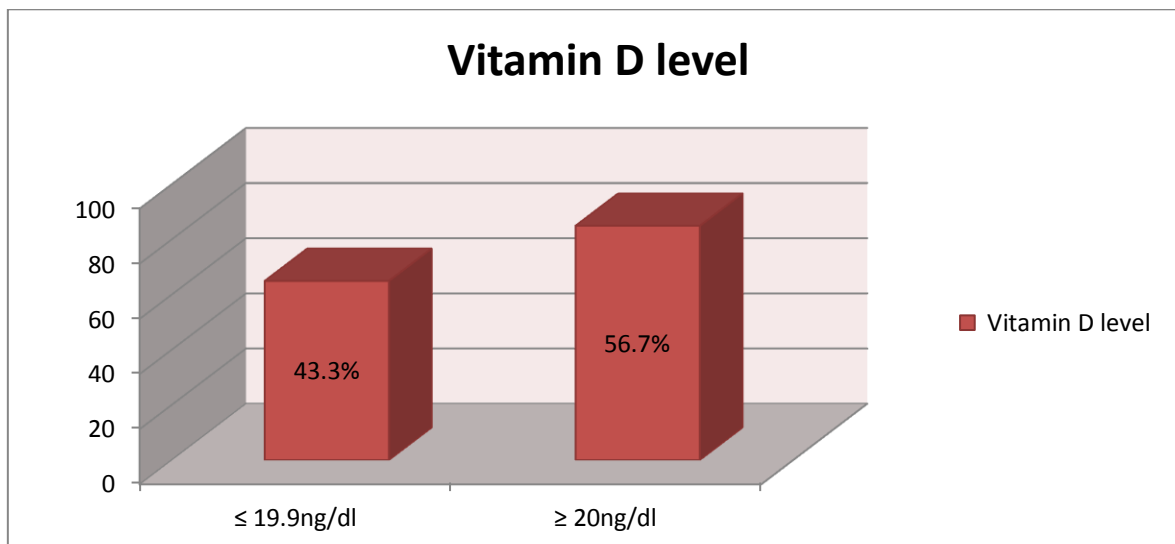
Characteristic	N	%
<b>BMI</b>		
Underweight	35	23.3%
Normal	84	56%
Overweight & Obese	31	20.7%

#### 4.4 Micronutrients Levels for Study Sample

##### 4.4.1 Vitamin D Status in the Study Sample

Vitamin D insufficiency is one of the most common health problems among adolescents in Gaza strip as in this study, table 4.4 shows the distribution of vitamin D level among study sample as (n=65, 43.3%) of study sample had low vitamin D levels ( $\leq 19.9\text{ng/dl}$ ) and (n=85, 56.7%) of study sample had high vitamin D level ( $\geq 20\text{ng/dl}$ ) as shown below in figure 4.7. Those results explain the high rate of osteomalacia among children as the previous studies revealed that the prevalence of osteomalacia ranges between 10-18% among children. In addition, the results of Palestinian micronutrients survey findings presented that vitamin D insufficiency among adolescents in Gaza Strip was 71.9% among females and 55% among males considering vitamin D insufficiency as vitamin D level  $\leq 50\text{ng/dl}$  (Elmadfa et al., 2013). In the Middle East it was found that there is a high incidence of osteomalacia as in Turkey, studies showed that most of patients had vitamin D deficiency whereas in Egypt they had mostly calcium insufficiency combined with vitamin D deficiency (Abudayya et al., 2009).

Another study of vitamin D status among adolescents was mad in Emirates which resulted that the prevalence of vitamin D deficiency (10%) among males and (28%) among females (Muhairi et al., 2013)



**Figure 4.7 Distribution of vitamin D level among study sample**

#### **4.4.2 Hgb Level of Adolescents**

Anemia represents a chronic major public health problem in the Gaza Strip which may exacerbate with other health problems such as vitamin D deficiency. In this study, the percentage of anemia among adolescent was (n=32, 32%) and non-anemic adolescents were (n=118, 78.7%) as shown below in table 4.4. The percentage appears to be similar with the results of the national nutritional survey (2015) which revealed that the percentage of anemia among adolescents is 30.4% among males and 24.3% among females in Gaza Strip.

#### **4.4.3 Vitamin A Level of Adolescents**

Vitamin D level affects and is affected by other micronutrients level as vitamin A level so it was measured during this study to test the relationship between vitamin D and A levels. Among study population (n=9, 6%) of adolescents had vitamin A deficiency ( $\leq 316$ mcg/l) and (n = 141, 94%) of adolescents had normal vitamin A levels ( $\geq 316.1$ mcg/l) as shown in table 4.4 but in the national nutritional survey (2015), it was found that the prevalence of vitamin A deficiency was 16.3% among males and 23.1% among females.

#### **4.4.4 Zinc Level among Adolescents**

One of the most important micronutrients to be aware during adolescence is zinc level because it affects children health to a large extent and also it is associated with vitamin D deficiency. In this study it was found that (n=124, 82.7%) of the participants had low zinc level ( $\leq 90$ mcg/dl) as shown below in table 4.4 and this result comes in accordance with the national nutritional survey (2015) to some extent which revealed that the prevalence of zinc level deficiency among adolescents is about 73.35% in Gaza Strip.. This result represents a very high percentage of zinc deficiency and as a result it may play a role in vitamin D insufficiency for adolescents.

**Table 4.4 Micronutrients levels for study sample**

<b>Characteristic</b>	<b>N</b>	<b>%</b>
<b>Vitamin D</b>		
≤19.9ng/dl	65	43.3%
≥20ng/dl	85	56.7%
<b>Hgb level</b>		
Anemic	32	21.3%
Non-anemic	118	78.7%
<b>Vitamin A level</b>		
≤316mcg/l	9	6%
≥316.1mcg/l	141	94%
<b>Zinc level</b>		
≤90mcg/dl	124	82.7%
≥90.1mcg/dl	11	7.3%

#### **4.5 Risk Factors of Vitamin D Deficiency**

To investigate all possible associations found between serum vitamin D levels and the study variables, Cross tabulation and Chi square test was established to find the associations as the assumption of a test is satisfied, where the chi square requires that more than 25% of cells should include more than 5 expected observations. Distribution of vitamin D levels among socio-demographic characteristics is shown below in table 4.5.

During FGDs adolescents were asked about their knowledge about vitamin D, importance and diseases resulted from vitamin D deficiency. In Khan Younis females' school, they had little information about vitamin D and they said that vitamin D is important for bones and teeth and can prevent osteomalacia and osteoporosis and they added that sunlight is the main source of vitamin D but in males' school, they had more information about vitamin D and one student said:

*“Vitamin D can be get from sunlight when somebody is exposed to sun in the early morning”*

And another student added:

*“Vitamin D is important for bones especially for children and it has an important role in wound healing and absorption of calcium”*

But all of them confirmed that vitamin D deficiency can result in rickets, osteoporosis, osteomalacia and one student added:



*“Vitamin D is also important for prevention of atherosclerosis, thalassemia, gingivitis, weak immunity and stunting”*

When they were asked about its role in DM and cardiac diseases, they answered that it does not have any effect. In Gaza females' school they thought that vitamin D is very important for health and the main source is sunlight. They added that it is very important for the absorption of calcium and phosphorus and one female stated:

*“Vitamin D deficiency is responsible for many diseases including, rickets, osteoporosis, osteomalacia, weakness of teeth, general fatigue, hair loss and split nails”*

When girls were asked about the relationship between vitamin D level and chronic diseases such as cardiac diseases and DM, they said that they don't have any idea about that but in males school, they thought that vitamin D is one of the most important vitamins for body that gives us energy and is found in sunlight and one male student said:

*“Vitamin D deficiency may cause many diseases such as: rickets, osteoporosis, osteomalacia, weakness of teeth and overall immunity”*

When they were asked about the relationship between vitamin D deficiency and chronic diseases such as cardiac diseases and DM, one student stated:

*“Vitamin Deficiency may develop hypertension and other cardiac diseases”* but the rest of students did not have any idea.

It was noticed that there was a common miss-conception during FGDs as students in all schools of Khan Younis and Gaza of both genders had the same idea that vitamin D deficiency may cause poliomyelitis and this deficiency in knowledge should be taken into account and health education is recommended for adolescents in schools.

In the FGD with public health students, they discussed the problem in more depth and one student stated:

*“Vitamin D is absorbed from sunlight through direct exposure of skin to sun rays then it is synthesized in the liver and then passed to the kidney to be converted to the active form of vitamin D and it is responsible for precipitation of calcium on bones”*

And they confirmed that vitamin D deficiency may develop many diseases as one student mentioned:

*“The most common diseases which results from vitamin D deficiency are; rickets, osteoporosis, osteomalacia, autoimmune diseases and hyperparathyroidism”*

But when they were asked about chronic diseases such as cardiac diseases and DM, they did not have any idea.

#### **4.5.1 Effect of Socio-Demographic Factors on Vitamin D level**

##### **4.5.1 (a) Gender Differences in Vitamin D Levels**

As can be seen by the frequencies cross tabulated in Table 4.5, there was a significant relationship between vitamin D status and different socio-demographic characteristics. A statistically significant association was found between gender and vitamin D deficiency as 14.1% of study males had insufficient vitamin D levels ( $\leq 19\text{ng/dl}$ ), while this percentage reach to 75% of study females. The difference between groups reached statistical significant P-value  $< 0.001$  as shown in table 4.5.

Table 4.6 shows the mean of vitamin D level for both categories of the variable of gender by applying independent t-test which indicates that the mean of vitamin D level among males (30ng/dl) is more than that among females (17ng/dl). The difference in mean between the two groups reached a statistical significant level (P-value  $< 0.001$ ).

This marked gender difference in vitamin D status as the prevalence of vitamin D insufficiency was significantly higher in females than males. This is attributed to the fact that females in this age spent much more time indoor participating in house activities than males who spent longer time playing outside the house, allowing them an exposure time of more than an hour a day. This result was similar to that reported by Bahijri (2001) who found that vitamin D deficiency was more in females than males but Jazar, et al. (2011) found that there were no significant differences in serum vitamin D between males and females, possibly because they had similar duration of outdoor physical activity.

**Table 4.5 Vitamin D level of adolescents according to socio-demographic characteristics using Chi Square**

Characteristics	Vitamin D Status n (%)		P-value
	≤ 19ng/dl	≥20ng/dl	
<b>Gender</b>			
Male	11 (14.1%)	67 (85.9%)	0.001
Female	54 (75%)	18 (25%)	
<b>Age</b>			
12-14 years	22 (37.9%)	36 (62.1%)	0.204
15-17 years	42 (46.2%)	49 (53.8%)	
<b>Place of residency</b>			
North Gaza	13 (31%)	29 (69%)	0.042
Gaza	23 (44.2%)	29 (55.8%)	
South Gaza	29 (51.8%)	27 (48.2%)	
<b>Family size</b>			
≤ 7	31 (44.3%)	39 (55.7%)	0.478
≥ 8	34 (42.5%)	46 (57.5%)	

**Table 4.6 Vitamin D level of adolescents according to socio-demographic characteristics using t-test**

Characteristics	N	Mean	SD	P-value
<b>Gender</b>				
Male	78	30ng/dl	11.9	0.001
Female	72	17ng/dl	5.17	
<b>Age</b>				
12-14 years	58	23ng/dl	7.5	0.374
15-17 years	91	24.5ng/dl	13.14	
<b>Place of residency</b>				
North Gaza	42	28.36ng/dl	15.8	0.004
Gaza	52	23.46ng/dl	7.87	
South Gaza	56	20.75ng/dl	8.7	
<b>Family size</b>				
≤ 7	70	24.6ng/dl	12.67	0.409
≥ 8	80	23.11ng/dl	10	

During FGDs and starting with Khan Younis females' school, they thought that vitamin D insufficiency is not common among females except in case of elderly and females in early childhood but the gender is not a risk factor for vitamin D insufficiency but in males' school they thought that vitamin D insufficiency is not common in adolescent females as one student stated:

*“Females' need for vitamin D is less than males, so it is not a problem in females”.*

In the schools of Gaza, females' school thought that females are at more risk for getting vitamin D insufficiency as one student said:

*“Females have less chance for sunlight exposure due to cultural aspects but males are allowed to play, work and even stay outdoors for long time”*

In males' school they thought that males are at more risk for having lower vitamin D levels and one student explained this and said:

*“Males are responsible for hard tasks and are exposed to more risks for diseases than females”.*

On the other hand, public health students discussed this in more depth as the most of them thought that vitamin D insufficiency is more common among females than males and one student stated:

*“Females are at more risk because they have less chance of outdoor activities and direct sunlight exposure on skin in addition to the effect of pregnancy and lactation”*, this is coming in accordance with Muhairi (2013) study of the prevalence of vitamin D deficiency.

#### **4.5.1 (b) Distribution of Vitamin D Levels Among Age Groups**

Table 4.5 shows the relationship between age and vitamin D level. Cross tabulation resulted in non-statistical significant relationship between vitamin D status and age (Fisher's exact test, P-value=0.207) but vitamin D deficiency was higher among adolescents in the age group between 15 and 17 years of age (46.2%, n=42) than children in the age group between 12-14 years of age (37.9%, n=22).

After testing the relationship between vitamin D and age using independent t-test it was shown that there is no significant difference in mean between the two age groups as the age group (12-14) had a mean of vitamin D level about 23ng/dl but the age group (15-17) had a mean of vitamin D about 24.5ng/dl (P-value = 0.374) as shown in table 4.6. Although the difference is not significant, it was found that older adolescents are more prone to vitamin D deficiency which could be attributed to differences in the vitamin D intake and sun exposure patterns of different age groups.

The incidence of vitamin D deficiency was higher among the group aged 15-17 years. The reason for this might be due to changes in type of clothing in females who wear hijab

which act as a barrier for sunlight exposure or decreased dietary vitamin D intake as result of transitioning to low vitamin D containing fast foods.

Bahijri (2001) and Jazar, et al. (2011) assured in their studies that the mean value of serum vitamin D decreases as the child grows older, the reason for that is the higher dietary vitamin D intake in younger children.

During FGDs adolescent students had different opinions about vitamin D insufficiency in different age groups. In Khan Younis schools, females' school thought that vitamin d insufficiency is not common during adolescence and instead it is more common in elderly people and children in early ages and one females stated:

*“Vitamin D deficiency is more common among children 1-5 years of age because they are at more risk due to insufficient immunity during this life period”*

Another student said:

*“Vitamin D deficiency is more common among elderly people 55-60 years because they are exposed to low bone density and impaired absorption of vitamins from the gut”*

In Khan Younis males', school they had the same opinion but when they were asked about vitamin D status among adolescents, one student stated:

*“Vitamin D deficiency is more common among children 1-9 years and people above 60 years of age but adolescents are not at risk of having low vitamin D levels and osteomalacia because they had finished body building and bone formation”.*

In Gaza schools, females' school thought that vitamin D insufficiency is common among all age groups but a student had a different opinion and said:

*“Vitamin D is more common among elderly because bone density decrease during their life”*

And another female stated that:

*“Children 1-5 are exposed to vitamin D deficiency due to low immunity and insufficient nutrition in this stage”*

In Gaza males' school they thought that adolescents are not at risk of vitamin D deficiency as one student said:

*“Vitamin D insufficiency is not common among adolescents except when they did not eat healthy nutritious food containing high amounts of food”*

Public health students thought that vitamin D deficiency is more common among children and elderly but also it is common among adolescents due to their lifestyle and indoors living conditions and one student stated:

*“Adolescents stay much time indoors due to large amounts of school homework and study and does not find enough time for outdoor activities”.*

Also, Muhairi study resulted in the same evidence that prevalence of vitamin D deficiency is very high among adolescents.

#### **4.5.1 (c) Distribution of vitamin D levels among different places of residency**

Table 4.5 shows the difference in percentage of vitamin D insufficiency and sufficiency among participants from different places of residency as cross tabulation resulted in a significant difference (P-value = 0.042) between different places of residency in The Gaza Strip as (51.8%, n= 29) of study participants living in South Gaza, (44.2%, n=23) living in Gaza and (31%, n=13) living in North Gaza had vitamin D levels less than 19ng/dl. The largest proportion of sample was taken from South Gaza because it includes three governorates of Gaza Strip (Rafah, Khan Younis and Middle Zone) and the lowest proportion of sample was taken from North Gaza.

Table 4.6 shows the mean of vitamin D level among different places of residency which resulted from using One-Way ANOVA to test the mean difference between vitamin D levels among Gaza Governorates as vitamin level in North Gaza is more than the level in South Gaza (the mean difference = 7.6) and this difference reached a statistical significant level (P-value = 0.003). Although the mean difference between North Gaza and Gaza in vitamin D level equals 4.9, this difference did not reach a statistical significant level (P-level = 0.099). Mean difference between Gaza and South Gaza (2.7) did not reach statistical significant level (P-value = 0.607).

The difference in vitamin D level found in this study between different places of residence may be due the nature of residency and its relation to sunlight entry into houses as South Gaza had the highest level of vitamin D insufficiency followed by Gaza and North Gaza which may be due to overcrowdings in Gaza and South Gaza. El Hayek, et al. (2010) found that children lived in crowded households compared with those who did not had

lower vitamin D concentrations as crowding may be related to food security among many populations.

#### **4.5.1 (d) Effect of Family Size on Vitamin D Level**

Another factor that may have negative effect on vitamin D level is the family size, but in this study the variable of family size did not have a significant effect (P-value = 0.409) on vitamin D level as (44.3%, n=31) of the families less than 7 members and (42.5%, n=34) of the families more than 8 members living in the same house had low vitamin D level (less than 19ng/dl). On the other hand, there was (n= 39, 55.7%) of adolescents who live in families of less than 7 members had high vitamin D levels and (n= 46, 57.5%) of this group had high vitamin D level. As a result, in this study there is no significant difference in vitamin D level between different family sizes living in the same house as shown below in table 4.5.

Table 4.6 shows the mean of vitamin D level among different groups of family sizes of adolescents. The mean of vitamin D level among families with members less than 7 was 24.6ng/dl and among families with members more than 8 members was 23.11ng/dl. The difference between the two groups of family sizes did not reach a statistical significant level (P-value = 0.409)

#### **4.5.1 (e) Effect of Parents Education on Vitamin D Deficiency**

In this study it was found that there is no significant association as (45.9%, n=17) and (45.9%, n=50) of children who have fathers and mothers with primary education level respectively, (45.3%, n=34) and (28.6%, n=8) with secondary education level and (36.8%, n=14) and (53.8%, n=7) with high education level had low vitamin D levels (less than 19ng/dl). As shown below in table 4.7.

Table 4.8 shows the mean difference between different education levels for father and mother of participants using One-Way ANOVA test. The table shows that adolescents whose fathers had a secondary education level had better vitamin D level than primary education level with mean difference of (1.6) and adolescents whose fathers had high education level had higher vitamin D level difference with a mean difference of (0.03) but this difference did not reach a statistical significant level (P-value = 0.712).

Mother education level affect vitamin D levels of adolescents as educated women care about healthy nutrition for their children. In this study, adolescents whose mothers with

higher education levels had more vitamin D levels with mean differences showed in table 4.8 but this difference did not reach a statistical significant level (P-value = 0.369).

The result that almost none of the parents of the study population were illiterate reflects a well-educated community. Literacy and education currently have higher standards in Palestine than they have in several Arab countries (Giacaman, et al., 2009). Review of the literature reveals that there is no consensus on the effect of parental education especially maternal education on vitamin D status of the children. Several studies have suggested a strong positive effect of the mothers' educational level on the child vitamin D status (Mushtaha, 2006; Weng, et al., 2007). In addition, Gilbert-Diamond, et al. (2010) found that there is no relation between maternal education and serum vitamin D levels of the children

#### **4.5.1 (f) Effect of Parents Employment Status on Vitamin D Level**

Employment status of parents which may affect vitamin D level of children was tested by Chi Square test which resulted in non-significant relationship between vitamin D status of children in the study and occupation status of their parents. In the study sample there was (45.9%, n=50) and (41.2%, n=7) of children's employed fathers and mothers respectively, (28.6%, n=8) and (44.3%, n=58) of children's unemployed fathers and mothers respectively and (53.8%, n=7) and (0%, n=0) of children's dead fathers and mothers had low vitamin D levels (less than 19ng/dl) as shown below in table 4.7.

The table shows also the mean difference between groups within the variable as employment status of parents affects vitamin D level of adolescents. Children whose fathers are not employed had more vitamin D level than those whose fathers are employed or dead with a mean difference of (3.24, 6.61) respectively and children whose fathers are employed had a vitamin D level more than those whose fathers are dead with a mean difference of (3.36) but this difference in means between different groups did not reach a statistical significant level (P-value = 0.189) as shown in table 4.8.

Mother employment status usually affects children health in general as they are the care givers for them and they have the responsibility to prepare healthy food for their children. In this study it was found that children whose mothers are not employed had a vitamin D level more than those whose mothers are employed with a mean difference of (0.13) and children whose mother are dead had a vitamin D level more than those whose mothers are employed with a mean difference of (3.15) but this difference did not reach a statistical significant level (P-value = 0.921) as shown in table 4.7



**Table 4.7 Vitamin D level of adolescents according to socio-demographic characteristics using Chi Square**

Characteristics	Vitamin D Status n (%)		P-value
	≤ 19ng/dl	≥20ng/dl	
<b>Father education</b>			
Primary	17 (38.6%)	27 (61.4%)	0.762
Secondary	25 (45.5%)	30 (54.5%)	
High education	22 (44.9%)	27 (55.1%)	
<b>Mother education</b>			
Primary	17 (45.9%)	20 (54.1%)	0.645
Secondary	34 (45.3%)	41 (54.7%)	
High level	14 (36.8%)	24 (63.2%)	
<b>Father work</b>			
Employed	50 (45.9%)	59 (54.1%)	0.187
Unemployed	8 (28.6%)	20 (71.4%)	
Dead	7 (53.8%)	6 (46.2%)	
<b>Mother work</b>			
Employed	7 (41.2%)	10 (58.8%)	0.447
Unemployed	58 (44.3%)	73 (55.7%)	
Dead	0 (0%)	2 (100%)	

**Table 4.8 Vitamin D level of adolescents according to socio-demographic characteristics using t-test**

Characteristics	N	Mean (P-value)	SD	P-value
<b>Father education</b>				
Primary	44	23.2ng/dl	7.7	0.712
Secondary	45	24.83ng/dl	13.5	
High education	49	23.24ng/dl	11.57	
<b>Mother education</b>				
Primary	37	24ng/dl	9.27	0.369
Secondary	75	22.67ng/dl	9.56	
High level	38	25.84ng/dl	15.57	
<b>Father work</b>				
Employed	109	23.5ng/dl	12	0.189
Unemployed	28	26.71ng/dl	8.9	
Dead	13	20.146ng/dl	8	
<b>Mother work</b>				
Employed	17	23.9ng/dl	14.5	0.921
Unemployed	131	23.76ng/dl	10.95	
Dead	2	27ng/dl	8.69	

#### 4.5.2 Effect of Diet on Vitamin D Level

Type of food consumed by adolescents affects their health status to a large extent especially vitamin D level. Bohon & Goolsby (2013) study estimated that 20% of vitamin D in human body is from diet.

**Table 4.9 Vitamin D level of adolescents according to diet using Chi Square**

Characteristics	Vitamin D Status n (%)		P-value
	≤ 19ng/dl	≥ 20ng/dl	
<b>Milk</b>			
High	14 (28%)	36 (72%)	0.009
Low	51 (51%)	49 (49%)	
<b>Egg</b>			
High	51 (51%)	65 (56%)	0.465
Low	14 (41.2%)	20 (58.8%)	
<b>Fish</b>			
High	25 (45.9%)	33 (54.1%)	0.36
Low	37 (41.6%)	42 (58.4%)	

**Table 4.10 Vitamin D level of adolescents according to diet using t-test**

Characteristics	N	Mean (P-value)	SD	P-value
<b>Milk</b>				
High	50	27.1ng/dl	11.65	0.015
Low	100	22.19ng/dl	10.84	
<b>Egg</b>				
High	116	24.68ng/dl	12.19	0.024
Low	34	20.9ng/dl	6.99	
<b>Fish</b>				
High	61	22.6ng/dl	10.45	0.274
Low	89	24.66ng/dl	11.86	

In this study, four types of food were chosen to be studied and its relationship with vitamin D level was examined. Table 4.9 illustrates the amount of some types of foods consumption among adolescents and its relation with vitamin D level using Chi Square test. Table 4.10 shows the mean difference between groups according to vitamin D level.

#### **4.5.2(a) Milk Consumption**

Milk is one of the main food sources for vitamin D so adolescents were asked about their consumption of milk per week and it was high (n= 14, 28%) and low (n= 51, 51%) in adolescents with low vitamin D level ( $\leq 19.9\text{ng/dl}$ ) and it was high (n= 36, 72%) and low (n = 49, 49%) in adolescents with high vitamin D levels ( $\geq 20\text{ng/dl}$ ) and this difference reached a statistical significant level (P-value= 0.009) as shown in table 4.9.

Comparing the mean of vitamin D level between adolescents who drink large amounts of milk (27.1ng/dl) and adolescents who drink low amounts of milk (22.19ng/dl) there was a statistical significant difference between the two groups (P-value= 0.015) as shown below in table 4.10.

This result comes in accordance with Holick (2008) study that confirms the importance of milk consumption as it is one of the most important vitamin D sources.

#### **4.5.2(b) Egg Consumption**

Egg contains a good amount of vitamin D level that may help in preserving a sufficient serum vitamin D level. In this study egg consumption was high (n= 51, 51%) and low (n= 14, 41.2%) in adolescents with low vitamin D levels ( $\leq 19.9\text{ng/dl}$ ) and it was high (n= 65, 56%) and low (n= 20, 58.8%) in adolescents with high vitamin D levels ( $\geq 20\text{ng/dl}$ ) but this difference did not reach a statistical significant level (P-value= 0.465) as shown below in table 4.9.

Table 4.10 illustrates the mean of vitamin D level among adolescents who eat high amounts of eggs was (24.68ng/dl) and the mean among those who eat low amounts of eggs was (20.9ng/dl) and this difference between means reached a statistical significant level (P-value= 0.024)

#### **4.5.2(c) Fish Consumption**

Table 4.9 shows that fish consumption affects vitamin D level as consumption was high (n= 25, 45.9%) and low (n= 37, 41.6%) in adolescents who had low vitamin D level ( $\leq 19.9\text{ng/dl}$ ) and it was high (n= 33, 54.1%) and low (n= 52, 58.4%) in adolescents with high vitamin D levels ( $\geq 20\text{ng/dl}$ ) but this difference did not reach a statistical significant level (P-value= 0.36). In contrast Holick (2008) study revealed the importance of fatty fish and other types of fish as a source of vitamin D.

The mean of vitamin D level among adolescents who eat high amounts of fish was (22.6ng/dl) and the mean among adolescents who eat low amount of fish was (24.66ng/dl) but this difference between means did not reach a statistical significant level (P-value= 0.263) as shown below in table 4.10.

During FGDs nutritional habits and its effect on vitamin D level was discussed and students had submitted different opinions. In Khan Younis schools, females' school thought that vitamin D is found in milk, egg, and yogurt and when they were asked about fish, some students agree that it is important for normal vitamin D levels and others thought that it does not have any effect on vitamin D level but one student added:

*“Vitamin D is found in citrus fruits such as orange and citrus fruits are the main source if vitamin D”*

Also, in Khan Younis males' school, they thought that vitamin D is found in milk, egg, fish and some types of vegetables and fruits. On the other hand, Gaza schools students had another point of view; females' school thought that vitamin D is found in many types of foods as one female stated:

*“The most common types of food containing vitamin D are; citrus fruits, oats, milk, egg and fish and they are considered as one of the main sources of vitamin D”*

In Gaza males' school, students said that vegetables and fruits are the main source of vitamin D and when they were asked about other types of food containing vitamin D, one student answered:

*“The main source of vitamin D in food is clementine, cheese-weed plant, milk products, citrus fruits, and fish”*

However, when they were asked about egg they answered it may contain vitamin D but in little amounts. Public health students thought that vitamin D is found in some types of food but in very little amounts and one student explained in details.

*“Vitamin D is not found in foods as a main source but some types may contain little amounts of vitamin D such as fortified milk, fish and other milk products and the main source for absorption of vitamin D is the sunlight”*

This coming in accordance with literature, it was mentioned that types of food containing trace amounts of vitamin D such as fatty fish, egg yolk, nuts, and certain fungi (Saggese, 2015)

#### 4.5.3 Sunlight Exposure Effect on Vitamin D Status

In literature, Bohon & Goolsby (2013) study estimated that 80% of vitamin D in human body can be get from sunlight.

Adolescents were asked about the effect of sunlight exposure on vitamin D level during FGDs. They had different opinions, starting with Khan Younis females' school they thought that sunlight is one of the main sources of vitamin D and when they were asked about the best time for sunlight exposure, one student stated:

*“The best time is from 8-10 in the morning but before 8 am the UV light is harmful”*

However, they argued about the duration as about 25% of them said that 30 minutes per day is enough and about 50% of them said that 60 minutes is enough and 25% said that 120 minutes is the best duration to prevent vitamin D deficiency. In Khan Younis males' school they thought that sunlight exposure is important for normal vitamin D level and the most suitable time for exposure is 6-10 in the morning and one male student stated:

*“After 10am the sunlight become harmful and does not affect vitamin D level and the best duration is about 30-60 minutes per day”*

In Gaza females' school they confirms the importance of sunlight for vitamin D and the best time for exposure is in the early morning from sunrise until 10 am or in the afternoon 3-5 pm and the duration should be 30-60 minutes but about 83% of them thought that the exposure should not be every day and may be 2-3 times per week. In Gaza males' school they thought that sunlight exposure is very important for the absorption of vitamin D and calcium and the best time for exposure was argued as 25% of them said that 6-9 am is the best time for exposure, 50% said that the best time is from sunrise until 12pm and 25% said that any time is suitable for exposure but one student added:

*“Every time is suitable for exposure except the times of strong burning sun rays in the afternoon”*

When they were asked about the duration, 34% of students said that 30 minutes is the standard duration for sunlight exposure, 42% of them said that 60 minutes is the best duration of exposure and 24% of them said that 10-15 minutes is enough for normal vitamin D levels but 75% of students think that the exposure should be every day and 25% of them thought that it is not important to be every day and 3 times per week is enough as one student said:

*“It is harmful to be exposed to sunlight directly daily as it may result in skin pigmentation and cancer”*

Public Health students thought that sunlight exposure is the main source for absorption of vitamin D and it is very important for protection from vitamin D deficiency but it should be before 10 am to avoid carcinogenic effect of sun rays and it should be about 15-20 minutes per day for about three times per week.

About this argument, Holick estimates that during the first days of late spring or early summer, exposure should not exceed few minutes a day in order to let the melanocyte cells in the skin to begin to create pigmentation which is very important to protect against consequences of later over exposure to the sun and he added that exposure time should be gradually increased and the standard need for sun exposure is limited to few minutes per day during summer to maintain normal levels of vitamin D level (Zielinska-Dabkowska & Karolina, 2014)

#### **4.5.4 Effect of Physical Activity on Vitamin D Level**

Using Chi square test, table 4.11 shows the distribution of physical activity according to vitamin D level among adolescents with vitamin D insufficiency was as follows: (53.9%, n= 48) of adolescents live a sedentary life, (21.1%, n= 4) are low active and (33.4%, n= 14) are active. On the other hand, the distribution of physical activity according to vitamin D level among adolescents with sufficient vitamin D level was as follows: (46.1%, n= 41) of adolescents live sedentary life, (78.9%, n= 15) are low active and (56%, n= 28) are active. Those differences among groups of different physical activities reached a statistical significant level (P-value=0.035) which means that being active may prevent the problem of vitamin D insufficiency.

One-Way ANOVA test for the relationship between vitamin D level and physical activity resulted that the mean of vitamin D level among adolescents living sedentary life was 21.2ng/dl but for those with low active or active life it was 27.6ng/dl for both of them and this difference in means between the different groups of physical activity reached a statistical significant level (P-value= 0.002) as shown in table 4.11.

**Table 4.11 Vitamin D level of adolescents according to physical activity**

Characteristics	Vitamin D Status n (%)		Mean (P-value)	P-value
	≤ 19.9ng/dl	≥20ng/dl		
<b>Physical activity</b>				
Sedentary	48(53.9%)	41(46.1%)	21.2ng/dl	0.035
Low active	4(21.1%)	15(78.9%)	27.6ng/dl	
Active	14(33.4%)	28(56%)	27.6ng/dl (0.002)	

The importance of physical activity was discussed with adolescents during FGDs and they introduced different opinions, In Khan Younis females’ school they said that physical activity is very important for body health especially outdoors activities such as running, jumping, and walking and when they were asked about the duration of physical activity they said 30-60 minutes is enough per day but they argued about the frequency as 42% of adolescents said that it should be 2-3 times per week and 46% of then said that every day activities is very important for protection from vitamin D deficiency and one female student stated:

*“We like doing many activities but we don’t have the chance to practice those activities duo to cultural aspects common in our community”*

In Khan Younis males’ school they said that physical activity is important for bone health and for vitamin D especially playing football, swimming, running, walking, volleyball and aerobics and when they were asked about duration they argued as 58% of them said that 30-60 minutes per day is enough for healthy bones and 42% of them said that 120 minutes is more useful for vitamin D and all of them confirms that it should be daily and one student added:

*“Physical activity and bone health are linked together as sports strengthen bones, enhance immunity and improve the overall health of human body”*

Also, Gaza females’ school thought that physical activity is important for overall health and for prevention of many diseases and one female stated:

*“It is better to be outdoors to get benefit from sunlight exposure in addition to the benefit of physical activity”*

And as in other schools, they argued about the duration and frequency per week as 67% of them said that it should be 60 minutes per day three times weekly and 33% of them thought that it should be 30-60 minutes daily. In males' school, 17% of them thought that physical activity does not have any effect on vitamin D level explaining that there is no association between physical activity and vitamin D level and 83% of them said that it is very important for bone health especially when it is practiced outdoors with sunlight exposure such as running and a student commented:

*“We have shortage in open places specified for physical activity, so we are not encouraged to do many types of sports”*

When they were asked about the duration and frequency, they said that it should be 30-60 minutes per day three times per week. Public Health students thought that physical activity is very important to avoid vitamin D deficiency because it helps in the control of obesity, so vitamin D trapped within lipids will get free in addition to the effect of sunlight exposure during outdoor physical activity and it should be for about 30 minutes per day three times weekly. Finally, most of participants in FGDs confirms the importance of physical activity for normal vitamin D level and this is coming in accordance with the results of Muhairi (2013) study which revealed that vitamin D concentration increase by the increase of physical activity score and individuals who spend much time in watching TV, playing video games or using computers are at more risk to have low vitamin D levels.

#### **4.5.5 Effect of type of dressing on vitamin D level**

The variable of dressing and type of clothes was discussed during FGDs as the four schools of adolescents and public health students had the same thought that the effect on vitamin D may be due to the color and textile of used clothes but when they were asked about their opinion about the surface of body exposed to sunlight and the effect of wearing hijab for females on vitamin D level, Khan Younis females' school said that it does not have any effect and one female student stated:

*“Wearing hijab is required and it does not affect the absorption of sunlight on skin”*

In Khan Younis males' school, they thought that covering all of the body by clothes or wearing hijab may reduce the absorbed amount of sunlight, but one student commented:



*“Wearing hijab or other clothes that cover most of the body does not block sunlight totally, so it does not have an important role in vitamin D deficiency”*

In Gaza females' school, they said that hijab does not have any effect on the absorption of sunlight, so it is not considered as a risk factor for vitamin D insufficiency. In Gaza males' school they said that they don't have any idea about the effect of hijab or covering all of the body on the absorption of sunlight during exposure.

Public Health students thought that clothes covering all of the body and Hijab affect the absorption of sunlight, so this problem can be controlled by governmental allocation of open areas for physical activity and aerobics and special areas for females to benefit from sunlight exposure without wearing Hijab. In addition to increasing the public awareness of people on the importance of sunlight exposure for vitamin D and overall health and other ways to compensate with the cultural and religious concepts and avoid vitamin D deficiency.

#### **4.5.6 Vitamin D Status of the Study Sample According to BMI**

The prevalence of vitamin D insufficiency and sufficiency according to BMI are presented in Table 4.12. Underweight, normal weight and obese adolescents who had low vitamin D level  $\leq 19.9$ ng/dl were (n= 12, 43.3%, n= 36, 42.9%, n= 17, 54.7%) respectively and those who had high vitamin D level  $\geq 20$ ng/dl were (n= 23, 65.7%, n= 48, 57.1%, n= 14, 45.2%) respectively but this difference in vitamin D level among adolescents according to BMI did not reach statistical significant level (P-level= 0.241) those results are illustrated in table 4.12.

There was a difference in vitamin D level among adolescents according to their BMI as the mean of vitamin D in underweight adolescents was (25.6ng/dl), in adolescents with normal vitamin D level was (24ng/dl) and in obese adolescents was (23.8ng/dl) but this difference in mean of vitamin D level did not reach a statistical significant level (P-value= 0.241) as shown in table 4.12. These results are coming in accordance with old studies which revealed that obesity causes sequestration of vitamin D in adipose tissues and as a result the bioavailability is reduced but in recent studies Vitamin D is considered as fat soluble hormone and its absorption is enhanced in obesity. However, a study by Drincic and colleagues did not find any evidence of sequestration of vitamin D either supplemental or endogenous 25(OH) D in fat cells (Sanghera et al., 2017)

**Table 4.12 Vitamin D level of adolescents according to BMI**

Characteristics	Vitamin D Status n (%)		Mean (P-value)	P-value
	≤ 19ng/dl	≥ 20ng/dl		
<b>BMI</b>				
Underweight	12 (43.3%)	23 (65.7%)	25.6ng/dl	0.241
Normal	36 (42.9%)	48 (57.1%)	24ng/dl	
Overweight & Obese	17 (54.7%)	14 (45.2%)	23.8ng/dl (0.284)	

**4.5.7 Effect of Micro-Nutrients Levels on Vitamin D Level**

Three micro-nutrients were tested during study to study their effect on vitamin D level for adolescents among study sample. The results are shown below in table 4.13.

**4.5.7(a) Effect of Hgb Level of Adolescents on Vitamin D Level**

There is a strong correlation between hemoglobin level and vitamin D level as anemia increase the tendency to have vitamin D insufficiency. Table 4.8 shows distribution of vitamin D level among different anemic status of adolescents using Chi Square test which resulted in: (71.9%, n= 23) of anemic adolescents and (36.4%, n= 43) of non-anemic adolescents had low vitamin D levels ( $\leq 19.9$ ng/dl). In addition, (28.1%, n= 9) of anemic adolescents and (63.6%, n= 75) of non-anemic adolescents had high vitamin D levels ( $\geq 20$ ng/dl) and the difference in percentage among groups of anemic status reached a statistical significant level (P-value= 0.001) as shown below in table 4.13.

When comparing the means between vitamin D level among different anemic status for participants using Independent t-test, it was found that the mean of vitamin D level among anemic adolescents was 18.76ng/dl and the mean among non-anemic adolescents was 25.2ng/dl and this difference reached a statistical significant level (P-value= 0.004) as shown below in table 4.14.

**Table 4.13 Vitamin D level of adolescents according to micronutrients levels using Chi Square**

Characteristics	Vitamin D Status n (%)		P-value
	≤ 19ng/dl	≥ 20ng/dl	
<b>Hgb level</b>			
Anemic	23 (71.9%)	9 (28.1%)	0.001
Non-anemic	43 (36.4%)	75 (63.6%)	
<b>Vitamin A level</b>			
≤ 14.4mcg/dl	6 (66.7%)	3 (33.3%)	0.177
≥14.5mcg/dl	59 (41.8%)	82 (58.2%)	
<b>Zinc level</b>			
≤ 70mcg/dl	37 (43.5%)	48 (56.6%)	0.249
≥70.1mcg/dl	18 (36%)	32 (64%)	

**Table 4.14 Vitamin D levels of adolescents according to micronutrients levels using t-test**

Characteristics	N	Mean	SD	P-vale
<b>Hgb level</b>				
Anemic	32	18.76ng/dl	5.86	0.004
Non-anemic	118	25.2ng/dl	12	
<b>Vitamin A level</b>				
≤ 316mcg/dl	9	24.07ng/dl	19	0.946
≥316.1mcg/dl	141	23.81ng/dl	10.75	
<b>Zinc level</b>				
≤ 70mcg/dl	85	23.5ng/dl	11.39	0.251
≥70.1mcg/dl	50	25.89ng/dl	11.88	

#### **4.5.7(b) Effect of Vitamin A Level of Adolescents on Vitamin D Level**

Table 4.13 show the distribution of vitamin D level among different vitamin A level. Using cross tabulation it was found that (n=6, 66.7%) of adolescents with low vitamin A level ≤ 316 mcg/l had low vitamin D level (≤ 19.9ng/dl) but (n= 3, 33.3%) of adolescents with low vitamin A level had high vitamin D level (≥ 20ng/dl). In contrast, (n=59, 41.8%) of adolescents with normal vitamin A ≥ 316.1 mcg/l levels had low vitamin D level but (n= 82, 58.2%) of adolescents with normal vitamin A level had normal vitamin D level. This difference in vitamin D levels did not reach a statistical significant level (P-value= 0.177).

When independent t –test was used, the mean of vitamin D level among study adolescents with low vitamin A level was 24ng/dl differs from the mean among adolescents with normal vitamin A levels was 23.8ng/dl but this difference did not reach a statistical significant level (P-value = 0.946) as shown in table 4.14.

#### **4.5.7(c) Effect of Zinc Level on Vitamin D Level**

Zinc level is associated with multiple preventable health problems as it is very important for the homeostasis of human body. In this study, zinc level was cross tabulated to test the relationship between zinc level and vitamin D level. The distribution of vitamin D was (n= 37, 43.5%) of adolescents with low zinc levels ( $\leq 70$ mcg/dl) had low vitamin D levels also and (n= 48(56.6%) of the same group had high vitamin D level, but (n= 18.36%) of adolescents with high zinc level ( $\geq 70.1$ mcg/dl) had high vitamin D level too and (n= 32, 64%) of the same group had low vitamin D levels. This difference in percentage of distribution did not reach a statistical significant level (P-value = 0.249) as shown below in table 4.13.

Table 4.14 shows the mean of vitamin D level among different categories of zinc status for adolescents participating in the study. It was found that the mean of vitamin D level among adolescents with low zinc levels ( $\geq 70$ mcg/dl) was 23.5ng/dl and the mean among adolescents with normal zinc level was 26.89ng/dl. This difference in mean did not reach a statistical significant level (P-value = 0.251).

## **Chapter Five**

### **Conclusion and Recommendations**

#### **5.1 Conclusion**

In conclusion, symptoms of vitamin D deficiency are unrecognized and often are undetected but it is very common among adolescents in the Gaza Strip; vitamin D insufficiency is a very important health problem that needs more study and investigations especially for people at high risk due to its effect on the bone health, in addition to its role in the etiology of many diseases.

The study results revealed modifiable risk factors for vitamin D insufficiency that can be prevented including: poor diet, low intake of vitamin D, being anemic, indoor activities, low skin exposure to sunlight, covering the whole body during sunlight exposure and weak knowledge about vitamin D. The results of this study revealed that indoor activities, poor dietary intake of vitamin D, and lifestyle of low direct skin exposure sunlight were associated with the vitamin D deficiency and as a result, any of associated diseases may be developed. Therefore, it may be beneficial to increase the consumption of some types of foods containing vitamin D (milk, egg and fatty fish). Milk consumption was a significant determinant of vitamin D level as adolescents who consumed large amounts of milk per day did had higher vitamin D level than those who consumed small amounts of milk. Also, to improve health awareness among children and to encourage them to eat healthy diet, play outdoor activities in order to be exposed to sunlight. Moreover, it is important to educate parents about healthy diet and importance of sunlight exposure for children for short periods of time (15-30 minutes) at least two or three times per week without sun protection that will provide them with their vitamin D requirement and to accommodate with cultural aspects that impede sunlight exposure and outdoor activities for females and find alternative methods to conserve optimal vitamin D level either by finding special places for them to do outdoor activities or food fortification or vitamin D supplementation.

## **5.2 Recommendations**

1. To provide public and health workers with a health education package including:
  - a. Direct exposure of skin to sunlight is the main source of vitamin D in addition to the nutritional intake of foods containing vitamin D it is required in higher amounts especially for those at high risk.
  - b. Daily supplementation with vitamin D or distribution of fortified milk among adolescents in schools is required
  - c. Recommended daily sunlight exposure is 15-30 minutes at least 2-3 times weekly without using sun protection products.
  - d. Fortification of food with vitamin D is necessary for people at high risk of having low vitamin D levels.
  - e. Health education programs is required to improve adolescents' knowledge about healthy nutrition and outdoor activities
  - f. Although 25 (OH) D assays are costly but if it is available it is cost effective in preventing osteomalacia and other associated diseases.
2. Education and training of health professionals about vitamin D deficiency and its consequences among adolescents
3. Integration of health Education about vitamin deficiency with the regular education curriculum

## **5.3 Recommendations for Future Researches**

1. To study the prevalence of vitamin D deficiency among adult females.
2. To assess the effect of vitamin D deficiency on cognitive function and academic achievement among adolescents.
3. To evaluate the efficacy of school curriculum content of health education.
4. To study the effect of types of food served in school on adolescents' health.

## References

- Abu daya, A. H., Stigum, H., Shi, Z., Abed, Y., & Holmboe-Ottesen, G. (2009). Sociodemographic correlates of food lhabits among school adolescents (12–15 year) in North Gaza Strip. *BMC Public Health*, 9(1), 185.
- Acar, S., Demir, K., & Shi, Y. (2017). Genetic Causes of Rickets. *Journal of clinical research in pediatric endocrinology*, 9(Suppl 2), 88.
- Alaklabi, A. M., & Alsharairi, N. A. (2018). Current Evidence on Vitamin D Deficiency and Metabolic Syndrome in Obese Children: What Does the Evidence from Saudi Arabia Tell Us?. *Children*, 5(1), 11.
- Ard El-Insan Association, 2015. [http://ardelinsan.ps/portal/?page\\_id=2](http://ardelinsan.ps/portal/?page_id=2) accessed on 16/03/2018
- Bahijri, S.M., 2001. Serum 25-hydroxy cholecalciferol in infants and preschool children in the western region of Saudi Arabia: etiological factors. *Saudi Medical Journal*, 22(11), pp. 973–979.
- Bikle, D. D. (2014). Vitamin D metabolism, mechanism of action, and clinical applications. *Chemistry & biology*, 21(3), 319-329.
- Binkley, N., Novotny, R., Krueger, D., Kawahara, T., Daida, Y. G., Lensmeyer, G., ... & Drezner, M. K. (2007). Low vitamin D status despite abundant sun exposure. *The Journal of Clinical Endocrinology & Metabolism*, 92(6), 2130-2135.
- Bohon, T. M., & Goolsby, M. A. (2013). The role of vitamin D supplements in women's health. *Clinical Medicine Insights: Women's Health*, 6, CMWH-S11067.
- Boucher, B. J. (2012). The problems of vitamin d insufficiency in older people. *Aging and disease*, 3(4), 313.
- CDC, 2015. About Child & Teen BMI. [https://www.cdc.gov/healthyweight/assessing/bmi/childrens\\_bmi/about\\_childrens\\_bmi.html](https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html) accessed on 14/03/2018
- Cheng, T. Y., Goodman, G. E., Thornquist, M. D., Barnett, M. J., Beresford, S. A., LaCroix, A. Z., ... Neuhausser, M. L. (2014). Estimated intake of vitamin D and its interaction with vitamin A on lung cancer risk among smokers. *International journal of cancer*, 135(9), 2135–2145. doi:10.1002/ijc.28846
- Courbage Y., Hammad B., Zagha A, (2016). Palestine 2030. Demographic Transition in Palestine and What it Means for Development

- DeHaven, C. (2014). VITAMIN D STATUS AND SUNSCREEN USE. Innovative skincare.  
[https://www.isclinical.com/media/WhitePapers/pdf/WhitePaper\\_VitaminD\\_Sunscreen\\_July2014\\_1\\_.pdf](https://www.isclinical.com/media/WhitePapers/pdf/WhitePaper_VitaminD_Sunscreen_July2014_1_.pdf) Accessed on 22/03/2018
- Del Valle, H. B., Yaktine, A. L., Taylor, C. L., & Ross, A. C. (Eds.). (2011). *Dietary reference intakes for calcium and vitamin D*. National Academies Press.
- El Hayek, J., Egeland, G., Weiler, H., 2010. Vitamin D status of Inuit preschoolers reflects season and vitamin D intake. *The Journal of nutrition*, 140(10), pp. 1839-1845.
- Elmadfa A, Abu Rub K, Ben-Abdullah A, Meyer A, Ramlawi L, Bahar N, Rizkallah A, Skaik Z, Zakout F, El-Aissawi I. (2014). Palestinian Micronutrient Survey (PMS) 2013 Results of the assessment of micronutrient status, prevalence of anaemia, nutritional and anthropometric indicators and food consumption habits in children aged 6 to 59 months and 7 to 12 years, adolescents aged 15-18 years, pregnant women and lactating mothers in the State of Palestine. Final Report March 2014.
- El-Sonbaty, M. R., & Abdul-Ghaffar, N. U. (1996). Vitamin D deficiency in veiled Kuwaiti women. *European journal of clinical nutrition*, 50(5), 315-318.
- Farmer, K. C., Naylor, M. F., Roca-Acén, J., & Larouche, M. (1996). Sun exposure, sunscreens, and skin cancer prevention: a year-round concern. *Annals of Pharmacotherapy*, 30(6), 662-673.
- Fernandes, M. R., Junior, B., & dos Reis, W. (2017). Association between physical activity and vitamin D: A narrative literature review. *Revista da Associação Médica Brasileira*, 63(6), 550-556.
- Fuleihan, G. E. H. (2010). Vitamin D deficiency in the Middle East and its health consequences. In *Vitamin D* (pp. 469-494). Humana Press.
- Gale Encyclopedia of Medicine. (2008). Vitamin D deficiency. (n.d.) Retrieved April 20 2018 from <https://medical-dictionary.thefreedictionary.com/vitamin+D+deficiency>
- Ghrayeb, F., Rusli, M., Al Rifai, A., & Ismail, M. (2013). Prevalence of Overweight and Obesity among Adolescents in Tarqumia, Palestine. *Canadian Journal of Basic and Applied Sciences*, 1(1), 49-57.
- Giacaman, R., Khatib, R., Shabaneh, L., Ramlawi, A., Belgacem, S., Sabatinelli, G., Khawaja, M., Laurance, T., 2009. Health status and health services in the occupied Palestinian territory. *The Lancet*, 373(9666), pp. 837-849.



- Gilbert-Diamond, D., Baylin, A., Mora-Plazas, M., Marin, C., Arsenault, J.E., Hughes, M.D., et al., 2010. Vitamin D deficiency and anthropometric indicators of adiposity in school-age children: a prospective study. *American Journal of Clinical Nutrition*, 92(6), pp. 1446-1451.
- Glaser, D. L., & Kaplan, F. S. (1997). Osteoporosis: definition and clinical presentation. *Spine*, 22(24), 12S-16S.
- Glass, E. J., Hume, R., Hendry, G. M., Strange, R. C., & Forfar, J. O. (1982). Plasma alkaline phosphatase activity in rickets of prematurity. *Archives of disease in childhood*, 57(5), 373-376.
- Holick, M. F. (2006). Resurrection of vitamin D deficiency and rickets. *The Journal of clinical investigation*, 116(8), 2062-2072.
- Holick, M., & Chen, T., (2008). Vitamin D deficiency: a worldwide problem with health consequences-. *The American journal of clinical nutrition*, 87(4), 1080S-1086S.
- Institute of Medicine, 2010. *Dietary Reference Intakes for Calcium and Vitamin D*, Washington D.C.: National Academies Press
- Jazar, A.S., Takruri, H.R., Khuri-Bulos, N.A., 2011. Vitamin D status in a sample of preschool children aged from 1 to 6 years visiting the Pediatrics Clinic at Jordan University Hospital. *Jordan Medical Journal*, 45(4), pp. 308-316.
- Kanis, J. A., Melton, L. J., Christiansen, C., Johnston, C. C., & Khaltaev, N. (1994). The diagnosis of osteoporosis. *Journal of bone and mineral research*, 9(8), 1137-1141.
- Kauffman, J. M. (2009). Benefits of vitamin D supplementation. *Journal of American Physicians and Surgeons*, 14(2), 38.
- Lagunova, Z., Porojnicu, A. C., Lindberg, F., Hexeberg, S., & Moan, J. (2009). The dependency of vitamin D status on body mass index, gender, age and season. *Anticancer research*, 29(9), 3713-3720.
- Lebovitz, H. E. (2001). Insulin resistance: definition and consequences. *Experimental and clinical endocrinology & diabetes*, 109(Suppl 2), S135-S148.
- Lee, S. H., Park, S. J., Kim, K. M., Lee, D. J., Kim, W. J., Park, R. W., & Joo, N. S. (2012). Effect of sunlight exposure on serum 25-hydroxyvitamin D concentration in women with vitamin D deficiency: using ambulatory lux meter and sunlight exposure questionnaire. *Korean journal of family medicine*, 33(6), 381-389.

- Meltzer, M. (2007). Vitamin D deficiency: Cultural influence and physician responsibility. *Arthritis Care & Research*, 57(6), 1107-1108.
- Mishal, A. A. (2001). Effects of different dress styles on vitamin D levels in healthy young Jordanian women. *Osteoporosis international*, 12(11), 931-935.
- MOH, (2005). The State of Nutrition: West Bank and Gaza Strip. A comprehensive review of nutrition situation of West Bank and Gaza Strip.
- MOH, (2008). Ministry of Health, health system, assessment report, Palestinian health sector reform and development project: the flagship project.
- MOH, (2013). Palestine Health Status Annual Report 2012. Nablus, Palestine: Ministry of Health (Palestine).
- Muhairi Sh, Mehairi A, Khouri AA, Naqbi M, Maskari F, et al. Vitamin D deficiency among healthy adolescents in Al Ain, United Arab Emirates. *BMC Public Health*. 2013 Jan 14;13:33.
- Muriuki, E. M. (2005). *Risk Factors Associated with Rickets in Infants and Children Aged 6-59 Months Attending Kiambu District Hospital, Kenya* (Doctoral dissertation).
- Musaiger, A. O., Al-Mannai, M., Tayyem, R., Al-Lalla, O., Ali, E. Y., Kalam, F., & Chirane, M. (2012). Prevalence of overweight and obesity among adolescents in seven Arab countries: a cross-cultural study. *Journal of obesity*, 2012.
- Mushtaha, R.F., 2006. Biochemical Changes Associated with Nutritional Rickets in Children up to Three Years Old in Gaza Strip. MSc. Islamic University-Gaza.
- Narchi, H., El Jamil, M., & Kulaylat, N. (2001). Symptomatic rickets in adolescence. *Archives of disease in childhood*, 84(6), 501-503.
- OCHA, (2018). <https://www.ochaopt.org/content/food-insecurity-opt-13-million-palestinians-gaza-strip-are-food-insecure> accessed on 11/05/2019
- Palestinian Central Bureau of Statistics – PCBS, (2015). Status of Palestinians residing in Palestine - 2015. Ramallah, Palestine.
- Palestinian Central Bureau of Statistics – PCBS, (2017)<sup>a</sup>. Preliminary Results of the Population, Housing and Establishments Census
- Palestinian Central Bureau of Statistics, (2017)<sup>b</sup>. Levels of Living in Palestine. <http://www.pcbs.gov.ps/post.aspx?lang=en&ItemID=3115>. Accessed on 23/04/2018

- Palestinian Central Bureau of Statistics, (2013). *Palestinians Population Status in the Palestine 2013*, Ramallah.
- Prentice, A. (2004). Diet, nutrition and the prevention of osteoporosis. *Public health nutrition*, 7(1a), 227-243.
- Rosen, C. J. (2011). Vitamin D insufficiency. *New England Journal of Medicine*, 364(3), 248-254.
- Saggese, G., Vierucci, F., Boot, A. M., Czech-Kowalska, J., Weber, G., Camargo, C. A., ... & Holick, M. F. (2015). Vitamin D in childhood and adolescence: an expert position statement. *European journal of pediatrics*, 174(5), 565-576.
- Sahay, M., & Sahay, R. (2012). Rickets–vitamin D deficiency and dependency. *Indian journal of endocrinology and metabolism*, 16(2), 164.
- Sanghera, D. K., Sapkota, B. R., Aston, C. E., & Blackett, P. R. (2017). Vitamin D Status, Gender Differences, and Cardiometabolic Health Disparities. *Annals of Nutrition and Metabolism*, 70(2), 79-87.
- Seelaboyina, K. N., Malonga, G., Setty, M. J., & Moulton, T. (2013). Vitamin D level and its correlation with hemoglobin in pediatric sickle cell disease patients.
- Shams, B., Afshari, E., Tajadini, M., Keikha, M., Qorbani, M., Heshmat, R., ... & Kelishadi, R. (2016). The relationship of serum vitamin D and Zinc in a nationally representative sample of Iranian children and adolescents: The CASPIAN-III study. *Medical journal of the Islamic Republic of Iran*, 30, 430.
- Silverberg, S. J. (2007). Vitamin D deficiency and primary hyperparathyroidism. *Journal of Bone and Mineral Research*, 22(S2), V100-V104.
- Story, M., & Stang, J. (2005)<sup>a</sup>. Nutrition needs of adolescents. *Guidelines for adolescent nutrition services*. Minneapolis, MN: Centre for Leadership, Education and Training in Maternal and Child Nutrition Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, 21-34.
- Story, M., & Stang, J. (2005)<sup>b</sup>. Understanding adolescent eating behaviors. *Guidelines for adolescent nutrition services*, 9-19.
- Thacher, T. D., & Clarke, B. L. (2011). Vitamin D insufficiency. In *Mayo Clinic Proceedings (Vol. 86, No. 1, pp. 50-60)*. Elsevier.

## Annexes

### Annex (1): Palestine map



## Annex (2): Helsinki Approval

**المجلس الفلسطيني للبحوث الصحي**  
**Palestinian Health Research Council**

تعزيز النظام الصحي الفلسطيني من خلال مأسسة استخدام المعلومات البحثية في صنع القرار  
Developing the Palestinian health system through institutionalizing the use of information in decision making

**Helsinki Committee  
For Ethical Approval**

**Date: 04/06/2018** **Number: PHRC/HC/396/18**

**Name: Samar Abd El-Rahman** الاسم:

We would like to inform you that the committee had discussed the proposal of your study about: **نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم حول:**

**Risk Factors Associated with Vitamin D Insufficiency among Adolescents in Gaza Strip**

The committee has decided to approve the above mentioned research. Approval number PHRC/HC/396/18 in its meeting on 04/06/2018  
و قد قررت الموافقة على البحث المذكور عليه بالرقم والتاريخ المذكوران عليه

**Signature**

**Member** **Member**

**Chairman**

**Specific Conditions:-**

**Genral Conditions:-**

1. Valid for 2 years from the date of approval.
2. It is necessary to notify the committee of any change in the approved study protocol.
3. The committee appreciates receiving a copy of your final research when completed.

E-Mail: pal.phrc@gmail.com

Gaza - Palestine فلسطين  
شارع النصر - مفترق العيون

**Annex (3): Questionnaire**

**Vitamin D insufficiency Questionnaire for Adolescents**

Abstracted from ‘Ard El-Insan’ Questionnaire

**“Prevalence and Determinants of Vitamin D Insufficiency among Adolescents in Gaza Strip”**

Serial Number: \_ \_ \_

‘Ard El Insan’ Series Number:

Student Name: -----

Birth Date: -----

Weight: -----

Height: -----

All the information in this questionnaire is secret and will be used for scientific research only

<b>Part 1: Personal Data</b>			
<b>1. Current age</b> -----		<b>2. Gender</b> a. Male   b. Female	
<b>3. Place of Living:</b>	a. Gaza b. South Gaza	<b>4. Your Home is:</b>	a. Owned b. Rented
<b>5. How many persons live with you at the same house?</b>		-----	
<b>6. Average of academic achievement in the past semester</b>		a. 50%-59%   b. 60%-69% c. 70%-79%   d. 80 and more	
<b>7. Father education level</b>		a. Primary education b. Secondary education c. High education	
<b>8. Mother education level</b>		a. Primary education b. Secondary education c. High education	
<b>9. Does your Father work</b>		a. Yes b. No c. Dead/passed away	

<b>10. Where does he work</b>	<ul style="list-style-type: none"> <li>a. Governmental employee</li> <li>b. NGOs employee</li> <li>c. Private sector</li> <li>d. International organization</li> <li>e. Freelancer</li> <li>f. Unemployed</li> </ul>
<b>11. Does your mother work</b>	<ul style="list-style-type: none"> <li>a. Yes</li> <li>b. No</li> <li>c. Dead/passed away</li> </ul>
<b>12. Where does she work</b>	<ul style="list-style-type: none"> <li>a. Governmental employee</li> <li>b. NGOs employee</li> <li>c. Private sector</li> <li>d. International organization</li> <li>e. Freelancer</li> <li>f. Unemployed</li> </ul>
<b>Part 2: Nutrition</b>	
<b>14. Did you receive any education about nutrition?</b>	<ul style="list-style-type: none"> <li>a. Yes</li> <li>b. No</li> </ul>
<b>15. How many meals do you actually take per day?</b>	<ul style="list-style-type: none"> <li>a. one</li> <li>b. Two</li> <li>c. Three</li> <li>d. Four or more</li> </ul>
<b>16. Do you skip breakfast?</b>	<ul style="list-style-type: none"> <li>a. Yes</li> <li>b. No</li> </ul>
<b>17. If yes, how many times do you actually skip breakfast per week?</b>	-----
<b>18. Causes of skipping</b>	<ul style="list-style-type: none"> <li>a. On Diet</li> <li>b. No time</li> <li>c. No appetite</li> </ul>
<b>19. Do you eat your meals with family?</b>	<ul style="list-style-type: none"> <li>a. always</li> <li>b. Very often</li> <li>c. Quiet often</li> <li>d. Seldom</li> <li>e. Never</li> </ul>

<p><b>20. Do you eat your meals while watching TV or using computer/mobile?</b></p>	<p>a. always b. Very often c. Quiet often d. Seldom e. Never</p>
<p><b>21. How often do you eat the following foods?</b></p> <p><b>1. Milk</b></p> <p><b>2. Egg</b></p> <p><b>3. Fish/sea food</b></p> <p><b>4. Cereals</b></p>	<p>a. Several times/day b. Several times/week c. 1-2 times/month d. Never</p> <p>a. Several times/day b. Several times/week c. 1-2 times/month d. Never</p> <p>a. Several times/day b. Several times/week c. 1-2 times/month d. Never</p> <p>a. Several times/day b. Several times/week c. 1-2 times/month d. Never</p>
<p><b>22. From your perspective, what does healthy food consist of?</b></p>	<p>-----</p>
<p><b>23. How important for you eating healthy food?</b></p>	<p>a. Very important b. Not important at all</p>
<p><b>Part 3: Physical activity</b></p>	
<p><b>24. How do you actually go to school?</b></p>	<p>a. Walking b. Transportation c. Both</p>
<p><b>25. If you go walking, how many minutes do you need to arrive to school?</b></p>	<p>-----</p>



**26. What of the under listed activities do you practice (either inside or outside school) and for how long?**

<b>Activity</b>	<b>Minutes/day</b>	<b>Minutes/week</b>
<b>1. Walking</b>		
<b>2. Running</b>		
<b>3. Volley Ball</b>		
<b>4. School Sport Exercise</b>		
<b>5. Swimming</b>		
<b>6. Domestic Exercise</b>		
<b>7. Homework/studying</b>		
<b>8. Watching TV</b>		
<b>9. Using Computer</b>		
<b>10. Others</b>		

### **Laboratory Results**

Vitamin D Level: -----

Vitamin A Level: -----

Hemoglobin Level: -----

Zinc Level: -----

## Annex (4): Consent Form

### موافقة مستنيرة على المشاركة في بحث علمي (Consent Form) نتائج ومؤثرات نقص فيتامين د لدى الاطفال 12-17 سنة الذكور والإناث في قطاع غزة

اسم الباحثة: سمر علي محمود عبد الرحمن

- مكان إجراء البحث: المدارس الحكومية التابعة لوزارة التربية و التعليم في المرحلتين الاساسية العليا و الثانوية للذكور و الاناث.
- أخي/أختي المتطوع(ة): هذا البحث هو أحد الأبحاث الطبية التي تقوم بها طالبة في كلية الصحة العامة مسار الاوبئة كمتطلب للحصول على درجة الماجستير في جامعة القدس بغزة، ويهدف إلى :معرفة اهم العوامل المؤثرة على نقص فيتامين د في قطاع غزة حيث ظهرت هذه المشكلة في الاعوام الاخيرة السابقة و كان لها دور كبير في العديد من المشاكل الصحية و الامراض، و قد تم اختيار هذه الفئة العمرية بناء على المعايير العالمية فهي من اكثر الفئات عرضة لهذه المشكلة
- أرجو أن أبين ما يلي:
- إن مشاركتك في هذا البحث طوعية تماما، ومن شأنها إفادة المجتمع الفلسطيني وعملية البحث العلمي بشكل عام ، وإفادة المرضى بشكل خاص.
- في حال مشاركتك بالبحث، سيبقى اسمك طبي الكتمان وسيذكر اسمك فقط على نموذج الموافقة، وسيتم التعامل مع المعلومات الخاصة بك بطريقة الترميز لحماية لخصوصيتك، ويحق لك الانسحاب من البحث متى شئت من دون أي أثر يذكر عليك.
- لا توجد خطورة جراء مشاركتك في هذا البحث و يجدر الإشارة إلى أن لجنة الدراسات العليا في كلية الصحة العامة قد وافقت على إجراء هذا البحث، وتعتبر هي اللجنة المؤسسية المرجعية للبحوث والدراسات.
- الإجراءات المتبعة هي : عمل مجموعات بحثية مع طلاب المدارس في المرحلتين الاساسية العليا و الثانوية حيث سوف تشمل كل مجموعة 12 طالب من كل مدرسة حيث سيتم طرح عدد من النقاط خلال الجلسة و مناقشتها مع الطلاب و تسجيل ملاحظات

أنا المتطوع \_\_\_\_\_ قرأت المعلومات المذكورة أعلاه وفهمتها،  
وبناء عليه فإنني أوافق على المشاركة في البحث .

التاريخ

التوقيع

## Annex (5): Focus Group Discussion

### Questions to be asked during FGD

(Welcome + Informed consent)

▪ كل جلسة ستشمل طرح النقاط التالية و مناقشتها مع الطلاب :

- ما هو فيتامين د و ما اهميته؟
  - ( تكوين العظام - الوقاية من الامراض- اكثر الاشخاص المعرضين لنقص فيتامين د)
- ما هي اهم الامراض التي تنشأ نتيجة نقص فيتامين د؟
  - ( الكساح - لين العظام - امراض القلب - مرض السكري)
- التعرض لاشعة الشمس المباشرة و علاقته بنقص فيتامين د.
  - ( ما هو افضل وقت للتعرض للشمس للحصول على فيتامين د؟
  - ما المدة المثالية للتعرض للشمس للاستفادة من اشعة الشمس في الحصول على فيتامين د؟)
- ما هي انواع الطعام المهمة للحصول على معدل مثالي من فيتامين د في الدم ؟
  - ( الحليب - البيض - الاسماك)
- هل للرياضة علاقة بنقص فيتامين د؟
  - ( ما هي انواع الانشطة التي تقوم بها؟ مدة الانشطة التي تقوم بها خارج المنزل
  - كم مرة خلال الاسبوع تقوم/ين بممارسة الرياضة خارج المنزل؟)
- نوع الملابس او الحجاب يؤثر على معدل فيتامين د. ما رأيك في هذه العبارة ؟

Thank the group

**Annex (6): Validation of questionnaire**

<b>No.</b>	<b>Name</b>
1.	Prof. Dr. Yehia Abed
2.	Dr. Bassam Abu Hammad
3.	Dr. Khitam Abu Hammad
4.	Dr. Ashraf El-Jedi
5.	Dr. Yousif El-Jeish
6.	Dr. Ashraf El-Bayyaa
7.	Dr Amal Abu Jamee
8.	Dr. Mazen Al-Saqqa
9.	Miss. Hanady skeek
10.	Dr. Salah el-Sousi

## عوامل الخطر المؤثرة على نقص فيتامين (د) لدى الأطفال المراهقين في قطاع غزة

إعداد: سمر علي عبد الرحمن

إشراف: أ.د. يحيى عابد ، د. عدنان الوحيد

### ملخص:

خلال السنوات القليلة الماضية لوحظ ان معدل فيتامين (د) في الدم يحظى باهتمام متزايد من قبل الاطباء و المرضى لما له من دور مهم في صحة جسم الانسان بالاضافة الى دوره في حماية الجسم من العديد من الامراض مثل: الكساح و هشاشة العظام و السرطان و امراض القلب و الأوعية الدموية. من المعروف أن معظم العوامل المؤثرة على مستوى فيتامين (د) قابلة للتغيير و يمكن الوقاية منها عن طريق تغيير نمط الحياة.

كان الهدف من الدراسة هو تحديد العوامل المؤثرة على نقص فيتامين (د) لدى الاطفال في سن المراهقة (12-17 عام) في قطاع غزة لتجنب حدوث اي من الاعراض او الامراض المصاحبة لنقص فيتامين (د) و تقديم مقترحات للوقاية من نقص فيتامين (د) و علاجه.

تم استخدام منهجية بحث مختلطة لجمع البيانات حيث تم اجراء دراسة مستعرضة على أساس البيانات التي تم جمعها بواسطة جمعية أرض الانسان التي تم فيها اختيار 150 طفل مراهق تتراوح اعمارهم بين (12-17 عام) لفحص معدل فيتامين (د) لديهم و تم تضمين هؤلاء الطلاب البالغ عددهم 150 طالباً في هذه الدراسة. حيث تم التعامل مع البيانات التي تخص ما يلي من المتغيرات: الخصائص الديموغرافية الاجتماعية و العادات الغذائية و مشر كتلة الجسم و مستوى بعض العناصر الغذائية الأخرى في الدم. بالإضافة إلى اجراء اربع حلقات نقاش مع اطفال في سن المراهقة و أخرى مع طلاب كلية الصحة العامة لاستقصاء بعض المتغيرات مثل: التعرض لأشعة الشمس و النشاط البدني و النظام الغذائي.

أثبتت الدراسة ان معدل انتشار نقص فيتامين (د) لدى الاطفال في سن المراهقة هو بنسبة 43% و ان الاناث هم اكثر عرضة لنقص فيتامين (د) حيث اسفرت الدراسة عن نسبة 54% من الاناث و 11% من الذكور يعانون من نقص فيتامين و اثبتت ايضا ان الحليب هو من اهم محددات فيتامين (د) حيث كان 51% من المشاركين بالبحث الذب يتناولون كميات كبيرة من الحليب يعانون من نقص فيتامين (د) و لكن 51% من المشاركين الذين يتناولون كميات قليلة من الحليب يعانون من نقص فيتامين (د). نتج من الدراسة ايضا أن 31.5% من الذكور و 80% من الاناث المصابين بفقر الدم لديهم مستويات منخفضة من فيتامين (د).

أخيراً، خلصت الدراسة الى ان نقص فيتامين د الذي يصعب الكشف عنه بسهولة يمثل مشكلة وبائية لدى الاطفال في سن المراهقة في قطاع غزة. أسفرت الدراسة عن بعض العوامل المؤثرة على نقص فيتامين (د) القابلة للتعديل و التي يمكن الوقاية منها مثل: تناول غذاء غير صحي ولا يحتوي على كميات كافية من فيتامين (د) مثل الحليب و الأسماك، قلة التعرض لأشعة الشمس بالاضافة الى تغطية الجسم كله أثناء التعرض لأشعة الشمس و قلة المعرفة بأهمية فيتامين (د).

كشفت حلقات النقاش التي أجريت مع الأطفال المشاركين بالبحث عن عجز كبير في المعلومات الصحية الخاصة بالتغذية السليمة و أهمية فيتامين (د) لصحة الانسام و عواقب نقص فيتامين (د) و كيفية الوقاية منه. لذلك من المهم تثقيف الوالدين حول النظام الغذائي الصحي و أهمية التعرض لأشعة الشمس للأطفال لفترات قصيرة (15-30 دقيقة) مرتين او ثلاث مرات أسبوعياً على الأقل بدون استخدام أي وسيلة للوقاية من الشمس. يوصى ايضا بتناول 400 وحدة من فيتامين للرضاع و الأطفال يومياً كوسيلة للوقاية من نقص فيتامين (د).