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Vitamin D Deficiency and Possible Risk Factors Among Middle Eastern University Students in London, Ontario, Canada

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A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Foods and Nutrition

VITAMIN D DEFICIENCY AND POSSIBLE RISK FACTORS AMONG MIDDLE EASTERN UNIVERSITY STUDENTS IN LONDON, ONTARIO, CANADA

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by

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ABSTRACT

Objectives: To Identify multiple risk factors for vitamin D deficiency in Middle Eastern men and women aged 18-33 years who have immigrated to Canada for 5 years or less and attending Western University by measuring the level of vitamin deficiency and insufficiency based on serum vitamin D 25hydroxyvitamin level.

Hypothesis: Middle Eastern population who has been living in Canada for 5 years or less would commonly have vitamin D deficiency as a result of multiple risk factors.

Null Hypothesis: Middle Eastern population who has been living in Canada for 5 years or less would have normal vitamin D levels.

Methodology: Fifty-one healthy Middle Eastern men and women aged 18-33 years who have been living in Canada for five years or less studying at the University of Western Ontario participated in the study. Serum vitamin D 25-hydroxyvitamin was measured by collecting blood samples, which were analyzed at a medical laboratory. Questionnaires were used to collect dietary data, lifestyles, cultural practices, sunlight exposure, and any etiology of non-specific signs or symptoms of vitamin D deficiency.

Results: Thirty three percent (33%) of the males and 35% of the females had insufficient vitamin D, where serum levels of [25- (OH) D] falls between 25-74 nmol/L. More females were significantly deficient (< 25 nmol/L) in vitamin D (22%) than males (8%). Forty three percent of the younger age within their cohort had more insufficient and deficient values compared to the slightly older group. Participants who have been in Canada for less than 3 years had more deficient and insufficient vitamin D values compared to participants who have been in Canada for 3 years and more. Twenty three percent of the participants who had suffered from malady were vitamin D deficient. Participants who were not taking vitamin D, calcium, and multivitamin supplements had deficient and insufficient vitamin D values. Additionally, only 4 % of the participants who spent more than 30 minutes per day outdoors under the sun were vitamin D deficient. Participants who were mostly covered by their clothing especially dark colors and thick material had more deficient and insufficient vitamin D values.

Value of the research: Published studies in Middle Eastern population at home and abroad show a significant risk of vitamin D deficiency with other related diseases. A majority of this population share similar lifestyles, cultural practices and dietary habits. Further research needs to be done to help future dietitians become more knowledgeable about the major factors that threaten their vitamin D status. Implementation of programs based on the results of this study may increase awareness of the importance of vitamin D for bones and general health. Possible solutions may help this population get the needed vitamin D from different sources that are within their cultural practices and lifestyles.

Keywords: Vitamin D deficiency, Middle Eastern students, Risk factors, Cultural practices, Sunning practices.

DEDICATION

I dedicate my work especially to my parents for their kindness and devotion and to all my family for their endless support throughout my academic studies.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

nmol/L	Nanomole per Liter
ng/mL	Nanograms/milliliter
SPF	Sun Protection Factor

GLOSSARY

Vitamin D:

Deficiency < 25 nmol/L (results from inadequate nutritional intake or sunlight exposure causing several bone diseases such as osteomalacia, osteoporosis and rickets).

Insufficiency 25-74 nmol/L (at risk of being vitamin D deficient).

Normal 75-250 nmol/L (healthy level, essential for the absorption of calcium and the prevention of bone diseases and some other diseases such as cancer and diabetes).

High Temperature in Middle East: (47.5 °C - 52.0°C) based on data available from the National Climate Data Center.

Conservative Clothes: "In any discussion of Arab women's dress, one can hardly avoid reference to veiling, the hijab (modern headscarf), or the lack thereof. However, an in-depth examination of head/facial covering is beyond the scope of this article, and women's choices on the subject will be dealt with only as part of their overall image" [Kelly, 2010].

Sun Protection Factor (SPF): "Ultraviolet B radiation is responsible for making vitamin D. So a sunscreen with an SPF of 8 is supposed to absorb 92.5% of UVB radiation. If you put a sunscreen with an SPF of 8 on your skin properly, which is a certain amount per unit area; it will absorb 92.5% of UVB and decrease your ability to make vitamin D in your skin by 92.5%. SPF of 15 reduces the ability by 99%" [Lampe et al, 2008].

Snowball Sampling Technique: A random sample of individuals is drawn from a given finite population. Each individual in the sample is asked to name *k* different individuals in the population, where *k* is a specified integer; for example, each individual may be asked to name his " *k* best friends," or the " *k* individuals with whom he most frequently associates," or the " *k* individuals whose opinions he most frequently seeks," etc. For the sake of simplicity, we assume throughout that an individual cannot include himself in his list of *k* individuals [Goodman, 1961].

Laryngospasm: "Laryngospasm (LS) is a symptom that is diagnosed clinically by the classic signs of paroxysms of coughing and inspiratory stridor as a condition characterized by high-pitched inspiratory noise, sometimes mistaken for the wheeze of asthma [Gdynia et al, 2006].

Paresthesia: "Neural injury can cause paresthesia, manifested as a burning or prickling sensation or partial numbness. In dentistry, the inferior alveolar nerve (IAN) and mental nerve (MN) are most often involved, and the paresthesia can result from systemic or local factors [Nonsurgical Paresthesia, 2010].

Dermatopathic: "Dermatopathic lymphadenitis is a well-described histopathological entity characterized by expansion of subcortical zone by dendritic histiocytoid cells. Dermatopathic lymphadenitis represents a benign form of reactive lymph node hyperplasia. The relationship between lymph node hyperplasia and cutaneous disease was first described by Pautrier and Woringer as lipomelanotic reticulosis" [Vanisri et al, 2009].

Phytates: Phytates are known to have an inhibitory effect on mineral absorption by forming insoluble complexes with essential minerals, such as Zn, Ca, Cu and Fe [Kim et al, 2009].

Gulf Region: Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

Other Middle Eastern Countries: Egypt, Israel, Jordan, Lebanon, Palestine, Syria, Turkey, and Yemen.

CHAPTER 1

1. INTRODUCTION

In most cases, vitamin D deficiency occurs when individuals do not get enough exposure to sunlight and do not eat foods that are rich in vitamin D [Prentice, 2008]. Vitamin D deficiency is a global problem and it is known as an essential factor involved in different immune functions besides skeletal and muscle development [Prentice, 2008; El-Hajj Fuleihan, 2009]. A recent study reported that most of the nonspecific etiologies of common symptoms can result from vitamin D deficiency [Knutsen et al, 2010]; although some researchers emphasized that more studies need to be done to prove that vitamin D deficiency can lead to common symptoms of unknown etiologies such as headache and fatigue [Knutsen et al, 2010]. Another study found that the prevalence of non-specific muscle pains among the Middle Eastern population might result from vitamin D deficiency [Badsha et al, 2009].

Vitamin D deficiency has been defined differently from country to country. Some consider people are at risk of vitamin D deficiency at serum 25(OH) D concentrations <30 nmol/L [Moreno-Reyes et al, 2009]. Others define vitamin D deficiency based on 50 nmol/L as the lowest acceptable value for serum 25(OH) D concentrations [Moreno-Reyes et al, 2009; Lips, 2010]. The dietary reference intakes (DRIs) recommended by Canadian and American scientists for vitamin D are as follows: The recommended dietary allowance (RDA) is 600 international units (IU) (15 mcg) per day for children and adults from 9 to 70 years old and the tolerable upper intake level (UL) for the same age group is 4000 IU (100 mcg). To avoid any adverse health effect of taking vitamin D above the tolerable upper intake, total vitamin D intake should remain below the UL [Health Canada, 2012].

Latitudes from 12°N to 42°N in different countries of the Middle East such as Iran, Kuwait Saudi Arabia, Lebanon, Jordan, Turkey and United Arab Emirates (UAE) allow year-round vitamin D production [El-Hajj Fuleihan, 2009; Fonseca et al, 1984]. However, Middle Eastern countries have the highest prevalence of vitamin D deficiency and insufficiency risk factors and consequences on health [El-Hajj Fuleihan, 2009]. Despite abundant sunshine, several studies show that the prevalence of vitamin D deficiency has increased in the Middle Eastern populations in general from about 25 nmol/L to 10 nmol/L [Lips, 2010; Fields et al, 2011; Mithal et al, 2009]. The causes of vitamin D deficiency among the Middle Eastern population remain uncertain, as well as the factors that may increase their risk for low vitamin D. Studies indicate that lack of sun exposure in Middle Eastern population results from cultural practices such as conservative clothing and use of veils in Muslim women, in addition to their lifestyle habit of spending most time indoors [Lips, 2010; Christie et al, 2011].

Women from the Middle East have higher rates of vitamin D deficiency than men [Knutsen et al, 2010]. The level of serum vitamin D is low and it is not varied during the year from season to season in most people from the Middle East due to some common reasons such as skin pigmentation, limited sun exposure and low intake of vitamin D food sources [Knutsen et al, 2010]. A study done on vitamin D status in a multi- ethnic population found that 83% of the Middle Eastern population and some ethnic groups such as Africans and South Asians have low serum vitamin D level [Knutsen et al, 2010]. There are increased rates from 30 nmol/L to 12-nmol/Lof vitamin D deficiencies in girls wearing conservative clothes in comparison with females living in suburban and urban areas [El-Hajj Fuleihan, 2009; Lips, 2010].

The prevalence of a lower level of serum vitamin D (<25 nmol/L) is most common in the Middle East and is associated with women, darker skin pigmentation, limited sun exposure, higher latitude and lack of foods fortified with vitamin D [Mithal et al, 2009]. A study done in Arab populations and some other countries such as South Asia which might have similar practices suggests that skin pigmentation is probably the biggest risk factor in vitamin D deficiency regardless of the ultraviolet (UV) light exposure [Knoss et al, 2012; Badsha et al, 2009; Arabi et al, 2010]. In addition, the type of residence such as apartments, where walls or window glasses block all the sun, has an effect on limiting the time of sun exposure in the Middle East especially in Saudi Arabia. Subjects living in apartments have more vitamin D deficiency than subjects living in villas with open areas where serum vitamin D level range from (5 nmol/L - 45 nmol/L) and (5 nmol/L - 37 nmol/L) respectively [Fonseca et al, 1984].

Based on the flour fortification initiative (A Public-Civic-Private Investment in Each Nation), legislation status for wheat flour fortification in the Middle East has been defined and categorized as mandatory, voluntary and no fortification. Bahrain, Iran, Iraq, Jordan, Kuwait, Oman, Palestine, Saudi Arabia and Yemen have mandated fortification of one or more types of wheat. While Lebanon and Syria have no fortification of any type of wheat, Qatar and the United Arab Emirates have voluntary fortification [Verster, 2012].

Vitamin D recommendations should be included in public education and with food manufacturers to increase foods fortified with vitamin D, in addition to earlier screening and treatment by vitamin D supplementation for the Middle Eastern population. In different Middle Eastern countries, the lack of governmental regulation for recommended food fortification with vitamin D is one of the most prevalent barriers to achieve desirable levels of serum vitamin D [El-Hajj Fuleihan, 2009]. Further studies in this area in Middle Eastern countries could be the next step to highlight the importance of increasing the number of foods fortified with vitamin D based on population need. As well, raising the public consciousness on sun exposure as a significant source of vitamin D besides the natural food sources is highly recommended [Fonseca et al, 1984].

Recent studies point out that serum vitamin D levels are improved in North America and Europe; however, vitamin D deficiency continues to be prevalent in many regions of the Middle East such as Yemen and Turkey [Prentice, 2008; Christie et al, 2011]. As a result, this population is at risk of many vitamin D-related diseases and this is one of reasons why we conducted this study.

1.1 Rationale and Purpose of the Study

The purpose of this study is to investigate the degree of vitamin D deficiency and risk factors among Middle Eastern men and women aged 18-33 years who have been immigrants to Canada for five years or less and attending Western University in London, Ontario. Deficiency is measured using serum vitamin D 25hydroxyvitamin level and risk factors are determined using a questionnaire on anthropometric and demographic variables, diet and health lifestyles, sun exposure and cultural practices.

The benefit of the research is to make people who are at risk of hypovitaminosis D aware that a deficiency may lead to major risks of health problems such as osteoporosis, cardiovascular disease, diabetes and different types of cancers [Prentice, 2008; El-Hajj Fuleihan, 2009; Lips, 2010]. One of the specific objectives of the study is to determine the major risk factor responsible for low vitamin D level among this population. The research is important for healthcare professionals and dietitians because they must consider the variation of risk factors among different ethnic populations.

The findings of the study may assist people who are mainly at risk to access services of dietitians and address the link between risk factors and low vitamin D level. Educational strategies might be implemented in London, Ontario as well as many Middle Eastern countries based on the study results to increase the vitamin D levels and improve the overall health of the population, for example, by addressing changes in their lifestyle habits such as replacing indoor activities with outdoor activities. The results of this research might also encourage Middle Eastern governmental regulation for vitamin D fortified foods and may involve manufacturers to play a role in changing and improving population health status. It is possible that the research results may lead to reasonable solutions that can help this population get their needed vitamin D from different sources considering their cultural practices and lifestyles.

More studies need to be done on vitamin D deficiency among the Middle Eastern population. Most of the literature reviews have indicated that the severity of vitamin D deficiency in this population can lead to serious implications for the growth of future generations and the overall health of the community.

1.2 Objectives

Our first objective is to investigate the level of vitamin D deficiency in Middle Eastern men and women aged 18-33 years who have immigrated to Canada for 5 years or less and attending Western University by measuring serum vitamin D 25-hydroxyvitamin level through laboratory analysis done by LifeLabs.

The second objective is to determine risk factors for vitamin D deficiency such as cultural practices, skin pigmentation, limited sun exposure including tanning and dietary patterns to identify participants at high or low risk of vitamin D deficiency through a questionnaire.

1.3 Hypothesis

We hypothesize that Middle Eastern students aged 18-33 years who have been living in Canada for five years or less would have vitamin D deficiency as a result of multiple risk factors.

1.4 Null Hypothesis

Middle Eastern population who has been living in Canada for 5 years or less would have normal vitamin D levels.

CHAPTER 2

2. LITERATURE REVIEW

In this chapter, 100 articles and manuscripts on vitamin D deficiency and risk factors were reviewed. Most of these were obtained from the following journals or resources: Journal of Nutrition, Clinical Review in Bone and Mineral Metabolism, Scandinavian Journal of Primary Health Care, Clinical Rheumatology, European Journal of Nutrition, Steroid Biochemistry and Molecular Biology, Postgraduate Medical, International Journal of Rheumatic Diseases, Osteoporosis International Journal, Clinical Densitometry, American Journal of Physiology, New England Journal of Medicine, American Journal of Clinical Nutrition, Canadian Medical Association, American Medical Association, Clinical Endocrinology and Metabolism, Atmospheric Sciences, European Journal of Clinical Nutrition, International Journal of Gynecology and Obstetrics, International Journal for Vitamin and Nutrition, Public Health Nutrition, BioMed Central Public Health, Clinical Endocrinology, Australian Family Physician, Hormone and Metabolic Research, Middle Eastern Studies, Saudi Medical, Sultan Qaboos University Medical Journal, International Journal of Food Sciences and Nutrition, Annals of Nutrition and Metabolism, Lancet, Critical Care, Bone and Mineral Research, Clinical Investigation, Annals of Internal Medicine, American Journal of Cardiology, American Association of Clinical Endocrinology, Archives of Internal Medicine, Southern Medical, Diabetes Care, Presse Medicale, Institute of Medicine of the National Academies, Current Osteoporosis Reports, Nutrition and Health, Lippincott Williams & Wilkins, International Journal of Gynecology & Obstetrics, American Academy of Pediatrics, Annals of Tropical Paediatrics: International Child Health, American College of Nutrition, European Journal of Heart Failure, Calcified Tissue International, Diabetic Medicine, International Journal of Sport Nutrition and Exercise Metabolism, Israel Medical Association, Medical Sciences, Nutrition &

Metabolism, International Journal of Artificial Organs, and Nature Reviews Endocrinology. Most of the articles and reviews were published from 1961 to 2012.

Vitamin D deficiency defined as serum [25(OH) D] concentrations <30 nmol/L [Health Canada, 2012] has been associated with several health problems. Now vitamin D deficiency is known as global public health problem. The published literature on vitamin D includes several studies that examine a variety of populations and outcomes from different countries of Middle East. This literature review required widespread studies to characterize the associations of vitamin D deficiency with different risk factors. For the 100 articles reviewed, several databases were searched and these were as follows: Online Library Wiley, Springer Link, Scholars Portal, PMJ, ProQuest, PubMed, American Society for Clinical Nutrition, Endocrine Society, Cambridge, BMC Public Health, J Store, Business Source Complete, Academic Search Complete, JAMA Internal Network, Wolters Kluwer Health, Endocrine Society, American Association of Clinical Endocrinologists, National Academy of Sciences, EBSCO*host*, Hospital Paediatrics, Springer Science, American Society for Nutritional Sciences, Human Kinetics, Georg Thieme Verlag, National Center for Biotechnology Information, SAGE, and International Journal of Artificial Organs.

2.1 Vitamin D

The vitamin D endocrine system is important to facilitate calcium absorption [Adriana et al, 2005] and it has an essential role in maintaining bone and skeletal health [Holick, 2007]. Serum 25-hydroxyvitamin D [25(OH) D] is the measurement variable for vitamin D status [Vieth, 1999]. The human body can obtain vitamin D through exposure to sunlight, from diet and dietary supplements. Vitamin D from the sunshine and diet is metabolized within 3 days by the liver into 25(OH) D, which is used to determine a patient's vitamin D status [Vieth et al, 2001;

Rucker et al, 2002; Steingrimsdottir et al, 2005]. Vitamin D is converted from 7-dehydrocholesterol to 25-hydroxyvitamin D3 when it is transported to the liver by a binding protein [Adriana et al, 2005]; 25-hydroxyvitamin D is further converted to 1, 25(OH) 2D in the kidney as the final step in the activation of vitamin D [Adriana et al, 2005]. When there is not enough sun exposure, serum 25-hydroxyvitamin D decreases gradually, with a half-life of at least 2 months [Vieth, 1999]. The maximum number of days for serum levels of the [25(OH) D] metabolite after getting the highest sun exposure in the summer is about 30 – 60 days [Adams et al, 2010].

2.2 Vitamin D from the Sun

Skin exposure to solar UV-B radiation is a significant source of vitamin D [Holick, 2007]. For example, someone exposed to the sun wearing only a bathing suit will get vitamin D_2 equivalent to the ingestion of approximately 20,000 IU [Holick, 2007]. Because of the shorter atmospheric distance between the earth's surface and the sun (which is directly above the Equator) and the ozone layer being naturally thinner in areas close to the Equator (which make it easy to absorb UV radiation), the geographic regions around the Equator which include Middle Eastern countries have the greatest UV rays [Kanan et al, 2012]. Moreover, seasons contribute essentially to vitamin D deficiency in all populations. A higher rate of vitamin D deficiency occurs during winter and spring, even if people in the Middle Eastern countries and other areas are taking vitamin D supplements [Mavroeidi et al, 2010; Manios et al, 2011, Arabi et al, 2010] because of the positioning of the sun's rays as it hits the earth, which can affect "both quantity and quality of solar radiation reaching the earth's surface" [Webb et al, 1988]. However, some studies done at low latitude areas e.g. 24 N° show a prevalence of low vitamin D [Agarwal et al, 2011; Gannage-Yared et al, 2005; Kanan et al, 2012]. In addition, obesity (because of the possible sequestration of vitamin D in body fat) [Holick, 2007] and darker skin in Saudi Arabia are common factors that increase the time required for sun exposure to get the ideal vitamin D level [Kanan et al, 2012]. The enhanced fat solubility and decreased bioavailability of vitamin D produces low serum vitamin D levels with obesity [Fields et al, 2011]. Exposing the skin to sunlight to absorb vitamin D is a major factor in increasing the body's circulating serum vitamin D. In addition, there are different factors that affect the amount of vitamin D synthesized by the skin through sunlight exposure such as individual, geographical and seasonal variations [Gozdzik et al, 2008; Karohl et al, 2010; Al-Daghri et al, 2012].

Risk of common skin cancers is decreased when serum vitamin D is around 75 nmol/L [Holick, 2007]. Risk of skin cancer is one of the barriers to sun exposure [El-Hajj Fuleihan, 2009]. However, too much sun may result in sunburn and damage the skin, which may lead to skin cancer. If a person is going to be exposed to the sun for a long time, it is better to use sunscreen protection [Whittaker, 1995].

2.3 Vitamin D from Food

Not too many foods are considered good natural sources of vitamin D. For example, fatty fish, eggs, organ meats and UV-irradiated mushrooms are some of the main sources of vitamin D. In addition, in Saudi Arabia fortified foods are limited to very few dairy products and cereals [Madani et al, 2000; Kanan et al, 2012]. Another study has shown that the Gulf regions are poor in foods fortified with vitamin D [El-Hajj Fuleihan, 2009]. The Middle Eastern countries are poor in food fortification in general and in vitamin D specifically [Verster, 2012]. Only wheat flour fortification is mandatory in terms of legislation in most of the Middle Eastern countries. Some countries such as Lebanon and Syria have no fortification of any type of wheat, while Qatar and the UAE have voluntary fortification [Verster, 2012].

In Canada, there are more foods that fortified with vitamin D compared to the Middle Eastern countries. Examples of foods fortified with vitamin D in Canada are orange juice, grain products, soy beverage, eggs, some meat and alternatives, and some fats and oils [Dietitians of Canada, 2014]

2.4 Vitamin D from Supplements

Dietary supplements are one source of vitamin D. There are different kinds of supplementation such as over-the-counter and prescription supplements. In some cases, use of supplements is needed to fulfill the body's vitamin D requirement [Holick, 2007]. A study reported that after one year of vitamin D supplementation, there is evidence of increased lean mass, bone area, and bone mass [El-Hajj Fuleihan, 2009]. In addition to that another study showed that with vitamin D supplementation, the overall risk of mortality was reduced. Positive outcomes with vitamin D supplementation were significant for patients with vitamin D deficiency. However, it has not been established yet whether vitamin D supplementation have any positive impact on chronic diseases associated with hypovitaminosis D and a few studies have shown benefit of vitamin D supplementation. More studies are needed in this area to determine the role of vitamin D supplementation- on overall health outcomes [Vacek et al, 2012; El-Hajj Fuleihan, 2009]. With severe vitamin D deficiency; vitamin D supplementation may help to improve vitamin D serum level as shown among study participants where their serum vitamin D level was elevated to sufficient range [Kumar et al, 2012]. In anotherstudy, exceeding the upper intake level of vitamin D may have resulted in hypercalcemia, hypercalciuria, and hyperphosphatemia [Teleni et al, 2013].

The recommended dietary allowance (RDA) for vitamin D is 600 international units (IU) (15 mcg) per day for children and adults 9 to 70 years old and for the same age group the tolerable upper intake level (UL) is 4000 IU (100 mcg) [Health Canada, 2012].

2.5 Vitamin D Deficiency

Estimates of about one billion people are reportedly suffering from vitamin D deficiency and it is a widespread problem [Christie et al, 2011]. Vitamin D deficiency has been associated with different chronic diseases, such as rickets in children and osteoporosis in adults, because it has an important role in bone metabolism and many cellular and immunological processes [Elsammak et al, 2010].

The Canadian Health Measures Survey reported that vitamin D $\geq$ 50 nmol/L was considered as a sufficient level of serum vitamin D to meet the recommended dietary allowance (RDA), while < 50 nmol/L was considered insufficient level of serum vitamin D. Serum vitamin D <30 nmol/L represents the deficiency level. About 32% of Canadians were below the vitamin D cut-off of 50 nmol/L and 10% were considered vitamin D deficient (< 30 nmol/L). The national average of serum [25(OH) D] levels was 64 nmol/L [CHMS, 2013].

The best marker of vitamin D stores is serum 25-hydroxyvitamin D [25(OH) D]; thus, vitamin D deficiency is diagnosed by measuring serum 25-hydroxyvitamin D. In addition, vitamin D deficiency can be identified through clinical assessment of rickets in children or osteomalacia in adults. However, vitamin D deficiency can occur for some time before the bone manifestations of the clinical deficiency state present to medical attention [Holick, 2007]. The healthier level of [25(OH) D] is higher than the normal range recommended for the population and how the ideal [25(OH) D] levels are defined varies from country to country. However, Health Canada stated that people who had serum [25(OH) D] < 30 nmol/L are considered at risk of vitamin D deficiency [Health Canada, 2012].

A general perception is that the Middle East is a hot area with adequate sunshine. Although there are no fixed boundaries of the region, most geographical sites mentioned include countries like Egypt, Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates, and Yemen [Koppes, 1976; Beaumont et al, 1988]. Despite the adequacy of sunshine, hot weather and arid climate which allow maximum vitamin D production in humans (through skin exposed to UVB light for about 5-30 minutes depending on the time of day, season, latitude, and skin sensitivity) [Holick, 2007], there have been many studies that show the population of this area being deficient in Vitamin D [El-Hajj Fuleihan, 2009; Badsha et al, 2009; Lips, 2010; Fonseca et al, 1984].

Vitamin D is an important vital amine with several important physiological functions in the human body of all age groups, from infancy to old age. Vitamin D deficiency is grounded into many socio-cultural, religious, dietary, life style patterns and factors, which make it an arduous task to change their influence. Worldwide, it is estimated that almost 1 billion people suffer from Vitamin D deficiency [Christie et al, 2011]. We know that sunlight is a major source, yet the populations of countries receiving most of it are estimated to suffer the most, with worst figures and prevalence rates [Al-Turki et al, 2008; Lotfi et al, 2007; Al-Kindi, 2011; Laleye et al, 2011; Batieha et al, 2011]. According to a European study, people living in sunny countries have more deficiency than other countries because of inadequate exposure to sunlight [Van der Wielen et al, 1995]. A study done on Saudi Arabia's population found that they have a high prevalence of vitamin D deficiency at (28nmo/L- 33 nmol/L) in both summer and winter seasons and it was even higher in the winter season [Kanan et al, 2012]. Researchers have surmised that vitamin D deficiency among Saudi women can result from a lack of public awareness [Siddiqui et al, 2007]. However, post-menopausal women had high serum vitamin D levels in the study among Saudi female outpatients [Kanan et al, 2012], while another study on healthy Saudi women has the opposite [Ardawi et al, 2011]. The study on Saudi female outpatients as study groups had higher serum vitamin D levels possibly because many clinicians tend to routinely recommend calcium and vitamin D supplements to post-menopausal women, without measuring their vitamin D status, as a protection against osteoporosis [Kanan et al, 2012].

2.6 Health Problems Associated with Vitamin D Deficiency

People who are suffering from severe serum vitamin D deficiency experience some symptoms of numbness, paresthesia (abnormal or impaired skin sensation), muscle cramps, laryngospasm, tetany and seizures, while those with minor deficiency may complain from having muscle weakness or pain [Kapoor et al, 2001]. In addition, a deficiency may cause rickets, osteomalacia, osteoporosis, multiple fractures, and growth retardation [Christie et al, 2011]. Another study found that low bone mineral density in adults is strongly associated with low serum 25-hydroxyvitamin D level [Bischoff-Ferrari et al, 2009] and low serum vitamin D leads to reduced ability to absorb calcium [Quarles, 2008]. In pregnant women, low vitamin D can be noticeable in the fetal skeleton during the 19th week of pregnancy [Cauley et al, 2008]. In some cases low serum 25-hydroxyvitamin D levels is associated with colon cancer mortality [Wu et al, 2007]. A study done on the American population showed that vitamin D insufficiency/deficiency is associated with cardiovascular disease deaths [Kim et al, 2008]. Vitamin D is also important for some of the metabolic syndromes such as hypertension [Pepper et al, 2009], obesity [Looker et al, 2008], insulin resistance and glucose intolerance [Ginde et al, 2009]. Other studies show that vitamin D deficiency is associated with several chronic diseases such as cancer, infection, asthma, and dermatopathies (skin problems of unknown etiologies) [Bell, 2011], insulin resistance, diabetes and related microvascular complications [Joergensen et al, 2011] and retinopathy [Kaur et al, 2011]. Vitamin D insufficiency can cause calcium malabsorption and secondary hyperparathyroidism [Meddeb et al, 2005]. Multiparity and menopause also seem to be statistically associated with hypovitaminosis D [Meddeb et al, 2005]. Obesity has indirect effects on physical activity by decreasing movement and as a result, sun exposure may be restricted which will decrease vitamin D levels [Holick, 2007; Osei, 2010]. Recent studies found that vitamin D deficiency is also associated with autoimmune disorders, CVD and cancers [Holick, 2007; Kanan et al, 2012].

2.7 Statistics on Vitamin D Deficiency in the Middle East

In countries that have similar cultural practices and lifestyle habits outside of the Middle Eastern countries such as Tunisia, the prevalence of vitamin D deficiency was 47.6% and the deficiency increased with age. Those in the age group between 50-59 years have a deficiency of about 59.5% while those in the age group between 20-29 years have less deficiency of about 35.8% [Meddeb et al, 2005]. In addition, the severe deficiency level of serum vitamin D was 12.5 nmol/L and it is commonly prevalent among a certain group of women [Meddeb et al, 2005]. About 70.5% of veiled women had the deficiency, which is higher than that of unveiled women at 48.9% [Meddeb et al, 2005]. However, vitamin D deficiency is infrequent in the United States and Japan. In Japan, 7.9% of the study participants have low levels of vitamin D; while 14.5% women in the United States study have hypovitaminosis D lower than 37.5 nmol/L [McKenna, 1992]. In the United States, more foods are fortified with vitamin D compared to Europe [Gannage-Yared et al, 2005]. In Canada, 10% of Canadians were considered as being vitamin D deficient (< 30 nmol/L) [CHMS, 2013]

Many of the young and aging people in the Middle East suffer from hypovitaminosis D. A study done in Lebanon showed that 41% have severe deficiency, levels lower than serum 12.5 nmol/L [Gannage-Yared et al, 2005]. About 84% of young females had serum vitamin D levels lower than 30 nmol/L [Gannage-Yared et al, 2005]. The Gulf region (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates, Iran, Iraq) has a prevalence of insufficiency and deficiency of serum vitamin D at levels of 25(OH) D < 30ng/mL (< 74 nmol/L) [Ross et al, 2010; Laleye et al, 2011].

In 2011, scientists agreed on a recommended 4000 IU/day (100 mcg) of vitamin D as a tolerable upper limit. The National Academy of Sciences Institute of Medicine advocates for a daily intake of 400 to 600 IU/day for adults 18 to 70 years old and 400 to 800 IU/day for those older than 70 years [Fields et al, 2011]. The American Association of Clinical Endocrinologists recommends a higher intake of 1000 to 2000 IU/day to reach a target vitamin D serum concentration of 30 to 50ng/mL [Ross et al, 2010; Laleye et al, 2011; Fields et al, 2011]. Another study showed that 70% of Iran's and 80% of Saudi Arabia's populations have low serum vitamin D levels [Mithal et al, 2009; Fields et al, 2011]. Another study done about vitamin D deficiency in the Middle East showed that Emirati (UAE) women have more vitamin D deficiency than western women living in UAE [El-Hajj Fuleihan, 2009]. About 83 % of Saudi women who have low levels of vitamin D have been reported to also have back pain [Al Faraj et al, 2003; Fields et al, 2011].

2.8 Influence of Cultural Practices on Vitamin D Status

There are a number of factors with large influence on people's health from the Gulf region (Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE) with a service-oriented society. These factors include sedentary activity [Al-Kandari, 2006] and unhealthy dietary patterns and environmental factors [Mabry et al, 2010]. There are a number of worldwide limitations for getting adequate vitamin D. The levels of serum 25-hydroxyvitamin D can decrease with less consumption of milk fortified with vitamin D, use of sun protection factors, increasing body mass and skin pigmentation [Looker et al, 2008]. Vitamin D is made in the skin by the ultraviolet B radiation; therefore, 92.5% of UVB radioactivity can be absorbed by a sun blocker with an SPF of 8 [Lampe et al, 2008]. There will be a decline by 92.5% in the ability to make Vitamin D in the skin and the absorption of UVB will be 92.5% if you use a sunscreen with an SPF of 8 [Lampe et al, 2008]. However, a study in Kuwait about the relationship between the use of sunscreen and vitamin D level found that the usage of sunscreen did not play an important role of causing vitamin D deficiency [Al-Mutairi et al, 2012]. The authors discovered that both participants who used sunscreen and who never used it had low vitamin D levels in general, no matter what SPF level they used [Al-Mutairi et al, 2012]. Cultural practices and norms are the most common reasons why Middle Eastern women keep their whole body covered [Allali et al, 2006; Fonseca et al, 1984; Hamilton et al, 2010]. Because of these norms and practices, people in many countries such as India, Australia, Brazil and the Middle East have a high prevalence of vitamin D deficiency [Agarwal et al, 2011; Gannage-Yared et al, 2005]. These norms and cultural practices may contribute to limited sun exposure especially among women [Narchi, 2000]. Cultural factors such as clothing style, veils, long sleeves, type of residence, indoor activities and lack of physical activity are all considered as risk factors of vitamin D deficiency [Laleye et al, 2011; Bahijri, 2001; Dong et al, 2010].

Currently, technology and development have significant negative effects on people's lifestyle and health status in many developing countries [Poskitt, 2009; Misra et al, 2010]. Technology and entertainment services have limited the time spent in physical activity both inside and outside the home. Also, transportation facilitation has decreased the activity level among people in Gulf region [Mabry et al, 2010; Fields et al, 2011]. Countries in the Gulf region (Bahrain, Kuwait, Iran, Iraq, Oman, Qatar, Saudi Arabia, and the UAE) have a high prevalence of hypovitaminosis 25-hydroxyvitamin D 25(OH) D levels < 30ng/mL) [Ross et al, 2010; Laleye et al, 2011].

A study done in Tunisian women showed that most of the risk factors for vitamin D deficiency include multiparity, menopause, wearing the veil and dietary intake [Meddeb et al; 2005]. However, the levels of serum [25(OH) D] in Tunisia are similar to levels in southern European countries rather than in the Middle Eastern countries [Meddeb et al; 2005]. Inadequate intakes of foods rich in vitamin D and clothing style are the major causes of vitamin D deficiency in Tunisia [Meddeb et al; 2005]. The study encouraged people to consider taking vitamin D supplements or foods that are fortified with vitamin D and changing their lifestyles to improve vitamin D status in Tunisia [Meddeb et al; 2005].

There are several causes of vitamin D deficiency among women in the Gulf region such as clothing style, lack of foods rich in vitamin D, lack of vitamin D supplement, multiparity and obesity [Saadi et al, 2006]. Vitamin D was low in both the summer and winter seasons; it was even lower during the summer as a result of limited outside activities and lack of sun exposure due to high temperatures (as high as 52 ºC) [El-Hajj Fuleihan, 2009; Fields et al, 2011]. About 321 premenopausal Saudi women with conservative clothes had low vitamin D [Ghannam et al, 1999; Fields et al, 2011]. Conservative clothes include an “abaya” (a full black cover) and sometimes a specific veil “niqab,” worn to cover their face as well as hands and feet among some people [Fields et al, 2011; El-Hajj Fuleihan, 2009; Meddeb et al, 2005]. There are some risk factors linked with low serum vitamin D that can be changed such as diet, clothing and sun exposure; while others cannot be changed such as skin pigmentation and the body's ability to metabolize vitamin D precursors from sun exposure [Saadi et al, 2006; Fields et al, 2011]. Skin pigmentation, which results in dark skin and more melanin, possibly decrease skin vitamin D production and reduce the production of cholecalciferol "because of its competition with 7-dehydrocholesterol and attraction of UVB photons away from 7-dehydrocholesterol" [Gallieni et al, 2009; Fields et al, 2011]. Sedentary activity has increased in the Middle Eastern countries because of the easy access to technology services that reduce the time spent in outdoor activities. Besides urbanization, there are a lot of different norms and cultural practices that might affect people's total activity level [Mabry et al, 2010; Fields et al, 2011]. Multiple factors limit sun exposure such as the hot environment/weather, social norms and religious habits [Kanan et al, 2012]. The high prevalence of vitamin D deficiency among Saudis has been reported in the literature since the 1980s [Siddiqui et al, 2007; Fonseca et al, 1984]. The reasons for this deficiency remain unresolved and might have been increasing in recent times by increased sun avoidance due to more urbanized lifestyles and aesthetic reasons, for example, the culture tends to favor a fair skin which is not suntanned. Therefore, even in the privacy of their own homes, women from this culture tend to avoid sun exposure [Kanan et al, 2012].

2.9 Sunning Practices

Vitamin D deficiency is a widespread disease in many countries around the world in different age groups such as North America, Europe and the Middle East [Binkley et al, 2007; Rockell et al, 2005]. Despite the high latitude and long sunlight hours in the Middle Eastern countries, lack of sunlight exposure is the major cause of vitamin D deficiency among the populations [Andersen et al, 2005]. Young male athletes have normal vitamin D levels especially those who spend most of their sport practice outdoors although athletes are still at risk of vitamin

D deficiency [Willis et al, 2008].

One of the studies among Saudis report a lack of sun exposure with only 6 male participants out of 200 participants exposing themselves to sunlight for vitamin D from the sun [Sadat-Ali et al, 2009]. Lack of sun exposure was also reported as one of the most important predictors of hypovitaminosis D in developing countries [Arabi et al, 2010]. Another study on vitamin D deficiency among Saudi married couples reported that males were significantly exposing themselves to sunlight more than their female partners [Elshafie et al, 2012]. Lack of sun exposure is also one of the common results of sedentary lifestyle in the Gulf region [Fields et al, 2011]. In addition, sun exposure is greatly affected by clothing style that covers most of the body, which leads to reduced vitamin D production in the skin [Fields et al, 2011]. Thus, limited sun exposure in the Middle East appears to be mostly due to cultural practices, clothing styles and limited outdoor activity [Pettifor, 2004; Thacher et al, 2006].

2.10 Food Habits

Dietary factors have an important role in vitamin D deficiency among the Middle Eastern populations. Their intake of foods rich in vitamin D is limited and this has been shown as one of the main risk factors of vitamin D deficiency [Laleye et al, 2011; Bahijri, 2001]. There is also a lack of awareness in Delhi (India) on the value of taking vitamin D supplements [Goswami et al, 2000]. Lack of food and dairy products fortified with vitamin D is a problem in many countries of the Middle East. For example, in Saudi Arabia, the Saudi Ministry of Health is trying to change this by increasing milk fortification [Fields et al, 2011]. However, the Saudis have low consumption of milk and dairy products due to lactose intolerance, and in addition, phytates in bread can limit the absorption of calcium in the gut [El-Hajj Fuleihan, 2009; Fields et al, 2011]. The food habits in some Middle Eastern regions have changed from healthy foods such as dates, milk, fresh vegetables and fruit, whole wheat and fish to fast and unhealthy foods such as fried chicken and beef burgers which are low in vitamin D [Musaiger, 1993; Fields et al, 2011]. In addition, some Gulf countries rely on importing a lot of food to meet their population needs while they export a lot of seafood [Musaiger et al, 2011; Fields et al, 2011]. People in the Gulf countries tend to gather a lot and cook and eat foods at home together, which lead to high intakes of calories per day [Al-Kandari, 2006].

2.11 Men versus Women

Men's work environment in the Middle East is different than women's in terms of having a lot of time working outdoors, thus exposing themselves to sunlight. Men mostly spend a lot of time exposing themselves to sunlight because of their work purposes while most of women have indoor environment workplaces. As a result, women (70%) have more deficiency of < 25 nmol/L of serumvitamin D than men (40%) [Kanan et al, 2012; Elshafie et al, 2012].

There are not enough studies that show the difference between men and women in terms of vitamin D deficiency. Some studies considered vitamin D deficiency based on gender, but with no actual comparisons between both genders in terms of vitamin deficiency and its risk factors [Elsammak et al, 2010; Oren et al, 2010]. As mentioned earlier a study in 2012 on Saudi married couples compared the physical activity and sun exposure among men and women. The study found that the exposure to sunlight was higher in men compared to women [Elshafie et al, 2012]. In terms of risk factors affecting vitamin D level and controlling for some confounding variables between genders, most men were wearing lighter clothing than women; however, there were no differences in physical activity, medication intake, and skin color [Elshafie et al, 2012].

Dietary patterns were quite similar between men and women in the study of Saudi married couples; however, the intake for both fresh milk and soft drinks were higher among men.

Indeed, the study concluded that the difference between men and women in serum vitamin D levels might be a result of differences in clothing and sun exposure [Elshafie et al, 2012].

CHAPTER 3

3. METHODOLOGY

This chapter includes the study design, participant recruitment, inclusion and exclusion criteria, sample size, data collection and statistical analysis procedures. It also describes the development and design of the socio-demographic, diet, health and cultural factors questionnaire and the standard protocols of measurement at the LifeLabs laboratory for vitamin D analysis. Issues related to ensuring scientific rigor of the data, privacy and confidentiality are also included in the chapter.

3.1 Ethics Approval

The Western University Review Board for Health Sciences Research approved the study protocol (see Appendix A).

3.2 Study Design

A cross-sectional study using a 28-item health questionnaire and laboratory testing was conducted during the summer months of 2013. A snowball sampling technique was used to recruit study participants. Student organizations at the university that specifically represented each of the different Middle Eastern countries were contacted as sources of potential study participants; however, we did not get a response because our data collection started during the summer time. Thus, we contacted the participants individually face-to-face around the university campus and we followed our snowball sampling technique. The study participants were from the Middle Eastern countries and through the questionnaire they self-identified their nationality (e.g., Saudi, Emirati, Turkish, etc.). The men and women recruited for the study were between 18-33 years of age living in London, Ontario, Canada who were attending Western University and were healthy without pre-existing conditions affecting their vitamin D or calcium metabolism. Interested participants were given a printed copy of the Letter of Information (Appendix B) and

Consent Form (Appendix C). A socio- demographic, health and cultural factors questionnaire (Appendix D) was used to collect specific data from participants about different risk factors for vitamin D deficiency. The 28-item questionnaire administered to the participants is a series of questions to determine different socio-demographic, health and cultural risk factors for vitamin D deficiency. An agreement with LifeLabs was obtained to get participants go to their laboratory located at the University Community Center to have their blood test done without any need for a physician lab referral (Appendix E).

3.3 Participant Recruitment

A snowball sampling approach was used to recruit participants. Participants were recruited individually when we did not get any response from the Western University Student Associations during the summer time. We started our participant recruitment during May and June 2013 and as a co-investigator (AA) I started (as a member of one of the Middle Eastern Associations) to contact members who I knew were at the university campus. Using a prepared script (see Appendix F), we presented information about the research, our research objectives and purposes to the participants individually or sometimes as a group in a study room at Western University. Then we requested them to participate and what they need to do in the study. We followed our snowball sampling technique by asking the initial participants to recall people they know who might be interested to participate in the study. The participants were reselected based on our inclusion and exclusion criteria. Participants were given a printed copy of the Letter of Information (Appendix B), Consent Form (Appendix C) and Vitamin D Blood Test Request Form (Appendix G).

3.4 Inclusion and Exclusion Criteria

Inclusion Criteria:

Our inclusion criteria were any Middle Eastern men and women aged between 18-33 years who have immigrated to London, Ontario, Canada for 5 years or less and attending Western University at the undergraduate or graduate level.

Exclusion Criteria:

Students were excluded if they had any pre-existing condition affecting vitamin D or calcium metabolism including liver or kidney disease, eating disorders, skin diseases, pregnancy and breast feeding status.

3.5 Sample Size

We considered the various Middle Eastern student populations at Western University for our sample size. Since no study has been done on vitamin D deficiency among Middle Eastern immigrants and/or university students in London Ontario, we did not have any means or standard deviations to use for sample calculation. The sample size was based on available statistics of the sample population in London, Ontario in 2006 from Statistics Canada reports. Of the 9,925 estimated population of Arab/ Muslim origin, approximately 65 % were between the ages 18-33 years and 10% of them have immigrated to London 5 years or less [Statistics Canada, 2006] We chose 10% of the selected age group, and based on the enrollment statistics at the university we recruited approximately 51 participants.

3.6 Data Collection

During the individual or group presentation using the prepared script (see Appendix F), the study co- investigator (AA) explained the nature of the study in detail and how to fill out the questionnaire. In addition, the co- investigator (AA) explained how, when and where the blood sample will be taken. Participants were divided into groups based on their availability to come to the LifeLabs located in the Western University campus at the University Community Center (UCC). After the participants had their blood sample taken at LifeLabs, they were asked to fill out the questionnaire in a separate private room at the UCC. The co- investigator (AA) was available to help participants fill the questionnaire and answer any questions, but did not look at or influence their answers. I was far away from the participants and participants were far away from each other for privacy purposes. Participants were encouraged to ask any question or express any concern they might have about the study or about the questionnaire itself.

3.7 Questionnaire: Socio-demographic, Diet, Health and Cultural Factors

The Socio-demographic, Diet, Health and Cultural Factors Questionnaire was developed to meet the purpose of this study (see Appendix D). The questionnaire is a series of questions to determine different socio-demographic, diet, health and cultural risk factors for vitamin D deficiency. In addition, the questionnaire was divided into 5 different sections to determine particular risk factors to identify participants at high risk of vitamin D deficiency. The questionnaire starts with personal information, then health information followed by dietary information and sunning practices.

We created the questionnaire specifically for this study. At first, we decided what we want to know about this population in order to determine vitamin D risk factors and how we are going to use the data. We started reading on previous studies about vitamin D deficiency among Middle Eastern populations to understand what has been done already on the topic. We looked at scientific studies on what health and dietary factors might impact serum vitamin D level. We used close-ended questions for the quantitative data we were interested in. We also considered Middle Eastern norms and cultural practices regarding clothing and lifestyle habits by envisioning a list of possible answers so we can frame appropriate questions. In addition we added questions specific for Muslim women only as we understand they follow more restrictive cultural practices.Thus a lot of thinking and work went into developing this questionnaire, which was then pilot-tested among four colleagues and friends from the Middle Eastern population to test the cultural appropriateness of the questions and possible choices for answers.

In the demographic section, the questionnaire asked for participants' gender and their age. In addition, they were asked how long they have been immigrants in Canada classified as less than 1 year, 2 years and 3-5 years. The educational level of the participants was classified into four options: Bachelor's degree, Master's degree, PhD and others. The nationality information was also collected.

In the health section, the participants' were asked to record their weight. There were some specific questions for women only about their pregnancy status or if they are currently breastfeeding. In addition, questions were asked regarding any diseases such as chronic fatigue, coeliac sprue, colitis, Crohn's disease, diabetes, eating disorders, eczema or serious skin disease, kidney disease, lactose intolerance and ulcer in the digestive tract. Participants were also asked if they have experienced any pain in the last 6 months and they were asked to specify the location and the reason of the pain, if known.

In the dietary information section, eight questions asked about their intake of dairy products such as milk and the serving sizes were classified to 4 groups: less than 1cup, 1-2 cups, 3-4 cups or more than 4 cups. Moreover, questions were asked about any vitamin D, calcium, cod-liver oil and omega -3 fatty acid supplements. Participants were asked to record their intake of vitamin D in international units and their intake of calcium in milligrams.

The section on sunning practices targeted participants' average length and time of sunlight exposure. The questions were about how many days a week, how many minutes per day and what time they mostly spend outdoors under the sun. In addition, participants were asked to describe their usual clothing when they are outdoors under the sun by choosing from nine options about different possible clothing style. Specifically Muslim women were asked about their usual clothing when they are in the company of women only in outdoor private settings. Information was requested about using sunscreen and the specific SPF (Sun Protective Factor) number they used if known and if they had used any tanning equipment in the last 6 months.

3.8 Vitamin D Lab Test

The level of serum vitamin D was obtained using standard protocols of measurement at the LifeLabs laboratory. Each participant's serum level of 25-hydroxyvitamin D [25(OH)D] was measured once using LifeLabs protocol (see 3.9 below). Subjects were assigned into groups based on their availabilty to visit LifeLabs for their blood samples to be taken by the laboratory technicians. The LifeLabs laboratory collected the results of the serum level analysis. Confidentiality was maintained by using codes and no personal identifiers were collected. The results were subsequently submitted by the lab to the co- investigator (AA) for safekeeping.

3. 9 Vitamin D Assay Principle

"The Liaison 25 (OH) Vitamin D assay is a direct competitive chemiluminescence immunoassay (CLIA) for quantitative determination of total 25 (OH) vitamin D in serum. During the first incubation, 25 (OH) Vitamin D is dissociated from its binding protein and binds to the specific antibody on the solid phase. After 10 minutes, the tracer (vitamin D linked to an isoluminol derivative) is added. After a second 10-minute incubation, the unbound material is removed with a wash cycle. Subsequently, the starter reagents are added to initiate a flash chemiluminescent reaction. The light signal is measured by a photomultiplier as relative light units (RLU) and is inversely proportional to the concentration of 25 (OH) vitamin D present in calibrators, controls, or samples" [LifeLabs Methodology, 2013].

3.10 Statistical Data Analysis

All data from the Socio-demographic, Health and Cultural Questionnaire were tabulated using SPSS descriptive analysis software (version 22, 2013, SPSS Inc., IBM Corporation) for statistical analysis. Data entry was doubled checked by the researchers for accuracy. Participants were assigned codes for the questionnaire responses. Data were entered into the SPSS statistical analysis program by the co- investigator (AA) and the data were doubled checked for accuracy. These same codes were used in the analysis of the questionnaire data using SPSS. Tests included means, for example, mean age and weight. In addition we used t-test for comparing men versus women with different variables and vitamin D deficiency and insufficiency with different variables. After running the analysis, all SPSS analysis results were tabulated. These tables were then used to calculate frequency totals and averages and other statistical results. In general, significance was set at ($p < 0,05$), but in case where the analysis was more complicated, significance was set at ($p < 0.01$) or ($p < 0,001$) to capture any differences.

3.11 Privacy and Confidentiality

The participants' identifier codes used in the data collection form (see Appendix H) corresponds to the codes of the questionnaire completed by participants to allow for appropriate data analysis. The master list identifying individuals participating in the study with specific codes were kept separately. All collected data were stored in a password-protected computer in the graduate office at Brescia University College. Hard copy records were stored in a locked cabinet in the locked graduate office at Brescia and will be destroyed after five years. Only the researchers have access to these records.

3.12 Scientific Rigor of the Study

To ensure scientific rigour of our study, we analyzed the data from our questionnaire, (using statistical techniques in the SPSS software version 22 (2013), SPSS Inc., IBM Corporation, Ref.# 7038407) which produced statistically reliable information about a specific Middle Eastern population. Sample participants were selected based on our inclusion and exclusion criteria and they were from different countries of Middle East, representing a wide variety of the Middle Eastern population. Vitamin D analysis was done by the LifeLabs laboratory using their standard parameters and methods to measure serum 25-hydroxyvitamin D (cut-off point for deficiency is < 25 nmol/L).

The questions, for the most part, were closed-ended because the participants' answers were based on simple facts, modified in a way that answers to some questions were based on cultural context. The series of questions about clothing style when subjects exposed themselves to sunshine outdoors were based on the literature review. We excluded any option under these questions regarding sunlight exposure wearing a bathing suit or any similar non-conservative clothes because these are not the norms among the Middle Eastern population. We asked a specific question for Muslim women only because our literature review revealed that Muslim women are the ones who mostly wear conservative clothes; and it was known that being fully clothed is one of the limitations to beneficial sun exposure. In terms of validity, our questionnaire allowed us to gain knowledge for a better understanding of the socio-demographic, health and cultural factors that support our lab test measurement of vitamin D status. Regarding external validity, our study results can be generalized to the population of the same age groups who share the same culture, norms, diet and life style characteristics other than being immigrants in Canada or any similar country. With respect to the quantitative techniques for collecting and analyzing the lab data and questionnaire responses, we made sure that we were able to support our interpretations with adequate statistical evidence. In terms of controlling for confounding factors, we used pair matching wherein we selected for each subject one or more subjects with similar characteristics, such as same sex and clothing style.

CHAPTER 4

4. RESULTS

This chapter includes information about the study participants as well as the resulting information from the responses to the questionnaire and the results of the laboratory assay of serum vitamin D. Also included are the statistical results on the relationships between vitamin D status and the socio-demographic, health and cultural factors.

4.1 Anthropometric and Demographic Characteristics

Fifty-one students participated in the study, 59% (n=30) were females and 41% (n=21) were males. The average age ± SD of all participants was 24 ± 5 years old. The mean age for females was 26 ± 5 while the mean age for males was 22 ± 4. This age difference was significant (p=.008) (see Table 1).

More participants (51%) have been in Canada for 3-5 years, however, there was no significant difference between both genders in terms of how long they have been in Canada. The average weight in kilograms for all participants was 66 ± 18 SD; and 56.7 ± 14.1 average weight for women versus 80.1 ± 14.2 average weight for men. About 58% of the participants had a bachelor's degree. There was a significant difference between men and women in terms of their educational attainment. Men mostly had a bachelor's or lower educational level, while women were equally divided between a bachelor's or lower and master's or higher educational level. Participants came from 12 different countries of the Middle East; however, 57% of the participants were from Saudi Arabia. In terms of their countries or regions of origin, there was a significant difference between men and women. Both women and men were equally from the Gulf region (Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE); however, there were more women than men coming from other Middle Eastern countries (Iran, Turkish, Egypt, Palestine, Syria, Lebanese, Yemen).

Table 1. Anthropometric and Demographic Characteristic of Participants Organized by Sex

Variables	Women (n=30)	Men (n=21)	*t* (p- value)
Ave. Age (year)	26.4 ± 5.0	21.8 ± 3.7	.008
Ave. Weight (kg)	56.7 ± 14.1	80.1 ± 14.2	.886
Years living in Canada (n)			
< 3 years	14 (27%)	11 (21%)	.900
3-5 years	16 (31%)	10 (20%)	
Educational attainment (n)			
Bachelor and lower	15 (29%)	19 (36%)	.000
Master and higher	15 (29%)	2 (4%)	
Country of Origin (n)			
Gulf Region	18 (35%)	18 (35%)	.000
Other Middle Eastern Countries	12 (23%)	3 (6%)	

4.2 Dietary Data and Health Information

Based on dietary and healthy information (Table 2), there was no significant difference in the average milk intakes between men and women. Sixty seven percent of the participants drank less than 1 cup of milk daily and only 6 % reported that they drank 3 or 4 cups daily. All participants were not taking any cod-liver oil, and only one of the participants was taking omega-3 fatty acid (fish oil) supplement. About 76% of the participants reported that they do not take multivitamin supplements daily. There was no significant difference between men and women in terms of those who took multivitamin supplements. In addition, 88% of the participants were not taking vitamin D supplements, and 90% of participants reported not taking calcium daily.

About 92 % of the participants have none of the diseases listed on the questionnaire such as chronic fatigue, eating disorder and eczema. In terms of experiencing any malady such as muscle pains, headache and weakness, 31% did not experience any and 23 % reported suffering monthly from headache. In addition, 52% of the participants reported suffering from some pain anywhere in the body for different known and unknown reasons, but there was no significant difference between women and men.

Both omega-3 fish oil and vitamin D supplement intakes were significantly different between men and women. While no men were taking vitamin D supplements, 6 women reported taking significantly more vitamin D supplements per day. Men and women were significantly different in terms of taking calcium supplements every day, 5 women were taking calcium supplements per day while no men were taking it. However, the same number of men and women participants was taking multivitamin supplements per day.

In terms of health information, there was a significant difference between the number of women and men who did not have any diseases, 26 vs. 21 participants, respectively. Only 4 women reported that they had chronic fatigue, eating disorder or eczema, and no men reported that they had any of the diseases. There was no significant difference in the number of participants who had deficient (< 25 nmol/L) or insufficient (25 nmol/L-74 nmol/L) vitamin D values (see Table 2).

Table 2. Dietary and Heath Information of Participants Organized by Sex

Variables	Women (n=30)	Men (n=21)	*t* (p- value)
Dietary information: (n)			
Milk intake (Average in Cups)	1.4 $\pm$ .65	1.4 $\pm$ .67	.655
Omega-3 fish oil supplement /day:			
Yes	1 (2%)	0 (0%)	.015
No	20 (39%)	30 (59%)	
Multivitamin supplement/day:			
Yes	6 (12%)	6 (12%)	.178
No	24 (47%)	15 (29%)	
Vitamin D supplement/day:			
Yes	6 (12%)	0 (0%)	.000
No	24 (47%)	21 (41%)	
Calcium supplements /day:			
Yes	5 (10%)	0 (0%)	.000
No	25 (49%)	21(41%)	
Health information: (n)			
No diseases	26 (51%)	21 (41%)	.000
Chronic fatigue, eating disorder, eczema	4 (8%)	0 (0%)	
No malady	5 (10%)	11 (21%)	.000
Muscle pain, headache, weakness	25 (49%)	10 (20%)	
No bodily pain	19 (37%)	8 (16%)	.841
Pain anywhere in the body	11 (22%)	13 (25%)	
Vitamin D status: (n)			
Deficient	9 (%)	6 (12%)	.222
Insufficient	20 (39%)	15 (29%)	

4.3 Sunning Practices, Use of Sunscreen and Usual Clothing

Based on the time of sun exposure, about 63 % (n= 32) of the participants exposed themselves for 4 and more days per week to the sunlight. The average number of days per week participants exposed themselves to the outdoor sun was significantly different between both genders as shown in Table 3. Thirty seven percent of the participants reported spending more than 30 minutes per day outdoors under the sun. The main period that 53% participants spent outdoors under the sun was from 10 am – 4 pm. However, there were no significant differences between men and women in the average number of minutes per day and time of the day they exposed themselves to sunlight.

Based on using sunscreen outdoors under the sun, 61 % of the participants almost never use sunscreen, while 20% reported that they used sunscreen almost all of the time (> 50 - 95%). In addition, 96 % of the participants reported that they have not used any indoor tanning equipment. There was a significant difference between women and men in their sunscreen usage. More men than women were not using sunscreen, 19 vs. 12, respectively. No men were using sunscreen more than 50 % of the time, while 12 women were using sunscreen more than 50 % of the time.

Based on participants' clothing style outdoors under the sun, 43% of both women and men had their head covered but their hands were exposed. Almost 8% of the participants reported that they were fully covered when they were outdoors under the sun. In terms of the question asked exclusively of Muslim women, regarding their clothing when in private setting, 57% indicated that they wore long pants and T- shirt or similar top. There was no significant difference between women and men in terms of their usual clothing worn outdoors.

Table 3. Sunning Practices, Use of Sunscreen and Usual Clothing Organized by Sex

Variables	Women (n=30)	Men (n=21)	*t* (p- value)
Sunning practices: (n)			
Exposure to outdoors sun:			
Ave. Day/week	3 ± 1.4	3.5 ± .87	.002
Ave. Minute/day	1.6 ± .76	2.6 ± .68	.283
Time of exposure:			
7-10 am	7 (14%)	1(2%)	
10am - 4 pm	13 (25%)	14 (27%)	.269
4pm – 7pm	10 (20%)	6 (12%)	
Sunscreen use: (n)			
Never use	12 (23%)	19 (38%)	.000
5 -50%	6 (12%)	2 (4%)	
> 50 %	12 (23%)	0 (0%)	
Usual clothing: (n)			
Short and T-shirt or similar top	2 (4%)	10 (%20)	
Long pants and Head T-shirt or similar top	1 (2%)	10 (20%)	
Long pants and long sleeves	1 (2%)	1 (0%)	.948
Head covered and hand exposed	22 (44%)	0 (%0)	
Fully covered	4 (8%)	0 (0%)	

4.4 Vitamin D Status and Demographic Characteristics

Based on our participants' vitamin D status and demographic data, 33% of the males and 35% of the females had insufficient vitamin D, which falls between 25-74 nmol/L (see Table 4). In addition, there were more females deficient (< 25 nmol/L) in vitamin D (22%) than males (8%). The results also showed that 43% of the younger age (18-25 years) had more insufficient values compared to the slightly older group (26-33 years), while only 8% of the older group was vitamin D deficient. The younger group of participants had more deficient vitamin D values (average of 13 nmol/L) than the older group (average of 19 nmol/L), although the difference did not come up significant (p= .070). In addition, more of the younger participants had insufficient vitamin D values compared to the older group.

Participants who have been in Canada for 3 to 5 years were more deficient and insufficient than those who have been in Canada for less than 3 years. Insufficient vitamin D values were significantly different (p= .001) between participants who have been in Canada for less than 3 years and 3-5 years, with an average of 36 nmol/L vs. 44 nmol/L, respectively.

Based on educational level, participants with bachelor's degree or lower had higher percentages of being deficient (19%) and insufficient (39%). Because there were more participants from Saudi Arabia, there were also more who had deficient (15%) and insufficient (41%) values for vitamin D from this country. Overall, only 1 participant had a normal value of serum vitamin D (86 nmol/L) and she was an older Iranian highly educated female who had been in Canada for two years. As well, participants from the Gulf Region and other Middle Eastern Countries had average insufficient vitamin D values of 36 nmol/L vs. 49 nmol/L, respectively. Their values were significantly different (p=. 001) (see Table 4).

Table 4. Demographic Characteristics of Participants Organized by Vitamin D Status

Demographic Characteristics	**Vitamin D Status**			
	Deficiency ***< 25 nmol/L***	***t*** **(p- value)**	**Insufficiency** ***25-74 nmol/*L**	***t*** **(p- value)**
Gender: (n)				
Male	4	.142	17	.351
Female	11		18	
Age: (n)				
18-25	11	.070	22	.373
26-33	4		13	
Length of stay in Canada: (n)				
< 3 years	7	.487	17 (36 nmol/L)	.001
3-5 years	8		18 (44 nmol/L)	
Educational attainment: (n)				
Bachelor and lower	10	.903	24	.197
Master and higher	5		11	
Nationality: (n)				
Gulf Regions	11		25 (36 nmol/L)	
Other Middle Eastern Countries	4	.712	10 (49 nmol/L)	.001

4.5 Vitamin D Status and Health Information

In terms of the participants who did not report that they were suffering from any disease, 63 % were insufficient and 27% were deficient in vitamin D (see Table 5). In addition, 22% of the participants who indicated not experiencing any malady such as muscle pains, headache and weakness had insufficient vitamin D. Twenty three percent of the participants who had suffered from muscle pains, headache and weakness were vitamin D deficient and 47% were vitamin D insufficient. There was only 1 participant who did not suffer from any disease, malady, and pain anywhere in the body and had a normal vitamin D value. As shown in Table 5, insufficient vitamin D values were significantly different between participants who had no diseases and those who were suffering from chronic fatigue, eating disorder and eczema (p= 0.04). The average vitamin D values for both groups (no diseases, suffering from any disease) were 40 nmol/L and 36 nmol/L, respectively.

Table 5. Health Information of Participants Organized by Vitamin D Status

Health Information	**Vitamin D Status**			
Suffering from any disease: (n)	**Deficiency** ***< 25 nmol/L***	***t*** **(p- value)**	**Insufficiency** ***25-74 nmol/*****L**	***t*** **(p- value)**
No diseases	14	----	32	.042
Chronic fatigue, eating disorder, eczema	1		3	
Experience any malady: (n)				
No malady	3	.700	11	.306
Muscle pains, headache, weakness	12		24	
Any pain anywhere in the body: (n)				
No bodily pain	9	.485	14	.865
Pain anywhere in the body	6		21	

4.6 Vitamin D Status and Dietary Data

Of the participants who indicated that they drank less than 1 cup of milk per day, 63% had vitamin D insufficiency, while only 6 % of participants who drank more than 2 cups of milk were vitamin D insufficient (see Table 6). Of the participants who were not taking multivitamin supplement per day, 27% were vitamin D deficient and 47 % had insufficient values. In addition, 59 % of the participants who indicated that they were not taking vitamin D supplements had insufficient vitamin D. The one participant who had a normal vitamin D value was consuming less than one cup of milk and taking multivitamin supplements daily but not vitamin D supplement. There were no significant differences between the vitamin D values (whether deficient or insufficient) according to the dietary variables examined as shown in Table 6. The only significant difference (p=. 037) in the insufficient vitamin D values (31 nmol/L vs 41 nmol/L) was in participants' intake of calcium supplements every day.

Table 6. Dietary Data of Participants Organized by Vitamin D Status

Dietary Information	**Vitamin D Status**			
	Deficiency ***< 25 nmol/L***	***t* (p- value)**	**Insufficiency** ***25-74 nmol/*L**	***t* (p- value)**
Serving of milk/ day: (n) <2 cup >2 cups	15 0	-----	32 3	.870
Taking multivitamin /day: (n) Yes No	1 14	-----	11 24	.179
Taking vitamin D supplement /day: (n) Yes No	1 14	-----	5 30	.121
Taking calcium supplements /day: (n) Yes No	1 14	-----	4 (31nmol/L) 31(41nmol/L)	.037

4.7 Vitamin D Status, Sunning Practices and Use of Sunscreen

Even with 4 or more days spent outdoors, 43% were vitamin D insufficient, while 20% were vitamin D deficient (see Table 7). Only 4 % of the participants who spent more than 30 minutes per day outdoors under the sun were vitamin D deficient, while 33% of them were vitamin D insufficient. No matter what time period was spent under the sun, 30% had vitamin D deficiency, while 47% of the participants who spent before 10 am up to 4 pm outdoors under the sun had insufficient values. The one participant who had a normal vitamin D value was exposed heavily to sunlight for more than 4 days per week, and about 15- 30 minutes per day from 7-10 am.

Based on participants' usage of sunscreen, 60% of participants did not use sunscreen and were not included in the analysis for this portion of the study. In addition, 12 % of the participants who use sunscreen occasionally (5-50% of the time) had insufficient vitamin D and a similar percentage for who also used it regularly (> 50-100% of the time) were also deficient. The one participant who had normal vitamin D was using sunscreen only occasionally (5-20% of the time). About 94 % of those who had deficient and insufficient values have not used any indoor tanning equipment.

In terms of participants' sunning practices, the only significant difference (p= .047) in the insufficient vitamin D values was in the use of sunscreen outdoors under the sun between participants who use it 5- 50 % of the time (average vitamin D = 31 nmol/L) and those who use it more than 50 – 100 % of the time (average vitamin D value was 41 nmol/L) (Table 7).

Table 7. Sunning Practicing of Participants Organized by Vitamin D Status

Sunning practices	**Vitamin D Status**			
Days/ week expose to sunlight: (n)	**Deficiency** ***< 25 nmol/L***	***t*** **(p- value)**	**Insufficiency** ***25-74 nmol/*L**	***t*** **(p- value)**
1-3 day	5	.737	13	.222
4 or more days	10		22	
Min/ day spent outdoors under the sun: (n)				
15 -30 min or less /day	13	.133	18	.590
>30 min /day	2		17	
Time mostly spend outdoors under the sun: (n)				
Before 10 am - 4 pm	10	.863	24	.592
4-7 pm	5		11	
Use of sunscreen outdoors in the sun: (n)				
5-50% of the time	2	.786	6 (31 nmol/L)	.047
>50- 100 % of the time	5		6 (41 nmol/L)	
Use of indoor tanning equipment: (n)				
I haven't used	15	-----	33	.657
I have used	0		2	

4.8 Vitamin D Status and Usual Clothing In the Sunlight

The lowest percent of vitamin D deficiency (2%) was observed in the group who wore long pants and T- shirt or similar top, although 20% of them had insufficient values (see Table 8). The participants who covered their head but with their hands exposed had higher vitamin D insufficiency. Regarding the Muslim women's clothing in private settings, 4% of the participants who wore shorts and T- shirt or similar top had vitamin D deficiency. Approximately 45 % of the participants (41% men and 4% not Muslim women) were excluded from the analysis of this question. Furthermore, 29% of the participants who had their face, head and hands exposed were vitamin D insufficient. Table 8 shows that there was a significant difference between the group who had their faces, heads with hands exposed, and those who wore shorts with T-shirt or similar top. The average vitamin D deficiency was 18 nmol/L for the group who had their face, head with hands exposed and11 nmol/L for those who wore shorts with T-shirt or similar top.

Table 8. Usual Clothing of Participants Organized by Vitamin D Status

Usual Clothing	**Vitamin D Status**			
	Deficiency ***< 25 nmol/L***	***t* (p- value)**	**Insufficiency** ***25-74 nmol/*L**	***t* (p- value)**
Usual clothing under the sun (n)				
Short and long pants with T-shirt or similar top	3	.209	19	.559
Mostly covered	21		16	
Usual clothing outdoor at private setting:(Muslim women only) (n)				
Face, head and hand exposed	9 (18nmol/L)	.008	15	-----
Short and T-shirt or similar top	2 (11nmol/L)		1	

In summary, deficient or insufficient vitamin D levels were significantly associated with younger age, female, lower education level, drank less cups of milk daily, did not take multivitamin/vitamin D/calcium supplements, suffered from malady, did not use indoor tanning equipment, used sunscreen more than 50 – 100 % of the time, exposed themselves less to sunlight, spent early morning and later afternoon from 7-10 am and 4-7 pm outdoors under the sun with conservative clothes.

CHAPTER 5

5. DISCUSSION

The high prevalence of vitamin D deficiency and insufficiency among Middle Eastern university students in London, Ontario, Canada has not been well established before this study was undertaken. Vitamin D deficiency has been well predictable across the entire Middle East and the developing world based on the literature we reviewed, however, we did not ask the participants if their vitamin D status had been tested before they came to Canada. The highlight of the present study is the discovery that there is a high prevalence of vitamin D deficiency and insufficiency among Middle Eastern students regardless of their country of origin, educational level, length of stay in Canada, dietary and health information and patterns of sunning practices. The study subjects represented a supposedly healthy Middle Eastern population who have been in Canada for 5 years or less and studying at Western University.

5.1 Anthropometric and Demographic Characteristics

In our study, younger participants (18- 25 years old) had higher vitamin D deficiency and insufficiency than older participants (26-33 years old). This is similar to a study done in 126 young adult Jordanians where 60% had 25(OH) D levels below 12 ng/mL (29 nmol/L) [Mishal, 2001]. A study in 2010 among patients in Norway showed a significant correlation between vitamin D levels and lower mean age in the study population [Knutsen et al, 2010]. Also in our study, eleven women were vitamin D deficient, while only 4 men had vitamin D deficiency. This result was not surprising and is similar to the findings of a study of 316 Lebanese adults that indicated 84% women and 48% men had low vitamin D levels below 12ng/ mL (or 30 nmol/L) [Holick, 2007].

There was no strong association between participants' vitamin D values and the number of years living in Canada. According to the data obtained from our questionnaire, this result may be due to the fact that most of our participants practiced the same lifestyle habits and wore clothes similar to what they have been wearing in their countries of origin. These findings are similar to a review of studies on hypovitaminosis D in developing countries [Arabi et al, 2010]. The review found that low vitamin D levels in developing countries are similar to those in Western countries where the participants had the same kind of eating habits, skin pigmentation, lack of sun exposure and conservative covered clothing style [Arabi et al, 2010].

In the present study, participants who had a bachelor's or lower educational attainment had more vitamin D deficiency and insufficiency than participants who had a master's or higher educational level. This outcome indicates and emphasizes the need to increase the awareness of the importance of vitamin D among the general population [Prentice, 2008; Knutsen et al, 2010]. Also, this may be interpreted as the participants who had higher educational level being more aware about the importance of their health than participants with lower educational level. The average age of women was higher than men and the women also had higher vitamin D deficiency and insufficiency than men. Indeed, a study done in a western region of Saudi Arabia reported that there was a high prevalence of vitamin D deficiency among women and this result may have been due to the absence of public awareness [Siddiqui et al, 2007].

Participants from the Gulf Region were more vitamin D deficient and insufficient than other Middle Eastern countries. This result agrees with a previous study done within Middle Eastern countries, which found that the population of Gulf countries had a high prevalence of hypovitaminosis D. This finding is possibly explained by multiple factors such as cultural and religious practices, skin pigmentation, and indoor activity [Saadi et al, 2006].

In our study, we did not find any positive or negative relationship between weight and vitamin D level. However, one study reported that there is an association between obesity and low vitamin D level especially if the obese persons have undergone bariatric surgery because of some reasons such as postoperative malabsorption, decreased nutrient and calcium and vitamin D intakes [Goldner et al, 2008]. In addition, the enhanced fat solubility and decreased bioavailability of vitamin D produces low serum vitamin D levels with obesity [Fields et al, 2011]. However, It has also been reported in multiple studies that there is an association between obesity and low serum 25-hydroxyvitamin D concentrations [Bell et al, 1985; Liel et al, 1988; Lagunova et al, 2009].

5.2 Dietary Data

Out of 30 women participants, only 6 participants in the present study were taking Vitamin D supplements, while no male participants were taking any vitamin D supplements. This outcome may be due to lack of awareness of the recommended amount of vitamin D intake. This study also found that taking vitamin D supplements per day slightly increased the values of vitamin D. According to a study done in the Gulf Region, the researchers advocated the increase of vitamin D supplementation to maintain healthy serum 25(OH)-vitamin D levels [Al-Daghri et al, 2012]. The Canadian Health Measures Survey stated that a large percentage of Canadians who took supplements containing vitamin D were above the cut-off value for deficiency level compared to those who did not (85% vs. 59%) [CHMS, 2013]. In addition, this study found a positive relationship between taking multivitamin supplements daily and serum vitamin D values. By taking multivitamin supplements per day, vitamin D values were slightly increased. The Canadian Health Measures Survey reported that people who consumed milk once or more per day had a higher average vitamin D level than those who consumed milk less than once per day

(68 nmol/L vs. 59 nmol/L) [CHMS, 2013]. In the present study, there was a positive relationship between serving size of milk and vitamin D values. By increasing the serving size of milk or foods fortified with vitamin D, vitamin D values increased. These findings are similar to what has been reported in a study about the effect of a fortified milk drink on vitamin D status, which indicated that serum 25-hydroxyvitamin D had been improved by increasing the intake of milk fortified with vitamin D [Kruger et al, 2010].

5.3 Health Information

In this present study, both women and men reported suffering from muscle pain, headache and weakness; however, more women were suffering from malady, diseases or pain anywhere in the body than men. A previous study conducted in the Middle East, Africa, and South Asia reported that more women had lower vitamin D levels than men [Knutsen et al, 2010]. Indeed, in our study, most of the participants who had deficient or insufficient vitamin D values were suffering from muscle pain, headache, weakness or all together. Similarly, according to a study on vitamin D status in patients with musculoskeletal pain, fatigue and headache, there was a higher prevalence of hypovitaminosis D in patients with non-specific musculoskeletal pain, headache, or fatigue [Knutsen et al, 2010]. Twenty three percent of the participants in this present study reported suffering mostly from headache and had low vitamin D levels. This outcome is also consistent with the study by Knutsen et al [2010], where the mean for vitamin D levels was much lower in patients with headaches compared with patients with other symptoms [Knutsen et al, 2010]. Also, the present study found that participants who had pain anywhere in the body suffered from more maladies. In addition, 31% of participants who reported not suffering from any malady had higher levels of vitamin D than the other participants. Our results demonstrated that there is no strong correlation between vitamin D level and muscle pains.

Because only 8% of the participants had muscle pains, the lack of correlation may be due to other health problems or signs and symptoms of a deficiency other than vitamin D deficiency.

5.4 Sunning Practices and Use of Sunscreen

Men in the present study had a higher average compared with women in terms of the number of days per week they exposed themselves to sunlight. Most men and women exposed themselves to sunlight between 10 am to 4 pm. Participants who exposed themselves to sunlight for 4 or more days had higher levels of vitamin D values than participants who exposed themselves to sunlight for 1-3 days. According to other studies, vitamin D levels were low among people who spent more time indoors, avoided sunlight with protective clothing and had a darker skin pigmentation [Holvik et al, 2008; Pearce et al, 2010]. Indeed, men who exposed themselves more to sunlight (slightly higher average in terms of minutes per day) had a higher average of serum vitamin D values than women. Also the present study indicated that by increasing the time per day spent outdoors under the sun, vitamin D values were slightly increased. According to some studies, men mostly spent a lot of time exposing themselves to sunlight because of their work activities, while most women worked mostly in indoor environments [Kanan et al, 2012; Elshafie et al, 2012]. Since dark skin pigmentation is probably the biggest risk factor for vitamin D deficiency in the Middle Eastern population [Knoss et al, 2012; Badsha et al, 2009; Arabi et al, 2010], they need more time to expose themselves to sunlight to allow vitamin D synthesis by the skin. Individuals with dark skin need to expose themselves to sunlight more than those who are fair-skinned for more effective vitamin D synthesis [Pearce et al, 2010; Knutsen et al, 2010]. Consequently, the differences in the results may be due to the exposure to sunlight for longer time periods and more days. Vitamin D values were a little higher for participants who exposed themselves to sunlight before 10 am to 4pm than the Vitamin D values of participants who exposed themselves to sunlight from 4pm to 7 pm. A study in Saudi Arabia of ultraviolet radiation reported that the best time to expose oneself to sunlight to get vitamin D with less risk of skin cancer is before 10 am and after 3 pm [Hannan et al, 1984]. The present study, conducted in the summer, found that the older age group (26- 33 years) was mostly outdoors under the sun between 1- 4 pm and 4 -7 pm, while younger age group (18- 25) was mostly outdoors between 1- 4 pm. Another interesting relationship was that participants who drank less than one cup of milk per day had the lowest average of how many minutes per day they exposed themselves to sunlight.

There was a significant difference between women and men in terms of using sunscreen. Women were using sunscreen more than men, and this is also consistent with the study in Saudi Arabia by Hannan et al [1984] who reported that women had higher sunscreen usage than men. While 12 women used sunscreen more than 50% of the time, no men used it more than 50% of the time and 19 male participants never used sunscreen in the present study. Maybe because fewer men were using sunscreen, they had higher levels of vitamin D values as compared to women. Similarly, a study in Kuwait on the relationship between the use of sunscreen and vitamin D levels reported a higher vitamin D deficiency and insufficiency among participants who used sunscreen compared with non-sunscreen users [Al-Mutairi et al, 2012]. However, the authors concluded that there was no significant difference between participants who used sunscreen and those who did not use sunscreen [Al-Mutairi et al, 2012].

5.5 Usual Clothing In the Sunlight

Lack of sun exposure and a covered clothing style were the most important risk factors for low 25-hydroxyvitamin D in Middle East [Ozkan et al, 2009; Gharaibeh et al, 2009]. In our study, participants who were mostly covered (45 %) used sunscreen more, spent less time outdoors under the sun than other groups and had higher vitamin D deficiency. In addition, there was a significant difference in vitamin D values between female participants who had just their face, head and hands exposed and women who wore shorts with T-shirt or similar top. Women who had only their face, head and hands exposed were more vitamin D deficient than women who wore shorts with T-shirt or similar top. This is similar to the finding that there are increased rates of vitamin D deficiency in girls wearing conservative clothes with a cover (‘hijab’ or ‘niqab’) in comparison with females wearing western dress style [El-Hajj Fuleihan, 2009; Lips, 2010]. Indeed, in our study most of the women participants tended to be mostly in the group who covered their heads with hands exposed and fully covered as their usual clothing under the sun (52%), while men had a variance of wearing short and T- shirt or similar top and long pants with T-shirt or similar top (45%). Also, a previous study reported that most men participants wore lighter clothing style and material than women and the difference between men and women in vitamin D levels might be a result of the differences in clothing and sun exposure [Elshafie, 2012]. However, there is a need to understand that overexposure to the sun may result in sunburn and damage to the skin, which may eventually lead to skin cancer. If a person is going to be exposed to the sun for a long time, it is better to use sunscreen protection or a clothing cover [Whittaker, 1995]. Our study results indicated that there is a relationship between vitamin D and usual clothing. Participants who covered their heads with hands exposed and wore long pants and sleeves (45 % of participants) had lower levels of vitamin D than those who wore shorts with T-shirt, and long pants with long sleeves (55 % of participants). This is also consistent with a study finding that clothing styles are a major cause of vitamin D deficiency in Tunisia [Meddeb; 2005]. Other studies also indicated that cultural factors such as clothing style, veils and long sleeves, are all considered as risk factors of vitamin D deficiency [Laleye, 2011; Bahijri, 2001;

Dong et al, 2010]. In this present study, those who were mostly fully covered (45% of participants) spent less time outdoors under the sun in comparison with those who wore shorts and T-shirt, and long pants with long sleeves (55 % of participants). The older group (26-33 years) was mostly covered compared with the younger group (18-25 years).

In summary, those who had low vitamin D levels could be characterized as follows: a) female, b) younger, c) stayed less years in Canada, d) had less education, e) came from the Gulf Region, f) drank less than 2 cups of milk daily, g) were not taking multivitamin or vitamin D supplements, h) suffered from muscle pain, i) headache and weakness, j) have not used indoor tanning equipment, k) used sunscreen more than 50 – 100 % of the time, l) exposed themselves to sunlight less than 15 minutes, m) spent time from 7-10 am and 4-7 pm outdoors under the sun, and n) were mostly fully clothed. These findings are similar to many studies done among the Middle Eastern populations by various authors.

5.6 Study Limitations

Our study had several limitations, which may make the results only generalizable to a population group with similar characteristics as our sample participants. Our study population consisted of only students at Western University who were present on campus during the summer session. Since we collected our data during the summer time, most of the students who were from the Middle East had left and went back home for vacation. This made it difficult for us to choose a sufficient or large sample size with a wide range of age groups for more statistically significant findings. We had limited access to most of the Middle Eastern organizations at Western University, which would have helped us in participant recruitment. It is possible that we might get more supportive evidence with a larger sample size and wider range of participants from the Middle Eastern population.

Since we did not have the participants' vitamin D values before they came to Canada, the seasonal trends in vitamin D absorption in this population may be different in their country of origin. Vitamin D levels are affected by seasonal exposure to the sun and in our study sample we did not observe their vitamin D status during winter season to be compared with the summer season.

Data on sun exposure, health information and dietary patterns were based on self-administered questionnaires. This might reflect self-report bias with participants trying to recall some of their practices as best as they could.

In reviewing the literature, we found limited long-term studies that have been done among Middle Eastern population for comparison of vitamin D levels (including the use of vitamin D supplements) among Middle Eastern population inside and outside their countries of origin. This supportive evidence would have been useful to the researchers to compare vitamin D levels among populations, i.e., if there is any improvement or change when they migrate to other countries.

CHAPTER 6

6. SUMMARY AND RECOMMENDATIONS

In this chapter, I made recommendations for future studies based on our study findings and the needs of the Middle Eastern populations. As well, I suggested some possible programs to increase vitamin D levels among Middle Eastern populations living in London, Ontario, Canada and perhaps to some extent provide an awareness to the Middle Eastern health authorities of the vitamin D status of their populations and if possible encourage them to take a positive step forward to improve their populations' health.

6.1 Summary

This cross sectional study was done to investigate the level of vitamin D (in terms of deficiency, insufficiency, normality) and risk factors among Middle Eastern students attending Western University in London, Ontario Canada aged 18-33 years and who have been immigrants to Canada for five years or less. We measured their vitamin D status using serum vitamin D 25-hydroxyvitamin level and the risk factors were determined using a prepared questionnaire on socio-demographic, diet, health and cultural aspects. The study participants were recruited using a snowball sampling approach.

The results of the present study in London, Ontario, Canada supported previous findings from numerous Middle Eastern and international studies elsewhere that revealed a high prevalence of vitamin D deficiency and insufficiency among Middle Eastern populations. Similarly, participants in the present study also provided evidence of the prevalence of vitamin D deficiency and insufficiency among Middle Eastern populations. Sixty-three percent of the participants, who were not suffering from any disease, were insufficient and 27% were deficient in vitamin D. In addition, 22% of the participants who indicated not experiencing any malady had insufficient vitamin D. Twenty-three percent of the participants who had suffered from malady were vitamin D deficient and 47% were vitamin D insufficient. While 63% of participants who drank less than 1 cup of milk per day had vitamin D insufficiency, only 6 % of the participants who drank more than 2 cups of milk were vitamin D insufficient. In terms of participants who were not taking vitamin D supplements, 59 % had insufficient vitamin D. The most surprising result was that 43% of the participants who spent 4 or more days under the sun had vitamin D insufficiency, while 20% were vitamin D deficient. There was a significant difference between groups who had their face, head with hands exposed and those who wore shorts with T-shirt or similar top.

There was only one participant who had normal vitamin D value. She was an older Iranian highly educated female who did not suffer from any disease, malady, and pain anywhere in the body. In addition, she was consuming less than one cup of milk but taking multivitamin supplements daily,not vitamin D supplement, exposed heavily to sunlight for more than 4 days per week for about 15- 30 minutes per day from 7-10 am and using sunscreen only occasionally (5-20% of the time).

6.2 Recommendations

Considering the multiple risk factors observed in this study, it seems that increasing this population's awareness of vitamin D and its effects on health will be an important strategy overall. This strategy could be implemented in many ways. For example, because our results showed that only a few participants were taking multivitamins, calcium and vitamin D, we need to encourage clinicians to prescribe vitamin D supplementation throughout the year to prevent vitamin D deficiency and its related diseases.

Since we found that participants with lower education level had low levels of vitamin D status, educational programming through health units such as Western University's student health clinic is needed to increase the awareness of the importance of sun exposure during the summer months and the effects of limited sun exposure. More studies are needed in this research area, for example, a longer observation study to determine whether diets rich in vitamin D and vitamin D supplements have any effect on vitamin D level as well as the seasonal differences on serum levels. It would be a good strategy to compare vitamin D supplementation with sunlight exposure and dietary modification to increase intake of culturally appropriate foods rich in vitamin D to determine which one has more effect in improving vitamin D levels.

In our literature review we mentioned that Middle Eastern countries are poor in terms of the variety of foods fortified with vitamin D. As a result, we recommend that if possible there is a need to encourage the Middle Eastern health ministries to persuade the food industry to take the responsibility to provide more vitamin D enriched food products in the country's food supply chain. This may help to improve the vitamin D status of the population, in addition to the efforts of the scientific researchers and healthcare professionals who need to encourage them to consume more foods that are already fortified with vitamin D, especially in their new country, Canada. The study results indicated that men exposed themselves to sunlight slightly more than women. Thus, we recommend that in terms of facilities, health authorities in the Middle East or those of authority in their ethnic associations London, Ontario, Canada may have to consider building and designing more areas and spaces for covered women to get freely uncovered and expose themselves to sunlight in deference to their cultural practices.

6.3 Relevance to Dietetic Practice

This research has provided and will inform local Canadian and other healthcare professionals around the world significant information and data about the vitamin D status and multiple risk factors among Middle Eastern populations living in London, Ontario, Canada recently immigrated to London. Canadian dietitians will be more aware of the specific reasons that may cause the prevalence of low vitamin D in their Middle Eastern clients. In addition, it may be possible to identify and plan for educational programs that may generate some kind of improvement in their serum vitamin D levels when they move to Canada or other countries, with the corresponding changes in their lifestyle and food habits due to mainstream acculturation. Data collected for this study is not just about the students or participants. The study provided data that are relevant to the Middle Eastern populations who emigrate to Canada and elsewhere. Our research outcomes could build awareness or consciousness among healthcare professionals and assist them to better manage the prevalence of vitamin D deficiency in this population, in addition to gaining knowledge about the risk factors associated with hypovitaminosis D. Healthcare professionals in Canada and elsewhere need updated data on how many Middle Eastern immigrants are at risk of vitamin D deficiency. Moreover, this area of the study can help improve the vitamin D status of Middle Eastern populations through building or fostering an environment that increases the population's awareness of the significance of this particular vitamin. It is very possible that the research findings may also encourage the health ministries of Middle Eastern countries to persuade the food industry to provide more vitamin D enriched food products which can help improve vitamin D status in their populations. Our findings will also help dietitians to have a better understanding of this population's cultural practices and lifestyles and educate or encourage them to take the next steps toward changing what can be possible to change with the end goal of improving their vitamin D status.

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Appendix A. Ethics Approval by the Western University Review Board for Health Sciences

Western Research

Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Alicia Garcia
File Number:103612
Review Level: Delegated
Approved Local Adult Participants:60
Approved Local Minor Participants:0
Protocol Title: Vitamin D Deficiency and Possible Risk Factors among Middle Eastern UNIVERSITY STUDENTS in London, Ontario,Canada
Department & Institution: Brescia\Nutrition and Food Sciences,Brescia University College
Sponsor:
Ethics Approval Date: May 17, 2013 **Expiry Date:**April 30, 2014
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Other	Appendix E- Data Collection Form	2013/03/04
Response to Board Recommendations	Responses to the Recommendations - REB # 103612	2013/04/18
Letter of Information	Appendix A	2013/05/14
Other	Socio-demographic questionnaire	2013/05/14
Other	Presentation script	2013/05/14

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

[redacted]
Signature

Ethics Officer to Contact for Further Information

[redacted]	[redacted]	[redacted]

This is an official document. Please retain the original in your files.

Western University, Research, Support Services Bldg., Rm. 5150
London, ON, Canada N6A 3K7 [redacted]

Appendix B. Letter of Information

Letter of Information

Participant Code: ___

Title of Research Study: Vitamin D Deficiency and Possible Risk Factors among Middle Eastern University Students in London, Ontario, Canada.

Researchers: Amal Alshahrani, BSc Honours, Nutrition and Food Science, MScFN (Candidate)

Dr. Alicia C. Garcia, PhD, RD, CFE, Director, Graduate Program in Foods and Nutrition

Purpose of the study and objectives: You are being asked to participate in a research study to investigate vitamin D deficiency and risk factors among Middle Eastern men and women aged between 18-33 years who have been immigrants in Canada for 5years or less and attending Western University, by measuring serum vitamin D 25-hydroxy vitamin level. In addition, study participants will be required to fill out a questionnaire at the same time of their visit to the lab for the one time blood sample test. Your participation is being requested because Middle Eastern populations are prone to vitamin D deficiency as shown in the following studies.

Middle Eastern countries have the highest prevalence of vitamin D deficiency and insufficiency risk factors as well as consequences on health. Despite abundant sunshine, several studies show that the prevalence of vitamin D deficiency has increased in the Middle Eastern populations. The causes of vitamin D deficiency among the Middle Eastern population remain uncertain, as well as the factors that may increase their risk for low vitamin D. Studies indicate that lack of sun exposure in Middle Eastern populations result from cultural practices such as conservative clothing and veiling in Muslim women in addition to their lifestyle habit of spending most time indoors. Women from the Middle East have higher rates of vitamin D deficiency than men. The level of vitamin D is low and it is not varied during the year from season to season in most people from the Middle East due to some common reasons such as skin pigmentation, limited sun exposure and low intake of vitamin D food sources. A study done on vitamin D status in a multi- ethnic population found that 83% of the Middle Eastern population and some ethnic groups have low vitamin D levels. There are increased rates of vitamin D deficiency in girls wearing conservative clothes in comparison with females living in suburban and urban areas. The prevalence of a lower level of Vitamin D (<25 nmol/L) is most common in the Middle East and is associated with women, darker skin pigmentation, limited sun exposure, higher latitude and lack of foods fortified with vitamin D. A study done in Arab populations and some other countries, which have similar practices, suggests that skin pigmentation is probably the biggest risk factor for vitamin D deficiency regardless of the UV exposure. In addition, the type of residence has an effect on limiting the time of sun exposure in Middle East especially in Saudi Arabia. Subjects living in apartments have vitamin D deficiency more than subjects living in villas with open areas.

This study will try to validate some of these findings.

Your participation: As a participant in the proposed study, you will be asked to answer a short questionnaire and provide a blood sample to be collected at the LifeLabs laboratory by qualified laboratory technicians. LifeLabs is located at the western campus at the University Community Center. The cost of your vitamin D blood test will be paid by our research fund. If you would like to receive a copy of your vitamin D status results please let your family physician know about this request. The questionnaire, which you will answer on your own, will take approximately 10-15 minutes of your time. The blood sample collection will take approximately 10-15 minutes of your time and is dependent on the patient load at the clinic at the time of your visit. If your vitamin D level is low and you are interested, we will provide you some educational resources to improve your vitamin D status. Please let researcher know if you are participating in any other research.

Your Rights: Your participation in our study is voluntary. You may refuse to participate, refuse to answer any of the questions or withdraw from the study at any time with no effect on your health care. You are encouraged to answer the questions as completely as possible. All information provided is strictly confidential and will be compiled in such a way that individual responses cannot be identified. You can withdraw from the study at any time and you do not waive any legal rights by signing the consent form, however, once the hard copy of the questionnaire has been submitted it will not be possible to withdraw it, as there are no personal identifiers attached to the survey questionnaire.

Confidentiality: Your research records will be stored in a locked cabinet in a secure office and will be destroyed after five years. Only the researchers will have access to these records. If the results of the study are published, your name will not be used and no information that discloses your identity will be released or published without your explicit consent to the disclosure.

Risks/Benefits: There are no risks associated with this research except for a slight discomfort or pain at the time your blood sample is taken at the clinic. There are no direct benefits to the participant, but by completing the questionnaire the participants may gain an awareness of the risk factors associated with their vitamin D status. Participants may help the researchers gain new knowledge that may result in developing educational tools for their group.

For more Information:

1-If you have any question about the study or you know someone who fits our study criteria and wants to participate, please contact Amal Alshahrani

2-If you have any question about the study, please contact the principal investigator: Dr. Alicia C. Garcia.

3-If you have any questions about your rights as a research participant or the conduct of this study, you may contact the Office of Research Ethics at Western University.

This letter is yours to keep. Thank you in advance for considering your participation in our study.

Appendix C. Consent Form

Western Brescia

Consent form

Participant Code: ___

Title of Research Study: Vitamin D Deficiency and Possible Risk Factors among Middle Eastern University Students in London, Ontario, Canada.

I have read the letter of information, have had the nature of the study explained to me. I agree to participate in the study. All questions I have regarding my participation in this study have been answered to my satisfaction.

____
Participant's Printed Name

_______________________ _______________________
Participant's Signature Date

____
Printed Name of Person Obtaining Consent

____ ____________________
Signature Name of Person Obtaining Consent Date

Appendix D. Socio-demographic, Health and Cultural Factors Questionnaire

Socio-demographic, Health and Cultural Factors Questionnaire

Participant Code: ___

Title of Research Study: Vitamin D Deficiency and Possible Risk Factors among Middle Eastern University Students in London, Ontario, Canada.

All information in this questionnaire is confidential and only reviewed by the members of the research team and ethics board.

Personal Information:

1- Gender:

- ◻ Male
- ◻ Female

2- Age: _________years.

3- How long have you been in Canada?

◻ Less than 1year ◻ 2 years ◻ 3-5 years

4- Educational Level:

◻ Bachelor degree ◻ Master degree

◻ PhD ◻ Other

5- Nationality:

◻ Bahraini	◻ Egyptian	◻ Palestinian	◻ Kuwaiti
◻ Iranian	◻ Iraqi	◻ Israeli	◻ Syrian
◻ Omani	◻ Qatari	◻ Jordanian	◻ Lebanese
◻ Turkish	◻ Emiratis	◻ Saudi Arabian	◻ Yemeni

Health Information:

6- What is your current weight?

- ◻ Pounds _______ or ◻ Kilograms_______

If you are a female: Please answer questions number **7** and **8**, otherwise move to question number **9**

7- Are you currently pregnant?

- ◻ Yes
- ◻ No

8- Are you currently breastfeeding?

- ◻ Yes
- ◻ No

9- Are you suffering from any of the following diseases?

- ◻ Chronic fatigue
- ◻ Coeliac sprue
- ◻ Colitis
- ◻ Crohn's disease
- ◻ Diabetes
- ◻ Eating disorders
- ◻ Eczema or serious skin disease
- ◻ Kidney disease
- ◻ Lactose intolerance
- ◻ Ulcer (digestive tract)
- ◻ None

10- In the last 6 months, have you experienced?

- ◻ Muscle pains
- ◻ Headache
- ◻ Weakness
- ◻ None

11- Have you suffered from any pain anywhere in your body?

- ◻ Yes
- ◻ No

12- If yes, specify the location

- ◻ Body part affected________________ ◻ Reason if known___________

Dietary Information:
In the past 6 months:
13- On average, how many servings of milk do you drink daily?

- ◻ Less than 1cup
- ◻ 1-2 cups
- ◻ 3-4 cup
- ◻ More than 4 cups

14- Do you take multivitamins daily?

- ◻ Yes
- ◻ No

15- Do you take vitamin D supplements?

- ◻ Yes
- ◻ No

16- If yes, how much vitamin D is in the supplement? _______ IU

17- Do you take calcium with vitamin D?

- ◻ Yes
- ◻ No

18- If yes, how many milligrams of calcium are in the supplement? ________ Mg

19- Do you take cod-liver oil?

- ◻ Yes
- ◻ No

20- Do you take omega-3 fatty acid (fish oil) supplement?

- ◻ Yes
- ◻ No

Sunning Practices:
21- On the average, how many days a week do you expose yourself to the sun?

- ◻ Not at all
- ◻ 1 day
- ◻ 2 days
- ◻ 3 days
- ◻ 4 or more days

22- On average, approximately how many minutes per day do you spend outdoors under the sun?

- ☐ 15 minutes or less per day
- ☐ 15–30 minutes per day
- ☐ More than 30 minutes per day

23- What time do you mostly spend outdoors under the sun?

☐ 7-10 am ☐ 10-1 pm ☐ 1- 4 pm ☐ 4-7 pm

24- Describe your usual clothing when you are outdoors under the sun:

- ☐ Shorts and very brief top with shoulders exposed
- ☐ Shorts and T-shirt or similar top
- ☐ Shorts and long sleeves
- ☐ Long pants and T-shirt or similar top
- ☐ Long pants and long sleeves
- ☐ Cover face and head with hand exposed
- ☐ Cover head with arms exposed
- ☐ Cover head with hand exposed
- ☐ Fully covered

25- For Muslim Women Only:
When you are in the company of women only in outdoor private settings, describe your usual clothing:

- ☐ Face, head and hands exposed
- ☐ Shorts and very brief top with shoulders exposed
- ☐ Shorts and T-shirt or similar top
- ☐ Shorts and long sleeves
- ☐ Long pants and T-shirt or similar top
- ☐ Long pants and long sleeves

26- Describe your usual use of sunscreen when outdoors in the sun in the past 6 months.

- ☐ I almost never use sunscreen
- ☐ I use it occasionally (5-20% of the time)
- ☐ I use it somewhat regularly (20-50% of the time)
- ☐ I use it most of the time (50-80% of the time)
- ☐ I use it almost all of the time (80-95% of the time)
- ☐ I use it all the time (95-100%)

If you are using sunscreen answer questions number 27 and 28
27- What SPF sunscreen level do you usually use when you are under the sung? "SPF sun

◻ 4	◻ 8	◻ 10	◻ 15
◻ 20	◻ 30	◻ 40	◻ 50
◻ 60+	◻ Don't know		

28- During the past 6 months:

- ◻ I have not used indoor tanning equipment.
- ◻ I have received UV exposure from indoor tanning just a few times.
- ◻ I have received UV exposure from indoor tanning regularly.

Appendix E. LifeLabs Agreement

100 International Blvd
Toronto Ontario M9W 6J6

LifeLabs

May 31, 2013

University of Western Ontario
Dr. A. Garcia
c/o Amal Alshalrani
1285 Western Road
London, ON N6G 1H2

Dear Dr. Garcia,

Re: **Provision of Laboratory Services**

LifeLabs is pleased to provide you with laboratory services to meet your needs. This includes access to fixed collection sites and/or mobile collections to ensure that all of your requirements are met with the highest level of client satisfaction.

With over 30 years of experience in laboratory services including pre-analytical, analytical, and post-analytical procedures, LifeLabs is confident that this proposal will meet all your requirements.

Enclosed with this letter is our Service Agreement for Laboratory Services. To initiate service, kindly sign and return to LifeLabs one copy of the Service Agreement.

Thank you for providing LifeLabs the opportunity to work with you on this program. We value your business and are committed to providing high standards of quality and cost effective services.

Yours truly,
LifeLabs Medical Laboratory Services

Janine Veniot
Diagnostic Account Representative

Appendix F. Presentation Script

Presentation Script

The first research objective is to investigate vitamin D deficiency and risk factors among the Middle Eastern men and women aged between 18 -35 years who have immigrated to Canada for 5 years or less and attending Western University, by measuring serum vitamin D 25-hydroxyvitamin level. The second objective is to determine the risk factors for vitamin D deficiency such as lifestyle, cultural and dietary practices, and lack of sun exposure among this population.

The research will provide healthcare professionals significant information and data to help manage the prevalence of vitamin D deficiency among Middle Eastern people. Dietitians will be more aware of what is the specific reason for the prevalence of low vitamin D status. In addition, the research will provide more updated data on how many Middle Eastern people are at risk of vitamin D deficiency. The research will provide data to relevant stakeholders in Middle Eastern countries about vitamin D status for potential intervention to decrease vitamin D deficiency. When immigrated to Canada research findings will be important for healthcare professionals because they need to consider various risk factors between different ethnic groups and cultural backgrounds. In addition, findings will ensure that people who are mainly at risk will get assistance from dietitians to address the link between patient risk factors and low vitamin D status level. Based on the study results, educational strategies might be implemented in many Middle Eastern countries in order to improve the overall health of the population and increase their vitamin D levels.

More studies need to be done on vitamin D deficiency among Middle Eastern population to enhance awareness of the public on making positive changes to their lifestyle habits, for example, replacing indoor activities with more outdoor activities. The results of this research might encourage Middle Eastern governmental regulation of vitamin D fortified foods and involve manufacturers to play a role in changing and improving population health status. The research might recommend strategies for reasonable solutions that can help this population get their needed vitamin D from different sources along with changes in their cultural practices and lifestyles.

If you are interested please contact Amal Alshahrani who will arrange for you to participate in the study. You will be given a letter of information, consent form and a referral letter for your physician to sign. Once you have your blood sample collected at the LifeLabs, Amal will arrange with you a date when you can complete the short questionnaire at Brescia University College. You will be given a parking pass, if needed. Thank you for your interest in our study.

Appendix G. Blood Test Request Form

LifeLabs®
Medical Laboratory Services

University of Western Ontario Vitamin D
Issue Date:June 07,2013
Revision Date:

CONTRACT NUMBER:	D312-01	Demographic Label
Reference Study Name:	Vitamin D Study	
Report to Client Number:	D312-01	
Ordering Doctor Name:	Dr. A Garcia	
Requesting Physician Name	Dr. A. Garcia	Test List Label
Copy To:	Leave Blank	
Bill to Client #	D312-01	

Patient Last Name		**Patient First Name**		
Date of Birth (YYYYMMDD)		**Sex**	"M"ale	"F"emale
Date Collected: (YYYYMMDD)		**Time Collected:** (HH:MM)		

TESTS REQUESTED

Test	TR#
☑ Documentation Fee	106
☑ Vitamin D 25	1992

VALID IN ONTARIO ONLY

The minimum amount of patient information is collected for provision of the service requested. This information is considered confidential and privileged. Unauthorized use and

Appendix H. Data Collection Form

Data Collection Form

Date	Participant's Identifier Code	25-hydroxyvitamin D level	Deficient*	Non-Deficient*

***Deficient, Non-Deficient: According to LifeLabs Parameter of 25-hydroxyvitamin D level.**

CURRICULUM VITAE

Amal Alshahrani

EDUCATION

Princess Nora Bint Abdul Rahman College, Riyadh **April 2009**
College of Home Economics and Art Education,
Bachelor of Nutrition and Food Science
Very good Standing with honours

G.P.A: 85.19%

Relevant Coursework

- Human Nutrition
- Organic Chemistry
- Food Analysis
- Biochemistry
- Educational Psychology
- World Food Safety
- Community Nutrition

CultureWorks Institute **April 2010**
Full Time Student with CultureWorks ESL English as a Second Language School located at the University of Western Ontario

Brescia University College, University of Western Ontario **May 2011**
Pre- Master of Science in Food and Nutrition as an Upgrading Program

Relevant Coursework

- Food and Community Nutrition
- Communication
- Statistics for Sociology
- Research Methods in Sociology
- Introduction to University Essay Writing
- Diet and Nutritional Assessment
- Clinical Nutrition

Brescia University College, University of Western Ontario **May 2013**
Master of Science in Foods and Nutrition.
Research Area: *Vitamin D Deficiency and Possible Risk Factors among Middle Eastern University Students in London, Ontario, Canada*

Relevant Coursework

- Statistics for Sociology
- Research Methods in Sociology

- Clinical Nutrition
- Research and Thesis Planning *
- Nutritional Epidemiology

PROFESSIONAL TRAINING AND WORKSHOPS

- Completed the Teacher Assistant Training Program (TATP) at Western University; an interdisciplinary course for teaching assistants on the strategies and practices of university teaching
- Attended a workshop for practical training programs at the Balance of Health, Nutrition and the Arab Program for Food Analysis on 20/5/2009.
- Attended a course on the use of computer programs about diet and meal planning. The Saudi Commission accredited the course for Health Specialties under 3 hours continuing medical education on 19/5/2009. Held at the Department of Nutrition, Home Economics Faculty, Princess Nora Bint Abdul Rahman College, Riyadh
- International computer driving (ICDL) Course
- Academic Engagement Workshop
- Acceptance Exam LSAT, GRE, GMAT Workshop
- Art of communication in Dialogue Workshop
- Dietitians of Canada; Herbal Supplements Workshop
- Innovative Ways to Demonstrate Ideas Workshop
- Magic Mind Workshop
- Mind Maps Workshop
- Causes of Stress of Academic Study Workshop
- The Language of Advance Discussions Workshop
- Formative Evaluations to Assess Student Understanding
- Preparing Teaching Dossier
- Using Social Media Effectively in the University Classroom
- Productive Assessment: Asking the Right Questions
- Communication in the Canadian Classroom Workshop
- Food Hypersensitivity Online Workshop

RELEVANT SKILLS AND EXPERIENCES

- Experience in conducting experimental tests in organic and biological chemistry laboratory.
- Conducted an academic proposal for an academic study. The study included a comprehensive research on estimating the ratio of shortage of vitamins among pregnant women in Riyadh city.

PERSONAL ASSETS

- Ability to work under stress
- Ability to perform academic and lab research independently and under direct supervision
- Reasoning and linking results and comparing them to each other
- Like effective participation in the activities and volunteering campaign

- Ability to enjoy good observation and create new ideas
- Ability to understand the nature of the academic research and focus on the scope of research
- Eager to acquire the academic and scientific doctoral research experience
- Ability to diagnose the case of sicknesses, analyzing it and knowing ways of treating them.
- Ability to make recommendations based on the results obtained

LANGUAGE SKILLS

- Fluency in Arabic and English

PERSONAL INTERESTS

- Reading
- Fieldwork related to nutrition
- Using computers