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

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Technological University Dublin

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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

By:-
Imann Khadrawi

Supervisors:-
Dr. John Kearney and Dr. Mairead Stack

School of Biological Sciences
Dublin Institute of Technology
April 2013
DECLARATION 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.

This thesis was prepared in accordance with the regulations for postgraduate study of Dublin Institute of Technology and has not been submitted in whole or in part for an award in any other Institute or University.

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Declaration of the researcher

Signature

Date: 25 April 2013

Imann Abdullah Khadrawi
AKNOWLEGMENT

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.

Special appreciation goes to my supervisors, Dr. John Kearney and Dr. Mairead Stack, for their enthusiasm, encouragement and guidance, without which this project could not have been completed. My gratitude mostly goes to the mothers who gave their time for the interview and without whose support this research would not have been possible. Special thanks to the people who helped me at the Islamic Culture Center of Ireland especially Sister Summayah Kenna and Brother Ahmed and Al-Noor and Hera'a and Maternity and Children Hospitals in Makkah, Saudi Arabia. Thanks also to Annemarie for her help and support.

I would like to thank my beloved family for all that they did for me from the beginning of my life until now. My thanks go to my father, Mr. Abdullah Khadrawi, and my mother, Mrs. Fatimah Hashim for their prayers, support and encouragement to do my best and for always believing in me. I would like to thank my sister Rawiah and my brother Ismail for their support.

Sincere thanks to my husband Emad for being a great supportive. I would like to thank him for his help, encouragement, love and care. I would like to thank my daughter Yara and my son Adnan for their patience.

To those who indirectly contributed in this research, your kindness means a lot to me. Thank you very much.
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

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

MENA
Middle East and North Africa

μg/d
Microgram per day

mm
Millimeter

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 coefficient

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)D_{3}  25-hydroxyvitamin D
1,25(OH)_{2}D_{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 1 diabetes, 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.

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

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)$_2$D$_3$ 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)$_2$D$_3$) by the enzyme 1-α-hydroxylase (1-αOHase or CYP27B1) (Azhar,2009). 1,25(OH)$_2$D$_3$ 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)$_2$D$_3$ from the liver and turn it to 1,25(OH)$_2$D$_3$ (Bouillon, Norman and Lips, 2007). 1,25(OH)$_2$D$_3$ 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)$_2$D$_3$ 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)$_2$D$_3$ 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

<table>
<thead>
<tr>
<th>Vitamin D level nmol/L*</th>
<th>Vitamin D level ng/ml</th>
<th>Health Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25</td>
<td>&lt;10</td>
<td>Considered deficiency</td>
</tr>
<tr>
<td>25-50</td>
<td>10-20</td>
<td>Considered as insufficient</td>
</tr>
<tr>
<td>&gt;50</td>
<td>&gt;20</td>
<td>Considered adequate</td>
</tr>
</tbody>
</table>

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 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° (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° 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

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 Musculoskeletal 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 its 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 musculoskeletal and non-musculoskeletal 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 musculoskeletal 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 hypercalcemia 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)\(_2\)D\(_3\) 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)\textsubscript{2}D\textsubscript{3} concentrations among 36 rachitic infant’s mothers residing in central Saudi Arabia. The results indicated extremely low levels of serum 25(OH)\textsubscript{2}D\textsubscript{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)\textsubscript{2}D\textsubscript{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 Musculo-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)\textsubscript{2}D\textsubscript{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)\textsubscript{2}D\textsubscript{3} 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)\textsubscript{2}D\textsubscript{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)\textsubscript{2}D\textsubscript{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)\textsubscript{2}D\textsubscript{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)\textsubscript{2}D\textsubscript{3}, and fetal femur length at 20 weeks in the winter cohort. Additionally a positive correlation was noted between 25(OH)\textsubscript{2}D\textsubscript{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)\textsubscript{2}D\textsubscript{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 D3 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 D3 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 D3 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)\(_2\)D\(_3\) 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)D₃ 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)D₃ 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)D₃ 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)2D3 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 D3 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)2D3 and fetal adiposity or weight at 34 gestation weeks.

Al-Harthy, El-Metwaly and Al-Seoud (2012) measured 25(OH)2D3 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)2D3 >75 nmol/L, insufficient 25(OH)2D3 37.5 – 75 nmol/L) and deficient 25(OH)2D3 <37.5 nmol/L). The findings revealed a range of 3 to 91 nmol/L for the levels of 25(OH)2D3
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)2D3 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)D3 revealed a weak association between birth weight and 25(OH)2D3 (Al-Harthy, El-Metwaly and Al-Seoud, 2012).

2.6.4.2 Type 1 diabetes

Type 1 diabetes 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 1 diabetes and vitamin D is not new. Baumgartl et al. (1991) showed that measuring serum 25(OH)2D3 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 type 1 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)\textsubscript{2}D\textsubscript{3} concentration level was the same for both patients and controls. In addition, they found a significant negative association between PTH and 25(OH)\textsubscript{2}D\textsubscript{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 $25(\text{OH})_2\text{D}_3$ 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)\(_2\)D\(_3\) 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)\(_2\)D\(_3\) 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).

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>EU</th>
<th>UK</th>
<th>Ireland</th>
<th>Saudi Arabia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>The minimum</td>
<td>The requirements</td>
<td>The requirements</td>
<td>The lower limit for</td>
<td>Infants should</td>
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<tr>
<td></td>
<td>supplementation</td>
<td>for children from 6</td>
<td>for children from 6</td>
<td>infants for</td>
<td>be allowed</td>
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<tr>
<td></td>
<td>requirements for</td>
<td>m-1yr are 25µg/per,</td>
<td>m-5yr are 7µg/per</td>
<td>supplements is 5 µg</td>
<td>substantial</td>
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<tr>
<td></td>
<td>children below 12m</td>
<td>from 1yr-10 yr 50 µg</td>
<td>day and upper limits</td>
<td>µg/per day and</td>
<td>intake of vitamin</td>
</tr>
<tr>
<td></td>
<td>are 10µg/per day</td>
<td>per day</td>
<td>vitamin D. The</td>
<td>limits is 25 µg/</td>
<td>D in comparative</td>
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<td></td>
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<td></td>
<td>requirements for</td>
<td>per day.</td>
<td>levels similar to</td>
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<td>breastfed infant</td>
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<td></td>
<td>from 1m-6m are 8.5 µg</td>
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<td>currently offers</td>
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<td>per day.</td>
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<td>as recommended</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>by (IOM, 2010).</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>15 µg/per day</td>
<td>100 µg/per day</td>
<td>10µg/per day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adults</td>
<td>20 µg/per day</td>
<td>100 µg/per day</td>
<td>pregnant and</td>
<td></td>
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<tr>
<td></td>
<td>pregnant and</td>
<td></td>
<td></td>
<td>breastfeeding women</td>
<td>Vitamin D levels</td>
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<td>breastfeeding women</td>
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<td>this group takes</td>
<td>should be increased</td>
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<td>this group takes</td>
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<td></td>
<td>10µg/per day</td>
<td>during the summer</td>
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<td></td>
<td>10µg/per day</td>
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<td>months for pregnant</td>
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<td>and lactating</td>
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<td>women.</td>
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<tr>
<td>Pregnancy</td>
<td>(IOM, 2010)</td>
<td>(EFSA., 2012)</td>
<td>(Barts and the</td>
<td>(FSAL2007) (HSE,</td>
<td>Saudi Food and</td>
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<td>london school of</td>
<td>2010)</td>
<td>Drug Authority</td>
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<td></td>
<td>medicen and</td>
<td></td>
<td>(SFDA, n.d)</td>
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<td></td>
<td></td>
<td></td>
<td>dentistry, 2011)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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).

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>EU</th>
<th>UK</th>
<th>Ireland</th>
<th>Saudi Arabia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0-6 months</td>
<td>10</td>
<td>—</td>
<td>8.5×</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>6-12 months</td>
<td>10</td>
<td>10−25</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10 years</td>
<td>15</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Adults (Male)</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10−15</td>
<td></td>
</tr>
<tr>
<td>Adults (Female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥65</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Pregnant &amp;</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>lactating women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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

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)\(_2\)D\(_3\) 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)₂D₃ 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)₂D₃ 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

<table>
<thead>
<tr>
<th></th>
<th>Ireland</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Mothers should exclusively breastfeed infants for the first six months (FSAI, 1999).</td>
</tr>
<tr>
<td>B</td>
<td>Mothers should desist from introducing complementary food before 15 weeks, unless recommended by a medical practitioner (FSAI, 1999).</td>
</tr>
<tr>
<td>C</td>
<td>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).</td>
</tr>
<tr>
<td>D</td>
<td>In the case of formula-based milk, weaning should begin in the fourth month, while continuing the formula for one year (FSAI, 1999).</td>
</tr>
<tr>
<td>E</td>
<td>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).</td>
</tr>
</tbody>
</table>

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

*Pearson’s chi-square test used to determine differences  *Significant p<0.05
Ω 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](image)

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)

<table>
<thead>
<tr>
<th>Time (years)</th>
<th>Ireland % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;3</td>
<td>50.6 (39)</td>
</tr>
<tr>
<td>1 to 2</td>
<td>22.1 (17)</td>
</tr>
<tr>
<td>&lt;1</td>
<td>27.3 (21)</td>
</tr>
</tbody>
</table>

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 (%)

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

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

<table>
<thead>
<tr>
<th></th>
<th>Ireland (n=77) % (n)</th>
<th>Saudi Arabia (n=121) % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every day</td>
<td>94.8 (73)</td>
<td>86.8 (105)</td>
</tr>
<tr>
<td>Once a week</td>
<td>3.9 (3)</td>
<td>6.6 (8)</td>
</tr>
<tr>
<td>Rarely</td>
<td>1.3 (1)</td>
<td>6.6 (8)</td>
</tr>
</tbody>
</table>

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

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

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 (%)

<table>
<thead>
<tr>
<th>Feeding methods</th>
<th>Ireland</th>
<th>Saudi Arabia</th>
<th>Significance P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=77)</td>
<td>(n=121)</td>
<td></td>
</tr>
<tr>
<td>Initiated breastfeeding</td>
<td>92.2 (71)</td>
<td>88.4 (107)</td>
<td></td>
</tr>
<tr>
<td>Formula milk</td>
<td>7.8 (6)</td>
<td>11.6 (14)</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Ω 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

<table>
<thead>
<tr>
<th>Still breastfeeding</th>
<th>Ireland</th>
<th>Saudi Arabia</th>
<th>Significance P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=77)</td>
<td>(n=121)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>42.9 (33)</td>
<td>40.5 (49)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>57.1 (44)</td>
<td>59.5 (72)</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Ω 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

<table>
<thead>
<tr>
<th></th>
<th>Ireland (n=77)</th>
<th>Saudi Arabia (n=121)</th>
<th>Significance P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean±SD</td>
<td>61.7 ± 33.9</td>
<td>70.2 ± 26.6</td>
<td>0.26</td>
</tr>
</tbody>
</table>

*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)

<table>
<thead>
<tr>
<th>Weaning age</th>
<th>Ireland (n=65)</th>
<th>Saudi Arabia (n=115)</th>
<th>Significance P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% (n)</td>
<td>% (n)</td>
<td></td>
</tr>
<tr>
<td>&lt; 4</td>
<td>1.5 (1)</td>
<td>0.9 (1)</td>
<td></td>
</tr>
<tr>
<td>4 to 6</td>
<td>80.0 (52)</td>
<td>62.6 (72)</td>
<td></td>
</tr>
<tr>
<td>7 to 9</td>
<td>12.3 (8)</td>
<td>20.0 (23)</td>
<td>0.07</td>
</tr>
<tr>
<td>10 or above</td>
<td>6.2 (4)</td>
<td>16.5 (19)</td>
<td></td>
</tr>
</tbody>
</table>

*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 4.1. 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>
<thead>
<tr>
<th>Skin color</th>
<th>Ireland (n=77)</th>
<th>Saudi Arabia (n=121)</th>
<th>Significance</th>
<th>$P$ value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>24.7 (19)</td>
<td>21.5 (26)</td>
<td></td>
<td>0.47</td>
</tr>
<tr>
<td>Medium</td>
<td>66.2 (51)</td>
<td>63.6 (77)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark</td>
<td>9.1 (7)</td>
<td>14.9 (18)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time spent outside per day (minutes/day)</th>
<th>Ireland (n=77)</th>
<th>Saudi Arabia (n=121)</th>
<th>Significance</th>
<th>$P$ value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>15.6 (12)</td>
<td>29.8 (36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 5</td>
<td>6.5 (5)</td>
<td>9.1 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-15</td>
<td>22.1 (17)</td>
<td>20.6 (25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-30</td>
<td>15.6 (12)</td>
<td>3.3 (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 30</td>
<td>40.2 (31)</td>
<td>37.2 (45)</td>
<td></td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clothing worn outside</th>
<th>Ireland (n=77)</th>
<th>Saudi Arabia (n=121)</th>
<th>Significance</th>
<th>$P$ value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covering arms and legs</td>
<td>100.0 (77)</td>
<td>100.0 (121)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covering hair</td>
<td>96.0 (74)</td>
<td>99.1 (120)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunglasses</td>
<td>27.3 (21)</td>
<td>26.4 (32)</td>
<td></td>
<td>0.31</td>
</tr>
</tbody>
</table>

Sunscreen use

Table 4.11 the status of mothers’ exposure to sunlight
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  \\
\(^2\)Significant p<0.05  \\
\(^2\)Self-perceived  \\
\(^4\)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) | Saudi Arabia (n=121) | Significance P value: 
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health status during pregnancy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>23.4 (18)</td>
<td>29.8 (36)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>59.7 (46)</td>
<td>57.9 (70)</td>
<td></td>
</tr>
<tr>
<td>Fairly good</td>
<td>14.3 (11)</td>
<td>9.0 (11)</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>2.6 (2)</td>
<td>2.5 (3)</td>
<td></td>
</tr>
<tr>
<td>Very poor</td>
<td>0.0 (0)</td>
<td>0.8 (1)</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clinical conditions during pregnancy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15.6 (12)</td>
<td>14.0 (17)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>84.4 (65)</td>
<td>86.0 (104)</td>
<td>0.92</td>
</tr>
<tr>
<td>Preeclampsia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5.2 (4)</td>
<td>3.3 (4)</td>
<td>0.77</td>
</tr>
<tr>
<td>No</td>
<td>94.8 (73)</td>
<td>96.7 (117)</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Pearson’s chi-square test used to determine differences  
\(^\Omega\) 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

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

* Pearson’s chi-square test used to determine differences
** Multi-vitamin supplement specially for pregnancy
Ω 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

<table>
<thead>
<tr>
<th></th>
<th>Mothers took vitamin D supplements in Ireland</th>
<th>Mothers took vitamin D supplements in Saudi Arabia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes (n=22)</td>
<td>yes (n=9)</td>
</tr>
<tr>
<td></td>
<td>% (n)</td>
<td>% (n)</td>
</tr>
<tr>
<td>Doctor</td>
<td>95.4 (21)</td>
<td>88.8 (8)</td>
</tr>
<tr>
<td>Nurse</td>
<td>9.0 (2)</td>
<td>0.0 (0)</td>
</tr>
<tr>
<td>Internet</td>
<td>9.0 (2)</td>
<td>11.1 (1)</td>
</tr>
<tr>
<td>Family</td>
<td>4.5 (1)</td>
<td>0.0 (0)</td>
</tr>
<tr>
<td>Friends</td>
<td>0.0 (0)</td>
<td>11.1 (1)</td>
</tr>
<tr>
<td>Oneself</td>
<td>4.5 (1)</td>
<td>0.0 (0)</td>
</tr>
</tbody>
</table>

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) (Table 4.15).

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) | Saudi Arabia (n=121) | Significance P value \( \Omega^* \)  \\
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>62.3 (48)</td>
<td>37.2 (45)</td>
<td>0.00</td>
</tr>
<tr>
<td>No</td>
<td>37.7 (29)</td>
<td>62.8 (76)</td>
<td></td>
</tr>
</tbody>
</table>

\( \Omega \) 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

<table>
<thead>
<tr>
<th></th>
<th>Ireland (n=77)</th>
<th>Saudi Arabia (n=121)</th>
<th>Significance P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% (n)</td>
<td>% (n)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>49.4 (38)</td>
<td>13.2 (16)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>50.6 (39)</td>
<td>86.8 (105)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th></th>
<th>Mothers heard about the recommendations to give baby vitamin D drops in Ireland (n=48) % (n)</th>
<th>Mothers heard about the recommendations to give baby vitamin D drops in Saudi Arabia (n=45) % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health professional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doctor</td>
<td>46.8 (36)</td>
<td>29.8 (36)</td>
</tr>
<tr>
<td>Nurse</td>
<td>3.9 (3)</td>
<td>0.8 (1)</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Book/Magazine</td>
<td>5.2 (4)</td>
<td>3.3 (4)</td>
</tr>
<tr>
<td>T.V</td>
<td>13.0 (10)</td>
<td>6.6 (8)</td>
</tr>
<tr>
<td>Internet</td>
<td>9.1 (7)</td>
<td>7.4 (9)</td>
</tr>
<tr>
<td>Family and Friends</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>5.2 (4)</td>
<td>9.1 (11)</td>
</tr>
<tr>
<td>Sister</td>
<td>2.6 (2)</td>
<td>5.8 (7)</td>
</tr>
</tbody>
</table>
### 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>
<thead>
<tr>
<th></th>
<th>Ireland (n=77)</th>
<th>Saudi Arabia (n=121)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% (n)</td>
<td>% (n)</td>
<td>P value</td>
</tr>
<tr>
<td><strong>Giving children vitamin D protects them against rickets</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally agree</td>
<td>28.6 (22)</td>
<td>34.7 (42)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>49.4 (38)</td>
<td>38.8 (47)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>1.3 (1)</td>
<td>5.0 (6)</td>
<td></td>
</tr>
<tr>
<td>Totally disagree</td>
<td>0.0 (0)</td>
<td>0.8 (1)</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td>20.7 (16)</td>
<td>20.7 (25)</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>Taking vitamin D reduces cancer risk</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally agree</td>
<td>6.5 (5)</td>
<td>13.2 (16)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>22.1 (17)</td>
<td>20.7 (25)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>5.2 (4)</td>
<td>11.6 (14)</td>
<td></td>
</tr>
<tr>
<td>Totally disagree</td>
<td>3.9 (3)</td>
<td>2.5 (3)</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td>62.3 (48)</td>
<td>52.0 (63)</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Taking vitamin D may prevent heart disease</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally agree</td>
<td>3.9 (3)</td>
<td>10.7 (13)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>9.1 (7)</td>
<td>20.7 (25)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>9.1 (7)</td>
<td>10.7 (13)</td>
<td></td>
</tr>
<tr>
<td>Totally disagree</td>
<td>2.6 (2)</td>
<td>1.7 (2)</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td>75.3 (58)</td>
<td>56.2 (68)</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Taking vitamin D helps to increase muscle strength</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally agree</td>
<td>22.0 (17)</td>
<td>24.8 (30)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>42.9 (33)</td>
<td>47.9 (58)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>2.6 (2)</td>
<td>4.9 (6)</td>
<td></td>
</tr>
<tr>
<td>Totally disagree</td>
<td>1.3 (1)</td>
<td>1.7 (2)</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td>31.2 (24)</td>
<td>20.7 (25)</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Taking Vitamin D makes bones healthy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally agree</td>
<td>55.8 (43)</td>
<td>42.1 (51)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>35.1 (27)</td>
<td>47.1 (57)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>1.3 (1)</td>
<td>0.8 (1)</td>
<td></td>
</tr>
<tr>
<td>Totally disagree</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td>7.8 (6)</td>
<td>10.0 (12)</td>
<td>0.28</td>
</tr>
<tr>
<td><strong>Taking vitamin D reduces the risk of Multiple Sclerosis (MS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally agree</td>
<td>5.2 (4)</td>
<td>14.0 (17)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>7.8 (6)</td>
<td>12.4 (15)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>1.3 (1)</td>
<td>6.6 (8)</td>
<td></td>
</tr>
<tr>
<td>Totally disagree</td>
<td>0.0 (0)</td>
<td>2.5 (3)</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td>85.7 (66)</td>
<td>64.5 (78)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*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)2D3 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 vitamin 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 1 year. 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 1 year.

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


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.


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):
<table>
<thead>
<tr>
<th><strong>Surname:</strong> KHADRAWI</th>
<th><strong>Forename:</strong> IMANN</th>
<th><strong>Title:</strong> MRS</th>
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</thead>
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**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. ☐

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**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](http://www.dit.ie/DIT/graduate/ethics/index.html)

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<td>Impact on human subject(s) and/or the researcher(s) [Appendix 1]</td>
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<td>X</td>
<td>Consent and advice form given to subjects prior to their participation in the research [Appendix 2]</td>
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<td>Consent form for research involving 'less powerful' subjects or those under 18 years [Appendix 3]</td>
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<td>Conflict of interest [Appendix 4]</td>
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<td>Work involving Genetically Modified Organisms Risk Assessment [Appendix 12]</td>
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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:

<table>
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<th>Documents to be attached</th>
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<tr>
<td>Research Proposal</td>
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<td>Letters (to subjects, parents/guardians, GPs, etc)</td>
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<td>Questionnaire(s)</td>
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<td>6.1 Advertisement/Poster</td>
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<td>Ethical clearance from other ethical research committees</td>
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<td>Generic Protocol</td>
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<td>Researcher's Name</td>
<td>Title: MRS</td>
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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/informant/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.
| **اللقب** | أنسة |
| **اسم الباحثة** | إيمان عبدالله خضراوي |
| **المدرسة** | كلية علوم الأحياء، كلية العلوم |
| **عنوان الدراسة** | مكملات فيتامين D وممارسات أثناء فترة الحمل والرضاعة لدى عينة من النساء المسلمات المقيمات في إيرلندا والمملكة العربية السعودية. |

يرجى أن يتم تعبئة الموذج وفق المعلومات الشخصية

| **3.1 هل بلغت/ قرأتي ورقة المعلومات الخاصة بالبحث؟** | نعم/لا |
| **2.3 هل كان لديك فرصة لطرح الأسئلة ومناقشة هذه الدراسة؟** | نعم/لا |
| **3.3 هل تلقيت أجابات مقنعة لجميع أسئلتك؟** | نعم/لا |
| **هل تلقيت معلومات كافية عن هذه الدراسة وجميع الأمور الصحية وأثرها على السلامة إن وجدت؟** | نعم/لا |
| **هل تعلمي أنه لديك الحرية في الانسحاب من هذا المشروع في أي وقت من غير أن تعطي سبب لإنسحابك؟** | نعم/لا |
| **هل انت موافقة على المشاركة في هذه الدراسة التي من المرجح أن يتم نشر نتائجها؟** | نعم/لا |

يرجى ملاحظة ما يلي:

يرجى إجراء توقيعك في الإسما وتوقيع الباحثة.

يرجى ملاحظة ما يلي:

يرجى توقيعك على البوصة المعنية التوقيع على الإستمارة بعد أن شرحت المشروع لهذا الموضوع، وبعد أن أجبت 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
عوان الدراسة البحثية

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

ورقة معلومات للمشاركين

عززتي الأم:

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

قبل أن تقرر ما إذا كنت ستشاركتين في هذه الدراسة من المهم أن تعرف ما هو البحث وما الذي سوف يطلب منك القيام به. يرجى أن تأخذ الوقت الكافي قراءة المعلومات التالية ومناقشتها مع الآخرين إن رغبتي في ذلك. الأمر متروك لك ما إذا كنت تريدين المشاركة في الدراسة. سوف تعطي لك هذه الورقة للإحتفاظ بها كما سوف يطلب منك التوقيع على إستمارة موافقة. يمكنك أن تغيري رأيك في أي وقت أو أن تنسحب من الدراسة دون إعطاء سبب. مستوى الاهتمام بك لن يتغير ما إذا قررت المشاركة أم عدم المشاركة في هذه الدراسة.

لمزيد من المعلومات لا تتردد في إتصال بي.

الغرض من هذه الدراسة البحثية هو:
1. تحديد مدى إنتشار استخدام مكملات فيتامين د لدى النساء المسلمات الحوامل والمرضعات اللاتي يقمن في إيرلندا والمملكة العربية السعودية.
2. مقارنة ممارسة استخدام مكملات فيتامين D بين النساء المسلمات المقيمات في إيرلندا والمملكة العربية السعودية.
3. استخدام المعلومات التي تم الحصول عليها من أجل زيادة الوعي لدى النساء المسلمات الحوامل.

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

لقد تم اختيارك لأنك أنجبتي طفل خلال الأشهر الثلاثة الماضية. سوف تشمل هذه الدراسة 244 مشاركة، 244 إمرأة مسلمة من إيرلندا و244 إمرأة مسلمة من المملكة العربية السعودية. ستكون المقابلة حوالي 11 دقيقة. إذا أردتي المشاركة، ستكون هناك مكان مناسب لإجراء المقابلة.

سوف تتم مقابلة الشخص عن طريق برنامج مسح على الآي باد وسيتم تخزين الآي باد في مكان آمن ومغلق في جميع الأوقات، وسيتم كذلك حماية بيانات الكمبيوتر من التسجيل. سوف تتعامل إجابتك بسرية تامة. وسيتم تحليل هذه المقابلات عن طريق استخدام الكمبيوتر من قبل فريق طبي في نهاية البحث.

سوف تعامل إجابتك بسرية تامة، وبعد إتمام الدراسة، سوف يتم حماية البيانات في مكان مناسب.

لا تتردد في الإتصال بي إذا كنت بحاجة إلى مزيد من المعلومات.

الاسم: إيمان عبدالله خضراوي
الرقم المدني: 4115121421
البريد الإلكتروني: ummyara2008@yahoo.com

لمزيد من المعلومات حول هذه الدراسة يمكنك الإتصال به:

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

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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 0 □
   2. No 0 □

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

2. Describe your overall health during your pregnancy? (Please tick one)
   1. Excellent 0 □
   2. Good 0 □
   3. Fairly good 0 □
   4. Poor 0 □
   5. Very poor 0 □

3. Have you been diagnosed with any of the following during your pregnancy:
   1. Gestational diabetes YES 0 □ / NO 0 □
   2. Preeclampsia YES 0 □ / NO 0 □
   3. Crohn's disease YES 0 □ / NO 0 □
   4. Ulcerative colitis YES 0 □ / NO 0 □
   5. Coeliac disease (Celiac sprue) YES 0 □ / NO 0 □
4. Did you take any nutritional supplements during your pregnancy?
   1. Yes  
   2. No   (Please go to question 7)

   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  
   2. No   

8. Did you take any Vitamin D supplements during your pregnancy?
   1. Yes  
   2. No   (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)

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

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

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

If yes, how often: (Please tick one)

1. Once a week
2. Twice a week
3. Three times a week
4. More than three times a week
13. Did you take Cod liver oil or Omega-3 fatty acid supplements?
   1. Yes ☐
   2. No ☐

14. Which of the following Dairy products do you normally consume? (Please tick as many as you wish)
   1. Fresh milk ☐
   2. Powdered/Dried milk ☐
   3. Soya milk ☐
   4. Yoghurt ☐
   5. High fat cheese (cheddar) ☐
   6. Low fat cheese (cottage) ☐
   7. Butter or dairy spreads ☐
   8. Cream or Ice cream ☐

15. How often do you consume dairy products? (Please tick one)
   1. Never ☐
   2. Rarely ☐
   3. Once per week ☐
   4. Every day ☐

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

-----------------------------------------------

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Section Two: Your skin and the sun

17. What skin color do you have? (Please tick one)
   1. Light
   2. Medium
   3. Dark

18. On an average day, how much time do you spend outside? (Please tick one)
   1. None
   2. Less than 5 minutes per day
   3. 5 – 15 minutes per day
   4. 15 – 30 minutes per day
   5. More than 30 minutes per day

19. When you are outside do you: (Please tick as many as you wish)
   1. Normally cover your arms and your legs
   2. Cover your hair
   3. Wear sunglasses

20. Do you wear sunscreen just in the summer months or in winter too? (Please tick one)
   1. Just summer
   2. Summer and winter
   3. Neither
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  
   2. No  (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  
   2. No  (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  
   2. Your sister  
   3. Internet  
   4. Book/Magazine  
   5. Your doctor  
   6. T.V  
   7. Your nurse  
   8. Family  
   9. Relatives  

31. Have you given your baby Vitamin D drops?
   1. Yes  
   2. No  (Please go to question 32)

If yes, what was the brand name?
32. Are you aware of Vitamin D guidelines for babies?
   1. Yes
   2. No

33. Are you aware of the FSAI which is Food Safety Authority Vitamin D guidelines for babies? (Ireland only)
   1. Yes
   2. No

34. Are you aware of any risks associated with taking Vitamin D supplements?
   1. Yes
   2. No (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

   **Section Five: General information**

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
2. Boy

46. What was your baby's birth weight?

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

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

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

48. What is your highest education level?

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

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

1. House wife
2. Employed
3. Student
4. Retired
5. Other (specify)

50. What level of education did your husband complete? (Please tick one)
   1- Primary school
   2- Secondary school
   3- Higher education

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 الاستبيان لا يشتمل على أي اسم لذا هو بالكامل سري.

الرقم: ..................................................................................................................

الاستبيان: ...........................................................................................................

تاريخ ..........................

الموقع: ..............................................................

القسم الأول: معلومات عن صحتك خلال فترة الحمل

1. هل كان لديك أي مشاكل صحية خلال فترة الحمل؟
   1. نعم
   0
   2. لا
   0

إذا كانت الإجابة بنعم، ماذا كان لديك؟ (أرجوا التحديد): ......................................

2. كيف كانت حالتك الصحية بشكل عام خلال فترة الحمل؟ أرجوا إختيار أحد الإجابات أدناه:
   1. ممتازة
   0
   2. جيدة
   0
   3. مقبولة
   0
   4. سيئة
   0
   5. سيئة جداً
   0

3. هل سبق وأن تم تشخيصك بأحد هذه الأمراض المذكورة أدناه خلال فترة الحمل:
   1. سكري الحمل
   نعم 0 لا 0
   0
   2. تسمم الحمل
   نعم 0 لا 0
   0
   3. مرض كرون
   نعم 0 لا 0
   0
   4. التهاب الورم التقرحي
   نعم 0 لا 0
   0
   5. حساسية معوية
   نعم 0 لا 0
   0

إذا كانت الإجابة بنعم، ماذا كنت تستخدم؟ (أرجوا التحديد): ......................................

4. هل أستخدمت أي مكملات غذائية خلال فترة الحمل?
   1. نعم
   0
   0
   2. لا
   (انقل إلى السؤال 7)

إذا كانت الإجابة بنعم، ماذا كنت تستخدم؟ (أرجوا التحديد): ......................................

5. مني بدأني باستخدام هذه المكملات؟ (اختاري إجابة واحدة)
   1. قبل الحمل
   0
   0
   2. أثناء الشهر الأول من الحمل (1-4 شهور)
   0

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3. أثناء الشهور الأخيرة من الحمل
4. بعد الولادة

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

7. هل سبق أن قمت بالإجراء فحص للدم لتحديد مستوى فيتامين د؟
   1. نعم
   2. لا

8. هل أخذتي مكملات فيتامين د خلال فترة الحمل؟
   1. نعم
   2. لا (انتقال للسؤال 12)

9. ما هو النوع (اسم الشركة) الذي استخدمته؟ (أرجوا التحديد)

10. كم كانت الكمية (الجرعة) المتناولة يومياً من هذه المكملات؟ (أرجوا التحديد)

11. أي مما يلي نصحك بإستخدام مكملات فيتامين د؟ (يمكن اختيار أكثر من إجابة)
   1. نفسك
   2. والدتك
   3. أختك
   4. عائلتك
   5. طبيبك
   6. ممرضتك
   7. كتب/مجلة
   8. الإنترنت
   9. أصدقائك
   10. التلفاز
12. هل تأكلين سمك السالمون، سمك الترويت، التونة أو غيرها من الأسماك الغنية بالزيوت (الماكريل، السردين، الرنجة)؟

1. نعم 
2. لا

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

3. مرة واحدة في الأسبوع 
4. مرتين في الأسبوع 
5. ثلاث مرات في الأسبوع 
6. أكثر من ثلاث مرات في الأسبوع

13. هل تأخذي زيت كبد الحوت أو مكملات أوميغا 3؟

1. نعم 
2. لا

14. أي من منتجات الألبان التالية تستهلكينها عادة؟ (يمكن اختيار أكثر من إجابة)

1. حليب طازج 
2. حليب المجفف 
3. حليب الصويا 
4. زبادي (الروب) 
5. جبن عالية الدهون (تشدر) 
6. جبن منخفضة الدهون (ريكوتا) 
7. زبدة أو منتجات الألبان القابلة للدهن 
8. قشطة طازجة أو آيس كريم

15. كم عادة تتناولين من منتجات الألبان؟

1. أبداً 
2. نادرًا 
3. مرة في الأسبوع 
4. كل يوم
القسم الثاني: بشرتك والشمس

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

17. ماهو لون بشرتك؟ (اختاري إجابة واحدة)
   1. فاتحة
   2. وسط
   3. غامقة

18. في اليوم العادي، كم من الوقت تستمديه خارج المنزل؟ (اختاري إجابة واحدة)
   1. لأشياء
   2. أقل من 5 دقائق يومياً
   3. من 5 - 15 دقيقة يومياً
   4. من 15 - 30 دقيقة يومياً
   5. أكثر من 30 دقيقة يومياً

19. عادة حينما تكوني خارج المنزل هل: (يمكن اختيار أكثر من إجابة)
   1. تغطي ذراعك وساقك
   2. تغطي شعرك
   3. ترتدين النظارات الشمسية

20. هل تستخدمين كريم واقي الشمس فقط في أشهر الصيف أم أيضاً في أشهر الشتاء؟ (اختاري إجابة واحدة)
   1. في الصيف فقط
   2. في الصيف وفي الشتاء

21. كيف تكون ردة فعل جلدك عندما تجلسين في الشمس؟ (اختاري إجابة واحدة)
   1. تان بسهولة
   2. حرق ثم تان
   3. حرق ثم تقشر
القسم الثالث: الرضاعة الطبيعية وفيتامين د

22. كيف ترضعين طفلك؟

1. رضاعة طبيعية
0
2. رضاعة إصطناعية
0 (انتقالي للسؤال 25)
3. رضاعة مزدوجة
0

23. هل لا زلت ترضعين طفلك رضاعة طبيعية؟

1. نعم
0 (انتقالي للسؤال 26)
0
0

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

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

26. كم كان عمر طفلك حينما بدأتين بتقديم الأطعمة الصلبة له؟ (أرجو التحديد)

27. ما هو أول طعام صلب تناوله طفلك؟

28. هل أعطيت طفلك أي مكملات غذائية؟

1. نعم
0 (انتقالي للسؤال 29)
2. لا
0

إذا كانت الإجابة بنعم، فما هي؟

29. هل سبق وأن سمحت بوضع أطراف قطرات فيتامين د؟

1. نعم
0 (انتقالي للسؤال 31)
2. لا
0

30. اين سمحت بوضع هذه الأطراف؟ (يمكن اختيار أكثر من إجابة)
1. والدتك
2. أختلك
3. الإنترنت
4. كتاب/مجلة
5. طبيبك
6. ممرضتك
7. عائلتك
8. أقاربك
9. عائلتك
10. التلفاز

31 هل أعطيت طفلك قطرات فيتامين د؟

1. نعم
2. لا (إنتقلي للسؤال 32)

إذا كانت الإجابة بنعم، ما هو اسم الشركة؟

32 هل أت على علم بالمبادئ التوجيهية لفيتامين D للرضع؟

1. نعم
2. لا

33 هل أت على علم بالمبادئ التوجيهية لفيتامين D للرضع الصادرة من (FSAI) سلطة سلامة الأغذية الإيرلندية؟ (للأخوات في إيرلندا فقط)

1. نعم
2. لا

34 هل أت على علم بأي مخاطر متعلقة بتناول مكملات فيتامين D؟

1. نعم
2. لا (إنتقلي للسؤال 35)

إذا كانت الإجابة بنعم، ارجو ذكر المخاطر؟
إلى أي مدى توافق على العبارات التالية: (اختاري إجابة واحدة)

1- إعطاء الأطفال فيتامين د يقيهم من الكساح
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

2- تناول فيتامين د يقلل من مخاطر الإصابة بالسرطان
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

3- تناول فيتامين د قد يمنع الإصابة بآسياض القلب
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

4- تناول فيتامين د يساعد على زيادة قوة العضلات
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

5- تناول فيتامين د يجعل العظام قوية وصحية
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

6- تناول فيتامين د يقلل من خطر الإصابة بالتصلب المتعدد (MS)
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

7- تناول فيتامين د يقلل من خطر الإصابة بارتفاع ضغط الدم
أوافق بشدة لا أوافق بشدة لا أوافق لا أوافق

القسم الخامس: معلومات عامة

36. ما هي جنسيتك؟ .............................................................
37. بلد الميلاد: ..............................................................
38. عدد الأشهر في إيرلندا: ..............................................
39. عمرك: ..................................................................
40. عمرك عندما أنجبت طفلك: ........................................
41. هل هذا طفلك الأول: ....................................................
42. هل ولد طفلك (الأخير) في إيرلندا أم في الخارج؟
3. هل كانت ولادة طبيعية أم ولادة قصرية؟

4. تاريخ ولادة طفلك؟

5. ماهو جنس طفلك؟
   - ذكر
   - أنثى

6. وزن طفلك عند الولادة؟ Kg

7. ماهي حالتك الاجتماعية الحالية؟ (اختاري إجابة واحدة)
   - متزوجة
   - مطلقة
   - منفصلة
   - أرملة

8. ماهو مستوى التعليمي؟
   - إبتدائي
   - ثانوي
   - تعليم عالي

9. ماهي وظيفتك الحالية؟ (اختاري إجابة واحدة)
   - ربة منزل
   - موظفة
   - طالبة
   - متقاعدة

5. أخرى (أرجو التحديد)

50. ماهو مستوى زوجك التعليمي؟ (اختاري إجابة واحدة)
   - إبتدائي
   - ثانوي
   - تعليم عالي

51. ماهي وظيفة زوجك؟ (أرجو التحديد)

أشكرك على المشاركة.
Appendix v – Sample of iPad Survey Application

Location

Ireland
Saudi Arabia

Did you take any Vitamin D supplements during your pregnancy?

YES  NO

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

Are you aware of Vitamin D guidelines for babies?