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Association of Glucosamine and/or Chondroitin Use with Reports of Improved Health and Joint Pain among Individuals with Arthritis, National Health Interview Survey (NHIS) 2012

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B.S., Anthropology and Human Biology
Emory University, 2013

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the Requirements for the Degree

MASTER OF PUBLIC HEALTH

GEORGIA STATE UNIVERSITY

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ABSTRACT

BACKGROUND: Arthritis is increasingly becoming a public health concern as it is the leading cause of disability. Glucosamine and chondroitin, which are alternative dietary supplements, are commonly marketed for persons with joint pain. The purpose of this study is to examine if self-reported 12-month and past 30-day use of glucosamine and/or chondroitin among persons with any arthritis, unspecified arthritis, and rheumatoid arthritis is associated with reports of past 12 month improved health and reports of past 30-day joint pain, aching, and stiffness, respectively.

METHODS: The 2012 National Health Interview Survey (NHIS), a nationally representative cross-sectional household interview survey, was used for this study. The adult sample consisted of 34,525. Subgroup analyses were conducted on 7,654 respondents with any arthritis, 6,016 with unspecified arthritis, and 898 with rheumatoid arthritis. The independent variables were defined as the use of glucosamine only, chondroitin only, or glucosamine and chondroitin one or more times in the past 12 months and past 30 days. The dependent variables were defined as self-reported past 12 month improved health and past 30 day pain, aching, and stiffness. Descriptive, bivariate, and multivariate analyses were conducted using SAS 9.4 accounting for the complex survey design, computing missing values as missing completely at random for variance estimation. All multivariate logistic regression models included sociodemographics, use of other alternative therapies, and any other chronic conditions.

RESULTS: Approximately 21.8% of U.S adults had any arthritis, 17.0% had unspecified arthritis and 2.5% had rheumatoid arthritis. Among persons with any arthritis, approximately 3.7% used glucosamine, 0.4% used chondroitin, and 3.4% used both glucosamine and chondroitin within the past 12 months while approximately 5.1% used glucosamine, 0.6% used chondroitin, and 0.4% used both glucosamine and chondroitin within the past 30 days. Among persons with unspecified arthritis, approximately 3.7% used glucosamine, 0.5% used chondroitin, and 3.8% used both glucosamine and chondroitin within the past 12 months while 5.5% used glucosamine, 0.5% used chondroitin, and 0.4% used both glucosamine and chondroitin within the past 30 days. Among persons with rheumatoid arthritis, approximately 2.4% used glucosamine, 0.3% used chondroitin, and 2.1% used both glucosamine and chondroitin within the past 12 months while approximately 2.9% used glucosamine, 0.7% used chondroitin, and 0.5% used both glucosamine and chondroitin within the past 30 days. Women used more of all supplements (past 12 months and past 30 days) except past 12 month use of chondroitin among persons with any arthritis. Persons 56 to 70 years old had the highest proportion of past 12 month and 30 day supplement use among persons with unspecified arthritis.
After adjusting for sex, age, race, BMI, poverty level, other health conditions, and other CAM therapies (acupuncture, energy, mind-body, and chiropractic/osteopathic therapies), the use of chondroitin only (adjusted OR= 0.6; p= <0.01) and the use of both glucosamine and chondroitin (adjusted OR= 5.7; p= <0.01) during the past 30 days was associated with self-reported past 30 day joint pain, aching, and stiffness among persons with any arthritis. After adjusting for age, BMI, poverty level, region, other health conditions, and other CAM therapies (acupuncture, energy, mind-body, and chiropractic/osteopathic therapies), the use of chondroitin only was also associated with past 30 day joint pain, aching, and stiffness among persons with unspecified arthritis (adjusted OR= 0.5; p= 0.02).

CONCLUSION: Chondroitin alone was associated reports of past 30 day joint pain, aching, and stiffness among persons with any arthritis and unspecified arthritis highlighting a potential effective role and use for this supplement. In addition, the use of both glucosamine and chondroitin were associated with reports of past 30 day joint pain, aching, and stiffness among persons with any arthritis. Marketing may play a role in these relationships and should be further examined.

Association of Glucosamine and/or Chondroitin Use and Reports of Improved Health and Joint Pain among Individuals with Arthritis, National Health Interview Survey (NHIS) 2012

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CHAPTER I

INTRODUCTION

BACKGROUND

Arthritis is the inflammation of one or more joints, and includes several rheumatic diseases and conditions. Arthritis is a disease that naturally worsens with age. Because the workforce in the United States is aging, arthritis is increasingly becoming a public health issue. In 2003, an estimated $128 billion in medical-care costs and lost earnings were due to arthritis alone in the United States (CDC 2007). This estimate has only increased over the years.

Osteoarthritis and rheumatoid arthritis are the two most common forms of arthritis. Osteoarthritis is characterized by progressive degeneration of articular cartilage (Gibson et al. 2014). Rheumatoid arthritis is a chronic inflammatory disease that results in damage to bone and cartilage (Md Yusof & Emery 2013). Current treatment for these conditions mostly consists of analgesics and non-steroidal anti-inflammatory drugs (NSAIDs). Unfortunately, long-term use of these treatments could potentially cause serious adverse gastrointestinal and cardiovascular events (Wu et al. 2013). Using complementary and alternative medicine (CAM) therapies instead of, or in combination with, these treatments can potentially decrease susceptibility to experiencing these common side effects.

Complementary and alternative medicine (CAM) therapies are non-traditional medical practices performed with the intent to treat or prevent a condition. There are various forms of CAM therapies, which may include homeopathy, naturopathy, meditation and prayer, herbal and dietary supplements, chiropractic and massage therapy, and energy therapies (NCCIH 2000). Among adults with arthritis, the use of dietary supplements is one form of CAM that is becoming widely used. Glucosamine and chondroitin are two supplements of interest. Glucosamine and

chondroitin can be found separately or in combination pills. Both supplements are thought to have a role in protecting joints from degeneration (Gibson et al. 2014; Stuber et al. 2011). The classification of glucosamine and chondroitin as dietary supplements instead of pharmaceutical drugs mean that they are not approved by the U.S Food and Drug Administration (FDA) for medicinal use. However, the two supplements are typically safe to use (Barnes et al. 2008; Dahmer & Schiller 2008). Currently, glucosamine and chondroitin, alone or in combination, are marketed towards persons with arthritis. Glucosamine is also often used as a preventive measure to maintain health, and has been identified as a potential treatment for pain relief of degenerative disc disease (Hopman et al. 2006; Stuber et al. 2011). Glucosamine and chondroitin are of particular interest because they could potentially be an effective way to reduce pain and restore joint function in persons with arthritis while decreasing risk of adverse side effects.

While glucosamine and chondroitin appears to show some promise in reducing pain and restoring joint function in persons with arthritis, findings from multiple studies have been inconclusive about their true effectiveness in these functions. While some studies are finding glucosamine and chondroitin to be moderately effective in decreasing pain and stopping the progression of osteoarthritis (Bruyere & Reginster 2007; McAlindon et al. 2000), others are finding the supplements to be no more effective than placebos (Clegg et al. 2006; Kwoh et al. 2014). What is also less understood is the proportion of adults with arthritis who use glucosamine and/or chondroitin and derive any benefits from its use such as positive quality of life or improved health and decreased pain. This study will contribute to this gap.

RESEARCH QUESTIONS AND HYPOTHESES

1. What are the socio-demographic characteristics of U.S. adults with any arthritis, unspecified arthritis and rheumatoid arthritis?

2. What are the socio-demographic characteristics of U.S. adults with any arthritis, unspecified arthritis, and rheumatoid arthritis who use glucosamine and/or chondroitin?

3. Does self-reported improved health or joint pain, aching, and stiffness among U.S. adults with any arthritis, unspecified arthritis, and rheumatoid arthritis differ based on glucosamine and/or chondroitin use?

- $H1_0$: Adults with any arthritis who report using glucosamine and/or chondroitin will not differ from adults who do not use glucosamine and /or chondroitin on self-reported health improvement in the past 12 months.
- $H2_0$: Adults with unspecified arthritis who report using glucosamine and /or chondroitin will not differ from adults who do not use glucosamine and /or chondroitin on self-reported health improvement in the past 12 months.
- $H3_0$: Adults with rheumatoid arthritis who report using glucosamine and /or chondroitin will not differ from adults who do not use glucosamine and /or chondroitin on self-reported health improvement in the past 12 months.
- $H4_0$: Adults with any arthritis who report current glucosamine and/or chondroitin use will not differ from adults who do not use glucosamine and /or chondroitin on self-reported symptoms of joint pain, aching, and stiffness in the past 30 days.

- $H5_0$: Adults with unspecified arthritis who report current glucosamine and /or chondroitin use will not differ from adults who do not use glucosamine and /or chondroitin on self-reported symptoms of joint pain, aching, and stiffness in the past 30 days.
- $H6_0$: Adults with rheumatoid arthritis who report current glucosamine and /or chondroitin use will not differ from adults who do not use glucosamine and /or chondroitin on self-reported symptoms of joint pain, aching, and stiffness in the past 30 days.

CHAPTER II

REVIEW OF LITERATURE

OVERVIEW OF ARTHRITIS

Arthritis is the inflammation of one or more of joints, with osteoarthritis and rheumatoid arthritis as the most common forms of arthritis (CDC 2014). Arthritic symptoms include pain, aching, and swelling around the joints. Arthritis is the leading cause of disability and among the leading causes of work limitations in adults (Helmick et al. 2008).

Though anyone can be affected, arthritis tends to be an illness of the aging population and is most common among adults aged 65 years or older (CDC 2014). While the prevalence of juvenile arthritis is often difficult to estimate due to differences in nomenclature and a consistent case definition, NHIS data suggests a prevalence of 150 per 100,000 for all types of childhood arthritis (Helmick et al. 2008). In addition to age, sex and weight are risk factors for arthritis (CDC 2014).

In 2003, an estimated $128 billion in medical-care costs and lost earnings were due to arthritis alone in the United States (CDC 2007). Analyzed data from the National Health Interview Survey (NHIS) for years 2010-2012 found that 52.5 million (22.7%) of adults ages 18 years or older self-reported doctor-diagnosed arthritis. Of these people, 22.7 million reported being limited in physical activity due to having arthritis. In addition, the prevalence of arthritis in this population is greater among persons with other health complications when compared to the general population prevalence of 22.7%. For example, the prevalence of doctor-diagnosed arthritis among obese adults, persons with diabetes, and persons with heart disease was 31.2%, 47.3%, and 49.0% respectively (Barbour et al. 2013). Equally alarming is the prevalence of persons with these conditions being limited in activity due to arthritis; the prevalence is 26.8%,

25.7%, and 15.2%, respectively. With arthritis driving cost and physically limiting the work force, it is increasingly becoming a public health concern.

OSTEOARTHRITIS

Osteoarthritis is the most common form of arthritis and is characterized by progressive degeneration of articular cartilage (Gibson et al. 2014). This disease is estimated to affect approximately 15% of the population. The primary location of osteoarthritis is commonly seen in the knee and hip, which is the leading cause of lower extremity disability amongst older adults (Johnson & Hunter 2014). While the etiology of osteoarthritis is not fully understood, disease progression can be divided into two phases at the cellular level: a biosynthetic phase and a degenerative phase (Gibson et al. 2014). Chondrocytes are the mature cells found in cartilage. These cells are partly responsible for maintaining the extracellular matrix (Mollenhauer 2008). The biosynthesis phase begins when the extracellular matrix is damaged and the chondrocytes fails to repair it. When this occurs, production of the extracellular matrix is inhibited causing chondrocytes to release proteolytic enzymes, accelerating cartilage loss. This begins the degenerative phase. By products of the extracellular matrix travel throughout the joint, creating build up and inflammation that contributes to further disease progression (Hunziker 2002; Mollenhauer 2008).

Because osteoarthritis is the result of the complex interaction between mechanical, cellular, and biomechanical factors, there are several associated risk factors, which include: age, gender, genetics, obesity, diet, and occupational and physical activity. Johnson and Hunter identifies the increased risk of incident osteoarthritis through two categories: susceptible joints and predisposed individual (Johnson & Hunter 2014). Susceptible joint is determined by five modifiable risk factors: muscle strength, physical activity/occupation, joint injury, joint

alignment, and leg length inequality. Predisposed individuals, on the other hand, are determined through two additional categories: modifiable systemic risk factors and non-modifiable systemic risk factors. Modifiable systemic risk factors include: obesity, diet, and bone metabolism. Non-modifiable systemic risk factors include: age, sex, genetics, and ethnicity.

Osteoarthritis can be ascertained using three different diagnostic approaches: pathological screening, radiographical screening, or clinical screening (Johnson & Hunter 2014). Typically, diagnosis is made using a radiographical or clinical screening. Clinically diagnosed osteoarthritis is based on the examination revealing characteristic symptomology. Radiographical diagnosis of osteoarthritis is based on graded radiographs according to the Kellgen and Lawrence (KL) grading system. The KL grading system grades on a scale of 0 to 4. It assesses the severity of the disease on a plain radiograph based on the visibility of joint space narrowing, osteocytes, and bone deformity. Any grade greater than 2 results in a diagnosis of osteoarthritis (Johnson & Hunter 2014). According to Elders, an estimated 60% of the United States' population develops radiographic evidence of osteoarthritis by the time they reach age 55 (Elders et al. 2000).

Radiographic knee and hip osteoarthritis each had a prevalence of 28% in the Johnston County Osteoarthritis Project of African American and Caucasian men and women (Jordan et al. 2007; Jordan et al. 2009). These two studies also found reported prevalence rates of 17% symptomatic knee osteoarthritis and 10% for symptomatic hip osteoarthritis. These prevalence rates are different because all persons with radiographic osteoarthritis do not experience concomitant symptoms (Johnson & Hunter 2014).

A Sweden population based study found a proportion of 26.6% of persons aged 45 years and older with any doctor-diagnosed osteoarthritis. The proportion of women, 30.5%, was higher than the proportion of men, 22.4%. About 27% of the prevalent cases had osteoarthritis in

multiple joints (Turkiewicz et al. 2014). Prevalence of radiographic knee osteoarthritis in the United States is 52.4% in African Americans, 36.2% in Whites, and 37.6% in Mexican Americans (Lawrence et al. 2008).The prevalence is significantly higher in African Americans when compared to Whites and Mexican Americans.

RHEUMATOID ARTHRITIS

Rheumatoid arthritis is a chronic inflammatory disease that results in damage to bone and cartilage. It is a term that includes several rheumatic diseases and conditions such as rheumatoid arthritis, lupus, osteoarthritis, fibromyalgia, and gout. Symptoms of this condition include fatigue, pain, and other extra-articular manifestations (Md Yusof & Emery 2013). Rheumatoid arthritis is a fairly common disease that occurs two to three times more frequently in women than in men (Gabriel 2001; Smolen & Steiner 2003). While it can occur at any age, prevalence peaks are most common in the 4th and 6th decade of life. The most commonly affected joints are those of the hands, feet, and knees (Smolen & Steiner 2003). While obesity is associated with increased risk of arthritis, being underweight due to weight loss is associated with accelerated mortality in rheumatoid arthritis (Baker et al. 2015).

The cause of rheumatoid arthritis is unknown. It is thought to have a polygenic basis although the genes involved in pathogenesis have yet to be identified (Smolen & Steiner 2003). What is clear is that rheumatoid arthritis is initiated by CD4+ T cells. These cells amplify the immune response by stimulating other mononuclear cells, synovial fibroblasts, chondrocytes, and osteoclasts. Cytokines such as TNF-a, interleukin-1, and interleukin-6 are released resulting in synovial inflammation (Choy & Panayi 2001). Long term inflammation results in the joint damage that is associated with rheumatoid arthritis. Patients with arthritis have synovial

membranes that are characterized by hyperplasia, increased vascularity, and an infiltrate of inflammatory cells such as CD4+cells (Smolen & Steiner 2003).

About half of the patients newly diagnosed with rheumatoid arthritis are 65 years of age and older (Waljee et al. 2015). A Quebec study found a prevalence of 9.9 per 1,000. This study found a male prevalence of 4.1 per thousand and female prevalence of 5.6 per 1,000. In addition, older women had a higher prevalence for any demographic group (Bernatsky et al 2014). A US study analyzing data from Olmsted County, Minnesota from 1955 to 2006 found that the overall annual age and sex adjusted rheumatoid arthritis incidence was about 40.9 per 100,000 (Myasoedova et al. 2010). Age adjusted incidence in women was much higher than in men. Women had an age adjusted incidence of 53.1 per 100,000 while men had an age adjusted incidence of 27.7 per 100,000. When extrapolated to the US population, 1.5 million US adults were estimated to have arthritis in 2007 compared to 1.3 million reported in 1995 (Myasoedova et al. 2010).

CURRENT TREATMENT

Pharmacological therapy for osteoarthritis and rheumatoid arthritis mostly consists of analgesics and non-steroidal anti-inflammatory drugs (NSAIDs). This is particularly alarming because the overuse of these drugs could cause serious adverse gastrointestinal and cardiovascular events (Wu et al. 2013). In addition, analgesics and NSAIDs do not improve the underlying structural cartilage damage. Patients with symptomatic hip or knee osteoarthritis that use non-steroidal anti-inflammatory drugs are typically advised to use the lowest effective dose and avoid long-term use if possible (Wu et al. 2013). In severe cases, joint replacement surgeries may be deemed necessary.

Disease-modifying anti-rheumatic drugs (DMARDs) are becoming more readily available for rheumatoid arthritis (Smolen & Steiner 2003). Early therapy intervention can lead to better disease control and lessen joint damage. Because treatment with disease-modifying anti-rheumatic drugs (DMARDs) is only justified when the risk-benefit or cost-effectiveness ratios are favorable, early detection is necessary for the use of these drugs (Visser et al. 2002). Patients diagnosed at a later stage or who have had rheumatoid arthritis over a long period of time, may have less pharmacological options and therefore may resort to complementary and alternative medicine (CAM) therapies.

ALTERNATIVE THERAPIES FOR ARTHRITIS

Complementary and Alternative Medicine (CAM) therapies are treatment/prevention strategies not considered to be a biomedical intervention. CAM therapies are becoming increasingly difficult to define, as it includes a broad range of systems and strategies. Throughout the literature, there is a lack of consistency of what should be considered CAM therapies. This is partly due to scientific evidence that may or may not support these therapies but, also due to political ramifications. Licensure is a sure form of recognition for any therapy however, not all CAM therapies are licensed or many have few or no formal regulation. Chiropractic, acupuncture, and massage therapy are licensed in most states while naturopathy and homeopathy are licensed in fewer (Johnson & Hunter 2014).

While there are several CAM therapy classification systems, the most widely used classification structure was developed by the National Center for Complementary and Integrative Health (NCCIH), formerly known as the National Center for Complementary and Alternative Medicine (NCCAM) (Kaptchuk & Eisenberg 2001; NCCIH 2000). According to this classification system, there are five categories of CAM modalities: alternative medical systems,

mind-body interventions, biologically based treatments, manipulative and body-based methods, and energy therapies (NCCIH 2000). Alternative medical systems refer to a paradigm or system of theory that is not of conventional medicine. Homeopathy, Acupuncture, Ayurveda, and naturopathy are example of alternative medical systems. Mind-body interventions are therapies that are used to bring awareness to how stress, thoughts, and feelings can impact our physical health. Mind-body interventions are typically those that help to reduce the "fight or flight" response, which occurs during times of stress and which is used to calm the mind and assist in emotional regulation. Meditation and prayer are just two examples of mind-body therapies, but there are many others. Chiropractic and massage therapies are classified as manipulative and body-based, which work towards aligning and reducing muscle tension, which often result from physical or emotional stress and trauma. Energy therapies consist of the manipulation and application of energy fields to the body. In the same way that electromagnetic fields exist outside of the body, these therapies rely on the assumption that there too exist energy fields within the body. Reiki and Qi Gong are examples of this classification type. Finally, biological based therapies use herbal products, dietary supplements, hormones, and other natural products (NCCIH 2000).

Several CAM therapies have been identified as being effective in symptom relief of arthritic conditions such as acupuncture, energy, chiropractic/osteopathic, and mind-body therapies, and dietary supplements- namely glucosamine and chondroitin. For example, a 2013 meta-analysis of physical treatments that included 114 trials, found acupuncture to be more strongly associated with pain reduction than standard care among persons with osteoarthritis of the knee (Corbett et al. 2013). A 2009 study of 40 patients with a mean age of 65 years found Tai Chi to be effective in reducing pain and improving physical function and self-efficacy. It also

showed benefits for improving depression and health-related quality of life for knee osteoarthritis (Wang et al. 2009). A systematic review on use of yoga for persons with arthritis found yoga to be effective in improving self-efficacy and mental health, and in symptom reduction such as tender/swollen joints, pain, and disability (Haaz & Bartlett 2011). In a clinical pilot trial, persons with hip osteoarthritis waiting for arthroplasty, chiropractic therapy was proven to be effective in improving self-rated hip pain, function in daily living, and hip related quality of life (Thorman et al. 2010). In addition, a randomized clinical trial found that relaxation response training significantly improves pain associated with rheumatoid arthritis (Barsky et al. 2010). This thesis recognizes that there are other forms of CAM therapies that can influence reports of improved health and joint pain, aching, and stiffness however, will focus on these outcome relationships with glucosamine and/or chondroitin use. These other CAM therapies will be considered potential covariates.

GLUCOSAMINE

Glucosamine is a naturally occurring amino-monosaccharide that is thought to be active in protecting joints from degeneration (Gibson et al. 2014). It is an integral part of the normal growth and repair of connective tissues (Henrotin et al. 2013). Glucosamine is a preferred substrate for the production of aggrecans and other proteoglycans in cartilage (Wu et al. 2013). As one of the major constituents of the extracellular matrix (ECM), its potential chondroprotective properties are key. Glucosamine supplements can be found on the shelves of pharmacies and many grocery stores and are commonly sold in two forms: glucosamine sulfate and glucosamine hydrochloride. Of the two, glucosamine sulfate has been identified as the more promising supplement in alleviating pain and symptoms associated with arthritis due to its structure and function (Henrotin et al. 2013).

Glucosamine is currently classified as a dietary supplement and not a drug, therefore is not approved by the U.S Food and Drug Administration (FDA) for medicinal use (Barnes et al. 2008). However, glucosamine is among the most commonly used CAM treatments among persons with arthritis. For example, when current CAM use was observed in a study of 612 patients with arthritis, glucosamine use (about 34.1%) was reported the most (Herman et al. 2004). In addition to use for arthritic symptoms, glucosamine is also used as a preventive measure to maintain health, and has been identified as a potential treatment for pain relief of degenerative disc disease (Hopman et al. 2006; Stuber et al. 2011). Reported adverse effects of glucosamine are generally uncommon and minor (Dahmer & Schiller 2008). However, intravenous administration of glucosamine was shown to cause insulin resistance and endothelial dysfunction in animal models. A 2006 study set out to determine if oral glucosamine is likely to cause or worsen these conditions in lean or obese subjects (Muniyappa et al. 2006). Findings from this study suggest that standard doses of oral glucosamine for six weeks does not cause or worsen insulin resistance or endothelial dysfunction in lean or obese subjects.

CHONDROITIN

Chondroitin is often found in combination supplement pills with glucosamine. Because chondroitin constitutes the majority of the glycosaminoglycans in articular cartilage, it is speculated to be active in maintaining the viscosity in joints, stimulating cartilage repair, and inhibiting enzymes responsible for cartilage degeneration (Stuber et al. 2011). For this reason, it is mostly used among persons with arthritis to decrease pain and other associated symptoms through its potential structural modifying effects. While chondroitin is considered a generally safe supplement, similar to glucosamine, chondroitin is classified as a dietary supplement and therefore, is not approved by FDA for medicinal purposes (Barnes et al. 2008).

SOCIODEMOGRAPHICS OF GLUCOSAMINE/CHONDROITIN USE

A 2008 study analyzing 2007 National Health Interview Survey (NHIS) data found that 38% of adults 18 years and older in the Northeast region were CAM users while 41.4% were users in the Midwest, 32.5% in the South, and 44% in the West. This same study shows that persons age 50-59 years of age had the highest prevalence of CAM use (Barnes et al. 2008). In a study observing CAM use among overweight and obese persons with radiographic knee osteoarthritis, BMI was inversely associated with CAM use. Persons classified as obese (BMI $\geq$30 kg/m^2) were less likely to use CAM therapies, alone or in combination with conventional medications when compared to persons underweight or normal weight (BMI <25 kg/m^2) (Lapane et al. 2013). While there are studies on the distribution of general use of complementary and alternative therapies (CAM), less is known about glucosamine and/or chondroitin use. Understanding the socio-demographic characteristics of glucosamine and/or chondroitin use is important for this thesis.

An Australian study of persons 45 years of age and older found that higher income is associated with glucosamine use (Sibbritt et al. 2012). A Canadian study, similarly, found that glucosamine use occurred more in the western regions when compared to all other regions (Hopman et al. 2006). In addition, it is estimated that almost 400,000 elderly diabetic persons in the U.S use glucosamine (Simon et al. 2011).

A 2006 study using the US Food and Administration 2002 Health and Diet Survey found that glucosamine sulfate or glucosamine and chondroitin constituted 10.9% of the use of specific herbs, botanicals, and other nonvitamin/nonmineral dietary supplements during the past 12 months (Timbo et al. 2006). Prevalence of persons using chondroitin 45 to 64 years of age was 2.3% while prevalence of its use for persons 65 years of age and older was 3.9% in 2002. The

prevalence of chondroitin use in 2002 has increased since 1998/1999 (Kelly et al. 2005). However, there has been 12 years since this study. This thesis will determine if changes in chondroitin use has changed since 2002.

CLINICAL STUDIES

A systematic review conducted by Bruyere and Reginster, which included eight primary trials over a 12 month period, found glucosamine sulfate and chondroitin to be effective in showing improvements in joint space loss, pain, and function (Bruyere & Reginster 2007). The same review, analyzing two additional studies, found glucosamine sulfate to reduce the need for knee arthroplasty from 14.5% to 6.3% at eight years' follow-up. This study concluded that there is evidence that glucosamine sulfate and chondroitin sulfate may interfere with progression of osteoarthritis with respect to the structure modifying effect (Bruyere & Reginster 2007).

Similarly, a systematic quality assessment and meta-analysis conducted by McAlindon also found glucosamine and chondroitin to demonstrate moderate to large effects in decreasing symptoms of osteoarthritis (McAlindon et al. 2000). This study included 15 double-blind, randomized, placebo-controlled trials lasting 4 or more weeks from 1996 to June 1999. Only those analyzing glucosamine or chondroitin for knee or hip osteoarthritis with reported extractable data on the effect of treatment on symptoms were included. Findings may have been exaggerated due to quality issues and likely publication bias. The authors admit that several of the analyzed studies were conducted by manufacturers. Although the extent to which glucosamine or chondroitin was effective is unknown, this study has enough evidence to suggests that glucosamine and chondroitin does exhibit some effectiveness in decreasing symptoms of osteoarthritis.

On the other hand, a study conducted by Kwoh concluded that there are no structural benefits of glucosamine supplementation particularly in individuals with chronic knee pain (Kwoh et al. 2014). This randomized, placebo-controlled clinical trial, included 201 participants with mild-to-moderate pain in one or both knees, as defined by a Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Participants received 1,500 mg glucosamine hydrochloride in beverage form or a placebo beverage over the duration of 24 weeks. The adjusted odds ratio for the likelihood of cartilage damage decreasing over 24 weeks in the glucosamine treatment group compared to the control group was 0.938 (Kwoh et al. 2014). This short-term study concluded that there is no evidence to support the idea that glucosamine supplementation in individuals with chronic knee pain possesses some structural benefits.

The conclusion of the study conducted by Clegg coincides with those from the Kwoh et al. (2014) study. A total of 1,583 patients with symptomatic knee osteoarthritis participated in this study. Patients were randomly assigned to one of five groups where they could receive 1,500 mg of glucosamine daily or 1,200 mg of chondroitin sulfate daily or both glucosamine and chondroitin sulfate or 200 mg of celecoxib daily or placebo for 24 weeks (Clegg et al. 2006). This study found that the use of glucosamine and chondroitin sulfate, alone or in combination, were not significantly better than placebo in reducing knee pain by 20 percent.

While there are several clinical trials and systematic reviews on glucosamine and/or chondroitin and arthritis, observational studies are scarce. An observational study by Jawahar et al. (2012) found that the use of complementary and alternative medicine (CAM) either alone or in combination with prescription medicine was common among individuals with knee osteoarthritis. Findings from this study also suggest that glucosamine and/or chondroitin use

does not differ by gender among complementary and alternative medicine users (Jawahar et al. 2012).

Additional studies and analyses are needed to better understand socio-demographic characteristics of adults with arthritis who use glucosamine and/or chondroitin. Determining whether the use of these supplements result in self-reported improved health and decreased joint pain, aching, and stiffness when compared to those who do not use these supplements are important. This study utilizes 2012 National Health Interview Survey (NHIS) data to provide cross-sectional analyses. The association of glucosamine and/or chondroitin use one or more times within the past 12 months and reports of improved health when compared to 12 months ago is one relationship that will be analyzed. The association between glucosamine and/or chondroitin use within the past 30 days and self-reported symptoms of joint pain, aching, and stiffness in the past 30 days will also be analyzed. While previous clinical studies have included ways to account for the effect that dose may have in such associations, this study will analyze glucosamine and/or chondroitin use as a four level variable: glucosamine only, chondroitin only, neither glucosamine nor chondroitin, and both glucosamine and chondroitin.

CHAPTER III

METHODOLOGY

DATA SOURCE

The 2012 National Health Interview Survey (NHIS), a cross-sectional household interview survey, was used for this study. This data source is provided through the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC). NHIS has been continuously collected since July of 1957 to provide national estimates for healthcare utilization and access, health indicators, and health related behaviors for the U.S. civilian noninstitutionalized residents. Participants are recruited through a cost-effective complex sampling frame which includes multistage stratification, clustering, and differential sampling rates. Weights are adjusted based on the 2010 U.S census data. Black, Hispanic, and Asian persons are oversampled and Black, Hispanic, or Asian persons aged 65 years have increased chances of being selected. Participants are drawn from each state and the District of Columbia to be nationally representative for the U.S civilian noninstitutionalized population.

The NHIS consists of four main components that are included each year: The Household Composition Section, the Family Core questionnaire, the Sample Child Core, and the Sample Adult Core. The Household Composition Section asks basic demographic and relationship information on persons within the household. Because several families can live within one household, The Family Core questionnaire is administered to each family within a household. This questionnaire collects information on all persons in the family on topics related to health status, health insurance coverage, and access and utilization of health care services. The Sample Child Core is administered to one child 17 years of age or younger if present. The Sample Adult Core is administered to one adult 18 years of age or older. An emancipated minor is not eligible

to participate in the Sample Child or the Sample Adult survey. Supplemental questionnaires are included at different time intervals. The Adult Alternative Medicine and Child Alternative Medicine questionnaires have been included every five years since 2002. The 2012 NHIS consisted of eight data files. Because the adult population was the population of interest for this study, only four of the eight data files were merged: Sample Adult file, Adult Alternative Medicine Household file, and Family file.

APPROVAL

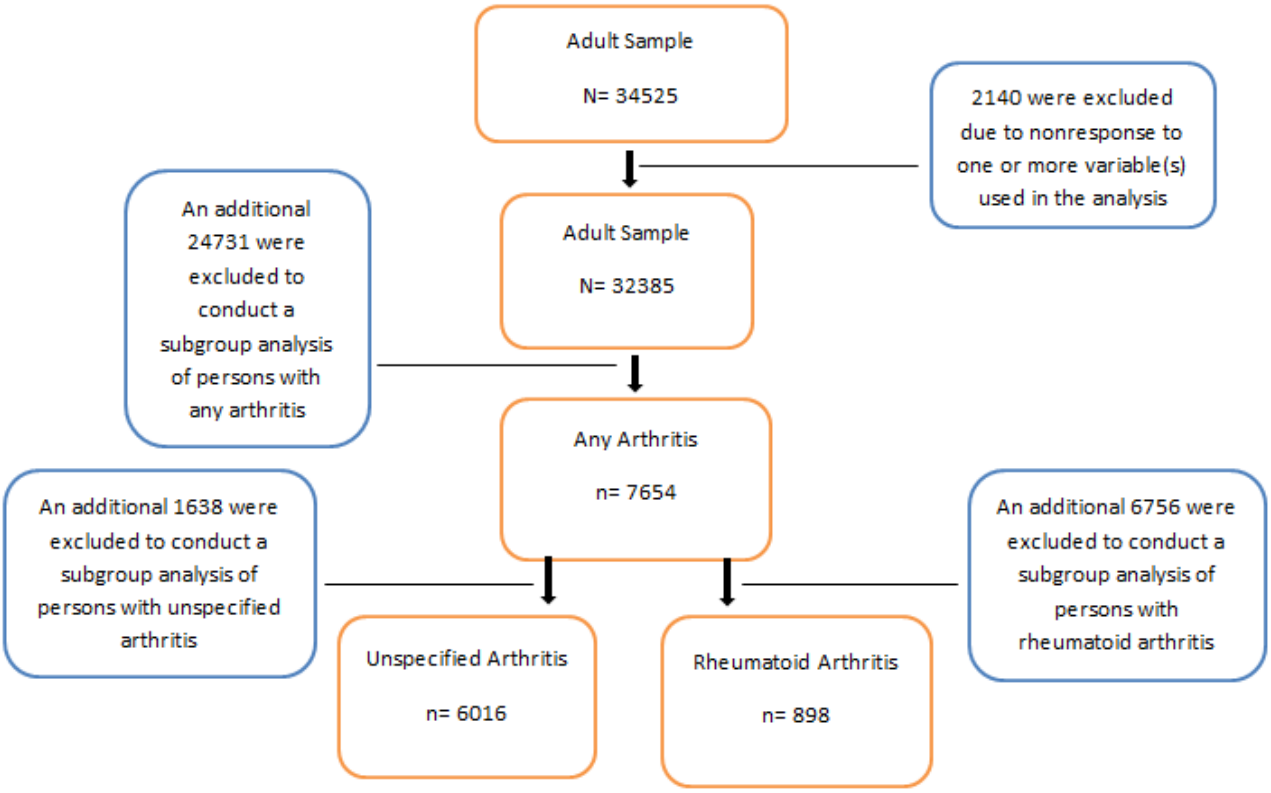
This thesis utilizes secondary public use data and did not require Institutional Review Board (IRB) approval. The NHIS is a preapproved data source with exempt status determined by the Georgia State University IRB (Institutional Review Board Policies).

INCLUSION AND EXCLUSION CRITERIA

While the adult sample consisted of 34,525 persons 18 years of age and older, persons with missing responses to any of the questions used for this analysis were excluded from the analysis of the study, resulting in a population size of 32,385 as shown in Figure 1. Furthermore, because the subpopulation of interest are adults with arthritis, the sample was restricted to persons that answered "yes" to: "Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?" Responses of "yes" to this question will be referred to as "any arthritis" throughout this paper. Further analysis was conducted on subpopulations of persons that responded "arthritis" and/or "rheumatoid arthritis" to the follow up question: "You just mentioned that you were told by a doctor or other health professional that you had some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia. Which of these were you told you had?" A person is classified as having "unspecified arthritis" if they responded "arthritis" to the

follow up question. Likewise, a person is classified as having "rheumatoid arthritis" if they responded "rheumatoid arthritis" to this question. Figure 1 illustrates the three subgroups: any arthritis, unspecified arthritis, and rheumatoid arthritis.

Figure 1. Flow Diagram of 2012 National Health Interview Survey (NHIS) Adult Sample and Subpopulations Used in Analyses



Note: No observations were deleted but were excluded for analyses. Missing values were computed as *missing completely at random* for variance estimation. SAS Survey procedures were used to account for the complex survey design.

INDEPENDENT VARIABLES

All variables of interest were assessed through self-reported data. Use of glucosamine and/or chondroitin was assessed over two different time intervals. The first assessment was use within the past 12-months. The second assessment was use within the past 30 days. These variables are used as four level variables: "no supplemental use", "glucosamine only", "chondroitin only", and "both". A person is determined to have "no supplemental use" if they

respond neither “glucosamine” nor “chondroitin” to: “Please tell me which of these supplements you have taken during the past 12 months?” or “Which of these supplements have you taken during the past 30 days?” Using these same questions, a person was determined to use “glucosamine only” if they respond “glucosamine” but did not respond “chondroitin” to these questions. A person was determined to use “chondroitin only” if they respond “chondroitin” but not “glucosamine” to these questions. Finally, a person was determined to be a user of “both” if the respond both “glucosamine” and “chondroitin” to these questions.

Demographics were placed into variable categories based on survey responses from the Adult Sample questionnaire. Sex is used as a dichotomized variable, “men” and “women”. Age was used as a categorical variable where categories were “18-39 years old”, “40-55 years old”, “56-70 years old”, “70-84 years old”, and “≥85 years old.” Region, education, and race were also categorical variables. The categories for region are “Northeast”, “Midwest”, “South”, and “West”. Education was documented as the highest level of education achieved by a family member. These categories are “Did Not Complete High School”, “GED”, “High School Diploma”, “Some College, No Degree”, “Associate’s Degree”, “Bachelor's Degree”, and “Master's, Professional, or Doctoral Degree”. Race categories are “White”, “Black/African American”, “Hispanic/Latino”, “American Indian or Alaskan Native”, and “Asian”. Poverty level is a calculated variable in the public release data. Because poverty level was missing about 8.2% as shown in Table 1, poverty level was used as a three level variable, “Above Poverty Line”, “At or Below Poverty Line”, and “Unknown” to eliminate missing.

To achieve better estimates, other health conditions and BMI were also analyzed. A dichotomized variable for other health conditions was created in which a person determined to have “other health conditions” responded “yes” to being told by a doctor or other health

professional that they had either diabetes (except when pregnant if female) or a heart condition. Because BMI is a risk factor for arthritis, it is also included (CDC 2014). Because BMI is associated with certain forms of arthritis, BMI was used as a three level variable where categories are "≤ 24.9", ">24.9 and <30.0", and "≥ 30.0" to identify persons that are underweight and normal weight, overweight, and obese.

To control for confounding with other therapies used by respondents, the following were categorized as dichotomous variables if respondents reported the use of therapies, either themselves or with a professional, within the past 12 months: chiropractic or osteopathic manipulation, energy therapies, mind-body therapies, and acupuncture. In previous studies, all of these CAM therapies were described as potentially being effective in improving health and/or decreasing pain (Corbett et al. 2013; Wang et al. 2009; Haaz & Bartlett 2011; Thorman et al. 2010; Barsky et al. 2010). Energy therapies include the use of Yoga, Tai Chi, and Qi Gong. Mind-body therapies include the use of Mantra Meditation, Mindful Meditation, Spiritual Meditation, Guided Imagery, and Progressive Relaxation. While Yoga and Tai Chi are often classified as Mind-body therapies as well, they will be considered energy therapies for this thesis to be consistent with the 2012 NHIS classifications and to prevent Qi Gong from representing this category alone.

DEPENDENT VARIABLES

This study has two dependent variables. The first dependent variable assessed in this thesis is improved health in the past 12-months. A person is determined to have "improved health" if they respond "better" to: "Compared with 12 months ago, would you say your health is better, worse, or about the same?" Likewise, a person is determined to have "unimproved health" if they responded "worse" or "about the same" to this question. The other dependent variable

assessed in this thesis is joint pain, aching, and stiffness in the past 30 days. A person is determined to have "pain" if they respond "yes" to: "During the past 30 days, have you had any symptoms of pain, aching, or stiffness in or around a joint?" If a person answered "no" to this question, they are then classified as having "no pain".

Table 1: Missing Variables in the 2012 National Health Interview Survey (NHIS)

2012 NHIS Adult Sample N= 34525			
Characteristics	Not Missing	Missing	% Missing
Any Arthritis	34485	40	0.1
Unspecified Arthritis	34473	52	0.2
Rheumatoid Arthritis	34473	52	0.2
12 Month Glucosamine Use	34495	30	0.1
30 Day Glucosamine Use	34525	0	0.0
12 Month Chondroitin Use	34495	30	0.2
30 Day Chondroitin Use	34525	0	0.0
Sex	34525	0	0.0
Age	34525	0	0.0
Race/Ethnicity	33919	606	1.5
BMI	33170	1355	4.1
Education	34457	68	0.1
Poverty Level	31661	2864	8.2
Poverty Level Recode*	34525	0	0.0
Region	34525	0	0.0
Other Health Conditions	34488	37	0.1
Energy Therapies	34522	3	0.0
Acupuncture	34525	0	0.0
Mind-Body Therapies	34524	1	0.0
Chiropractic/ Osteopathic Therapy	34521	4	0.2
Total**	32385	2140	6.0

*Poverty was recoded from a bivariate to a three level variable to eliminate missing.
**The calculated total uses the recoded variable of poverty level. It is important to note that this total is not a simple tally of all missing variables but a count of all persons with at least one missing variable.

DATA ANALYSIS

All analyses for this study were conducted using Statistical Analysis System 9.4 (SAS 9.4). The analysis accounted for the survey design and nonresponse using SAS survey procedures. All estimates were weighted to the U.S. population to generate nationally representative estimates based on 2010 U.S. census data.

Descriptive statistics were used to summarize characteristics that are potential risk or protective factors for arthritis. Frequency distributions are used to identify the proportion of the 2012 National Health Interview Survey (NHIS) population that has any arthritis, unspecified arthritis, and rheumatoid arthritis. It is also used to identify glucosamine and/or chondroitin use within the past 12 months and within the past 30 days of the administration of the 2012 NHIS among these subgroups.

Logistic regressions were used to conduct bivariate analyses of selected characteristics and reports of improved health over a 12 month period among persons with each any arthritis, unspecified arthritis, and rheumatoid arthritis. Logistic regressions were also used to conduct bivariate analyses of selected characteristics and reports of joint pain, aching, and stiffness in the past 30 days among persons with each any arthritis, unspecified arthritis, and rheumatoid arthritis. Because chondroitin only and both glucosamine and chondroitin use within the past 30 days among persons with rheumatoid arthritis was unable to be observed due to small sample size, past 30 day glucosamine use was modeled as a bivariate variable: “no glucosamine use” and “glucosamine use”. All of these analyses were then used to identify possible confounding.

Logistic multivariate regression models were built using all selected CAM therapies (energy therapies, acupuncture, mind-body therapies, chiropractic/osteopathic therapy) and demographics that yielded statistically significant odds ratios in the bivariate analyses. The level

of significance was alpha= 0.05. Different models were fit to quantify the associations of glucosamine and/or chondroitin use within the past 12 months and self-reported improved health when compared to 12 months ago among persons with each any arthritis, unspecified arthritis, and rheumatoid arthritis. The same was done to quantify the associations of glucosamine and/or chondroitin use within the past 30 days and reports of joint pain, aching, or stiffness in or around a joint over the past 30 days among persons with each any arthritis, unspecified arthritis. Due to the small sample size of chondroitin only and both glucosamine and chondroitin use within the past 30 days among persons with rheumatoid arthritis, past 30 day glucosamine use was dichotomized as: “no glucosamine use” and “glucosamine use”.

CHAPTER IV

RESULTS

DESCRIPTIVE STATISTICS

Approximately 21.8% of the U.S population had any arthritis in 2012 (Table 2); 17% had unspecified arthritis and 2.5% reported having rheumatoid arthritis. Women were more likely than men to report some form of arthritis. Approximately 25% of women reported having any arthritis, 19.7% reported having unspecified arthritis, and 3.2% reported having rheumatoid arthritis when compared to 18.4% of any arthritis, 14.2% unspecified arthritis and 1.7% rheumatoid arthritis among men. As can be seen in Table 2, prevalence of any arthritis, unspecified arthritis, and rheumatoid arthritis increases with age and BMI. In addition, persons with diabetes and/or heart conditions (other health conditions) had prevalence rates of some form of arthritis more than twice of that of persons who did not have other health conditions. Persons with other health conditions had a 44.2% prevalence of any arthritis, 34.8% of unspecified arthritis, and 5.4% of and rheumatoid arthritis. Persons that did not have other health conditions had a prevalence rate of 17.7% of any arthritis, 13.7% of unspecified arthritis, and 1.9% of rheumatoid arthritis.

Table 2: Prevalence and Demographic Characteristics of Sample Adults Ages 18+ with Any Arthritis, Unspecified Arthritis, and Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Adult Population N= 32385						
Characteristics	No Arthritis n (%)	Any Arthritis n (%)	No Unspecified Arthritis n (%)	Unspecified Arthritis n (%)	No Rheumatoid Arthritis n (%)	Rheumatoid Arthritis n (%)
Total	24731 (78.2)	7654 (21.8)	26369 (83.0)	6016 (17.0)	31487 (97.5)	898 (2.5)
Sex						
Men	11735 (81.6)	2889 (18.4)	12377 (85.8)	2247 (14.2)	14340 (98.3)	284 (1.7)
Women	12996 (75.0)	4765 (25.0)	13992 (80.3)	3769 (19.7)	17147 (96.8)	614 (3.2)
Age						
18-39 years old	11019 (94.5)	662 (5.5)	11242 (96.3)	439 (3.7)	11594 (99.2)	87 (0.8)
40-55 years old	7003 (80.0)	1826 (20.0)	7492 (85.3)	1337 (14.7)	8582 (97.3)	247 (2.7)
56-70 years old	4472 (60.0)	3030 (40.0)	5068 (67.8)	2434 (32.2)	7157 (95.9)	345 (4.1)
71-84 years old	1819 (52.5)	1669 (47.5)	2082 (60.3)	1406 (39.7)	3320 (95.4)	168 (4.6)
>85 years old	418 (47.4)	467 (52.6)	485 (55.2)	400 (44.8)	834 (94.5)	51 (5.5)

Race/Ethnicity						
White	14261 (75.0)	5346 (25.0)	15444 (80.2)	4263 (19.8)	19175 (97.5)	532 (2.5)
Black/African American	3614 (78.9)	1248 (21.1)	3917 (84.1)	945 (15.9)	4657 (96.4)	205 (3.6)
Hispanic/Latino	4808 (88.1)	777 (11.9)	4990 (91.1)	595 (8.9)	5451 (97.8)	134 (2.2)
American Indian or Alaskan Native	1799 (89.9)	234 (10.1)	1853 (92.3)	180 (7.7)	2017 (99.1)	16 (0.9)
Asian	149 (76.0)	49 (24.0)	165 (84.7)	33 (15.3)	187 (94.5)	11 (5.5)
BMI						
≤ 24.9	9781 (84.8)	2051 (15.2)	10205 (88.1)	1627 (11.9)	11586 (98.2)	246 (1.8)
>24.9 and <30.0	8588 (78.1)	2629 (21.9)	9137 (82.8)	2080 (17.2)	10940 (97.8)	277 (2.2)
≥ 30.0	6362 (69.8)	2974 (30.2)	7027 (76.6)	2309 (23.4)	8961 (96.3)	375 (3.7)
Education						
Did Not Complete High School	2488 (75.2)	986 (24.8)	2652 (79.1)	822 (20.9)	3348 (96.6)	126 (3.4)
GED	549 (72.4)	221 (27.6)	605 (79.8)	165 (20.2)	733 (95.5)	37 (4.5)
High School Diploma	4630 (74.9)	1698 (25.1)	5003 (80.3)	1325 (19.7)	6114 (96.9)	214 (3.1)
Some College, No Degree	4941 (77.3)	1554 (22.7)	5273 (82.3)	1222 (17.7)	6310 (97.4)	185 (2.6)
Associate's Degree	3138 (75.8)	998 (24.2)	3378 (82.0)	758 (18.0)	3999 (96.7)	137 (3.3)
Bachelor's Degree	5411 (83.0)	1242 (17.0)	5673 (86.4)	980 (13.6)	6540 (98.6)	113 (1.4)
Master's, Professional, or Doctoral Degree	3574 (80.2)	955 (19.8)	3785 (84.9)	744 (15.1)	4443 (98.2)	86 (1.8)
Poverty Level						
Above Poverty Line	18603 (78.2)	5753 (21.8)	19833 (82.9)	4523 (17.1)	23730 (97.6)	626 (2.4)
Below Poverty Line	4305 (79.7)	1254 (20.3)	4594 (84.6)	965 (15.4)	5353 (96.9)	206 (3.1)
Unknown	1823 (76.2)	647 (23.8)	1942 (80.6)	528 (19.4)	2404 (97.5)	66 (2.5)
Region						
Northeast	4131 (79.2)	1281 (20.8)	4394 (83.6)	1018 (16.4)	5255 (97.5)	157 (2.5)
Midwest	5057 (76.0)	1712 (24.1)	5385 (80.7)	1384 (19.3)	6595 (97.6)	174 (2.4)
South	8907 (77.6)	2924 (22.4)	9566 (82.7)	2265 (17.3)	11467 (97.4)	364 (2.6)
West	6636 (80.6)	1737 (19.4)	7024 (85.3)	1349 (14.7)	8170 (97.7)	203 (2.3)
No Other Health Conditions	21703 (82.3)	5092 (17.7)	22789 (86.3)	4006 (13.7)	26233 (98.1)	562 (1.9)
Other Health Conditions	3028 (55.8)	2562 (44.2)	3580 (65.2)	2010 (34.8)	5254 (94.6)	336 (5.4)
No Energy Therapies	22265 (77.8)	7073 (22.2)	23778 (82.7)	5560 (17.3)	28498 (97.4)	840 (2.6)
Energy Therapies	2466 (81.9)	581 (18.1)	2591 (85.6)	456 (14.4)	2989 (98.4)	58 (1.6)
No Acupuncture	24349 (78.4)	7456 (21.6)	25945 (83.1)	5860 (16.9)	30931 (97.5)	874 (2.5)
Acupuncture	382 (66.7)	198 (33.3)	424 (74.3)	156 (25.7)	556 (96.0)	24 (4.0)
No Mind-Body Therapies	23729 (78.5)	7234 (21.5)	25261 (83.2)	5702 (16.8)	30111 (97.6)	852 (2.4)
Mind-Body Therapies	1002 (71.1)	420 (28.9)	1108 (78.9)	314 (21.1)	1376 (96.9)	46 (3.1)
No Chiropractic/ Osteopathic Therapy	22755 (78.9)	6780 (21.1)	24223 (83.6)	5312 (16.4)	28715 (97.5)	820 (2.5)
Chiropractic/ Osteopathic Therapy	1976 (71.1)	874 (28.9)	2146 (76.7)	704 (23.3)	2772 (97.5)	78 (2.5)
12 Month Supplement Use:						
Neither	24127 (79.1)	7142 (20.9)	25679 (83.8)	5590 (16.2)	30424 (97.6)	845 (2.4)
Glucosamine Only	347 (56.8)	267 (43.2)	407 (66.2)	207 (33.8)	582 (96.9)	32 (3.1)
Chondroitin Only	44 (57.8)	26 (42.2)	46 (61.2)	24 (38.8)	67 (96.4)	3 (3.6)
Both	213 (47.8)	219 (52.2)	237 (53.8)	195 (46.2)	414 (96.3)	18 (3.7)
30 Day Supplement Use:						
Neither	24229 (78.9)	7244 (21.1)	25798 (83.6)	5675 (16.4)	30617 (97.6)	856 (2.4)
Glucosamine Only	353 (48.8)	339 (51.2)	405 (56.1)	287 (43.9)	658 (96.7)	34 (3.3)
Chondroitin Only	121 (71.8)	45 (28.2)	131 (78.7)	35 (21.3)	163 (96.3)	3 (3.7)
Both	28 (57.9)	26 (42.1)	35 (68.6)	19 (31.4)	49 (94.0)	5 (6.0)

*This table presents unweighted frequencies and weighted row percentages.

Table 3 presents past 12 month glucosamine and/or chondroitin use among persons with any arthritis. Approximately 3.7% of persons with any arthritis use glucosamine, 0.4% use chondroitin, and 3.4% use both glucosamine and chondroitin. While glucosamine and both glucosamine and chondroitin users were more likely to be women (58.9% and 59.7% respectively), chondroitin users were more likely to be men (60.8%). Glucosamine, chondroitin, and both glucosamine and chondroitin users were more likely to be between the ages of 56 to 70 (46.5%, 41.6%, and 57.3% respectively). Persons above the poverty line were more likely to be supplement users than persons below the poverty line or persons whom income level is unknown. Persons above the poverty line made up 91.3% of glucosamine use, 86.4% of chondroitin use, and 94.2% of both glucosamine and chondroitin use. While persons in the West made up the majority of glucosamine users (40.1%), persons in the Midwest made up the majority of chondroitin users (50.4). Persons in the Northeast had the lowest prevalence of any supplement use. In addition, more than a quarter of glucosamine users (27.7%) had other health conditions (diabetes and/or heart conditions).

Table 3: Demographic Characteristics of Glucosamine and/or Chondroitin Use within the Past 12 Months among Sample Adult Ages 18+ with Any Arthritis, 2012 National Health Interview Survey (NHIS)

Sample Adult with Any Arthritis n= 7654				
Characteristics	No Supplemental Use n (%)	Glucosamine Only n (%)	Chondroitin Only n (%)	Both n (%)
Total	7142 (92.5)	267 (3.7)	26 (0.4)	219 (3.4)
Sex				
Men	2689 (41.5)	99 (41.0)	12 (60.8)	89 (40.3)
Women	4453 (58.5)	168 (58.9)	14 (39.2)	130 (59.7)
Age				
18-39 years old	628 (10.0)	22 (9.1)	0 (0.0)	12 (6.8)
40-55 years old	1702 (26.8)	72 (26.7)	7 (37.8)	45 (22.3)
56-70 years old	2776 (38.5)	119 (46.5)	11 (41.6)	124 (57.3)
71-84 years old	1582 (19.7)	48 (16.0)	7 (17.2)	32 (11.9)
>85 years old	454 (5.0)	6 (1.8)	1 (3.4)	6 (1.7)

Race/Ethnicity				
White	4926 (76.7)	206 (83.4)	23 (93.0)	191 (91.0)
Black/African American	1203 (11.6)	29 (8.8)	1 (3.3)	15 (4.2)
Hispanic/Latino	748 (8.6)	18 (5.0)	2 (3.7)	9 (3.1)
American Indian or Alaskan Native	220 (2.5)	11 (2.5)	0 (0.0)	3 (1.3)
Asian	45 (0.5)	3 (0.3)	0 (0.0)	1 (0.5)
BMI Category				
≤ 24.9	1925 (25.7)	74 (28.1)	6 (18.7)	46 (20.0)
>24.9 and <30.0	2442 (35.1)	95 (35.8)	9 (38.7)	83 (34.3)
≥ 30.0	2775 (39.2)	98 (36.0)	11 (42.6)	90 (45.7)
Education				
Did Not Complete High School	973 (8.9)	8 (1.4)	1 (1.9)	4 (1.7)
GED	218 (2.6)	2 (0.1)	0 (0.0)	1 (0.6)
High School Diploma	1625 (21.3)	47 (16.4)	3 (8.9)	23 (10.9)
Some College, No Degree	1450 (20.8)	61 (20.8)	5 (17.2)	38 (14.7)
Associate's Degree	912 (15.0)	39 (16.1)	6 (29.4)	41 (22.2)
Bachelor's Degree	1127 (17.6)	55 (21.1)	4 (18.9)	56 (26.4)
Master's, Professional, or Doctoral Degree	837 (13.8)	55 (24.0)	7 (23.7)	56 (23.5)
Poverty Level				
Above Poverty Line	5291 (78.7)	239 (91.3)	22 (86.4)	201 (94.2)
Below Poverty Line	1227 (12.6)	17 (5.7)	3 (10.2)	7 (1.5)
Unknown	624 (8.6)	11 (3.0)	1 (3.4)	11 (4.3)
Region				
Northeast	1219 (17.7)	33 (10.5)	2 (12.4)	27 (14.5)
Midwest	1583 (24.8)	65 (29.0)	11 (50.4)	53 (29.9)
South	2801 (38.5)	58 (20.4)	7 (28.6)	58 (29.0)
West	1539 (19.0)	111 (40.1)	6 (8.5)	81 (26.6)
Other Health Conditions	2433 (32.3)	71 (27.7)	5 (8.2)	53 (19.1)
Energy Therapies	483 (7.0)	45 (18.3)	6 (21.5)	47 (21.4)
Acupuncture	165 (2.1)	21 (8.3)	2 (12.7)	10 (4.7)
Mind-Body Therapies	352 (5.0)	34 (13.1)	3 (12.6)	31 (14.0)
Chiropractic/ Osteopathic Therapy	758 (11.0)	56 (22.5)	5 (23.2)	55 (24.8)

*This table presents unweighted frequencies and weighted column percentages.

Table 4 presents past 12 month glucosamine and/or chondroitin use among persons with unspecified arthritis. Approximately 3.7% of persons with unspecified arthritis were glucosamine users, 0.5% were chondroitin users, and 3.8% were both glucosamine and chondroitin users. Similar to among persons with any arthritis, among persons with unspecified arthritis, glucosamine and both glucosamine and chondroitin users were more likely to be women (60.7% and 61.9% respectively) than men. Men were more likely to be chondroitin users (57.3). Persons ages 56-70 years of age made up a large proportion of supplement used (49.1% glucosamine use, 45.2% chondroitin use, and 60.7% both glucosamine and chondroitin use). More than half (54.9%) of the proportion of chondroitin users were from the Midwest.

Table 4: Demographic Characteristics of Glucosamine and/or Chondroitin Use within the Past 12 Months among Sample Adult Ages 18+ with Unspecified Arthritis, 2012 National Health Interview Survey (NHIS)

Sample Adult with Unspecified Arthritis n= 6016				
Characteristics	No Supplemental Use n (%)	Glucosamine Only n (%)	Chondroitin Only n (%)	Both n (%)
Total	5590 (92.0)	207 (3.7)	24 (0.5)	195 (3.8)
Sex				
Men	2087 (41.2)	74 (39.3)	10 (57.3)	76 (38.1)
Women	3503 (58.8)	133 (60.7)	14 (42.7)	119 (61.9)
Age				
18-39 years old	418 (8.5)	11 (6.1)	0 (0.0)	10 (6.9)
40-55 years old	1243 (25.3)	52 (26.0)	6 (33.2)	36 (18.2)
56-70 years old	2207 (39.5)	101 (49.1)	11 (45.2)	115 (60.7)
71-84 years old	1332 (21.2)	38 (16.6)	6 (17.8)	30 (12.6)
>85 years old	390 (5.5)	5 (2.2)	1 (3.7)	4 (1.6)
Race/Ethnicity				
White	3909 (77.7)	161 (84.1)	22 (93.2)	171 (91.8)
Black/African American	907 (11.1)	23 (9.5)	1 (3.6)	14 (4.5)
Hispanic/Latino	574 (8.2)	12 (4.1)	1 (3.2)	8 (3.1)
American Indian or Alaskan Native	170 (2.5)	9 (2.2)	0 (0.0)	1 (0.2)
Asian	30 (0.4)	2 (0.1)	0 (0.0)	1 (0.5)
BMI Category				
≤ 24.9	1524 (26.0)	59 (27.9)	6 (20.3)	38 (18.4)
>24.9 and <30.0	1928 (35.2)	71 (35.4)	9 (42.1)	72 (32.5)
≥ 30.0	2138 (38.7)	77 (36.6)	9 (37.5)	85 (49.1)
Education				
Did Not Complete High School	812 (9.6)	5 (0.6)	1 (2.0)	4 (2.0)
GED	163 (2.4)	1 (0.1)	0 (0.0)	1 (0.7)
High School Diploma	1264 (21.5)	36 (15.5)	2 (8.8)	23 (12.3)
Some College, No Degree	1136 (20.8)	48 (22.5)	5 (18.7)	33 (14.1)
Associate’s Degree	684 (14.2)	32 (15.6)	5 (24.1)	37 (21.9)
Bachelor's Degree	883 (17.9)	41 (22.2)	4 (20.6)	52 (27.5)
Master's, Professional, or Doctoral Degree	648 (13.5)	44 (23.5)	7 (25.8)	45 (21.5)
Poverty Level				
Above Poverty Line	4137 (78.6)	186 (93.4)	21 (93.1)	179 (93.9)
Below Poverty Line	947 (12.5)	10 (2.8)	2 (3.2)	6 (1.6)
Unknown	506 (9.0)	11 (3.8)	1 (3.7)	10 (4.6)
Region				
Northeast	967 (17.9)	25 (10.8)	2 (13.5)	24 (14.2)
Midwest	1269 (25.4)	56 (32.2)	11 (54.9)	48 (30.1)
South	2167 (38.3)	38 (16.6)	6 (23.2)	54 (29.9)
West	1187 (18.4)	88 (40.4)	5 (8.4)	69 (15.9)
Other Health Conditions	1904 (32.7)	55 (26.7)	4 (8.1)	47 (20.2)
Energy Therapies	372 (7.1)	37 (18.5)	6 (23.4)	41 (20.5)
Acupuncture	131 (2.1)	16 (7.6)	2 (13.9)	7 (2.9)
Mind-Body Therapies	258 (4.7)	27 (11.0)	2 (5.8)	27 (13.4)
Chiropractic/ Osteopathic Therapy	604 (11.4)	47 (23.6)	5 (25.3)	48 (23.0)

*This table presents unweighted frequencies and weighted column percentages.

Table 5 presents past 12 month glucosamine and/or chondroitin use among persons with rheumatoid arthritis. Approximately 2.4% of persons with rheumatoid arthritis used glucosamine while 0.3% used chondroitin, and 2.1% used both glucosamine and chondroitin. The majority of glucosamine and both glucosamine and chondroitin use were women (59.3% and 58.0% respectively) however; men made up 94.0% of chondroitin use. Persons 40-55 years old made up 85.1% of chondroitin use. Obese (BMI >30.0) individuals had the highest proportion of glucosamine and chondroitin use (42.9% and 94.0% respectively). While glucosamine use and both glucosamine and chondroitin use were most common among persons above poverty level (83.3% and 100.0% respectively), persons below poverty level made up the highest proportion of chondroitin use (85.1%).

Table 5: Demographic Characteristics of Glucosamine and/or Chondroitin Use within the Past 12 Months among Sample Adult Ages 18+ with Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Sample Adult with Rheumatoid Arthritis n= 898				
Characteristics	No Supplemental Use n (%)	Glucosamine Only n (%)	Chondroitin Only n (%)	Both n (%)
Total	845 (95.2)	32 (2.4)	13 (0.3)	18 (2.1)
Sex				
Men	263 (34.2)	10 (40.7)	2 (94.0)	9 (42.0)
Women	582 (65.8)	22 (59.3)	1 (6.0)	9 (58.0)
Age				
18-39 years old	81 (11.7)	4 (23.4)	0 (0.0)	2 (9.6)
40-55 years old	233 (31.1)	8 (23.1)	1 (85.1)	5 (44.1)
56-70 years old	323 (35.8)	13 (40.2)	1 (6.0)	8 (37.8)
71-84 years old	159 (16.8)	6 (12.3)	1 (8.9)	2 (7.6)
>85 years old	49 (4.6)	1 (1.0)	0 (0.0)	1 (1.0)
Race/Ethnicity				
White	495 (67.0)	21 (64.5)	2 (91.1)	14 (75.7)
Black/African American	199 (17.0)	5 (16.6)	0 (0.0)	1 (2.8)
Hispanic/Latino	128 (13.4)	4 (15.3)	1 (8.9)	1 (5.4)
American Indian or Alaskan Native	13 (1.5)	1 (1.1)	0 (0.0)	2 (16.1)
Asian	10 (1.0)	1 (2.5)	0 (0.0)	0 (0.0)
BMI Category				
≤ 24.9	233 (26.7)	7 (21.6)	0 (0.0)	6 (39.0)
>24.9 and <30.0	257 (30.7)	13 (35.5)	1 (6.0)	6 (33.2)
≥ 30.0	355 (42.6)	12 (42.9)	2 (94.0)	6 (27.7)

Education				
Did Not Complete High School	123 (10.1)	3 (12.8)	0 (0.0)	0 (0.0)
GED	36 (3.6)	1 (1.2)	0 (0.0)	0 (0.0)
High School Diploma	208 (23.4)	5 (14.2)	1 (8.9)	0 (0.0)
Some College, No Degree	171 (20.9)	12 (29.1)	0 (0.0)	2 (8.6)
Associate's Degree	129 (18.0)	4 (17.6)	1 (85.1)	3 (31.9)
Bachelor's Degree	105 (12.8)	4 (14.9)	0 (0.0)	4 (26.3)
Master's, Professional, or Doctoral Degree	73 (11.0)	3 (10.4)	1 (6.0)	9 (33.3)
Poverty Level				
Above Poverty Line	578 (76.1)	28 (83.3)	2 (14.9)	18 (100.0)
Below Poverty Line	201 (16.0)	4 (16.7)	1 (85.1)	0 (0.0)
Unknown	66 (7.9)	0 (0.0)	0 (0.0)	0 (0.0)
Region				
Northeast	151 (19.0)	4 (7.7)	0 (0.0)	2 (6.3)
Midwest	164 (21.4)	4 (20.8)	0 (0.0)	6 (52.6)
South	351 (39.4)	11 (39.4)	1 (85.1)	1 (3.7)
West	179 (20.2)	13 (32.1)	2 (14.9)	9 (29.3)
Other Health Conditions	321 (35.1)	9 (20.7)	2 (14.9)	4 (12.1)
Energy Therapies	49 (5.3)	3 (12.1)	1 (6.0)	5 (40.6)
Acupuncture	19 (1.9)	2 (7.6)	0 (0.0)	3 (29.5)
Mind-Body Therapies	40 (4.6)	3 (9.2)	1 (85.1)	2 (25.7)
Chiropractic/ Osteopathic Therapy	63 (7.7)	7 (22.7)	0 (0.0)	8 (53.5)

*This table presents unweighted frequencies and weighted column percentages.

Table 6 presents past 30 day glucosamine and/or chondroitin use among persons with any arthritis. Approximately 5.1% of persons with any arthritis used glucosamine, 0.6% used chondroitin, and 0.4% used both glucosamine and chondroitin within the past 30 days. As presented in Table 6, women made up the majority of all past 30 day supplement use (59.3% glucosamine, 76.6% chondroitin, and 63.4% both glucosamine and chondroitin). Persons 56 to 70 years old had the highest proportion of all past 30 day supplement use (55.7% glucosamine, 57.7% chondroitin, and 39.2% both glucosamine and chondroitin). White people also made up the majority of all past 30 day supplement use (90.3% glucosamine, 81.9% chondroitin, and 72.4% both glucosamine and chondroitin). Persons above poverty level also made up the majority of all past 30 day supplement use (92.1% glucosamine, 80.2% chondroitin, and 96.7% both glucosamine and chondroitin).

Table 6: Demographic Characteristics of Glucosamine and/or Chondroitin Use within the Past 30 Days among Sample Adult Ages 18+ with Any Arthritis, 2012 National Health Interview Survey (NHIS)

Sample Adult with Any Arthritis n= 7654				
Characteristics	No Supplemental Use n (%)	Glucosamine Only n (%)	Chondroitin Only n (%)	Both n (%)
Total	7244 (94.0)	339 (5.1)	45 (0.6)	26 (0.4)
Sex				
Men	2738 (41.7)	132 (40.7)	11 (23.4)	8 (36.6)
Women	4506 (58.3)	207 (59.3)	34 (76.6)	18 (63.4)
Age				
18-39 years old	640 (10.0)	13 (5.0)	6 (9.6)	3 (11.1)
40-55 years old	1734 (27.0)	72 (20.9)	12 (21.0)	8 (28.6)
56-70 years old	2821 (38.5)	177 (55.7)	21 (57.7)	11 (39.2)
71-84 years old	1593 (19.5)	67 (16.5)	6 (11.7)	3 (18.4)
>85 years old	456 (5.0)	10 (1.9)	0 (0.0)	1 (2.7)
Race/Ethnicity				
White	5012 (76.8)	282 (90.3)	33 (81.9)	19 (72.4)
Black/African American	1213 (11.6)	22 (4.1)	7 (7.6)	6 (25.4)
Hispanic/Latino	751 (8.5)	21 (4.0)	5 (10.5)	0 (0.0)
American Indian or Alaskan Native	222 (2.5)	11 (1.3)	0 (0.0)	1 (2.1)
Asian	46 (0.5)	3 (0.2)	0 (0.0)	0 (0.0)
BMI Category				
≤ 24.9	1948 (25.5)	84 (26.1)	11 (33.3)	8 (19.0)
>24.9 and <30.0	2476 (35.1)	127 (34.6)	15 (23.6)	11 (55.7)
≥ 30.0	2820 (39.4)	128 (39.3)	19 (43.1)	7 (25.3)
Education				
Did Not Complete High School	973 (8.7)	7 (1.2)	3 (4.9)	3 (6.7)
GED	216 (2.5)	2 (0.5)	3 (3.5)	0 (0.0)
High School Diploma	1636 (21.1)	53 (15.6)	5 (12.9)	4 (17.8)
Some College, No Degree	1474 (20.8)	65 (16.8)	9 (21.2)	6 (17.8)
Associate's Degree	930 (15.1)	62 (20.5)	6 (13.5)	0 (0.0)
Bachelor's Degree	1156 (17.7)	68 (22.2)	8 (20.0)	10 (32.0)
Master's, Professional, or Doctoral Degree	859 (14.0)	82 (23.2)	11 (23.8)	3 (25.8)
Poverty Level				
Above Poverty Line	5388 (79.0)	308 (92.1)	33 (80.2)	24 (96.7)
Below Poverty Line	1230 (12.5)	14 (3.6)	9 (15.0)	1 (0.6)
Unknown	626 (8.5)	17 (4.3)	3 (4.8)	1 (2.7)
Region				
Northeast	1231 (17.5)	44 (14.5)	2 (6.5)	4 (9.1)
Midwest	1612 (25.0)	83 (30.8)	12 (34.9)	5 (12.9)
South	2822 (38.4)	80 (22.3)	15 (31.0)	7 (29.0)
West	1579 (19.1)	132 (32.5)	16 (27.6)	10 (49.1)
Other Health Conditions	2459 (32.2)	86 (22.9)	13 (20.2)	4 (28.6)
Energy Therapies	509 (7.3)	52 (15.5)	11 (34.7)	9 (47.4)
Acupuncture	171 (2.2)	18 (5.9)	5 (9.3)	4 (16.7)
Mind-Body Therapies	365 (5.2)	40 (11.6)	9 (21.2)	6 (28.7)
Chiropractic/ Osteopathic Therapy	777 (11.2)	75 (23.5)	13 (22.9)	9 (35.8)

*This table presents unweighted frequencies and weighted column percentages.

Table 7 presents past 30 day glucosamine and/or chondroitin use among persons with unspecified arthritis. Approximately 5.5% of persons with unspecified arthritis had past 30 day use of glucosamine, 0.5% chondroitin, and 0.4% both glucosamine and chondroitin. Women made up the majority of all supplement use (62.4% glucosamine, 69.7% chondroitin, and 56.8% both glucosamine and chondroitin). Persons age 56 to 70 years old reported the highest proportion of past 30 day supplement use (57.9% glucosamine, 57.1% chondroitin, 33.0% both glucosamine and chondroitin). Supplement use was most common among white persons with unspecified arthritis (90.9% glucosamine, 78.3% chondroitin, and 67.2% both glucosamine and chondroitin). Persons above poverty level also had the highest proportion of all supplement use (93.0% glucosamine, 76.6% chondroitin, and 95.5% both glucosamine and chondroitin). Persons with unspecified arthritis in the Northeast had the lowest proportion of any supplement use (14.7% glucosamine, 2.0% chondroitin, and 5.3% both glucosamine and chondroitin).

Table 7: Demographic Characteristics of Glucosamine and/or Chondroitin Use within the Past 30 Days among Sample Adult Ages 18+ with Unspecified Arthritis, 2012 National Health Interview Survey (NHIS)

Sample Adult with Unspecified Arthritis n= 6016				
Characteristics	No Supplemental Use n (%)	Glucosamine Only n (%)	Chondroitin Only n (%)	Both n (%)
Total	5675 (93.5)	287 (5.5)	35 (0.5)	19 (0.4)
Sex				
Men	2125 (41.4)	106 (37.6)	10 (30.3)	6 (43.3)
Women	3550 (58.6)	181 (62.4)	25 (69.7)	13 (56.8)
Age				
18-39 years old	422 (8.5)	9 (4.9)	6 (12.7)	2 (10.0)
40-55 years old	1271 (25.5)	56 (18.3)	7 (15.5)	3 (26.6)
56-70 years old	2249 (39.6)	158 (57.9)	17 (57.1)	10 (33.0)
71-84 years old	1341 (20.9)	57 (16.9)	5 (14.8)	3 (24.7)
≥ 85 years old	392 (5.5)	7 (2.0)	0 (0.0)	1 (3.7)
Race/Ethnicity				
White	3984 (77.9)	242 (90.9)	24 (78.3)	13 (67.2)
Black/African American	915 (11.1)	19 (4.3)	6 (7.7)	5 (30.0)
Hispanic/Latino	575 (8.1)	15 (3.3)	5 (14.0)	0 (0.0)
American Indian or Alaskan Native	170 (2.4)	9 (1.4)	0 (0.0)	1 (2.8)
Asian	31 (0.5)	2 (0.1)	0 (0.0)	0 (0.0)
BMI Category				
≤ 24.9	1543 (25.8)	69 (24.3)	9 (37.4)	6 (21.3)
>24.9 and <30.0	1954 (35.2)	104 (34.6)	14 (30.5)	8 (49.9)

≥ 25.0	2178 (39.0)	114 (41.1)	12 (32.1)	5 (28.8)
Education				
Did Not Complete High School	811 (9.4)	6 (1.3)	3 (6.4)	2 (6.3)
GED	162 (2.3)	1 (0.5)	2 (1.9)	0 (0.0)
High School Diploma	1275 (21.3)	44 (14.9)	3 (6.7)	3 (22.3)
Some College, No Degree	1157 (20.8)	51 (16.7)	8 (27.4)	6 (23.9)
Associate's Degree	698 (14.3)	55 (19.5)	5 (11.2)	0 (0.0)
Bachelor's Degree	905 (18.0)	63 (24.8)	6 (19.5)	6 (30.4)
Master's, Professional, or Doctoral Degree	667 (13.7)	67 (22.2)	8 (26.7)	2 (17.1)
Poverty Level				
Above Poverty Line	4221 (80.0)	261 (93.0)	24 (76.6)	17 (95.5)
Below Poverty Line	946 (12.2)	10 (2.2)	8 (17.1)	1 (0.8)
Unknown	508 (8.8)	16 (4.8)	3 (6.3)	1 (3.7)
Region				
Northeast	978 (17.8)	37 (14.7)	1 (2.0)	2 (5.3)
Midwest	1297 (25.6)	76 (32.6)	8 (30.5)	3 (14.0)
South	2182 (38.1)	65 (21.4)	12 (32.0)	6 (37.4)
West	1218 (18.6)	109 (31.4)	14 (35.5)	8 (43.3)
Other Health Conditions	1927 (32.5)	72 (22.8)	9 (20.1)	2 (19.3)
Energy Therapies	396 (7.4)	45 (15.4)	8 (38.6)	7 (41.1)
Acupuncture	133 (2.1)	15 (5.1)	5 (12.3)	3 (17.5)
Mind-Body Therapies	270 (4.9)	32 (9.4)	7 (21.0)	5 (21.0)
Chiropractic/ Osteopathic Therapy	621 (11.5)	68 (24.3)	9 (19.1)	6 (22.8)

*This table presents unweighted frequencies and weighted column percentages.

Table 8 presents past 30 day glucosamine and/or chondroitin use among persons with rheumatoid arthritis. Approximately 2.9% of persons with rheumatoid arthritis had past 30 day use of glucosamine, 0.7% chondroitin, and 0.5% both glucosamine and chondroitin. Persons 18 to 39 years old reported the largest proportion of both glucosamine and chondroitin use. Persons 56 to 70 years old reported the largest proportion of glucosamine use (42.9%) and chondroitin use (85.8%). Persons above poverty level also had the highest proportion of all supplement use (95.7% glucosamine, 100.0% chondroitin, and 100.0 both glucosamine and chondroitin). A large proportion of persons that reported past 30 day chondroitin use were from the Midwest (60.9%). Nearly half of the proportion of persons with rheumatoid arthritis that reported use of chiropractic/osteopathic therapy reported past 30 day use of chondroitin (46.7%) and both glucosamine and chondroitin (52.9%).

Table 8: Demographic Characteristics of Glucosamine and/or Chondroitin Use within the Past 30 Days among Sample Adult Ages 18+ with Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Sample Adult with Rheumatoid Arthritis n= 898				
Characteristics	No Supplemental Use n (%)	Glucosamine Only n (%)	Chondroitin Only n (%)	Both n (%)
Total	856 (96.0)	34 (2.9)	3 (0.7)	5 (0.5)
Sex				
Men	270 (34.9)	12 (29.7)	0 (0.0)	2 (65.2)
Women	586 (65.1)	22 (70.2)	3 (100.0)	3 (34.8)
Age				
18-39 years old	83 (11.9)	2 (4.6)	0 (0.0)	2 (65.2)
40-55 years old	236 (31.4)	8 (35.4)	1 (14.2)	2 (22.1)
56-70 years old	328 (35.4)	14 (42.9)	2 (85.8)	1 (12.7)
71-84 years old	160 (16.7)	8 (15.7)	0 (0.0)	0 (0.0)
≥ 85 years old	49 (4.6)	2 (1.5)	0 (0.0)	0 (0.0)
Race/Ethnicity				
White	502 (66.8)	24 (74.6)	2 (85.8)	4 (87.3)
Black/African American	201 (17.0)	2 (4.7)	1 (14.2)	1 (12.7)
Hispanic/Latino	129 (13.3)	5 (16.4)	0 (0.0)	0 (0.0)
American Indian or Alaskan Native	14 (1.8)	2 (2.2)	0 (0.0)	0 (0.0)
Asian	10 (1.0)	1 (2.0)	0 (0.0)	0 (0.0)
BMI Category				
≤ 24.9	234 (26.5)	9 (33.4)	1 (39.1)	2 (22.1)
>24.9 and <30.0	262 (31.1)	13 (26.6)	0 (0.0)	2 (38.9)
≥ 30.0	360 (42.4)	12 (40.0)	2 (60.9)	1 (39.0)
Education				
Did Not Complete High School	124 (10.3)	1 (1.2)	0 (0.0)	1 (14.0)
GED	36 (3.6)	1 (1.0)	0 (0.0)	0 (0.0)
High School Diploma	208 (23.0)	3 (8.2)	1 (46.7)	2 (20.8)
Some College, No Degree	174 (20.9)	10 (23.6)	1 (14.2)	0 (0.0)
Associate's Degree	131 (18.3)	6 (33.0)	0 (0.0)	0 (0.0)
Bachelor's Degree	107 (12.9)	3 (5.8)	1 (39.1)	2 (65.2)
Master's, Professional, or Doctoral Degree	76 (11.1)	10 (27.3)	0 (0.0)	0 (0.0)
Poverty Level				
Above Poverty Line	586 (75.7)	32 (95.7)	3 (100.0)	5 (100.0)
Below Poverty Line	204 (16.4)	2 (4.3)	0 (0.0)	0 (0.0)
Unknown	66 (7.9)	0 (0.0)	0 (0.0)	0 (0.0)
Region				
Northeast	151 (18.8)	5 (14.6)	0 (0.0)	1 (14.0)
Midwest	165 (21.3)	7 (37.6)	2 (60.9)	0 (0.0)
South	353 (39.3)	7 (19.5)	1 (39.1)	3 (59.9)
West	187 (20.6)	15 (28.3)	0 (0.0)	1 (26.1)
Other Health Conditions	325 (35.0)	10 (19.4)	0 (0.0)	1 (8.1)
Energy Therapies	51 (5.3)	5 (26.0)	1 (39.1)	1 (26.1)
Acupuncture	20 (2.0)	2 (17.4)	1 (14.2)	1 (26.1)
Mind-Body Therapies	42 (4.9)	3 (22.0)	0 (0.0)	1 (12.7)
Chiropractic/ Osteopathic Therapy	69 (8.1)	5 (23.5)	1 (46.7)	3 (52.9)

*This table presents unweighted frequencies and weighted column percentages.

BIVARIATE ANALYSES

Table 9 presents odds ratios, 95% Confidence intervals (95% CI), and p-values for selected characteristics and self-reported past 12 month improved health among persons with any arthritis, unspecified arthritis, and rheumatoid arthritis. Age, sex, and region were demographic characteristics that yielded statistically significant associations with self-reported past 12 month improved health among persons with any arthritis. When compared to persons 18 to 39 years old, persons 40 to 55 years old were 0.6 times likely to report improved health (OR= 0.6; p= 0.04), persons 71 to 84 years old were 0.4 times likely to report improved health (OR= 0.4; p= 0.01), and persons 85 years old and older were 0.2 times likely to report improved health (OR= 0.2; p= <0.01) among persons with any arthritis. Men were 0.8 times likely to report improved health when compared to women (OR= 0.8; p= 0.02). Persons in the West were 1.3 times likely to report improved health when compared to persons in the Northeast (OR=1.3; p= 0.01).

All other observed CAM therapies (acupuncture, energy, chiropractic/osteopathic, and mind-body therapies), were shown to be associated with self-reported past 12 month improved health among persons with any arthritis. Persons that saw an acupuncturist one of more times within the 12 months prior to survey administration were 1.9 times likely to report improved health when compared to persons that has not seen an acupuncturist (OR= 1.9; p= <0.01). Persons that engaged in energy therapies one or more times within the 12 months prior to taking the survey were 2.2 times likely to report improved health when compared to persons that never engaged in energy therapy (OR= 2.2; p= <0.01) among persons with any arthritis. Persons that engaged in a mind-body therapy one or more times within the 12 months prior to the administration of the survey were also 2.2 times likely to report improved health when compared to persons that never engaged in an energy therapy (OR=2.2; p= <0.01). Persons that saw a

chiropractor one of more times within the 12 months prior to survey administration were 1.4 times likely to report improved health when compared to persons that did not (OR= 1.4; p= <0.01).

Sex, age, BMI, and education were demographic characteristics that yielded statistically significant associations with self-reported past 12 month improved health among persons with unspecified arthritis, as seen in Table 9. Men were 0.8 times likely to report improved health than women (OR= 0.8; p= 0.02). When compared to persons 18 to 39 years old, persons 71 to 84 years old were 0.3 times likely to report improved health (OR= 0.3; p= <0.01) and persons 85 years and older were 0.2 times likely to report improved health (OR= 0.2; p= <0.01). Obese (BMI ≥ 30) persons with unspecified arthritis were 1.3 times likely to report improved health than persons that were either underweight or normal weight (OR= 1.3; p= 0.01). When compared to persons that did not complete high school, persons with a high school diploma were 0.9 times likely to report improved health (OR= 0.9; p= <0.01), persons with some college were 1.5 times likely to report improved health (OR= 1.5; p= 0.02), and persons with an associate's degree 1.6 times likely to report improved health (OR= 1.6; p= 0.04).

As can be seen in Table 9, all other observed CAM therapies (acupuncture, energy, chiropractic/osteopathic, and mind-body therapies) were shown to be associated with self-reported past 12 month improved health among persons with unspecified arthritis. Persons who saw an acupuncturist one of more times within the 12 months prior to survey administration were 1.8 times likely to report improved health when compared to persons that has not seen an acupuncturist (OR= 1.8; p= 0.01). Persons that engaged in energy therapies one or more times within the 12 months prior to taking the survey were 2.1 times likely to report improved health when compared to persons that never engaged in an energy therapy during this period (OR= 2.1;

p= <0.01). Persons that engaged in mind-body therapy one or more times within the 12 months prior to the administration of the survey were also 2.2 times likely to report improved health when compared to persons that never engaged in a mind-body therapy during this period (OR=2.2; p= <0.01). Persons that saw a chiropractor one of more times within the 12 months prior to survey administration were 1.3 times likely to report improved health when compared to persons that did not (OR= 1.3; p= 0.01).

While no demographic characteristics yielded statistically significant associations with self-reported past 12 month improved health among persons with rheumatoid arthritis, all other observed CAM therapies (acupuncture, energy, chiropractic/ osteopathic, and mind-body therapies) did, as seen in Table 9. Persons who saw an acupuncturist one of more times within the 12 months prior to survey administration were 4.6 times likely to report improved health when compared to persons that had not (OR= 4.6; p= <0.01). Persons that engaged in an energy therapy one or more times within the 12 months prior to taking the survey were 2.7 times likely to report improved health when compared to persons that had not (OR= 2.7; p= 0.01). Persons that engaged in a mind-body therapy one or more times within the 12 months prior to the administration of the survey were also 2.7 times likely to report improved health when compared to persons that never engaged in an mind-body therapy during this period (OR=2.7; p= <0.01). Persons that saw a chiropractor one of more times within the 12 months prior to survey administration were 2.5 times likely to report improved health when compared to persons that did not (OR= 2.5; p= <0.01).

Table 9: Bivariate Analysis of Selected Characteristics and Reports of Improved Health Over a 12 Month Period among Persons with Arthritis, Unspecified Arthritis, and Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Self-Reported Improved Health over a 12-Month Period						
Characteristics	Any Arthritis n= 7654		Unspecified Arthritis n= 6016		Rheumatoid Arthritis n= 898	
	OR (95%CI)	p-value	OR (95%CI)	p-value	OR (95%CI)	p-value
No Supplement Use	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Glucosamine Only	1.4 (1.0-1.9)	0.07	1.2 (0.8-1.8)	0.40	1.5 (0.7-3.4)	0.47
Chondroitin Only	0.7 (0.3-1.7)	0.28	0.7 (0.3-1.9)	0.43	0.4 (0.1-2.8)	0.17
Glucosamine and Chondroitin	1.1 (0.7-1.7)	0.67	1.1 (0.7-1.7)	0.65	2.7 (0.8-9.5)	0.11
Sex						
Women	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Men	0.8 (0.7-1.0)	0.02	0.8 (0.7-1.0)	0.02	1.0 (0.6-1.5)	0.86
Age						
18-39 years old	1.0 (referent)		1.0 (referent)		1.0 (referent)	
40-55 years old	0.6 (0.4-0.7)	0.04	0.5 (0.4-0.7)	0.10	0.5 (0.2-1.0)	0.37
56-70 years old	0.5 (0.4-0.7)	0.27	0.5 (0.4-0.7)	0.21	0.5 (0.2-1.0)	0.23
71-84 years old	0.4 (0.3-0.5)	0.01	0.3 (0.2-0.5)	<0.01	0.4 (0.2-0.9)	0.59
>85 years old	0.2 (0.1-0.4)	<0.01	0.2 (0.1-0.3)	<0.01	0.1 (0.0-0.3)	<0.01
Race/Ethnicity						
White	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Black/African American	1.1 (0.9-1.3)	0.98	1.1 (0.8-1.3)	0.98	1.2 (0.8-1.8)	0.59
Hispanic/Latino	1.3 (1.0-1.6)	0.28	1.3 (1.0-1.6)	0.38	1.1 (0.7-1.8)	0.79
American Indian or Alaskan Native	1.1 (0.7-1.7)	0.99	1.3 (0.8-2.1)	0.50	0.4 (0.1-1.7)	0.09
Asian	1.0 (0.4-2.8)	0.89	0.8 (0.2-3.5)	0.66	2.8 (1.0-7.4)	0.03
BMI Category						
≤ 24.9	1.0 (referent)		1.0 (referent)		1.0 (referent)	
>24.9 and <30.0	1.0 (0.8-1.2)	0.29	1.0 (0.8-1.3)	0.42	0.6 (0.4-1.0)	0.25
≥ 30.0	1.1 (0.9-1.3)	0.10	1.3 (1.0-1.5)	0.01	0.5 (0.3-0.9)	0.06
Education						
Did Not Complete High School	1.0 (referent)		1.0 (referent)		1.0 (referent)	
GED	0.9 (0.5-1.5)	0.13	1.0 (0.6-1.9)	0.44	0.6 (0.2-2.0)	0.23
High School Diploma	0.9 (0.7-1.3)	<0.01	0.9 (0.7-1.3)	<0.01	0.9 (0.4-1.7)	0.32
Some College, No Degree	1.4 (1.1-1.9)	0.05	1.5 (1.1-2.1)	0.02	1.0 (0.5-2.0)	0.85
Associate's Degree	1.6 (1.2-2.1)	<0.01	1.6 (1.1-2.2)	0.04	1.5 (0.8-2.7)	0.07
Bachelor's Degree	1.4 (1.0-1.8)	0.15	1.3 (1.0-1.9)	0.39	1.4 (0.5-3.4)	0.45
Master's, Professional, or Doctoral Degree	1.5 (1.1-2.0)	0.04	1.5 (1.1-2.0)	0.08	1.5 (0.7-2.9)	0.21
Poverty Level						
Above Poverty Line	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Below Poverty Line	0.9 (0.7-1.1)	0.28	1.0 (0.8-1.3)	0.58	0.6 (0.4-1.0)	0.32
Unknown	0.8 (0.6-1.1)	0.30	0.9 (0.6-1.2)	0.38	0.7 (0.3-1.3)	0.60
Region						
Northeast	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Midwest	1.1 (0.8-1.4)	0.91	1.1 (0.8-1.4)	0.71	1.1 (0.6-1.9)	0.83
South	1.0 (0.8-1.2)	0.09	1.0 (0.7-1.2)	0.12	0.9 (0.5-1.6)	0.25
West	1.3 (1.0-1.6)	0.01	1.2 (0.9-1.5)	0.09	1.5 (1.0-2.5)	0.02
No Other Health Conditions	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Other Health Conditions	1.0 (0.8-1.2)	0.99	1.0 (0.9-1.2)	0.87	0.9 (0.6-1.3)	0.42
No Energy Therapies	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Energy Therapies	2.2 (1.7-2.8)	<0.01	2.1 (1.6-2.8)	<0.01	2.7 (1.4-5.1)	<0.01

No Acupuncture Acupuncture	1.0 (referent) 1.9 (1.3-2.8)	<0.01	1.0 (referent) 1.8 (1.2-2.8)	0.01	1.0 (referent) 4.6 (1.8-11.5)	<0.01
No Mind-Body Therapies Mind-Body Therapies	1.0 (referent) 2.2 (1.7-3.0)	<0.01	1.0 (referent) 2.2 (1.6-3.2)	<0.01	1.0 (referent) 2.7 (1.3-5.5)	0.01
No Chiropractic/ Osteopathic Therapy Chiropractic/ Osteopathic Therapy	1.0 (referent) 1.4 (1.2-1.7)	<0.01	1.0 (referent) 1.3 (1.1-1.7)	0.01	1.0 (referent) 2.5 (1.4-4.4)	<0.01

*Estimates presented were found using a logistic regression.

Table 10 presents odds ratios, 95% Confidence intervals (95% CI), and p-values for selected characteristics and self-reported joint pain, aching, and stiffness within the past 30 days prior to taking the survey among persons with any arthritis, unspecified arthritis, and rheumatoid arthritis. Sex, age, race, BMI, poverty level, other health conditions (diabetes and/or heart condition), and chiropractic/osteopathic therapy were characteristics that yielded statistically significant associations with self-reported past 30 day joint pain, aching, and stiffness among persons with any arthritis. Men were 0.9 times likely to report past 30 day joint pain, aching, and stiffness than women (OR= 0.9; p= 0.02) among persons with any arthritis. Persons 56 to 70 years old were 1.5 times likely to report past 30 day joint pain, aching, and stiffness than persons 18 to 39 years old (OR= 1.5; p= <0.01) among persons with any arthritis. When compared to white persons with any arthritis, Black/African Americans were 1.2 times likely to report past 30 day joint pain, aching, and stiffness (OR= 1.2; p= 0.04) and American Indian or Alaskan Native were 0.7 times likely to report past 30 day joint pain, aching, and stiffness (OR= 0.7; p= 0.03). Obese persons (BMI $\geq$ 30) were 1.8 times likely to report past 30 day joint pain, aching, and stiffness than persons either underweight or normal weight (BMI< 25) (OR= 1.8; p= <0.01). Persons below the poverty line were 1.3 time likely to report past 30 day joint pain, aching, and stiffness than persons above the poverty line (OR= 1.3; p= 0.04). Persons with other health conditions (diabetes and heart conditions) were 1.4 times likely to report past 30 day joint pain, aching, and stiffness than persons without other health conditions (OR= 1.4; p= <0.01). Persons

that saw a chiropractor one of more times within the 12 months prior to survey administration were 1.3 times likely to report past 30 day joint pain, aching, and stiffness when compared to persons that did not (OR= 2.5; p= <0.01).

Age, BMI, poverty level, region, other health conditions (diabetes and/or heart condition), mind-body therapies, and chiropractic/osteopathic therapy were characteristics that yielded statistically significant associations with self-reported past 30 day joint pain, aching, and stiffness among persons with unspecified arthritis, as seen in Table 10. Persons 56 to 70 years of age were 1.4 times likely to report past 30 day joint pain, aching, and stiffness than persons 18 to 39 years old (OR= 1.1; p= <0.01). Obese persons (BMI ≥ 30) were 2.0 times likely to report BMI past 30 day joint pain, aching, and stiffness than persons underweight and normal weight (BMI < 25) (OR= 2.0; p= <0.01). Persons below poverty level were 1.3 times likely to report past 30 day joint pain, aching, and stiffness than persons above poverty level (OR= 1.3; p= 0.03). Persons in the South were 1.5 times likely to report past 30 day joint pain, aching, and stiffness than persons in the Northeast region (OR= 1.5; p= 0.01). Persons with other health conditions (diabetes and heart conditions) were 1.6 times likely to report past 30 day joint pain, aching, and stiffness than persons without other health conditions (OR= 1.6; p= <0.01). Persons that reported past 12 month use of mind-body therapy were 1.4 times likely to past 30 day joint pain, aching, and stiffness than persons that never engaged in mind-body therapy (OR=1.4; p= 0.02). Persons that saw a chiropractor one of more times within the 12 months prior to survey administration were 1.3 times likely to report past 30 day joint pain, aching, and stiffness when compared to persons that did not (OR= 1.3; p= 0.03).

As shown in Table 10, only poverty level and mind-body therapies were characteristics that yielded statistically significant associations with self-reported past 30 day joint pain, aching,

and stiffness among persons with unspecified arthritis, as seen in Table 10. When compared to persons above the poverty level, persons below were 2.6 times likely to report past 30 day joint pain, aching, and stiffness (OR= 2.6; p= <0.01), and persons whom poverty level is unknown were 0.8 time likely to report past 30 day joint pain, aching, and stiffness (OR= 0.8; p= 0.03). Finally, persons that engaged in mind-body therapy one or more times within the 12 months prior to the administration of the survey were 0.4 times likely to report past 30 day joint pain, aching, and stiffness when compared to persons that never engaged in mind-body therapy (OR= 0.4; p= 0.03).

Table 10: Bivariate Analysis of Selected Characteristics and Reports of Joint Pain, Aching, or Stiffness in or around a Joint Over the Past 30 Days among Persons with Arthritis, Unspecified Arthritis, and Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Self-Reported Joint Pain in Past 30 Days						
Characteristics	Any Arthritis n= 7654		Unspecified Arthritis n= 6016		Rheumatoid Arthritis n= 898	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
No Supplement Use	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Glucosamine Only	2.2 (1.6-3.1)	0.32	2.5 (1.7-3.7)	0.29	1.7 (0.5-5.8)	0.43
Chondroitin Only	0.7 (0.3-1.4)	0.01	0.5 (0.2-1.3)	0.01	--	--
Glucosamine and Chondroitin	6.2 (1.5-26.3)	0.02	7.4 (1.0-56.8)	0.07	--	--
Sex						
Women	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Men	0.9 (0.7-1.0)	0.02	1.0 (0.8-1.1)	0.70	0.9 (0.6-1.3)	0.48
Age						
18-39 years old	1.0 (referent)		1.0 (referent)		1.0 (referent)	
40-55 years old	1.1 (0.9-1.5)	0.79	1.1 (0.8-1.5)	0.72	1.8 (0.9-3.5)	0.30
56-70 years old	1.5 (1.1-1.9)	0.00	1.4 (1.0-1.9)	0.00	2.4 (1.2-4.5)	0.02
71-84 years old	1.0 (0.8-1.3)	0.10	0.9 (0.7-1.3)	0.06	1.3 (0.7-2.4)	0.36
>85 years old	1.0 (0.7-1.4)	0.21	1.0 (0.7-1.5)	0.58	1.4 (0.6-3.4)	0.77
Race/Ethnicity						
White	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Black/African American	1.2 (1.0-1.4)	0.04	1.2 (0.9-1.4)	0.15	1.7 (1.1-2.8)	0.28
Hispanic/Latino	0.9 (0.7-1.1)	0.69	0.7 (0.6-0.9)	0.11	1.9 (1.2-2.8)	0.09
American Indian or Alaskan Native	0.7 (0.5-0.9)	0.03	0.7 (0.5-1.1)	0.18	0.9 (0.2-3.9)	0.53
Asian	1.0 (0.5-2.2)	0.83	1.2 (0.4-3.7)	0.57	1.9 (0.4-10.6)	0.68
BMI Category						
≤ 24.9	1.0 (referent)		1.0 (referent)		1.0 (referent)	
>24.9 and <30.0	1.2 (1.0-1.5)	0.30	1.2 (1.0-1.5)	0.06	1.7 (1.1-2.7)	0.23
≥ 30.0	1.8 (1.5-2.1)	<0.01	2.0 (1.7-2.3)	<0.01	1.7 (1.1-2.8)	0.19

Education						
Did Not Complete High School	1.0 (referent)		1.0 (referent)		1.0 (referent)	
GED	1.1 (0.7-1.6)	0.84	1.0 (0.6-1.5)	0.62	0.7 (0.2-2.4)	0.96
High School Diploma	1.1 (0.9-1.3)	0.89	1.1 (0.9-1.4)	0.80	0.8 (0.4-1.5)	0.89
Some College, No Degree	1.1 (0.9-1.4)	0.60	1.1 (0.9-1.5)	0.39	0.6 (0.3-1.2)	0.35
Associate's Degree	1.2 (0.9-1.6)	0.17	1.3 (1.0-1.8)	0.05	0.7 (0.3-1.5)	0.74
Bachelor's Degree	1.0 (0.8-1.2)	0.43	0.9 (0.7-1.2)	0.15	1.1 (0.5-2.6)	0.14
Master's, Professional, or Doctoral Degree	0.9 (0.7-1.2)	0.11	1.0 (0.8-1.3)	0.73	0.5 (0.2-1.0)	0.06
Poverty Level						
Above Poverty Line	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Below Poverty Line	1.3 (1.1-1.6)	0.04	1.3 (1.1-1.6)	0.03	2.6 (1.5-4.7)	<0.01
Unknown	1.1 (0.9-1.4)	0.63	1.1 (0.8-1.3)	0.50	0.8 (0.4-1.5)	0.03
Region						
Northeast	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Midwest	1.2 (0.9-1.4)	0.70	1.3 (1.0-1.7)	0.95	0.7 (0.4-1.2)	0.21
South	1.3 (1.0-1.6)	0.08	1.5 (1.2-1.9)	0.01	0.9 (0.5-1.5)	0.69
West	1.0 (1.0-1.6)	0.13	1.5 (1.1-1.9)	0.11	0.8 (0.5-1.4)	0.92
No Other Health Conditions	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Other Health Conditions	1.4 (1.2-1.6)	<0.01	1.6 (1.4-1.9)	<0.01	1.4 (0.9-2.2)	0.16
No Energy Therapies	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Energy Therapies	1.1 (0.8-1.4)	0.53	1.1 (0.8-1.5)	0.48	0.9 (0.4-2.3)	0.91
No Acupuncture	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Acupuncture	1.3 (0.8-2.0)	0.29	1.4 (0.9-2.4)	0.16	0.5 (0.2-1.9)	0.35
No Mind-Body Therapies	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Mind-Body Therapies	1.3 (1.0-1.8)	0.06	1.4 (1.1-2.0)	0.02	0.4 (0.2-0.9)	0.03
No Chiropractic/ Osteopathic Therapy	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Chiropractic/ Osteopathic Therapy	1.3 (1.0-1.6)	0.02	1.3 (1.0-1.6)	0.03	1.3 (0.6-2.9)	0.46

*Estimates presented were found using a logistic regression.
**Chondroitin only and glucosamine and chondroitin yielded a small sample size in rheumatoid arthritis therefore, could not be analyzed.

MULTIVARIABLE ANALYSES

Table 11 presents adjusted odds ratios, 95% Confidence intervals (95% CI), and p-values for selected characteristics and self-reported 12 month improved health among persons with any arthritis, unspecified arthritis, and rheumatoid arthritis. After adjusting for age, education, energy therapies, and mind-body therapies, supplement use (glucosamine only, chondroitin only, and both glucosamine and chondroitin) was not associated with self-reported improved health among persons with any arthritis. After adjusting for sex, age, BMI, education, mind-body therapies, and chiropractic/osteopathic therapy, supplement use (glucosamine only, chondroitin only, and both glucosamine and chondroitin) was not associated with self-reported 12 month improved

health among persons with unspecified arthritis. After adjusting for mind-body and chiropractic/osteopathic therapies, supplement use (glucosamine only, chondroitin only, and both glucosamine and chondroitin) was not associated with self-reported 12 month improved health among persons with rheumatoid arthritis.

Adjusted age, education, energy therapies, and mind-body therapies were characteristics that yielded statistically significant associations with self-reported past 12 month improved health among persons with any arthritis. When compared to persons 18 to 39 years old, persons 71 to 84 years old were 0.4 times likely to report past 12 month improved health (adjusted OR= 0.4; p= 0.04) and persons 85 years or older were 0.3 times likely to report past 12 month improved health (adjusted OR= 0.3; p= <0.01). When compared to persons that did not complete high school, persons with an associate's degree were 1.3 times likely to report past 12 month improved health than persons that did not complete high school (adjusted OR= 1.3; p= 0.02). Persons that engaged in energy therapies one or more times within the 12 months prior to the administration of the survey were 1.5 times likely to report past 12 month improved health than persons that did not (adjusted OR=1.5; p= <0.01). Persons that engaged in mind-body therapies one or more times within the 12 months prior to the administration of the survey were also 1.5 times likely to report past 12 month improved health than persons that did not (adjusted OR=1.5; p= <0.01).

Adjusted sex, age, BMI, education, mind-body therapies, and chiropractic/osteopathic therapy were characteristics that yielded statistically significant associations with self-reported 12 month improved health among persons with unspecified arthritis, as illustrated in Table 11. Men were 0.8 time likely to report past 12 month improved health than women (adjusted OR= 0.8; p= 0.03). When compared to persons 18 to 39 years old, person 71 to 84 years old were 0.4

time likely to report past 12 month improved health (adjusted OR= 0.4; p= 0.03) and persons 85 years and older were 0.3 time likely to report past 12 month improve health (adjusted OR= 0.3; p= <0.01). When compared to persons that did not complete high school, persons with a high school diploma were 0.9 times likely to report past 12 month improved health (adjusted OR= 0.9; p= 0.02). Obese persons (BMI ≥ 30) were 1.3 times likely to report past 12 month improved health than person who were either underweight or normal weight (adjusted OR= 1.3; p= 0.02). Persons that engaged in energy therapies one or more times within the 12 months prior to the administration of the survey were 1.5 times likely to report past 12 month improved health than persons that did not (adjusted OR=1.5; p= 0.01). Persons that engaged in mind-body therapies one or more times within the 12 months prior to the administration of the survey were also 1.6 times likely to report past 12 month improved health than persons that did not (adjusted OR=1.6; p= 0.02).

Adjusted mind-body and chiropractic/osteopathic therapies yielded statistically significant associations with self-reported 12 month improved health among persons with rheumatoid arthritis, as illustrated in Table 11. When compared to persons that did not use mind-body therapies in the 12 months prior to administration of the survey, persons that did use mind-body therapies were about two times likely to report improved health (adjusted OR= 1.9; p= 0.05). Persons that saw a chiropractor or osteopathic practitioner one or more times within the 12 months prior to taking the survey were 1.8 time likely to report improved health than persons that did not (adjusted OR= 1.8; p= 0.04).

Table 11: Adjusted Odds Ratio for Glucosamine Use Within the Past 12 Months and Reports of Improved Health when Compared to 12 Months Ago among Sample Adults Ages 18+ with Any Arthritis, Unspecified Arthritis, and Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Self-Reported Improved Health over a 12-Month Period						
Characteristics	Any Arthritis n= 7654		Unspecified Arthritis n= 6016		Rheumatoid Arthritis n= 898	
	OR (95%CI)	p-value	OR (95%CI)	p-value	OR (95%CI)	p-value
No Supplement Use	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Glucosamine Only	1.1 (0.8-1.6)	0.19	1.0 (0.6-1.5)	0.51	1.2 (0.6-2.5)	0.25
Chondroitin Only	0.6 (0.2-1.3)	0.31	0.6 (0.2-1.8)	0.45	0.2 (0.0-2.2)	0.18
Glucosamine and Chondroitin	0.9 (0.6-1.3)	0.96	0.9 (0.6-1.3)	0.98	1.2 (0.4-3.2)	0.38
Sex						
Women	1.0 (referent)		1.0 (referent)		--	--
Men	0.9 (0.7-1.0)	0.06	0.8 (0.7-1.0)	0.03	--	--
Age						
18-39 years old	1.0 (referent)		1.0 (referent)		--	--
40-55 years old	0.6 (0.4-0.7)	0.15	0.5 (0.4-0.7)	0.40	--	--
56-70 years old	0.5 (0.4-0.7)	0.40	0.5 (0.4-0.7)	0.45	--	--
71-84 years old	0.4 (0.3-0.6)	0.04	0.4 (0.3-0.6)	0.03	--	--
>85 years old	0.3 (0.2-0.4)	<0.01	0.3 (0.1-0.4)	<0.01	--	--
Race/Ethnicity						
White	--	--	--	--	--	--
Black/African American	--	--	--	--	--	--
Hispanic/Latino	--	--	--	--	--	--
American Indian or Alaskan Native	--	--	--	--	--	--
Asian	--	--	--	--	--	--
BMI Category						
≤ 24.9	--		1.0 (referent)		--	--
>24.9 and <30.0	--	--	1.1 (0.9-1.4)	0.89	--	--
≥ 30.0	--	--	1.3 (1.0-1.6)	0.02	--	--
Education						
Did Not Complete High School	1.0 (referent)		1.0 (referent)		--	--
GED	0.8 (0.5-1.3)	0.14	0.9 (0.5-1.6)	0.42	--	--
High School Diploma	0.9 (0.7-1.2)	0.06	0.9 (0.6-1.2)	0.02	--	--
Some College, No Degree	1.2 (0.9-1.6)	0.14	1.3 (0.9-1.8)	0.06	--	--
Associate's Degree	1.3 (1.0-1.7)	0.02	1.3 (1.0-1.9)	0.08	--	--
Bachelor's Degree	1.1 (0.8-1.5)	0.55	1.1 (0.8-1.6)	0.82	--	--
Master's, Professional, or Doctoral Degree	1.2 (0.9-1.6)	0.21	1.3 (0.9-1.7)	0.21	--	--
Poverty Level						
Above Poverty Line	--	--	--	--	--	--
Below Poverty Line	--	--	--	--	--	--
Unknown	--	--	--	--	--	--
Region						
Northeast	1.0 (referent)		--	--	--	--
Midwest	1.0 (0.8-1.3)	0.88	--	--	--	--
South	1.0 (0.8-1.2)	0.32	--	--	--	--
West	1.1 (0.9-1.4)	0.13	--	--	--	--
No Other Health Conditions	--	--	--	--	--	--
Other Health Conditions	--	--	--	--	--	--

No Energy Therapies Energy Therapies	1.0 (referent) 1.5 (1.1-1.9)	<0.01	1.0 (referent) 1.5 (1.1-2.0)	0.01	1.0 (referent) 1.8 (0.9-3.4)	0.07
No Acupuncture Acupuncture	1.0 (referent) 1.4 (0.9-2.0)	0.13	1.0 (referent) 1.4 (0.9-2.2)	0.14	1.0 (referent) 2.3 (1.0-5.3)	0.06
No Mind-Body Therapies Mind-Body Therapies	1.0 (referent) 1.5 (1.1-2.1)	<0.01	1.0 (referent) 1.6 (1.1-2.3)	0.02	1.0 (referent) 1.9 (1.0-3.8)	0.05
No Chiropractic/ Osteopathic Therapy Chiropractic/ Osteopathic Therapy	1.0 (referent) 1.2 (0.9-2.0)	0.12	1.0 (referent) 1.1 (0.9-1.5)	0.29	1.0 (referent) 1.8 (1.0-3.1)	0.04

*Multivariable logistic regression models used to present the adjusted odds ratios, 95% Confidence Intervals (CI) and p-values.
**Variables denoted by '—' were not included in the arthritis specific model.

Table 12 presents adjusted odds ratios, 95% Confidence intervals (95% CI), and p-values for selected characteristics and self-reported joint pain, aching, and stiffness within the past 30 days prior to taking the survey among persons with any arthritis, unspecified arthritis, and rheumatoid arthritis. After adjusting for sex, age, race, BMI, poverty level, other health conditions, and other CAM therapies (acupuncture, energy, mind-body, and chiropractic/ osteopathic therapies), the use of chondroitin only one or more times during the past 30 days prior to taking the survey was found to be associated with self-reported past 30 day joint pain, aching, and stiffness among persons with any arthritis (adjusted OR= 0.6; p= <0.01). Glucosamine and chondroitin was also found to be associated with self-reported past 30 day joint pain, aching, and stiffness among persons with any arthritis (adjusted OR= 5.7; p= 0.03). Glucosamine only was not associated with past 30 day joint pain, aching, and stiffness among persons with any arthritis (adjusted OR= 2.1; p= 0.26), as can be seen in Table 12. After adjusting for age, BMI, poverty level, region, other health conditions, and other CAM therapies (acupuncture, energy, mind-body, and chiropractic/osteopathic therapies), use of chondroitin only was found to be associated with past 30 day joint pain, aching, and stiffness among persons with unspecified arthritis (adjusted OR= 0.5; p= 0.02). Glucosamine only and glucosamine and chondroitin were not associated with past 30 day joint pain, aching, and stiffness among persons with unspecified arthritis (p> 0.05). After adjusting for poverty level and other CAM therapies

(acupuncture, energy, mind-body, and chiropractic/osteopathic therapies), glucosamine only was also not associated with past 30 day joint pain, aching, and stiffness among persons with rheumatoid arthritis ($p>0.05$), as can be seen in Table 12.

Adjusted sex, BMI, poverty level, other health conditions, and chiropractic/ osteopathic therapy were characteristics that yielded statistically significant associations with self-reported past 30 day joint pain, aching, and stiffness among persons with any arthritis. Men were 0.8 times likely to report past 30 day joint pain, aching, and stiffness than women (adjusted OR= 0.8; p= 0.02). Obese persons (BMI≥ 30) 1.6 times likely to report past 30 day joint pain, aching, and stiffness than persons that were either underweight or normal weight (BMI< 25) (adjusted OR= 1.6; p= <0.01). When compared to person above the poverty line, person below the poverty line were 1.4 time more likely to report past 30 day joint pain, aching, and stiffness (adjusted OR= 1.4; p= 0.03). Persons with other health conditions were 1.3 time likely to report past 30 day joint pain, aching, and stiffness than persons without these conditions (adjusted OR= 1.3; p= <0.01). Persons that saw a chiropractor or osteopathic practitioner one or more times within the 12 months prior to taking the survey were 1.2 times likely to report past 30 day joint pain, aching, and stiffness than persons that did not (adjusted OR= 1.2; p= 0.05).

Adjusted age, BMI, poverty level, region, other health conditions, chiropractic/ osteopathic therapy, and mind-body therapy were characteristics that yielded statistically significant associations with self-reported past 30 day joint pain, aching, and stiffness among persons with unspecified arthritis. When compared to persons 18 to 39 years old, persons 56 to 70 years old were 1.3 times likely to report past 30 day joint pain, aching, and stiffness (adjusted OR= 1.4; p= 0.01). Obese persons (BMI≥ 30) were 1.8 times likely to report past 30 day joint pain, aching, and stiffness than persons that were either underweight or normal weight (BMI<

25) (adjusted OR= 1.8; p= <0.01). Persons with unknown poverty level were 1.8 times likely to report past 30 day joint pain, aching, and stiffness than persons below poverty level (adjusted OR= 1.8; p= <0.01). Persons in the South were 1.6 times likely to report past 30 day joint pain, aching, and stiffness than persons in the Northeast region of the U.S (adjusted OR= 1.6; p= <0.01). Persons with other health conditions were 1.5 times likely to report past 30 day joint pain, aching, and stiffness than persons without other health conditions (adjusted OR= 1.5; p= <0.01). Persons that engaged in mind-body therapies one or more times within the 12 months prior to the administration of the survey were also 1.4 times likely to report past 30 day joint pain, aching, and stiffness than persons that did not (adjusted OR=1.4; p= 0.04). Persons that saw a chiropractor or osteopathic practitioner one or more times within the 12 months prior to taking the survey were 1.3 times likely to report past 30 day joint pain, aching, and stiffness than persons that did not (adjusted OR= 1.3; p= 0.04).

Adjusted poverty level, chiropractic/osteopathic therapy, and mind-body therapy were characteristics that yielded statistically significant associations with self-reported past 30 day joint pain, aching, and stiffness among persons with rheumatoid arthritis. When compared to persons above poverty level, persons below poverty level were 2.6 time likely to report past 30 day joint pain, aching, and stiffness (adjusted OR= 2.6; p= <0.01) and persons with unknown poverty level were 0.8 times likely to report past 30 day joint pain, aching, and stiffness (adjusted OR= 0.8; p= 0.05). Persons that saw a chiropractor or osteopathic practitioner one or more times within the 12 months prior to taking the survey were two times likely to report past 30 day joint pain, aching, and stiffness than persons that did not (adjusted OR= 2.0; p= 0.01). Persons that engaged in mind-body therapies one or more times within the 12 months prior to the

administration of the survey were also 1.4 times likely to report past 30 day joint pain, aching, and stiffness than persons that did not (adjusted OR=1.4; p= 0.02).

Table 12: Adjusted Odds Ratio for Glucosamine and/or Chondroitin Use within the Past 30 days and Reports of Joint Pain, Aching, or Stiffness in or around a Joint over the Past 30 Days among Sample Adults Ages 18+ with Any Arthritis, Unspecified Arthritis, and Rheumatoid Arthritis, 2012 National Health Interview Survey (NHIS)

Self-Reported Joint Pain in Past 30 Days						
Characteristics	Any Arthritis n= 7654		Unspecified Arthritis n= 6016		Rheumatoid Arthritis n= 898	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
No Supplement Use	1.0(referent)		1.0 (referent)		1.0 (referent)	
Glucosamine Only	2.1 (1.5-3.0)	0.26	2.5 (1.7-3.6)	0.22	0.8 (0.3-2.0)	0.57
Chondroitin Only	0.6 (0.3-1.2)	<0.01	0.5 (0.2-1.1)	<0.01	--	--
Glucosamine and Chondroitin	5.7 (1.3-24.3)	0.03	6.7 (0.2-1.1)	0.08	--	--
Sex						
Women	1.0 (referent)		--	--	--	--
Men	0.8 (0.7-1.0)	0.02	--	--	--	--
Age						
18-39 years old	1.0 (referent)		1.0 (referent)		--	--
40-55 years old	1.1 (0.8-1.4)	0.69	1.1 (0.8-1.5)	0.94	--	--
56-70 years old	1.4 (1.1-1.8)	<0.01	1.3 (1.0-1.8)	0.01	--	--
71-84 years old	1.0 (0.7-1.3)	0.10	1.0 (0.7-1.4)	0.09	--	--
>85 years old	1.0 (0.7-1.5)	0.72	1.2 (0.8-1.8)	0.60	--	--
Race/Ethnicity						
White	1.0 (referent)		--	--	--	--
Black/African American	1.1 (0.9-1.3)	0.13	--	--	--	--
Hispanic/Latino	0.8 (0.7-1.0)	0.53	--	--	--	--
American Indian or Alaskan Native	0.7 (0.5-1.0)	0.20	--	--	--	--
Asian	0.9 (0.4-2.0)	0.98	--	--	--	--
BMI Category						
≤ 24.9	1.0 (referent)		1.0 (referent)		--	--
>24.9 and <30.0	1.2 (1.0-1.5)	0.57	1.2 (1.0-1.4)	0.09	--	--
≥ 30.0	1.6 (1.4-2.0)	<0.01	1.8 (1.5-2.2)	<0.01	--	--
Education						
Did Not Complete High School	--	--	--	--	--	--
GED	--	--	--	--	--	--
High School Diploma	--	--	--	--	--	--
Some College, No Degree	--	--	--	--	--	--
Associate's Degree	--	--	--	--	--	--
Bachelor's Degree	--	--	--	--	--	--
Master's, Professional, or Doctoral Degree	--	--	--	--	--	--
Poverty Level						
Above Poverty Line	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Below Poverty Line	1.4 (1.1-1.7)	0.03	1.2 (1.0-1.4)	0.09	2.6 (1.5-4.7)	<0.01
Unknown	1.1 (0.9-1.4)	0.64	1.8 (1.5-2.2)	<0.01	0.8 (0.4-1.6)	0.05
Region						
Northeast	--	--	1.0 (referent)		--	--
Midwest	--	--	1.3 (1.0-1.7)	0.88	--	--
South	--	--	1.6 (1.2-2.0)	<0.01	--	--
West	--	--	1.5 (1.1-1.9)	0.13	--	--

No Other Health Conditions	1.0 (referent)		1.0 (referent)		--	--
Other Health Conditions	1.3 (1.1-1.5)	<0.01	1.5 (1.3-1.8)	<0.01	--	--
No Energy Therapies	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Energy Therapies	1.0 (0.8-1.4)	0.78	1.1 (0.8-1.5)	0.58	1.3 (0.6-2.6)	0.47
No Acupuncture	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Acupuncture	1.2 (1.0-1.8)	0.51	1.3 (0.8-2.2)	0.27	0.5 (0.2-1.2)	0.12
No Mind-Body Therapies	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Mind-Body Therapies	1.2 (0.9-1.6)	0.18	1.4 (1.0-2.0)	0.04	0.4 (0.2-0.8)	0.02
No Chiropractic/ Osteopathic Therapy	1.0 (referent)		1.0 (referent)		1.0 (referent)	
Chiropractic/ Osteopathic Therapy	1.2 (0.7-1.8)	0.05	1.3 (1.0-1.6)	0.04	2.0 (1.2-3.4)	0.01

*Multivariable logistic regression models used to present adjusted odds ratios, 95% Confidence Intervals (CI) and p-values.
**Chondroitin only and glucosamine and chondroitin yielded a small sample size in rheumatoid arthritis therefore, could not be analyzed. This is Denoted by '—'.
***Other variable denoted by '--' were not included in the arthritis specific model.

CHAPTER V

DISCUSSION & CONCLUSION

DISCUSSION

This study set out to identify the socio-demographic characteristics of U.S. adults with any arthritis, unspecified arthritis, and rheumatoid arthritis, identify their use of glucosamine and/or chondroitin, and to determine if reports of improved health or reports of joint pain, aching, and stiffness differs based on glucosamine and/or chondroitin use. In 2012, approximately 21.8% of U.S adults had any arthritis, 17.0% had unspecified arthritis, and 2.5% had rheumatoid arthritis. This thesis found that women were more likely than men to report some form of arthritis. This was expected because gender, particularly being a woman, has been identified as a risk factor for arthritis (Johnson & Hunter 2014; Turkiewicz et al. 2014). The prevalence of any arthritis, unspecified arthritis, and rheumatoid arthritis increases with age and BMI. Both of these characteristics were previously identified as risk factors for arthritis (Johnson & Hunter 2014). In addition, persons with diabetes and/or heart conditions (other health conditions) had prevalence rates of some form of arthritis more than twice of that of persons who did not have other health conditions. A previous study similarly found large proportions of persons with arthritis to have comorbidities such as diabetes and heart disease (Barbour et al. 2013).

When assessing past 12 month supplement use among persons with any arthritis, approximately 3.7% used glucosamine, 0.4% used chondroitin, and 3.4% used both glucosamine and chondroitin. When assessing past 30 day supplement use among persons with any arthritis, approximately 5.1% of persons with any arthritis used glucosamine, 0.6% used chondroitin, and 0.4% used both glucosamine and chondroitin. Approximately 3.7% of persons with unspecified

arthritis reported past 12 month glucosamine use, 0.5% reported past 12 month chondroitin use, and 3.8% reported past 12 month both glucosamine and chondroitin use. Approximately 5.5% of persons with unspecified arthritis had past 30 day use of glucosamine, 0.5% had past 30 day use of chondroitin, and 0.4% had past 30 day use of both glucosamine and chondroitin. Approximately 2.4% of persons with rheumatoid arthritis used glucosamine while 0.3% used chondroitin, and 2.1% used both glucosamine and chondroitin within the past 12 months. Approximately 2.9% of persons with rheumatoid arthritis had past 30 day use of glucosamine while 0.7% used chondroitin, and 0.5% used both glucosamine and chondroitin.

Women used more of all supplements (past 12 months and past 30 days) except past 12 month use of chondroitin among persons with any arthritis. Among persons with unspecified arthritis, women were more likely than men to report past 12 month glucosamine and past 12 month both glucosamine and chondroitin use. Men, however, were more likely to be chondroitin users (57.3%). Among persons with rheumatoid arthritis, the majority of glucosamine and both glucosamine and chondroitin users were women (59.3% and 58.0% respectively) however; men made up 94.0% of chondroitin use.

Persons 56 to 70 years old had the highest proportion of past 12 month and 30 day supplement use among persons with unspecified arthritis. Among persons with unspecified arthritis, persons 40-55 years old made up 85.1% of 12 month chondroitin use. Persons age 56 to 70 years old with unspecified arthritis reported the highest proportion of past 30 day supplement use (57.9% glucosamine, 57.1% chondroitin, 33.0% both glucosamine and chondroitin). Persons 56 to 70 years old reported the largest proportion of past 30 day glucosamine use (42.9%) and chondroitin use (85.8%) among persons with rheumatoid arthritis. A previous study identified persons 50 to 59 years of age as having the highest prevalence of CAM use (Barnes et al. 2008).

While part of the 50 to 59 and the 56 to 70 age groups overlap, it was unexpected to find that persons 18 to 39 years old reported the largest proportion of past 30 day use of both glucosamine and chondroitin among persons with rheumatoid arthritis.

White people accounted for the majority of all past 30 day supplement use among persons with any arthritis. Past 30 day supplement use was most common among white persons with unspecified arthritis (90.9% glucosamine, 78.3% chondroitin, and 67.2% both glucosamine and chondroitin). Persons in the Northeast had the lowest prevalence of any past 12 month and past 30 day supplement use among persons with any arthritis. Persons in the West accounted for a large proportion of past 12 month glucosamine use while a large proportion of chondroitin use was in the Midwest among persons with any arthritis. The Northeast also had the lowest proportion of any past 30 day supplement use among persons with unspecified arthritis. Among persons with unspecified arthritis, more than half (54.9%) of past 12 month chondroitin use were from persons in the Midwest. Similarly, a large proportion of persons with rheumatoid arthritis that reported past 30 day chondroitin use were from the Midwest (60.9%). These findings are somewhat similar to the results of a Canadian study. This study found that glucosamine use occurred more in the western regions when compared to all other regions (Hopman et al. 2006).

Obese (BMI $\geq$ 30.0) individuals had the highest proportion of past 12 month glucosamine and chondroitin use (42.9% and 94.0% respectively) among persons with unspecified arthritis. Similarly, obese (BMI $\geq$ 30.0) individuals had the highest proportion of past 12 month glucosamine and chondroitin use (42.9% and 94.0% respectively) among persons with rheumatoid arthritis. These findings were surprising to find. In a study observing CAM use among overweight and obese persons with radiographic knee osteoarthritis, BMI was inversely associated with CAM use. Persons classified as obese (BMI $\geq$ 30) were less likely to use CAM

therapies, alone or in combination with conventional medications when compared to persons underweight or normal weight (BMI < 25) (Lapane et al. 2013).

Persons above the poverty line had the highest proportion of supplement use among persons with any arthritis. Persons above poverty level also had the highest proportion of all past 30 day supplement use (93.0% glucosamine, 76.6% chondroitin, and 95.5% both glucosamine and chondroitin) among persons with unspecified arthritis. Past 12 month glucosamine use and past 12 month both glucosamine and chondroitin use were most common among persons above poverty level (83.3% and 100.0% respectively) with rheumatoid arthritis. These findings coincides with the Australian study of persons 45 years of age and older that found that higher income is associated with glucosamine use (Sibbritt et al. 2012). However, persons below poverty level made up the highest proportion of past 12 month chondroitin use (85.1%) among persons with rheumatoid arthritis.

MAJOR FINDINGS

Past 12 month use of glucosamine only was not associated with reported past 12 month improved health among persons with any arthritis (adjusted OR=1.1; p= 0.19), unspecified arthritis (adjusted OR= 1.0; p= 0.51), or rheumatoid arthritis (adjusted OR=1.2; p= 0.25). Past 30 day use of glucosamine only was also not associated with reports of past 30 day joint pain, aching, and stiffness among persons with any arthritis (adjusted OR= 2.1; p= 0.26), unspecified arthritis (adjusted OR= 2.5; p= 0.22), or rheumatoid arthritis (adjusted OR= 0.8; p= 0.57). Past 12 month use of chondroitin only was not associated with reports of past 12 month improved health among persons with any arthritis (adjusted OR= 0.6; p= 0.31), unspecified arthritis (adjusted OR= 0.6; p= 0.45), or rheumatoid arthritis (adjusted OR= 0.2; p= 0.18). Past 30 day use of chondroitin only was associated with reported past 30 day joint pain, aching, and stiffness

among persons with any arthritis (adjusted OR= 0.6; p= <0.01) and unspecified arthritis (adjusted OR= 0.5; p= <0.01). Past 12 month use of both glucosamine and chondroitin was not associated with reports of past 12 month improved health among persons with any arthritis (adjusted OR= 0.9; p= 0.96), unspecified arthritis (adjusted OR= 0.9; p= 0.98), or rheumatoid arthritis (adjusted OR= 1.2; p= 0.38). Past 30 day use of both glucosamine and chondroitin was associated with reports of past 30 day joint pain, aching, and stiffness among persons with any arthritis (adjusted OR= 5.7; p= 0.03) but was not associated with joint pain, aching, and stiffness among persons with unspecified arthritis (adjusted OR= 6.7; p= 0.08).

There were no observable associations between past 12 month use of glucosamine and/or chondroitin and reports of improved health among persons with any arthritis, unspecified arthritis, or rheumatoid arthritis. These findings support the claims from clinical studies presented by Kwoh and Clegg (Kwoh et al. 2014; Clegg et al. 2006). This thesis finds no evidence to support the marketed claim that glucosamine and/or chondroitin can improve the health conditions of persons with arthritis.

The association of past 30 day use of chondroitin only and reports of past 30 day joint pain, aching, and stiffness among persons with any arthritis and unspecified arthritis yielded a decreased odds. This suggests that persons with past 30 day use of chondroitin were less likely to report joint pain, aching, and stiffness than persons that did not use the observed supplements. Several factors could have contributed to these findings. To start, only a small proportion of the observed subpopulations were users of chondroitin only. In addition, when compared to glucosamine and combination (glucosamine and chondroitin) supplements, chondroitin seems to be less readily available on the market. Finally, this finding may also suggest that the use of chondroitin alone can be for reasons other than those associated with arthritis.

Past 30 day use of both glucosamine and chondroitin was also found to be associated with self-reported past 30 day joint pain, aching, and stiffness among persons with any arthritis. This finding would suggest that persons who use glucosamine and chondroitin within the 30 days prior to administration of the survey were more likely to report past 30 day joint pain, aching, and stiffness. This could also be interpreted to mean that persons that experience joint pain are more likely to use chondroitin and glucosamine. This may mean that marketing glucosamine and chondroitin together as a CAM treatment for persons with arthritis has been effective.

Glucosamine and/or chondroitin are marketed to persons with arthritis for their potential chondroprotective properties (Gibson et al. 2014). These findings may be used to provide insight on the effectiveness of marketing. It is important to note that glucosamine and/or chondroitin are classified as dietary supplements therefore, are not regulated drugs. Marketing claims may not be backed by scientific findings.

IMPORTANCE

While there are several clinical studies examining the effects of glucosamine and/or chondroitin on arthritic and rheumatoid condition and outcomes, there are very few observational studies that do the same. To date, there are no observational studies that have specifically investigated the relationship between self-reported glucosamine and/or chondroitin use among persons with some form of arthritis and reports of improved health or self-reported pain. While this study was limited to the data provided in the 2012 NHIS adult sample, it fills in the literature gap by providing observational analyses of these associations among persons with any arthritis, unspecified arthritis, and rheumatoid arthritis with reports of improved health and joint pain, aching, or stiffness.

LIMITATIONS

Although 2012 NHIS data included variables specifically for some arthritis and rheumatoid conditions (i.e. rheumatoid arthritis, gout, lupus, and fibromyalgia), there was not a variable specifically for osteoarthritis. Previous clinical studies examined the effect of glucosamine use on osteoarthritis specifically (Bruyere & Reginster 2007; McAlindon et al. 2000; Jawahar et al. 2012); however, this cross-sectional observational study could not investigate this relationship with the given data. Perhaps if future observational studies examine this specific relationship, results would be different.

In addition, the exposure and outcome measurements for this study left room for uncertainty. The question "Compared with 12 months ago, would you say your health is better, worse, or about the same?" covers a large time frame. Various factors can affect a response to this question and though the study was focused on persons with arthritis, a response to this question could be unrelated. Likewise, the question "Please tell me which of these supplements you have taken during the past 12 months?" covers a large time frame. Taking a supplement one or more time may not be a good estimate to analyze.

The following questions are better measures in term of time frame: "Which of these supplements have you taken during the past 30 days?" and "During the past 30 days, have you had any symptoms of pain, aching, or stiffness in or around a joint?" However, they fall short of determining an association with symptom improvement. Asking about joint pain is not the same as asking if joint pain has decreased or been eliminated. Better measures to analyze this were not included in 2012 NHIS.

FUTURE STUDIES

As previously mentioned, an analysis of the association of glucosamine and/or chondroitin use among persons specifically with osteoarthritis and improved health could not be analyzed. Future observational studies should examine this relationship as well as glucosamine and/or chondroitin's relationship with decreased joint pain among persons with specific forms of arthritis. Perhaps, NHIS could include an "osteoarthritis" variable in future surveys. Finally, while the findings of this study did not yield any statistically significant association between glucosamine and/or chondroitin use and reports of improved health, future studies are needed that can examine these relationships longitudinally through experimental study designs.

CONCLUSION

Past 12 month use of glucosamine and/or chondroitin is not associated with self-reported 12 month improved health among persons with any arthritis, unspecified arthritis, or rheumatoid arthritis. Past 30 day glucosamine use was not associated with reports of past 30 day pain, aching, and stiffness among person with any arthritis, unspecified arthritis, and rheumatoid arthritis however, past 30 day use of chondroitin only and past 30 day use of both glucosamine and chondroitin is associated with reports of past 30 day pain, aching, and stiffness among person with any arthritis. Past 30 day use of chondroitin only is also associated with past 30 day pain, aching, and stiffness among person with unspecified arthritis. Because marketing is expected to have an effect on the factors found to be associated, this study warrants the need for future studies on the effects of advertisement and supplement use.

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