2016

Dietary Supplements: A Consumer Profile of Knowledge and Use

Sarah J. Kucera
Bethel University

Yen Nguyen
Bethel University

DIETARY SUPPLEMENTS: A CONSUMER PROFILE OF KNOWLEDGE AND USE

A MASTER'S THESIS
SUBMITTED TO THE GRADUATE FACULTY
GRADUATE SCHOOL
BETHEL UNIVERSITY

BY
SARAH KUCERA
YEN NGUYEN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTERS OF SCIENCE IN PHYSICIAN ASSISTANT

JANUARY 2016

BETHEL UNIVERSITY

Dietary Supplements: A Consumer Profile Of Knowledge And Use

Sarah Kucera and Yen Nguyen

July 2016

GRADUATE RESEARCH APPROVAL

Wallace Boeve

Wallace Boeve, EdD, PA-C

Lisa Naser

Lisa Naser, MS, PA-C

ABSTRACT

Alternative medicine, in the form of dietary supplements, is appealing to Americans. Supplements have been marketed as being natural promoters of general well-being, healing, and disease prevention. Even with minimal regulation and research, the majority of supplement use is self-prescribed, fueling an industry last estimated at $32.5 billion in 2012.

The study explored the degree of consumer knowledge with regards to regulation, appropriate indications and dosages, and potential adverse effects of various dietary supplements. The study also sought to evaluate the relationship between supplement knowledge and demographic information as well as the extent of discussion about supplement use with a provider, if any.

The instrument utilized was a novel survey developed by the researchers of this study. Surveys were distributed at CHI Saint Alexius Health and Dakota Community Bank in Bismarck, North Dakota.

Data analysis revealed a <50% knowledge level among all populations surveyed. The extent of provider discussion was also minimal. No significant relationship was found between supplement users' demographic data and their level of knowledge. Among all groups surveyed, no significant correlation appeared to exist between their level of knowledge and their extent of discussion with a provider.

ACKNOWLEDEMENTS

We would like to acknowledge faculty committee members Dr. Wallace Boeve, EdD, PA-C, and Lisa Naser, PA-C for their time and support as well as Dr. Donald Hopper, Ph.D, for his assistance and statistical expertise.

We will also acknowledge CHI Saint Alexius Health of Bismarck, North Dakota, for allowing us to access their patient population and Dakota Community Bank and Trust of Bismarck, North Dakota, for allowing us access to their customers.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter One: Introduction

Introduction

More than half of American adults use dietary supplements (Bailey, Gahche, Miller, Thomas, & Dwyer, 2013). As a result of consumers' increased interest in "natural" healing modalities, dietary supplements have flooded the market, many with little scientific evidence concerning proper indications, dosages, and adverse effects.

Despite the lack of scientific evidence regarding their efficacy, United States (US) investments in herbal supplements alone have amounted to billions of dollars, last estimated at $32.5 billion in 2012 (Garcia-Cazarin, Wambogo, Regan, & Davis, 2014). Further, dietary supplements have little regulation, so consumers cannot always be sure they get what they pay for.

The study analyzed supplement users' level of knowledge regarding the regulation of dietary supplements as well as proper indications, appropriate dosages, and potential risks associated with dietary supplements. The study also analyzed the extent of patient-provider communication regarding dietary supplements.

Background

The majority of supplement use in the US is self-prescribed (Thompson & Nichter, 2007). Many people receive their information regarding supplements from the media. In a survey conducted by Marinac et al (2007), 75% of people reported having heard information related to dietary supplements within the last month. In that study, 73% of people reported a television source, 30% reported magazine and radio sources, 13% reported newspaper sources, eight percent reported friends, and five percent reported store displays.

Vitamin and herbal supplements are widely used by the US population for reported reasons such as promoting good health, alleviating arthritis, improving memory, and prophylaxis for colds and osteoporosis (Kaufman, Kelly, Rosenberg, Anderson, & Mitchell, 2002). A small percentage of users report that they either do not know why they take supplements or that they take supplements for no reason (Kaufman et al., 2002). Further, some consumers purchase dietary supplements as a means of delaying unaffordable medical care (Avogo, 2008), but this approach may be less cost-effective than they imagine. Additionally, some persons' usage of herbal medicine stems from their dissatisfaction with the effectiveness and safety of conventional allopathic medicines (Alissa, 2014).

While there is a wealth of evidence that dietary supplements are effective in preventing and treating nutritional deficiencies, little evidence exists regarding their efficacy in preventing or treating diseases (National Institutes of Health [NIH], 2012). Consumer willingness to take a dietary supplement is perhaps compounded by the perception that products derived from natural sources means those products are pure and not harmful (Kaptchuk & Eisenberg, 1998). However, in the realm of dietary supplements, natural does not mean safe. (NIH, 2012). Potential risks are involved with supplement use, including adverse reactions from excessive doses and prescription drug interactions.

Excessive dosage of dietary supplements has both health and financial implications. For example, excessive Vitamin D intake has been associated with anorexia, weight loss, heart arrhythmias, and even hypercalcemia, which can put consumers at increased risk for damage to the heart, blood vessels, and kidneys (NIH,

2012). In other cases, excessive doses of certain vitamins or minerals are simply excreted from the body, thereby providing no effect. Thus, it is neither medically beneficial nor cost-effective to take dietary supplements without education regarding one's current body stores (especially in the case of Vitamin D) or appropriate dosing.

The US Food and Drug Administration (FDA) does not strictly regulate herbs and supplements. Although the manufacturing facilities are registered and inspected by the FDA, dietary supplement manufacturers are not required to demonstrate safety or efficacy of their products before they are sold to consumers, as per the Dietary Supplement Health and Education Act passed by Congress in 1994 (Ventola, 2010). The lack of regulation and standardization results in variability in safety, quality, purity, and potency of supplements (Kunle, Egharevba, & Ahmadu, 2012). For example, the pharmacologic activity of a plant can vary according to where it was grown, when it was harvested, and how it was stored (Crone & Wise, 1998). Researchers have reported that measured levels of compound concentration in dietary supplements varied and did not match labeled concentrations. Additionally, pharmacologic activity cannot be guaranteed (Harkey, 2001).

As herbs are considered pharmacologically active compounds, concerns exist regarding adverse effects and interactions with prescription and nonprescription pharmaceuticals (Alissa, 2014). For example, St. John's wort is used to treat mild to moderate depression but has been shown to inhibit cytochrome P450 (CYP) enzymes as well as contribute to serotonin syndrome when used with other serotonergic drugs (Shi & Klotz, 2012). Clinical studies have shown interaction of St. John's wort with imatinib, warfarin, voriconazole, buspirone, omeprazole, tacrolimus, and simvastatin, among many

others (Shi & Klotz, 2012). Therefore, clinicians must inquire about patients' use of dietary supplements, especially those receiving cardiovascular, immunosuppressant, or antiretroviral therapy (Alissa, 2014).

Unfortunately, most patients do not discuss their usage of alternative medicine with their physicians. In one survey (Eisenberg et al., 2001), over half of patients either did not believe it was important for their physician to know of their supplement use or reported that their physician never asked. Nearly a third believed that their use of alternative medicine was not the physician's business, and some believed that the physician would not understand their reasons for supplement use (Eisenberg et al., 2001). In another survey of primary care physicians (Tarn et al., 2014), of all conversations regarding supplement use in the office, only 28% included how to take the supplement, 17% discussed potential risks, and 17% discussed efficacy. The study conducted by Tarn et al. (2014) concluded that it is likely that more provider-patient communication is needed to adequately inform patient decisions about supplement use.

Of the extensive number of herbal and dietary supplements available, many are taken without definitive scientific evidence for efficacy and safety. The following list of supplements (to be used in this study) was curated based on popularity as established by the literature review. A spectrum of supplements was chosen, from commonly-used Vitamin D to less popular cinnamon. In choosing both widely used and less frequently used supplements, consumer knowledge regarding both necessity and appropriate use of each will be tested. The supplements in this study include the following:

1. Vitamin D
2. Conezyme Q10 (CoQ10)

3. Fish oil
4. Garlic
5. St. John's wort
6. Cinnamon
7. Magnesium

Vitamin D, fish oil, and St. John's wort were chosen because they are popular yet pose potential threats. Excess Vitamin D intake can be toxic (Pazirandeh & Burns, 2014). Fish oil may increase bleeding risk and decrease immunity (Zelig & Rigassio-Radler, 2012), while St. John's wort has potential drug interactions (Shi & Klotz, 2012). Garlic and CoQ10 also pose risks for consumers. Garlic can thin the blood, and CoQ10 can both lower blood pressure and increase clotting (Zelig & Rigassio-Radler, 2012). Cinnamon is commonly self-prescribed to prevent insulin resistance and decrease inflammation; however, evidence shows that cinnamon does not prevent exacerbation of metabolic disorders (Soare, Weiss, Holloszy, & Fontana, 2014). Excess magnesium intake has serious risks, including hypotension, urine retention, depression, arrhythmias, and cardiac arrest (Musso, 2009).

Problem Statement

Dietary supplements are easily accessible and widely used by American consumers. Often, supplements are consumed with scant evidence regarding appropriate indications and efficacy. Supplements are also consumed without sufficient knowledge regarding potential side effects and risks. Finally, supplement use is seldom discussed with healthcare providers. Consumers must be aware of the potential risks of supplement use as well as appropriate supplement indications and dosages. Consumers must discuss

their interest in supplements with a healthcare provider before usage, especially those consumers concurrently taking prescription medications. Further, providers must educate themselves regarding dietary supplements so they are able to appropriately advise their patients.

Purpose of the Study

The purpose of this study was to determine whether consumers of dietary supplements are knowledgeable regarding FDA regulation of dietary supplements, appropriate indications, and any potential risks involved with dietary supplement consumption, including drug interactions. The study also established how consumers determine their supplement dosages and what aspects of supplement use, if any, were discussed with their healthcare provider.

Significance of the Study

The study has significance for both potential and current dietary supplement consumers as well as both aspiring and current healthcare practitioners. Consumers may use the study as a means of self-education in terms of indications and risks related to dietary supplement use. Further, the study may encourage patients to discuss their supplement use with clinicians.

The study also establishes a platform for providers to discuss supplement use with their patients during routine physicals. It may also prompt providers to further research dietary supplements to increase their own level of understanding regarding the indications, appropriate dosages, benefits, and risks of dietary supplements.

Finally, the findings from the study may prompt further research into the efficacy, appropriate dosage and duration, and potential risks (side effects, drug interactions) related to dietary supplements.

Research Questions

To gain insight concerning dietary supplement use of surveyed populations, the research instrument (survey) was designed to answer the following inquiries:

1. To what degree, if any, are supplement users knowledgeable regarding the regulation, appropriate indications and dosages (as determined by literature review), and potential adverse effects of dietary supplement use? What relationship, if any, exists between supplement users' demographic data and their knowledge of the aforementioned factors?
2. To what extent, if any, do supplement users discuss their dietary supplement use with healthcare providers? What relationship, if any, exists between supplement users' level of knowledge regarding dietary supplements and their extent of discussion of dietary supplements with healthcare providers?

Definitions

Dietary supplements: Dietary supplements are defined by the FDA as products that contain one or more of the following: a vitamin, a mineral, an herb or other botanical, an amino acid, a substance to supplement the diet by increasing the total dietary intake, and/or a concentrate, metabolite, constituent, or extract (FDA, 2016).

Supplement use: Participants were asked to report data regarding supplements they *currently* took at the time of the survey.

Healthcare provider: The healthcare provider will be defined as a certified Physician Assistant (PA-C), Nurse Practitioner (NP), Medical Doctor (MD), or Doctor of Osteopathy (DO) in any specialty.

Knowledgeable: Whether survey participants were considered knowledgeable regarding supplement use was determined by their overall survey score for all of the supplements they take. The survey instrument was comprised of questions that did have correct answers; the more questions a respondent answered correctly, the more knowledgeable he or she was considered regarding that supplement.

Summary

Dietary supplements are easily accessible and widely used by American consumers. Despite the evidence that they are effective for treating nutritional deficiencies, little evidence exists regarding their efficacy in treating other diseases. Supplement users, especially those taking prescription medications, must be aware of their potential side effects as well as drug interactions. They must also be aware of appropriate dosages, as excess supplement concentrations either provide no benefit or cause harmful side effects. Supplement users must discuss their consumption with their healthcare providers before beginning a regimen.

The study assessed consumers' knowledge level regarding appropriate indications and potential risks of dietary supplement use. The study also evaluated the degree to which consumers discuss their dietary supplement use with their healthcare providers.

Chapter 2: Literature Review

Introduction

The following literature review will consist of a history of dietary supplements, current regulation practices for the manufacturing and monitoring of dietary supplements, consumer knowledge regarding regulation, common sources of information for supplement consumers, and the extent of provider-patient communication regarding supplement use. The literature review will also present information regarding indications, efficacy, appropriate dosages, and adverse effects of the supplements to be included in the study. Current research lacks adequate long-term randomized controlled trials studying the efficacy of supplements for commonly reported indications. Further, little research exists regarding consumers' multi-faceted level of knowledge regarding dietary supplements, including their regulation, indications, appropriate dosages, and potential adverse effects.

History of Dietary Supplements

Herbal medicine is regarded as the oldest form of healthcare and has been historically used in all cultures (Barnes, Anderson, & Phillipson, 2007). Physical evidence for early herbal use dates back to 60,000 B.C. with Neanderthals (Solecki, 1975). Throughout history, humans have relied on nature for health, using plants as a resource for food, clothing, shelter, and medicine. By trial and error, early humans distinguished ineffective or harmful plants from those with beneficial effects and developed methods of processing and combining plants to yield optimal results (Kunle, Egharevba, & Ahmadu, 2012).

Knowledge of herbal medicine passed on through millennia has become the knowledge base for today's traditional medicine. In fact, herbs are still the most central form of medicine in some communities, which may be due to poverty and inaccessibility to modern medicine (Kunle et al., 2012).

Today, dietary supplements are legally defined as products that are intended to supplement the diet. They are distinguished from pharmaceuticals in that they are not intended to prevent, diagnose, treat, mitigate, or cure diseases (Bailey et al., 2013). Dietary supplements include vitamins, minerals, herbs, amino acids, extracts, concentrates, and metabolites (FDA, 2016).

Regulation of Dietary Supplements

The Dietary Supplement Health and Education Act (DSHEA) of 1994 claimed dietary supplements were neither food nor drug and thereby allowed manufacturers to sell dietary supplements without evidence of safety or efficacy (Ashar & Rowland-Seymour, 2008). Consequently, companies are not required to determine potential side effects or drug-supplement interactions (Alissa, 2014).

Compounding the concerns regarding safety and efficacy of dietary supplements is the questionable purity and potency of those products. The difficulty of standardizing purity and potency of supplements stems from the source of the supplements. Variability exists in the source and quality of the plants due to differences in climate and soil composition as well as diverse conditions during preparation, storage, and transport (Alissa, 2014; Kunle et al., 2012).

In 2007, the FDA ruled that dietary supplement manufacturers are required to follow Good Manufacturing Practices (GMP) (Ashar, Miller, Pichard, Levine, & Wright,

2008), or pharmaceutical-grade production practices, to ensure products are unadulterated, properly labeled, and have consistent identity, purity, strength, and composition (FDA, 2014). Although the FDA performs audits to ensure the conduction of GMP, it does not test supplements before they are sold. However, supplement manufacturers can send their products to be tested for purity and potency. Those marked with the seals of the National Safety Foundation (NSF) or United States Pharmacopeia (USP) have undergone this testing and should be recommended over supplements with no such seals (Ashar et al., 2008).

Marketing of Dietary Supplements

The FDA allows structure/function claims on the labels of dietary supplements but forbids the inclusion of health claims without FDA approval. A structure/function claim describes the role of a product in maintaining the structure or function of the body, while health claims describe the effect of the product on disease prevention (FDA, 2013). Manufacturers must include on the label a disclosure that the product is not intended to treat, prevent, or cure specific diseases (Denham, 2011).

Manufacturers are allowed, however, to imply health benefits in the titles of their products (for example, "Cold-Away" and "Migraine-B-Gone") (Peterson, 2014). Consequently, consumers often interpret the structure/function claims as "thinly veiled health and disease claims" (Thompson & Nichter, 2007), which can result in the replacement of medications that have been thoroughly tested for safety and efficacy (Denham, 2011).

Despite the regulation of claims, dietary supplement companies often market their products as drugs. In 2010, the Government Accountability Office (GOA) performed an

audit of online retailers and gathered claims of dietary supplements "treating, preventing, and curing conditions such as diabetes, cancer, and cardiovascular disease" (Denham, 2011). One retailer suggested garlic supplements could replace hypertension medication, while another stated ginkgo biloba could treat Alzheimer's disease, depression, and impotence (Denham, 2011).

Finally, many consumers are unaware of the regulation practices regarding dietary supplements. In one survey in which participants were shown an advertisement for a dietary supplement, 52% were unaware that the FDA did not test the supplement for safety or efficacy (Ashar & Rowland, 2008).

Dietary Supplement Consumer Profile

Currently about half of American adults report using one or more dietary supplements (Bailey et al., 2013). These American consumers are often Caucasian, well-educated, and employed. A large proportion of these individuals are young to middle-aged females and are aware of the importance of a healthy lifestyle (Crone & Wise, 1998). Use among ethnic populations is typically associated with cultural beliefs and/or practices (Crone & Wise, 1998).

Consumers are inundated with information regarding dietary supplements. In one survey (Marinac et al., 2007), 75% of people reported having heard information related to dietary supplements within the last month. In that study, 73% of people reported a television source, 30% reported magazine and radio sources, 13% reported newspaper sources, eight percent reported friends, and five percent reported store displays (Marinac et al., 2007). In a qualitative study conducted by Thompson and Nichter, 20% of surveyed participants reported being skeptical of printed sources of information regarding

dietary supplements, while 35% trusted information from friends and family, and 23% credited their own "experimental" use as the most important factor in determining whether to take (and how to take) a supplement (Thompson & Nichter, 2007).

Consumer-Reported Indications for Dietary Supplement Use

Those who are dissatisfied with or those who cannot access conventional medicine are more likely to use supplements (Avogo, 2008). Such practices are especially prevalent in patients with chronic conditions or life-threatening prognoses such as cancer, human immunodeficiency virus (HIV), Alzheimer's disease, and chronic fatigue syndrome; herbal medicines become attractive when conventional medicine fails to yield the desired outcome (Crone & Wise, 1998).

Consumers are enamored by the language of alternative medicine, as it sounds person friendly and holistic (Kaptchuk & Eisenberg, 1998). Consumers often cite the natural healing effects of dietary supplements as reasons for their use; supplements are presumed to be safer and more mild than pharmaceuticals (Ashar et al., 2008). Supplements are easily accessible and often inexpensive and provide a means for consumers to be proactive regarding their health; in fact, many consumers believe supplements have curative effects that can be obtained without the hassle of healthcare appointments, lifestyle changes, and/or procedures (Ashar et al., 2008).

Many of the most commonly reported reasons for supplement use are more likely to be driven by individual perceptions of efficacy than by scientific evidence of efficacy (Blendon, Benson, Botta, & Weldon, 2013). Consumers most commonly report dietary supplement use to "improve" (45%) or "maintain" (33%) their overall health (Bailey et al., 2013). Though the National Institutes of Health (NIH) currently recommends dietary

supplement use only for alleviating nutritional deficiencies (NIH, 2012), only 22% of supplement users cite this as their primary reason for consuming supplements (Bailey et al., 2013). Further, a small percentage of consumers report that they do not know why they are taking supplements (Kaufman et al., 2002).

Supplement Efficacy

Little research exists regarding the efficacy of dietary supplements for disease prevention, management, or treatment in well-nourished populations (Bailey et al., 2013). Studies measuring specific health parameters (such as blood pressure) have been too short in duration to obtain information on primary outcomes for conditions such as cancer and heart disease (Bailey et al., 2013).

Bailey et al. conclude that the epidemiologic study of supplement use in disease prevention and health promotion is rendered difficult by the inability to disentangle supplement use from other health-seeking behaviors (Bailey et al., 2013). However, further trials studying the safety and efficacy of dietary supplements may not dramatically impact the industry. In a study by Blendon et al., 75% of dietary supplement users claimed they would be "minimally influenced by government statements contradicting the efficacy claims of supplement manufacturers" (Blendon et al., 2013). Consumers' beliefs in self-prescribed vitamins are "unshakable" and solidified by skewed perceptions of scientific facts while contrary evidence is overlooked (Apple, 1996).

Appropriate Dosage and Adverse Effects of Supplements

The literature contains a vast amount of evidence regarding pharmacologic activity in dietary supplements as well as potential interactions when taken with prescription medications (Alissa, 2014).

The combined use of dietary supplements and drugs may increase or reduce the effects of either by affecting pharmacokinetics and/or pharmacodynamics (Alissa, 2014). Synergistic effects may lead to toxicity by affecting organ systems, receptor sites, and enzymes (Alissa, 2014), while antagonistic effects may lead to reduced efficacy and therapeutic failure (Hu et al., 2005). The risk for drug interactions also increases with the number of products (drugs and supplements) consumed (Alissa, 2014).

Marinac et al. (2007) suggested that dietary supplement consumers may be unaware of potential adverse drug reactions. Their research concluded that 66% of people believed that dietary supplements "pose no risk to the general population" (Marinac et al., 2007). However, in this same survey, 12 dietary supplement consumers had potential drug interactions. Two participants were taking garlic along with aspirin, despite evidence that garlic poses an increased bleeding risk, and five were taking gingko biloba, known to have anti-platelet and anticoagulant effects, along with aspirin or non-steroidal anti-inflammatory drugs (NSAIDs).

Some dietary supplements can also cause toxicity when consumed in excess, as reviewed below. In one study, 23% of consumers tailored their supplement regimens experimentally or essentially viewed the suggested dosages on the labels as general guidelines and consumed more or less as they deemed necessary (Thomspon & Nichter, 2007).

Supplement Review

The following paragraphs summarize current literature regarding indications, appropriate dosages, and potential adverse reactions of the supplements in the study. The

discussion regarding the choice of these particular supplements can be found in Chapter 1.

Vitamin D. Vitamin D is a fat-soluble vitamin synthesized by the body and provided by very few foods. It requires several enzymatic conversions to the active form for use. Vitamin D is involved in calcium homeostasis and bone metabolism and is therefore considered necessary for good health (Pazirandeh & Burns, 2014; Bikle, 2012). It functions to promote enterocyte differentiation and intestinal calcium absorption. Other actions include some promotion of intestinal phosphate absorption, suppression of parathyroid hormone release, regulation of osteoblast function, and bone resorption (Pazirandeh & Burns, 2014).

The Institute of Medicine (IOM) set recommendations for vitamin D intake based on the beneficial effects of calcium and vitamin D on skeletal health (IOM, 1997). The recommended daily allowance per the IOM for persons ages one-70 is 600 international units (IU) or 15 micrograms (mcg) daily. For adults over 70 years of age, the recommended daily dose is 800 IU (20 mcg). Intake can be dietary or supplemental. As dermal synthesis of vitamin D varies by individual and environment, the IOM assumed minimal sun exposure.

A tolerable upper level intake (UL) as defined by the IOM is the maximum level at which toxic effects are unlikely to occur. The UL for vitamin D, is 4,000 IU (100 mcg) for children ages nine-18, healthy adults, and pregnant and lactating women.

Toxicity usually occurs after inappropriate intake, often in fad dieters consuming "megadoses" or in those on vitamin D replacement therapy. Sun exposure does not cause toxicity (Pazirandeh & Burns, 2014). Symptoms of acute toxicity such as confusion,

polyuria, anorexia, vomiting, and weakness result from hypercalcemia. Chronic toxicity can cause nephrocalcinosis and bone demineralization and pain (Pazirandeh & Burns, 2014).

A study by Schwartz (2009) has shown that vitamin D interacts with atorvastatin. By activating CYP3A, vitamin D reduces the bioavailability of atorvastatin. Paradoxically, vitamin D also lowers low density lipoprotein (LDL) and total cholesterol levels (Schwartz, 2009). Studies have also shown that vitamin D deficiency may be a risk factor for the development of tuberculosis (TB) (Sheng et al., 2015). Anti-tuberculosis drugs, namely isoniazid (INH) and rifampin (RIF) affect cytochrome P450 enzymes, which are responsible for the hydrolysis of vitamin D. The same research has shown that RIF alone or in combination with INH induces renal and hepatic hydroxylation of Vitamin D, ultimately leading to elevated serum 25-hydroxyvitamin, D3, a major metabolite.

Coenzyme Q10 (CoQ10). CoQ10 is a potent antioxidant, and reduced levels have been reported in Parkinson's disease. Low CoQ10 levels have also been associated with worse heart failure outcomes, but this is more likely because low CoQ10 is a marker rather than predictor of advanced heart failure (Dennehy & Tsourounis, 2012). CoQ10 supplement consumers have reported use for heart failure, hypertension, angina, and Parkinson's disease (Bailey et al., 2013).

Three studies have shown CoQ10 can reduce both systolic and diastolic blood pressure (by 11 and seven mm Hg, respectively), but the methods of these studies, including adequate randomization and blinding, have been questioned (Dennehy & Tsourounis, 2012). CoQ10 has also been shown to improve ejection fraction by 3.7% in

patients not using an angiotensin converting enzyme (ACE) inhibitor (Dennehy & Tsourounis, 2012). CoQ10 may also have benefits in coronary artery disease and chronic stable angina, as it has been associated with improvements in lipoprotein a, high-density lipoprotein (HDL), exercise tolerance, and time to development of ischemic changes on stress testing (Dennehy & Tsourounis, 2012).

Adverse effects of CoQ10 supplements are rare. Less than 1% report gastrointestinal (GI) upset, maculopapular rash, thrombocytopenia, irritability, dizziness, and headache (Dennehy & Tsourounis, 2012). CoQ10 is structurally similar to vitamin K and can therefore interfere with warfarin and decrease the international normalized ratio (INR), so those on warfarin should avoid CoQ10 supplements or be carefully monitored (Dennehy & Tsourounis, 2012). A daily dosage of 30 milligrams (mg) is adequate, but studies have suggested 100-600 mg/day may be needed for cardiac effects (Dennehy & Tsourounis, 2012).

Fish oil. Fish oil is commonly taken to lower blood pressure and triglycerides and to prevent heart disease and stroke (Zelig & Rigassio-Radler, 2012). Systolic blood pressure reduction by two mm Hg has been estimated to cause a 10% lower stroke mortality. Diastolic blood pressure reduction by five mm Hg can reduce the risk of stroke by about one third and coronary heart disease by one fifth (Campbell, Dickinson, Critchley, Ford, & Bradburn, 2013).

In addition to lowering blood pressure, fish oil may also reduce arterial stiffness. Reducing both the hypertension and vessel stiffness risk factors, which are associated with cognitive decline, may benefit heart and brain health (Pase et al., 2015). Some have

suggested that cognitive benefits stem from improved cardiovascular health; others suggest improved cerebral perfusion and blood-brain barrier integrity (Pase et al., 2015).

Pase et al. (2015) sought to determine the effects of fish oil on cognitive function in terms of reaction time, cognitive processing speed, short-term memory, and visual memory. Other goals included determining fish oil effects on aortic stiffness, aortic blood pressure, and red blood cell fatty acid levels. These researchers showed that the treatments had no effect on primary cognitive endpoints but noted that increases in omega-3/6 ratio were associated only with improved spacial working memory response time. Those subjects receiving six g of daily fish oil had a reduction in aortic pulse pressure and aortic augmentation pressure. These vascular effects were not associated with consistent improvements in cognitive performance.

Campbell et al. performed three meta-analyses which found small, statistically significant reductions in both systolic blood pressure (two to four mm Hg) and diastolic blood pressure (two–2.51 mm Hg) among hypertensive fish oil consumers (Campbell et al., 2013). The meta-analysis did not show statistically significant blood pressure reduction in normotensive patients. Campbell's study concluded that, given the modest blood pressure effects of fish oil, treatment with pharmaceuticals approved for hypertension is recommended (Campbell et al., 2013). Further, Bailey et al. performed two meta-analyses that found fish oil supplementation had little or no benefit in preventing the risk of major cardiovascular disease events or all-cause mortality (Bailey et al., 2013).

Fish oil supplements are generally well tolerated (Zelig & Rigassio-Radler, 2012). However, excess intake may result in immunosuppression, prolonged bleeding time, and

increased risk of hemorrhagic stroke. Thus, patients at increased risk for infection or those taking immunosuppressives, warfarin, or aspirin should consult with a physician before consumption (Zelig & Rigassio-Radler, 2012). No current data establishes a safe upper limit, but the FDA has endorsed up to two grams (g)/day from a dietary supplement FDA, 2004). The general recommended daily intake is 500 mg (Opperman, 2013).

Garlic. Garlic is commonly used by individuals with hypertension, high cholesterol, and heart disease (Zelig & Rigassio-Radler, 2012). Garlic has also been reported to have immune-enhancing and antimicrobial effects and is therefore commonly used by HIV patients to prevent opportunistic infections (Hu et al., 2005). For potential benefits, garlic supplements should contain 1.3% alliin or have alliin-generating potential of 0.6%.

Cumulative data regarding the efficacy of garlic shows the herb can improve total cholesterol and triglycerides but not high-density lipoprotein (HDL) or low-density lipoprotein (LDL). However, it may not reduce cholesterol to a clinically significant extent (Dennehy & Tsourounis, 2012). Studies also show garlic has anti-platelet effects and can work as a fibrinolytic agonist. Thus, garlic may provide benefit in those with atherosclerosis (Dennehy & Tsourounis, 2012). The antimicrobial effect of garlic is not well studied, so its usefulness is limited, especially due to the availability of effective antimicrobial agents (Dennehy & Tsourounis, 2012).

Adverse effects associated with garlic consumption include GI upset, allergic reactions, hypotension, and bleeding. Breath and body odor are reported by 20-40% of garlic supplement consumers (Dennehy & Tsourounis, 2012). Due to its anti-platelet effects, garlic should be avoided or used cautiously by patients taking warfarin,

ibuprofen, and aspirin (Zelig & Rigassio-Radler, 2012). Garlic has also been shown to decrease the serum concentration of saquinavir, an anti-viral HIV drug (Hu et al., 2005).

A dosage of 600-900 mg/day is common for powdered garlic; this is equivalent to one fresh garlic clove per day. (Dennehy & Tsourounis, 2012).

St. John's Wort. St. John's wort is commonly taken to alleviate depression and has been shown to be more efficacious than placebo and equivalent to low-dose antidepressants in the treatment of mild to moderate depression (Dennehy & Tsourounis, 2012).

The herb, however, has some serious adverse effects, including mania, anxiety, and insomnia (Peterson, 2014). It can also cause photosensitization, so consumers should be advised to wear sunscreen and eye protection (Dennehy & Tsourounis, 2012). St. John's wort should not be used by pregnant or lactating women, as it may induce abortion and cause lethargy in infants (Peterson, 2014).

St. John's wort also has various potential drug interactions, as it induces many CYP enzymes (3A4, 2C9, 1A2) and P-glycoprotein (Dennehy & Tsourounis, 2012). St. John's wort has been shown to decrease the levels of warfarin, statins (Ashar et al., 2008), tacrolimus, cyclosporine, (Hu et al., 2005), oral contraceptives, HIV protease and non-nucleotide reverse transcriptase inhibitors, theophylline, and anticonvulsants (Dennehy & Tsourounis, 2012). Because it potentially inhibits neurotransmitter uptake, it should not be taken with drugs with a similar mechanism of action, including antidepressants and stimulants, due to the risk of serotonin syndrome (Dennehy & Tsourounis, 2012).

The appropriate dosage for antidepressive effects is 900 mg daily. St. John's wort may take two to four weeks for effect, and effects beyond 12 weeks have not been studied (Dennehy & Tsourounis, 2012).

Cinnamon. Often used as a spice, cinnamon has also been used to treat headaches, dyspepsia, wounds, inflammation, nausea, and diarrhea (Natural Medicines Comprehensive Database [NMCD]). Cinnamon has been considered a natural treatment for type two diabetes by controlling blood glucose levels, but randomized controlled trials have shown no significant difference in hemoglobin A1c or serum insulin levels between cinnamon and placebo groups (Delahanty & McCulloch, 2014; Leach & Kumar, 2012).

Cassia cinnamon, a specific type of cinnamon used in some supplements, contains coumarin, which is a hepatotoxic compound (Ballin & Sorensen, 2014). Coumarin doses of 50-700 mg have been known to cause reversible hepatotoxicity (Howard & White, 2013).

The NMCD considers cinnamon intake to be safe if the dosage remains within the one to six g/day range. Long-term intake of high doses is potentially unsafe (Howard & White, 2013). Although hepatotoxicity is unlikely with the recommended supplement dosage, concern still exists due to the coumarin content, especially in those at risk for liver disease (NMCD, 2014).

Regarding drug interactions, a case report analyzed by Brancheau, Patel, and Zughaib (2015) demonstrated the risk of hepatotoxicity when cinnamon is taken concomitantly with a statin (Brancheau et al., 2015).

Magnesium. Magnesium is an intracellular cation that is essential for enzymatic functions, deoxyribonucleic acid (DNA) transcription and replication, messenger ribonucleic acid (mRNA) translation, bioelectric-activity, ionic pumps, and calcium-channel function.

Normal magnesium body content is about 22.6 g, 50%-60% of which is stored in the bone (Musso, 2009). The recommended magnesium intake for adults is approximately 420 mg/day for men and 320 mg/day for women (Musso, 2009).

Magnesium is clinically used to treat asthma, pre-eclampsia, and coronary arteriopathy (Musso, 2009). In the form of supplements, magnesium can be used to treat mild cases of hypomagnesemia but may cause diarrhea (Musso, 2009).

Symptomatic hypermagnesemia due to excessive intake occurs when serum magnesium levels exceed four to six mg/deciliter (Musso, 2009). Toxicity can manifest as hypotension, nausea, vomiting, facial flushing, urinary retention, ileus, depression, and lethargy. In severe cases, symptoms can progress to flaccid skeletal muscular paralysis, hyporeflexia, bradyarrhythmia, respiratory depression, and cardiac arrest (Musso, 2009).

Magnesium has various types of interactions with many classes of medications. Decreased drug effectiveness is seen with allopurinol, aspirin, azithromycin, cefdinir, ciprofloxacin, levofloxacin, doxycycline, fexofenadine, gabapentin, iron, levothyroxine, sucrasulfate, and tetracycline (Yetley, 2007). Decreased plasma drug concentration has been noted with digoxin and atazanavir (Yetley, 2007). Increased risk of bleeding has been noted with succinylcholine and vecuronium and increased risk of adverse drug effects with dicumarol (Yetley, 2007). Hypotension may occur with felodipine (Yetley,

2007). The risk of QT prolongation is also increased with levomethadyl, and increased serum drug levels have been noted with tacrolimus (Yetley, 2007).

Provider-Patient Communication

Most dietary supplement consumers use supplements by personal choice (77%) rather than due to the advice of their healthcare provider (23%) (Bailey et al., 2013). Additionally, national surveys have shown that approximately 40% of adults typically do not disclose their use of alternative medicine to their physicians (Eisenberg et al., 2001). Of these adults, 60% agreed to both statements "it is not important for the doctor to know" and "the doctor never asked" (Eisenberg et al., 2001). About a third felt that alternative medicine use was "none of the doctor's business" and/or that "the doctor would not understand," while 14% expressed concern that their physician would "disapprove of" or "discourage" their alternative medicine use (Eisenberg et al., 2001). Two percent felt their doctor would discontinue being their provider (Eisenberg et al., 2001).

Patients seek reliable information about supplements amidst many confusing claims, and they desire a partnership with their clinicians, who they hope are knowledgeable about dietary supplements and general nutrition (Eliason, Huebner, & Marchand, 1999). Patients have reported the best conversations with clinicians regarding alternative medicine were those in which the provider had a sense of ambivalence and told the patient to continue using a supplement if the patient was comfortable with it (Eliason et al., 1999).

Clinicians should be aware of available resources, including web databases and clinical pharmacists, that can assist in protecting patients from potential adverse effects.

Clinicians should also monitor for physiologic response to dietary supplements (Ashar et al., 2008). Response, or lack thereof, should be discussed with patients so they can make an informed decision to continue taking the same supplement, try a different brand, or abandon its use altogether (Ashar et al., 2008).

Summary

Dietary supplements are currently used by over half of Americans despite the lack of adequate scientific evidence regarding efficacy. Most dietary supplement users acquire information regarding supplements from media and lay sources (friends and family) rather than from healthcare providers or published clinical trials. Further, most do not disclose their supplement use to their healthcare providers. Many commonly used supplements may interact with drugs, especially anti-platelet and anticoagulation medications.

The study served to elucidate the gaps in knowledge of dietary supplement consumers regarding regulation practices, appropriate indications, and potential adverse effects. The study may also prompt clinicians to encourage their patients to disclose alternative medicine practices as well as offer nonjudgmental education and advice.

Chapter Three: Methods

Introduction

The purpose of the study was to determine whether consumers of dietary supplements are knowledgeable regarding FDA regulation of dietary supplements and appropriate indications and any potential risks involved with dietary supplement consumption, including drug interactions. The study also sought to establish how consumers determine their supplement dosages and what aspects of supplement use, if any, were discussed with their healthcare provider. The research questions addressed in the study included the following:

1. To what degree, if any, are supplement users knowledgeable regarding the regulation, appropriate indications and dosages (as determined by literature review), and potential adverse effects of dietary supplement use? What relationship, if any, exists between supplement users' demographic data and their knowledge of the aforementioned factors?
2. To what extent, if any, do supplement users discuss their dietary supplement use with healthcare providers? What relationship, if any, exists between supplement users' level of knowledge regarding dietary supplements and their extent of discussion of dietary supplements with healthcare providers?

The purpose of this chapter is to discuss the methods used to conduct the research project. The following sections will be covered in this chapter: study design, study site, sample population, instrumentation and procedure, data analysis, reliability and validity, dispensation of data, and limitations and delimitations regarding the study.

Study Design

The study design was pre-experimental; more specifically, it was a one-shot case study. In a one-shot case study, a group of respondents is identified based on pre-existing criteria, in this case, supplement use. Respondents were administered a packet which included a survey informed consent form (Appendix A), survey instructions (Appendix B), and the survey (Appendix C). Hospital laboratory staff and bank employees distributed surveys to potential participants, asking them to complete and return the packet. No treatment was imposed on the subjects, nor were any other measurements taken.

Study Site

The surveys were distributed at CHI St. Alexius Health outpatient laboratory in Bismarck, North Dakota. A letter of intent for research affiliation with CHI St. Alexius Health can be found in Appendix D. Surveys were also distributed to customers of Dakota Community Bank and Trust in Bismarck, North Dakota. A letter of intent for research affiliation with this institution can be found in Appendix E.

Population

Participants were required to be age eighteen or greater and could be either gender and any ethnicity. The survey was available to all consumers age eighteen or greater but was completed on a voluntary basis.

Inclusion criteria included consumers who were current supplement users, ages eighteen or greater. The survey instructions served to clarify the list of supplements about which participants were asked. The instructions stated that if the participant did not currently take any of the listed supplements, he/she was not eligible for the study.

Therefore, criteria for exclusion were those consumers who did not *currently* take any of the listed supplements at the time of the survey as well as those who did not fully complete the survey. However, survey questions regarding supplements not taken by the participant could be left unanswered; as long as the participant answered all the questions pertaining to at least one supplement that he/she currently took, his/her survey was scored.

In order to detect a meaningful difference with a standard deviation of two, at least 20 subjects were needed for each group analyzed (see Data Analysis, page 29). Because ANOVA was utilized to analyze differences among respondents with different levels of education, three groups were required, so at least 60 participants were needed. Therefore, the researchers of the study had a goal sample size of 75 completed surveys.

Instrument and Procedure

The study's researchers developed the survey tool; no previously developed instrument questions were used. The survey consent form, instructions, and instrument were reviewed to determine whether each was understandable to the target population. The panel of reviewers included a physician, two registered nurses, and an administrative director, all who regularly work with the population surveyed. After review, the documents were edited to meet all suggestions to achieve readability and understandability. The survey layout was changed from a two-page format to the current format that utilizes one page for each supplement, and the definition of "dose" was included to ensure respondent comprehension of the word.

The research instrument was a survey that was distributed in a packet with an informed consent document and instructions. Questions in the survey assessed participant

knowledge of regulation, indications, and risks associated with specific supplements. The survey also contained questions regarding supplement dosage and discussion of use with a provider. The survey also collected demographic data including gender, age, and level of education. No unique identifying information was collected, such as name, date of birth, or contact information.

The surveys were distributed at CHI St. Alexius Health outpatient laboratory by receptionists upon appointment check-in. Seven surveys were completed by the CHI St. Alexius patient population over the course of eight weeks, so the researchers sought an additional population to increase the sample size. The researchers secured an affiliation with Dakota Community Bank and Trust in Bismarck, North Dakota. "Good Neighbor Loyalty Club" representatives, employed by the bank, distributed the surveys to senior travel club members during a bus trip. See Appendix F for this research addendum. The researchers of the study personally collected all completed surveys.

Data Analysis

The researchers of the study developed a scoring system for the survey. General questions (found on the demographic information page) and survey questions one, two, three, four, and six were scored. Responses associated with inappropriate supplement knowledge or use as determined by the literature review received a score of zero. Responses demonstrating knowledge or use that was supported by the literature received a score of one. A detailed description of the scoring system is found in Appendix G.

The percentage of respondents who answered each general question correctly was reported in order to quantify the overall knowledge level of the population regarding general supplement knowledge.

Mean scores for knowledge level and extent of provider discussion were calculated for each demographic group. Regression analysis was utilized to determine whether a statistically significant correlation existed between each demographic group and the level of knowledge. P values and R^2 values were implemented to establish or reject a relationship.

Regression analysis was also utilized to determine whether a relationship existed between the knowledge score and extent of provider discussion. A respondent's score (out of five points) was one variable, while the second variable was the extent of their discussion with a provider (out of four points). Because the highest score possible for knowledge level was five, and the highest score possible for extent of provider discussion was four, a one-point change was considered statistically meaningful.

Unpaired *t* tests were used to analyze mean differences and establish relationships via P-values between knowledge levels and extent of provider discussion among different demographic groups.

ANOVA (rather than regression analysis) was used to compare the means of knowledge level as well as provider discussion scores in different age groups, as there were more than two groups. The calculated P-values and confidence intervals assisted in determining whether the difference across the age groups was statistically significant.

Reliability and Validity

Since all subjects received the same questionnaire, every measurement was consistent and could be reproduced; it was therefore reliable. Similar questions were reviewed for consistency of responses as a measure of survey reliability. Intrarater and instrument reliability were not of concern, as the survey was standardized. However, as

interrater reliability relies on the respondent adhering to the task (fully completing the survey), this was effectively controlled by eliminating those surveys that were not complete. A panel of reviewers evaluated the consent form, instructions, and survey for readability, further enhancing the reliability of the survey instrument.

The study had adequate face validity, as user knowledge was being assessed and analyzed, so the method (survey) was appropriate. Content validity was lacking, as the survey utilized only a few questions and did not encompass all possible aspects of supplement use. Some demographic data was collected, so some data was generalized, allowing for population-related external validity. The survey sought to determine supplement users' level of knowledge and communication with providers. The theory that levels of knowledge vary and may correlate with provider communication was made based on various studies reviewed in the literature, therefore providing construct validity.

Dispensation of Data

The collected data was transferred to a hard drive and placed in the possession of the Bethel University Physician Assistant Program research coordinator. The data will be stored in a secure, locked space. Data will be destroyed in accordance with the policies of the Physician Assistant Program.

Limitations and Delimitations

Limitations included sample size and applicability to the general population. Willingness to participate limited the sample size. Another limitation was that the gathered information could not be generalized to populations to which the survey was not distributed. The survey was also sensitive to temporal threats, since it did not measure past or future supplement use. The research also rendered limitations because data was

self-reported, meaning answers may have been fabricated due to the inability to recall circumstances related to supplement use or due to the desire to conceal truthful information regarding supplement use. Further, many survey participants did not take all supplements listed, so data was limited for less popular supplements. Illiteracy and language barriers were also potential limitations.

A delimitation was that the results could not be generalized to urban populations which are known to be diverse in terms of race, ethnicity, education levels, and socioeconomic status. As the surveys were distributed in the outpatient laboratory of a hospital and a bank, the study likely omitted certain minority populations, such as homeless individuals. Also, as mentioned in the literature review, dietary supplement consumers are often Caucasian, well-educated, and employed. Additionally, a large proportion of supplement users are young to middle-age females. These biases were a threat to the external validity of the study.

As the study evaluated use of only a select few supplements, a delimitation was that the results were not applicable to all supplement users. Some respondent bias could also have existed based on survey question interpretation.

Chapter Four: Results

Introduction

Chapter four contains the results of data analysis. Data is organized according to three main participant groups: gender, age, and education level. Descriptive statistics are first provided for each of these groups regarding trends of supplement consumption. The statistical analysis of the extent of their knowledge regarding supplement use is then described in terms of mean scores; these have been normalized due to varying numbers of supplements used by each responder. Mean scores for the extent of their discussion with a provider are also presented. Finally, correlations are presented for each group regarding their demographic information, knowledge level, and extent of provider discussion.

Calculations

The survey scoring system is described in detail in Appendix G. One point was awarded for each of the general knowledge questions answered correctly, and the maximum score for each supplement consumed was three. Therefore, the total possible knowledge score was five. The total possible provider score was four.

Key terms utilized in this chapter include mean score and mean total score; the mean total score is also reported in percentage form. The mean score for knowledge level was calculated using only the supplement questions and thus did not take into account the general knowledge questions. The value was calculated as the average score per supplement as a means to normalize the data (over a denominator of three). The mean total score incorporated general supplement knowledge (as assessed by the survey's "general supplement questions") in addition to supplement knowledge applicable to all of the supplements consumed by each participant. The value was also normalized (over a

denominator of five). The total score is also presented in percentage form as the total number of correct answers over the maximum number of points possible, depending on the number of supplements taken. The percentage was calculated using the following equation: [(total score + general question score)/(max score for supplements taken+2)] * 100.

Survey Population

Seventy-seven (77) surveys were collected, but 15 were rejected because they were not complete. Some responders failed to supply demographic information, while others failed to answer all of the survey questions about the supplements they took. Therefore, data was analyzed using 62 qualified surveys. Of the 62 qualified participants, 49 (79.0%) were female, and 13 (21.0%) were male. Participants ranged from ages 18 to over 61. The majority of participants were greater than 61 years of age (51 participants, or 82.3%). One participant was 18-25 years of age (1.6%), two were 26-40 (3.2%), two were 41-50 (3.2%), and six were 51-60 (9.7%). Also, the majority of participants' highest level of education was a high school graduate (41 participants, or 66.1%). Twenty-one (33.9%) had either an associate's or bachelor's degree.

Population Description: Gender

The supplements analyzed in this study included vitamin D, fish oil, coenzyme Q10, St. John's wort, garlic, cinnamon, and magnesium. For each gender, all but one participant used vitamin D (48/49 females and 12/13 males) (Figure 1). Fish oil was the next most commonly used supplement, consumed by 28 (57%) females and 11 (84%) males. In descending order of use behind vitamin D, female participants used coenzyme Q10 and magnesium equally at 24% each (12/49). Twenty percent of females used

cinnamon (10/49), 14% used garlic (7/49), and St. John's wort was the least commonly consumed supplement (6%, 3/49). Forty-six percent (6/13) of males used coenzyme Q10. Cinnamon and magnesium were each consumed by 30% (4/13) of respondents. Garlic was used by 23% (3/13), and St. Johns wort was consumed by eight percent (1/13).

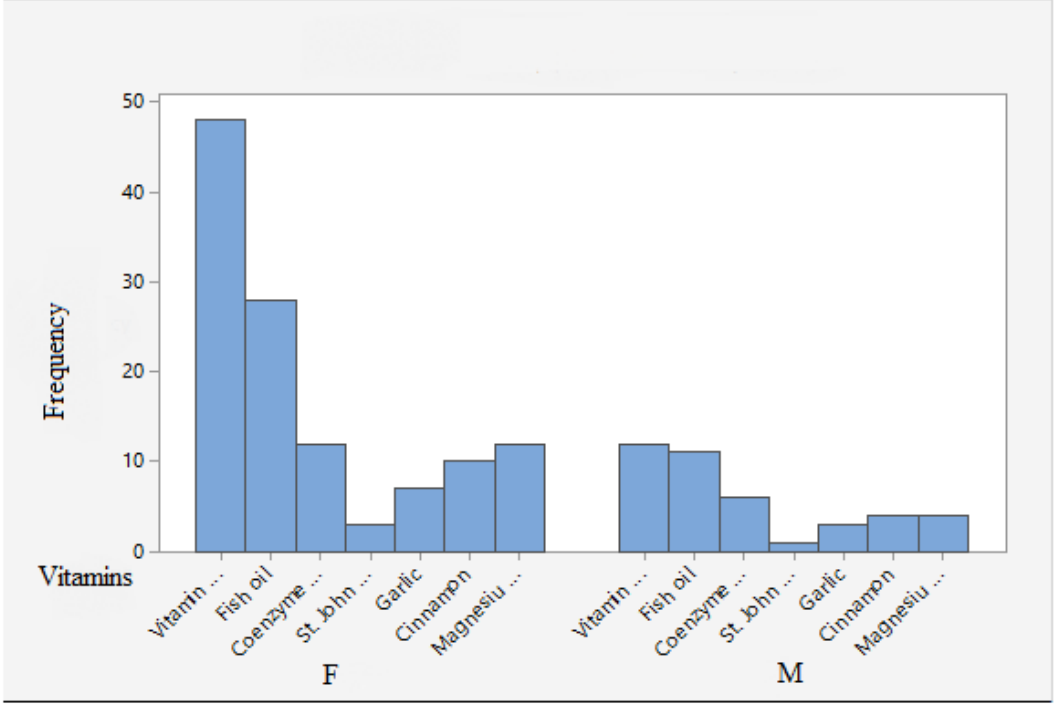

Figure 1. Gender and Suppplement Frequency. F: frequency; M: males. Shows number of participants reporting use of each supplement. Of the 62 participants, 49 were male and 13 male.

Supplement Knowledge Based on Gender

The mean knowledge score per supplement was similar between both genders, males scoring 1.25 (41.7%, StDev 0.75) and females 1.59 (53.0%, StDev 0.61). The mean total knowledge score, including the general knowledge score, was 1.63 (over a total of five) (31.2%, StDev 1.33) for males and 2.16 (43.6%, StDev 1.06) for females. The mean score as a percentage for males was 35.3% (StDev 24) and females 46.0% (StDev 19.6) (Figure 2).

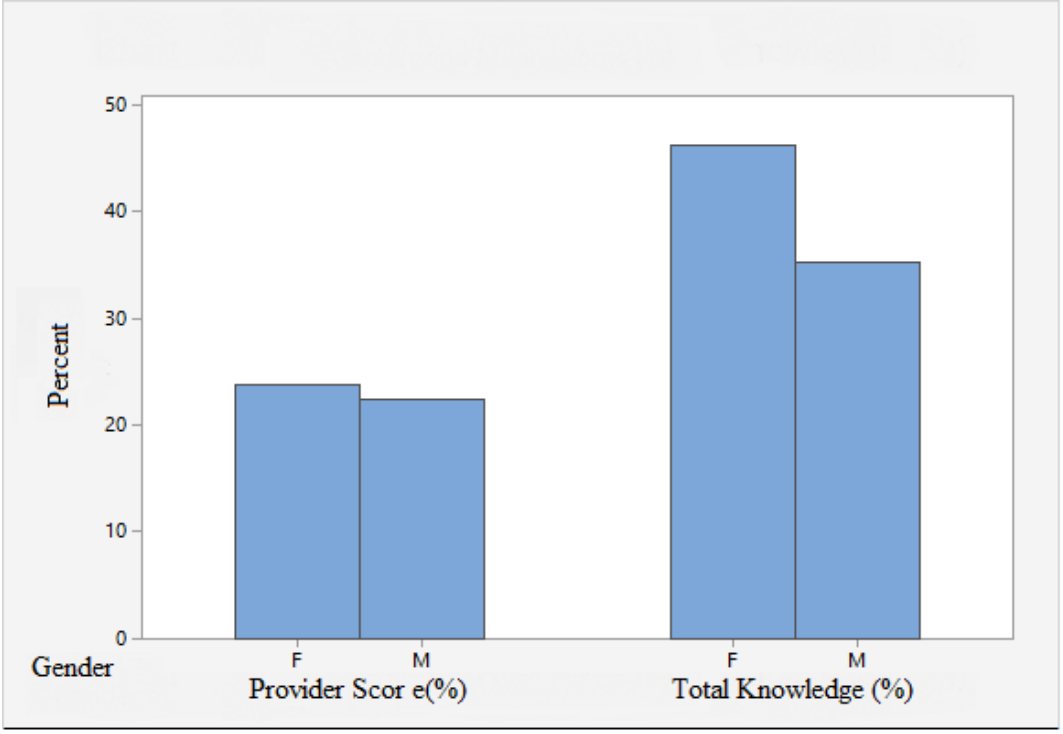

Figure 2. Gender and Mean Scores (%). F: female; M: male

Provider Discussion Based on Gender

The maximum number of points for the provider score per supplement was four. Among females, the mean score per supplement was 0.95 (StDev 0.7030); among males, it was 0.89 (StDev 0.9419). The mean scores in percentage from, labeled as the provider score (%), were 23.7% (StDev17.58) for females and 22.32% (StDev 23.55) for males (Figure 2).

Correlations Based on Gender

Regression analysis using gender versus knowledge level revealed a P-value of 0.0925 (R^2 4.64%) (Figure 3). A simple regression analysis studying provider discussion score and knowledge level (%) yielded high P-values for each gender: female 0.1501 (R^2 4.27%) and male 0.4820 (R^2 5.06%).

Figure 3. Gender and Total Knowledge (%). Fitted line plot. 0.0: female; 1.0: male. P-value: 0.0925

Population Description: Age

Responders were of limited age variation. The largest group of participants was the >61 age group, which contained 51 respondents. The supplement use trend was analyzed for the largest age group (>61); descending order is as follows: 96% used vitamin D, 65% fish oil, 29% coenzyme Q10, 25% magnesium, 24% cinnamon, six percent garlic, and six percent St. John's wort. Other age groups were difficult to analyze, as there was limited data (Figure 4).

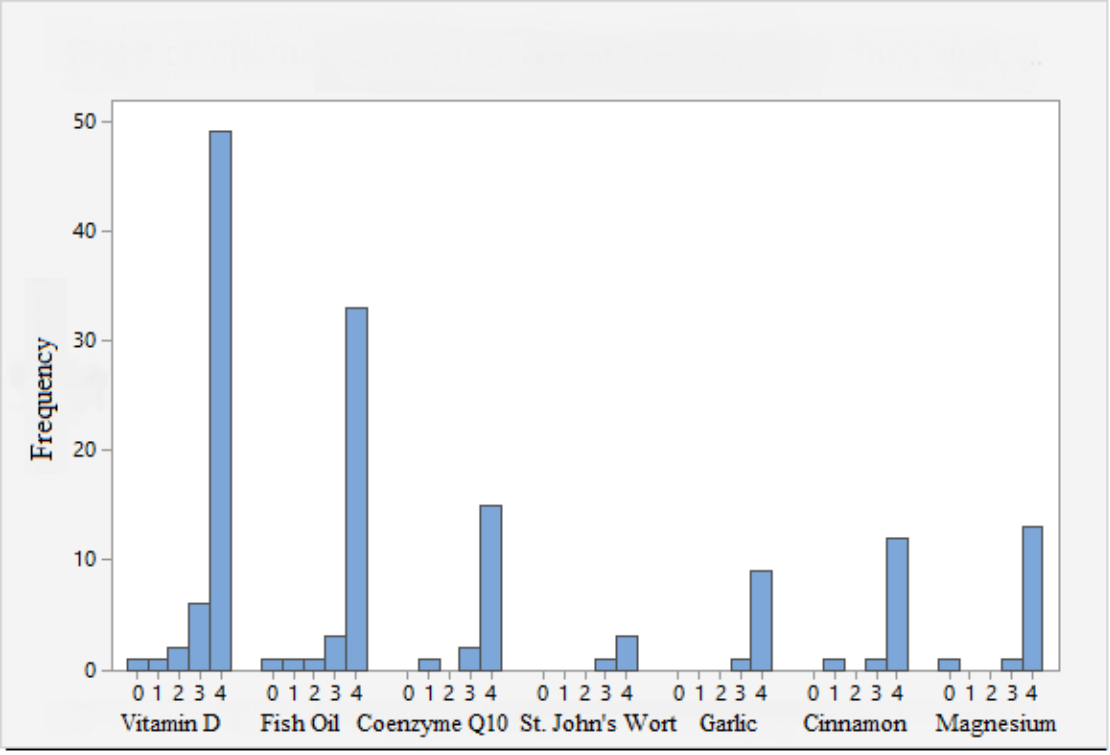

Figure 4. Age and Supplement Frequency. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group.

Supplement Knowledge Based on Age

The mean knowledge score, over a maximum of three, for ages 18-25 was 2.0 (67%, StDev 0). The age 18-25 group contained only one participant. The second highest average knowledge score was 1.57 (52.6%, StDev 0.43) among those in the 51-60 age group; this group consisted of six participants. The average score for ages >61 was 1.54 (51.3%, StDev 0.66); this group consisted of 51 participants. The lowest average scores were found in age groups 26-40 and 41-50. The average score in each of these groups was 1.0 (33%); both groups consisted of two participants. Ages 26-40 had a standard deviation of 1.4, while ages 41-50 had a standard deviation of 0.

The mean total score was calculated over a maximum of five. Values and corresponding standard deviations can be found in Table 1. Calculated total knowledge in percent can be found summarized with a graphical representation in Table 2 and Figure 5.

Table 1

Statistical Summary of Age and Mean Total Knowledge

Age Coding	N	Mean	StDev
0	1	2	0
1	2	1	0
2	2	2.000	2.828
3	6	1.9127	0.8006
4	51	2.1108	1.1346

Note. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group. Maximum score: 5. Calculations include general supplement knowledge.

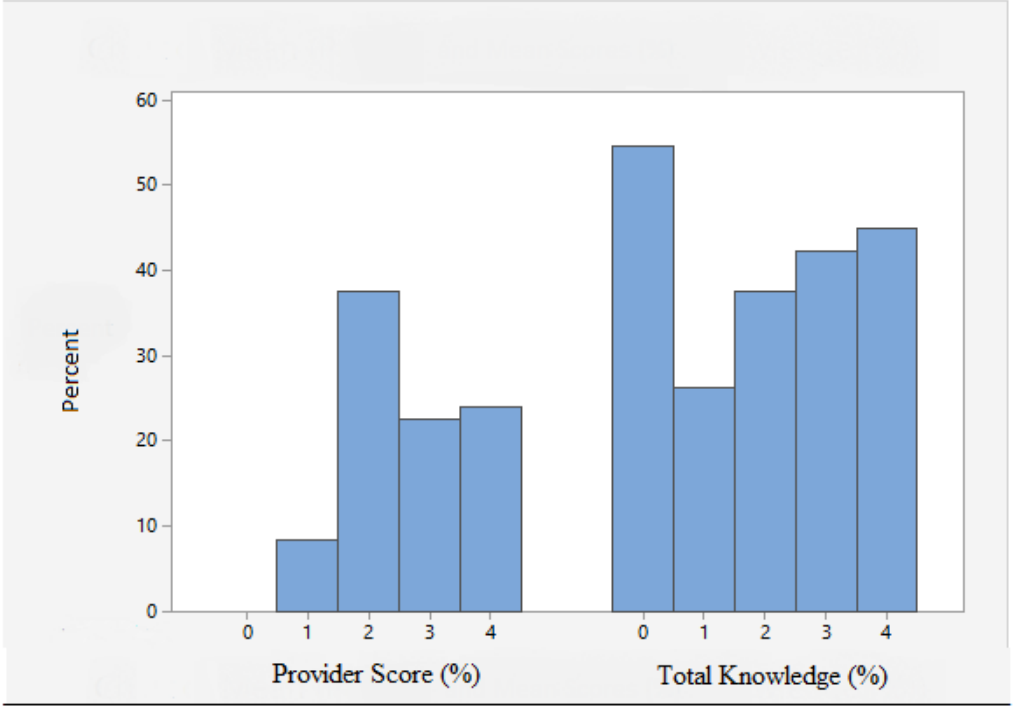

Figure 5. Age and Mean Scores. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group. Values refer to percentage of correct responses.

Provider Discussion Based on Age

The maximum provider score per supplement was four. The average value for each participant was calculated and used to calculate the average value for the corresponding age group. The 18-25 age group did not score any points. The 26-40 age group scored a mean of 0.33 (StDev 0.47), the 41-50 age group scored 1.50 (StDev 0.71), the 51-60 age group scored 0.90 (StDev 0.70), and the > 61 age group scored 0.96 (StDev 0.76).

Percentage of correct provider responses was also calculated, and the means were compared. Values can be found in Table 2 and graphical representation in Figure 6. As seen in Figure 6, wide confidence intervals (CI) are observed in the 18-25, 26-40, and 41-50 age groups and a narrow CI in the >61 age group. Additionally, a P-value of 0.41 was produced.

Table 2

One-Way ANOVA: Age vs. Provider Score (%)

Age Coding	N	Mean	StDev	95% CI
0	1	0	*	(-37.5802, 37.5802)
1	2	8.333	11.785	(-18.240, 34.907)
2	2	37.50	17.68	(10.93, 64.07)
3	6	22.520	17.627	(7.178, 37.862)
4	51	24.048	19.011	(18.785, 29.310)

Pooled StDev = 18.7670

Note. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group.

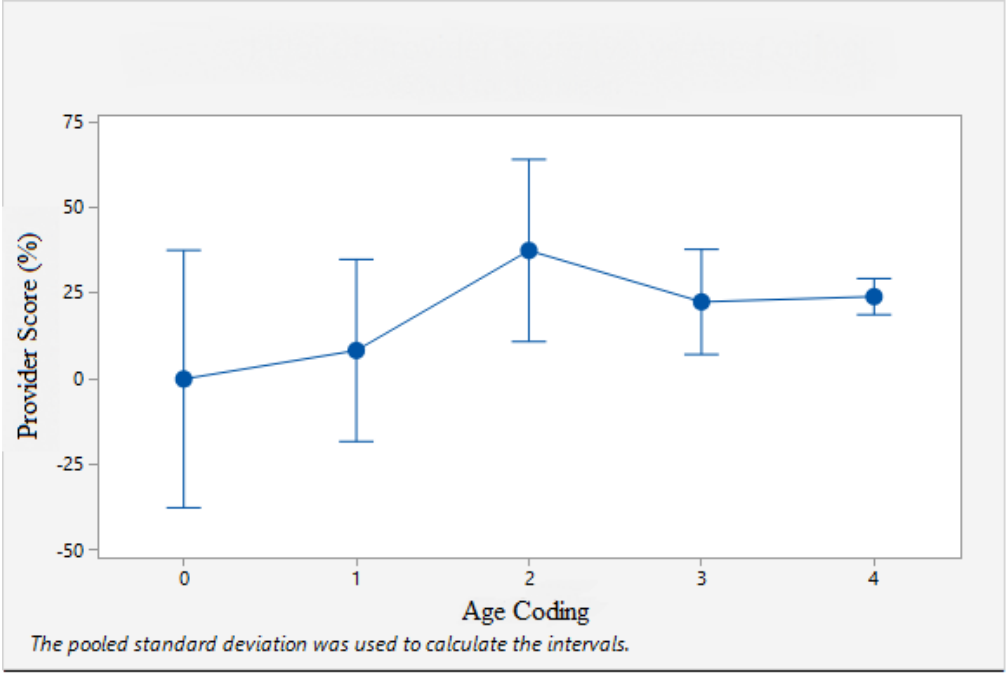

Figure 6. One-Way ANOVA: Age and Provider Score (%). Interval plot of age and provider score (%) with 95% confidence interval (CI) for the mean. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group. Values refer to percentage of correct responses.

Correlations Based on Age

ANOVA was used to determine the differences in extent of knowledge among age groups (Table 3 and Figure 7). A P-value was obtained for analysis of total knowledge (P-value 0.74, R^2 3.35%). To note is the wide CI for the 18-25, 26-40, and 41-50 age groups and a narrow CI for the >61 age group.

Table 3

One-Way ANOVA: Age vs. Total Knowledge (%)

Age Coding	N	Mean	StDev	95% CI
0	1	54.5455	*	(11.8941, 97.1968)
1	2	26.136	1.607	(-4.023, 56.295)
2	2	37.50	53.03	(7.34, 67.66)
3	6	42.238	16.514	(24.826, 59.650)
4	51	44.914	20.823	(38.942, 50.887)

Pooled StDev = 21.2994

Note. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group.

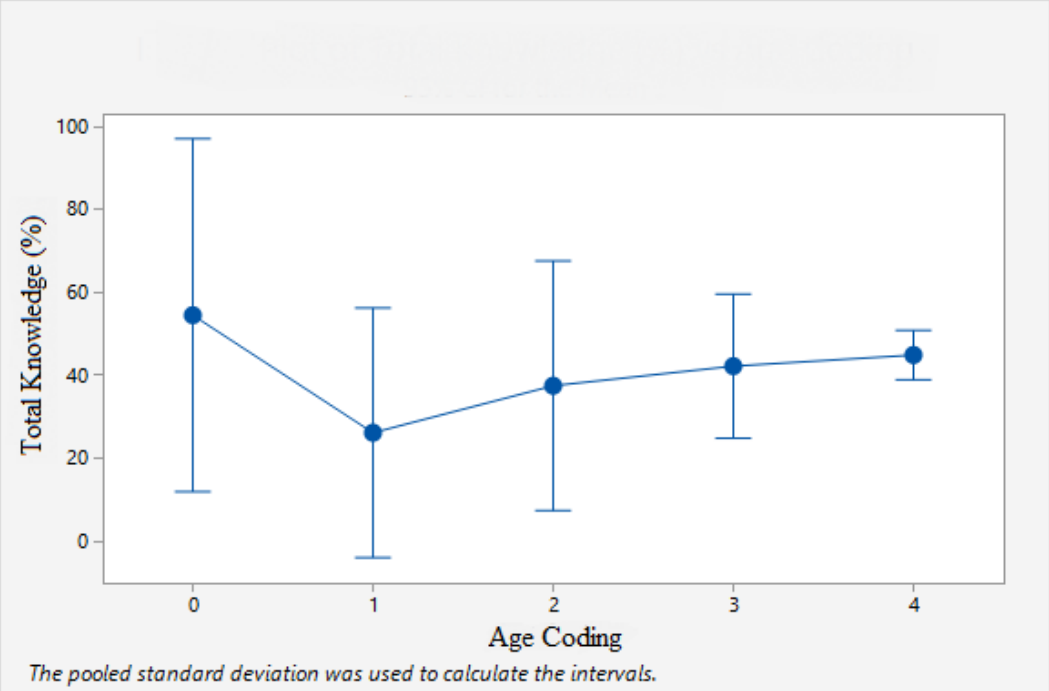

Figure 7. One-Way ANOVA: Age and Total Knowledge Score (%). Interval plot of age and total knowledge (%) with 95% confidence interval (CI) for the mean. 0: 16 - 25 age group; 1: 26 - 40 age group; 2: 41 - 50 age group; 3: 51 - 60 age group; 4: >61 age group.

For each age group, the total knowledge score (%) was studied for possible correlation with the total provider score (%). As with knowledge score analysis, there was insufficient data for the 18-25, 26-40, and 41-50 age groups. Regression analysis of the 51-60 age group revealed a P-value of 0.27 and R^2 of 28.91% (Figure 8). A higher P-value of 0.98 was obtained with the >61 age group, accompanied by an R^2 of 0.00% (Figure 9).

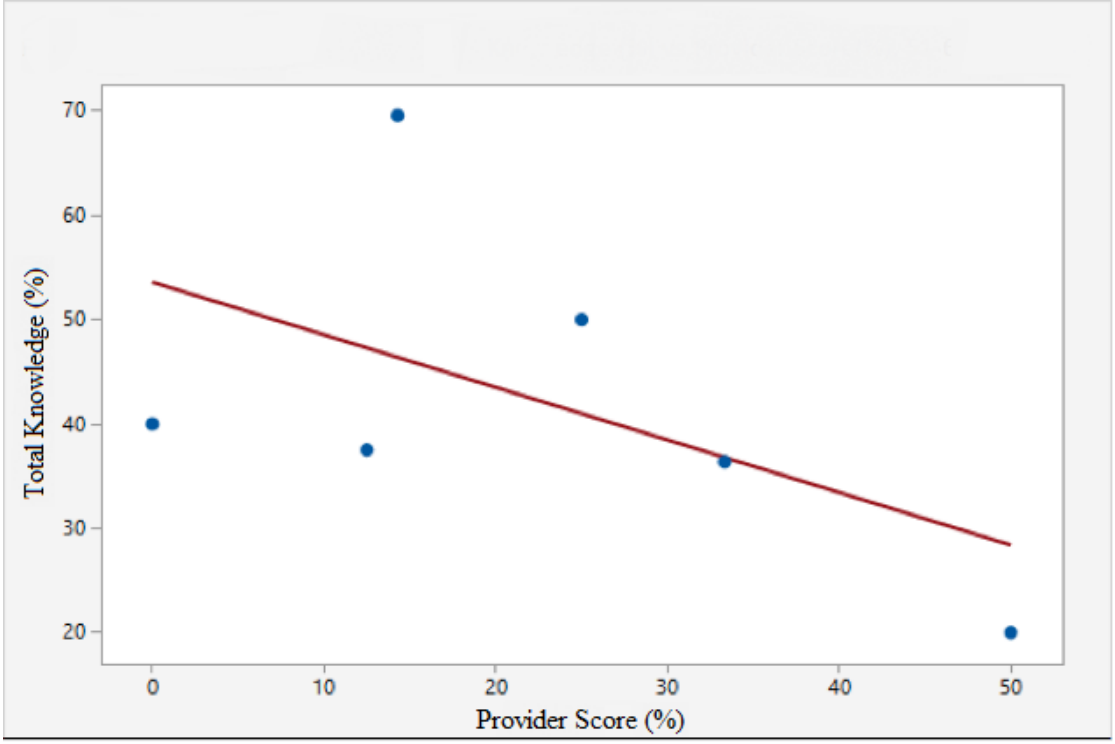

Figure 8. Total Knowledge (%) vs Provider Score (%), 51 - 60 age group. Fitted line plot. P-value 0.27

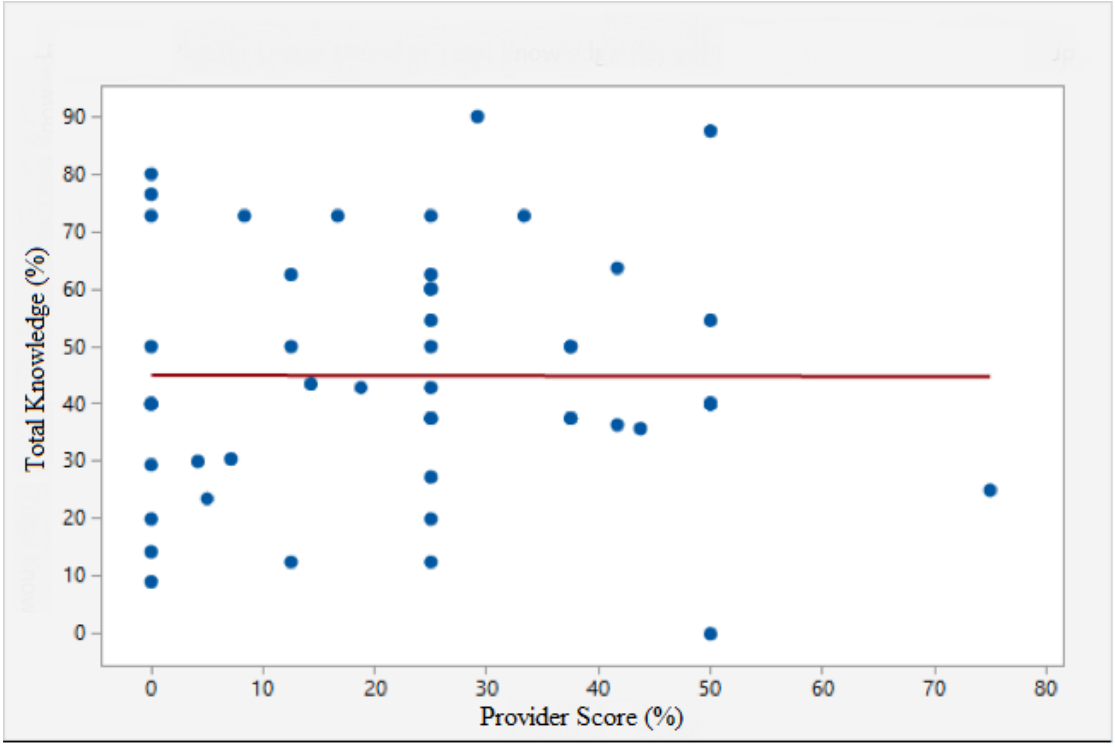

Figure 9. Total Knowledge (%) vs. Provider Score (%), >61 age group. Fitted line plot. P-value: 0.98.

Population Description: Education

Among the possible education categories, all participants were either in the high school graduate (HS) or associate's/bachelor's degree (AS/BS) groups. Of the 62 participants, the majority (41, or 66%) were in the HS group; 21 (34%) were in the AS/BS group.

Among HS graduates, 96% took vitamin D, 54% took fish oil, 27% took coenzyme Q10, 27% took magnesium, 9.5% took cinnamon, 7.6% took garlic, and 3% took St. John's wort. Among those who held AS/BS degrees, 95% took vitamin D, 81% took fish oil, 74% took coenzyme Q10, 41% took magnesium, 33% took cinnamon, 10% took garlic, and five percent took St. John's wort (Figure 10).

In terms of reported use, both groups showed similar patterns of supplement use. In order of decreased use: vitamin D, fish oil, coenzyme Q10, magnesium (at the same frequency as coenzyme Q10 for HS graduates), cinnamon, garlic, and St. John's wort.

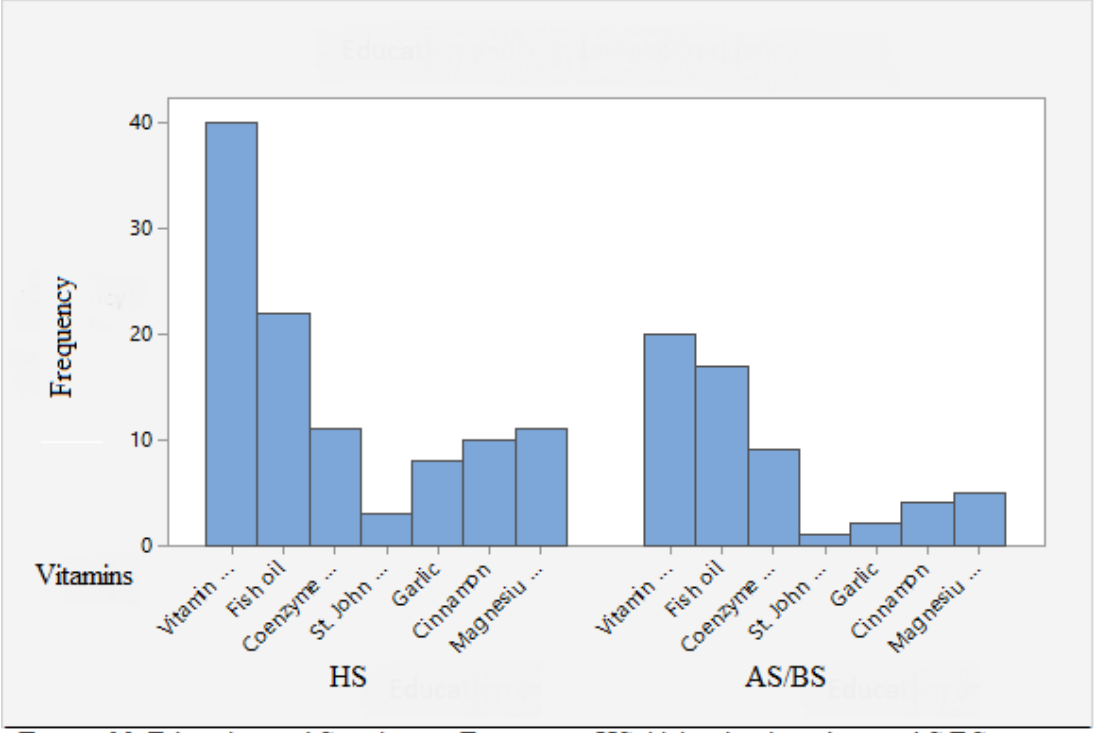

Figure 10. Education and Supplement Frequency. HS: high school graduates; AS/BS: associates or bachelor's graduates

Supplement Knowledge Based on Education

The mean knowledge score over a maximum of three per supplement was 1.50 (StDev 0.62) for HS graduates and 1.55 (StDev 0.72) for AS/BS graduates. The mean total knowledge score for the HS group was 1.99 (StDev 1.00), while AS/BS graduates obtained a score of 2.17 (StDev1.37). The average total knowledge in percent for HS graduates is 42.79% (StDev 18.35) and AS/BS 46.27% (StDev 25.61) (Figure 11).

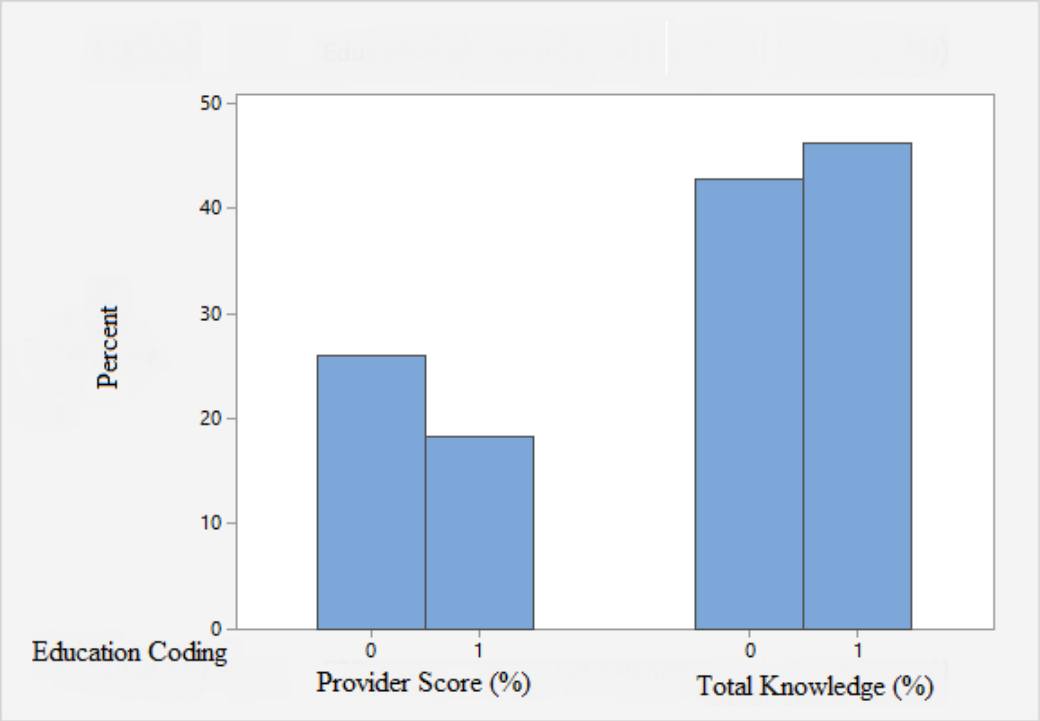

Figure 11. Education and Mean Scores (%). 0: high school graduates. 1: associate/bachelor's graduates

Provider Discussion Based on Education

The maximum score for provider discussion per supplement, written as provider score, was four. High school graduates scored a mean of 1.04 (StDev 0.77) and AS/BS graduates 0.73 (StDev 0.69). The provider score in percentage form was found to be 26.05% (StDev 19.24) for HS graduates and 18.34% (StDev 17.13) for AS/BS graduates (Figure 11).

Correlations Based on Education

Analysis to determine whether a correlation existed between education levels and total knowledge correct (%) revealed a P-value of 0.54 and R^2 of 0.63%. To determine if a correlation existed between provider discussion and knowledge level, a simple regression analysis of HS provider score (%) and total knowledge level correct (%)

revealed a P-value of 0.08 (R^2 7.79%). As for the AS/BS graduates, regression analysis yielded a P-value of 0.18 (R^2 9.43%).

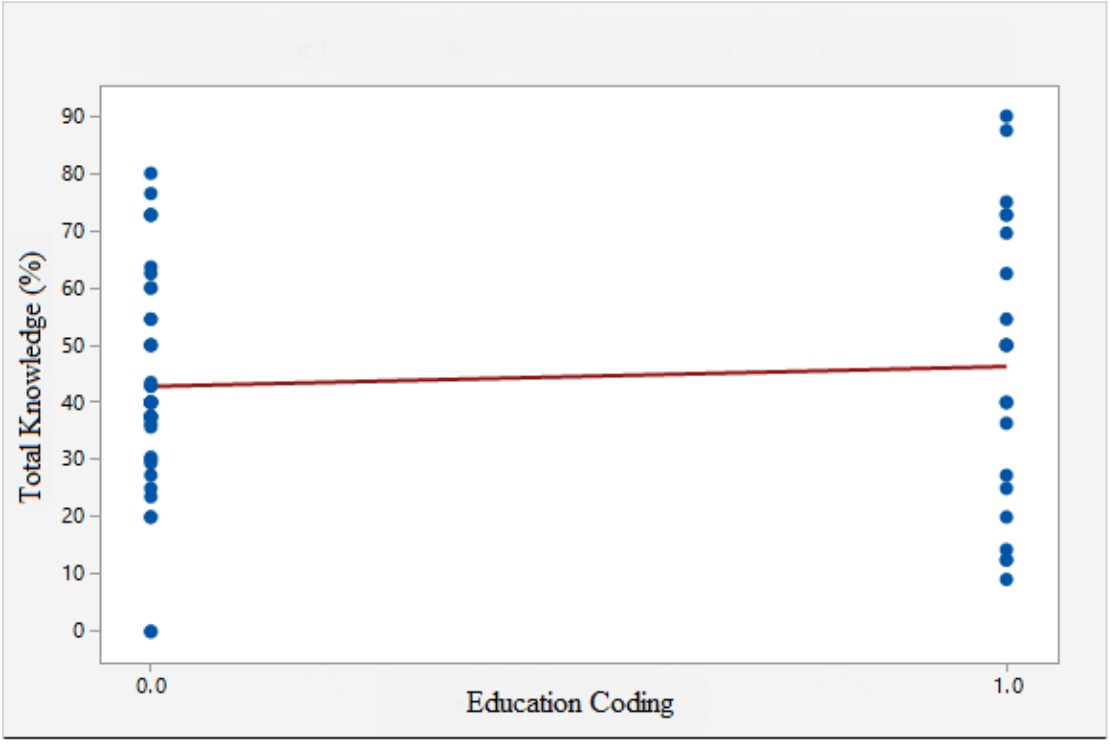

Figure 12. Education and Total Knowledge (%). Fitted line plot. HS: high school graduates; AS/BS: associates/bachelor's graduates. P-value. 0.54.

Additional Analysis

The first of the general knowledge questions received 18/62 (29.0%) correct responses. Question two received 15/62 (24.2%) correct responses. The mean knowledge level was calculated using all of the mean scores obtained in data analysis. The average mean knowledge score was 1.52, the average total knowledge score was 2.05, and the average total knowledge (%) was 43.97%. The average provider score was 0.94, and the average provider score (%) was 23.44%

Further investigation was warranted regarding the provider score (%) and knowledge level (%) in the >61 age group. As previously mentioned, 51 of the 62

participants were >61 years of age. Twelve of the 41 were male, and 29 were female. Both Figures 6 and 7 show narrow CI's for this age group. Among females, the average provider score (%) was 24.0 (StDev 17.74) and total knowledge (%) 48.38 (StDev 18.48). Among males, the mean provider score (%) was 24.18 (StDev 23.58) and total knowledge (%) 22.67 (StDev 24.71). Regression analysis generated a P-value of 0.98, suggesting a lack of correlation between the provider score (%) and gender in the >61 age group. A correlation existed between knowledge level (%) and gender, at a P-value of 0.03 (Figure 13). The limited sample size for the other four age groups was the likely cause for the wide CI's. Thus, these age groups were considered unsuitable for further study.

Figure 13. Gender and Total Knowledge (%), > 61 age group. 0.0: female; 1.0: male. P-value: 0.03.

Summary

In this chapter were the results of data analysis. Descriptive statistics were used to analyze the population; these revealed a lack of variability across each demographic, where 79% of responders were female, 82% were greater than 61 years of age, and 66% were high school graduates. Correlation studies using regression analysis and ANOVA were performed to determine whether relationships existed between demographics and knowledge level as well as knowledge level and extent of discussion with a provider. These studies revealed high P-values except in the case of the >61 age group, in which a P-value of 0.03 was achieved when correlating gender and knowledge level (%). Due to the small sample size in most demographic categories, analysis of provider discussion and knowledge levels was difficult. Chapter 5 includes interpretation of all results noted in Chapter 4 as well as conclusions based on those results.

Chapter Five: Discussion and Conclusions

Introduction

Within this chapter are the conclusions drawn from the data analysis. Once again, this project served to analyze supplement users' knowledge levels and possible correlations with demographics and provider discussion. For the purpose of the study, knowledge is used as a blanket term to include correct understanding of regulation, appropriate indications and dosages, as well as potential adverse effects of supplement use. Additional terms were introduced in the data analysis so as to normalize and place the values into a different perspective.

Demographic Data and General Knowledge

The average participant of this sample of 62 participants was a female over the age of 61 whose highest level of education was a high school graduate. The majority of responders were >61 years of age (51/62 participants). This population was not the result of random sampling; rather, the surveys were distributed to people over age 60 due to convenience and accessibility of that population through Dakota Community Bank. None of the responders had higher than a bachelor's degree. Although employment status was not assessed, the population findings in this study did not agree with those reported by Bailey (Bailey et al., 2013), who found the average American supplement consumer was a young to middle-aged, well-educated, employed individual. However, the survey was distributed primarily to adults >61 years of age, which could explain the discrepancy between this study and previous studies.

The most commonly used supplement was vitamin D, followed by fish oil. Coenzyme Q10, cinnamon, and magnesium were less frequently used, and garlic and St. John's wort were the least commonly consumed supplements.

The majority of participants (71%) were not aware that the FDA does not test dietary supplements for safety and efficacy. A previous study also noted that the majority (52%) of responders were unaware that the FDA did not test supplements for safety or efficacy (Ashar & Rowland, 2008). Further, most participants (75.8%) did not believe that a supplement with the USP seal was superior to a supplement without such seal. Thus, among the supplement users surveyed, a deficit of knowledge regarding the regulation of dietary supplements was apparent.

Supplement Users' Knowledge Level

The first research question addressed in the study was the following: To what degree, if any, are supplement users knowledgeable regarding the regulation, appropriate indications and dosages (as determined by literature review), and potential adverse effects of dietary supplement use?

The mean total knowledge scores (%) were similar among males (35.3%) and females (46.0%). Thus, taking into account all of the factors assessed by the survey, the extent of knowledge among both males and females was less than 50%.

Knowledge scores did not follow any trend in terms of age, as the highest score was in the youngest age group (which consisted of only one participant), but the lowest scores were found in the middle age groups. Calculated knowledge levels in each age group varied from 26.1% to 54.5%, meaning the extent of knowledge was again <50%, with the exception of the 18-25 age group, for which it was still low (<60%). Regarding

knowledge level and education, the AS/BS group scored higher than those in the HS group. However, both groups again achieved a <50% knowledge score, with the HS group at 42.8% and the AS/BS group at 46.3%. Therefore, it appeared that education level did not have a significant effect on the level of participant knowledge.

In assessing knowledge of the overall population surveyed (the mean scores of all demographic groups), the mean knowledge score was 1.52, the mean total knowledge score was 2.05, and the total knowledge (%) was 43.97%. Though the data analysis in the study presented total knowledge scores rather than scores regarding specific aspects of knowledge, the results were in accordance with previous studies that reported a lack of knowledge regarding supplement use. A study by Bailey (Bailey et al., 2013) reported only 22% of supplement users cited nutritional deficiency as their primary indication for supplement use. Further, Kaufman et al. (2002) reported a small percentage of consumers did not know why they took supplements. Another study (Marinac et al., 2007) concluded that 66% of people believed that dietary supplements "pose no risk to the general population," indicating a lack of knowledge regarding potential drug interactions (12 responders in that study had potential drug interactions with the supplements they took). Thus, the overall knowledge score of <50% correlated with a similar lack of knowledge found in previous studies.

Correlation of Demographic Data and Supplement Knowledge

The research question addressed in this section is the following: What relationship, if any, exists between supplement users' demographic data and their knowledge of the aforementioned factors?

The numerical value used to evaluate knowledge level was the total knowledge percent score; this was compared with demographic data. Across the demographic groups, regression analysis yielded high P-values. With gender, the null hypothesis could not be rejected, signifying a lack of relationship between gender and knowledge level, at a P-value of 0.09. Similarly, the level of education did not appear to be a predictor of knowledge level, where the P-value was 0.54. ANOVA analysis among the age categories produced a P-value of 0.744, so the difference in means was not statistically significant. Wide 95% confidence intervals (CI) were also found with the 18-25, 26-40, and 41-50 age groups, where the CI's overlapped, signifying no significant difference. Improved certainty was noted with the >61 age group due to the tighter CI, but once again, age alone did not appear to be correlated with knowledge level. Reviewing the literature, the researchers of the study did not find previous studies that attempted to correlate demographic data with level of knowledge of dietary supplements; therefore, no comparisons could be made to findings of previous studies.

Supplement Users' Discussion with Provider

The following research question is addressed in this section: To what extent, if any, do supplement users discuss their dietary supplement use with healthcare providers?

Key points in the provider discussion, if such an event occurred, included discussion about indications, dosages, and possible drug interactions. Overall, the extent of supplement discussion with providers was low, where the average provider score per supplement was 0.94 over a maximum of four points, and the average score in percent was 23.44%. Among genders, the mean score was similar, and the scores in percentage were within about one percent of that of the general population. In terms of education,

there was more variation. High school graduates scored 1.04 and 26.05%, while the AS/BS group scored 0.73 and 18.34%. Based on these numbers, HS graduates appeared to discuss more with providers than AS/BS graduates, but there is minimal deviation from the overall population scores. Across the age groups, there was more variability, in which the lowest score was 0.00 with a provider percent score at 0% in the 18-25 age group, and the highest score was 1.50 and 37.5% in the 41-50 age group. ANOVA analysis produced a P-value of 0.41, indicating that the difference in values across all age groups was not statistically significant. The analysis also reported wide 95% confidence intervals (CI) for the 18-25, 26-40, and 41-50 age groups, so there was less certainty concerning the mean as opposed to the tighter CI with the >61 age group.

The overall low provider score (0.94/4) correlated with previous studies regarding discussion of supplement use with providers. One previous study concluded 77% of dietary supplement consumers used supplements by personal choice rather than due to the advice of their healthcare provider (Bailey et al., 2013). In another survey (Eisenberg et al., 2001), over half of patients either did not believe it was important for their physician to know of their supplement use or reported that their physician never asked. Another previous study of primary care physicians (Tarn et al., 2014) also noted a lack of patient-provider discussion. In that study, of all conversations regarding supplement use in the office, only 28% included how to take the supplement, 17% discussed potential risks, and 17% discussed efficacy. Included in the overall provider score for the study was a question regarding dosage. A previous study performed by Thompson and Nichter revealed 23% of consumers tailored their supplement regimens experimentally or viewed the suggested dosages on the labels as general guidelines (Thomspon & Nichter, 2007).

Though this study did not present data regarding specific aspects of supplement use discussed with a provider, the results correlated with these previous studies, which noted an overall lack of patient-provider discussion regarding dietary supplement use.

Correlation of Knowledge Level with Provider Discussion

The following research question is addressed in this section: What relationship, if any, exists between supplement users' level of knowledge regarding dietary supplements and their extent of discussion of dietary supplements with healthcare providers?

High P-values were obtained in studying the correlation of knowledge level (%) and provider discussion among males (0.4820) and females (0.1501). P-values obtained from correlation studies between knowledge level (%) and provider discussion were only presented for two age groups (51-60 and >61), as there was insufficient data to obtain P-values from other age groups. Analysis of the 51-60 age group revealed a P-value of 0.27, while a higher P-value of 0.98 was obtained with the >61 age group. Finally, analysis of the education demographic revealed P-values of 0.08 for the HS group and 0.18 for the AS/BS group. Due to these high P-values, no correlations were found between knowledge level and extent of provider discussion for any of the demographic groups studied. Again, the researchers of the study did not find previous studies regarding the correlation of knowledge level with extent of provider discussion, so these results could not be compared with results of previous studies.

Additional Analysis

ANOVA analysis of provider score (%) and total knowledge (%) of the >61 age group revealed a tight confidence interval. An unpaired t-test revealed a correlation between gender and total knowledge (%) in this age group, with a P-value of 0.03;

however, no correlation was found between gender and provider score (%). Gender and age, then, were predictors of total knowledge (%), where females over the age of 61 (n=38) were associated with a higher knowledge level. As other age groups had limited sample size and therefore high variability with overlapping CI's, there was likely no significant difference, so no further analysis was conducted.

Limitations

In scoring the surveys, the researchers found significant inconsistency among many supplement users. Though all supplements have the potential for harmful side effects and drug interactions, those who used more than one supplement commonly reported that some supplements they consumed, but not others, had the aforementioned dangers. Overall correct responses to each survey question could therefore not be tallied and reported in percentage form, due to the variability in each responder's survey answers.

The results of the study cannot be easily applied to all supplement users, as the sample size was small, and the population consisted almost entirely of one demographic group. In comparing means, a minimum sample size of 50 per category analyzed would reveal a more accurate average, while 100 would be ideal. The only category studied that met this minimum was the >61 age group.

Another limitation of the study was that the researchers did not include a demographic option for those participants who did not earn a high school degree; high school graduate was the lowest level of education presented as a choice on the survey. Some participants did not choose a level of education, perhaps for this reason, and therefore were eliminated from analysis.

Recommendations for Further Research

If this study were repeated, the researchers recommend a larger sample size consisting of more varied demographic groups. Ideally, each demographic group would have approximately the same number of participants to avoid results that are weighted toward one specific population.

Further research regarding dietary supplements should focus on one supplement or general supplement knowledge rather than multiple, specific supplements. The survey was broad, and the sample size for those taking some supplements, such as St. John's wort, was small. Further, many potential participants refused to take the survey because they reported it was too lengthy. A shorter, more concise survey may yield a larger sample size.

Conclusions

Based on the available data, supplement users have a <50% knowledge level regarding all aspects of supplement use analyzed with the survey instrument. No significant relationship was found between supplement users' demographic data and their level of knowledge aside from females >61 years of age. Females >61 had a greater level of knowledge, but again due to the small sample size, further study is warranted to validate this relationship. The extent of participants' discussion of supplement use with a provider was minimal, where most provider scoring values hovered at 25% or less for the majority of demographic categories. Finally, among all groups surveyed, there appeared to be no significant correlation between their level of knowledge and their extent of discussion with a provider; this was expected, however, as both their knowledge level and extent of provider discussion were minimal.

In scoring the surveys, the inconsistent responses regarding different supplements taken by a single responder revealed that supplement consumers may be more knowledgeable regarding one supplement than another. Further data analysis could seek to correlate knowledge level regarding a single supplement with provider discussion. Further research could seek to determine the reason for the inconsistencies.

The sample size was small, and most of the data analyzed was from a single population of supplement users, namely those >61 years of age. Little data was available from other age groups and across varying levels of education, so the data regarding other demographics is less significant. Therefore, in repeating this study, an effort should be made to garner a larger population and perhaps focus on one commonly used supplement rather than multiple supplements at once.

Because the researchers developed a novel survey instrument, some aspects of this study could not be directly related to previous studies. Literature review did not reveal previous studies that sought to correlate demographic data with knowledge level or knowledge level with provider communication. Further, the data analysis for this study resulted in overall knowledge scores rather than individual scores for each aspect of supplement knowledge and discussion analyzed. Overall knowledge scores were obtained due to the varied responses for each supplement taken by a single survey respondent. However, overall analysis correlated with previous studies that revealed a lack of knowledge regarding supplement regulation, appropriate indications and dosages, and potential adverse effects. The study also correlated with previous studies that noted a lack of discussion with a healthcare provider regarding dietary supplement use.

REFERENCES

Alissa, E. M. (2014). Medicinal herbs and therapeutic drugs interactions. *Therapeutic Drug Monitoring, 36*(4), 413-422. doi:10.1097/FTD.0000000000000035 [doi]

American Botanical Council. Herbal supplement sales experience slight increase in 2008. HerbalGram 2009; 82:58.

Apple, R.D. (1996). Vitamania: Vitamins in American Culture. Rutgers University Press, New Brunswick, NJ.

Ashar, B. H., Miller, R. G., Pichard, C. P., Levine, R., & Wright, S. M. (2008). Patients' understanding of the regulation of dietary supplements. *Journal of Community Health, 33*(1), 22-30. doi:10.1007/s10900-007-9063-7

Ashar, B. H., & Rowland-Seymour, A. (2008). Advising patients who use dietary supplements. *American Journal of Medicine, 121*(2), 91-97. doi:10.1016/j.amjmed.2007.10.031

Avogo, W. (2008). The effects of health status on the utilization of complementary and alternative medicine. *Health Education Journal, 67*(4), 275-258.

Bailey, R. L., Gahche, J. J., Miller, P. E., Thomas, P. R., & Dwyer, J. T. (2013). Why US adults use dietary supplements. *JAMA Internal Medicine, 173*(5), 355-361. doi:10.1001/jamainternmed.2013.2299

Ballin, N. Z., & Sørensen, A. T. (2014). Coumarin content in cinnamon containing food products on the danish market. *Food Control, 38*(1), 198-203.

Barnes, J., Anderson, L.A., & Phillipson, J. D. (2007). Herbal medicine. 3rd Edition, Pharmaceutical Press, London. pp 1-23.

Bikle, D.D. (2012). Agents that affect bone mineral homeostasis. In B.G. Katzung, S.B. Masters, & A.J. Trevor (Eds.), *Basic and Clinical Pharmacology* (12th ed.) (pp. 781). New York, NY: McGraw-Hill Companies, Inc.

Blendon, R. J., Benson, J. M., Botta, M. D., & Weldon, K. J. (2013). Users' views of dietary supplements. *Journal of the American Medical Association Internal Medicine, 173*(1), 74-76.

Brancheau, D., Patel, B., & Zughaib, M. (2015). Do cinnamon supplements cause acute hepatitis? *American Journal of Case Reports*, (16), 250-254. doi: 10.12659/AJCR.892804

Campbell, F., Dickinson, H. O., Critchley, J. A., Ford, G. A., & Bradburn, M. (2013). A systematic review of fish-oil supplements for the prevention and treatment of hypertension. *European Journal of Preventive Cardiology, 20*(1), 107-120.

Crone, C. C., & Wise, T. N. (1998). Use of herbal medicines among consultation-liaison populations: A review of current information regarding risks, interactions, and efficacy. *Psychosomatics, 39*(1), 3-13.

Delahanty L.M., & McCulloch, D.K. (2014). Nutritional considerations in type 2 diabetes mellitus. UpToDate. Retrieved from www.uptodate.com+nutritional-considerations-in-type-2-diabetesmellitus?source=search_result&search=cinnamon+supplement&selectedTitle=1~17

Denham, B. E. (2011). Dietary supplements - regulatory issues and implications for public health. *Journal of the American Medical Association, 306*(4), 428-429.

Dennehy, C.E., & Tsourounis, C. (2012). Dietary supplements & herbal medications. In B.G. Katzung, S.B. Masters, & A.J. Trevor (Eds.), *Basic and Clinical Pharmacology* (12th ed.) (pp. 1125-1137). New York, NY: McGraw-Hill Companies, Inc.

Eisenberg, D. M., Kessler, R. C., Van Rompay, M. I., Kaptchuk, T. J., Wilkey, S. A., Appel, S., & Davis, R. B. (2001). Perceptions about complementary therapies relative to conventional therapies among adults who use both: Results from a national survey. *Annals of Internal Medicine, 135*(5), 344-351.

Eliason, B. C., Huebner, J., & Marchand, L. (1999). What physicians can learn from consumers of dietary supplements. *Journal of Family Practice, 48*(6), 459-463.

Food and Drug Administration. (2014). Dietary supplement current good manufacturing practices (CGMPs) and interim final rule (IFR) facts. Retrieved from http://www.fda.gov/Food/GuidanceRegulation/CGMP/ucm110858.htm

Food and Drug Administration. (2016). Dietary supplement products and ingredients. Retrieved from http://www.fda.gov/Food/DietarySupplements/ProductsIngredients/default.htm

Food and Drug Administration. (2004). FDA announces qualified health claims for omega-3 fatty acids. Retrieved from http://www.fda.gov/SiteIndex/ucm108351.htm

Food and Drug Administration. (2013). Label claims for conventional foods and dietary supplements. Retrieved from http://www.fda.gov/food/ingredientspackaginglabeling/labelingnutrition/ucm111447.htm

Garcia-Cazarin, M. L., Wambogo, E. A., Regan, K. S., & Davis, C. D. (2014). Dietary supplement research portfolio at the NIH, 2009-2011. *Journal of Nutrition, 144*(4),

414-418.

Harkey, M. R. (2001). Variability in commercial ginseng products: An analysis of 25 preparations. *The American Journal of Clinical Nutrition, 73*(6), 1101-1106.

Howard, M., & White, N.D. (2013). Potential benefits of cinnamon in type 2 diabetes. *American Journal of Lifestyle Medicine*. 2013;7(1):23-26.

Hu, Z., Yang, X., Ho, P. C. L., Sui, Y. C., Heng, P. W. S., Chan, E., … Zhou, S. (2005). Herb-drug interactions: A literature review. *Drugs, 65*(9), 1239-1282.

Institute of Medicine (IOM). Food and Nutrition Board. Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride. Washington, DC: National Academy Press, 1997.

Institute of Medicine. Report at a Glance, Report Brief: Dietary Reference Intakes for Calcium and Vitamin D, released 11/30/2010. Retrieved from http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-Calcium-and-Vitamin-D/Report-Brief.aspx

Kaptchuk, T. J., & Eisenberg, D. M. (1998). The persuasive appeal of alternative medicine. *Annals of Internal Medicine, 129*(12), 1061-1065.

Kaufman, D.W., Kelly J.P., Rosenberg L., Anderson, T.E., & Mitchell, AA. (2002). Recent patterns of medication use in the ambulatory adult population of the United States: The Slone Survey. *Journal of the American Medical Association.* 287(3):337-344. doi:10.1001/jama.287.3.337

Kunle, O. F., Egharevba, H. O., & Ahmadu, P. O. (2012). Standardization of herbal medicines-A review. *International Journal of Biodiversity and Conservation*, *4*(3),

101-112.

Leach M.J., & Kumar, S. Cinnamon for diabetes mellitus. Cochrane Database Syst Rev 2012; 9:CD007170.

Marinac, J. S., Buchinger, C. L., Godfrey, L. A., Wooten, J. M., Sun, C., & Willsie, S. K. (2007). Herbal products and dietary supplements: A survey of use, attitudes, and knowledge among older adults. *Journal of the American Osteopathic Association,107*(1), 13-23.

Musso, C. G. (2009). Magnesium metabolism in health and disease. *International Urology and Nephrology, 41*(2), 357-362. doi:10.1007/s11255-009-9548-7 [doi]

National Institutes of Health. (2012). Time to talk about dietary supplements: 5 things consumers need to know. Retrieved from http://nccam.nih.gov/health/tips/supplements

Natural Medicine Comprehensive Database (2014). Retrieved from http://www.naturaldatabase.com

Opperman, M. (2013). What health professionals should know about omega-3 fatty acid supplements. *South African Journal of Clinical Nutrition, 26*(2), 6-11.

Pase, M. P., Grima, N., Cockerell, R., Stough, C., Scholey, A., Sali, A., & Pipingas, A. (2015). The effects of long-chain omega-3 fish oils and multivitamins on cognitive and cardiovascular function: A randomized, controlled clinical trial. *Journal of the American College of Nutrition*. 34(1), 21-31.

Pazirandeh, S., & Burns, D.L. (2014) Overview of vitamin D. UpToDate. Retrieved from www.uptodate.com+overview-ofvitamind?source=search_result&search=vitamin+d &selected Title=2~150

Peterson, C. (2014, November 24).Vitamins, supplements and herbal products. Lecture conducted from Bethel University, Arden Hills, Minnesota.

Schwartz, J. (2009). Effects of vitamin D supplementation in atorvastatin-treated patients: A new drug interaction with an unexpected consequence. *Clinical Pharmacology & Therapeutics, 85*(2), 198-203. doi:10.1038/clpt.2008.165

Sheng, L., Xue, Y., He, X., Zhu, Y., Li, H., Wu, Y., . . . Jiang, P. (2015). Effects of repeated administration of rifampicin and isoniazid on vitamin D metabolism in mice. *Steroids, 104*, 203-207. doi:10.1016/j.steroids.2015.10.004

Shi, S., & Klotz, U. (2012). Drug interactions with herbal medicines. *Clinical Pharmacokinetics, 51*(2), 77-104. doi:10.2165/11597910-000000000-00000

Soare, A., Weiss, E. P., Holloszy, J. O., & Fontana, L. (2014). Multiple dietary supplements do not affect metabolic and cardiovascular health. *Aging, 6*(2), 149-157.

Solecki, R.S. (1975). Standardized product as well as the quality of the consumer information on the herbal remedy. Hanidar IV. Science, 190: 880.

Tarn, D. M., Guzmán, J. R., Good, J. S., Wenger, N. S., Coulter, I. D., & Paterniti, D. A. (2014). Provider and patient expectations for dietary supplement discussions. *Journal of General Internal Medicine,29*(9), 1242-1249. doi:10.1007/s11606-014-2899-5

Thompson, J. J., & Nichter, M. (2007). The compliance paradox: What we need to know about "real-world" dietary supplement use in the United States. *Alternative Therapies in Health and Medicine, 13*(2), 48-55.

Ventola, C. L. (2010). Current issues regarding complementary and alternative medicine (cam) in the united states - part 2: Regulatory and safety concerns and proposed governmental policy changes with respect to dietary supplements. *P and T, 35*(9), 514-522.

Yetley, E. A. (2007). Multivitamin and multimineral dietary supplements: Definitions, characterization, bioavailability, and drug interactions. *American Journal of Clinical Nutrition, 85*(1), 269S-276S.

Zelig, R., & Rigassio-Radler, D. (2012). Understanding the properties of common dietary supplements: Clinical implications for healthcare practitioners. *Nutrition in Clinical Practice, 27*(6), 767-776. doi:10.1177/088453361244619

APPENDIX A

Survey Consent Form

SURVEY CONSENT FORM

You are invited to participate in a study of dietary supplement use. The researchers of this study hope to learn information about the knowledge level and practices of persons who currently use dietary supplements. This research is being conducted by students pursuing a Master's of Physician Assistant Studies degree at Bethel University in Saint Paul, Minnesota. This research is required for completion of the Master's program. No funding agency is involved in this research.

Participation in this study is voluntary. If you choose to participate, you will be asked to complete a survey regarding certain dietary supplements. You must currently take one or more of the supplements listed on the instructions page (page 2) in order to participate. The survey will take approximately 15 minutes to complete.

Your decision whether or not to participate will not affect your future relations with CHI Saint Alexius Health or Bethel University in any way. If you decide to participate, you are free to discontinue participation at any time.

There are no risks associated with participation in this study, and confidentiality will be maintained. No identifying information will be collected. Only authorized research personnel will review survey responses.

This research project has been reviewed and approved in accordance with Bethel University's Levels of Review for Research with Humans. It has been reviewed at the appropriate level and is in accordance with federal guidelines and ethical principles. The CHI Saint Alexius Health Institutional Review Board has also reviewed and approved this research project. If you have any questions about the research and/or research participants' rights, please call Sarah Kucera (701-391-5177) or Yen Nguyen (612-462-5734).

By proceeding with this study, you are agreeing that you are at least 18 years of age. You are also acknowledging your understanding of the terms of your participation in this study as described above and agree to participate based on those terms. You may withdraw at any time should you choose to discontinue participation in this study.

APPENDIX B

Survey Instructions

SURVEY INSTRUCTIONS

1. Please read each question carefully before responding.

2. Please record responses only for the supplements you **currently** use. Each page of the survey is to be completed only if you currently take the supplement listed at the top of that particular page. If you do not take the supplement named at the top of the page, please skip that page.

3. **The supplements in this study include the following:**

- Vitamin D
- Fish oil
- Coenzyme Q10 (CoQ10)
- St. John's Wort
- Garlic
- Cinnamon
- Magnesium

If you do not currently use one of these supplements, you are not eligible to take this survey.

4. Please respond to all survey questions. Please do not guess the correct response, but rather choose "UNKNOWN" if you do not know the answer.

5. Demographic information (next page) must also be supplied.

DEMOGRAPHIC INFORMATION

Please check the option that best describes you.

Gender

☐Male
☐Female

Age

☐18-25
☐26-40
☐41-50
☐51-60
☐60+

Highest Level of Education Completed

☐High school graduate OR some college
☐Associate's degree OR Bachelor's degree
☐Master's degree OR Doctoral degree

GENERAL SUPPLEMENT QUESTIONS

Answer these if you currently take ANY of the dietary supplements listed on the instructions page (page 2).

1. Does the FDA (Food and Drug Administration) test dietary supplements for safety and efficacy (whether they work)?	☐UNKNOWN ☐YES ☐NO
2. Is a supplement with the USP (United States Pharmacopeia) seal in any way better than a supplement with no such seal?	☐UNKNOWN ☐YES ☐NO

APPENDIX C

Survey Instrument

VITAMIN D

1. Is there any potential for harmful side effects with the consumption of this supplement?

	nt □ Possible drug interactions

FISH OIL

1. Is there any potential for harmful side effects with the consumption of this supplement?

	ssible drug interactions

COENZYME Q10 (CoQ10)

1. Is there any potential for harmful side effects with the consumption of this supplement?

	ug interactions

ST. JOHN'S WORT

1. Is there any potential for harmful side effects with the consumption of this supplement?

	nteractions

GARLIC

1. Is there any potential for harmful side effects with the consumption of this supplement?

	ment □ Possible drug interactions

CINNAMON

1. Is there any potential for harmful side effects with the consumption of this supplement?

	t □ Possible drug interactions

MAGNESIUM

1. Is there any potential for harmful side effects with the consumption of this supplement?

	ement □ Possible drug interactions

APPENDIX D

CHI St. Alexius Letter of Intent

St. Alexius Medical Center
PrimeCare

Date: May 5, 2015

To: Sarah Kucera and Yen Nguyen, Bethel University Physician Assistant Students

From: Elaine Kucera, CHI St. Alexius Health, Director Laboratory and Imaging Services

Re: Proposed Research Study

I have reviewed the outline of the proposed research study, Dietary Supplements: A Consumer Profile of Perceptions and Practices. This letter provides administrative approval for the Laboratory and Radiology front desk staff to hand out the questionnaire to patients that come for lab or radiology procedures.

APPENDIX E

Dakota Community Bank Letter of Intent

Dakota COMMUNITY BANK & TRUST

Good Neighbor Loyalty Club™

Date: May 13, 2016

To: Sarah Kucera and Yen Nguyen, Bethel University Physician Assistant Students

From: Karen Holt, Dakota Community Bank & Trust Good Neighbor Club Assistant Director

Karen Holt

Re: Proposed Research Study

I have reviewed the outline of the proposed research study, Dietary Supplements: A Consumer Profile of Perceptions and Practices. This letter provides administrative approval for The Good Neighbor Loyalty Club Representatives to hand out the questionnaire to our senior travel club members.

APPENDIX F

Addendum

ADDENDUM TO DIETARY SUPPLEMENTS: A CONSUMER PROFILE OF KNOWLEDGE AND USE

Study Site and Population

The surveys will be distributed at an additional site due to lack of patient participation at the CHI St. Alexius Health outpatient laboratory. The researchers have secured an affiliation with Dakota Community Bank and Trust in Bismarck, North Dakota. The surveys will be distributed by the "Good Neighbor Loyalty Club" representatives employed by Dakota Community Bank and Trust. The surveys will be dispensed to senior travel club members during a bus trip the week of May 16 through May 20, 2016. A sample size of 40 is desired. Data collection will persist beyond May 20, 2016, if an adequate sample size is not achieved by that date. If this is required, employees of Dakota Community Bank and Trust will distribute surveys to customers as time permits. The researchers of this study will personally collect the completed surveys. A letter of intent for research affiliation with Dakota Community Bank and Trust can be found below.

APPENDIX G

Survey Scoring System

The demographic information will not be scored in any way.

General questions:

Does the FDA (Food and Drug Administration) test dietary supplements for safety and efficacy (whether they work)?

- A score of "0" will be given if the subject responds "unknown" or "yes."
- A score of "1" will be given if the subject responds "no."

Is a supplement with the USP (United States Pharmacopeia) seal in any way better than a supplement with no such seal?

- A score of "0" will be given if the subject responds "unknown" or "no."
- A score of "1" will be given if the subject responds "yes."

The following questions are applied to each of the surveyed supplements: Vitamin D, fish oil, Co-Q10, garlic, St. John's wort, cinnamon, and magnesium. The scoring will be based on whether the subjects choose appropriate indications supported by the literature.

Question 1. Is there any potential for harmful side effects with the consumption of this supplement?

- A score of "0" will be given if the subject chooses "unknown" or "no."
- A score of "1" will be given if the subject chooses "yes."

Question 2. Is it safe to take this supplement with any prescription drug?

- A score of "0" will be given if the subject chooses "unknown" or "yes."
- A score of "1" will be given if the subject chooses "no."

Question 3. Why did you start taking this supplement? Check all that apply.

- A score of "0" will be given if the subject chooses indications that are not supported by the literature or if the respondent chooses "I don't know."
- A score of "1" will be given if the subject chooses indications supported by the literature.

Question 4. How do you decide the dose (how much to take) of this supplement?

- A score of "0" will be given if the subject chooses "I decide the dose myself."
- A score of "1" will be given if the subject chooses "label" or "provider."

Question 5 will not be scored.

Question 6. If you have discussed this supplement use with a healthcare provider, which of the following did you discuss? Check all that apply.

- A score of "0" will be given for "not applicable."
- A score of "1" will be given for each aspect discussed.

APPENDIX H

IRB Approval

February 18, 2016

Sarah & Yen;

As granted by the Bethel University Human Subjects committee as the program director, I write this letter to you in approval of Level 3 Bethel IRB of your project entitled: "Dietary Supplements: A Consumer Profile of Knowledge and Use." This approval is good for one year from today's date. You may proceed with data collection and analysis. Please let me know if you have any questions."

Sincerely;

Wallace Boeve, EdD, PA-C
Program Director
Physician Assistant Program
Bethel University
w-boeve@bethel.edu
651 308-1398 cell
651 635-1013 office
651 635-8039 fax
http://gs.bethel.edu/academics/masters/physician-assistant