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Vitamin D Supplementation Practices during Pregnancy and Infancy among a Sample of Muslim Women in Ireland and Saudi Arabia

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Vitamin D Supplementation Practices during Pregnancy and Infancy among a Sample of Muslim Women in Ireland and Saudi Arabia

A thesis submitted for the degree of Master of Philosophy

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April 2013

DECLERATION of WORK

I certify that this thesis which I now submit for examination for the award of Master of Philosophy, is entirely my own work and has not been taken from the work of others save and to extent that such work has been cited and acknowledge within the text of my work.

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Signature Date: 25 April 2013

Imann Abdullah Khadrawi

AKNOWLEDGMENT

In the name of Allah, the Most Gracious and the Most Merciful; Alhamdulillah all praises to Allah for the strengths and His blessing as I completed this thesis.

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DEDICATION

This thesis is dedicated to my mother and father for their love and sacrifice, my husband for his support and encouragement. To my wonderful children, thank you for your patience throughout this process. And to all women in my country, Saudi Arabia.

LIST of ABBREVIATIONS

ADA	American Diabetes Association
BMD	Body Mineral Density
BMI	Body Mass Index
DBP	Vitamin D Binding Protein
ESRI	Economic and Social Research Institute
EU	European Union
EFSA	European Food Safety Authority
FSAI	Food Safety Authority of Ireland
g	Gram
GDM	Gestational Diabetes Mellitus
HLA	Human Leukocyte Antigen
HSE	Health Services Executive
IADPSG	International Association of Diabetes and Pregnancy Study Group
ICCI	Islamic Culture Center of Ireland
IOM	Institute of Medicine
IQR	Interquartile Range
IU	International Unites
KFAFH	King Fahad Armed Hospital

m	Months
MENA	Middle East and North Africa
µg/d	Microgram per day
mm	Milli meter
MS	Multiple Sclerosis
n	Sample Size
ng/ml	Nanograms per milliliter
NHS	National Health Services
NICN	National Institute Care Unit
NIH	National Institute of Health
nmol/L	Nanomoles per liter
OGTT	Oral Glucose Tolerance Test
PTH	Parathyroid Hormone
PCOS	Polycystic Ovary Syndrome
r	Correlation conefficient
SFDA	Saudi Food Drug Authority
SPSS	Statistical Package for the Social Science
U/L	Units per liter
UK	United Kingdom

US	United State
UV	Ultraviolet
UVB	Ultraviolet B
WHO	World Health Organization
yr	Years
$25(OH)_2D_3$	25-hydroxyvitamin D
$1,25(OH)_2D_3$	1,25-dihydroxyvitamin D

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ABSTRACT

Vitamin D is a steroid hormone, a group of fat-soluble pro-hormones, which encourages the absorption and metabolism of calcium and phosphorous. The requirement for the nutrient is high at particular stages of the lifecycle especially during pregnancy and infancy. Severe vitamin D deficiency during pregnancy may increase the risk of developing preeclampsia and gestational diabetes in pregnancy and rickets in the child. While vitamin D supplementation has been a policy recommendation in Ireland since 2007, at the time of this study, it was not a policy recommendation in Saudi Arabia.

The present quantitative cross-sectional survey was conducted to determine the prevalence of vitamin D supplementation in pregnancy as well as to infants 0-3 years of age among Muslim mothers living in Ireland and in Saudi Arabia. Seventy seven Muslim mothers living in Ireland were recruited from the Islamic Culture Center of Ireland while one hundred and twenty one Muslim mothers living in Saudi Arabia were recruited from three hospitals in Makkah.

Only 28.6% (22/77) of the Irish cohort mothers and 7.4% (9/121) of the Saudi mothers had taken vitamin D supplements during their pregnancy. While 62.3% (48/77) of the Muslim mothers in Ireland and 37.2% (45/121) in Saudi Arabia were aware of the recommendation to give a daily vitamin D supplements to their infants until they were one year of age just 49.4% (38/77) living in Ireland and 13.2% (16/121) from Saudi Arabia did so. While a majority of mothers living in Ireland (53.2%; 41/77) and Saudi Arabia (37.2%; 45/121) were spending more than 30 minutes a day outside, protective clothing that completely cover the body was worn by the entire sample (100%), sunscreen was used by 44.2% (34/77) in Ireland and 53.7% (65/121) in Saudi Arabia.

Poor vitamin D supplementation practices are evident among Muslim mothers and infants both in Ireland and Saudi Arabia. To improve this situation, mothers should be educated about the importance of vitamin D during pregnancy and infancy.

CHAPTER 1 – INTRODUCTION

This chapter presents a background to the research, the study motivation, the purpose of the study and approach of the study. The structure of the study is also described.

1.1 Background of the Research

Vitamin D insufficiency in countries in the Middle East where there is a lot of sunlight all year round is normally not expected. Studies however indicate that there is a high prevalence of vitamin D deficiency among women of Islamic religion living in the Middle East as well as those living in other countries (Ghannam *et al.*, 1999). Vitamin D supplementation has been proposed as a way of addressing this issue. However, data on behavior as well as attitude of Muslim women towards vitamin D supplementation is scarce.

Studies such as those conducted by Prentice (2008) indicate that vitamin D deficiency during pregnancy and infancy can result in many health conditions for the mother as well as for the child. Vitamin D plays a vital role in calcium metabolism and bone mineralization and in the immune system as well as preventing diseases such as depression, cardiovascular disease including type 1diabetes, and hypertension, cancer, and high blood pressure (Prentice, 2008).

Vitamin D deficiency is common among persons living in northern latitudes, dark-skinned individuals, and those who are devoid of sunlight exposure (Ghannam *et al.*, 1999). According to Hollis and Wangner (2004), between 30 and 70 % of Muslim women and those residing in Northern latitudes have reported a high incidence of vitamin D deficiency. Muslim women are often at risk for vitamin D deficiency as the traditional long clothes that are worn by veiled women are preventing them from sun exposure and synthesis of vitamin D (Andersen *et al.*, 2008; Glew *et al.*, 2010; Gannage-Yared *et al.*, 2009 and Reed *et al.*, 2007).

Interest in the role of vitamin D in treating and preventing disease has increased worldwide. Scientific evidence from recent studies in fact links vitamin D to a number of chronic diseases in children as well as in adults (Tarrant *et al.,* 2011). In spite of food fortification policies in most countries as well as recommendations for vitamin D supplementation of groups that are at risk, vitamin D deficiency as infantile rickets and osteomalacia are still major public health issues for many parts of the world (Prentice, 2008). According to Dratva, Merten & Ackermann-Liebrich (2006), prevention of vitamin D deficiency and ensuring adequate consumption of vitamin D throughout childhood may decrease the risk of developing osteoporosis and other long-latency disease processes that have been linked to vitamin D deficiency states in adulthood.

Although vitamin D is produced by the human body due to exposure to sunlight, it can also be obtained by consuming foods such as fatty fish, egg yolks, liver, fish-liver oil and mushrooms. Researchers such as Prentice (2008) have suggested vitamin D supplementation during pregnancy and infancy as a safe way of improving outcomes among these groups of individuals.

One of the reasons for the supplementation recommendations in Ireland was the increased number of rickets in Ireland, over 20 cases of rickets in infants and toddlers have been reported at two Dublin hospitals according to FSAI (2011).

The current literature review has shown that there is a gap of knowledge of vitamin D supplementation among Irish and Saudi populations. In addition, there is a paucity of information about the supplementation practices among Muslim women who are at high–risk of hypovitaminosis D (a condition produced by lack of vitamin D) due to combination of inadequate exposure to sunlight, frequent pregnancies and breast feeding.

1.2 Motivation

Interest in the research undertaken for this study stems for two reasons. Firstly, previous studies have found that countries such as Saudi Arabia (Ghannam *et al.,* 1999) and Ireland (Tarrant *et al.,* 2011) have registered low levels of vitamins D. This is a serious public health problem as it affects individuals in all life stages but particularly pregnant women, infants, and the elderly. In addition, rickets, which is a consequence of low vitamin

D levels, is still reported in a number of countries in the Middle East in spite of it having been eradicated in developed countries.

Secondly, there is need to establish ways through which this condition can be eradicated in countries in the Middle East. Because of the various functions of vitamin D in the body including maintaining bone integrity as well as calcium homeostasis, there is a need to evaluate the role of vitamin D in pregnancy and infancy (De-Regil *et al.*, 2012).

1.3 Purpose of the Study

Given the above motivation, the main purpose of the study is to explore and understand the main behaviors as well as attitudes of Muslim women living in Ireland and Saudi Arabia towards vitamin D supplementation and to help the researcher to develop potential strategies to address the appropriate management of pregnant Muslim women in terms of supplementation practice. This study seeks to establish the prevalence of utilization of vitamin D supplements among these women, to compare vitamin D supplementation practice of Muslim mothers living in Ireland and Saudi Arabia and to use the findings and knowledge to increase awareness on the importance of vitamin D adequacy and hence its supplementation among Muslim women.

1.4 Approach of the Study

To achieve the purpose of the study, a cross-sectional quantitative inquiry was conducted. The study was located in Ireland and Saudi Arabia. Snowball sampling technique was used to select a number of Muslim women with a child between 0-3 years living in the two areas and who attend the selected sites. Data was collected using a questionnaire. Data was analyzed using statistical methods by applying Statistics Predictive analytics Software and Solutions (SPSS).

1.5 The structure of the Study

The plan of the study is as follows. Chapter 2 reviews related literature so as to identify existing gaps or contradictions in the findings of earlier studies and hence justify the need for the current study.

Chapter 3 outlines the methodology that was used to collect data and how it was analyzed. Chapter 4 presents the results obtained from the analysis of the collected data. In Chapter 5 the findings of the study are discussed suggests a venues for future research.

CHAPTER 2 – LITERATURE REVIEW

This chapter presents some relevant literature about vitamin D. It includes five sections. The first section includes a review of vitamin D status and metabolism. This is followed by a review of issues relating to vitamin D status of pregnant and lactating women. Current recommendations and guidelines for vitamin D intake are summarized in section three and infant feeding and weaning practices in section four. Section five concludes with the aim and objectives of this study.

2.1 Vitamin D Metabolism and Functions

2.1.1 Definition

Vitamin D is a substance that is essential for human health but can’t be produced by the human body. It’s a fat soluble vitamin that acts as a pro-hormone in the body (Azhar, 2009). The role of vitamin D in the body is in the regulation of calcium and phosphorous metabolism and it is necessary for normal bone mineralization and bone growth.

2.1.2 Sources of Vitamin D

There are three sources of vitamin D: synthesis due to exposure to sunlight, foods containing vitamin D and supplements. The UVB rays is the major source of vitamin D; research work shows that exposure to sunlight for at least 10-15 minutes in a day stimulates the production of vitamin D and reduces vitamin D deficiency risk (NHS,2011; Sarfraz, 2010). Vitamin D is primarily stored in the liver and adipose tissues.

Eating food rich in vitamin D is beneficial if the body is not exposed to sunshine. However; the quantity supplied by food types varies significantly. Most fish species are rich in vitamin D with salmon registering more than twice the amount required for daily intake by man. Milk is also hailed as a source of the vitamin. Specifically, nutritionists refer to fortified milk as an ideal source of about a fifth of the daily vitamin D intake (Sarfraz, 2010). Also, cereal intake has a capability to provide vitamin D. The amount of vitamin D varies by cereal brand (Sarfraz, 2010). Eggs are also a source of vitamin D but the recommendation focuses on at least two eggs per day. A wide variety of mushrooms are also a source of vitamin D. An important aspect of food sources of vitamin D is the cultural and religious determinants of consumption. For instance, pork is an ideal source of vitamin D but the Islamic religion bars its consumption. Besides, the readily available beef liver is another source of vitamin D.

The following table from the Food Safety Authority of Ireland (FSAI) lists the foods that naturally contain vitamin D and those fortified with vitamin D (*).

Table 2.1 Dietary sources of vitamin D in Ireland.

Dietary source	Quantity	Vitamin D (µg)
Egg (vitamin D is found in yolk)	1 egg	0.9
Liver (lamb)	100 g	0.9
Kidney (lamb)	100 g	0.6
Salmon	200 g	16
Mackerel	200 g	18
Sardines (canned in oil)	100 g	5
Super milk (*)	200 ml (glass)	2
Kellogg's Cornflakes(*)	35 g	0
Kellogg's special K (*)	35 g	2.5
Infant formula (*)	500 ml	5.5-7.5

Source: Food Safety Authority of Ireland (2011)

(*) denotes fortification.

While sunshine is the richest source of vitamin D there are some people who can't expose to the sun either because of their illness or the indoor work; those people are recommended to take vitamin D supplements which come in the form of vitamin D_2 and vitamin D_3 to get their daily intake of vitamin D.

2.1.3 Metabolism and Functions of Vitamin D

In nature there are two main types of vitamin D. Vitamin D_2 (ergo-calciferol) is produced in the plants and fungi when exposed to the sunlight. Vitamin D_3 (cholecalciferol) is produced naturally in the human body when sunlight hits the skin. In the body vitamin D_3 makes Calcidiol prehormone (which is 25- hydroxyvitamin D) and Calcitriol (which is 1, $25(OH)_2$ D_3) which is a potent steroid hormone. Researchers agreed that vitamin D_3 is the effective form of vitamin D in terms of raising blood levels of vitamin D (Lanham-New *et al.,* 2011).

The synthesis and metabolism of vitamin D is shown in figure 1. When the skin is exposed to the UVB 7-dehydrocholesterol (which is distributed throughout the epidermis and dermis in the skin of humans) is converted to pre-vitamin D_3. The pre-vitamin D_3 immediately converts into vitamin D_3 (Azhar, 2009). The vitamin D_3 makes its way to the liver (Lanham-New *et al.,* 2011) where it is converted to calcidiol 25-$(OH)_2D_3$ by the enzyme vitamin D 25- hydroxylase (25-Hase or CYP27A1)(Wangyang, 2010), and is then transported to the kidney and converted to calcitriol (1,25$(OH)_2D_3$) by the enzyme 1-α-hyroxylase (1-αOHase or CYP27B1) (Azhar,2009). 1,25$(OH)_2D_3$ is the active and potent form of vitamin D in the body (Azhar, 2009). It has found that most tissues and cells of the body have the ability to metabolize 25$(OH)_2D_3$ from the liver and turn it to 1,25$(OH)_2D_3$ (Bouillon, Norman and Lips, 2007). 1,25$(OH)_2D_3$ plays an important role with PTH to increase serum calcium concentrations (Wangyang, 2010). According to Azhar (2009) long term vitamin D deficiency can lead to increased PTH concentrations and decrease serum 1,25$(OH)_2D_3$ concentrations which lead to the development of rickets, osteomalacia and other disease.

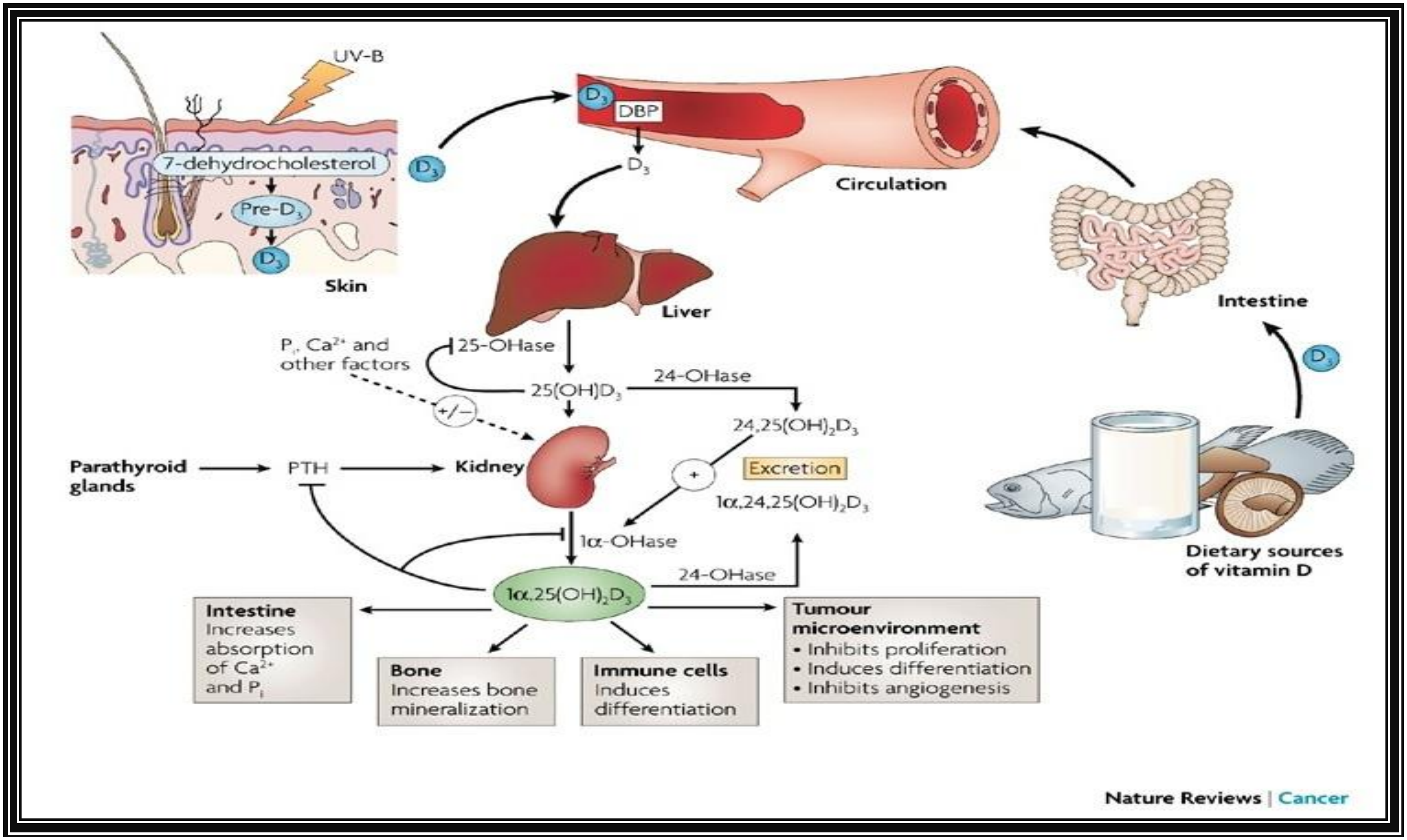


Figure 2.1 Synthesis and metabolism of vitamin D (Deeb *et al.*, 2007)

2.1.4 Vitamin D Status

Assessment of Vitamin D status is usually made by measuring serum 25$(OH)_2D_3$ concentrations, which is the form of vitamin D that is processed in the liver not the active form of vitamin D. This value includes both oral intake and subcutaneous vitamin D production (Azhar, 2009). Vitamin D level in the blood is expressed either in ng/ml or nmol/L which is 1nmol/L = 3.18 ng/ml. Table 2 summarizes the definition of serum 25 $(OH)_2$ D_3 concentrations.

Table 2.2 Definition of serum 25$(OH)_2$ D_3 concentrations for health and disease

Vitamin D level nmol/L*	**Vitamin D level** ng/ml	**Health Status**
<25	<10	Considered deficiency
25-50	10-20	Considered as insufficient
>50	>20	Considered adequate

Source: (NHS, 2011)

*1 nmol/L= 40 IU

2.1.4.1 Factors Influencing Vitamin D Status

According to Azhar (2009) vitamin D status is affected by things that impact on dermal synthesis rate of vitamin D. The dermal production of vitamin D is influenced by several factors including: exposure to the sun, geographical factors, skin pigmentation and sunscreen use, culture influences and obesity.

2.1.4.1.1 Exposure to the sun

The human body makes 90% of its requirement of vitamin D naturally from the UVB rays of the sun. The amount of vitamin D made by the skin depends on the time of the day and the season. The best time the body will be able to produce vitamin D is between 10 am and 2 pm from 10-15 minutes on the face, arms and legs without sunscreen a few times a week will be sufficient and adequate proper sun exposure (NHS, 2011). Age also affects the amount of UVB induced synthesis. According to Azhar (2009) the elderly have decreased concentrations of skin 7-dehydrocholesterol which reduced synthesis of precursors to the vitamin.

2.1.4.1.2 Geographical Factors

A study conducted in United Kingdom by Gibney, Vorster and Kok (2002) established that the levels of vitamin D synthesis are relatively high during the summer season because the sun has a considerable amount of UV rays which increase the formation of vitamin D.

Rosen (2009) established that vitamin D production is lowest in the winter months especially in temperate regions because winter sunlight has insufficient amount of UV to allow the skin to produce vitamin D (Azhar, 2009). The impacts are more noticeable for people residing in latitudes greater than 35^0 (Huotari and Herzik, 2008). Consequently, the levels of vitamin D are affected to a discernible degree when latitudes combine with seasons to affect cutaneous production of calcidiol circulating levels. For instance, Ireland at latitude 51 to 55^0 north, is one of the countries which is heavily reliant on body stores and diet to maintain vitamin D status for six months of the year (FSAI, 2007).

Cloud cover was cited to impact on the levels of vitamin D in the body. The findings were related to the reduction in the ability of the body to synthesize vitamin D as a result of failure of UV rays to reach the earth's surface (Feldman *et al.*, 2011).

2.1.4.1.3 Skin Pigmentation and Sunscreen use

Absorption of UV radiation is affected by the level of pigmentation of the skin (Mercus, 2008). Skin pigments like melanin protects the skin against strong UV light from the sun. Consequently, this blocks a substantial amount of UV light exposure of the skin for the efficient production of vitamin D. Pigmentation is cited as an important factor in the determination of levels of 25 $(OH)_2$ D_3. Studies show that people with pigmented skin exposed to the same amount of UV show little increase in the production of vitamin D compared with people with non pigmented skin (Holick, 2004), although they have the same ability as non pigmented skin people in terms of making vitamin D (Azhar,2009). According to the Food Safety Authority of Ireland (FSAI, 2007) people with darker skin need 10-50 times more sun exposure than people with light skin.

Research revealed the application of sunscreen plays a pivotal role to the levels of vitamin 25$(OH)_2$ D_3 in the plasma (Holick, 2010). To reduce the risk of skin damage and cancer people are advised to use sunscreen to protect the skin. This can reduce vitamin D synthesis by more than 98% (FSAI, 2007).

2.1.4.1.4 Culture influences

Covering the skin with clothes impacts on UV absorption to a great extent. This is either because of life style or cultural practices. The traditional long clothes that are worn by Muslim women prevent them from sun exposure and therefore synthesis of vitamin D. These women may have limited facial exposure and therefore some vitamin D syntheses, while others who wear the burkha also have the face covered.

2.1.4.1.5 Obesity

Vitamin D is a fat soluble vitamin. Obese people store vitamin D in their fat cells which gives the body less to work with. As a result the body tissues and organs cannot benefit from vitamin D (Bray, 2012). Therefore, obese people may need more vitamin D than those who have normal weight to get their daily need of vitamin D.

Other factors that decrease vitamin D absorption or metabolism are Crohn’s disease, ceoliac disease, inflammatory bowel disease, kidney and liver disease (Bray, 2012)

2.2 Calcium absorption

One of the main functions of vitamin D in the body is to work with PTH in order to maintain the balance of calcium and phosphorus concentration in the blood (Azhar, 2009). When the plasma calcium levels is low vitamin D reabsorbs calcium from the bones to maintain calcium levels back to normal (Liddel, 2011). Low levels of calcium and phosphorus in the blood, leads to increased PTH.

Increased PTH can stimulate the kidney to produce calcitriol, which can cause changes in gene expression (Wang, 2012; Azhar, 2009). This leads to normalization of calcium concentration in the blood by increasing intestinal calcium absorption, renal reabsorption and mobilization of calcium from bone (Azhar, 2009). In addition, increased PTH leads to phosphaturia which leads to low serum phosphorus levels (Wang, 2012) (Figure 2).

If there is no adequate calcium – phosphorus product, bone cannot be remineralized and rickets in children and osteomalacia in adults may develop (Wang, 2012; Azhar, 2009).

Wangen (2009) conceded that synthetic forms of vitamin D may not be enough to facilitate in the absorption of calcium in the small intestines. The reasons cited involve the inability of such vitamin forms to be converted to active forms of vitamin D (Wangen, 2009).

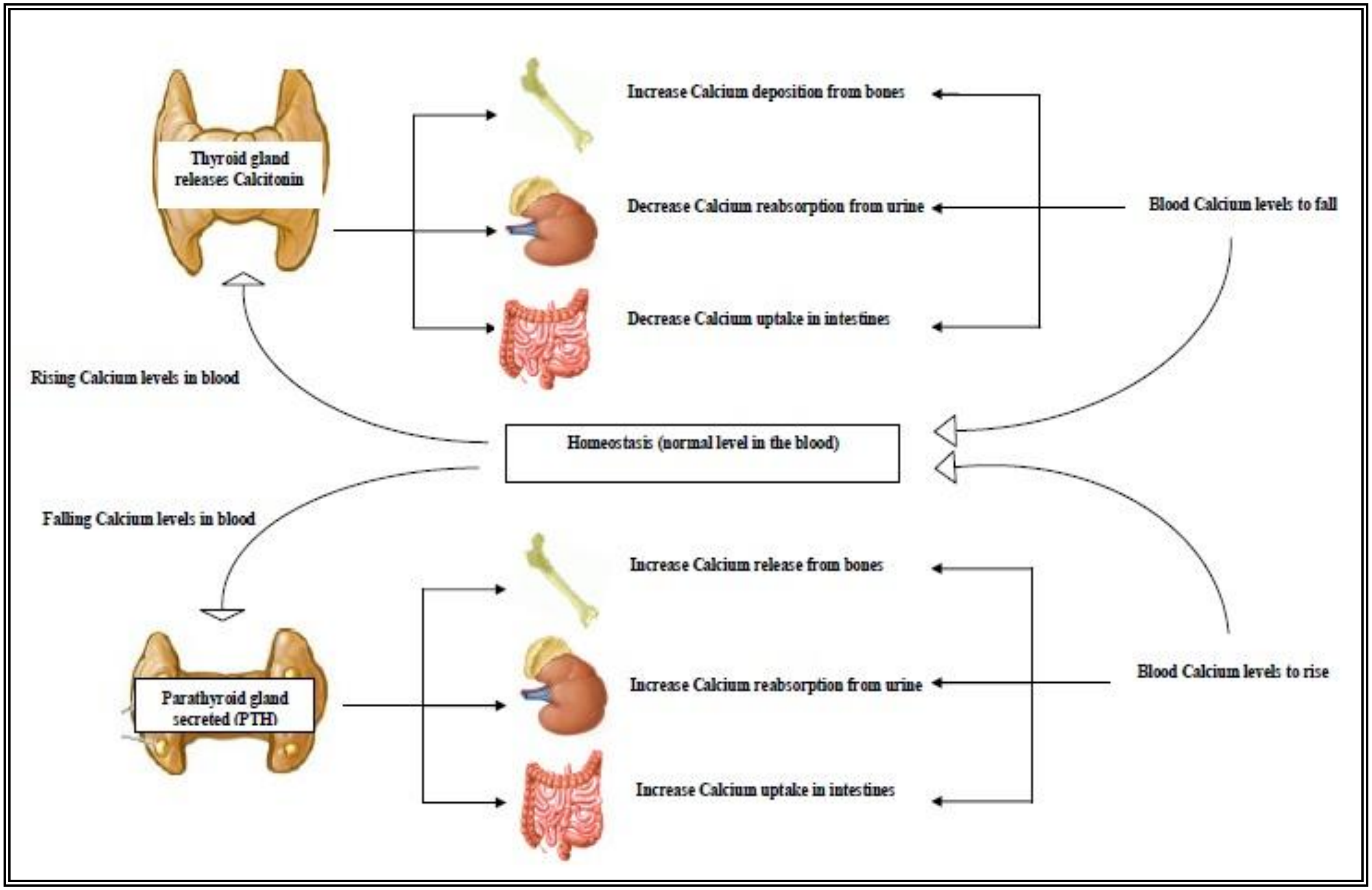


Figure 2.2 The Homeostatic Regulation of Calcium ion concentrations

Adapted from: Martini, Nath and Bartholomew (2009). Fundamentals of Anatomy and Physiology, 8th ed. Pearson Education, Inc., Benjamin Cummings, USA

2.2.1 Bone density

Research on bone density relates to the importance of vitamin D and calcium absorption processes in the body. Winzenberg *et al.* (2011) conducted a study on the effects of vitamin D supplementation on bone density in healthy children and adolescents (aged 1 month to <20 years). The researchers found that vitamin D supplementation of deficient children and adolescents could improve the lumbar spine bone mineral density and total body bone mineral content. Another study by Green and Naughton (2011) investigated the relationship between calcium and vitamin D supplementation on female identical twins. The finding showed that supplementation with vitamin D and calcium boosted both bone density and bone strength.

Studies have shown that many factors could influence bone density including: physical fitness, diet, hormones status, pregnancy and lactation. Physical fitness, according to the National Institute of Arthritis and Muscloskeletal and Skin Disease and the National Institute on Aging (2007) and an increase in the body weight was associated with increase in levels of BMD. Also a lack of physical activity may result in lower bone density. Kumar and Clark (2002) suggest exercising at least for 30 minutes of weight-bearing exercise three times a week helps build and maintain strong bones. In addition, dietary calcium influences bone density. Therefore, low calcium intake increases the risk of reduction in bone density. In pregnancy and lactation, studies have shown that women lose bone density during pregnancy or breastfeeding and recover after childbirth or weaning (NIH, 2012). Other hormones may also affect bone density later in life. Reduction in sex hormone (estrogen or testosterone in women and men respectively) increase the likelihood of developing bone related complications in both sexes. Also, people with thyroid problems (underactive thyroid, overactive thyroid and thyroid nodules) have been associated with bone mineral loss.

2.3 Vitamin D deficiency

The definition of vitamin D deficiency relates to the having circulating serum levels of calcidiol in the plasma that are considered lower than 25 nmol/L and this occurs as result of several factors: vitamin D intake is lower than recommended levels or limited exposure to sunlight or the kidney cannot convert calcidiol to it’s a active form or because of the absorption of vitamin D from the digestive tract is inadequate.

The most immediate effect of deficiency is poor mineralization of bones (Miller and Comacho, 2007) which leads to bone malformation (Bonnick, 2010). Vitamin D deficiency can be corrected by taking vitamin D supplements or food fortified with vitamin D.

2.3.1 Common disease associated with Vitamin D deficiency

Vitamin D deficiency has an effect on the muscuskeletal and non- muscuskeletal health especially in pregnant women and infants (which will be discussed in section 2.6 under the heading vitamin D in pregnancy and infancy).

The most common muscuskeletal diseases that are associated with vitamin D deficiency are: rickets, osteomalacia and osteoporosis. Rickets in children is characterized by bow legs and a distorted appearance of the body frame. This deficiency leads to soft bones that are susceptible to breaking due to fragility and to soft teeth. Osteomalacia, known as adult’s rickets is also associated with vitamin D deficiency. Osteomalacia is characterized by pain in muscle and bones as result of release of calcium from bone with no effect on the bone density (Gibney, Vorster and Kok, 2002). This leads to soft and weak bones. Osteomalacia could occur during pregnancy (will be discussed in Section 2.6.1). Osteoporosis is a disease that can occur at any age but is much more common in the elderly with vitamin D deficiency as a result of loss of bone density over time (Gibney, Vorster and Kok, 2002). The first symptom of the disease is a painful fracture which is often back pain or thigh pain (Glaser & Kaplan, 1997). In some cases, women develop osteoporosis during pregnancy or while breastfeeding and recover after childbirth or breastfeeding.

The medical conditions that increase the risk of osteoporosis are: low levels of sex hormones, hyperthyroidism, and parathyroid disease.

Research links vitamin D inadequacy to other major illnesses like different cancers (breast, colon, prostate and so on) (Holick, 2005; Grant, Garland and Holick, 2005; Lappe *et al.,* 2007), coronary heart disease, Alzheimer’s, rheumatoid arthritis and hypertension (Holick, 2005). Another study by Holick (2007) links vitamin D deficiency to immune system disorders

2.4 Vitamin D Toxicity

Research relates vitamin D toxicity with high calcium levels. This results when hyper-absorption of calcium and phosphorous occur as a result of high levels of calcidiol in the plasma. Incidences of toxicity of vitamin D are manifested in hypercalcemia, renal failure, and vascular calcification. Research shows that hypercalcamia and hyperphosphatemia cases result in vascular calcification cases especially in children.

However, cases of vitamin D intoxication from natural production of vitamin D are rare. This implies that the high sunshine exposure of people especially those living close to the tropics do not show cases of intoxication.

Supplementation of vitamin D to correct deficiencies may lead to toxicity. This implies that administration of vitamin D for corrective cases that require high doses should take place under controlled conditions (Whitney *et al.,* 2011).

2.5 Vitamin D in pregnancy and infancy

2.5.1 Vitamin D status of pregnant and lactating women

There is growing evidence suggesting that vitamin D deficiency is common during pregnancy (the American College of Obstetricians and Gynecologists, 2011).

In Ireland, there are studies done by Hollis and Wagner (2004) and Muldowney (2010) that offer proof of increased likelihood for pregnant mothers to suffer inadequate stores of vitamin D. Mulligan *et al.* (2010); Wagner and Greer (2008) and Ward *et al.* (2007) report increased vitamin D insufficiency rates of between 5-50% during pregnancy. Consequently, infants are subject to extra risk if born to mothers who have low status of vitamin D (Hollis and Wagner, 2004). Using a sample of 264 women where over 95 % were white, Muldowney (2010) established that 19 % of expectant mothers in Cork, Ireland had serum $25(OH)_2D_3$ levels below 25 nmol/L and 70% of the expectant mothers had levels <50 nmol/L which is considered as insufficient.

In Saudi Arabia, vitamin D deficiency among women is common as shown by various studies. Elidrissy, Sedrani and Lawson (2006) investigated serum $25(OH)_2D_3$ concentrations among 36 rachitic infant's mothers residing in central Saudi Arabia. The results indicated extremely low levels of serum $25(OH)_2D_3$ (5.2 ng/mL) among all mothers. An earlier study done by Serenius, Elidrissy and Dandona (1984) utilized a sample of 119 expectant women residing in Saudi Arabia's central region and found that the median concentrations of serum $25(OH)_2D_3$ was 5.7 ng/mL.

2.5.2 Vitamin D metabolism during pregnancy and lactating

The formation of the placenta occurs at the fourth week of gestation and this allows for the transfer of nutrients to the fetus from its mother (Kaludjerovic, 2010). From the gestation period to term, calcidiol diffuses easily through the placenta, making it possible for the calcidiol concentrations within the fetal cord blood to reach 87% of the concentrations of the mother (Dent and Gupta, 1975). However, calcitriol which is the active metabolite physiologically does not freely cross the placenta. However, the fetal kidney and the placenta express the 1α-hydroxylase, which in turn transforms calcidiol to calcitriol within these tissues and could contribute to calcitriol fetal circulating levels (Greer, 2008).

Usually, there is a 100-200% increase in the total calcitriol concentrations in both the fetus and the mother beginning in the first three months. However, most of this vitamin D remains bound to the vitamin D-binding protein (VBP) (Kaludjerovic, 2010). There is widespread assumption that the free hormone that is not protein-bound reflects the more biologically active vitamin D form. Research by Kovacs (2008) shows elevation of free calcitriol concentration within the final trimester only and could be implicated during the initiation of labor (Kaludjerovic, 2010).

Research by Barrera *et al.* (2007) shows that calcitriol is responsible for the regulation of progesterone and estradiol placental hormones. In addition, it prevents the initiation of inflammatory cytokines, which stimulate premature labor and preeclampsia (Diaz *et al.,* 2009). Such findings partially explain the observation that women with vitamin D deficiency are five times more likely to develop preeclampsia according to Bodnar *et al.* (2007b). After delivery, the calcitriol concentrations of the mother fall considerably. This significant drop in part explains the importance of supplementing infants with vitamin D (Kaludjerovic, 2010).

2.6 Consequences of inadequate vitamin D during pregnancy & lactating

Adverse maternal deficiency of vitamin D, serum $25(OH)_2$ D_3 of <25 nmol/L causes neonatal hypocalcemic seizures (Seizures that occur in neonates due to deficient parathyroid hormone (PTH) secretion and low calcium) (Camadoo, Tibbott and Isaza, 2007). However, undiagnosed maternal hypoparathyroidism (A disorder where the parathyroid glands fail to secrete adequate levels of PTH) could also lead to hypocalcemic seizures (Fong and Khan, 2012). There are studies that suggested that maternal vitamin D deficiency increases the risk to pregnancy outcomes such as enhanced vulnerability to the development of pre-eclampsia (Bodnar *et al.,* 2007a), gestational diabetes (Zhang *et al.,* 2008), caesarian section deliveries and an enhanced risk of giving birth to small-for-gestational-age babies (Bodnar and Simhan, 2010).

There are several reports of vitamin D deficiency occurring in women diagnosed with Polycystic Ovary Syndrome (PCOS) (Azhar, 2009). It is likely that vitamin D deficiency contributes to some of the biochemical anomalies associated with PCOS (A condition whereby women have imbalances of the female sex hormones). On the other hand, studies by Liepa, Sengupta and Karsies (2008) show that providing women with enough vitamin D and calcium amounts enhance the occurrence of normal ovulation cycles.

2.6.1 Musclo-Skeletal health of pregnant women

Borg-Stein, Dugan and Gruber (2005) argue that virtually every woman experiences some level of musculoskeletal discomfort when pregnant, which affects their health negatively (Pasco *et al.,* 2008). Furthermore, 25 % of pregnant women who suffer such musculoskeletal discomfort during pregnancy exhibit temporary disabling symptoms. In addition, such deficiency is cause for concern as it exposes the musculoskeletal health of the offspring.

Data suggests that the status of maternal vitamin D during pregnancy has effects on intrauterine skeletal mineralization (Gale *et al.,* 2001) and skeletal growth in offspring (Javaid *et al.,* 2006). There are links connecting maternal veiling during pregnancy, which is a substitute for low levels of vitamin D, with reduced bone mass among boys in adolescent ages (Nabulsi *et al.*, 2007). A longitudinal study involving children and their mothers in the UK associated reduced maternal vitamin D in the latter pregnancy stages with lower mineral content of the lumbar spine bone and that of the entire body in children aged nine (Javaid *et al.*, 2006). Interestingly, exposure to maternal supplementation of vitamin D and UVB radiation in the latter pregnancy stages predicted the status of maternal vitamin D and bone mass of the child at age nine.

Morley *et al*. (2006) measured the status of maternal vitamin D at about 11 weeks and 28-32 weeks gestation. They also attained anthropometric measurements in the child during birth and later at one year. Offspring born to women who had low levels of $25(OH)_2$ D_3 (28nmol/L) at the commencement of the last trimester had 4.3mm smaller knee-to-heel length at delivery, signifying growth impairment of the long bone *in utero*. The gestation length was shorter while the variation in knee-to-heel length reduced to -2.7mm following gestation length adjustment. This implied that there was partial mediation of the growth deficit through a vitamin D effect on the length of gestation. Additionally, Morley *et al.* (2006) associated low maternal $25(OH)_2$ D3 with lesser calf and mid-upper arm circumference of the offspring at birth without proof of a variation in the skinfold thickness of the triceps. These findings imply that offspring born to mothers who have low $25(OH)_2$ D_3 in the late stages of pregnancy have been responsible for the decrease in limb lean tissue. Walsh *et al*. (2013) measured serum $25(OH)_2$ D_3 in early pregnancy, at 28 weeks and in cord blood at delivery. Two specific subgroups were analyzed in order to examine results in the context of known seasonal variation in $25(OH)_2$ D_3. They also attained anthropometric measurements with ultrasound in the child at 20 and 34 weeks and at delivery birth weight, length and head circumference were recorded. Positive correlation was found between first trimester and cord $25(OH)_2$ D_3, and fetal femur length at 20 weeks in the winter cohort. Additionally a positive correlation was noted between $25(OH)_2$ D_3 at 28 weeks and in cord blood and fetal femur length at 34 weeks. No significant association was noted between maternal and fetal $25(OH)_2$ D_3 and infant birth weight, length or head circumference. These findings imply that maternal hypovitaminosis D is particularly high in women who are pregnant during winter months in northern latitudes. Lawlor *et al.* (2013) assessed vitamin D levels among 3,960 pregnant women, recording data from all three trimesters. When their children had reached nine years and 11 months their bone mineral content was assessed. The research found that there is no significant association between a mother's vitamin D status during pregnancy and their child bone health later in life.

Despite the indication that maternal adjustments during pregnancy offer adequate calcium without depending on vitamin D, there is paucity of human data (Kovacs, 2008). Vitamin D insufficiency could lead to increased bone turnover, osteomalacia and bone loss (Glerup *et al.,* 2000; Lips, 2001). In the rural areas of Northern India, 74 % of pregnant mothers in their second trimester out of a sample of 139 showed vitamin D insufficiency where $25(OH)_2\ D_3$ was less than 50 nmol/L. In line with the deficiency, Sahu *et al.* (2008) found biochemical osteomalacia, which is the heat-stable placental alkaline phosphate greater than 240 U/I, in 43% of the women. However, there were no signs of clinical osteomalacia (Sahu *et al.,* 2008).

There could be connections between insufficient vitamin D and chronic pain in the lower back connected with osteomalacia. Owing to extra weight, additional maternal calcium demands and conformational change the bones undergo, pregnant women usually report lower back pain. Research conducted in Saudi Arabia by Al Faraj and Al Mutairi (2003) involving 324 non-pregnant female patients revealed that 85% of them attended spinal and internal medicine clinics had treatment with vitamin D supplements. After using the supplement for three months (125/250 μg/d), 95% of the patients achieved standard $25(OH)_2\ D_3$ concentration levels (>22 nmol/L) and exhibited back pain disappearance.

2.6.2 Non-Skeletal health of pregnant women

Vitamin D insufficiency also affects the non-skeletal health of mothers. Some of the most common non-skeletal health diseases include preeclampsia and gestational diabetes.

2.6.2.1 Preeclampsia (include the percentage of this in Ireland and Saudi Arabia)

Kenny *et al.* (2010) define preeclampsia as a syndrome that is specific to pregnancy and state that it is the cause of a good fraction of fetal and maternal mortality and morbidity. It affects approximately 5 % of nulliparous pregnancies with a global affliction rate of an estimated 4 million women per year (Kenny *et al.,* 2010).

Moreover, preeclampsia affects the health of women later in life and increases the risk of stroke, coronary artery disease, diabetes mellitus type 2 and hypertension (Bellamy *et al*., 2007).

In Ireland, the Institute of Obstetricians & Gynaecologists, Royal College of Physicians of Ireland and Clinical Strategy and Programmes Directorate, Health Service Executive (2013) argues that preeclampsia is responsible for complication in 5 to 7 % of pregnancies in nulliparous women and 2 to 3 % of all the other pregnancies. Moreover, it is still a leading perinatal and maternal mortality and morbidity in Ireland and globally.

A study by Makhseed, Musin and Ahmed (1998) on preeclampsia conducted in Saudi Arabia examined the medical records (n=10407) of pregnant mothers with the intention of examining the relationship with preeclampsia. The study revealed a preeclampsia incidence percent of 1.68. Al-Mulhim *et al.* (2003) conducted another study involving 27,787 mothers who had given birth at King Fahad University Hospital during the period commencing 1992 and ending 2001. The aim of their study was to investigate preeclampsia incidence in the women and to examine the maternal risk factors as well as neonates' and mothers' outcome in pregnancies that the condition complicates. The results showed that 2.47 % (n=685) of women diagnosed as having preeclampsia among 40 % of these were nulliparous women (Al-Mulhim *et al.*, 2003).

There are indications that high maternal concentrations of $25(OH)_2$ D_3 in early stages of pregnancy seemingly cushion against the occurrence of preeclampsia (Bellamy *et al.,* 2007). A study by Hypponen *et al.* (2007) based on the 1966 Northern Finland birth cohort involving 2,969 women revealed that 2.3 % of the women who developed preeclampsia during their first pregnancy had vitamin D deficiency in their early life. However, the preeclampsia risk among women receiving vitamin D supplementation on regular basis in their first year of life exhibited 50 % reduced risk of preeclampsia (Hypponen *et al.,* 2007). In a different study by Bodnar *et al.* (2007a) showed that neonates whose mothers had preeclampsia had a doubled likelihood of having poor vitamin D status compared to control neonates.

2.6.2.2 Gestational Diabetes

Gasim (2012) defines Gestational Diabetes Mellitus (GDM) "as glucose intolerance diagnosed for the first time during pregnancy and usually disappears during the puerperium". However, the World Health Organization (WHO; 1985) contends that GDM is a distinct entity from diabetes mellitus and reduced glucose tolerance. Instead, WHO states that GDM applies to temporary derangement in tolerance of carbohydrate that occurs for the first time during pregnancy. During pregnancy, gestational diabetes raises the probability of complications for both the child and the mother (Buckley *et al.*, 2012).

Globally, GDM incidence is on a rapid increase and the women who suffer from GDM are more likely to develop diabetes type 2 later in their lives (Coffey, 2006). However, Coffey (2006) cites the absence of a national Irish register on diabetes although figures gathered from maternity hospital registers imply that GDM prevalence in Ireland ranges from 1 % to 2 %. O'Sullivan *et al.* (2011) utilized the International Association of Diabetes and Pregnancy Study Group (IADPSG) criteria and established that 12.4 % of pregnant women in Ireland had GDM.

In Saudi Arabia, Al-Rowaily and Abolfotouh (2010) investigated the prevalence of GDM and its prediction in a high-parity group of pregnant women (n=770) who had attended the King Fahd hospital antenatal clinic between July 2005 and July 2006 and had no diabetes history before pregnancy. A total of (n= 633, 50.1% grand multiparas) women completed a 2-hour Oral Glucose Tolerance Test (OGTT). According to WHO criteria, GDM was diagnosed in 79 women, prevalence of 12.5% while according to American Diabetes Association (ADA) criteria there were only 24 women with GDM, prevalence of 3.8%. Multiparous women were 8.29 times more likely to have GDM than nulliparous women.

2.6.3 Musclo-Skeletal health of the infant

There are indications that Vitamin D insufficiency during pregnancy negatively affects the unborn child's skeletal mineralization and calcium homeostasis, through the occurrence of reduced bone minerals and congenital rickets (Specker, 1994; Arden *et al.*, 2002; Namgung and Tsang 2003).

Rickets is possibly the most widely known clinical consequence of insufficient vitamin D. The characterization of rickets entails weakened, soft bones that result from poor mineralization in the formation of new bone tissue (Kimball, Fuleihan and Vieth, 2008). Belated closure of the fontanel is an early symptom of rickets for infants below one year (Pettifor, 2002). Later characterization of rickets involves broadening of long bones at the ends, retarded growth and skeletal distortions such as the spine, legs, rib cage and arms leading to the characteristic knocked knees or bowed legs (Wharton and Bishop, 2003). In most cases, infants with rickets have serum $25(OH)_2D_3$ concentration levels below 10 nmol/L, increased alkaline phosphatase (which is a bone formation marker) and elevated concentrations of the parathyroid hormone (Dijkstra *et al.,* 2007; Wharton and Bishop, 2003). Rickets also cause hyperparathyroidism changes in phosphorus and calcium metabolism and absorption. Nonetheless, it is possible to implement effective treatment for rickets when diagnosed at an early stage. Unfortunately, untreated rickets can lead to perpetual skeletal distortions like pelvic deformity (Dijkstra *et al.,* 2007). Altogether, it is uncommon for newborns to have rickets, children aged 6 to 24 months are the most common victims (Dijkstra *et al.,* 2007).

Rickets prevalence differs significantly across various countries. For instance, Northern China registered 50% rickets occurrence among children aged below three years (Guan, Ying and Ma, 1984). Contrastingly, rickets was at one point considered nonexistent in several developed nations (Abrams, 2002), although there are cases reported among young children and neonates in numerous parts of the developed world such as the US and Europe. Probably, this is due to the rise in the number of dark-skinned immigrants to high latitude countries (Weisberg *et al.,* 2004; Nozza and Rodda, 2001), direct sunlight avoidance (Pettifor, 2008) and breastfeeding for over six months without supplementing vitamin D (Holick, 2004; Greer, 2008; Abrams, 2002).

In the case of Ireland, research by Ward *et al.* (2007); The Food Safety Authority of Ireland, (2007) and Gordon *et al.* (2008) document increased occurrence of rickets among toddlers and infants. According to the Food Safety Authority of Ireland (FSAI, 2011) there were more than 20 incidences of rickets in toddlers and infants at two hospitals in Dublin alone between 2006 and 2007. Additionally, several recent studies indicate that reduced vitamin D levels are widespread among the general Irish population (Hill *et al.,* 2006).

In Saudi Arabia, numerous research studies within the western and central regions show that children suffer from vitamin D deficiency in spite of there being adequate sunshine all year round (Sedrani, 1984; Elidrissy, 1991; Fida, 2003). In the study by Al-Mustafa *et al.* (2007) a larger fraction of the children with rickets (75% out of 61) exhibited an average of <20 nmol/L serum $25(OH)_2D_3$ concentration. Using a sample of 13,382 children age range between 3-36 months, Fida (2003) found that 60 cases were diagnosed as nutritional rickets. However, it is possible to attribute the rickets in children who had sufficient $25(OH)_2D_3$ to calcium deficiency or genetic causes (Okunufua *et al.,* 1991; Miller and Portale, 1999; Thacher *et al.,* 1999). Al-Mustafa *et al.* (2007) also established that most of the rachitic children had hypophosphatemia, hypocalcaemia and increased PTH and alkaline phosphatase levels.

The significance of maternal status of vitamin D during pregnancy and lactation is irrefutable especially when it comes to curbing the incidence of rickets. It is possible that rickets occurs when vitamin D deficiency happens as a result of inadequate $25(OH)_2D_3$ transfers to the fetus from the mother. This is especially common in the last trimester (Tarrant *et al.*, 2011).

Figure 2.3 Photo of an Irish girl with rickets

Source: Dimitri and Bishop (2007)

Figure 2.4 20-month old Saudi girl with rickets

Source: Mousa (n.d.)

2.6.4 Non-Skeletal health of infant

Vitamin D insufficiency also affects the non-skeletal health of infants. Researchers like Miyake *et al.* (2009); Morris *et al.* (1995) and Erkkola *et al.* (2009) linked the incidence of Infant birth weight, type 1diabetes, multiple sclerosis, mental disorders and autism with poor status of vitamin D in infants.

2.6.4.1 Infant birth weight

Study by Marya *et al.* (1981) demonstrated a correlation between the status of maternal vitamin D and the birth weight of an infant. Research (McGrath, Barnett and Eyles, 2005; Waldie *et al.*, 2000) shows the likelihood of heavier infants being born in spring compared to any other season of the year. The explanation behind this relationship is the effect of seasons on the concentration of maternal vitamin D. Since vitamin D enhances cellular differentiation and reduces cellular proliferation, insufficient levels during pregnancy could lead to a rise in cell count and consequential heavier infants. Infants faced with deficiency of vitamin D $25(OH)_2D_3$ below 37.5 nmol/L registered heavier weights than the infants adequately supplied with vitamin D (3698 against 3399g; $P = 0.022$) in the study by Weiler *et al.* (2005).

Walsh *et al.* (2012) conducted a cohort study on women ($n = 60$) recruited on their first antenatal consultation visits at gestation of weeks 14.3 ± 2.3 at the National Maternity Hospital in Ireland from January 2008 to October 2010. The researchers did not find any significant relationship between maternal $25(OH)_2$ D_3 at any point of time and maternal weight, BMI, upper arm circumference or height in the early pregnancy stages. There was no significant correlation between weight gain at 34 or 28 gestation weeks. Additionally, Walsh *et al.* (2012) did not find any significant relationship between fetal or maternal $25(OH)_2D_3$ and fetal adiposity or weight at 34 gestation weeks.

Al-Harthy, El-Metwaly and Al-Seoud (2012) measured $25(OH)_2D_3$ concentrations in near-term infants' cord blood at the King Fahad Armed Forces Hospital (KFAFH) in Jeddah, Saudi Arabia. Through the prospective study carried out between August 1, 2011 and January 31, 2012, the researchers included 153 near-term infants in the 34 to 36 gestational weeks' range. They classified their results as sufficient $25(OH)_2D_3$ >75 nmol/L), insufficient $25(OH)_2D_3$ 37.5 – 75 nmol/L) and deficient $25(OH)_2D_3$ <37.5 nmol/L). The findings revealed a range of 3 to 91 nmol/L for the levels of $25(OH)_2D_3$

with an average of 26.91 ± 13.934 nmol/L. Further, the results showed that 88.2 % (n=134) of babies suffered from vitamin D deficiency while 10.5 % (n=16) of the babies had insufficient $25(OH)_2D_3$ concentration levels. Only 1.3 % (n=2) of the babies had sufficient levels of vitamin D. However, the correlation tests between birth weight, gestational age, admission to NICU (Neonatal Intensive Care Unit) and concentration levels of $25(OH)D_3$ revealed a weak association between birth weight and $25(OH)_2D_3$ (Al-Harthy, El-Metwaly and Al-Seoud, 2012).

2.6.4.2 Type 1 diabetes

Type 1diabetes occurs when the immune system attacks the pancreas and destroys the islets cells that produce insulin (Mathieu and Badenhoop, 2005; Hypponen, 2010). In spite of the fact that human fetuses may not face skeletal complications from vitamin D insufficiency and deficiency, they still face the elevated risk of developing non-skeletal problems in their childhood, including Type 1 diabetes especially if their mothers had low intakes of vitamin D during pregnancy (Kovacs, 2008). The correlation between type 1diabetes and vitamin D is not new. Baumgartl *et al.* (1991) showed that measuring serum $25(OH)_2D_3$ concentration levels at matched points of time all year through reveals lower levels in patients who newly acquire type 1 diabetes more than in healthy controls.

The EURODIAB Substudy 2 Study Group (1999) investigated the relationship between the development of type1 diabetes and vitamin D supplementation in the first year of life. The findings of the group showed that supplementation with vitamin D in the first year of life relates with reduced type 1 diabetes risk. There are indications that the region of Middle East and North Africa (MENA) has a lower occurrence rate of type 1 diabetes in children as compared to that of North America and Europe. However, such claims are oblivious of the numerous variations in incidence rates between MENA nations that are hotspot countries like Kuwait that have a 22.3 per 100,000 incidence rate and those with considerably lower rates of 0.5 per 100,000 like Pakistan (The Diabetes Atlas, 2010).

Habeb *et al.* (2011) conducted an observational study in Al-Madinah, Northwest of Saudi Arabia with an attempt to define the childhood type 1 diabetes incidence during the 2004 to 2009 period. Their sample comprised of 431 children aged 0-12 years diagnosed with diabetes between January 1,2004 and December 2009 within Al-

Madinah. The estimated mean annual crude incidence rate for type 1 diabetes stood at 27.6 per 100,000. Habeb *et al.* (2011) also noted a considerable seasonal variation with the diagnosis of more cases during the months of winter and autumn in which exposure to the sun remains limited. The researchers attribute the seasonal variation in the type 1 diabetes onset to reduced UVB radiation exposure, which is necessary for synthesizing vitamin D in human skin, among other factors.

A study by Roche *et al.* (2002) investigated the incidence of type 1 diabetes in children aged below 15 years in the Irish Republic. The researchers revealed that the directly standardized incidence rate was 16.3 per 100,000 per year.

2.6.4.3 Multiple Sclerosis

Comptons and Coles (2002) define multiple sclerosis as an inflammatory autoimmune disease that affects the central nervous system specially the myelin which protects the brain and the spinal cord. Several researchers (Willer *et al.*, 2005; Templer *et al.*, 1992) contend that multiple sclerosis incidences rise with the elevation of latitudes. In addition, there is a relationship between multiple sclerosis incidence rates and seasonal alterations. The US Nurses' Health Study (Munger *et al.*, 2004) suggests that exposure to sunlight and the consequential increase in the concentration levels of vitamin D could lessen the risk of developing multiple sclerosis. Researchers (Cantorna, 2000; DeLuca and Cantrona, 2001; Embry, 2004) postulate that the manner in which vitamin D lowers the risk of developing multiple sclerosis is by firming the immune system the multiple sclerosis theoretical etiological factor of viral infections. Deficient vitamin D level during early years and pregnancy could elevate the risk of a child developing multiple sclerosis later in life (Embry, 2004).

Lonergan *et al.* (2011) investigated the prevalence of multiple sclerosis in Ireland to establish its relationship to HLA genotype and vitamin D status. They involved 632 Irish patients with multiple sclerosis from three areas in Ireland located on different latitudes. The mean serum $25(OH)_2D_3$ concentration level was the same for both patients and controls. In addition, they found a significant negative association between PTH and $25(OH)_2D_3$ levels in multiple sclerosis patients ($r = -0.17$; $p<0.002$) and among controls ($r= -0.24$; $p<0.0003$). Interestingly, 44 control subjects showed vitamin D deficiency levels (<25 nmol/L) with an average of 20.8 nmol/L in the range 14.3 – 24.6. Overall, Lonergan *et al.* (2010) rejected their initial postulation that the gradient of prevalence would exhibit an association to reduced $25(OH)_2D_3$ in multiple sclerosis.

2.6.4.4 Mental Disorders

Like all tissues in the body, there are vitamin D receptors in the brain, which means that the brain has the capacity to produce its own vitamin D active form (Levenson and Figueirôa, 2008). Low levels of vitamin D have been linked to an increased risk for depression and schizophrenia. Epidemiological studies like the one conducted by McGrath, Selten and Chan (2002) show an elevated schizophrenia risk in populations that live in higher latitudes and among people born in the spring or winter seasons. Similarly, this applies to people born in times and areas characterized by relatively less exposure to the sun and cutaneous vitamin D synthesis. Davies *et al.* (2003) described a small yet significant schizophrenia risk in children born in spring or winter in the Northern Hemisphere.

However, McGrath and Welham (1999) did not confirm the same following a meta-analysis of studies on the Southern Hemisphere.

Mersch *et al.* (1999) associated low sun exposure levels with seasonal affective disorder while Rasanen, Hakko and Jarvelin (1999) associated them with mood disturbances. It remains vague whether vitamin D deficiency or reduced exposure to the sun that connected to the latter conditions.

2.6.4.5 Autism

A syndrome that consists of a set of behavioral and development characteristics that involve impairment in communication and social interaction in addition to restrained, iterative and archetypical interests and behavior patterns refers to autism (Bakare, Munir and Kinney, 2011). Genetic and environmental factors are significant in autism's aetiology (Currenti, 2010). Several researchers like Grant and Soles (2009); Meguid *et al.* (2010) and Cannell (2010) established that deficiency of vitamin D *in utero* and during early stages of childhood have an association with elevated risks of developing autism. In addition, a study by Waldman *et al.* (2008) shows that varying environmental factors, which contribute to a deficiency of vitamin D has a connection with increased autism risk.

Evidence for a vitamin D deficiency etiologic role in autism includes higher incidence rates in high latitude populations, regions with strong high precipitation and air pollution (Grant and Soles, 2009; Cannell, 2008; Kinney *et al.,* 2010). On the other hand, children who have Williams Syndrome normally exhibit significantly increased levels of vitamin D and contrasting behavioral phenotypes from autistic children (Cannell, 2008). While most aetiologic characterization of autism leans on genetic affiliation, vitamin D's role in the aetiology is significant since it affects autism-related gene expression (Bakare, Munir and Kinney, 2011). Slc25a12 is an example of a gene implicated in autism and whose expression vitamin D influences (Palmieri *et al.,* 2010; Sakurai *et al,* 2010).

In a cross-sectional study with 50 autistic children aged between 5 years and 12 years in Saudi Arabia, Mostafa and Al-Ayadhi (2012) investigated the link between autism and vitamin D deficiency. Their results showed that children with autism had considerably lower serum concentration levels of $25(OH)_2D_3$ where the median (IQR" Interquartile range (IQR), which is the difference between the 75th and 25th percentiles" = 18.5 (14) ng/mL) in comparison to the healthy controls with a median (IQR) = 33 (11) ng/mL) with a significance level P <0.001. The vitamin D levels for the autistic children were 40 % (deficient) while the healthy children had insufficient levels at 48 %. Furthermore, the researchers found elevated anti -myelin-associated glycoprotein (anti-MAG) autoantibodies in 70 % of the children with autism. This was the first published study investigating the correlation between the serum $25(OH)_2D_3$ levels and the anti-MAG autoantibodies in children with autism.

2.7 Vitamin D recommendations

2.7.1 Current guidelines for Vitamin D Supplements in US, UK, EU, Ireland & Saudi Arabia

Guidelines pertaining to the supplementation of vitamin D are summarized in Table 2.3. These vary from one country to another depending on factors that affect vitamin D.

Table 2.3 Summary of current Guidelines for Vitamin D intakes in US, EU, UK, Ireland and Saudi Arabia (µg/per day).

	US	**EU**	**UK**	**Ireland**	**Saudi Arabia**
Children	The minimum supplementation requirements for children below 12m are 10 µg/per day. The requirements for 1-10 yr are15µg/per day	The requirements for children from 6 m-1yr are 25µg/per, from 1yr-10 yr 50 µg/per day	The requirements for children from 6 m-5 yr are 7µg/per day of vitamin D. The requirements for breastfeed infant from 1m-6m are 8.5 µg/per	The lower limit for infants for supplements is 5 µg/per day and upper limits is 25 µg/ per day.	Infants should be allowed substantial intake of vitamin D in comparative levels similar to what the US currently offers as recommended by (IOM, 2010).
Adults	15 µg/per day	100 µg/per day	10µg/per day	10µg/per day	
Pregnancy	20 µg/per day	100 µg/per day	pregnant and breastfeeding women this group takes 10µg/per day	10µg/per day	Vitamin D levels should be increased during the summer months for pregnant and lactating women.
	(IOM, 2010)	(EFSA., 2012)	(Barts and the london school of medicen and dentistry, 2011)	(FSAI,2007) (HSE, 2010)	Saudi Food and Drug Authority (SFDA, n.d)

*These vitamin D supplementation rates apply to pregnant and breastfeeding women who are not exposed to sunshine

2.7.2 Current recommendations for Vitamin D supplements in US, UK, EU, Ireland & Saudi Arabia

Different countries propose different recommendations concerning daily amounts of vitamin D (as is shown in Table 2.4).

Table 2.4 Summary of current recommendations for Vitamin D Supplements in US, EU, UK, Ireland and Saudi Arabia (µg/per day).

	US	EU	UK	Ireland	Saudi Arabia
Infant					follows vitamin D recommendations for the US
0-6 months	10	–	8.5**	8.5	
6-12 months	10	10 – 25	7	7	
Children					
1-10 years	15	10	7	10	
Adults (Male Female)	15	10*	10	10 – 15 Ω	
≥65	20	10	10	10	
Pregnant & lactating women	15	10	10	10ΩΩ	
Source	(IOM, 2010)	*Nutrient and energy intakes for the European Community (1992)*	(NHS, 2009)	(FSAI, 1999)	(SFDA, n.d).

* Males and Females from 11-17 years take 15

** Formula fed infant do not need for vitamin D supplement until they receiving less than 500 ml of infant formula a day

Ω Males and Femals from 11-17 years take 15

ΩΩ Second half of pregnancy first 6 months of lactation

2.7.3 Vitamin D status in US, UK, EU, Ireland & Saudi Arabia

Using $25(OH)_2D_3$ as the indicator, more than half of the adults in the European Union having vitamin D levels of 20ng/ml, are suffering from vitamin D insufficiency (Wagner *et al.*, 2012).

In the US 75% of the population have adequate vitamin D levels at 20ng/ml 17% had insufficient vitamin D levels at 10-20ng/ml, and 8% suffered from vitamin D deficiency at less than 10ng/ml (Looker *et al.*, 2011).

In the UK vitamin D deficiency is common with more than half of the adults' population having insufficient levels between 10-20ng/ml and 16% have vitamin D deficiency of less than 10ng/ml, which worsens during winter and spring. The highest deficiency rates are in Scotland, Northern England and Northern Ireland. In the EU, more than 50% of adults suffer from vitamin D insufficiency with levels of 10-20ng/ml. Similarly, vitamin sufficiency decreases during winter. A daily intake of 5µg during summer and 10µg during winter of vitamin D is recommended (International Osteoporosis Foundation, 2012).

In Saudi Arabia, the prevalence of vitamin D insufficiency is very high, with males having an average of 10.1ng/ml and females 9.9ng/ml, which is in the range of vitamin D insufficiency of 10-20ng/ml (Elsammak *et al.,* 2009). Saudi Arabia has plentiful sunshine; therefore, the marked low levels of $25(OH)_2D_3$ might be attributed to genetic predisposition (Aloia *et al.,* 2008), veiled clothing (Dror & Allen, 2010), long time spent indoors by pregnant Muslim women (Fuleihan, 2009), which altogether reduce the length of exposure to the sunlight.

On the other hand, in Ireland, weather and season are the main factor that affects vitamin D status, especially among pregnant women (Prentice, 2008). While 6.7% of the Irish adults had deficient level of vitamin D of 10ng/ml throughout the year, 40.1% had insufficient levels of $25(OH)_2D_3$ between 10-20ng/ml (Cashman *et al.*, 2012). In winter, vitamin D status drops due to weak sunlight to stimulate cutaneous bio-synthesis of vitamin D (McCarthy, 2007).

2.8 Infant feeding and weaning practices in Ireland & Saudi Arabia

According to the Economic and Social Research Institute (ESRI) (2012), 56% of Irish mothers breastfeed compared to 81% in the United Kingdom (UK). Tarrant (2008) adds that Ireland has a very low breastfeeding initiation rates and high premature cessation rates, with 8% of mothers ceasing breastfeeding in the fifth month, below the six months suggested by World Health Organization (WHO) (2001). While breast milk provides sufficient energy and proteins to meet growing needs of infants up to six months, in Ireland (Northern latitudes), there is insufficient sunlight to stimulate cutaneous synthesis of vitamin D for breast milk (Butte *et al.*, 2002). Therefore, mothers should give infants aged 0-12 months 5µg per day of vitamin D supplements with breast milk (FSAI, 2007).

In Saudi Arabia, the rate of exclusive breastfeeding is low at only 24.4% of 1,801 infants were breastfeed at the age of 6 months, with a majority of working mothers stopping breastfeeding immediately after they return to work (El-Gilany, Shady & Helal, 2011). Moreover, rates of mixed breast and bottle-feeding decreased rapidly from 92% at birth, to 51% at one month and 10% in the sixth month (El-Gilany, Shady & Helal, 2011). According to Mouzan *et al.* (2009), the high numbers of Saudi mothers begin weaning before the sixth month, which risks exposing infants to vitamin D and other important nutrients deficiency according to (WHO, 2001).

2.8.1 Guidelines and recommendations for breastfeed and weaning in Ireland & Saudi Arabia

The Food Safety Authority of Ireland (FSAI) (1999) notes that it is wrong to generalize nutritional needs of infants because each infant needs are unique.

Table 2.5 Guideline and Recommendations for Breastfeed and Weaning in Ireland

	Ireland
A	Mothers should exclusively breastfeed infants for the first six months (FSAI, 1999).
B	Mothers should desist from introducing complementary food before 15 weeks, unless recommended by a medical practitioner (FSAI, 1999).
C	For mothers who are not breastfeeding, formula-based milk should be used in compliance with Standards No. 243 of 1998 (European Communities "Infant Formulae and Follow-on Formulae" Regulations) within the first year (FSAI, 1999).
D	In the case of formula-based milk, weaning should begin in the fourth month, while continuing the formula for one year (FSAI, 1999).
E	In the case of mothers suffering from vitamin D deficiency, mothers should supplement breast milk with 5µg of vitamin D especially during winter's months when vitamin D deficiency is at its highest (FSAI, 1999).

According to EL-Mouzan *et al.* (2009) in Saudi Arabia mothers should start to breastfeed as early as the first hour after delivery and should exclusively breastfeed for six months. Since there is a high prevalence of vitamin D deficiency among Saudi women, it is essential that mothers give infants vitamin D supplements, while mothers should begin weaning at the sixth month, they should continue breastfeeding up to two years to meet the nutritional needs of infants. For mothers who have inadequate milk for the infant, Elsammak, *et al*. (2009) recommends using formula-based milk to supplement breast milk within the first six months.

2.9 Supplementation practice in Ireland and Saudi Arabia

Vitamin D supplementation recommendations were introduced in Ireland in 1999 and the subsequent guidelines for supplementation began in 2007. At the time of the study no recommendations/guidelines for vitamin D supplementation were in place for Saudi Arabia. However, if vitamin D is prescribed it is by US recommendations and not to Saudi Arabia specific needs.

In Ireland, according to Tarrant *et al.* (2011) results from a study of 450 mother-infant pairs recruited from the Coombe Women and Infants University Hospital in Dublin during the period of 2004-2006 revealed that only (1.1%; 5/450) women took vitamin D supplements during their pregnancy, while they found that 4.4% of infants had received vitamin D drops. In Saudi Arabia, a study done by Azhar (2008) on 118 women from Al-Noor hospital -in Makkah revealed that 16.1% of the women in her study took vitamin D supplements.

Possibly one of the best ways in helping to increase compliance of supplementation is to educate mothers about the importance of vitamin D during pregnancy and early infancy.

2.10 Summary of the Literature Review

There are three sources of vitamin D: exposure to sunlight, foods containing vitamin D and supplements. Those most at risk of vitamin D deficiency are pregnant women and infants. The major diseases of vitamin D deficiency are preeclampsia and gestational diabetes in pregnant women and rickets in the child. Vitamin D insufficiency is linked to different cancers, coronary heart disease and hypertension.

The current guidelines for vitamin D supplement in Ireland are 10 µg daily for pregnant women and 5 µg daily for infants, whereas the recommended amount of vitamin D according to FSAI (1999) is 10 µg daily for pregnant women and from 7- 8.5 µg daily for infants (as shown in Table 2.4). The current guidelines for vitamin D supplement in Saudi Arabia are the same as the US (SFDA, n.d) that is 20 µg daily for pregnant women and 10 µg daily for infants. The recommended amount of vitamin D is 15 µg daily for pregnant women and 10 µg daily for infants.

2.11 Aims and Objectives of the research

The main aim of this study was to identify the main behaviors and attitudes towards Vitamin D supplementation and help the investigator develop potential strategies to address the appropriate management of Muslim women in terms of supplementation practice.

The specific study objectives included the following:

1. To identify the prevalence of utilization of vitamin D supplements among Muslim mothers living in Ireland and Saudi Arabia
2. To compare adequacy of vitamin D supplementation practice among Muslim mothers living in Ireland to Muslim mothers in Saudi Arabia.
3. To use the obtained knowledge to increase awareness in Muslim women of childbearing age.

CHAPTER 3 - METHODS

This chapter illustrates the research design and methods that were used in this study. The methodology for the study is largely determined by the aim and specific objectives of the study. This section explains the research methods used with emphasis on study design, selection of the target population, the sampling procedures, the research instruments, data collection techniques and data analysis procedures that were used in this study.

3.1 Ethical Approval

Ethical approval was obtained from the Dublin Institute of Technology Ethics Committee for the study (January 2012) (**Appendix i**). In addition, the fieldworks which was conducted in the Islamic Culture Center of Ireland (ICCI) in Ireland, received permission from Dr. Nooh Al-Kaddo also permission was received from Al-Noor, Hera'a and Maternity and Children Hospitals in Makkah, Saudi Arabia.

3.2 Quantitative Study

To achieve the purpose of the study, a quantitative study was designed and conducted. Borrego, Douglas & Amelink (2009) explains that the main purpose of quantitative research is to enable objective generalization of results of data collected from a study sample to the entire population of interest. A quantitative study was selected because this type of study is reported to provide high levels of reliability which is attributed to the mass surveys as well as the controlled observations (Cohen, Manion & Morrison, 2004). It is the most applicable method when seeking to collect data and deduction that can be generalized to the population being investigated.

3.2.1 Study Design

The design for this study was a quantitative cross-sectional design. Cross-sectional timeframe was preferred because of the time constraints of this study as well as the nature of the research problem which does not require the subjects to be studied over time for the right information to be collected. A cross-sectional study was employed to provide a snapshot of the behaviors and attitudes of Muslim mothers towards vitamin D supplementation and to describe the behaviors as they currently are and therefore match well with a descriptive design whose purpose is to describe the phenomenon exactly as it is and does not require the researcher to manipulate variables that constitute the phenomenon (Trochim, 2006; Gratton & Jones, 2004). Descriptive research seeks to accurately portray the characteristics of situations, events, people or groups (Creswell, 2009). It is usually used to describe the variables that form the phenomenon rather than to test a preconceived relationship between the variables. A descriptive approach was used to collect data on the behaviors and attitudes of Muslim mothers towards vitamin D supplementation.

An advantage of the survey questionnaire is that is allows large numbers of subjects located in different area to be studied. Muijis (2004) explains that survey strategy has one main advantage over other designs such as experimental. That is, it allows multiple variables to be explored simultaneously. A survey strategy is also an effective design for quantitative studies especially when survey questionnaire is employed for data collection. As such, it is applicable to this study.

3.2.2 Selection of Sample

The study sites comprised of four sites one in Ireland: the Islamic Cultural Centre of Ireland (ICCI), Clonskeagh, Dublin 14, and three sites in Makkah, Saudi Arabia Al-Noor Hospital, Hera'a Hospital and Maternity and Children's Hospital. The study subjects were mothers with a child between 0-3 years of age living in Ireland or living in Saudi Arabia who attended the selected sites either for religious purposes (Ireland) or for routine care (Saudi Arabia).

The Islamic Cultural Centre of Ireland (ICCI), established by his highness Sheikh Hamdan Bin Rashid Al Maktoum's in 1996 is a distinguished landmark and an elite Islamic edifice in Europe as a whole. The ICCI is not just a Mosque; however it is a centre point for the whole community, offering many services including marriage services facilitation, translation services of books, marriage certificates etc from English into other languages, it offers periodic exhibitions, cultural and sporting events and Youth training for various sports (ICCI, 2002-2012). The site was chosen because of the large population of the target population that attends (ICCI) and the fact it has a child care center.

Hera'a Hospital was established in 1984 and currently it offers a complete continuum of healthcare. The priority areas of Hera'a Hospital is to serve the society with the best healthcare services of which are medical, women's, children's and surgical services (Hera'a Hospital,2008).

Because of knowing doctors in these selected medical facilities, this helped the researcher to perform the fieldwork there more easily and also because the hospitals have public health clinics that serve the target population. This provided an adequate convenience sample and also was a good representation and cross-section of Muslim mothers and children in Saudi Arabia.

3.2.3 Sampling Technique

Convenience sampling was used to identify the sites of the study. To increase the study population the snowball sampling method was employed. Snowball sampling is a method typically used with unknown populations. In such cases, members of these target populations have not all been previously identified and are more difficult to locate or contact than known populations (Spreen, 1992). Usually one subject or the initial contact gives the investigator the name of another subject, who in turn provides the name of a third, and so on (Vogt, 1999). In this way more subjects are recruited (usually friends and acquaintances) who fit the study selection criteria.

Atkinson & Flint (2001) explains that this sampling method is preferred because of its success in identifying individuals from unknown (and potentially very large) populations beyond any known segments of the population and it is cost effective. However one major limitation of the snowball sampling method is the sample obtained is not often representative of the population as not every subject has equal chance of forming the sample. This creates challenges in generalization of the findings. One way to minimize the sample selection bias is by obtaining a large sample size (Atkinson & Flint, 2001; Tsvetovat & Sharabati, 2006).

3.2.4 Recruitment into Study

At the ICCI in Dublin a notice explaining the research was placed in the women's section and the mothers were recruited by direct invitation and by snowballing. Mothers who agreed to take part in the study a suitable appointment was made with them. Women attending the ICCI came from Dublin and other urban centers of Ireland.

In the Saudi Arabian hospitals mothers attending clinics were directly invited to participate in the study. Mothers who agreed to take apart in the study a suitable appointment was made with them. Al-Noor and Hera'a are both general hospitals, while the Maternity and Children hospital is just for maternity and children. All of these hospitals are public. Women attending these clinics came from all parts of the city and therefore represented all socio-economic groups.

Seventy seven Muslim mothers living in Ireland and one hundred and twenty one Muslim mothers living in Saudi Arabia agreed to take apart in this study. Prior to taking part in the study, all participants signed an informed consent statement (see **Appendix ii - English, Appendix (A) - Arabic, Appendix (B)**) and information sheet (see **Appendix iii - English, Appendix (A) - Arabic, Appendix (B)**) read to them or were allowed to read it on their own.

Selection Criteria

Study subjects who agreed to give their consent and who met the selection criteria were recruited for the study and no financial incentive was offered since their participation was voluntary in nature.

Inclusion criteria

The criteria that was applied in the selecting sample was;

1. Muslim mothers who agreed to give informed consent to participate in the study were recruited during this period (February 1, 2012 and March 1, 2013)
2. Muslim mothers with children less than three years of age.
3. Muslim mothers residing in Ireland and Saudi Arabia.
4. Minimum age of 18 years and above.
5. Subjects must be practicing Muslims.

Exclusion criteria

1. Muslim mothers who refused to give informed consent to participate in the study
2. Muslim mothers who did not reside in Ireland or Saudi Arabia within three to six months prior to the study start (February 1, 2012).
3. Muslim mothers who were below 18yrs (since these are minors)
4. Individuals with pre-existing condition affecting vitamin D and/or calcium metabolism including liver or kidney disease, eating disorders, skin diseases and who used oral corticosteroids, anticonvulsants, insulin or bisphosphonates.

3.2.5 Questionnaire Design

A questionnaire is a formalized list of questions that are used to collect information from respondents (Balnaves & Caputi , 2001). Most researchers adopt questionnaire tool for data collection as it is economical, they can be easily completed and are easy to analyze (Bowling, 2009). With a questionnaire, one can easily make comparisons of data collected from the different groups being studied (Balnaves & Caputi, 2001). Usually a questionnaire is used to collect data from a sample that is selected using a random method and as such, provides data that can be related to the population of interest with a high degree of certainty. Structured questionnaires use standardized questions which make it possible for researchers to make precise measurements by subjecting the respondents to uniform definitions (Balnaves &Caputi, 2001). Standardization also allows comparative interpretation of data collected from different groups. Muijs (2004) also notes that the design of questionnaire provides findings that are high in reliability. However one limitation of a questionnaire with structured questions is that it limits the depth of participation and consequently the quality of data collected (Bowling, 2002).

For this research, the researcher used an interview-assisted questionnaire to gather the necessary data. The questionnaire was divided into four sections (see **Appendix iv - English, Appendix (A) - Arabic, Appendix (B)** for full questionnaire), the first section provided information about the mother's health during pregnancy which includes (mother's health status during pregnancy, information on their supplementation during pregnancy and their diet, information on the child and whether the child had received vitamin D supplementation), the second section provided information on their practices such as sun exposure which includes (time spent outside, clothing practice, sunscreen use and tanning), the third section provided information on breastfeeding practices which includes (feeding methods that were used, weaning age and the first foods that were introduced to the baby), the last section provided information on mothers socio-economic status which includes (their age, and education level, employment, marital status, nationality and gender of baby).

The survey instrument was translated into Arabic, the language most locals can read and understand in these areas. All mothers were offered the questionnaire in Arabic and English.

3.2.6 Pilot Study

A pilot study was undertaken before the commencement of fieldwork. This was important to check for reliability and quality of the tool (Balnaves & Caputi , 2001). In this study, the questionnaire tool was piloted amongst a group of Irish mothers (n=5). This group was asked to complete the questionnaire and to comment on the content and whether there were questions which were not needed or which were not clear to them. Wall, DeHaven & Oeffinger (2002) argues that piloting of questionnaires is important as it ensures that questions are worded clearly, that they are appropriate for the target population and that there are no redundant questions/items. The feedback from the pilot study helped in coming up with a refined standardized tool so that the questions are clear and concise and the tool is clear (Boynton & Greenhalgh , 2004). Any errors, inconsistency and any changes needed in the questionnaire were made appropriately.

3.2.7 Maximizing the Response Rate

Structured or closed questions are meant to save the respondents' time and get definitive answers. In this study strategies to adopt a maximum response included keeping the question as short as possible with a simple lay-out, the questions were numbered. At the same time the respondents were allowed enough time to respond to the questions as per the duration given. The survey questionnaire also provides greater uniformity across research situations as respondents respond to the same standardized questions.

3.2.8 Data Management and Analysis

3.2.8.1 Data Handling

In order to complete the questionnaire the researcher conducted a face to face interview with the selected subjects and the data was entered directly into the iPad software survey (Quick Tap Survey) from iPad Apple store www.quicktapsurvey.com (**Appendix v**). The 'Quick Tap Survey' data was automatically stored in an excel spreadsheet. The use of the iPad software helped in reducing human error that could arise from data entry of paper form questionnaires and was a convenient back up mechanism. Data quality control and cleaning commenced in the field by the researcher ensuring that all the information had been properly collected, recorded and checked for completeness of data and consistency. In Saudi Arabia written questionnaire was given in addition to using the iPad.

3.2.8.2 Closed question: Developing a coding frame

Coding of the quantitative data usually involves numerical coding. As described by Bowling (2009), the basic rules for development of a coding scheme were followed. Numerical codes were given to all items in the questions on the questionnaire. In a situation that requires the respondent to specify or mention the exact answer then items were coded according to the main themes identified from the answer.

3.2.8.3 Data Analyses

According to Flick *et al.* (2004) after data has been collected, it needs to be presented in a way that communicates the information and enables conclusions to be drawn. In this study data from the questionnaires spreadsheet was imported into the Statistical package for the Social Sciences (SPSS version17) software by the researcher.

Descriptive statistics of categorical variables was conducted to determine the general trend and to provide a summary of data collected and these results were presented in the form of frequencies (percentages), proportions, means and SD as appropriate. In addition, descriptive statistics and frequencies were used to check data consistency and to identify outliers which may have resulted in incorrect data entry.

Cross-tabulations and Chi-square statistical tests were performed as outlined in Field (2009) to determine associations between categorical variables in the two study sites. Where associations were being evaluated between two dichotomous variables then

Yate's continuity correction was applied. The level of statistical significance was fixed at ($p < 0.05$).

CHAPTER 4 - RESULTS

This chapter presents the characteristics of the study population, feeding method and weaning practices, as well as vitamin D supplementation practices during pregnancy and infancy. The total number of respondents consisted of (n=198) Muslim mothers of which 38.8% (n=77) were living in Ireland and 61.1 % (n=121) in Saudi Arabia.

4.1 Social and demographic characteristics of the sample

The social and demographic characteristics of the sample of Muslim mothers from both Ireland and Saudi Arabia are described in Table 4.1. No differences were found in age, education level attained between mothers from both regions. A significantly higher proportion of Muslim mothers in Ireland were students (42%) compared to Muslim mothers in Saudi Arabia (2%) ($P<0.001$). Differences were also seen in both their husband's education level with higher educational attainment seen among the husband's of Muslim mothers in Ireland (86% versus 48% of husbands of Saudi mothers) ($P<0.001$) and in employment status with 13% of husbands in Ireland being students compared to none of the Saudi husbands being students ($P< 0.001$) (Table 4.1).

Table 4.1 Comparison of the Muslim mother's and fathers social and demographic characteristics in Ireland and Saudi Arabia

Social and demographic characteristics	**Ireland (n=77) %(n)**	**Saudi Arabia (n=121) % (n)**	**Significance *P* value[1*]**
Mothers age (years)			
25 or less	32.5 (25)	19.0 (23)	
26-35	58.4 (45)	66.1 (80)	
36-45	7.8 (6)	14.0 (17)	
46 or above	1.3 (1)	0.8 (1)	0.13
Mothers educational level			
Primary school	5.2 (4)	8.3 (10)	
Secondary school	20.8 (16)	28.1 (34)	
Higher education	74.0 (57)	63.6 (77)	0.30
Fathers educational level			
Primary school	0.0 (0)	6.6 (8)	
Secondary school	11.7 (9)	30.6 (37)	
Higher education	85.7 (66)	47.9 (58)	0.00
Employment status of mothers			
House wife	54.5 (42)	46.3 (56)	
Employed	3.9 (3)	51.2 (62)	
Student	41.6 (32)	1.7 (2)	
Retired	0.0 (0)	0.8 (1)	0.00
Employment status of fathers			
Employed	80.5 (62)	79.3 (96)	
Unemployed	2.6 (2)	5.8 (7)	
Student	13.0 (10)	0.0 (0)	
Retired	1.3 (1)	0.0 (0)	0.00
Marital status			
Married	97.4 (75)	85.1 (103)	
Divorced	2.6 (2)	7.4 (9)	
Separated	0.0 (0)	5.0 (6)	
Widowed	0.0 (0)	2.5 (3)	0.37
First child $^{\Omega}$			
Yes	44.2 (34)	28.1 (34)	
No	55.8 (43)	71.9 (87)	0.03
Gender of baby $^{\Omega}$			
Female	46.8 (36)	41.3 (50)	
Male	53.2 (41)	58.7 (71)	0.54
Type of delivery			
Normal delivery	87.0 (67)	81.0 (98)	
Caesarean delivery	13.0 (10)	19.0 (23)	0.36

[1]Pearson's chi-square test used to determine differences *Significant $p<0.05$
$^{\Omega}$ Differences were assessed using Yate's continuity correction

While the vast majority of the Saudi mothers were Saudi Nationals (104/121), the number of Muslim mothers in Ireland that were Saudi Nationals was less 50% (36/77) (Figure 4.2A). The samples of Muslim mothers in Ireland were from a wide range of Muslim countries (Figure 4.2A).

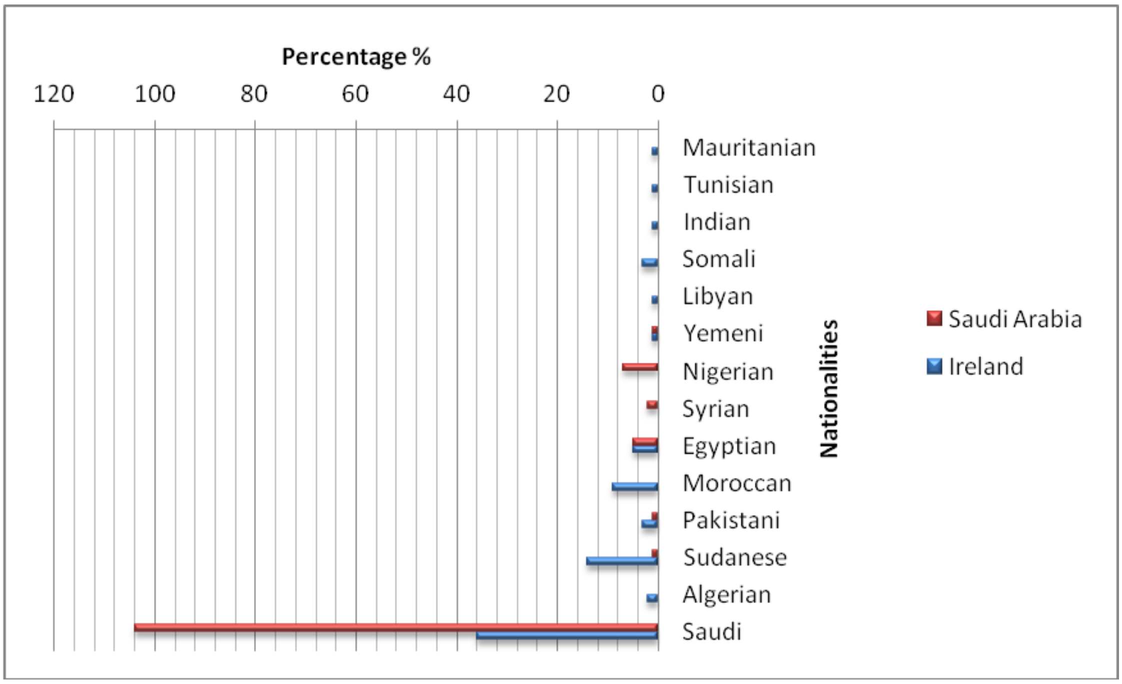


Figure 4.2A Nationalities in Ireland and Saudi Arabia

4.2 Duration in Ireland among the Irish cohort Muslim mothers

In order to be able to explore acculturation and its possible influence on supplementation practices, duration in Ireland among the Muslim mothers in the Irish cohort was measured. Just over half the Muslim mothers in Ireland had spent over 3 years in Ireland while over one quarter of them had been in Ireland for less than a year (Table 4.3). No differences were noted among time spent in Ireland and supplementation practices during pregnancy and infancy (p=0.81) and (p=0.94) respectively (data not shown).

Table 4.3 Duration in Ireland (years) among the Irish cohort Muslim mothers (n=77)

Time (years)	**Ireland % (n)**
>3	50.6 (39)
1 to 2	22.1 (17)
<1	27.3 (21)

4.3 What Dairy Products are consumed?

Vitamin D arising from the diet was examined by determining the main food sources of Vitamin D including dairy foods and oily fish. A large majority of the Muslim mothers in Ireland consume fresh milk and yoghurt regularly which contrasts with the Muslim mothers in Saudi Arabia who are more likely to consume powdered milk (Table 4.4). Three times more of the Muslim mothers in Ireland were regular consumers of butter compared to those mothers in Saudi Arabia.

Table 4.4 Dairy product consumption among Muslim women in Ireland and Saudi Arabia (%)

Kind of dairy products mothers usually consume	**Ireland (n=77) % (n)**	**Saudi Arabia (n=121) % (n)**
Fresh milk	92.2 (71)	45.8 (43)
Powdered/dried milk	22.1 (17)	57.6 (69)
Soya milk	1.3 (1)	0.0 (0)
Yoghurt	77.9 (60)	68.6 (83)
Low fat cheese	14.3 (11)	14.9 (18)
High fat cheese	41.6 (32)	25.6 (31)
Butter or dairy spreads	37.7 (29)	12.4 (15)
Cream or Ice cream	42.9 (33)	38.8 (47)

Percentages do not add up to 100 because some mothers gave more than one answer

4.4 Consumption of dairy products

Table 4.5 illustrates that the vast majority of mothers from both Saudi Arabia (86.8%) and Ireland (94.8%) consume dairy products every day.

Table 4.5 Consumption of dairy products

	Ireland (n=77) % (n)	Saudi Arabia (n=121) % (n)
Every day	94.8 (73)	86.8 (105)
Once a week	3.9 (3)	6.6 (8)
Rarely	1.3 (1)	6.6 (8)

4.5 Consumption of oily fish

Data were collected from mothers from Ireland (n=53) and Saudi Arabia (n=78) regarding the frequency of their consumption of fish (Table 4.6). Just 18.8% of Muslim mothers in Ireland and 37% of Muslim mothers in Saudi Arabia were consuming oily fish more than once per week.

Table 4.6 Consumption of oily fish consumed by mothers in Ireland and Saudi Arabia

	Ireland (n=53) % (n)	Saudi Arabia (n=78) % (n)
More than three times a week	1.9 (1)	3.8 (3)
Three times a week	1.9 (1)	12.8 (10)
Twice a week	15.0 (8)	20.5 (16)
Once a week	64.2 (34)	61.5 (48)
Less than once a week	17.0 (9)	1.3 (1)

4.6 Breastfeeding initiation

In order to get a fuller picture of vitamin D intake in infancy, mothers were asked about their early feeding practices. This included whether they were breastfed or formula fed and when they weaned their infant. Table 4.7 shows that the vast majority of Muslim mothers initiated breastfeeding in both Ireland and Saudi Arabia (92.2% and 88.4% respectively).

Furthermore, there was no significant difference in choice of feeding method between both countries. It is also significant to note that majority of the mothers who initiated breastfeeding were women of higher education level (data not shown).

Table 4.7 Breastfeeding initiation rates (%)

Feeding methods	**Ireland (n=77) % (n)**	**Saudi Arabia (n=121) % (n)**	**Significance *P* value** $^{\Omega*}$
Initiated breastfeeding	92.2 (71)	88.4 (107)	
Formula milk	7.8 (6)	11.6 (14)	0.53

$^{\Omega}$ Differences were assessed using Yate's continuity correction for a 2X2 cross-tabulation *Significant p<0.05

4.7 The prevalence of women who were still breastfeeding their babies at the time of the interview

No significant difference was noted in the breastfeeding mothers at the time of the interview (Table 4.8). A majority of Muslim mothers from Ireland (57.1%) and Saudi Arabia (59.5%) were no longer breastfeeding at the time of the interviews. However, those who were still breastfeeding at the time of the interview were mothers of higher educational attainment and most of them were also housewives (data not shown).

Table 4.8 Women who still breastfeeding their babies at the time of the interview

Still breastfeeding	**Ireland (n=77) % (n)**	**Saudi Arabia (n=121) % (n)**	**Significance *P* value** $^{\Omega*}$
Yes	42.9 (33)	40.5 (49)	
No	57.1 (44)	59.5 (72)	0.68

$^{\Omega}$ Differences were assessed using Yate's continuity correction
*Significant p<0.05

4.8 The average age (weeks) of the babies at the time of the interview

There was no significant difference between the mean age of babies from Ireland and Saudi Arabia (*p*=0.26).

Table 4.9 The average age (weeks) of the babies at the time of the interview

Ireland (n=77) mean±SD	**Saudi Arabia (n=121) mean±SD**	**Significance *P* value[1*]**
61.7 ± 33.9	70.2 ± 26.6	0.26

[1]Pearson's chi-square test used to determine differences [*] Significant p<0.05

4.9 Weaning age

No significant difference in weaning age was found between Irish cohort Muslim and Saudi infant (Table 4.10). A majority of mothers in Ireland (80%) and Saudi Arabia (62.6%) introduced food to their infant at the appropriate time between 4 to 6 months of age. However, while over a third of mothers in Saudi Arabia (36.5%) weaned later than this, half of this proportion (18.5%) did so in Ireland.

Table 4.10 Age at which infant was weaned (months)

Weaning age	**Ireland (n=65) % (n)**	**Saudi Arabia (n=115) % (n)**	**Significance *P* value[1*]**
< 4	1.5 (1)	0.9 (1)	
4 to 6	80.0 (52)	62.6 (72)	
7 to 9	12.3 (8)	20.0 (23)	
10 or above	6.2 (4)	16.5 (19)	0.07

[1]Pearson's chi-square test used to determine differences
*Significant p<0.05

Data was also gathered as to what weaning foods mothers gave their child (Figures 4.3 A and Figure 4.3 B). Thirty-percent of mothers from Saudi Arabia gave mashed vegetables to their child as a first food. Cerelac (cereal rice) was also given by as many as 29% of the mothers in Saudi Arabia (Figure 4.3 A).

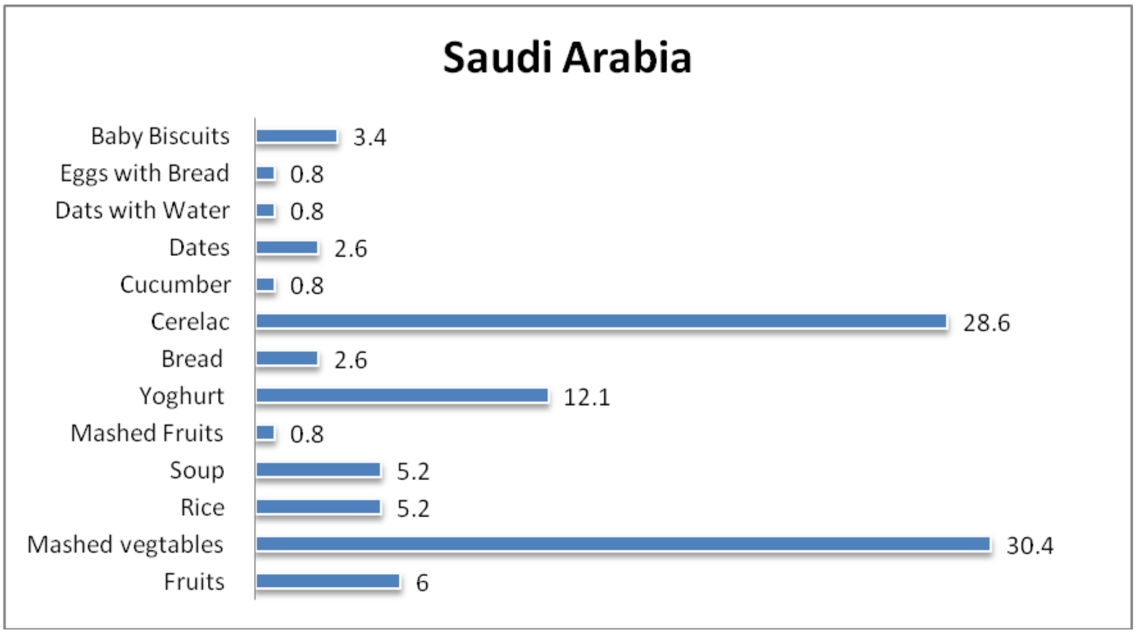


Figure 4.3A weaning foods in Saudi Arabia

In Ireland, baby rice was given by 32% of the mothers when weaning their children while mashed vegetables was given by 18% of mothers as a first food in the weaning diet (Figure 4.3 B).

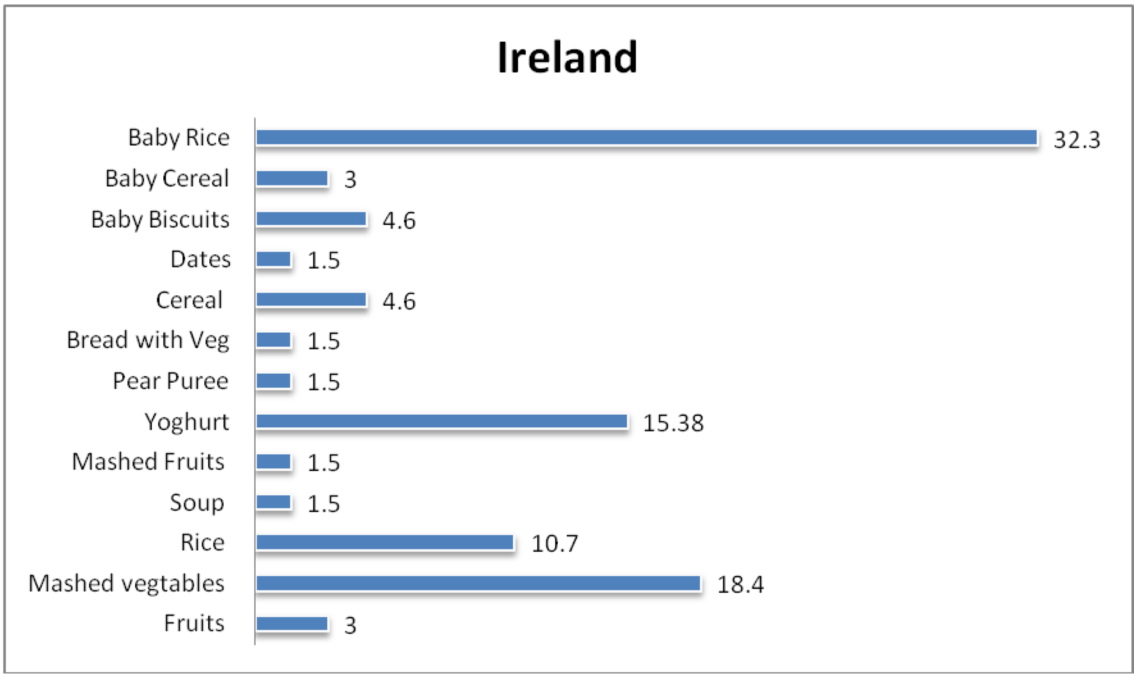


Figure 4.3 B Weaning foods in Ireland

4.10 The status of mothers exposure to sunlight

An important contributor to vitamin D status is exposure to sunlight. The differences in factors concerning the status of mothers' exposure to sunlight are outlined in Table 4.11 There was no difference (*p*=0.47) in self-assessed skin color between mothers in Ireland and Saudi Arabia with most respondents (66% and 64% in Ireland and Saudi respectively) considering their skin to be medium colored.

While a majority of mothers from Ireland (40.2%) and Saudi Arabia (37.2%) reported spending more than 30 minutes a day outside a considerable proportion of mothers in Saudi (29.8%) spent no time outside at all. Furthermore, almost (44%) of the Irish Muslim mothers spent 15 minutes or less outside per day. This was a considerably lower proportion of mothers compared to Saudi mothers where (59.5%) were spending just 15 minutes or less outside (*p*=0.01).

Almost all mothers in both countries wore clothing on their hair and bodies while approximately 25% in both countries tended to wear sunglasses outside. The self-reported reaction of exposed skin to sunlight was also not deemed significant (*p*=0.61) with 67.5% of mothers in Ireland and 69.4% of Saudi mothers reporting that they tan easily.

Table 4.11 the status of mothers' exposure to sunlight

	Ireland (n=77) % (n)	**Saudi Arabia (n=121) % (n)**	**Significance *P* value[1*]**
Skin color[2]			
Light	24.7 (19)	21.5 (26)	
Medium	66.2 (51)	63.6 (77)	
Dark	9.1 (7)	14.9 (18)	0.47
Time spent outside per day (minutes/day)			
None	15.6 (12)	29.8 (36)	
Less than 5	6.5 (5)	9.1 (11)	
5-15	22.1 (17)	20.6 (25)	
15-30	15.6 (12)	3.3 (4)	
More than 30	40.2 (31)	37.2 (45)	0.01
Clothing worn outside[§]			
Covering arms and legs	100.0 (77)	100.0 (121)	
Covering hair	96.0 (74)	99.1 (120)	
Sunglasses	27.3 (21)	26.4 (32)	0.31
Sunscreen use			

Never	41.5 (32)	33.1 (40)	
Just summer	44.2 (34)	53.7 (65)	
Summer and winter	14.3 (11)	13.2 (16)	0.40
Exposed skin reaction[2]			
Burn then peel	24.7 (19)	19.8 (24)	
Tan easily	67.5 (52)	69.4 (84)	
Burn then tan	7.8 (6)	10.7 (13)	0.61

[1]Pearson's chi-square test used to determine differences

[*]Significant p<0.05 [2]Self-perceived

[§]Percentages do not add up to 100 because some mothers gave more than one answer

4.11 Mother's health status during pregnancy in Ireland and Saudi Arabia

The health status of the study participants was also assessed. No differences were reported between mothers in both countries with regard to their health status and clinical conditions such as gestational diabetes and preeclampsia (Table 4.12). A similar proportion of mothers in Ireland (15.6%) and Saudi (14.0%) reported having gestational diabetes during their pregnancy. Furthermore, a tiny minority of mothers 2.6% and 3.3% in Ireland and Saudi Arabia respectively, regarded their health as poor or very poor.

Table 4.12 Comparison of the Muslim mothers' health during pregnancy characteristics in Ireland and Saudi Arabia

	Ireland (n=77) % (n)	**Saudi Arabia (n=121) % (n)**	**Significance *P* value[1*]**
Health status during pregnancy[2]			
Excellent	23.4 (18)	29.8 (36)	
Good	59.7 (46)	57.9 (70)	
Fairly good	14.3 (11)	9.0 (11)	
Poor	2.6 (2)	2.5 (3)	
Very poor	0.0 (0)	0.8 (1)	0.64
Clinical conditions during pregnancy [Ω]			
Gestational diabetes			
Yes	15.6 (12)	14.0 (17)	
No	84.4 (65)	86.0 (104)	0.92
Preeclampsia			
Yes	5.2 (4)	3.3 (4)	
No	94.8 (73)	96.7 (117)	0.77

[1] Pearson's chi-square test used to determine differences

[Ω] Differences were assessed using Yate's continuity correction

*Significant p<0.05

[2]Self- perceived

4.12 Use of supplements during pregnancy

The next 5 sections present results on supplementation practices. Firstly, results on general supplementation by the mother during pregnancy are presented and then sections on Vitamin d supplementation during pregnancy and infancy. While 80.5% of Muslim mothers in Ireland took a supplement during pregnancy just 36.4% of Saudi mothers did so (P<0.001) (Table 4.13). Significant differences were also seen in supplements of folic acid, iron, calcium and vitamin D (P<0.001). Indeed Muslim mothers in Ireland were four times more likely to take a vitamin D supplement during pregnancy compared to Saudi mothers (28.6% v 7.4%) (P<0.001).

Table 4.13 Use of supplements during pregnancy

	Ireland (n=77) % (n)	**Saudi Arabia (n=121) % (n)**	**Significance *P* value[1*]**
Use supplements during pregnancy $^{\Omega}$			
Yes	80.5 (62)	36.4 (44)	
No	19.5 (15)	63.6 (77)	0.00
Supplements use			
Vitamins			
Folic acid	42.8 (33)	19.8 (24)	
Minerals			
Iron	49.3 (38)	25 (30)	
Calcium	35.1 (27)	12.3 (15)	
Zinc	0.0 (0)	0.8 (1)	
Pregnacare**	23.4 (18)	0.0 (0)	0.00
Vitamin D supplements during pregnancy $^{\Omega}$			
Yes	28.6 (22)	7.4 (9)	
No	71.4 (55)	92.6 (112)	0.00
Cod liver oil or Omega-3 fatty supplements $^{\Omega}$			
Yes	14.3 (11)	18.2 (22)	
No	85.7 (66)	81.8 (99)	0.60

[1] Pearson's chi-square test used to determine differences
** Multi-vitamin supplement specially for pregnancy
$^{\Omega}$ Differences were assessed using Yate's continuity correction
*Significant p<0.05

4.13 Source of information on vitamin D supplementation in pregnancy among those who took supplements in pregnancy

In both countries doctors were overwhelmingly the principal sources of information (Table 4.14).

Table 4.14 Sources of information on vitamin D supplementation in pregnancy among those who take supplements in pregnancy

	Mothers took vitamin D supplements in Ireland yes (n=22) % (n)	**Mothers took vitamin D supplements in Saudi Arabia yes (n=9) % (n)**
Doctor	95.4 (21)	88.8 (8)
Nurse	9.0 (2)	0.0 (0)
Internet	9.0 (2)	11.1 (1)
Family	4.5 (1)	0.0 (0)
Friends	0.0 (0)	11.1 (1)
Oneself	4.5 (1)	0.0 (0)

Percentages do not add up to 100 because some mothers gave more than one answer

4.14 Awareness of recommendations to give baby vitamin D drops for the first 12 months

Significant inter country differences were seen in the mothers awareness of vitamin D supplementation practices to infants. A majority of mothers from Ireland (62.3%) know about the recommendations of giving infants vitamin D drops, just 37.2% of Saudi mothers did so (P<0.001) (Table4.15).

Table 4.15 Awareness of recommendations to give baby vitamin D drops for the first 12 months

Mothers heard about recommendations to give baby vitamin D drops	**Ireland (n=77) % (n)**	**Saudi Arabia (n=121) % (n)**	**Significance *P* value $^{\Omega*}$**
Yes	62.3 (48)	37.2 (45)	0.00
No	37.7 (29)	62.8 (76)	

$^{\Omega}$ Differences were assessed using Yate's continuity correction
*Significant p<0.05

4.15 Vitamin D supplementation for infants in the first year of life.

While a majority of mothers from Ireland (62.3%) and Saudi Arabia (37.2%) know about the recommendation of giving infants vitamin D drops, just 49.4 % from Ireland and 13.2% from Saudi gave their infant vitamin D drops (P<0.001) (Table 4.16).

Table 4.16 Vitamin D supplementation for infants in first year

	Ireland (n=77) % (n)	**Saudi Arabia (n=121) % (n)**	**Significance *P* value***
Yes	49.4 (38)	13.2 (16)	
No	50.6 (39)	86.8 (105)	0.00

* Differences were assessed using Yate's continuity correction

4.16 Sources of information on giving vitamin D supplementation to infants during their first year.

Table 4.17 illustrates the main sources of information regarding vitamin D supplementation to infants up to one year of age among those who were currently or had supplemented their baby with vitamin D drops. The main source of information on vitamin D was provided by doctors with 46.8% of mothers in Ireland and 29.8% of Saudi mothers getting information on recommendations to supplement their infant with vitamin D to one year of age. Other important sources of information were the television for mothers in Ireland (13%) and the Internet for both countries (9.1% and 7.4% for mothers in Ireland and Saudi respectively).

Table 4.17 Sources of information on giving vitamin D supplements to the infant in the first 12 months among those who had or were giving vitamin D supplement to their baby

	Mothers heard about the recommendations to give baby vitamin D drops in Ireland (n=48) % (n)	**Mothers heard about the recommendations to give baby vitamin D drops in Saudi Arabia (n=45) % (n)**
Health professional		
Doctor	46.8 (36)	29.8 (36)
Nurse	3.9 (3)	0.8 (1)
Others		
Book/Magazine	5.2 (4)	3.3 (4)
T.V	13.0 (10)	6.6 (8)
Internet	9.1 (7)	7.4 (9)
Family and Friends		
Mother	5.2 (4)	9.1 (11)
Sister	2.6 (2)	5.8 (7)

Family	3.9 (3)	7.4 (9)
Relatives	7.8 (6)	9.9 (12)

Percentages do not add up to 100 because some mothers gave more than one answer

4.17 Muslim mothers knowledge about vitamin D

No difference was seen between Muslim mothers in Ireland and Saudi in their knowledge about vitamin D giving protection against rickets (*p*=0.38) (Table 4.18). A majority of mothers from both countries either agreed or totally agreed that vitamin D was protective against rickets, however as many as one fifth of mothers in both countries were unsure.

There was also no significant difference in the knowledge of mothers from both cohort about vitamin D reducing the risk of cancer (*p*=0.25). The majority of mothers from Ireland and Saudi Arabia did not know about this claim (Table 4.18).

A significant difference (*p*=0.04) was found in the knowledge of mothers in Ireland and Saudi Arabia regarding the statement that vitamin D may prevent heart diseases with Saudi mothers much more likely to agree or totally agree (31.4%) with this compared to just 13% of Irish cohort Muslim mothers.

There was no significant difference (*p*=0.28) in the knowledge of mothers about vitamin D regarding making bones healthy with the majority of mothers from both Ireland and Saudi Arabia agreeing or totally agreeing with this.

A significant difference (*p*=0.01) was noted among mothers who said that vitamin D might reduces the risk of Multiple Sclerosis with Saudi mothers twice as likely to agree or totally agree with this compared to Irish cohort Muslim mothers. Similar to many of the other factors, a very large percentage of respondents were unsure about it (Table 4.18).

Table 4.18 Muslim mothers' knowledge about vitamin D

	Ireland (n=77) % (n)	**Saudi Arabia (n=121) % (n)**	**Significance *P* value[1*]**
Giving children vitamin D protects them against rickets			
Totally agree	28.6 (22)	34.7 (42)	
Agree	49.4 (38)	38.8 (47)	
Disagree	1.3 (1)	5.0 (6)	
Totally disagree	0.0 (0)	0.8 (1)	
Don't know	20.7(16)	20.7 (25)	0.38
Taking vitamin D reduces cancer risk			
Totally agree	6.5 (5)	13.2 (16)	
Agree	22.1 (17)	20.7 (25)	
Disagree	5.2 (4)	11.6 (14)	
Totally disagree	3.9 (3)	2.5 (3)	
Don't know	62.3 (48)	52.0 (63)	0.25
Taking vitamin D may prevent heart disease			
Totally agree	3.9 (3)	10.7 (13)	
Agree	9.1 (7)	20.7 (25)	
Disagree	9.1 (7)	10.7 (13)	
Totally disagree	2.6 (2)	1.7 (2)	
Don't know	75.3 (58)	56.2 (68)	0.04
Taking vitamin D helps to increase muscle strength			
Totally agree	22.0 (17)	24.8 (30)	
Agree	42.9 (33)	47.9 (58)	
Disagree	2.6 (2)	4.9 (6)	
Totally disagree	1.3 (1)	1.7 (2)	
Don't know	31.2 (24)	20.7 (25)	0.52
Taking Vitamin D makes bones healthy			
Totally agree	55.8 (43)	42.1 (51)	
Agree	35.1 (27)	47.1 (57)	
Disagree	1.3 (1)	0.8 (1)	
Totally disagree	0.0 (0)	0.0 (0)	
Don't know	7.8 (6)	10.0 (12)	0.28
Taking vitamin D reduces the risk of Multiple Sclerosis (MS)			
Totally agree	5.2 (4)	14.0 (17)	
Agree	7.8 (6)	12.4 (15)	
Disagree	1.3 (1)	6.6 (8)	
Totally disagree	0.0 (0)	2.5 (3)	
Don't know	85.7 (66)	64.5 (78)	0.01

[1]Pearson's chi-square test used to determine differences

*Significant $p<0.05$

4.19 Main results summary

Vitamin D intakes arising from exposure to sunlight, diet and supplements is sub-optimal especially among the Muslim mothers in Saudi Arabia where supplementation practice in pregnancy and infancy were as low as 7.4% and 13.2% respectively.

CHAPTER 5 – DISCUSSION and RECOMMENDATIONS

5.1 The Sample and recruitment procedure

The sample was made up of Muslim mothers living in Ireland and Saudi Arabia. The recruitment procedure differed between locations due to the fact that in Ireland, Muslims are a small minority population while in Saudi Arabia they the majority. Thus, in Ireland recruitment was through the ICCI in Clonskeagh which serves as not only a place of worship but also offering many services including marriage services facilitation, translation services of books, marriage certificates etc from English into other languages. It offers periodic exhibitions, cultural and sporting events and Youth training for various sports. In Saudi Arabia recruitment was through a number of hospitals which are representative of different socio-economic levels located in Makkah. In both locations convenience sampling was used for recruitment. The snowball method was also employed. Snowball sampling is a method typically used in studies when subjects are hard to locate (Spreen, 1992). The samples differed primarily by education level with higher educational attainment seen among the mothers in Ireland (74% versus 63.6% of Saudi mothers). The majority of the Muslim mothers in Ireland was housewives or students (96.1%; 74/77) compared to mothers in Saudi Arabia were most of them were also housewives or employed (97.5%; 118/121). The higher proportion of students among the sample in Ireland is to be expected as that represents one of their main reasons for leaving their country and coming to Ireland.

5.2 Supplementation practices during pregnancy

Supplementation of micronutrients amongst Muslim mothers during their pregnancy in Ireland was much higher compared to Saudi Arabia. In the present study, 80.5% of the Irish cohort of Muslim mothers took supplements during their pregnancy. The most common supplements consumed amongst Irish cohort Muslim women were iron, folic acid and calcium. This result is consistent with the finding presented by Tarrant *et al.* (2011) that reported a high prevalence of notional supplementation was used among the pregnant women in Dublin, Ireland. A far lower consumption of supplements was seen among mothers in Saudi Arabian with only 36.4% taking supplements. This is consistent with the finding presented by Azhar (2008), which indicated that only 29.7% of the women in Makkah, Saudi Arabia used supplements, 31% of those were pregnant women. In public hospitals in Saudi Arabia, gynecologists prescribe folic acid for the mother for the first three months of pregnancy and recommended additional supplements if the blood tests show they are necessary (Azhar, 2008). The differences seen in supplementation practices during pregnancy between Ireland and Saudi Arabia probably reflect differences in culture as well as recommendations from health professionals.

5.3 Vitamin D supplementation practices during pregnancy

Of the Muslim mothers interviewed in Ireland (n=77), almost 28.6% reported taking a vitamin D supplement during their pregnancy. This follows the recommendation for pregnant women in Ireland to take 10µg per day in order to make up for the absence of sunlight (FSAI, 1999). This intake of 10µg per day ensures optimal fetal health and vitamin D status for the mother and fetus. In spite of the recommendation to supplement with vitamin D during pregnancy, the present study showed a low intake of vitamin D supplementation during pregnancy among Irish cohort Muslim mothers, which may explain vitamin D deficiency among Irish women (Hill *et al.*, 2006). This study is consistent with the findings reported by Muldowney (2010), that indicated 19% of expectant mothers in Cork, Ireland had serum $25(OH)_2D3$ levels below 25 nmol/L and 70% of the expectant mothers had levels <50 nmol/L which is considered as insufficient. In this study vitamin D supplementation among the mothers in Saudi Arabia (n=121) during pregnancy was uncommon with only 7.4% of them taking vitamin D supplements. This percentage revealing that the vast majority are not supplementing with vitamin D during pregnancy is consistent with the findings reported by Elidrissy, Sedrani, and Lawson (2006), which indicated extremely low levels of serum $25(OH)_2D_3$ among the sample of mothers in that study. In Saudi Arabia there are no country specific guidelines or recommendations for Saudi Arabian women to take vitamin D supplements during pregnancy.

Apart from playing a significant role in preventing vitamin deficiencies amongst pregnant women and infants, vitamin D also helps to reduce diseases of vitamin D deficiency (Holick, 2005). Mothers who have sufficient vitamin D are likely to deliver babies that have higher vitamin D levels both at birth and during the first six months of life. The results on vitamin D supplementation in this study suggest that in the case of Ireland greater awareness of the recommendation to supplement during pregnancy is needed while in Saudi Arabia the need for such a recommendation needs to be proposed and then promoted by the profession there.

5.4 Maternal diet and protection affecting sun exposure

Adopting dietary practices that are safe is crucial especially during pregnancy and infancy. A low intake of vitamin D rich foods in places where sunlight is minimal results in increased vitamin D deficiencies (FSAI, 2007). A large majority of Muslim mothers in Ireland were consuming diets comprising fresh milk, yoghurt, butter and oily fish. While the results from the women in Saudi Arabia, shows that most of the mothers there were consuming diets high in powdered milk, yoghurt, cream or ice-cream and oily fish. Pregnant and lactating mothers are advised to consume diets with rich sources of vitamin D twice per week, which is consistent with the findings from this study.

Studies have revealed that poor vitamin D status amongst pregnant women in Ireland is a significant problem (Mac Sharry, 2007). Another study revealed that the levels of vitamin D in body stores accumulated during the summertime are quickly lost in the months thereafter (FSAI, 2007). This leads to an increasing dependence on dietary intakes in order to maintain adequate vitamins status during the winter. However because the natural diet does not provide a good vitamin D source the options of fortification and supplementation are critically important. In Ireland increasing levels of fortification of dairy products such as Super milk produced by Avonmore are a direct response to the low levels observed in so many sub-groups in the Irish population. In Saudi Arabia vitamin D fortified foods are dairy products such as milk, buttermilk and yoghurt, but to the main extent powdered milk was more commonly consumed amongst the Saudi mothers due to the fact of its shelf life stability and convenience. They also consume large quantities of yoghurt.

5.4.1 Factors influencing one's exposure to sunlight

It has historically been believed that exposure to sunlight during the summer months was a way of the skin storing sufficient vitamin D to last during the winter months. However, following too much exposure to direct sun rays, people are advised to use sunscreens so as to reduce risks of sun damage to skin and diseases such as skin cancer (Garland *et al.,* 2009). Application of sunscreen, while it protects the skin from damage of sun burn greatly reduces skin synthesis of vitamin D. It blocks UVB radiation that is imperative for production of vitamin D by the skin. In this study sunscreen usage was not common among the participants from both countries. In Ireland in recent years there has been increasing awareness of the importance of sunscreens to prevent burning when going out in the sun. However, for Muslim women who are already covered up they are less inclined to apply sunscreen. This may reflect the fact that is not customary for them to do so or the fact that they may not be out for long in the sun and don't feel that they will burn.

Covering the skin also limits access to sunlight rays and greatly compromises synthesis of sunlight. Minimal exposure of the skin to sunlight therefore reduces the amount of vitamin D synthesized amongst Muslim women. The clothes that are worn by Muslim women which cover their whole body minimize the amount of sunlight synthesis and thus will result in lower vitamin D levels. Findings from this survey revealed that 100% of Muslim Saudi Arabian and the Irish cohort of Muslim mothers cover their bodies due to cultural and religious purposes. This therefore, significantly reduces the amount of sun exposure among pregnant women which in turn will result in much lower vitamin D production by this means and very likely will result in sub-optimal or deficiency levels of vitamin D amongst these women. This practice of covering their whole bodies for religious purposes precludes this being targeted for change. Thus, other routes for getting adequate vitamin D need to be considered among this population.

5.5 Vitamin D supplements to Infant

In Ireland, only 49.4% of the mothers gave their infants vitamin drops in spite of 62.3% of them having heard of the recommendation to supplement. While this was a considerably higher percentage compared to Tarrant *et al.* (2011) where in her study of 450 mother –infant pairs they found that 4.4% of infants had received vitamin D drops. The increase might be explained by virtue of the fact that Tarrant's study was conducted between 2004 and 2006 before the publication of FSAI recommendation on vitamin D supplementation to infants up to the age of 1year. In addition, while the sample in Tarrant's study was predominantly made up of Irish nationals with a very small number of Muslims, in this study it was comprised of 100% Muslims. Health professionals may be more aware of the increased risk of vitamin D inadequacy in this group and so more likely to provide them with specific advice to give their babies vitamin D drops.

Living in temperate climates like Ireland contributed to increased cases of vitamin D deficient diseases amongst infants. The Food Safety Authority of Ireland (FSAI) (2007) asserts that infants aged 0-12 months should be given 5µg per day. Thus, the advice given during birth and antenatal clinics played an important role in informing women on the importance of giving their infants vitamin D drops. The recommendations coming from healthcare services is also another factor that encouraged women to give infants vitamin D drops as found in this study.

In Saudi Arabia vitamin D supplementation amongst infants was generally low with only 13.2% of women giving their infants vitamin D drops. Due to limited information on the importance of vitamin drops and recommendation from doctors, 62.8% of Saudi women did not know about the importance of vitamin D drops for their infants. This greatly increases the infant's vulnerability to vitamin D deficiency.

5.6 Infant feeding and weaning practices

Results revealed that breastfeeding among Muslim mothers in Ireland (92.2 %) and Saudi Arabia (88.4 %) was very high. The WHO recommends that children should be breastfed exclusively for the first 6 months of their life (Ministry of health, Oman Muscat, 2008). After this period, the breast milk becomes insufficient in quality and quantity and cannot ensure appropriate growth and development of an infant (Pietra *et al.*, 2009). Certain weaning or complementary foods should be introduced while continuing to breastfeed until the infant reaches 2 years of age (Kikafunda *et al.*, 2003; Butte, N, Lopez-Alarcon, M, & Garza, C, 2002). The practice of long-term breastfeeding (up to two years) is widely encouraged in Ireland as it meets the requirements of the national Public Service Agreements concerning health inequalities (Health Inequalities: Progress and Next Steps, 2008). The same practice is encouraged among women in Saudi Arabia (El-Mouzan *et al.* 2009). In this study, high rates of breastfeeding were observed in both countries, indeed in Ireland the rates were much higher than those of Tarrant *et al.* (2008) in which they reported Ireland has having relatively low breastfeeding initiation rates (<50%) and high premature cessation rates.

The higher rate found in this study is more similar to the breastfeeding rates found in non-Nationals residing in Ireland (ESRI, 2010). Similarly, in the case of Saudi Arabia, the previous source points out that the country has relatively low exclusive breastfeeding rates of 24.4 % out of 1,801 infants were breastfeed at the age of 6 months (El-Gilany, Shady & Helal, 2011) which contradicts the findings of this study (88.4%).

Most mothers in Ireland (80%) and Saudi Arabia (62.6) started weaning at between 4 to 6 months by introducing solids into the diet of their infants. The study revealed certain risk factors for infants as they approached the weaning age of six months. Healthcare professionals advise that infants be exclusively fed on breast milk for the first six months. Most infants are thus weaned at around six months and introduced to solid foods. However, there may be an underlying health risk for infants who are exclusively breastfed for six months. These months are critical in the formation of the infant's bones, skeleton and skull. Whereas breast milk is highly nutritious, it does not provide adequate vitamin D and calcium to the infant. Failing to obtain nutrients like vitamin D at this age means that infants will be at increased risk of deficiencies. According to Lee & Chen (2008) exclusively breastfed infants without taking vitamin D supplements are more likely to show signs of rickets. Thus, additional awareness among those feeding exclusively to 6 months or later of the potential for inadequate intakes of vitamin D in their infants needs to be raised. Moreover, these mothers should also be encouraged to provide Vitamin D drops to their infant until they reach the age of 1year.

5.7 Mothers attitudes to vitamin D and their reported health benefit

Nearly all the mothers in Ireland and Saudi Arabia agreed or totally agreed about the importance of providing vitamin D supplements to ensure optimal vitamin D intakes for their infants and thereby protecting them from the risk of developing rickets. In addition, the majority agreed or totally agreed that taking vitamin D supplements makes bone healthy and helps to increase muscle strength. The results indicated that most of the mothers knew about the health benefit of taking vitamin D supplements for them and for their baby.

Though there are few natural dietary sources of vitamin D in both Ireland and Saudi Arabia, studies reveal that the mean daily intake of vitamin D supplements can help reduce vitamin D deficiencies significantly (Azhar, 2009). This highlights the importance of vitamin D supplementation during pregnancy and in early infancy in order to offset the lack of vitamin D from dietary sources. Through following supplementation practices pregnant women and infants can avoid becoming vitamin D deficient. It will moreover promote good health and reduce the risk of diseases that are linked to inadequate vitamin D status.

5.8 Strengths and Limitations of the study

One strength of this study was the fact that the researcher is herself a Muslim mother who therefore not only had direct contact and access with other Muslim mothers here in Ireland but also would have been more likely to elicit truthful responses from them. Strength of the study was the use of survey software on an iPad that permitted direct transfer of data from the questionnaire to an Excel spreadsheet, thereby saving on time and reducing the potential for error from manual data entry.

This study set out to examine vitamin D supplementation practices in a sample of Muslim mothers living in Ireland and in Saudi Arabia. It examined supplementation during pregnancy as well as infancy (first year of life). In order to be able to assess how important this supplementation of vitamin D in these life stages is it was necessary to explore other behaviors that influence vitamin D status such as dietary intakes and exposure to sunshine. A limitation of this study was that vitamin D status in Muslim mothers was not assessed directly. Instead, an indirect measure was used in the study through the assessment of diet, exposure to sunlight and supplementation practices. The study cannot therefore categorize individuals in the study as deficient. Additional research obtaining a direct measure of vitamin D status in these population sub-groups would be useful as a follow-up to this work.

The survey instrument was long and therefore this may have been a limitation in discouraging potential survey participants from taking part. Also, the snow-ball method of sampling was used in this study and that can make it very difficult to assess the degree to which the final sample were representative of the population they are supposed to represent.

Another limitation was the retrospective nature of the survey on supplementation practices. Mother’s recall of supplementation may be inaccurate due to mothers having to think back to when they were pregnant. Furthermore, there may be interviewer bias where mothers exaggerated this positive health behavior in an attempt to please the interviewer.

5.9 Conclusions

Vitamin D supplementation practices during pregnancy and infancy amongst Muslim mothers in Saudi Arabian and Ireland is an important study in identifying possible risk factors for vitamin D inadequacy and deficiency among Muslim women living in both Ireland and in Saudi Arabia. Through this study, results revealed that the majority of Muslim mothers were not supplementing with vitamin D during pregnancy. Additionally, a high proportion of their infants are not being given vitamin D drops (5 µg daily), in spite of a high percentage of the mothers having knowledge of vitamin D recommendations. The breastfeeding rates were higher among the Muslim mothers in both countries along with the rate of later weaning that contributes to certain risk factors (an increased risk of deficiencies).

5.10 Recommendations

Based on the findings of this research a number of recommendations have been made.

- Muslim women should be educated on the importance of vitamin D both for their own health & for that of their infants.
- In Saudi Arabia the Ministry of Health should provide recommendations for vitamin D supplementation among high risk groups (pregnancy and infancy).
- Health care providers need to inform pregnant women to take vitamin D supplements for the sake of their health and that of the baby.
- After birth, women should be informed to give their children a vitamin D supplement each day so as to reduce the risks of vitamin D deficiency.
- During pregnancy women should be checked for their vitamin D levels every three months.
- Supplements for both mother & child should be accessible & cost friendly.

5.11 Further Research

This research was an exploratory study about supplementation practices during pregnancy and infancy. Further research should be carried out to explore specific supplementation practices that are suitable for infants and pregnant women. Another area that needs further research is a detailed assessment of vitamin D deficiency among Muslim women in Saudi Arabia and Ireland as a result of socio-cultural and religious factors.

References

Abrams, SA. (2002). Nutritional Rickets: An Old Disease Returns. *Nutrition Reviews*, **60**, 111-15.

Al Faraj, S. & Al Mutairi, K. (2003). Vitamin D Deficiency and Chronic Low Back Pain in Saudi Arabia. *Spine*, **28**, 177-79.

Al-Harthy, W., El-Metwaly, D. & Al-Seoud, MMA. (2012). Vitamin D Levels in Near Term Infants – Poster #1319. *Archives of Disease in Childhood*, 97. Poster presentation, 4th Congress of the European Academy of Paediatric Societies, 5–9 October 2012, Istanbul, Turkey. doi:10.1136/archdischild-2012-302724.1319.

Al-Mulhim, AA., Abu-Heija, A., Al-Jamma, F. & El-Harith, EHA. (2003). Pre-eclampsia: Maternal Risk Factors and Perinatal Outcome. *Fetal Diagnosis and Therapy*, **18**, 275-80. doi:10.1159/000070809.

Al-Mustafa, Z K., Al-Madan, M., Al-Majid, HJ., Al-Muslem, S., Al-Ateeq, S & Al-Ali, AK. (2007). Vitamin D Deficiency and Rickets in the Eastern Province of Saudi Arabia. *Annals of Tropical Paediatrics*, **27**, 63-67.

Aloia, JF., Patel, M., Dimaano, R., Li-Ng, M., Talwar,Sa., Mikhail, M., Pollack, S., Yeh, JK. (2008). Vitamin D Intake to Attain a Desired Serum 25–Hydroxyvitamin D Concentration. *American Journal of Clinical Nutrition*, **87**, 1952-58.

Al-Rowaily, MA. & Abolfotouh, MA. (2010). Predictors of Gestational Diabetes Mellitus in a High-Parity Community in Saudi Arabia. *Eastern Mediterranean Health Journal*, **16**(6), 636-41.

American College of Obstetricians and Gynecologists (2011). Vitamin D Screening and Supplementation during Pregnancy. *Obstetrics and Gynecology*, **118**, 197-98.

Andersen, R., Molgaard, C., Skovgaard, LT., Brot, C., Cashman, KD., Jakobsen, J., Lamberg-Allardt, C. & Ovesen, L. (2008). Effect of Vitamin D Supplementation on Bone and Vitamin D Status Among Pakistani Immigrants in Denmark: A Randomised Double-Blinded Placebo-Controlled Intervention Study. *British Journal of Nutrition*, **100**(1), 197-207.

Arden, NK., Major, P., Poole, JR., Keen, RW., Vaja, S., Swaminathan, R., Cooper, C. & Spector, TD. (2002). Size at Birth, Adult Intestinal Calcium Absorption and 21,25(OH) Vitamin D. *Quarterly Journal of Medicine*, **95**, 15-21.

Atkinson, R. & Flint, J. (2001). Accessing Hidden and Hard-To-Reach Populations: Snowball Research Strategies, *Social Research Update*, Department of Sociology, University of Surrey Issue 33 [Online]. Available at http://sru.soc.survey.ac.uk/SRU33.html. [Accessed October 2012].

Azhar, W. (2009). A Determination of Vitamin D Status and Intake of Pregnant and Non-pregnant Saudi Arabian Women in Mecca, Saudi Arabia, B.Sc. unpublished dissertation, Eastern Michigan University, Michigan.

Bakare, MO., Munir, KM. & Kinney, DK. (2011). Association of Hypomelanotic Skin Disorders with Autism: Links to Possible Etiologic Role of Vitamin-D Levels in Autism? *Hypotheses*, **9**(1), 1-9.

Balnaves, M. & Caputi, P. (2001). *Introduction to Quantitative Research Methods: An Investigative Approach*, Sage, Thousand Oaks, CA.

Barts and the London School of Medicine and Dentistry. Clinical Effectiveness Group (2011) *Vitamin D Guidance*, Clinical Effectiveness Group, Barts and the London.

Barrera, D., Avila, E., Hernandez, G., Halhali, A., Biruete, B., Larrea, F. & Diaz, L. (2007). Estradiol and Progesterone Synthesis in Human Placenta is Stimulated by Calcitriol. *Journal of Steroid Biochemistry and Molecular Biology*, **103**, 529-32.

Baumgartl, HL., Standl, E., Schmidt-Gayk, H., *et al.* (1991). Changes of Vitamin D3 Serum Concentrations at the Onset of Immune-mediated Type 1 (Insulin-Dependent) Diabetes Mellitus. *Diabetes Research*, **16**, 145-48.

Bellamy, L., Casas, J P., Hingorani, A D., Williams, D J. (2007). Pre-eclampsia and Risk of Cardiovascular Disease and Cancer in Later Life: Systematic Review and Meta-Analysis. *BMJ*, **10**, 335- 974.

Bonnick, SL. (2010). *Bone Densitometry in Clinical Practice: Application and Interpretation*, John Wiley and Sons, Hoboken, New Jersey.

Bowling, A. (2002). *Research Methods in Health: Investigating Health and Health Services*, 2nd ed, Open University Press, Maidenhead, UK.

Bowling, A. (2009). *Research Methods in Health: Investigating Health and Health Services*, 3rd ed, Open University Press, Maidenhead, UK.

Butte, N., Lopez-Alarcon, M. & Garza, C. (2002). *Nutrient Adequacy of Exclusive Breastfeeding for the Term Infant during the First Six Months of Life*, WHO, Geneva.

Bodnar, L., Catov, JM., Simhan, FIN., Holick, MF., Powers, RW. & Roberts, JM. (2007a). Maternal Vitamin D Deficiency Increases the Risk of Preeclampsia. *Journal of Clinical Endocrinology and Metabolism*, **92**(35), 17-22.

Bodnar, LM. & Simhan, HN. (2010). Vitamin D May Be a Link to Black-White Disparities in Adverse Birth Outcomes. *Obstetrical and Gynecological Survey*, **65**, 273-84.

Bodnar, LM., Simhan, FIN., Powers, RW., Frank, MP., Cooperstein, E. & Roberts, JM. (2007b). High Prevalence of Vitamin D Insufficiency in Black and White Pregnant Women Residing in the Northern United States and Their Neonates. *Journal of Nutrition*, **137**, 447-52.

Borg-Stein, J., Dugan, S. & Gruber, J. (2005). Musculoskeletal Aspects of Pregnancy. *American Journal of Physical Medicine and Rehabilitation*, **84**, 180-92.

Borrego, M., Douglas, EP. & Amelink, CT. (2009). Quantitative, Qualitative, and Mixed Research Methods in Engineering Education. *Journal of Engineering Education*, **98**(1), 53-66.

Bouillon, R., Norman, AW. & Lips, P. (2007). Vitamin D Deficiency. *New England Journal of Medicine*, **357**, 1980-81; author reply 1981-82.

Boynton, PM. & Greenhalgh, T. (2004). Selecting, Designing, and Developing Your Questionnaire. *BMJ*, **328**, 1312-15.

Brand, C., Hodan, Y., Abi, D., Couch, A., Vindingini, A. & Wark, L. (2008). Vitamin D Deficiency: A Study of Community Beliefs Among Dark Skinned Veiled People. *Intl I Reum Dis*, **11**, 15-23.

Bray, K. (2012). *Vitamin D Deficiency* [Online]. Available: http://www.chocie.com.au/reviews-and-tests/food-and-health/general-health/conditions/vitamin-d-deficiency.aspx. [Accessed April 2012].

Buckley, BS., Harreiter, J., Damm, P., Corcoy, R., Chico, A., Simmons, D., Vellinga, A., Dunne, F. & DALI Core Investigator Group (2012). Gestational Diabetes Mellitus in Europe: Prevalence, Current Screening Practice and Barriers to Screening. A Review. *Diabetic Medicine*, **29**(7), 844-54. doi:10.1111/j.1464-5491.2011.03541.x.

Camadoo, L., Tibbott, R. & Isaza, F. (2007). Maternal Vitamin D Deficiency Associated With Neonatal Hypocalcaemic Convulsions. *Nutrition Journal*, **6**, 23.

Cannell, JJ. (2008). Autism and Vitamin-D. *Medical Hypotheses*, **70**(4), 750-59.

Cannell, JJ. (2010). On the Aetiology of Autism. *Acta Paediatrica*, **99**(8), 1128-30.

Cantorna, M. (2000). Vitamin D and Autoimmunity: Is Vitamin D Status an Environmental Factor Affecting Autoimmune Disease Prevalence? *Proceedings of The Society for Experimental Biology and Medicine*, **223**, 230-33.

Cashman, KD., Muldwney, S., McNulty, B., Nugent, A., Fitzgerald, AP., Kiely, M., Walton, J., Gibney, MJ. & Flynn, A. (2012). Vitamin D Status of Irish Adults: Findings from the National Adult Nutrition Survey. *British Journal of Nutrition*,**109**(7), 12248-56.

Coffey, M. (2006). *Diabetes mellitus- Gestational diabetes mellitus*, **14**(11), 41-42. Available from http://www.inmo.ie/tempDocs/diabetes_dec06.pdf. [Accessed February 2013].

Cohen, L., Manion, L. & Morrison, K. (2004). *Research Methods in Education*, 5th ed, Sage, New York.

Compston, A. & Coles, A. (2002). Multiple Sclerosis. *Lancet*, **359**, 1221-31.

Creswell, JW. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage, London.

Currenti, SA. (2010). Understanding and Determining the Etiology of Autism. *Cellular and Molecular Neurobiology*, **30**(2), 161-71.

Davies, G., Welham, J., Chant, D., Torrey, EF. & McGrath, J. (2003). A Systematic Review and Meta-Analysis of Northern Hemisphere Season of Birth Studies in Schizophrenia. *Schizophrenia Bulletin*, **29**, 587-93.

Dawodu, A. & Wagner, C. (2007). Mother–Child Vitamin D Deficiency: An International Perspective. *Archives of Disease in Childhood*, **92**, 737-40.

Deeb, KK., Trump, DL. & Johnson, CS. (2007). Vitamin D Signaling Pathways in Cancer: Potential for Anticancer Therapeutics. *Nature Reviews Cancer*, **7**, 684-700.

DeLuca, H. & Cantorna, MT. (2001). Vitamin D: Its Role and Uses in Immunology. *FASEB Journal*, **1**(5), 2579-85.

Dent, CE. & Gupta, MM. (1975). Plasma 25-Hydroxyvitamin-D-Levels during Pregnancy in Caucasians and in Vegetarian and Nonvegetarian Asians. *Lancet*, **2**, 1057-60.

Department of Health (2008). Health Inequalities: Progress and Next Step. UK Department of Health.

De-Regil, LM., Palacios, C., Ansary, A., Kulier, R. & Peña-Rosas, JP. (2012). *Vitamin D Supplementation for Women During Pregnancy (Review)*, John Wiley & Sons, Ltd. *The Cochrane Library* 2012, Issue 6.

Diabetes Atlas (2010). *Estimates of Type 1 Diabetes in Children – Middle East and North African Region*, 4th ed, IDF, International Diabetes Federation: Brussels; 2009.

Diaz, L., Noyola-Martinez, N., Barrera, D., Hernandez, G., Avila, E., Halhali, A., Larrea, F. (2009). Calcitriol Inhibits TNF-Alpha-Induced Inflammatory Cytokines in Human Trophoblasts. *Journal of Reproductive Immunology*, **81**, 17-24.

Dijkstra, SH., van Beek, A., Janssen, JW., de Vleeschouwer, LHM., Huysman, WA. & van den Akker, ELT. (2007). High Prevalence of Vitamin D Deficiency in Newborn Infants of High-Risk Mothers. *Archives of Disease in Childhood*, **92**, 750-53.

Dimitri, P. & Bishop, N. (2007). Rickets. *Paediatrics and Child Health*, **17**(7), 279-287. doi: 10.1016/j.paed.2007.04.004.

Dratva, J., Merten, S. & Ackermann-Liebrich, U. (2006). Vitamin D Supplementation in Swiss Infants. *Swiss Med Weekly*, **136**(29-30), 473-81.

Dror, DK. & Allen, LH. (2010). Vitamin D Inadequacy in Pregnancy: Biology, Outcomes and Interventions. *Nutrition Reviews*, **68**(8), 465-77.

Economic and Social Research Institute (2012). *Breastfeeding in Ireland 2012: Consequences and Policy Responses* [Online]. Available: http://www.esri.ie/news_events/latest_press_releases/breastfeeding_in_ireland_/index.xml. [Accessed January 2013].

Elidrissy, AWTH. (1991). Vitamin D Deficiency Rickets in Saudi Arabia. In: Glorieux F H (Ed) *Rickets. Nestlé Nutrition Workshop Series vol. 21*, Raven Press, New York.

El-Gilany, AH., Shady, E. & Helal, R. (2011). Exclusive Breastfeeding in Al-Hassa, Saudi Arabia. *Breastfeeding Medicine*, **6**(4), 209-13.

Elidrissy, AT., Sedrani, SH. & Lawson, DE. (2006). Vitamin D Deficiency in Mothers of Rachitic Infants. *Calcified Tissue International*, **36**, 266-68.

El-Mouzan, MI., Al-Salloum, AA., Al-Herbish, AS., Qurachi, MM. (2009). Trends in Infant Nutrition in Saudi Arabia: Compliance with WHO Recommendations. *Annals of Saudi Medicine*, **29**, 20-23.

Elsammak, MY., AL-Wossaibi, AA., AL-Howeish, A. & Alsaeed, J. (2009). High Prevalence of Vitamin D Deficiency in the Sunny Eastern Region of Saudi Arabia: A Hospital-Based Study. *Eastern Mediterranean Health Journal*, **17**(4), 317-22.

Embry, A. (2004). Vitamin D Supplementation in the Fight Against Multiple Sclerosis. *Journal of Orthomolecular Medicine*, **19**, 27-38.

Erkkola, M., Kaila, M., Nwaru, BI., Kronberg-Kippila, C., Ahonen, S., Nevalainen, J., Veijola, R., Penkkanen, J., IIONEN, J., Simell, O., Knip, M. & Virtanen, SM. (2009) .Maternal Vitamin D Intake During Pregnancy is Inversely Associated with Asthma and Allergic Rhinitis in 5-Year-Old Children. *Clinical and Experimental Allergy*, **39**, 875-82.

EURODIAB Substudy 2 Study Group (1999). Vitamin Supplement in Early Childhood and Risk for Type 1 (Insulin-Dependent) Diabetes Mellitus. *Diabetologia*, **42**, 51-54.

European Food Safety Authority (EFSA) (2012). Scientific Opinion on the Tolerable Upper Intake Level of Vitamin D, EFSA Journal, **10**, 2813.

Farend.net (2012). Islamic Cultural Centre of Ireland [Online]. Available: http://islamireland.ie/. [Accessed October 2012].

Feldman, D., Pike, JW. & Adams, JS. (2011). *Vitamin D*, 3rd ed, Academic Press, San Diego, CA.

Field, A. (2009). *Discovering Statistics Using SPSS*, 3rd ed, Sage Publications, London.

Fida, NM. (2003). Assessment of Nutritional Rickets in Western Saudi Arabia. *Saudi Medical Journal*, **24**, 337-40.

Flick, U., Von Kardorff, E. & Steinke, I. (2004). *A Companion to Qualitative Research*, Sage, London.

Fong, J. & Khan, A. (2012). Hypocalcemia Updates in Diagnosis and Management for Primary Care. *Canadian Family Physician*, **58**(2), 158-62.

Food Safety Authority of Ireland (FSAI) (2007).Recommendations for a National Policy on Vitamin D Supplementation for Infants in Ireland, *Food Safety Authority of Ireland Abbey Court, Lower Abbey Street, Dublin 1.*

Food Safety Authority of Ireland (FSAI) (2011). *Vitamin D – Q&A on Vitamin D Report Recommendations for a National Policy on Vitamin D Supplementation for Infants in Ireland* [Online]. Available: http://www.fsai.ie/faq/vitamin_d.html. [Accessed February 2013].

Fuleihan, GE. (2009). Vitamin D Deficiency in the Middle East and Its Health Consequences for Children and Adults. *Clinical Review of Bone and Mineral Metabolism*, **7**, 77-93.

Gale, CR., Martyn, CN., Kellingray, S., Eastell, R. & Cooper, C. (2001). Intrauterine Programming of Adult Body Composition. *Journal of Clinical Endocrinology and Metabolism*, **86**, 267-72.

Gannagé-Yared, MH., Maalouf, G., Khalife, S., Challita, S., Yaghi, Y., Ziade, N., Chalfoun, A., Norquist, J. & Chandler, J. (2009). Prevalence and Predictors of Vitamin D Inadequacy Amongst Lebanese Osteoporotic Women. *British Journal of Nutrition*, **101**(4), 487-91.

Garland, C., Gorham, E., Mohr, S. & Garland, F. (2009). Vitamin D for Cancer Prevention: Global Perspective. *Annals of Epidemiology*, **19**, 468-83.

Gasim, T. (2012). Gestational Diabetes Mellitus: Maternal and Perinatal Outcomes in 220 Saudi Women. *Oman Medical Journal*, **27**(2), 140-44.

Ghannam, NN., Hammami, MM., Bakheet, SMM. & Khan, BA. (1999). Bone Mineral Density of the Spine and Femur in Healthy Saudi Females: Relation to Vitamin D Status, Pregnancy, and Lactation. *Calcified Tissue International*, **65**(1), 23-28.

Gibney, MJ., Vorster, HH. and Kok, FJ. (2002).Introduction to Human Nutrition (Ed), Blackwell Science Ltd, Oxford, United Kingdom.

Glaser, D. & Kaplan, F. (1997). Osteoporosis: Definition and Clinical Presentation. *Spine*, **22**(24), 12S-16S.

Glerup, H., Mikkelsen, K., Poulsen, L., Hass, E., Overbeck, S., Andrsen, H., Charles, P., Eriksen, EF. (2000). Hypovitaminosis D Myopathy Without Biochemical Signs of Osteomalacic Bone Involvement. *Calcified Tissue International*, **66**(41), 9-24.

Glew, RH., Crossey, MJ., Polanams, J., Okolie, HI. & VanderJagt, DJ. (2010). Vitamin D Status of Seminomadic Fulani Men and Women. *Journal of the National Medical Association*, **102**(6), 485-90.

Gordon, CM., Feldman, HA., Sinclair, L., Williams, AL., Kleinman, PK., Perez-Rossello, J. & Cox, JE. (2008). Prevalence of Vitamin D Deficiency Among Healthy Infants and Toddlers. *Archives of Pediatrics and Adolescent Medicine*, **162**, 505-12.

Grant, WB. (2005). An Estimate of Premature Cancer Mortality in the US Due to Inadequate Doses of Solar Ultraviolet B Radiation. *Cancer*, **94**, 1876-75.

Grant, WB., Garland, CF. & Holick, MF. (2005). Comparisons of Estimated Economic Burdens Due to Insufficient Solar Ultraviolet Irradiance and Vitamin D and Excess Solar UV Irradiance for the United States. *Photochemistry and Photobiology*, **81**, 1276-86.

Grant, WB. & Soles, CM. (2009). Epidemiologic Evidence Supporting the Role of Maternal Vitamin-D Deficiency as a Risk Factor for the Development of Infantile Autism. *Dermato-Endocrinology*, **1**(4), 223-28.

Gratton, C. & Jones, I. (2004). *Research Methods for Sports Studies*, Routledge, London.

Green, DA. & Naughton, GA. (2011). Calcium and Vitamin D Supplementation on Bone Structural Properties in Peripubertal Female Identical Twins: A Randomized Controlled Trial. *Osteoporosis International*, **22**(2), 489-98.

Green, J. & Thorogood, N. (2006). *Qualitative Methods for Health Research*, Sage Publications, London.

Greer, FR. (2008). 25-Hydroxyvitamin D: Functional Outcomes in Infants and Young Children. *American Journal of Clinical Nutrition*, **88**(2), 529S-533S.

Guan, Q., Ying, C. & Ma, XC. (1984). National Survey on the Prevalence of Rickets in Infants and Young Children. In Guan Q R (Ed) *Prevention and Treatment of Rickets*, Hei Long Jiang Publishing Bureau, Harbin, China.

Habeb, AM., Al-Magamsi, MSF., Halabi, S., Eid, IM., Shalaby, S. & Bakoush, O. (2011). High Incidence of Childhood Type 1 Diabetes in Al-Madinah, North West Saudi Arabia (2004–2009). *Pediatric Diabetes*, **12**(8), 676-81. doi:10.1111/j.1399-5448.2011.00765.x.

Health Services Executive (2010). Vitamin D Supplementation for Infants – Information for Health Professionals. Available at http://www.hse.ie/eng/services/healthpromotion/VitaminDandyourbaby/vitamin%20D%20Information%20for%20professionals.pdf. [Accessed January 2013].

Hera'a Hospital (2008) [Online]. Available: http://herahospital.org/articles.php?action=show&id=6. [Accessed October 2012].

Hill, TR., Flynn, A., Kiely, M., Cashman, KD. (2006). Prevalence of Suboptimal Vitamin D Status in Young, Adult and Elder Irish Subjects. *Irish Medical Journal*, **99**(2), 48-9.

Holick, MF. (2004). Vitamin D: Importance in the Prevention of Cancers, Type 1 Diabetes, Heart Disease, and Osteoporosis. *American Journal of Clinical Nutrition*, **79**, 362-71.

Holick, MF. (2005). The Vitamin D Epidemic and Its Health Consequences. *Journal of Nutrition*, **35**, 2739S-2748S.

Holick, MF. (2007). Vitamin D Deficiency. *New England Journal of Medicine*, **357**, 266-81.

Holick, MF. (2010). *Vitamin D: Physiology, Molecular Biology, and Clinical applications*, Springer, New York.

Hollis, B. & Wagner, C. (2006). Nutritional Vitamin D Status During Pregnancy: Reasons for Concern. *Canadian Medical Association Journal*, **174**, 1287-90.

Hollis, BW. & Wagner, CL. (2004). Assessment of Dietary Vitamin D Requirements during Pregnancy and Lactation. *American Journal of Clinical Nutrition*, **79**(5), 717-26.

Huotari, A. & Herzig, KH. (2008). Vitamin D and Living in Northern Latitudes—An Endemic Risk Area for Vitamin D Deficiency. *International Journal of Circumpolar Health*, **67**(2-3), 164-78.

Hypponen, E., Hartikainen, AL., Sovio, U., Järvelin, MR. & Pouta, A. (2007). Does Vitamin D Supplementation in Infancy Reduce the Risk of Pre-Eclampsia? *European Journal of Clinical Nutrition*, **61**, 1136-39.

Institute of Medicine (2010). *Dietary Intakes for Calcium and Vitamin D*, National Academic Press, Washington DC.

Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and the Clinical Strategy and Programmes Directorate, Health Service Executive (2013). *The Diagnosis and Management of Pre-eclampsia and Eclampsia Clinical Practice Guideline* [Online]. Available: http://www.rcpi.ie/Faculties/Documents/Diagnosis%20and%20Management%20of%20Pre-Eclampsia%20and%20Eclampsia.pdf. [Accessed February 2013].

International Osteoporosis Foundation (2012). *Vitamin D Deficiency is widespread And on The Increase.* Available at http://www.osteifound.org/bonehealth/vitamin-d-deficiency-widespresd-and-increase. [Accessed February 2013].

Javaid, MK., Crozier, SR., Harvey, NC., Gale, CR., Dennison, EM., Boucher, BJ., Arden, NK., Godfrey, KM., Cooper, C. & Princess Ann Hospital Study Group (2006). Maternal Vitamin D Status during Pregnancy and Childhood Bone Mass at Age 9 Years: A Longitudinal Study. *Lancet*, **367**, 36-43.

Kaludjerovic, J. (2010). Relationship Between Vitamin D During Perinatal Development and Health. *Journal of Midwifery and Women's Health*, **55**(6), 550-60. doi:10.1016/j.jmwh.2010.02.016.

Kenny, LC., Broadhurst, D I., Dunn, W., Brown, M., North, RA., McCowan, L., Roberts, C., Cooper, GJ., Kell, DB., Baker, PN. & Screening for pregnancy Endpoints Consortium (2010). Robust Early Pregnancy Prediction of Later Preeclampsia Using Metabolomic Biomarkers. *Hypertension*, **56**, 741-49. doi:10.1161/ HYPERTENSIONAHA.110.157297.

Kikafunda, JK., Walker, AF. & Tumwine, JK. (2003). Weaning Foods and Practices in Central Uganda: A Cross-Sectional Study. *African Journal of Food, Agriculture, Nutrition and Development*, **3**(2), 1-13.

Kimball, S., Fuleihan, GEH. & Vieth, R. (2008). Vitamin D: A Growing Perspective. *Critical Reviews in Clinical Laboratory Sciences*, **45**, 339-414.

Kinney, DK., Barch, DH., Chayka, B., Napoleon, S. & Munir, KM. (2010). Environmental Risk Factors for Autism: Do They Help Cause De Novo Genetic Mutations That Contribute to the Disorder? *Medical Hypotheses*, **74**(1), 102-6.

Kovacs, CS. (2008). Vitamin D in Pregnancy and Lactation: Maternal, Fetal, and Neonatal Outcomes from Human and Animal Studies. *American Journal of Clinical Nutrition*, **88**(2), 520S-528S.

Kumar, P. & Clark, M. (2002). *Kumar & Clark Clinic Medicine*, 5th ed, Elsevier Science Limited, Edinburgh: W B Saunders.

Lanham-New, SA., Buttriss, JL., Miles, LM., Ashwell, M., Berry, JL., Boucher, BJ., Cashman, KD., Cooper, C., Darling, AL., Francis, RM., Fraser, WD, de Groot, CP. G. M., Hyppönen, E., Kiely, M., Lamberg-Allardt, C., Macdonald, HM., Martineau, AR., Masud, T., Mavroeidi, A., Nowson, C., Prentice, A., Stone, EM., Reddy, S., Vieth, R. and Williams, CM. (2011) Proceedings of the Rank Forum on Vitamin D. *British Journal of Nutrition*, **105** (1), 144-156.

Lappe, J. (2011). The Role of Vitamin D in Human Health: A Paradigm Shift. Journal of *Evidence-Based Complementary and Alternative Medicine*, **16**(1), 58-72.

Lappe, J., Travers-Gustafson, D., Davies, K., Recker, R. & Heaney, R. (2007). Vitamin D and Calcium Supplementation Reduces Cancer Risk: Results of a Randomized Trial. *American Journal of Clinical Nutrition*, **85**, 1586-91.

Lawlor, DA., Wills, AK., Fraser, A., Sayers, A., Fraser, WD. & Tobias, JH. (2013). Association of Maternal Vitamin D Status during Pregnancy with Bone-Mineral Content in Offspring: A Prospective Cohort Study [Online]. *The Lancet Journals.* Available: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)62203-X/fulltext#article_upsell. [Accessed February 2013].

Lee, P. & Chen, R. (2008). Vitamin D as an Analgesic for Patients with Type 2 Diabetes and Neuropathic Pain. *Archives of Internal Medicine*, **168**, 771-72.

Levenson, CW. & Figueirôa, SM. (2008). Gestational Vitamin D Deficiency: Long-Term Effects on the Brain. *Nutrition Reviews*, **66**, 726-29.

Liepa, GU., Sengupta, A. & Karsies, D. (2008). Polycystic Ovary Syndrome (PCOS) and Other Androgen Excess-Related Conditions: Can Changes in Dietary Intake Make a Difference? *Nutrition in Clinical Practice*, **23**, 63-71.

Liddel, A. (2011). *Absorbing Calcium and Vitamin D* [Online]. Available: http://www.livestrong.com/article/495719-absorbing-calcuim-vitamin-d/. [Accessed February 2013].

Lips, P. (2001). Vitamin D Deficiency and Secondary Hyperparathyroidism in the Elderly: Consequences for Bone Loss and Fractures and Therapeutic Implications. *Endocrinology Reviews*, **22**, 477-501.

Lonergan, R., Kinsella, K., Fitzpatrick, P., Brady, J., Murry, B., Dunne, C., Hagan, R., Duggan, M., Jordan, S., McKenna, M., Hutchinson, M. & Tubridy, N. (2011). Multiple Sclerosis in Ireland: Relationship to Vitamin D Status and HLA Genotype. *Journal* of *Neurology*, *Neurosurgery*, and *Psychiatry*, **82**(3), 237.

Looker, AC., Johnson, CL., Lacher, DA., Pfeiffer, CM., Schleicher, RL. & Sempos, CT. (2011). *Vitamin D Status: United States, 2001-2006.* U.S. Department of Health and Human Services: National Center for Health Statistics, Data Brief No. (59):1-8.

MacSharry, G. (2007). Finally the Issue of Vitamin Deficiency in Ireland is Highlighted. *Western Herbal Medicine and Nutrition(2007).*

Makhseed, M., Musini, VM., Ahmed, MA. (1998). Association of Fetal Gender with Pregnancy-Induced Hypertension and Pre-eclampsia. *International Journal of Gynecology and Obstetrics*, **63**(1), 55-56.

Martini, FH., Nath, JL. & Bartholomew, EF. (2009). *Fundamentals of Anatomy and Physiology*, 8th ed, Pearson Education, Inc., Benjamin Cummings, San Francisco.

Marya, RK., Rathee, S., Lata, V. & Mudgil, S. (1981). Effects of Vitamin D Supplementation in Pregnancy. *Gynecologic and Obstetric Investigation*, **12**, 155-61.

Mathieu, C. & Badenhoop, K. (2005). Vitamin D and Type 1 Diabetes Mellitus: State of the Art. *Trends in Endocrinology* and *Metabolism*, **16**, 261-66.

McCarthy, D. (2007). Vitamin D Intake and Status in Irish Elderly Women and Adolescent Girls. *Irish Journal of Medical Science*, **175**(2), 14-20.

McCarty, C. (2008). Sunlight Exposure Assessment: Can We Accurately Assess Vitamin D Exposure from Sunlight Questionnaires? *American Journal of Clinical Nutrition*, **87**, 1097S-101S.

McGrath, JJ., Barnett, AG. & Eyles, DW. (2005). The Association Between Birth Weight, Season of Birth and Latitude. *Annals of Human Biology*, **32**, 547-59.

McGrath, JJ., Selten, JP., Chan, D. (2002).Long-term Trends in Sunshine and its Association with Schizophrenia Birth Rates and Age at First Registration Data from Australia and the Netherlands. *Schizophrenia Research*. **54**(3), 199-212.

McGrath, JJ. & Weiham, JL. (1999). Season of Birth and Schizophrenia: A Systematic Review and Meta-Analysis of Data from the Southern Hemisphere. *Schizophrenia Research*, **35**, 237-42.

Meguid, NA., Hashish, AF., Anwar, M. & Sidhom, G. (2010). Reduced Serum Levels of 25-Dihydroxy Vitamin-D in Egyptian Children with Autism. *Journal* of *Alternative* and *Complementary Medicine*, **16**(6), 641-45.

Mercus, R. (2008). *Osteoporosis*, Elsevier, London.

Mersch, PP., Middendorp, HM., Bouhuys, AL., Beersma, DG. & van den Hoofdakker, RH. (1999). Seasonal Affective Disorder and Latitude: A Review of the Literature. *Journal of Affective* Disorders, **53**(1), 35-48.

Miller, PD. and Camacho, PM. (2007). *Osteoporosis*: *A Guide for Clinicians*, Wolters Kluwer, Philadelphia.

Miller, WL. & Portale, AA. (1999). Genetic Causes of Rickets. *Current Opinion in Pediatrics*, **11**, 333-39.

Ministry of Health, Oman Muscat: Ministry of Health (2008). *Micronutrients Testing, Community Health and Disease Surveillance, Newsletter*, **17**,12–13.

Miyake, Y., Sasaki, S., Tanaka, K. & Hirota, Y. (2009). Dairy Food, Calcium, and Vitamin D Intake in Pregnancy and Wheeze and Eczema in Infants. *European Respiratory Journal*, **35**(6), 1228-34. doi:10.1183/09031936.00100609.

Morley, R., Carlin, JB., Pasco, JA. & Wark, JD. (2006). Maternal 25-Hydroxyvitamin D and Parathyroid Hormone Concentrations and Offspring Birth Size. *Journal of Clinical Endocrinology and Metabolism*, ***91***, 906–912.

Morris, G., Zhou, Q., Hegsted, M. & Keenan, MJ. (1995). Maternal Consumption of a Low Vitamin D Diet Retards Metabolic and Contractile Development in the Neonatal Rat Heart. *Journal* of *Molecular and Cellular Cardiology*, **27**, 1245-50.

Mostafa, G. & Al-Ayadhi, L. (2012). Reduced Serum Concentrations of 25-Hydroxyvitamin D in Children with Autism: Relation to autoimmunity [Online]. *Journal of Neuroinflammation*, 9, 201. Available: http://www.JournalofNeuroinflammation.com/content/9/1/201. [Accessed December 2012].

Mousa, F. (n.d.). Rickets in Saudi Arabia: Clinical Presentation and Management. [Online]. PowerPoint Presentation 41. Available: http://www.slideworld.org/slideshow.aspx/Rickets-in-Saudi-Arabia-ppt-2842971#1a. [Accessed February 2013].

Muijs, D. (2004). *Doing Quantitative Research in Education with SPSS*, Sage, Thousand Oaks, CA.

Muldowney, S. (2010). Vitamin D Status and Its Association with Metabolic Risk Factors Throughout the Lifecycle, PhD unpublished dissertation, National University of Ireland, Dublin.

Mulligan, ML., Felton, SK., Riek, AE. & Bernal-Mizrachi, C. (2010). Implications of Vitamin D Deficiency in Pregnancy and Lactation. *American Journal of Obstetrics and Gynecology*, **202**(5), 429.e1-429.e9.

Munger, K., Zhang, SM., O'Reilly, E., Hernan, MA., Olek, MJ., Willet, WC. & Ascherio, A. (2004). Vitamin D Intake and Incidence of Multiple Sclerosis. *Neurology*, **62**, 606-15.

Nabulsi, M., Mahfoud, Z., Maalouf, J., Arabi, A. & Fuleihan, GE. (2007). Impact of Maternal Veiling During Pregnancy and Socioeconomic Status on Offspring's Musculoskeletal Health. *Osteoporosis International*, **19**(3), 295-302.

Namgung, R. & Tsang, RC. (2003). Bone in the Pregnant Mother and Newborn at Birth. *Clinica Chimica Acta*, **333**, 1-11.

National Institute for Health and Clinical Excellence (2011). *Diagnosis and Management of Vitamin D Deficiency/Insufficiency in Comden (for Use in Primary Care)* [Online]. Available: http://www.camden.nhs.uk/gpdownloads/Diagnosis%20and%20Mangament%20of%20Vitamin%20D%20Deficiency%20or%20Insufficiency.pdf. [Accessed February 2013].

National Health Service (2009). Vitamin D an essential nutrient for all…but who is at risk of vitamin D deficiency? [Online]. Available http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Consumer/Healthy%20Living/dh_111302.pdf. [Accessed September 2012].

National Health Service (2011). Sunlight and vitamin D [Online]. Available

http://www.nhs.uk/Livewell/summerhealth/Pages/vitamin-D-sunlight.aspx.

National Institute of Arthritis and Musculoskeletal and Skin Disease and the National Institute on Aging (2007). Study Identifies Factors Affecting Bone Mass in Men [Online]. Available: http://www.niams.nih.gov/News_and_Events/Spotlight_on_Reasearch/2007/bonemass_men.asp. [Accessed February 2013].

Nozza, JM. & Rodda, CP. (2001). Vitamin D Deficiency in Mothers of Infants with Rickets. *Medical Journal of Australia*, **175**, 253-55.

Okonufua, F., Gill, DS., Alabi, ZO., Thomas, M., Bell, H. & Dandona, P. (1991). Rickets in Nigerian Children; A Consequence of Calcium Malnutrition. *Metabolism*, **40**, 209-13.

O'Sullivan, EP., Avalos, G., O'Reilly, M., Dennedy, MC., Gaffney, G. & Dunne, F. (2011). Atlantic Diabetes in Pregnancy (DIP): The Prevalence and Outcomes of Gestational Diabetes Mellitus Using New Diagnostic Criteria. *Diabetologia*, **54**, 1670-75.

Palmieri, L., Papaleo, V., Porcelli, V., Scarcia, P., Gaita, L., Sacco, R., Hanger, J., Rousseau, F., Curatolo, P., Manzi, B., Militerni, R., Bravaccio, C., Trillo, S., Schneider, C., Melmed, R., Elia, M., Lenti, C., Saccani, M., Pascucci, T., Puglisi-Allegra, S., Reichelt, KL. & Persico, AM. (2010). Altered Calcium Homeostasis in Autism-Spectrum Disorders: Evidence from Biochemical and Genetic Studies of the Mitochondrial Aspartate/Glutamate Carrier AGC1. *Molecular Psychiatry*, **15**(1), 38-52.

Pasco, JA., Wark, JD., Carlin, JB., Ponsonby, AL., Vuillermin, PJ. & Morley, R. (2008). Maternal Vitamin D in Pregnancy May Influence Not Only Offspring Bone Mass but Other Aspects of Musculoskeletal Health and Adiposity. *Medical Hypotheses*, **71**(2), 266-69. doi:http://dx.doi.org/10.1016/j.mehy.2008.01.033.

Pettifor, J. (2002). Rickets. *Calcified Tissue International*, **70**(5), 398-399.

Pettifor, J. (2008). Vitamin D and/or Calcium Deficiency Rickets in Infants and Children: A Global Perspective. *Indian Journal of Medical Research*, **127**, 245-49.

Pietras, S., Obayan, B., Cai, M. & Holick, MF. (2009). Vitamin D2 Treatment for Vitamin D Deficiency and Insufficiency for Up to 6 Years. *Archives of Internal Medicine*, **169**(19), 1806-8.

Prentice, A. (2008). Vitamin D Deficiency: A Global Perspective. *Nutrition Reviews*, **66**(2), S153-S164.

Rasanen, P., Hakko, H. & Jarvelin, MR. (1999). Prenatal and Perinatal Risk Factors for Psychiatric Diseases of Early Onset: Results Are Different if Seasons Are Categorised Differently. *BMJ*, **318**(7198), 1622-23.

Reed, SD., Laya, MB., Melville, J., Ismail, SY., Mitchell, CM. & Ackerman, DR. (2007). Prevalence of Vitamin D Insufficiency and Clinical Associations Among Veiled East African Women in Washington State. *Journal of Women's Health*, **16**(2), 206-13.

Reports of the Scientific Committee for food, thirty-first series (1992). *Nutrient and Energy Intakes for the European Community*, Brussels, Luxembourg.

Roche, EF., Menon, A., Gill, D. & Hoey, HMCV. (2002). Incidence of Type 1 Diabetes Mellitus in Children Aged Under 15 Years in the Republic of Ireland. *Journal of Paediatric Endocrinology and Metabolism*, **15**(8), 1191-94.

Rosen, CJ. (2009). *Primer on the Metabolic Bone Diseases and Disorders of Mineral Metabolism*, 7 th ed, John Wiley and Sons, Hoboken, New Jersey.

Sadat-Ali, M., AlElq, A., Al-Turki, H., Al-Mulhim, F. & Al-Ali, A. (2009). Vitamin D Levels in Healthy Men in Eastern Saudi Arabia. *Annals of Saudi Medicine*, **29**, 378-82.

Sahu, M., Bhatia, V., Aggarwal, A., Rawat, V., Saxena, P., Pandey, A. & Das, V. (2008). Vitamin D Deficiency in Rural Girls and Pregnant Women Despite Abundant Sunshine in Northern India. *Clinical Endocrinology*, **70**(5), 680-84. doi:10.1111/J.1365-2265.2008.03360.x.

Sakurai, T., Ramoz, N., Barreto, M., Gazdoiu, M., Takahashi, N., Gertner, M., Dorr, N., Gama Sosa, MA., De Gasperi, R., Perez, G., Schmeidler, J., Mitropoulou, V., Le, HC., Hof, PR., Elder, GA. & Buxbaum, JD. (2010). Slc25a12 Disruption Alters Myelination and Neurofilaments: A Model for a Hypomyelination Syndrome and Childhood Neurodevelopmental Disorders. *Biological Psychiatry*, **67**(9), 887-94.

Sarfraz, Z. (2010). *Power of Vitamin D*. OP, New York.

Saudi Food and Drug Authority (SFDA) (n.d). Vitamin D and Health. Available: www.sfda.gov.sa/ar/drug/awareness/news/Pages/فيتامين(+د)+و+الصحة.aspx. [Accessed February 2013].

Sedrani, SH. (1984). Low 25-Hydroxyvitamin D and Normal Serum Calcium Concentrations in Saudi Arabia, Riyadh Region. *Annals of Nutrition and Metabolism*, **28**, 181-85.

Serenius, F., Elidrissy, AT. & Dandona, P. (1984). Vitamin D Nutrition in Pregnant Women at Term and in Newly Born Babies in Saudi Arabia. *Journal of Clinical Pathology*, **37**, 444-47.

Specker, B. (1994). Do North American Women Need Supplemental Vitamin D During Pregnancy or Lactation? *American Journal of Clinical Nutrition*, **59**(Suppl), 484S-490S.

Spreen, M. (1992). Rare Populations, Hidden Populations and Link-Tracing Designs: What and Why? *Bulletin Méthodologie Sociologique*, **36**, 34-58.

Tarrant, R. (2008). An Investigation of the Diets of Infants Born in Ireland During the First Six Months of Life, PhD unpublished dissertation, Dublin Institute of Technology, Dublin.

Tarrant, RC., Sheridan-Pereira, M., McCarthy, RA., Younger, KM. & Kearney, JM. (2011). Maternal and Infant Nutritional Supplementation Practices in Ireland: Implications for Clinicians and Policymakers. *Irish Medical Journal*, **104**(6), 173-77.

Templer, D., Trent, NH., Spencer, DA., Trent, A., Corgiat, MD., Mortensen, PB. & Gorton, M. (1992). Season of Birth in Multiple Sclerosis. *Acta Neurologica Scandinavica*, **85**, 107-9.

Thacher, TD., Fischer, PR., Pettifor, JM., Lawson, JO., Isichei, CO., Reading, JC. & Chan, GM. (1999). A Comparison of Calcium, Vitamin D, or Both for Nutritional Rickets in Nigerian Children. *New England Journal of Medicine*, **341**, 563-68.

The Economic and Social Research Institute (2010). Growing Up in Ireland: National Longitudinal Study of Children, the Infants and their families.

The National Dairy Council (ndc) (n.d.). A Guide to Weaning. Innovation House, Dublin.

The National Institute of Health (NIH). Osteoporosis and Related Bone Diseases National Resource Center (2012) Pregnancy, Breastfeeding, and Bone Health [Online], Bethesda, MD: National Resource Center. Available at http://www.niams.nih.gov/Health_info/Bone/Bone_Health/Pregnancy/default.asp. [Accessed February 2013]

Trochim, WMK. (2006. Time in research [Online]. Research Methods Knowledge Base, Web Center for Social Research Methods. Available: http://www.socialresearchmethods.net/kb/timedim.php. [Accessed October 2012].

Tsvetovat, M. & Sharabati, W. (2006). CSS 692: Social Network Analysis [Online]. *Life Journal*, Fall, 1-20. Available: http://www.academic2.american.edu/~sharabat/files/SNA_Problem_Set2.pdf. [Accessed October 2012].

Vogt, WP. (1999). *Dictionary of Statistics and Methodology: A Nontechnical Guide for the Social Sciences*, Sage, London.

Wagner, CL. & Greer, FR. (2008). American Academy of Pediatrics Section on Breastfeeding; American Academy of Pediatrics Committee on Nutrition. Prevention of Rickets and Vitamin D Deficiency in Infants, Children, and Adolescents. *Pediatrics*, **122**, 1142-52.

Wagner, CL., Taylor, SN., Dawodu, A., Johnson, DD. & Hollis, W. (2012). Vitamin D and Its Role During Pregnancy in Attaining Optimal Health of Mother and Fetus. *Nutrients* **4**, 208-30.

Waldie, KE., Poulton, R., Kirk, IJ. & Silva, PA. (2000). The Effects of Pre- and Post-Natal Sunlight Exposure on Human Growth: Evidence from the Southern Hemisphere. *Early Hum Dev*, **60**(1), 35-42.

Waldman, M., Nicholson, S., Adilov, N. & Williams, J. (2008). Autism Prevalence and Precipitation Rates in California, Oregon, and Washington Counties. *Archives of Pediatrics and Adolescent Medicine*, **162**, 1026-34

Wall, CR., DeHaven, MJ. & Oeffinger, KC. (2002). Survey Methodology for the Uninitiated , *J Fam Pract*, **51**, 573-580

Walsh, JM., McGowan, CA., Kilbane, M., McKenna, MJ. & McAuliffe, FM. (2012). The Relationship Between Maternal and Fetal Vitamin D, Insulin Resistance, and Fetal Growth. *Reproductive Sciences*, 1-6. doi:10.1177/1933719112459222.

Walsh, JM., Kilbane, M., McGowan, CA., McKenna, MJ. & McAuliffe, FM. (2013). Pregnancy in dark winters: implications for fetal bone growth. *Fertility and Sterility*, **99**(1),206-211.

Wang, R. (2012). An Investigation of Vitamin D Supplementation Practices for Infants Born in the Coombe Women and Infants Hospital, B.Sc. unpublished dissertation, Dublin Institute of Technology, Dublin.

Wangen, S. (2009). *Healthier without Wheat*, eBookIt.com, Seattle.

Wangyang, L. (2010). Vitamin D Status of Pregnant Women in Vancouver, B.Sc. unpublished dissertation, The University of British Columbia, Vancouver.

Ward, LM., Gaboury, I., Ladhani, M. & Zlotkin, S. (2007). Vitamin D-Deficiency Rickets Among Children in Canada. *Canadian Medical Association Journal*, **177**, 161-66.

Weiler, H., Fitzpatrick-Wong, S., Veitch, R., Kovacs, H., Schellenberg, J., McCloy, U. & Yuen, C. (2005). Vitamin D Deficiency and Whole-Body and Femur Bone Mass Relative to Weight in Healthy Newborns. *Canadian Medical Association Journal*, **172**, 757-61.

Weisberg, P., Scanlon, KS., Li, R. & Cogswell, ME. (2004). Nutritional Rickets Among Children in the United States: Review of Cases Reported Between 1986 and 2003. *American Journal of Clinical Nutrition*, **80**, 1697S-1705S.

Wharton, B. & Bishop, N. (2003). Rickets. *Lancet*, **362**(1), 389-400.

Whelan, B. (2010). An Exploration of Health Professional Support for Breastfeeding, PhD dissertation, Dublin Institute of Technology, Dublin.

Whitney, E., Whitney, E. & Rolfes, SR. (2011). *Understanding Nutrition*, Cengage Learning, New York.

Willer, C., Dyment, DA., Sadovnick, AD., Rothwell, PM., Murray, TJ. & Ebers, GC. for the Canadian Collaborative Study Group (2005). Timing of Birth and Risk of Multiple Sclerosis: Population-based Study. *BMJ*, 330(7483), 120.

Winzenberg, T., Powell, S., Shaw, KA. & Jones, G. (2011). Effects of Vitamin D Supplementation on Bone Density in Health Children: Systematic Review and Meta-analysis. *BMJ*, 342; c7254.

Woodhouse, NYJ. & Norton, WL. (1982). Low Vitamin D Level in Saudi Arabians, King Faisal Spec *Hosp Med J*, **2**, 127-31.

World Health Organization (1985). *Diabetes Mellitus*, Report of a WHO Study Group. Technical Report Series No. 727.

World Health Organization (2001). *Global Strategy for Infant and Young Child Feeding: The Optimal Duration of Exclusive Breastfeeding.* Department of Child and Adolescent Health and Development, 54th World Health Assembly, Geneva.

Zhang, C., Qiu, CF., Hu, FB., David, RM., van Dam, RM., Bralley, A. & Williams, MA. (2008). Maternal Plasma 25-Hydroxyvitamin D Concentrations and the Risk of Gestational Diabetes Mellitus. *PLoS ONE*, **3**(11); e3753. doi:10.137 1/journal.pone.0003753

APPENDICES

Appendix i – Ethics Approval

DECLARATION OF
RESEARCH ETHICS AND/OR ASSESSMENT OF RISK

All research and scholarship proposals, whether funded or not by internal or external funds, must submit a RESEARCH ETHICS/ASSESSMENT OF RISK FORM to the DIT Research Ethics Committee.

This is a self-declaration process. The researcher is asked to formally identify any possible ethical issues or risks that might arise in the course of the work, and to sign the documentation.

Please refer to the Guiding Principles and Procedures indicated on the DIT Research Ethics website prior to completing this form:

- http://www.dit.ie/DIT/graduate/ethics/index.html

PLEASE NOTE

- You are requested to attach a copy of your research application to this form.
- The RESEARCH ETHICS /ASSESSMENT OF RISK FORM must be signed by the applicant(s)
- Ethical Approval must be granted prior to start of any research/scholarly activity or prior to funding being released for the project, as appropriate.
- No postgraduate research student will normally be registered until the proposal is cleared by the DIT Research Ethics Committee.

Completed forms should be returned to: Research Ethics Committee, c/o Office of Graduate Studies, DIT, 143-149 Lower Rathmines Road, Dublin 6.

Title of the proposed project: Vitamin D supplementation practices during pregnancy and infancy among a sample of Muslim women in Ireland and Saudi Arabia
Applicant Details (Use Block Capitals):

Surname: KHADRAWI	Forename: IMANN	Title: MRS
Present appointment:		
School/Department/Centre: SCHOOL OF BIOLOGICAL SCIENCES Faculty: FACULTY OF SCIENCES Work Tel:0861234032 Fax: E-mail: ummyara2008@yahoo.com		

Other departments/organisations/individuals involved: NO a) b) c)
Source of Funding: Saudi Arabia Government
Has the current research project already received approval from another research ethics committee? NO If so, please enclose relevant information and documentation

Generic Projects:

Researchers may receive approval for a cluster of similar research activity by approval of a *generic protocol* to cover repetitive methodologies or activities. A *generic protocol* should comprise a covering letter setting out the circumstances and rationale for generic approval, outlining the procedures to be followed in all such projects, in addition to completion of the appropriate appendices.

If this project is part of a cluster of research with similar methodology, please tick here and submit a generic protocol to cover all such projects. ☐

Insurance

Normally, DIT insurance covers standard research activity, including fieldtrips. Are you aware of any unusual or exceptional risks or insurance issues to which DIT's insurance company should be alerted? If so, please list the issues: NO

Please note that no contract should be entered into for clinical/medical (including drug testing) or surgical trials/tests on any human subject until written confirmation has been received from the DIT's insurers that the relevant insurance cover is in place.

Are you or any members of the research team a member of any organisation that provides professional indemnity insurance? NO

Name of the organisation:

Please provide written confirmation of the terms of insurance cover.

Professional Code of Conduct

Please reference, if appropriate, the Code of Ethical Conduct produced by your relevant professional organization(s), which also informs your research.

Please note that: Where those requirements conflict with DIT requirements, the latter will normally be followed. In all such circumstances, please contact the Office of Research Ethics for clarification.

All researchers must confirm with the Data Protection Act 1988. Please consult the DIT Data Protection Officer for advice.

IDENTIFICATION OF ETHICAL ISSUES AND/OR RISK

Do any of the following ethical issues or risks apply in your research? If so, tick all box(es) which apply and complete the relevant Appendix, which can be downloaded from http://www.dit.ie/DIT/graduate/ethics/index.html		
Yes	**6 No**	**Does your research involve…**
X		Impact on human subject(s) and/or the researcher(s) [Appendix 1]
X		Consent and advice form given to subjects prior to their participation in the research [Appendix 2]
	✓	Consent form for research involving 'less powerful' subjects or those under 18 years [Appendix 3]
	✓	Conflict of interest [Appendix 4]
	✓	Drugs and Medical Devices [Appendix 5]
	✓	Ionising Radiation [Appendix 6]
	✓	Neonatal Material [Appendix 7]
	✓	Animal Welfare [Appendix 8]
	✓	General Risk Assessment [Appendix 9]
	✓	Hazardous Chemical Risk Assessment [Appendix 10]
	✓	Biological Agents Risk Assessment [Appendix 11]
	✓	Work involving Genetically Modified Organisms Risk Assessment [Appendix 12]
	✓	Field Work Risk Assessment [Appendix 13]
If other risk and/or ethical issues are identified please provide a written submission which outlines the issues and the manner in which they are being addressed.		

Please tick the appropriate box below

- ✓ **No, there are no** ethical issues and/or risks involved in your research project, **please tick here, and sign the declaration on page 5.**

- ☐ **Yes, there are ethical** issues and/or risks involved in your research, **please tick here and complete the appropriate forms identified above.**

In accordance with the Principles of the Declaration of Helsinki and DIT Principles and Procedures, I declare that the information provided in this form is true to the best of my knowledge and judgement.

I will advise the DIT Research Ethics Committee *of any adverse or unforeseen circumstances or changes in the research which might concern or affect any ethical issues or risks, including if the project fails to start or is abandoned.*

Signature of applicant 1: *Imann Khadrawi*

Signature of applicant 2: ______________________________________

Signature of applicant 3: ______________________________________

(An electronic signature is permissible)

Checklist

Please ensure the following, if appropriate, are attached:

Documents to be attached	**Tick if attached**	**Tick if not appropriate**
Research Proposal	✓	
Letters (to subjects, parents/guardians, GPs, etc)	✓	
Questionnaire(s)	✓	
6.1 Advertisement/Poster		✓
Ethical clearance from other ethical research committees		✓
Copy of signed agreement of professional indemnity		✓
Generic Protocol		✓
Other (please specify)		✓

Appendix ii A – Consent Form (English)

Researcher's Name :IMANN KHADRAWI (use block capitals)	**Title:** MRS
Faculty/School/Department: SCHOOL OF BIOLOGICAL SCIENCES, FACULTY OF SCIENCES	
Title of Study**:** Vitamin D supplementation practices during pregnancy and infancy among a sample of Muslim women in Ireland and in Saudi Arabia	
To be completed by the: **subject/patient/volunteer/<u>informant/</u>interviewee/parent/guardian *(delete as necessary)***	
3.1 Have you been fully informed/read the information sheet about this study? YES/NO 3.2 Have you had an opportunity to ask questions and discuss this study? YES/NO 3.3. Have you received satisfactory answers to all your questions? YES/NO Have you received enough information about this study and any associated health and safety implications if applicable? YES/NO Do you understand that you are free to withdraw from this study? at any time without giving a reason for withdrawing without affecting your future relationship with the Institute YES/NO Do you agree to take part in this study the results of which are likely to be published? YES/NO Have you been informed that this consent form shall be kept in the confidence of the researcher? YES/NO	
Signed_____________________ Date ___________________ Name in Block Letters: Signature of Researcher _ Imann Khadrawi Date	

Please note:

For persons under 18 years of age the consent of the parents or guardians must be obtained or an explanation given to the Research Ethics Committee and the assent of the child/young person should be obtained to the degree possible dependent on the age of the child/young person. **Please complete the Consent**

Form (section 4) for Research Involving 'Less Powerful' Subjects or Those Under 18 Yrs.

In some studies, witnessed consent may be appropriate.

The researcher concerned must sign the consent form after having explained the project to the subject and after having answered his/her questions about the project.

Appendix ii B- Consent Form (Arabic)

اسم الباحثة: إيمان عبدالله خضراوي	اللقب: آنسة
المدرسة: كلية علوم الأحياء،كلية العلوم	
عنوان الدراسة :مكملات فيتامين د و الممارسات أثناء فترة الحمل والرضاعة لدى عينة من النساء المسلمات المقيمات في إيرلندا والمملكة العربية السعودية.	
يجب أن يتم تعبئة الموذج وفق المعلومات الشخصية	
١,٣ هل بلغت/قراءتي ورقة المعلومات الخاصة بالبحث؟ نعم/لا ٢,٣ هل كان لديك فرصة لطرح الأسئلة ومناقشة هذة الدراسة؟ نعم/لا ٣,٣ هل تلقيت أجابات مقنعة لجميع أسئلتك؟ نعم/لا هل تلقيت معلومات كافية عن هذة الدراسة وجميع الأمور الصحية وأثرها على السلامة إن وجدت؟ نعم/لا هل تعلمي أنه لديك الحريه في الإنسحاب من هذة الدراسة؟ نعم/لا في أي وقت من غير أن تعطي سبب لإنسحابك هل انت موافقة على المشاركة في هذة الدراسة التي من المرجح أن يتم نشر نتائجها؟ نعم/لا هل بلغت أن نموذج الموافقة هذا سيتم حفظه في مكان آمن من قبل الباحثة؟ نعم/لا	
توقيعك:---------------------- التاريخ: --------------- اسمك: توقيع الباحثة:------------------------ التاريخ:-------------------	

يرجى ملاحظة مايلي :

يجب على الباحثة المعنية التوقيع على الإستمارة بعد أن شرحت المشروع لهذا الموضوع، وبعد أن أجابت لها على جميع الأسئلة المتعلقة بالمشروع

Appendix iii A – Information sheet

Title of Research Study:

"Vitamin D supplementation practices during pregnancy and infancy among a sample of Muslim women in Ireland and Saudi Arabia"

INFORMATION SHEET FOR PARTICIPANTS

Dear Mother,

You are invited to take part in a research study to explore current supplementation practices among pregnant Muslim women and infants living in Saudi Arabia and Ireland.

Before you decide whether to take part in the study it is important that you understand what the research is for and what you will be asked to do. Please take time to read the following information and discuss it with me if you wish. It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep. You will also be asked to sign a consent form. You are welcome to phone me if you would like any further information.

The purpose of the research study is to (1) identify the level of vitamin D supplementation among pregnant Muslim women living in Saudi Arabia and Ireland, (2) compare adequacy of vitamin D supplementation practices among Muslim pregnant women in Ireland to Saudi Arabia and (3) to use the obtained knowledge to increase awareness in pregnant Muslim women. I would like to ask you to answer some questions about your health during pregnancy and your knowledge of Vitamin D. There isn't any right or wrong answers – I just want to know your opinion.

You have been chosen because you have had a baby in the past 24 months. The study will involve up to 400 participants, 200 Muslim women living in Ireland and 200 Muslim women from Saudi Arabia, who will be interviewed individually. The interview will take approximately [15 min]. If you choose to take part I will organize a time and a location for the interview convenient to you.

The information gained from this research will reveal the current level of vitamin D supplementation among pregnant women in Ireland and Saudi Arabia. This will help us to more readily identify newborns and infants born from mothers with vitamin D deficiency that may be at risk and would therefore benefit from early supplementation.

You are free to stop the interview at any time if you do not wish it to continue.

The interview will be in person Via Apple iPad survey software. The iPad will be stored in a locked secure place at all times and the computer data will be protected from intrusion also. Your response will be treated with full confidentiality and anyone who takes part in the research will be identified only by code numbers and not by name. You can request a copy of the interview transcript if you wish. The interviews will be analyzed by using a computer package by myself. At the end of the research I will write a report and the results may be published in peer reviewed journals and conference presentations. No research participant will be identifiable from any publications. This study has been reviewed and approved by the Research Ethics Committee at DIT.

Please do not hesitate to contact me if you need any further information

Thanking you in anticipation,

Yours sincerely,

NAME: Imann Khadrawi
CONTACT DETAILS: Mob: 0861234032 email: ummyara2008@yahoo.com

If you wish to contact my DIT Master supervisors about this study, you may contact:

Dr. John Kearney, email: john.kearney@dit.ie or Dr. Mairead Stack, email: mairead.stack@dit.ie

Appendix iii B – Information Sheet (Arabic)

عنوان الدراسة البحثية

" مكملات فيتامين د والممارسات أثناء فترة الحمل والرضاعة لدى عينة من النساء المسلمات المقيمات في إيرلندا والمملكة العربية السعودية "

ورقة معلومات للمشاركات

عزيزتي الأم :

أنت مدعوة للمشاركة في دراسة بحثية لإكتشاف وتحديد نقاط القوة والضعف في الممارسات الحالية المتعلقة بمكملات فيتامين د لدى النساء المسلمات الحوامل والمرضعات المقيمات في إيرلندا والمملكة العربية السعودية الذين هم في خطر بسبب نقص (عوز) فيتامين د والتي من الممكن أن يكون لها تأثير سلبي على صحة الأم والجنين.

قبل أن تقرري ما إذا كنت ستشاركين في هذه الدراسة من المهم أن تعرفي ماهو البحث وما الذي سوف يطلب منك القيام به. يرجى أن تأخذي الوقت الكافي لقراءة المعلومات التالية ومناقشتها مع الآخرين إن رغبتي في ذلك. الأمر متروك لك ما إذا كنت تريدي المشاركة أم لا. إذا قررتي المشاركة في الدراسة سوف تعطى لك هذة الورقة للإحتفاظ بها كما سوف يطلب منك التوقيع على إستمارة موافقة. يمكنك أن تغيري رأيك في أي وقت أو أن تنسحبي من الدراسة دون إعطاء سبب. مستوى الإهتمام بك لن يتغير ما إذا قررتي المشاركة أم عدم المشاركة في هذة الدراسة. لمزيد من المعلومات لا تترددي بالإتصال بي هاتفيا.

الغرض من هذه الدراسة البحثية هو (١) تحديد مدى إنتشار استخدام مكملات فيتامين د لدى النساء المسلمات الحوامل والمرضعات اللاتي يقمن في إيرلندا والمملكة العربية السعودية ، (٢) مقارنة ممارسة استخدام مكملات فيتامين د بين النساء المسلمات المقيمات في إيرالندا والمملكة العربية السعودية (٣) استخدام المعلومات الي تم الحصول عليها من أجل زيادة الوعي لدى النساء المسلمات الحوامل.

أود أن أطلب منك أن تجيبي على أسئلة حول صحتك أثناء الحمل ومعرفتك بفيتامين د ، ليس هناك أي إجابات صحيحة أو خاطئة – أريد فقط أن أعرف رأيك حول الموضوع.

لقد تم إختيارك لأنك أنجبتي طفل خلال ال ٢٤ شهر الماضية. سوف تشمل هذه الدراسة ٤٠٠ مشاركه، ٢٠٠ إمرأة مسلمة من إيرلندا و ٢٠٠ إمرأة مسلمة من المملكة العربية السعودية وسوف يتم مقابلتهن كلن على حدا. المقابلة سوف تأخذ حوالي ١٥ دقيقة . إذا أردتي المشاركة سوف أنظم مكان مناسب لإجراء المقابلة.

يمكنك أن توقفي المقابلة في أي وقت إن كنتي لا ترغبي في الإستمرار.

سوف تتم مقابلة الشخص عن طريق برنامج مسح على الاي باد وسيتم تخزين الاي باد في مكان مأمون ومغلق في جميع الأوقات، وسيتم كذلك حماية بيانات الكمبيوتر من التسلل إيضا. سوف تعامل إجابتك بسرية تامة وأي شخص سيشارك في هذا البحث سوف يتم تحديده من قبل رمز فقط. يمكنك طلب نسخة من نص المقابلة إن رغبتي. سيتم تحليل هذه المقابلات عن طريق استخدام الكمبيوتلا من قبلي فقط. في نهاية البحث سوف أكتب تقريرا ومن الممكن أن يتم نشر النتائج في مجلات أو إستعراضها في مؤتمر لن يستطيع أحد التعرف على المشاركين تماما. لقد إستعرضت هذه الدراسه على DIT ولقد تم الموافقة عليها.

لا تترددي بالإتصال بي إذا كنتي بحاجة إلى مزيد من المعلومات

شكرا لك

الاسم : إيمان عبدالله خضراوي

محمول: ٠٥٥٦٥٢٥٠٢٥

إيميل : ummyara2008@yahoo.com

لمزيد من المعلومات حول هذه الدراسة يمكنك الإتصال :

Dr. John Kearney, email: john.kearney@dit.ie

Appendix iv A – Questionnaire (English)

Vitamin D supplementation practices during pregnancy and infancy among a sample of Muslim women in Ireland and in Saudi Arabia.

This work does not involve names and so is **completely ANONYMOUS.**

No. -------------- Date of survey --------------------------

Location -----------------------

Section One: Pregnancy health information

1. Did you have any health problems during your pregnancy?
   1. Yes O
   2. No O

   If so, what did you have? (Please state) ----------------

2. Describe your overall health during your pregnancy? (Please tick one)

1. Excellent O 2. Good O 3. Fairly good O 4. Poor O 5. Very poor O

3. Have you been diagnosed with any of the following during your pregnancy:
   1. Gestational diabetes YES O / NO O
   2. Preeclampsia YES O / NO O
   3. Crohn's disease YES O / NO O
   4. Ulcerative colitis YES O / NO O
   5. Coeliac disease (Celiac sprue) YES O / NO O

4. Did you take any nutritional supplements during your pregnancy?

   1. Yes O

   2. No O (Please go to question7)

   If so, please state what you took?

   ----

5. When did you start taking supplements? (Please tick one)

   1- Before conception

   2- During early pregnancy (1-4 months)

   3- During late pregnancy

   4- After the baby was born

6. How much did you take per day? (Please state)

   ----

7. Have you ever had a blood test to check your Vitamin D level?

   1. Yes O

   2. No O

8. Did you take any Vitamin D supplements during your pregnancy?

   1. Yes O

   2. No O (Please go to question 12)

   If yes, please state when did you start taking Vitamin D?

   ----

9. Which kind of Vitamin D supplements you used? (Please state)

   ----

10. How many Vitamin D supplements tablets did you take daily during your pregnancy? (Please state)

----

11. Who/Which of the following have influenced you to use Vitamin D supplements? (Please tick as many as you wish)

    1. Yourself O
    2. Your mother O
    3. Your sister O
    4. Your family O
    5. Your doctor O
    6. Your nurse O
    7. Book/Magazine O
    8. Internet O
    9. Friends O
    10. T.V O

12. Do you eat Salmon, Trout, Tuna or other oily fish (Mackerel, Sardines, and Herring)?

    1. Yes O
    2. No O (Please go to question 13)

If yes, how often: (Please tick one)

1. Once a week O
2. Twice a week O
3. Three times a week O
4. More than three times a week O

13. Did you take Cod liver oil or Omega-3 fatty acid supplements?

   1. Yes O
   2. No O

14. Which of the following Dairy products do you normally consume? (Please tick as many as you wish)

   1. Fresh milk O
   2. Powdered/Dried milk O
   3. Soya milk O
   4. Yoghurt O
   5. High fat cheese (cheddar) O
   6. Low fat cheese (cottage) O
   7. Butter or dairy spreads O
   8. Cream or Ice cream O

15. How often do you consume dairy products? (Please tick one)

   1. Never O
   2. Rarely O
   3. Once per week O
   4. Every day O

16. How much do you consume daily? (Please state)

Section Two: Your skin and the sun

17. What skin color do you have? (Please tick one)

    1. Light O
    2. Medium O
    3. Dark O

18. On an average day, how much time do you spend outside? (Please tick one)

    1. None O
    2. Less than 5 minutes per day O
    3. 5 – 15 minutes per day O
    4. 15 – 30 minutes per day O
    5. More than 30 minutes per day O

19. When you are outside do you: (Please tick as many as you wish)

    1. Normally cover your arms and your legs O
    2. Cover your hair O
    3. Wear sunglasses O

20. Do you wear sunscreen just in the summer months or in winter too? (Please tick one)

    1. Just summer O
    2. Summer and winter O
    3. Neither O

21. How does your skin react when you sit in the sun? (Please tick one)

    1. Tan easily O
    2. Burn then peel O
    3. Burn then tan O

Section Three: Breastfeeding and Vitamin D

22. How did you feed your baby?

    1. Breastfeeding O
    2. Bottle-feed " formula milk" O (Please go to question 25)
    3. Combined feeding O

23. Are you still breastfeeding your baby?

    1. Yes O (Please go to question 26)
    2. No O

24. If no, at what age did you stop breastfeeding your baby? (Please state)

    ----

25. If you are using Formula feeding what are the brand names that you use? (Please state)

    ----

26. At what age did you start your baby on solid food/ spoon feeds? (Please state)

    ----

27. What was the first food?

    ----

28. Did you give your baby any supplements?

    1. Yes O
    2. No O (Please go to question 29)

If so, what are they?

----

29. Have you ever heard about recommendations to give your baby Vitamin D drops?

    1. Yes O
    2. No O (Please go to question 31)

30. If yes (you have heard about Vitamin D recommendations), where did you hear about them? (Please tick as many as you wish)

    1. Your mother O
    2. Your sister O
    3. Internet O
    4. Book/Magazine O
    5. Your doctor O
    6. T.V O
    7. Your nurse O
    8. Family O
    9. Relatives O

31. Have you given your baby Vitamin D drops?

    1. Yes O
    2. No O (Please go to question 32)

If yes, what was the brand name?

----

32. Are you aware of Vitamin D guidelines for babies?

1. Yes O
2. No O

33. Are you aware of the FSAI which is Food Safety Authority Vitamin D guidelines for babies? (Ireland only)

1. Yes O
2. No O

34. Are you aware of any risks associated with taking Vitamin D supplements?

1. Yes O
2. No O (Please go to question 35)

If so, please state any risk you associate with taking Vitamin D supplements?

----

35. To what extent do you agree with the following statements: (Please circle only one)

1. Giving children Vitamin D protects them against rickets

   Totally agree Agree Disagree Totally disagree don't know

2. Taking Vitamin D reduces cancer risk.

   Totally agree Agree Disagree Totally disagree don't know

3. Taking Vitamin D may prevent heart disease.

   Totally agree Agree Disagree Totally disagree don't know

4. Taking Vitamin D helps to increase muscle strength.

   Totally agree Agree Disagree Totally disagree don’t know

5. Taking Vitamin D makes bones healthy.

   Totally agree   Agree   Disagree   Totally disagree   don't know

6. Taking Vitamin D reduces the risk of Multiple Sclerosis (MS).

   Totally agree   Agree   Disagree   Totally disagree   don't know

7. Taking Vitamin D decrease the risk of high blood pressure.

   Totally agree   Agree   Disagree   Totally disagree   don't know

<u>Section Five: General information</u>

36. What is your nationality: ------------

37. Country of birth: ------------

38. Number of months in Ireland: -----------

39. Your age(years): -----------

40. Age when you had the baby: ------------

41. Is this your first baby? ---------

42. Was your (most recent) child born in Ireland or abroad? ----------

43. Did you have your baby by normal delivery or by caesarean delivery? -----------
    ----

44. What is your baby's birth date? ---/----/------

45. Your baby is:

1. Girl O
2. Boy O

46. What was your baby's birth weight?

-------Kg ----------lbs

47. What is your current living situation? (Please tick one)

1. Married O
2. Divorced O
3. Separated O
4. Widowed O

48. What is your highest education level?

1. Primary school O
2. Secondary school O
3. Higher education O

49. What is your occupation: (Please tick one)

1. House wife O
2. Employed O
3. Student O

4. Retired O

5. Other (specify)-----------

50. What level of education did your husband complete? (Please tick one)

1- Primary school O

2- Secondary school O

3- Higher education O

51. What is your husband occupation? (Please state)

Thank you for your participation

Appendix iv B – Questionnaire (Arabic)

" مكملات فيتامين د والممارسات أثناء فترة الحمل والرضاعة لدى عينة من النساء المسلمات المقيمات

في إيرلندا والمملكة العربية السعودية "

هذا الإستبيان لا يشتمل على إي أسم لذا هو بالكامل سري

تاريخ الإستبيان: ..../......./....... **الرقم: .... للباحثة***

الموقع: ....

<u>القسم الأول : معلومات عن صحتك خلال فترة الحمل</u>

١. هل كان لديك أي مشاكل صحية خلال فترة الحمل ؟
١. نعم o
٢. لا o
إذا كانت الإجابة بنعم، ماذا كان لديك؟ (أرجوا التحديد):......................................

٢. كيف كانت حالتك الصحية بشكل عام خلال فترة الحمل؟ أرجوا إختيار أحد الإجابات أدناه:
١. ممتازة o ٢. جيدة o ٣. مقبولة o ٤. سيئة o ٥. سيئة جداً o

٣. هل سبق وأن تم تشخيصك بأحد هذه الأمراض المذكورة أدناه خلال فترة الحمل:

١. سكري الحمل.	نعم	o	لا	o
٢. تسمم الحمل.	نعم	o	لا	o
٣. مرض كرون.	نعم	o	لا	o
٤. إلتهاب القولون التقرحي.	نعم	o	لا	o
٥. حساسية معوية.	نعم	o	لا	o

٤. هل أستخدمتي أي مكملات غذائية خلال فترة الحمل؟
١. نعم o
٢. لا o (إنتقلي إلى السؤال٧)
إذا كانت الإجابة بنعم، ماذا كنتي تستخدمي؟ (أرجوا التحديد):......................................

٥. متى بدأتي بأستخدام هذه المكملات؟ (إختاري أجابة واحدة)
١. قبل الحمل o
٢. أثناء الشهور الأولى من الحمل (١-٤ شهور) o

٣. أثناء الشهور الأخيرة من الحمل o
٤. بعد الولادة o

٦. كم كانت الكمية المستخدمة (الجرعة) يومياً لهذه المكملات؟ (أرجوا التحديد)

....

٧. هل سبق أن قمتي بإجراء فحص للدم لتحديد مستوى فيتامين د ؟
١. نعم o
٢. لا o

٨. هل أخذتي مكملات فيتامين د خلال فترة الحمل؟
١. نعم o
٢. لا o (إنتقلي للسؤال ١٢)
إذا كانت الإجابة بنعم، متى بدأتي بإستخدامها؟ (أرجو التحديد)

....

٩. ما هو النوع (اسم الشركة) الذي إستخدمتيه؟(أرجو التحديد)

....

١٠. كم كانت الكمية (الجرعة) المتناولة يومياً من هذه المكملات؟ (أرجو التحديد)

....

١١. أي مما يلي نصحك بإستخدام مكملات فيتامين د؟ (يمكن إختيار أكثر من إجابة)

١. نفسك o
٢. والدتك o
٣. أختك o
٤. عائلتك o
٥. طبيبك o
٦. ممرضتك o
٧. كتاب/مجلة o
٨. الإنترنت o
٩. أصدقائك o
١٠. التلفاز o

١٢. هل تأكلي سمك السالمون، سمك الترويت، التونا أو غيرها من الأسماك الغنية بالزيوت (الماكريل، السردين، الرنجة)؟

١. نعم o

٢. لا o (إنتقلي للسؤال ١٣)

إذا كانت الإجابة بنعم، كم مرة في الأسبوع؟(إختاري إجابة واحدة):

٣. مرة واحدة في الأسبوع o

٤. مرتين في الأسبوع o

٥. ثلاث مرات في الأسبوع o

٦. أكثر من ثلاث مرات في الأسبوع o

١٣. هل تأخذي زيت كبد الحوت او مكملات أوميغا ٣؟

١. نعم o

٢. لا o

١٤. أي من منتجات الألبان التالية تستهلكينها عادة؟ (يمكن إختيار أكثر من إجابة)

١. حليب طازج o

٢. حليب المجفف o

٣. حليب الصويا o

٤. زبادي (الروب) o

٥. جبن عالية الدهون (تشدر) o

٦. جبن منخفضة الدهون (ريكوتا) o

٧. زبدة أو منتجات الألبان القابلة للدهن o

٨. قشطة طازجة أو آيس كريم o

١٥. كم عادة تتناولين من منتجات الألبان؟

١. أبداً o

٢. نادراً o

٣. مرة في الأسبوع o

٤. كل يوم o

١٦. ما مقدار ما تستهلكينه يومياً؟ (أرجو التحديد)

....

القسم الثاني: بشرتك والشمس

١٧. ماهو لون بشرتك؟ (إختاري إجابة واحدة)

١. فاتحة o

٢. وسط o

٣. غامقة o

١٨. في اليوم العادي، كم من الوقت تمضينه خارج المنزل؟ (إختاري إجابة واحدة)

١. لاشيء o

٢. أقل من ٥ دقائق يومياً o

٣. من ٥ -١٥ دقيقة يومياً o

٤. من ١٥- ٣٠ دقيقة يومياً o

٥. أكثر من ٣٠ دقيقة يومياً o

١٩. عادة حينما تكوني خارج المنزل هل: (يمكن إختيار أكثر من إجابة)

١. تغطي ذراعك وساقك o

٢. تغطي شعرك o

٣. ترتدين النظارات الشمسية o

٢٠. هل تستخدمين كريم واقي الشمس فقط في أشهر الصيف أم إيضاً في أشهر الشتاء؟ (إختاري إجابة واحدة)

١. في الصيف فقط o

٢. في الصيف وفي الشتاء o

٢١. كيف تكون ردة فعل جلدك عندما تجلسين في الشمس؟ (إختاري إجابة واحدة)

١. تان بسهولة o

٢. حرق ثم تقشر o

٣. حرق ثم تان o

القسم الثالث: الرضاعة الطبيعية وفيتامين د

٢٢. كيف ترضعين طفلك؟

١. رضاعة طبيعية o

٢. رضاعة إصطناعية o **(إنتقلي للسؤال ٢٥)**

٣. رضاعة مزدوجة o

٢٣. هل لا زلت ترضعين طفلك رضاعة طبيعية؟

١. نعم o **(إنتقلي للسؤال ٢٦)**

٢. لا o

٢٤. إذا كانت الإجابة لا، كم كان عمر طفلك حينما توقفتي عن إرضاعة رضاعة طبيعية؟ (أرجو التحديد)

....

٢٥. ما هي أسماء الشركات التي تستخدمينها؟(أرجو التحديد)

....

٢٦. كم كان عمر طفلك حينما بدأتي بتقديم الأطعمة الصلبة له؟ (أرجو التحديد)

....

٢٧. ما هو أول طعام صلب تناوله طفلك؟

....

٢٨. هل أعطيت طفلك أي مكملات غذائية؟

١. نعم o

٢. لا o **(إنتقلي للسؤال ٢٩)**

إذا كانت الإجابة بنعم، فما هي ؟

....

٢٩. هل سبق وأن سمعت عن توصيات لإعطاء طفلك قطرات فيتامين د؟

١. نعم o

٢. لا o **(إنتقلي للسؤال ٣١)**

٣٠. اين سمعت عن هذه التوصيات؟ (يمكن إختيار أكثر من إجابة)

١. والدتك o
٢. أختك o
٣. الإنترنت o
٤. كتاب/مجلة o
٥. طبيبك o
٦. ممرضتك o
٧. عائلتك o
٨. أقاربك o
٩. التلفاز o

٣١. هل أعطيت طفلك قطرات فيتامين د؟

١. نعم o
٢. لا o (إنتقلي للسؤال ٣٢)

إذا كانت الإجابة بنعم، ماهو اسم الشركة؟

....

٣٢. هل أت على علم بالمبادئ التوجيهية لفيتامين د للرضع؟

١. نعم o
٢. لا o

٣٣. هل أنت على علم بالمبادئ التوجيهية لفيتامين د للرضع الصادرة من (FSAI) سلطة سلامة الاغذية الايرلندية؟ (للأخوات في إيرلندا فقط)

١. نعم o
٢. لا o

٣٤. هل أنت على علم بأي مخاطر متعلقة بتناول مكملات فيتامين د؟

١. نعم o
٢. لا o (إنتقلي للسؤال ٣٥)

إذا كانت الإجابة بنعم، ارجو ذكر المخاطر ؟

....

٣٥. إلى أي مدى توافق على العبارات التالية: (إختاري إجابة واحدة)

١.إعطاء الأطفال فيتامين د يقيهم من الكساح

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

٢.تناول فيتامين د يقلل من مخاطر الإصابة بالسرطان

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

٣.تناول فيتامين د قد يمنع الإصابة بأمراض القلب

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

٤.تناول فيتامين د يساعد على زيادة قوة العضلات

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

٥.تناول فيتامين د يجعل العظام قوية و صحية

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

٦.تناول فيتامين د يقلل من خطر الإصابة باالتصلب المتعدد (MS)

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

٧.تناول فيتامين د يقلل من خطر الإصابة بإرتفاع ضغط الدم

لا أعلم لا أوافق بشدة لا أوافق أوافق أوافق بشدة

القسم الخامس: معلومات عامة

٣٦. ماهي جنستك: ....

٣٧. بلد الميلاد: ....

٣٨. عدد الأشهر في إيرلندا: ....

٣٩. عمرك: ....

٤٠. عمرك عندما أنجبت طفلك: ....

٤١. هل هذا طفلك الأول: ....

٤٢. هل ولد طفلك (الأخير) في إيرلندا أم في الخارج؟ ....

٤٣. هل كانت ولادة طبيعية أم ولادة قيصرية؟...................................

٤٤. تاريخ ولادة طفلك؟ ..../........../.............

٤٥. ماهو جنس طفلك؟

١. ذكر o ٢. أنثى o

٤٦. وزن طفلك عند الاولادة؟

...............Ibc Kg ....

٤٧. ماهي حالتك الإجتماعية الحالية؟ (إختاري إجابة واحدة)

١. متزوجة o

٢. مطلقة o

٣. منفصلة o

٤. أرملة o

٤٨. ماهو مستواك التعليمي؟

١. إبتدائي o

٢. ثانوي o

٣. تعليم عالي o

٤٩. ماهي وظيفتك الحالية؟ (إختاري إجابة واحدة)

١. ربة منزل o

٢. موظفة o

٣. طالبة o

٤. متقاعدة o

٥. أخرى(أرجو التحديد) ....

٥٠. ماهو مستوى زوجك التعليمي؟ (إختاري إجابة واحدة)

١. إبتدائي o

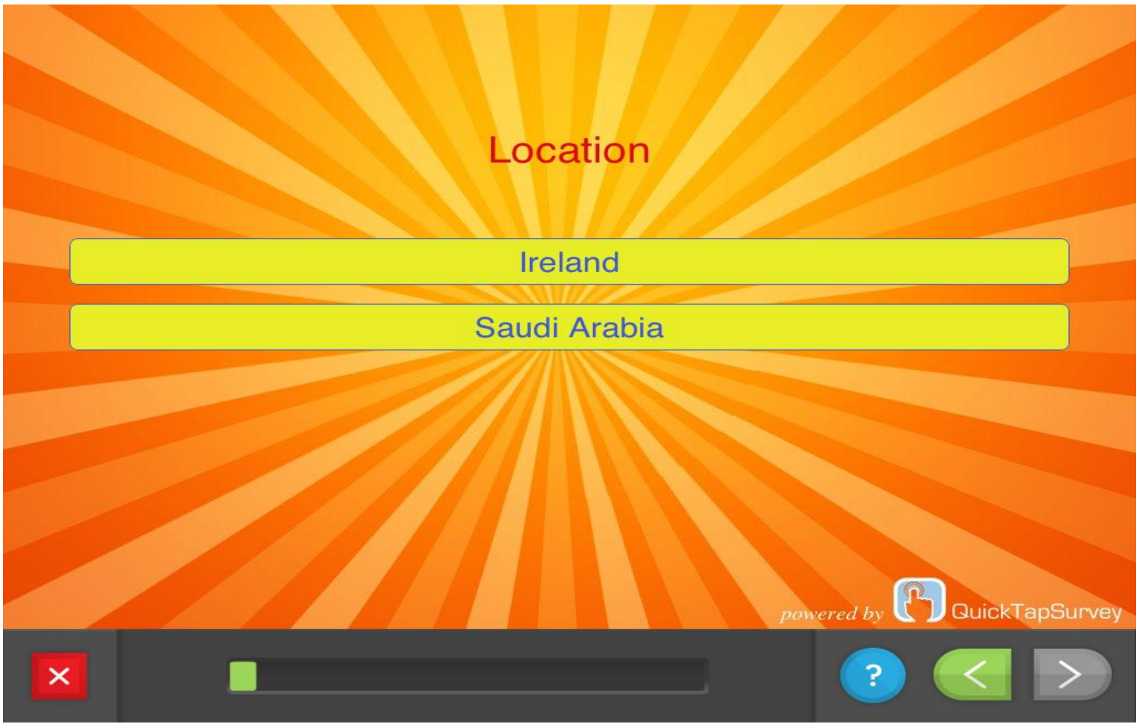
٢. ثانوي o

٣. تعليم عالي o

٥١. ماهي وظيفة زوجك؟ (أرجو التحديد) ....

أشكرك على المشاركة

Appendix v – Sample of iPad Survey Application




Are you aware of the FSAI which is Food Safety Authority Vitamin D guidelines for babies? (Ireland only)
YES
NO
powered by QuickTapSurvey
?


Are you aware of Vitamin D guidelines for babies?
YES
NO
powered by QuickTapSurvey
?