# Vitamin D Knowledge and Practices among Collegiate Athletes at the University of Idaho

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Science

with a

Major in Family and Consumer Sciences

in the

College of Graduate Studies

University of Idaho

by

Colin P. Whitaker

Major Professor: Katie Brown, Ph.D.

Committee Members: Ann Brown, Ph.D.; Chantal Vella, Ph.D.

Department Administrator: Michelle McGuire, Ph.D.

May 2019

**Authorization to Submit Thesis**

This thesis of Colin Whitaker, submitted for the degree of Master of Science with a major in Family and Consumer Sciences and titled "Vitamin D Knowledge and Practices among Collegiate Athletes at the University of Idaho" has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

Major Professor ________________________________Date__________________
Katie Brown, Ph.D.

Committee Members

________________________________Date__________________
Ann Brown, Ph.D.

________________________________Date__________________
Chantal Vella, Ph.D.

Department Administrator ________________________________Date__________________
Michelle McGuire, Ph.D.

**Abstract**

Vitamin D is a fat-soluble micronutrient that is responsible for many biological processes in the human body. Vitamin D is directly responsible for enhancing calcium absorption, which strengthen bones and reduce the risk for skeletal injury. Vitamin D also plays a role in the immune system and skeletal muscle activity. All of these factors play a significant role in the optimal health and performance of student-athletes. With limited food sources, and specific wavelengths of UVB needed for synthesis, athletes living in northern geographic locations are at risk of vitamin D deficiency.

At the time of this study, no existing vitamin D questionnaires had been tested for reliability or validity for use among collegiate athletes. Therefore, a survey was developed using some questions from previous research regarding vitamin D knowledge (Walker et al., 2014; Kung et al., 2006). A two-part testing sequence was performed in order to first assess the most appropriate question format, followed by the testing for reliability. A test-retest sequence allowed researchers to deem the questionnaire statistically reliable with Kappa values for each question ranging of 0.73-0.97.

Thirty-two student-athletes at the University of Idaho were participants in the vitamin D knowledge assessment. Results suggested that athletes had limited knowledge regarding vitamin D. Only 34% correctly listed food sources of vitamin D, 18% correctly listed health benefits and 34% correctly listed factors that affected vitamin D status. Surprisingly, 96% of athletes had knowledge of non-food sources of vitamin D. A majority of the athletes reported never taking a multivitamin (50%), vitamin D supplement (81%) or fish oil supplement that contained vitamin D (87%).

Of the twenty-four athletes who had their vitamin D plasma levels tested, 92%were classified as having inadequate or deficient serum vitamin D levels. There was no relationship ($p = .446$) between vitamin D knowledge and serum vitamin D levels among athletes at the University of Idaho.

## Acknowledgements

I would like to start by thanking my committee members, Dr. Ann Brown and Dr. Chantal Vella, for their guidance and support not only in this research project, but many other aspects of my life. You both have both been a positive influence on my education, approach towards continued knowledge, and career aspirations. You both set the bar on professionalism in the field of exercise physiology as well as exercise metabolism and I will strive each and every day to rise up to your level.

I want to give a special thanks to my major professor, Dr. Katie Brown, for all the constant support and encouragement over the past three years. You inspired an undergraduate student who had doubted himself in the world of research and is now on the steps of completing his Masters Degree. You challenged me, pushed me to achieve more and were always there with a laugh when needed. I will take the lessons that you have taught me and apply them each and every day in my career. Thank you for being an amazing influence on my life!

Lastly, I want to thank all my professors, mentors and staff within the Margaret Richie School of Family and Consumer Sciences. Over the past four years, you have all taken me in and made me feel like I was a part of something very special. I am honored to say that I was both an undergraduate and graduate student in the FCS department at the University of Idaho. I look forward to the day that I can give back to the school by mentoring young professionals in the way that you have all mentored me. Thank you all for your constant support!

# Table of Contents

# List of Tables

## List of Figures

# Chapter One

## Introduction

Vitamin D is involved in many biological processes that are critical to an athlete's overall health as well as physical performance. With the University of Idaho's geographic location residing north of the 40th parallel, there is low ultraviolet-B radiation during the winter months. This puts student-athletes at risk for potential deficiencies in their vitamin D status.

### Problem Statement

Existing research reveals that vitamin D deficiency is prevalent among individual who reside in geographic regions $40^0$ North or South of the equator. With vitamin D playing a vital role in the health and performance of athletes, it is necessary to assess the knowledge levels, practices and determine the current serum concentrations of vitamin D among athletes.

The first step in assessing the current knowledge levels of student-athletes is through a vitamin D knowledge questionnaire. In current research, there are no known vitamin D knowledge questionnaires that have been tested for reliability or validity. Therefore, there is a need to develop a vitamin D knowledge questionnaire that is reliable and applicable in an athletic population.

### Statement of Purpose

The purpose of this study is to develop a vitamin D knowledge questionnaire that is statistically reliable, then assess the knowledge and practices concerning vitamin D as well as assessing serum vitamin D concentrations among Division I student-athletes at the University of Idaho.

### Objectives

i. Develop a reliable vitamin D questionnaire for use among collegiate athletes.

ii. Determine University of Idaho student-athletes' vitamin D knowledge. This includes knowledge of sources of vitamin D, as well as health benefits of vitamin D.

iii. Determine the vitamin D supplement use among University of Idaho student-athletes.

iv. Perform serum 25(OH)D blood tests to determine the prevalence of vitamin D deficiency among student-athletes at the University of Idaho.

v. Determine the relationships between vitamin D knowledge and serum 25(OH)D levels in blood.

**Hypothesis**

Null Hypotheses ($H_0$):

i. Kappa values between the open-ended and select all that apply version of the questionnaire will have almost perfect agreement (0.81-1.0)

ii. The version of the questionnaire that is selected for reliability testing will Kappa values between 0.81-1.0 signifying almost perfect agreement.

iii. One hundred percent of participants will score 8/8 on a vitamin D knowledge questionnaire.

iv. One hundred percent of participants will report consuming supplemental vitamin D at least a few times per month.

v. One hundred percent of the student-athletes who participate in the vitamin D blood test will have adequate serum 25(OH)D concentrations.

vi. There will be no relationship between vitamin D knowledge and serum 25(OH)D concentrations. `

Alternative Hypotheses ($H_a$):

i. Kappa values between the open-ended and select all that apply version of the questionnaire will have less than almost perfect agreement (<0.81-1.0)

ii. The version of the questionnaire that is selected for reliability testing will have less than perfect agreement (<0.81-1.0).

iii. Less than one hundred percent of participants will score 8/8 on a vitamin D knowledge questionnaire.

iv. Less than one hundred percent of participants will report consuming supplemental vitamin D at least a few times per month.

v. Less than one hundred percent of the student-athletes who participate in the vitamin D blood test will have adequate serum 25(OH)D concentrations.

vi. There will be a positive relationship between vitamin D knowledge and serum 25(OH)D concentrations.

**Limitations**

It is important to consider that the sample size is limited to a very specific geographic region and might accurately reflect the knowledge and intake of vitamin D by collegiate athletes in other regions. Additionally, results from the serum 25(OH)D tests only reflect serum vitamin D concentrations from a very specific time and might be different at other points in time.

**Summary**

Due to the critical biological processes that vitamin D is associated with in terms of health and performance, it is important to ensure that student athletes are cognizant of the need for maintaining adequate vitamin D levels. Having the proper tools and resources to accurately assess a student-athlete's knowledge of a nutrient like vitamin D is the first step in determining what type of education or intervention is needed. The findings from this research will allow educators or practitioners to have a reliable vitamin D knowledge questionnaire that will serve as a platform for the education and support that is needed to assure that student athletes are meeting their bio-individual vitamin D needs.

# Chapter Two

# Literature Review

## Vitamin D Function

Vitamin D is a fat-soluble nutrient that occurs in two biologically inactive forms, cholecalciferol (vitamin $D_3$) and ergocalciferol (vitamin $D_2$) (Todd et al., 2015). Cholecalciferol is the natural form of vitamin D that is produced when skin is exposed to sunlight (ultraviolet B radiation), specifically in wavelengths of 290-320 nm (He et al., 2016). Upon epidermal and dermal exposure to UVB, the inactive form of vitamin D (cholecalciferol) is transported from the skin into the blood stream where it is carried by way of chylomicrons or vitamin D-binding proteins (DBP) to the liver (Gropper et al., 2013). Once in the liver, vitamin D is hydroxylated by cytochrome P-450 hydroxylases which convert vitamin D into calcidiol (25(OH)D), which is the main form of vitamin D in the body (Gropper et al., 2013). The calcidiol is then secreted from the liver and transported in the blood via DBP where it is taken up by the kidneys (Gropper et al., 2013). Once in the kidneys, calcidiol undergoes a second hydroxylation by the enzyme 1-hydroxylase (CYP27B1) and is then converted to the active form of vitamin D, calcitriol (Gropper et al., 2013).

Vitamin D2 undergoes the same hydroxylation reactions to eventually become calcitriol; however, it is initially ingested through limited plant sources such as mushrooms (Todd et al., 2015). Although both of the inactive forms of vitamin D (cholecalciferol and ergocalciferol) eventually lead to the same biologically active form, calcitriol, vitamin $D_3$ has shown to be 87% more potent in creating and maintaining calcitriol concentration levels (Owens et al., 2014).

While dermal synthesis of vitamin $D_3$ through UVB radiation is the most common and natural way to acquire the vitamin, it can also be obtained through food that is of animal origin, such as oily fish, egg yolk, liver, and milk (He et al., 2016). Additionally, sources of vitamin $D_3$ include, fortified foods such as cereals or margarine and supplements (Owens et al., 2014).

**Vitamin D Testing (Serum Levels)**

During the hydroxylation process, vitamin D is intermediately converted to calcifediol (25(OH)D), which is the major circulating metabolite of vitamin D in plasma (Health Quality Ontario, 2010). Therefore, the total plasma concentration of calcifediol is viewed as the primary indicator of an individual's vitamin D status (He et al., 2016). There are two common types of clinical tests used to assess calcifediol concentrations in plasma: high-pressure liquid chromatography (HPLC) and liquid chromatography-tandem mass spectrometry (LC-MS/MS) (He et al., 2016).

Once the tests have been performed, the results of vitamin D status are reported in the standard SI unit of nmol/L (Owens et al., 2014). The United States Institute of Medicine (US IoM) currently states the guidelines for what is considered severely deficient (<12 nmol/L), deficient (12-30 nmol/L), inadequate (30-50 nmol/L), and adequate (>50 nmol/L); although researchers argue that these values need revision (Owens et al., 2014).

With vitamin D being lipophilic in nature, its transport in plasma is dependent on protein carriers (Jones, 2008). Chylomicrons and vitamin D-binding proteins (DBP) are responsible for the uptake within adipose tissue as well as muscle tissue (Jones, 2008). Once taken up by the tissues, vitamin D has a half-life of approximately two months (Jones, 2008).

**Factors Limiting Vitamin D Synthesis**

While sufficient UVB exposure can provide 80-100% of the body's requirements of vitamin D (He et al., 2016), there are still many variables that can affect the vitamin D status of an individual. Season and latitude are most commonly recognized as possible factors for low UVB exposure. Individuals who live at latitudes greater than $40^{o}$ north or south of the equator show lower vitamin D concentrations during the winter months due to weaker UVB radiation, resulting in less UVB exposure (Todd et al., 2015).

Skin pigment also plays a critical role in the absorption of UVB radiation. Higher melanin content interferes with the absorption of UVB radiation by blocking the wavelength required to synthesize vitamin D (He et al., 2016). Research shows that the darker skin pigmentation in African

Americans prohibits nearly 99% of vitamin D production (Shuler et al., 2012). Sunscreen with a sun protection factor (SPF) of 15 is much like melanin, in that it creates a 99% decrease in Vitamin D absorption, even with an adequate amount of time in the sun (Ogan et al., 2013). Clothing can also act as a physical barrier, which prevents UVB radiation from reaching the skin, regardless of season or latitude (He et al., 2016).

Obesity, specifically in the context of an unhealthy amount of body fat, is defined as having a body mass index (BMI) greater than 30 kg/m$^2$ (Vimaleswaran et al., 2013). A study involving over 42,024 participants found that each 1kg/m$^2$ increase in BMI was associated with a 1.15% lowered serum vitamin D concentration (Vimaleswaran et al., 2013). This is likely due to the larger storage capacity and uptake of the lipophilic vitamin D molecule, thus lowering the serum vitamin D concentration (Vimaleswaran et al., 2013).

**Vitamin D Dosage: Deficiency vs. Toxicity**

The optimal dosage for vitamin D is under debate (Ogan et al., 2013). Before supplementation can be considered, it is important to understand that there are much inter-individual differences in vitamin D plasma concentrations (Owens et al., 2014). Researchers suggest that due to inter-individual variability, each athlete would benefit from monitoring their vitamin D concentrations (Bermon et al., 2017).

While the US IoM considers adequate vitamin D plasma levels to be >50 nmol/L, it is becoming more commonly accepted that more health benefits can be achieved by plasma concentrations of >75 nmol/L (Owens et al., 2014). In order to achieve this plasma concentration, researchers suggest supplementation with an oral vitamin $D_3$ at a dose of 5,000 IU/day for 8 weeks (Owens et al., 2014). However, it is important to understand that this dosage is considerably higher than the US IoM recommended daily intake (RDI) of 600 IU/day (for young adults) and tolerable upper intake (TUI) of 4,000 IU/day (Owens et al., 2014). The differences in recommendations illustrate the differing opinions of numerous research groups to that of governing organizations. The US IoM recommendations are to prevent clinical vitamin D deficiency (plasma concentrations <20 nmol/L) while researchers are aiming to reach optimal plasma levels of at least 40 nmol/L (Ogan et al., 2013).

Vitamin D toxicity is believed to be uncommon, however it is possible to occur with prolonged dosages of >10,000 IU/day (Dahlquist et al., 2015). Clinical signs of toxicity include nausea, vomiting, and constipation with the possibility of hypocalcemia as well as calcification of the soft tissues and kidneys (Health Quality Ontario, 2010). It is worth noting that considerable amount of skin exposure to sun can produce an endogenous vitamin D production of 10,000 – 20,000 IU in as little as 15 minutes, depending on skin type (He et al., 2016). However, vitamin D toxicity due to sun exposure has never been reported because vitamin D via UVB exposure is self-regulated by being converted back to its inactive form when synthesis is no longer required (Owens et al., 2014).

**Vitamin D Implication for Athletes**

Vitamin D deficiency is a well-documented phenomenon that affects many individuals worldwide, including elite athletes (Bermon et al., 2017). Research has shown that the incidence of vitamin D deficiency in elite indoor athletes is 94% for basketball players and 83% for gymnasts (Shuler et al., 2012). While many would assume that outdoor elite athletes are less likely to be at risk for vitamin D deficiency, a testing of New York Giants (NFL Football) during spring practices showed that 81% were vitamin D deficient (Shuler et al., 2012).

Vitamin D is involved in several functions that promote the optimal health and physical performance of athletes. Vitamin D enhances calcium absorption and osteoclast activity, which is essential for bone growth, density as well as remodeling (Ogan et al., 2013). With low vitamin D levels, there is an increase in bone turnover, which increases an athlete's risk of bone injuries such as stress fractures (Ogan et al., 2013).

Currently there is increasing interest on the role vitamin D plays on muscle tissue recruitment. Vitamin D receptors (VDR) are present in muscle cells and have been shown to participate in the muscle activity in two forms: genomic pathways as well as the nontranscriptional membrane-associated signaling pathway (Abrams et al., 2018). These pathways are responsible for the regulation of the cell cycle via activation of cyclin-dependent kinases as well and the activity of phospholipase $A_2$, protein kinase C $\alpha$, and prostaglandin $E_2$ (Abrams et al., 2018). Combined with enhanced calcium release from the sarcoplasmic reticulum, myosin movement over actin is enhanced, resulting in greater contractions of the skeletal muscle (Abrams et al., 2018).

Adequate vitamin D levels have shown to increase force and power output of skeletal muscle tissue (Dahlquist et al., 2015). A 2014 study with professional soccer players shows evidence of a linear relationship between vitamin D plasma levels with jumping performance, $VO_{2max}$, and 10-meter sprint performance (Koundourakis et al., 2014). Additionally, a study with 1,000 participants found that with increased plasma vitamin D levels, participants correlated with a higher physical activity metric, including greater handgrip strength (Abrams et al., 2018).

Vitamin D is also supportive of healthy immune function. Discovery of vitamin D receptors (VDR) in most immune cells, including T lymphocytes, B lymphocytes, neutrophils, monocytes and macrophages suggest that vitamin D has a significant role in the regulation of immune responses (He et al., 2016). Activation the VDR in B cells and various T cells have implications for antibody production and prevention of an exaggerated immune response (Owens et al., 2014). Vitamin D also shows enhancement of chemotaxis and the phagocytic capability of macrophages as well as monocytes (Owens et al., 2014). While moderate exercise has shown to reduce the risk of infection, high-level athletes who have prolonged bouts of strenuous levels of physical activity are at risk for exercise-induced immunosuppression (Owens et al., 2014). This affect has the risk to be compounded in athletes who are in a vitamin D deficient state (Owens et al., 2014).

**Vitamin D Knowledge**

Currently there is limited research regarding vitamin D knowledge, particularly among collegiate athletes. The few studies that have been performed in assessing knowledge of vitamin D indicate that athletic and non-athletic populations both have little knowledge regarding vitamin D; it’s health benefits and potential sources.

**Knowledge of Vitamin D Sources & Health Benefits**

A cross-sectional study of 110 elite New Zealand athletes reported that 97% of the athletes had heard of vitamin D (Walker et al., 2014). Seventy-six percent of the athletes who had heard of vitamin D were able to identify the sun as a source of vitamin D; however, only 17% were able to name another source of vitamin D such as food sources or supplements (Walker et al., 2014). The study also found that of the athletes who had heard of vitamin D, only 25% were able to name one health benefit (e.g. bone health, immunity, and muscle strength) of having an adequate vitamin D status (Walker et al., 2014).

An older study assessing knowledge of vitamin D among Chinese middle-aged and elderly women revealed a considerable lack of knowledge pertaining to vitamin D (Kung et al., 2006). The study found that 72.6% (397/547) of the participants stated that they had heard of vitamin D, however only 32.2% (176/547) were able to give accurate responses to the question, "what does vitamin D do?" (Kung et al., 2006). The three most common responses were bone strengthening (n=90,17.7%), enhance calcium absorption (n=66, 12.0%) and build immunity (n=21, 3.8%) (Kung et al., 2006). Additionally, only 38.4% (210/547) were able to identify correct sources of vitamin D, with sunlight being the most common answer (n=127, 23.2%) (Kung et al., 2006).

**Vitamin D Awareness and Relation to Intake**

A recent study with Division I NCAA athletes at the University of North Dakota assessed awareness of vitamin D and examined its association with total dietary vitamin D intake (Fitzgerald et al., 2017). The study had a total of 81 participants (52 females, 29 males) who competed in a variety of sports. Using five questions in an online questionnaire and comparing the responses to reported dietary intake, the results showed that 21% of the athletes had rarely heard of vitamin D (Fitzgerald et al., 2017). In regard to attitudes toward vitamin D, the majority of the athletes felt that vitamin D likely played a role in their health (88.9%) and physical performance (71.6%) (Fitzgerald et al., 2017). Assessment of dietary vitamin D intake showed that the RDA for vitamin D had only been met by 30% of female athletes, and 62% of male athletes (Fitzgerald et al., 2017). The study also showed that females who were familiar with vitamin D and males who were concerned about vitamin D levels had positive association with total dietary intake of vitamin D (Fitzgerald et al., 2017).

**Vitamin D Knowledge & 25(OH)D Concentrations**

A 2013 study assessing vitamin D knowledge and 25(OH)D levels amongst pregnant women revealed that 61% (71/116) were at risk of vitamin D deficiency due to low serum 25(OH)D levels (Toher et al., 2013). 23% of the participants were not aware of any sources of vitamin D, while 74% of the remaining participants named the sun as a source (Toher et al., 2013). The study also suggested that women who reported using a vitamin D supplement were less likely to have their 25(OH)D levels categorized as at risk for deficiency (Toher et al., 2013). It is stated that low dose vitamin D supplements were likely the most important determinant of 25(OH)D status, while controlling for factors such as ethnicity (Toher et al., 2013).

**Conclusion**

With vitamin D serving as an important nutrient for many biological functions related to health and performance, it is necessary to ensure that athletes are receiving adequate knowledge as well as adequate intake of vitamin D. This research will expand on the work performed by both Walker et al., 2014 and Fitzgerald et al., 2017 in assessing student athletes’ knowledge of vitamin D, practices of vitamin D and serum 25(OH)D levels.

# Chapter Three

## Vitamin D Questionnaire Development: Open-Ended vs. Closed-Ended Questions

### Background

The foundation of this research study was the creation of a vitamin D knowledge questionnaire that is statistically reliable. The aim of this chapter was to determine the content that would be included on the vitamin D questionnaire as well as what style of questions would be used, open-ended or close-ended.

The first step in the creation of the questionnaire was determining what aspects or content regarding vitamin D researchers were looking to assess. With vitamin D's significant role in an athlete's heath and performance, researchers felt the main focus of the questionnaire should be assessing athletes' knowledge on sources of vitamin D (food and non-food sources), health benefits of vitamin D, as well as factors that affected vitamin D status. The second component to the questionnaire would be assessing vitamin D practices among student-athletes.

Answers that researchers felt were relative for each respective question on the knowledge portion of the questionnaire were as follows: food sources (fish, eggs, mushrooms, liver, milk, fortified cereals); non-food sources (sun exposure, supplements); health benefits (bone health); and factors that affect vitamin D status (sunscreen use, skin pigment, age, geographic location or latitude, time of the year or season) (Ogan et al., 2013).

After reviewing literature on questionnaire development for assessing knowledge, researchers wanted to determine if open-ended questions (fill in the blank) were more reflective of vitamin D knowledge than closed-ended style questions (multiple choice or select all that apply) (Fowler, 2006, pg. 68). A study that assessed open-ended versus multiple-choice response formats with 285 students found that multiple-choice style formats generated cues that would lead participants to select their answers rather than generate them from scratch (Birenbaum et al., 1987). Furthermore, the study suggested that open-ended formats are more appropriate for use in assessing knowledge, although they are more complicated to score (Birenbaum et al., 1987).

The second half of the questionnaire was focused on questions regarding vitamin D practices. The questions that researchers felt would be most pertinent regarding vitamin D practices were multi-vitamin use, vitamin D supplementation, fish oil use and sunscreen use when exposed to sun (Kung et al., 2006; Walker et al., 2014; Fitzgerald et al., 2017; Toher et al., 2013). Researchers felt that closed-ended questions were appropriate in accurately assessing student-athlete's vitamin D practices, since this portion of the questionnaire would not be part of the knowledge assessment. Answers for the closed-ended questions regarding use of various supplements would be listed as: never, a few days per month, 1-3 days per week, 4-6 days per week, daily and other.

**Methods**

**Recruitment:** For the first phase of the vitamin D knowledge questionnaire (open ended vs. select all that apply style questions), undergraduate students at the University of Idaho were recruited to participate during their regularly scheduled classes (PEP 493: Fitness Assessment and Exercise Prescription, FCS 205: Concepts in Human Nutrition). The instructors of the courses had previously agreed to allow the researchers 15 minutes of regularly scheduled class time to conduct the recruitment and administer the questionnaire. Any student-athlete who was a member of either of these classes and wanted to volunteer for the later part of the research study was asked not to participate in the questionnaire development process as it would skew the data. The University of Idaho IRB had approved all of the procedures in this study and a letter of information was given to all participants who volunteered at the beginning of the study (see Appendix A & F).

**Procedure:** Packets were created that contained two versions the vitamin D knowledge questionnaire (version 1 & version 2). The knowledge portion of version 1 contained all open-ended questions asking about food sources of vitamin D, non-food sources of vitamin D, health benefits of vitamin D, and other factors that could affect an individual's vitamin D levels. Version 2 of the questionnaire asked the same questions in a select all that apply style format (see Appendix B & C).

Clasped envelopes containing both versions of the questionnaire were given to participants at the start of their respective class periods. Participants were instructed to open the envelope and complete the questionnaire in the sequence in which the questionnaire was formatted (version 1 then version 2). Once completed, participants placed the questionnaire back into the envelopes, and then turned them into the researchers.

**Questionnaire Scoring:** Total possible points for each vitamin D knowledge question were as follows: Food Sources of Vitamin D (2 points possible) (fish, eggs, mushrooms, liver, milk, fortified cereals), Non-food Sources of Vitamin D (2 points possible) (Sun = 1 point, Supplements = 1 point), Health Benefits (1 point possible) (Bone Health = 1 point), Other Factors that could affect an individual's vitamin D levels (3 points possible) (sunscreen use, skin pigment, body weight, age, BMI, geographic location or latitude, time of the year or season) (Kung et al., 2006; Walker et al., 2014; Fitzgerald et al., 2017; Toher et al., 2013). The knowledge portion of the vitamin D questionnaire was scored with an 8-point maximum. Total scores ≥4 were considered to be "adequate vitamin D knowledge" while scores <4 were considered to be "low vitamin D knowledge."

**Analysis:** Individual and total scores from both versions of the questionnaire (1 & 2) were calculated and a Kappa statistics analysis was performed to determine the most appropriate version of the questionnaire (Kappa values within the range of 0.41-0.80 were considered moderate-substantial agreement) (Sim et al., 2005).

## Results

Fifty-five students participated in this portion of the study. Average total vitamin D scores were 3.3 on the open-ended, and 7 on the select all that apply version of the questionnaire. After performing a Kappa Statistics analysis, results from the open-ended questionnaire (version 1) compared to the select all that apply questionnaire (version 2) were as follows (see Table 3.1): The Kappa and p values for the questions regarding food sources of vitamin D and health benefits showed slight and fair agreement and had small to fair levels of significance (Sim et al., 2005). The questions pertaining to non-food sources, other factors and total knowledge showed slight agreement with no significance (Sim et al., 2005).

**Table 3.1 Open-ended vs. Select All Kappa Results**

**Participants (N=55)**

| Question | Version 1 vs. Version 2 (Kappa Value) P-value |
|---|---|
| Food Sources | (0.119) .005 |
| Non-Food Sources | (0.088) .105 |
| Health Benefits | (0.262) .007 |
| Other Factors | (0.008) .804 |
| Total Score / Adequacy | (0.086) .117 |

**Discussion**

Literature on questionnaire development suggests that both styles of questions (open-ended & closed-ended) assess knowledge, however, closed-ended utilize recognition more than recall, with recognition being easier from a cognitive perspective (Fowler, 2006, pg. 68). In the review of previous research regarding vitamin D knowledge, the majority of the researchers utilized a variety of closed-ended style questions (Kung et al., 2006; Walker et al., 2014; Fitzgerald et al., 2017; Toher et al., 2013). By administering both styles of questions in the early phases of this study, researchers felt confident that the most accurate approach of measuring vitamin D knowledge was found and would be utilized moving forward.

**Conclusion**

With the goal of the first half of the questionnaire being to accurately assess the true knowledge of vitamin D within the athletic population, the open-ended (version 1) questionnaire was selected for further use in the study. The second half of the vitamin D questionnaire would consist of closed-ended questions to measure the practices of vitamin D.

# Chapter Four

## Questionnaire Development: Reliability Testing

### Background

After determining the format and style of questions that would be used in the knowledge portion of the vitamin D questionnaire, the goal of this chapter was to perform reliability testing. According to research regarding reliability and validity of assessment instruments, reliability is looking to give the same results each time it is used in the same setting, with the same subjects (Sullivan, 2011). One way this is accomplished is through a test/retest session in which there are no interval changes in what is being measured (Sullivan, 2011).

Current research has no known vitamin D knowledge questionnaires that are appropriate for the athletic population and have gone through a test/retest sequence for reliability. For this study, researchers felt it was a critical component to ensure that the knowledge assessment of vitamin D was not going to give different scores when completed by the same athlete due to an unreliable questionnaire.

### Methods

**Recruitment:** The second phase of the vitamin D knowledge questionnaire was to perform reliability testing. Undergraduate students at the University of Idaho were recruited to volunteer during their regularly scheduled course (FCS 205: Concepts in Human Nutrition). These FCS 205 students were scheduled in a different class period than the FCS 205 students who participated in the first phase of the questionnaire development. The instructor of the course had previously agreed to allow the researchers 15 minutes of regularly scheduled class time to conduct the recruitment and administer the questionnaire.

The University of Idaho IRB had approved all of the procedures in this study and a letter of information was given to all participants who volunteered at the beginning of the study (see Appendix A & G).

**Procedure:** Two versions (A & B) of the vitamin D questionnaire were created to perform reliability testing. The questionnaires contained the same questions, however version B contained slightly different sequencing of the open-ended questions. To ensure that the sequencing of questions did not have any impact on the answers provided by the participants, questionnaire developers from Washington State University were consulted and approved the two different versions of the questionnaire.

Packets were given to each participant that contained the two versions of the questionnaire. Each version of the questionnaire was in a separate clasped envelope that was coded (ex: 1A & 1B) to ensure that each questionnaire version could be matched, while still providing anonymity to the participant.

At the beginning of the FCS 205 class period, participants were instructed to open the clasped envelope labeled" A" and complete version A of the questionnaire. Once completed, the participants placed the completed questionnaire back into envelope. Nearing the conclusion of class (approximately 75 minutes later) students were instructed to open the clasped envelope labeled "B" and complete the version B of the questionnaire. Once again, upon completion, the participants placed the completed questionnaire back into the envelope and then returned both envelopes to the researchers. The class period did not include any content that was related to vitamin D.

**Questionnaire Scoring:** Total possible points for each vitamin D knowledge question were as follows: Food Sources of Vitamin D (2 points possible) (fish, eggs, mushrooms, liver, milk, fortified cereals) Non-food Sources of Vitamin D (2 points possible) (Sun = 1 point, Supplements = 1 point), Health Benefits (1 point possible) (Bone Health = 1 point), Other Factors that could affect an individual's vitamin D levels (3 points possible) (sunscreen use, skin pigment, body weight, age, geographic location or latitude, time of the year or season) (Walker et al., 2014). The knowledge portion of the vitamin D questionnaire was scored with an 8-point maximum. Total scores ≥4 were considered to be "adequate vitamin D knowledge" while scores <4 were considered to be "low vitamin D knowledge."

**Analysis:** Scores from both versions of the questionnaire (A & B) were calculated and a Kappa statistics analysis was performed to determine reliability of the questionnaire (Kappa values within the range of 0.41-0.60 was considered moderate agreement and was deemed acceptable) (Sim et al., 2005).

**Results**

Seventy-six undergraduate students completed the reliability-testing portion of the study**.** Results from the Kappa statistics analysis on the two different versions (A & B) of the open-ended questionnaire are listed on Table 4.1.

**Table 4.1 Reliability Testing Version A vs. Version B**

**Participants (n=76)**

| Question | Version A vs. Version B (Kappa Value) |
|---|---|
| Food Sources | (0.761)* |
| Non-Food Sources | (0.726)* |
| Health Benefits | (0.802)* |
| Other Factors | (0.968)* |
| Total Score / Adequacy | (0.784)* |

*p < 0.001

**Discussion**

The interpretations of these Kappa values indicate that the questionnaire had substantial (scores of 0.61-0.80) and almost perfect (scores of 0.81-1.0) agreement (Sim et al., 2005). These results build upon previous research aimed at assessing vitamin D knowledge or awareness in both athletic and non-athletic populations. Studies had utilized both opened-ended and closed-ended questions to assess knowledge and/or awareness of vitamin D among a specific population (Kung et al., 2006; Walker et al., 2014; Fitzgerald et al., 2017; Toher et al., 2013). Though those studies included appropriate vitamin D-related topics, survey reliability had not been assessed. Results of the current study built upon the previous work performed and ensured that the instrument used in assessing vitamin D knowledge is indeed reliable.

In consideration of the length of time between tests (75 minutes), researchers noted that test-retest intervals could occur anywhere from 10 minutes up to 1 month (Marx et al., 2003). Researchers were concerned that a longer period of time could have altered their knowledge of vitamin D. Researchers felt that this length of time was a reasonable compromise between recollection bias and unwanted knowledge change (Marx et al., 2003)

**Conclusion**

The findings from this research suggested that the knowledge portion of the vitamin D questionnaire was an appropriate instrument for further use in this study, as well as any potential future studies in which researchers wanted to assess vitamin D knowledge. Having a reliable instrument allowed researchers to move forward in this study and assess the knowledge levels of student-athletes at the University of Idaho.

# Chapter Five

# Vitamin D Knowledge and Practices among Collegiate Athletes at the University of Idaho

## Introduction

Vitamin D is a fat-soluble nutrient that is primarily obtained through sufficient sun exposure, specifically ultraviolet B (UVB) wavelengths of 290-320 nm (He et al., 2016). Additionally, vitamin D can be obtained through a limited number of dietary sources such as oily fish, eggs, liver and fortified milk or cereals (Todd et al., 2015). In athletics, vitamin D serves as an important nutrient for an athlete's overall health and performance. The majority of research shows vitamin D's involvement in bone health, due to its role in enhancing calcium absorption and osteoclast activity, which lower the risk of bone injuries (Ogan et al., 2013). Vitamin D is also involved in the recruitment of skeletal muscle tissue during physical activity and plays a role in the regulation of immune responses (Koundourakis et al., 2014; He et al., 2016).

There are many factors that limit the vitamin D synthesis that occurs in the human body, which can lead to vitamin D deficiency. Seasonal variations and latitudes 40° north or south of the equator lessen the strength of UVB radiation that an individual is exposed to (Todd et al., 2015). Darker skin pigmentation acts similarly to sunscreen or protective clothing in that it blocks the UVB radiation from being absorbed (He et al., 2016; Ogan et al., 2013). Due to these limiting factors, vitamin D supplementation is critical for individuals who live 40° north or south of the equator during the winter season, and who have darker skin pigmentation, wear protective clothing or use adequate amounts of sunscreen to limit UVB absorption (He et al., 2016; Ogan et al., 2013).

With the University of Idaho's geographic location residing north of the 40th parallel, there is low ultraviolet-B radiation during the winter months.  This puts student-athletes at risk for potential deficiencies in their vitamin D status.

In consideration of the various aspects regarding vitamin D synthesis and limited natural availability, researchers felt the assessment of vitamin D knowledge as well as serum vitamin D levels were vital to the student-athlete's overall wellbeing. The aim of this chapter was to utilize the vitamin D knowledge questionnaire in order to assess the knowledge levels and practices regarding vitamin D among student athletes at the University of Idaho.

**Methods**

**Recruitment:** Student-athletes at the University of Idaho were recruited to participate in the study during regularly scheduled team organized events (meetings and practices) and regularly scheduled class times (student-athletes in FCS 205). Additionally, student-athletes who had previously participated in other various research studies and expressed interest in future participation were re-recruited for this study.

**Procedure:** Student-athletes who volunteered for the study had the option to participate in the assessment of vitamin D knowledge and practices as well as the blood draw to test serum vitamin D levels. For student-athletes who did not wish to participate in the blood draw, a vitamin D knowledge and practices questionnaire was administered and concluded their participation in the research study. A separate sign-up sheet was provided for student-athletes who wanted to volunteer for the serum vitamin D assessment.

The blood draw for serum vitamin D testing took place on the University of Idaho campus, Physical Education Building (PEB) room 113 (Biosafety Level 2). Participants arrived to PEB 113 at their scheduled time to complete the vitamin D knowledge questionnaire and have their blood drawn for serum vitamin D testing. A total of 1 mL of blood was collected from a vein in the right or left arm of the participant by a licensed phlebotomist. Once the questionnaire and blood draw were completed, the materials (questionnaire and blood vile) were coded to protect the identity of the participant while allowing only the researchers to have access to their information. Blood samples were then transported to Gritman Medical Center in Moscow, Idaho for serum vitamin D analysis.

As incentives for the student-athlete's participation in the study, their names were entered into a drawing for one of eight $25 Amazon gift cards. For student-athletes who only participated in the vitamin D knowledge and practices questionnaire, their name was entered into the drawing one time.

For those who participated in the knowledge and practices questionnaire as well as the blood draw, their names were entered into the drawing a total of three times.

The University of Idaho Institutional Biosafety Committee (IBC) approved the methods, location and procedures for this blood draws (see Appendix I).

**Analysis:** Vitamin D knowledge scores were calculated with an 8-point maximum. Total possible points for individual vitamin D knowledge questions were as follows: Food Sources of Vitamin D (2 points possible) (fish, eggs, mushrooms, liver, milk, fortified cereals), Non-food Sources of Vitamin D (2 points possible) (Sun = 1 point, Supplements = 1 point), Health Benefits (1 point possible) (Bone Health = 1 point), Other Factors that could affect an individual's vitamin D levels (3 points possible) (sunscreen use, skin pigment, body weight, age, BMI, geographic location or latitude, time of the year or season) (Kung et al., 2006; Walker et al., 2014; Fitzgerald et al., 2017; Toher et al., 2013).

Frequencies were run for all correct answers on each of the vitamin D knowledge questions (see Table 5.2). Averages and standard deviations were calculated for serum vitamin D levels**,** vitamin D knowledge scores and BMI's within their respective categories (adequate, inadequate, deficient) (see Table 5.4).

A Shapiro Wilk Test was used to test normality between vitamin D knowledge and serum vitamin D levels. Vitamin D knowledge and vitamin D level data were not normally distributed, therefore, the non-parametric Spearman's Correlation test was performed to determine the relationship between the quantitative variables: student-athlete total knowledge scores and serum vitamin D levels.

Statistical analysis was performed using the software program SPSS V23. The level of significance was set at $p \leq .05$.

**Results**

Thirty-two student-athletes (19.9 ± 0.98 years) completed the questionnaire portion of the study. Participants represented the following sports: women's basketball, soccer, swimming & diving, tennis, volleyball and cross-country, as well as men's golf and football.

**Vitamin D Knowledge:** Average total vitamin D knowledge scores were 2.41 out of an 8-point total possible score. Thirty-four percent of student-athletes were able to correctly list at least one food source of vitamin D, with the average score of 0.4 (± 0.61). Six percent of student-athletes were able to correctly list more than one food source of vitamin D. Ninety-six percent of student-athletes were able to correctly list non-food sources of vitamin D, with an average score of 1.2 (± 0.49). Twenty-five percent of student-athletes were able to list more than on non-food source of vitamin D. Eighteen percent of student-athletes were able to correctly list that bone health was a health benefit of vitamin D. The average score for the question pertaining to health benefits of vitamin D was 0.18 (± 0.39). Thirty-four percent of student-athletes were able to correctly list factors that could affect an individual's vitamin D level, with an average score of 2.406 (± 1.5420). Fifteen percent of those participants were able to list more than one factor that could affect an individual's vitamin D level (see Table 5.1 & 5.2).

**Table 5.1 Student-Athlete Vitamin D Knowledge**

**Participants (n = 32)**

| **Question (Points Possible)** | **Students w/ Correct Responses n (%)** | **Mean Score (±SD)** |
|---|---|---|
| Food Sources (2) | 11 (34) | 0.406 (± 0.6148) |
| Students with >1 correct answer | 2 (6) | |
| Non-Food Sources (2) | 31 (96) | 1.218 (± 0.4908) |
| Students with >1 correct answer | 8 (25) | |
| Health Benefits (Bone Health) (1) | 6 (18) | 0.1875 (± 0.3965) |
| Factors Affecting Vitamin D (3) | 11 (34) | 2.406 (± 1.5420) |
| Students with >1 correct answer | 5 (15) | |
| Average Total Vitamin D Knowledge Score | 2.41 | |

**Table 5.2 Student-Athlete Response Frequency**

**Participants (n = 32)**

| Food Sources (n) | Non-Food Sources (n) | Health Benefits (n) | Other Factors (n) |
|---|---|---|---|
| Milk (9) | Sun (30) | Bone Health (6) | Seasons (4) |
| Fish (3) | Supplements (9) | | Location (8) |
| Eggs (1) | | | Sunscreen Use (4) |
| | | | Skin Pigment (3) |

Eight of the thirty-two student-athletes who completed the vitamin D questionnaire had scores that were ≥4, which was classified as having adequate vitamin D knowledge. The average total score on the knowledge portion of the vitamin D questionnaire was 2.406 (± 1.542).

**Vitamin D Practices:** The second portion of the vitamin D questionnaire assessed the student-athletes' vitamin D practices (see Table 4.2). Sixteen participants reported to never taking a multi-vitamin, eight reported taking a multi-vitamin a few days per month, two reported taking a multi-vitamin 1-3 days per week, one reported taking a multi-vitamin 4-6 days per week, and five reported taking a multi-vitamin daily.

In regard to vitamin D supplementation, twenty-six student athletes reported never taking a vitamin D supplement. Three participants reported taking a vitamin D supplement a few days per month, one reported taking a vitamin D supplement 1-3 days per week, and two reported taking a vitamin D supplement daily.

When asked how frequently the participants take a fish oil supplement that contains vitamin D, twenty-eight of the participants reported never taking a fish oil supplement. Two participants reported taking fish oil supplements a few days per month while two other participants reported taking fish oil daily.

**Table 5.3 Student-Athlete Vitamin D Practices**

**Participants (n = 32)**

| | **Never n (%)** | **A few days per month n (%)** | **1-3 days per week n (%)** | **4-6 days per week n (%)** | **Daily N (%)** |
|---|---|---|---|---|---|
| **Multivitamin** | 16 (50) | 8 (25) | 2 (6) | 1 (3) | 5 (15) |
| **Vitamin D Supplement** | 26 (81) | 3 (9) | 1 (3) | 0 (0) | 2 (6) |
| **Fish Oil w/ Vitamin D** | 28 (87) | 2 (6) | 0 (0) | 0 (0) | 2 (6) |

**Serum Vitamin D Levels:** Twenty-four of the student-athletes who participated in the vitamin D questionnaire also participated in the blood draw to perform serum vitamin D testing. Results from the serum vitamin D testing were as follows: twelve participants were deficient (12-30 nmol/L); 10 participants had inadequate levels (30-50 nmol/L); 2 participants had adequate levels (>50 nmol/L) (see Figure 5.1).

**Figure 5.1 Student-Athlete Serum Vitamin D Levels**

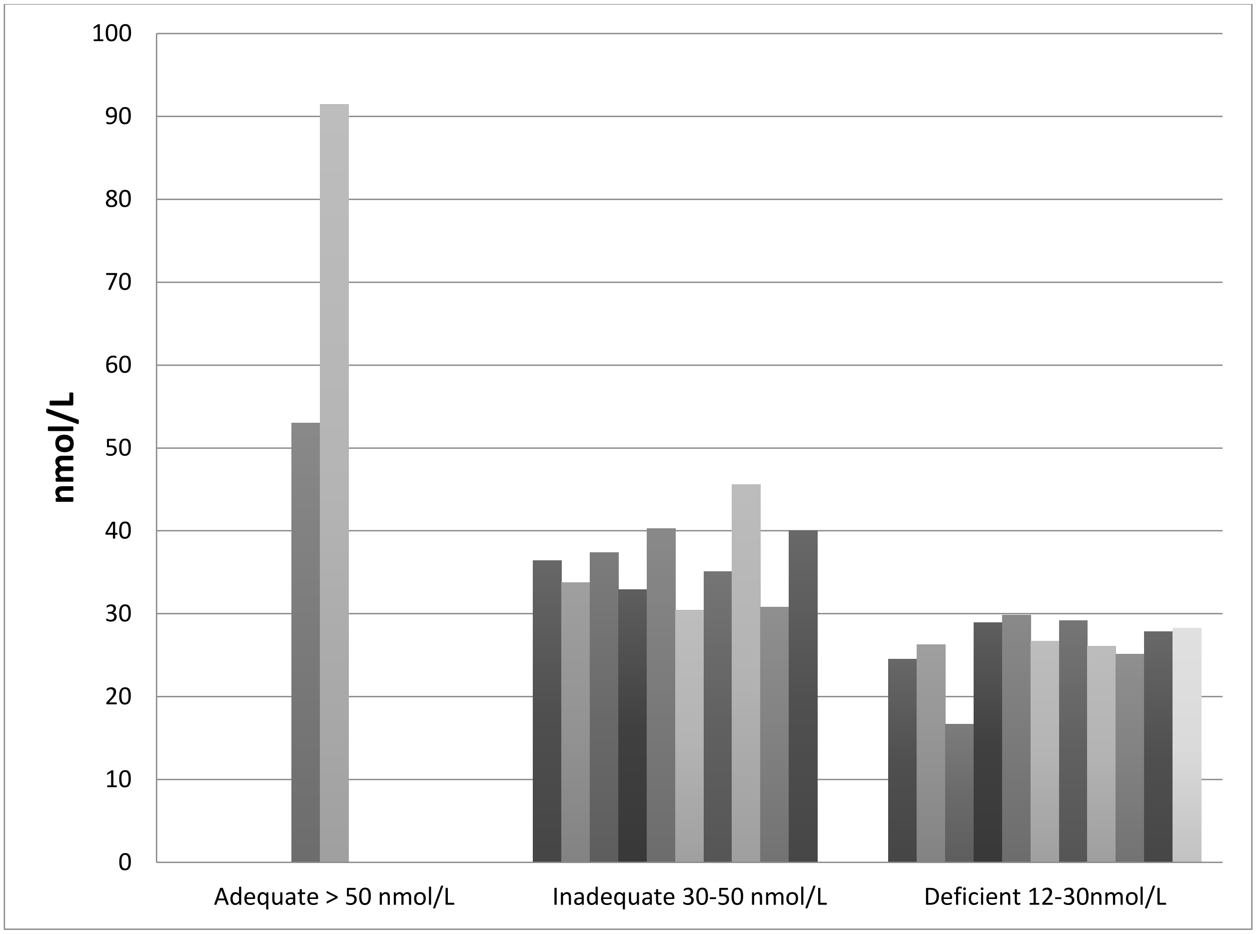
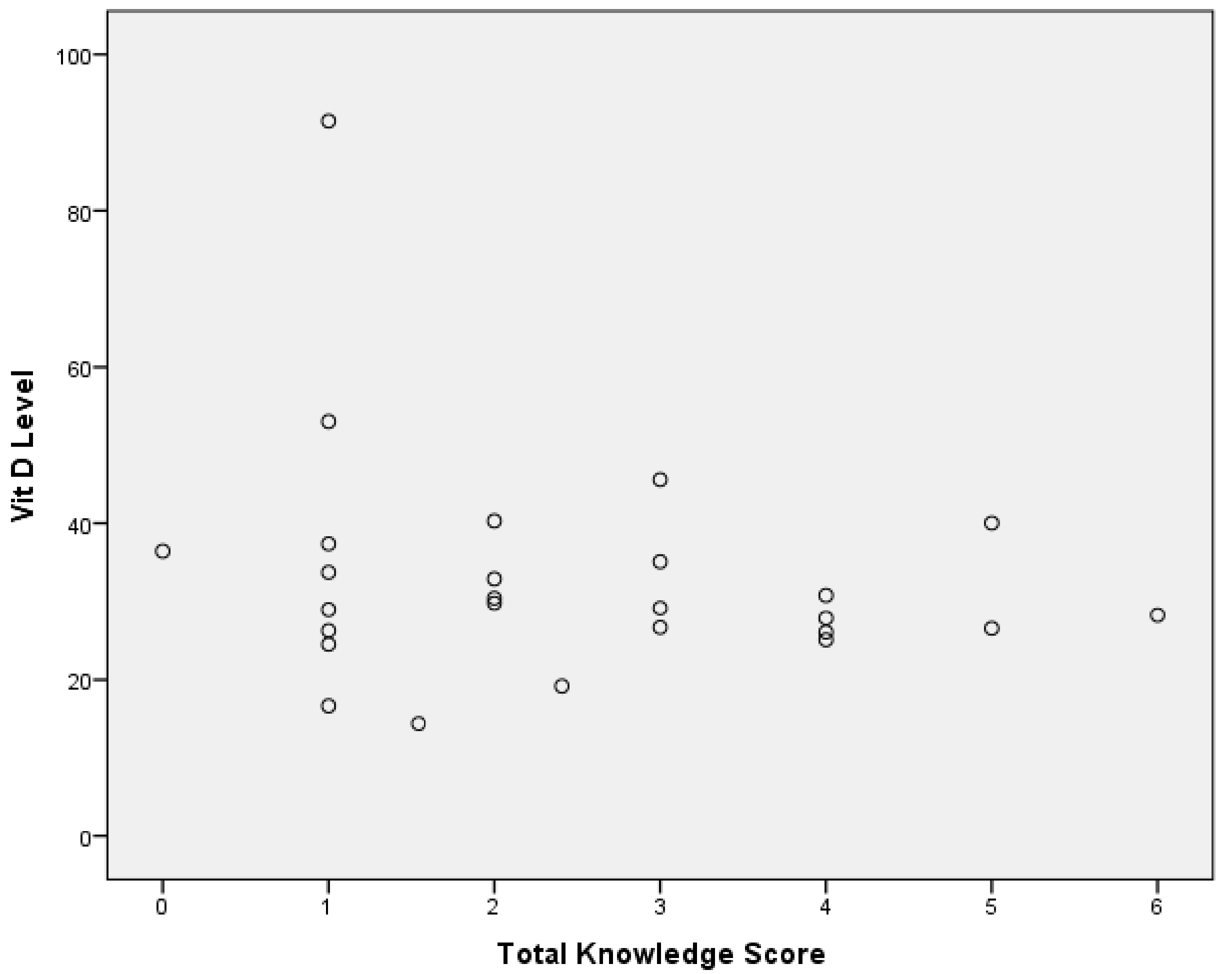



**Table 5.4 Participant Characteristics Across Levels of Serum Vitamin D Participants (n = 24)**

| | Adequate >50 nmol/L (n=2) Mean ± SD | Inadequate 30-50 nmol/L (n=10) Mean ± SD | Deficient 12-30 nmol/L (n=12) Mean ± SD |
|---|---|---|---|
| **Serum Vitamin D Level** | 72.25 ± 27.19 | 36.27 ± 4.73 | 26.23 ± 3.45 |
| **Vitamin D Knowledge** | 1 ± 0 | 2.3 ± 1.49 | 2.91 ± 1.72 |
| **BMI** | 24.9 ± 1.55 | 22.44 ± 1.42 | 23.16 ± 2.83 |

**Relationship Between Vitamin D Knowledge and Serum Vitamin D Levels:** The results showed that there was no relationship between knowledge of vitamin D and serum vitamin D levels (R = -.150; p = .446). Additionally, participants were found to have mostly inadequate or deficient serum vitamin D levels regardless of their vitamin D knowledge score (see Figure 5.2 and Table 5.4). Participant characteristics across the spectrum of vitamin D levels indicated that serum vitamin D levels were generally low, regardless of their vitamin D knowledge (see Table 5.4).

**Figure 5.2 Serum Vitamin D Levels vs. Vitamin D Knowledge**




**Discussion**

Student-athlete responses on the vitamin D knowledge questionnaire indicate that overall vitamin D knowledge among student-athletes at the University of Idaho is extremely low. Of the thirty-two athletes who completed the vitamin D knowledge questionnaire only eleven (34%) were able to correctly name a food source of vitamin D as well as well as a factor that affects vitamin D status. Six (18%) of the thirty-two athletes were able to name a health benefit of vitamin D. Results from the remaining knowledge question on non-food sources of vitamin D were substantially higher, with thirty-one (96%) of the participants being able to correctly name a non-food source of vitamin D (sun exposure and/or vitamin D supplements). The findings from this study further support prior research on vitamin D knowledge that showed a majority of participants were able to correctly identify the sun as a source of vitamin D, however, had very little knowledge of other sources of vitamin D (Toher et al., 2013).

A similar study that assessed vitamin D knowledge among undergraduate students in Canada (n=1,088) found that students could only answer 29% of questions correctly (Boland et al., 2014). These findings further suggest the relevance of poor vitamin D knowledge, especially in the college setting.

Assessing the results of vitamin D knowledge on studies among general population, which utilized closed-ended questionnaires, showed elevated averages of vitamin D knowledge in comparison to the results from this study. A study that utilized an open-ended style vitamin D knowledge questionnaire found that 32.2% of participants gave correct responses in regard to health benefits of vitamin D (Kung et al., 2006). Fifty-seven percent of participants gave positive responses when asked if they had heard that vitamin D is good for bone health (Kung et al., 2006). While this was higher than the results from the health benefits question from this study (18%), researchers hypothesize that the sequencing and wording of the questions could have generated correct or positive responses due to questions that were somewhat leading in nature. One study that utilized a closed-ended or multiple-choice style of vitamin D questionnaire reported a higher percentage of correct responses when asked about health benefits of vitamin D (76%) (Vu et al., 2010).

As stated in previous research, limited exposure to sufficient ultraviolet B radiation due to geographic location and season variations dramatically increases the risk of vitamin D deficiency, thus increasing the need for supplemental sources of vitamin D (Todd et al., 2015). Among the student-athletes at the University of Idaho who participated in the study, 25% reported taking a multi-vitamin at least once a week. 9% reported taking a vitamin D supplement at least once a week and 6% reported taking a fish-oil supplement that contained vitamin D at least once a week. This study however, did not investigate the dosage of the vitamin D that was contained in the multivitamin, fish oil or vitamin D supplement.

Of the twenty-four student-athletes who participated in the serum vitamin D testing, 92% were found to have deficient or inadequate plasma concentrations of vitamin D (12-50 nmol/L). Due to seasonal limitations of weaker ultraviolet B radiation at the University of Idaho campus (46°N) during the winter months, combined with an approximate two month half-life of vitamin D within the body, it was not surprising to find that the majority of athletes had lower plasma concentrations of vitamin D during the early spring months when the testing took place (Jones, 2008). The effects of living at latitudes greater than 40°N of the equator are clearly stated in prior studies (Todd et al., 2015). Serum vitamin D was tested only once; therefore seasonal variation was not assessed. It is possible that participants had inadequate or low vitamin D levels because winter season was just ending. However, even if plasma vitamin D levels were higher at other times during the year, deficiency in spring is still concerning.

Interestingly, analysis of the relationship between vitamin D knowledge and plasma vitamin D levels revealed that there is no substantial evidence to suggest that knowledge of vitamin D has any impact on a student-athletes plasma vitamin D concentration. Researchers hypothesize that factors such as geographic location and seasonal variations could have contributed to the overall low serum vitamin D levels among student-athletes at the University of Idaho; however, those factors were not controlled for in analysis in the current study.

**Limitations**

The sample size for this study was limited to a very specific geographic region and might not accurately reflect the knowledge and vitamin D practices of collegiate athletes in other regions.

Participants were not asked to disclose demographic information such as ethnicity, gender, academic major and were not asked to provide detailed information regarding the dosage of vitamin D in regard their supplemental intake. In addition, sun exposure was not controlled for, and serum vitamin D levels were assessed at only one period of time. Lastly, while researchers performed reliability testing on the knowledge portion of the vitamin D questionnaire, testing for validity was not performed.

**Implications for Future Research**

Low vitamin D knowledge levels combined with a high prevalence of vitamin D deficiency among student-athletes indicate a need for education and supplementation in the collegiate setting. Possible strategies for intervention include team education sessions or individual counseling sessions through the services of a nutrition professional. Additionally, the need for a supplemental protocol is evident to offset the many factors that prohibit athletes from maintaining adequate serum vitamin D levels.

A major component of this research study was the creation of a vitamin D knowledge questionnaire that was statistically reliable. Validation of the questionnaire would be the logical next step in order to properly utilize the questionnaire in future research. Validation can be achieved by comparing survey responses to face-to-face interviews. This would be beneficial as it would be a validated tool to assess vitamin D knowledge of collegiate athletes at various institutions.

Detailed expansion of the questionnaire would also likely be beneficial for future research. Having demographic information such as ethnicity (skin pigment) and gender of the participants would be relevant as those characteristics play a role in cutaneous vitamin D production (Shuler et al., 2012). Additional aspects that could be considered for future research include assessing the dosage of vitamin D that athletes are consuming via food (food frequency questionnaire) or supplements.

Another consideration in regard to serum vitamin D testing is the possibility of testing multiple times throughout the year. Research suggests that the half-life of vitamin D within the body is around two months (Jones, 2008). Performing serum vitamin D tests on a quarterly or seasonal basis would potentially serve as a more accurate assessment of serum vitamin D concentrations among the student-athlete population.

**Reference List**

Abrams, G. D., Feldman, D., & Safran, M. R. (2018). Effects of Vitamin D on Skeletal Muscle and Athletic Performance. The American Academy of Orthopedic Surgeons, 0(0), 1-8. doi:10.5435/JAAOS-D-1600464

Bermon, S., Castell, L. M., Calder, P. C., Bishop, N. C., Blomstrand, E., Mooren, F. C., Krüger K., Kavazis A.N., Quindry J.C., Senchina D.S., et al. (2017). Consensus Statement Immunonutrition and Exercise. *Exercise Immunology Review*, 23, 8–50. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:gih:diva-4801

Birenbaum, M., & Tatsuoka, K. K. (1987). Open-Ended Versus Multiple-Choice Response Formats—It Does Make a Difference for Diagnostic Purposes. Applied Psychological Measurement, 11(4), 385–395. https://doi.org/10.1177/014662168701100404

Boland, S., Irwin, J. D., & Johnson, A. M. (2014). A Survey of University Students' Vitamin D–Related Knowledge. Journal of Nutrition Education and Behavior, 47(1), 99-103.

Dahlquist, D. T., Dieter, B. P., & Koehle, M. S. (2015). Plausible ergogenic effects of vitamin D on athletic performance and recovery. *Journal of the International Society of Sports Nutrition*, *12*, 33. http://doi.org/10.1186/s12970-015-0093-8

Fitzgerald, J. S., Leitch, B. A., Wilson, P. B., Walch, T. J., Short, S. E., Ufholz, K., & Roemmich, J. N. (2017). Vitamin D Awareness and Intake in Collegiate Athletes. *Medicine and Science in Sports and Exercise*, 49, 100. doi:10.1249/01.mss.0000517101.99466.d5

Fowler, F. J. (2006). Improving survey questions: Design and evaluation (Vol. 38). Thousand Oaks: Sage Publ.

Gropper, S. A., & Smith, J. L. (2013). Advanced Nutrition and Human Metabolism (6th ed.). Boston, MA: Cengage Learning.

He, C., Yong, X., Walsh, N. P., & Gleeson, M. (2016). Is there an optimal vitamin D status for immunity in athletes and military personnel? *Exercise Immunology Review*, 22, 42-64.

Health Quality Ontario. (2010). Clinical Utility of Vitamin D Testing: An evidence-based analysis. *Ontario Health Technology Assessment Series*, *10*(2), 1–93.

Jones, G. (2008). Pharmacokinetics of vitamin D toxicity. The American Journal of Clinical Nutrition, 88(2). doi:10.1093/ajcn/88.2.582s

Koundourakis, N. E., Androulakis, N. E., Malliaraki, N., & Margioris, A. N. (2014). Vitamin D and Exercise Performance in Professional Soccer Players. *PLoS ONE*, *9*(7), e101659. http://doi.org/10.1371/journal.pone.0101659

Kung, A. W., & Lee, K. (2006). Knowledge of vitamin D and perceptions and attitudes toward sunlight among Chinese middle-aged and elderly women: a population survey in Hong Kong. *BMC Public Health*, 6(1). doi:10.1186/1471-2458-6-226

Marx, R. G., Menezes, A., Horovitz, L., Jones, E. C., & Warren, R. F. (2003). A comparison of two time intervals for test-retest reliability of health status instruments. Journal of Clinical Epidemiology, 56(8), 730-735. doi:10.1016/s0895-4356(03)00084-2

Mchugh, M. L. (2012). Interrater reliability: the kappa statistic. Biochemia Medica, 276-282. doi:10.11613/bm.2012.031

Ogan, D., & Pritchett, K. (2013). Vitamin D and the Athlete: risks, recommendations, and benefits. *Nutrients*, *5*(6), 1856–1868. http://doi.org/10.3390/nu5061856

Owens, Daniel J., Tang, Jonathan C. Y., Bradley, Warren J., Sparks, S. Andy, Fraser, William D., Morton, James P. & Close, Graeme L. (2017) *Efficacy of High-Dose vitamin D supplements for Elite Athletes. Medicine and Science in Sports and Exercise*, 49 (2). 349–356. ISSN 0195-9131

Owens, Daniel J., Fraser, William D. & Close, Graeme L. (2014) Vitamin D and the athlete: Emerging insights, *European Journal of Sport Science*, DOI: 10.1080/17461391.2014.944223

Shuler, F. D., Wingate, M. K., Moore, G. H., & Giangarra, C. (2012). Sports health benefits of Vitamin D. *Sports Health*, *4*(6), 496–501. http://doi.org/10.1177/1941738112461621

Sim, J., & Wright, C. C. (2005). The Kappa Statistic in Reliability Studies: Use, Interpretation, and Sample Size Requirements. Physical Therapy, 85(3). doi:10.1093/ptj/85.3.257

Sullivan, G. M. (2011). A Primer on the Validity of Assessment Instruments. Journal of Graduate Medical Education, 3(2), 119-120. doi:10.4300/jgme-d-11-00075.1

Todd, J. J., Pourshahidi, L. K., Mcsorley, E. M., Madigan, S. M., & Magee, P. J. (2015). Vitamin D: recent advances and implications for Athletes. *Sports Medicine*, 45(2), 213-229. doi:10.1007/s40279-014-0266-7

Toher, C., Lindsay, K., Mckenna, M., Kilbane, M., Curran, S., Harrington, L., Uduma, O., Mcauliffe, F. M. (2013). Relationship between vitamin D knowledge and 25-hydroxyvitamin D levels amongst pregnant women. Journal of Human Nutrition and Dietetics, 27(3), 261-269. doi:10.1111/jhn.12150

Walker, N., Love, T. D., Baker, D. F., Healey, P. B., Haszard, J., Edwards, A. S., & Black, K. E. (2014). Knowledge and attitudes to vitamin D and sun exposure in elite New Zealand athletes: a cross-sectional study. *Journal of the International Society of Sports Nutrition*, *11*, 47. http://doi.org/10.1186/s12970-014-0047-6

Vimaleswaran, K., Berry, D., Lu, C., Tikkanen, E., Pilz, S., Hiraki, L., . . . Hyppönen, E. (2013). Causal Relationship between Obesity and Vitamin D Status: Bi-Directional Mendelian Randomization Analysis of Multiple Cohorts. Nutritional Biochemistry, 145-169. doi:10.1201/b18536-11

Vu, L. H., Pols, J. C., Whiteman, D. C., Kimlin, M. G., & Neale, R. E. (2010). Knowledge and Attitudes about Vitamin D and Impact on Sun Protection Practices among Urban Office Workers in Brisbane, Australia. Cancer Epidemiology Biomarkers & Prevention, 19(7), 1784-1789. doi:10.1158/1055-9965.epi-10-0127

# Appendix A

University *of* Idaho
Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Katie N. Brown

Cc: Ann Brown, Chantal Vella, Colin Whitaker

From: Sharon Stoll
Chair, University of Idaho Institutional Review Board

Date: April 03, 2018

Title: Vitamin D Knowledge and Practices among Collegiate Athletes at the University of Idaho
Project: 18-050

Review Type: Expedite
Approved: 04/03/2018
Renewal: 04/02/2019

---

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the research project Vitamin D Knowledge and Practices among Collegiate Athletes at the University of Idaho is approved as offering no significant risk to human subjects. This approval is valid until 04/02/2019.

This study may be conducted according to the protocol described in the application. Research that has been approved by the IRB may be subject to further appropriate review and approval or disapproval by officials of the Institution. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice. As Principal Investigator, you are responsible for ensuring compliance with all applicable FERPA regulations, University of Idaho policies, state and federal regulations.

Federal regulations require researchers to follow specific procedures in a timely manner. For the protection of all concerned, the IRB calls your attention to the following obligations that you have as Principal Investigator of this study.

1. For any changes to the study (except to protect the safety of participants), an Amendment Application must be submitted to the IRB. The Amendment Application must be reviewed and approved before any changes can take place.

## Appendix B

### Vitamin D Questionnaire (Version 1)

Please be sure to mark your answers **DARK ENOUGH TO READ** and correctly as shown.

| **Answer Selection:** Correct = ● Incorrect = ⊠ ✓ ⊖ |
|---|

**Vitamin D Knowledge**

Please rate your agreement to the following questions:

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I feel like I have adequate knowledge of vitamin D sources. | O | O | O | O | O |
| 2. I feel like I have adequate knowledge of the health benefits of vitamin D. | O | O | O | O | O |

| Have you ever heard of vitamin D?<br><br>O Yes<br>O No |
|---|

Please complete the following questions to the best of your ability, if you are not able to provide an answer, write “don’t know.”

| | |
|---|---|
| What are food sources of vitamin D? | What are other ways you can get vitamin D? |
| List any known health benefits of vitamin D* | List any other factors that could affect an individual’s vitamin D levels. |

**Vitamin D Behaviors**

| How often do you take a multi-vitamin? | How often do you take a vitamin D supplement? |
|---|---|
| O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ | O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ |
| **How often do you take fish oil supplements that contain vitamin D?** | **How often do you use a tanning bed?** |
| O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ | O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ |
| **When in the sun, do you use sunscreen containing SPF ≥15?** | **Have you ever had your vitamin D levels tested?** |
| O Yes<br>O No | O Yes<br>O No<br><br>If yes, were you deficient? ___________ |

| Age | Academic year in college (please select one) |
|---|---|
| O 18<br>O 19<br>O 20<br>O 21<br>O 22<br>O Other________________ | O Freshman<br>O Sophomore<br>O Junior<br>O Senior |

*Walker, N., Love, T. D., Baker, D. F., Healey, P. B., Haszard, J., Edwards, A. S., & Black, K. E. (2014). Knowledge and attitudes to vitamin D and sun exposure in elite New Zealand athletes: a cross-sectional study. Journal of the International Society of Sports Nutrition, 11, 47. http://doi.org/10.1186/s12970-014-0047-6

## Appendix C

### Vitamin D Questionnaire (Version 2)

Please be sure to mark your answers **DARK ENOUGH TO READ** and correctly as shown.

**Answer Selection:** Correct = ● Incorrect = ☒ ✓ ⊖

**Vitamin D Knowledge**

Please rate your agreement to the following questions:

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I feel like I have adequate knowledge of vitamin D sources. | O | O | O | O | O |
| 2. I feel like I have adequate knowledge of the health benefits of vitamin D. | O | O | O | O | O |

Have you ever heard of vitamin D?

O Yes O No

| What are food sources of vitamin D? (Select all that apply) | What are other ways you can get vitamin D? (Select all that apply) |
|---|---|
| O Fatty Fish | O Sun Exposure |
| O Fortified Milk | O Tanning Beds |
| O Chicken | O Supplements |
| O Egg Yolk | O Exercise |
| O Olive Oil | O Adequate Amounts of Sleep |
| O Ground Beef | |
| O Shiitake Mushrooms | |
| O Fortified Cheeses | |
| O Almonds | |
| O Apples | |
| O Carrots | |
| O Fortified Cereals | |

| What are health benefits of vitamin D? (Select all that apply)<br><br>O Bone Health<br>O Immunity<br>O Increased Energy<br>O Improved Digestive Health<br>O Muscle Force Production<br>O Cognition<br>O Delays Aging Process<br>O Increases Fat Metabolism | What are other factors that could affect an individual's vitamin D levels? (Select all that apply)<br>O Distance from the Equator<br>O Higher Altitudes<br>O Cloudy Climates<br>O Exercise Frequency<br>O Dark Skin Pigmentation<br>O High BMI<br>O Average Hours of Sleep<br>O Utilization of Sun-block<br>O Time Spent in Front of a Computer<br>O Older Age<br>O Seasonal Variations in Sun Exposure |
|---|---|
| | |

# Appendix D

## Vitamin D Questionnaire (Version A)

Please be sure to mark your answers **DARK ENOUGH TO READ** and correctly as shown.

**Answer Selection:** Correct = ●    Incorrect = ⊠ ✓ ⊖

**Vitamin D Knowledge**

Please rate your agreement to the following questions:

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I feel like I have adequate knowledge of vitamin D sources. | O | O | O | O | O |
| 2. I feel like I have adequate knowledge of the health benefits of vitamin D. | O | O | O | O | O |

Have you ever heard of vitamin D?

O Yes
O No

Please complete the following questions to the best of your ability, if you are not able to provide an answer, write "don't know."

| | |
|---|---|
| What are food sources of vitamin D? | What are other ways you can get vitamin D? |
| List any known health benefits of vitamin D* | List any other factors that could affect an individual's vitamin D levels. |

**Vitamin D Behaviors**

| How often do you take a multi-vitamin? | How often do you take a vitamin D supplement? |
|---|---|
| O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ___________________ | O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ___________________ |
| How often do you take fish oil supplements that contain vitamin D? | How often do you use a tanning bed? |
| O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ___________________ | O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ___________________ |
| When in the sun, do you use sunscreen containing SPF $\geq 15$? | Have you ever had your vitamin D levels tested? |
| O Yes<br>O No | O Yes<br>O No<br><br>If yes, were you deficient? __________ |

| Age | Academic year in college (please select one) |
|---|---|
| O 18<br>O 19<br>O 20<br>O 21<br>O 22<br>O Other_______________ | O Freshman<br>O Sophomore<br>O Junior<br>O Senior |

*Walker, N., Love, T. D., Baker, D. F., Healey, P. B., Haszard, J., Edwards, A. S., & Black, K. E. (2014). Knowledge and attitudes to vitamin D and sun exposure in elite New Zealand athletes: a cross-sectional study. Journal of the International Society of Sports Nutrition, 11, 47. http://doi.org/10.1186/s12970-014-0047-6

**Appendix E**

**Vitamin D Questionnaire (Version B)**

Please be sure to mark your answers **DARK ENOUGH TO READ** and correctly as shown.

**Answer Selection:** Correct = ● Incorrect = ☒ ☑ ⊖

**Vitamin D Knowledge**

Please rate your agreement to the following questions:

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I feel like I have adequate knowledge of vitamin D sources. | O | O | O | O | O |
| 2. I feel like I have adequate knowledge of the health benefits of vitamin D. | O | O | O | O | O |

Have you ever heard of vitamin D?

O Yes
O No

Please complete the following questions to the best of your ability, if you are not able to provide an answer, write "don't know."

| | |
|---|---|
| List any known health benefits of vitamin D* | What are food sources of vitamin D? |
| What are other ways you can get vitamin D? | List any other factors that could affect an individual's vitamin D levels. |

**Vitamin D Behaviors**

| How often do you take a multi-vitamin? | How often do you take a vitamin D supplement? |
|---|---|
| O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ | O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ |
| **How often do you take fish oil supplements that contain vitamin D?** | **How often do you use a tanning bed?** |
| O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ | O Never<br>O A few days per month<br>O 1-3 days per week<br>O 4-6 days per week<br>O Daily<br>O Other ____________________ |
| **When in the sun, do you use sunscreen containing SPF ≥15?** | **Have you ever had your vitamin D levels tested?** |
| O Yes<br>O No | O Yes<br>O No<br><br>If yes, were you deficient? ___________ |

| Age | Academic year in college (please select one) |
|---|---|
| O 18<br>O 19<br>O 20<br>O 21<br>O 22<br>O Other________________ | O Freshman<br>O Sophomore<br>O Junior<br>O Senior |

*Walker, N., Love, T. D., Baker, D. F., Healey, P. B., Haszard, J., Edwards, A. S., & Black, K. E. (2014). Knowledge and attitudes to vitamin D and sun exposure in elite New Zealand athletes: a cross-sectional study. Journal of the International Society of Sports Nutrition, 11, 47. http://doi.org/10.1186/s12970-014-0047-6

**Appendix F**

UNIVERSITY OF IDAHO
Letter of Information (Phase 1)

Dear Participant,

You are invited to participate in a survey that contributes to a study being conducted by Dr. Katie Brown and Master's Student Colin Whitaker. The purpose of this study is to test the reliability of a Vitamin D knowledge and practices survey.

You will be asked to complete a brief vitamin D survey. No identifying information will be collected (e.g. name, student ID number), therefore your responses will be anonymous. Data collected during this study will only be accessed by researchers associated with the study. There are minimal risks associated with this study. One potential risk is that you may feel mental discomfort in answering questions about your knowledge and practices relating to vitamin D. You may skip any questions you are uncomfortable with, or may withdraw from the research at any time. Participation is voluntary and will not affect your standing in any class at the University of Idaho.

You may benefit from this study by learning more about vitamin D via an informational handout that will be provided after you have completed the survey. In addition, you may receive extra credit in your class. Society may benefit because there are currently no vitamin D surveys that have been tested for reliability.

The Institutional Review Board at the University of Idaho has classified this research as exempt. If you have any comments or concerns please contact primary investigator, Dr. Katie Brown, or student investigator, Colin Whitaker.

Thank you for your assistance in this project.
Colin Whitaker, Graduate Student, School of Family and Consumer Science, University of Idaho
Katie Brown, PhD, RDN, LD, Assistant Professor of Foods and Nutrition, School of Family & Consumer Sciences, University of Idaho Niccolls 302C
(208) 885-7664

**Appendix G**

UNIVERSITY OF IDAHO
Letter of Information (Phase 2)

Dear Participant,

You are invited to participate in a survey that contributes to a study being conducted by Dr. Katie Brown and Master's Student Colin Whitaker. The purpose of this study is to test the reliability of a Vitamin D knowledge and practices survey.

You will be asked to complete a brief vitamin D survey at the beginning of class, and a brief vitamin D survey at the end of class. No identifying information will be collected (e.g. name, student ID number), therefore your responses will be anonymous. Data collected during this study will only be accessed by researchers associated with the study. There are minimal risks associated with this study. One potential risk is that you may feel mental discomfort in answering questions about your knowledge and practices relating to vitamin D. You may skip any questions you are uncomfortable with, or may withdraw from the research at any time. Participation is voluntary and will not affect your standing in any class at the University of Idaho.

You may benefit from this study by learning more about vitamin D via an informational handout that will be provided after you have completed the survey. In addition, you may receive extra credit in your class. Society may benefit because there are currently no vitamin D surveys that have been tested for reliability.

The Institutional Review Board at the University of Idaho has classified this research as exempt. If you have any comments or concerns please contact primary investigator, Dr. Katie Brown, or student investigator, Colin Whitaker.

Thank you for your assistance in this project.
Colin Whitaker, Graduate Student, School of Family and Consumer Science, University of Idaho
Katie Brown, PhD, RDN, LD, Assistant Professor of Foods and Nutrition, School of Family & Consumer Sciences, University of Idaho Niccolls 302C
(208) 885-7664

**Appendix H**

**University of Idaho**

**College of Agricultural & Life Sciences**

**Informed Consent Form for Research Involving Human Subjects**

---

**Title:** Vitamin D Knowledge and Practices Among Collegiate Athletes at the University of Idaho

**Primary Investigator:** Katie Brown, RD, Ph.D.

**Other Investigators:** Colin Whitaker

**Participant's Printed Name**:

______________________________________________________

You are being asked to take part voluntarily in the research project described below. Please take your time in deciding. Before agreeing to take part in this research study, it is important that you read the consent form. Please ask the researcher to explain any words or information that you do not understand.

---

**VOLUNTARY CONSENT**

I voluntarily and without element of force or coercion, consent to be a participant in the research project entitled "Vitamin D Knowledge and Practices Among Collegiate Athletes at the University of Idaho." This study is being conducted by Mr. Colin Whitaker and Dr. Katie Brown, of the College of Agricultural & Life Sciences at the University of Idaho.

**PURPOSE**

The primary purpose of this study is to assess the vitamin D knowledge levels among student-athletes. The secondary purpose is to determine if there are any relationships between student-athletes' vitamin D knowledge, dietary vitamin D intake, bone mineral density, and serum vitamin D levels.

I must meet the following criteria to be included in the study: (1) current student-athlete between ages of 18-25, (2) have no contraindications to exercise based on the American College of Sports Medicine and American Heart Association (ACSM/AHA) risk stratification criteria including uncontrolled hypertension, currently taking blood pressure medications, or have been diagnosed with cardiovascular disease, stroke, diabetes, thyroid, or kidney dysfunction, (3) have no risk factors for cardiovascular disease as determined by ACSM guidelines, and (4) have no significant musculoskeletal injuries or other medical conditions over the past 6 months.

**PROCEDURES**

If I previously participated in the study titled "Risk of Relative Energy Deficiency in Sport (RED-S) among University of Idaho Student-Athletes" I permit the researchers of the present study to access my information previously collected. If I did not previously participate in the aforementioned study, I agree to have my height and weight measured using a standard stadiometer and scale, respectively.

If you agree to take part in this study, the research team will ask you to complete the Vitamin D Knowledge and Practices questionnaire. If you also agree to participate in the vitamin D blood testing portion of this study, you will be asked to attend 1 visit between in the Exercise Physiology Research Laboratory (PEB 113) within two weeks of completing the questionnaire. Both visits will take approximately 45-minutes total and all procedures are described in detail below.

Procedures include: (1) vitamin D knowledge and practices questionnaire; (2) blood draw for serum vitamin D test.

**ASSESMENT OF STUDENT-ATHLETE VITAMIN D KNOWLEDGE: FIRST VISIT**

The research team will coordinate with respective coaching staffs to attend a team meeting to seek participants in this research study. If you agree to participate, the written informed consent will be signed. I will then distribute the Vitamin D Knowledge and Practices Questionnaire.

<u>Questionnaire Information</u>: The questionnaire will be used to gather information regarding your vitamin D knowledge and practices. Questionnaires will not include your name and will be coded by a subject number to which only the researchers have access.

**BLOOD 25(OH)D TESTING: SECOND VISIT**

If you agree to participate in the blood draw to assess serum vitamin D status, you will be asked to attend the Exercise Physiology Research Laboratory (PEB 113). Upon arrival to the Exercise Physiology Laboratory, trained phlebotomist will perform the blood draw in order to analyze your serum vitamin D levels.

<u>Blood Draw</u>: A one-time blood draw of 1-3 mL will be taken from a vein in either the right or left arm. The blood samples will then be taken to Gritman Medical Center's laboratory to determine the serum vitamin D levels.

**DISCOMFORTS AND RISKS**

I understand there is a minimal level of risk involved if I agree to participate in this study. In regard to the vitamin D questionnaire, some people may feel mental fatigue or stress in trying to demonstrate knowledge of vitamin D and recalling of vitamin D practices. With regard to the blood draw, the needle stick may hurt or provided discomfort. There is also a small risk of bruising at the point where the blood is taken, redness or swelling of the vein, fainting, and a rare risk of infection. For your safety, a research team member will be with you at all times during test procedures and a trained phlebotomist will perform the blood draw.

If I am identified to be at risk in any of the variables being tested I will be referred to the appropriate medical provider (i.e. campus dietician and/or counseling center).

**POSSIBLE BENEFITS**

You can gain knowledge of your blood (serum) vitamin D concentrations. You may benefit by learning if you're in a vitamin D deficient status through the blood test (<30 nmol/L) and if you should seek nutritional counseling through Vandal Health Education at University of Idaho (https://www.uidaho.edu/current-students/vandal-health-education/nutrition). The benefit to society relates to a better understanding of vitamin D knowledge and how that relates to serum vitamin D statuses in student-athletes. After completing the vitamin D questionnaire, you will be entered in a drawing for one of three $25 Amazon gift cards. If you complete the blood draw, you will have your name entered into the drawing an additional three times.

**STATEMENT OF CONFIDENTIALITY**

The results of this study may be published but my name or identity will not be revealed. Information obtained during the course of the study will remain confidential, to the extent allowed by law. My name will not appear on any of the results. No individual responses will be reported. Only group responses will be reported in the publications. Confidentiality will be maintained by assigning each subject a code number and recording all data by code number. The only record with my name and code number will be kept by the principal investigator, Dr. Katie Brown, in a locked drawer in her office. Data will be kept for 10 years and then destroyed.

**CONTACT INFORMATION FOR QUESTIONS OR CONCERNS**

You may ask any questions you have now. If you have questions later, you may call Colin Whitaker or Katie Brown at the number or email listed below.

Colin Whitaker
Ph. (714) 742-3528
whit5416@vandals.uidaho.edu

Dr. Katie Brown
Ph. (208) 885-7986
katieb@uidaho.edu

If you have questions or concerns about your participation as a research subject, please contact the University of Idaho Institutional Review Board (IRB) at (208) 885-6340.

**SIGNATURE AND CONSENT TO PARTICIPATE IN RESEARCH**

The nature, demands, benefits and risks of the study have been explained to me. I knowingly assume any minimal risk involved. I have read the above informed consent form. I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of the benefits to which I may otherwise be entitled. In signing this consent form, I am not waiving my legal claims, rights or remedies. A copy of this consent form will be given to me.

**Participant Name: ________________________________**

**Participant Signature**: _____________________________ **Date: __________**
**Time: ___________**

I have discussed this research study with the subject using language that is understandable and appropriate. I believe I have fully informed the subject of the possible risks and benefits, and I believe the subject understands this explanation. I have given a copy of this form to the subject.

**Signature of Investigator:**_____________________________**Date: __________**
**Time:**________

# Appendix I

University of Idaho

Office of Research Assurances
Institutional Biosafety Committee
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-6014
ibc@uidaho.edu

To: Dr. Chantal Vella, Associate Professor & Director Exercise Physiology Research Laboratory, Department of Movement Sciences

From: Dr. Gulhan Unlu, Associate Professor, School of Food Science and Chair of University of Idaho Institutional Biosafety Committee (IBC)

Date: April 3, 2018

Subject: Approval of IBC# B-005-18, "Exercise Physiology Lab Procedures"

---

The IBC reviewed your above-named protocol in accordance with Occupational Health and Safety (OHSA) regulations and the Centers for Disease Control and Prevention (CDC) guidelines as well as local, state and federal environmental protection regulations. The IBC agreed that the proposed work, as described in the protocol, can be safely conducted at Biosafety Level 2 (BSL-2). IBC approval for these experiments was granted on 04/03/2018 and expires on 04/02/2021.

If the scope of the research changes it may be necessary to submit an amended biosafety form to the IBC. Consult with the biosafety officer (biosafety@uidaho.edu or 208-885-4054) prior to implementing any changes. Substantive changes that may require an amendment include, but are not limited to, using a microorganism or genetic tool other than what is listed in the experiments described, changes in procedures that may influence exposure potential, or changes in equipment, facilities, or personnel.

Please contact the IBC coordinator (ibc@uidaho.edu or 208-885-7258) or the biosafety officer with any questions.

Sincerely,

Gulhan Unlu

Dr. Gulhan Unlu
Chair, Institutional Biosafety Committee