BIOCULTURAL AND GENETIC FACTORS USED IN OSTEOPOROSIS RISK ASSESSMENT AND OSTEOPOROSIS EDUCATION FOR DIFFERENT FEMALE AGE DEMOGRAPHICS

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Biocultural and genetic factors used in osteoporosis risk assessment and osteoporosis education for different female age demographics

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Abstract

Previous studies emphasize the importance of acquiring maximal bone mineral density through modifiable behavioral practices during childhood and adolescence to help prevent geriatric onset of osteoporosis. The purpose of this study was to examine the biocultural and genetic risk factors medical professionals consider when assessing osteoporosis risk and to evaluate if the appropriate age demographic is targeted for osteoporosis education. Thirty-three medical professionals participated in a structured survey consisting of 20 questions about critical factors for determining osteoporosis risk. Survey results indicated that diet, multivitamin intake, physical activity level, history of low BMI, and cigarette smoking status are among the most important developmental factors respondents considered when evaluating patient risk. Professionals emphasized that the interplay between these modifiable factors significantly influences individual risk. A patient's age, sex, family history of osteoporosis, and past medical history were also important, albeit non-modifiable, factors. Results revealed that medical professionals adequately educate young female patients about osteoporosis risk and bone health in a clinical context. In an additional component of this study, the frequency and accuracy of osteoporosis and bone health information presented by media sources was assessed by analyzing five magazines and eight Twitter accounts that targeted young women. Results showed that discussion of bone health and osteoporosis was minimal compared to discussion of other aspects of health and the amount of content that focused on attaining a certain physical appearance. Examining the factors that contribute to the incidence of osteoporosis in modern human populations is crucial for understanding and preventing the disease.

Honor Pledge:

On my honor, I have neither given, nor received, any unauthorized aid on this honors thesis. Honor Code upheld.

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Claire Smith

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Introduction

Osteoporosis, defined as a reduction in bone mass over time, is currently a major public health concern that affects over 10 million people in the United States alone (Lein *et al*. 2011). It results in costs to the healthcare system approaching an excess of $13.5 billion per year (Schettler and Gustafson 2004). Additional estimates from the U.S. Department of Health and Human Services predict that over 44 million Americans are at risk for osteoporosis, and that this number will rise to 60 million by the year 2020 if no effective preventative plans are implemented (Schoenfeld et. al 2010). The National Osteoporosis Society reports that in the United Kingdom 1,150 people die each month as a result of hip fractures caused by osteoporosis, and that one in two women and one in five men will suffer an osteoporotic-related fracture after the age of fifty (Elliot 2011). Thirty percent of women who suffer a hip fracture caused by osteoporosis die within one year of the injury, and another 25% remain permanently disabled (Schettler 2004).

I believe that the general population is unaware of the danger of osteoporosis, uninformed about methods for prevention, and would be astounded by the number of people, in well-developed countries like the United States and the UK, who are detrimentally effected by osteoporosis. Additionally, I think people would be shocked at the exorbitant amount of money spent annually within the healthcare system on osteoporosis-related issues. In 2001 alone, the average cost to the U.S. health care system reached over $17 billion, surpassing the costs for asthma and lung disease combined (Schettler 2004). I believe that much of this problem originates from a lack of education and awareness about osteoporosis, which has motivated me to further research this problem. As a young woman residing in the U.S., I obtain information regarding my health from a variety of sources, including: magazines, television, visits to my healthcare providers, the internet, and social networks, such as Twitter, Facebook, Pinterest, and Instagram. I witness frequent hype

in the media surrounding essentially the same health issues, and osteoporosis and bone health are rarely included. My research is motivated by my desire to learn why the condition of osteoporosis, as serious and common as it is, is not one of the major health topics discussed with girls and young women. I believe that anthropology is well suited to address this issue. Collaboration between anthropologists among the different subfields has provided a wealth of information regarding the biocultural factors that affect bone health, and I believe that the next crucial step involves making sure researchers are aware of these anthropological findings and the inherent complexities regarding the etiology of osteoporosis. What medical professionals must recognize is that each cultural community, family, and individual experience contributes to the trajectory of skeletal health. This is why studying past populations, and emphasizing a holistic, multi-dimensional approach, characteristic of anthropology, is so beneficial for studying the disease of osteoporosis in an effort to prevent it in current populations.

It is widely agreed upon that the gold standard of treatment for osteoporosis is simply prevention (Schettler 2004). The interplay of numerous factors, including both genetic and developmental, contribute to an individual's osteoporosis risk. Together, they combine to produce one major predictor of osteoporosis: whether or not sufficient peak bone mineral density is reached by a specific age. Major factors affecting whether someone acquires maximal bone density include, but are not limited to: frequency of physical activity, involvement in sports, participation in weight lifting and strength training, current and past dietary habits, intake of dietary supplements, current and past use of alcohol and tobacco, use of sunscreen, regularity of menstruation, history of stress fractures, ethnic background, and any family history of osteoporosis or fractures after age fifty. A collaborative effort between health care providers, parents, schools, and coaches should be made to promote education about the ways to facilitate healthy bone development in addition to raising awareness about osteoporosis among people of all age demographics so that the disease can be

prevented. If efforts are successful, the incidence of osteoporosis should decrease, sparing millions of the debilitating disease in addition to decreasing the amount of money spent on osteoporosis-related issues in the healthcare system. Abundant evidence exists that practicing the beneficial modifiable behaviors and not partaking in behaviors that harm bone mass density can reduce the chances for developing osteoporosis, even if an individual is already genetically predisposed to the condition. It is now a matter of educating the public about these facts.

Literature Review: Bone Structure and Formation

Bone is the hard, calcified connective tissue that together with cartilage forms the skeleton of humans and other vertebrates (Considine 1995). Bone tissue constantly renews itself and possesses a great capacity to respond to altered environmental and developmental stresses (Ceausu 2010). Mature bone is made up of thin plates of bone tissue, called lamellae, which occur in bundles. Based on the shape and arrangement of lamellae, bone will take one of two forms, either trabecular or cortical (Considine 1995). Trabecular bone is the spongy, lighter form of bone, and it is usually found in protected areas of the skeleton, such as the marrow cavities at the enlarged ends of long bones, in the central bodies of vertebrae, in the ribs, and in the bones of the pelvis (Stini 1995). The other type of bone is cortical bone, also called compact bone. Cortical bone is denser than trabecular bone and typically forms the outer surface of bones (Stini 1995) (See Figure 1 below).

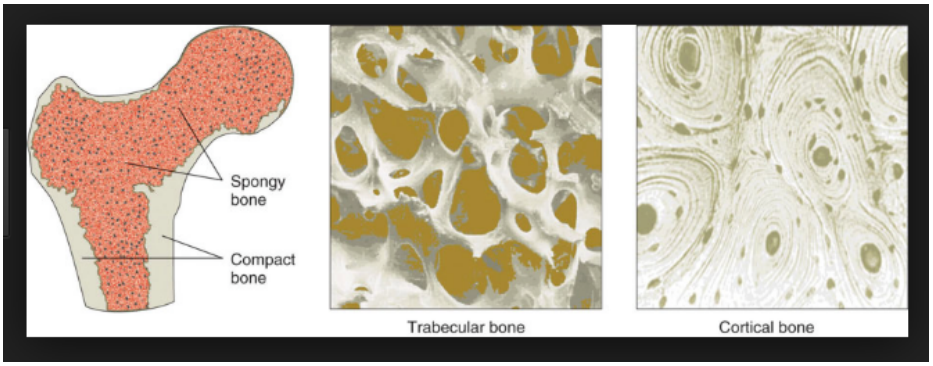

Figure 1 shows where trabecular (spongy) and cortical (compact) bone are located in a human femur and comparatively illustrates the arrangement of each. (Source: http://2012books.lardbucket.org/books/an-introduction-to-nutrition/s13-01-bone-structure-and-function.html)

The periosteum is a thin membrane that covers the outer surface of bone. It consists of layers of cells that participate in the remodeling and repair of bone tissue (Stini 1995).

Bone performs a variety of important functions. It has structural and mechanical roles, protects vital internal organs, serves as a site for the production of blood cells, and provides the body with a reserve of calcium (Ceausu 2010). The formation and remodeling of bone is accomplished by the interaction of bone cells whose activities are regulated by hormones and other molecules that circulate through the blood (Khosla 2012). Other regulators are produced locally in the bone tissue that serve to direct bone cell activity (Ceausu 2010). In order to maintain structural integrity of the skeleton, there must be a constant process of remodeling and repairing of the micro-cracks that develop in both trabecular and cortical bone. This process occurs through the interaction of osteoclasts, osteoblasts, and osteocytes (Khosla 2012). Osteocytes sense mechanical strain and developing microcracks, respond to hormonal changes, and activate bone remodeling (Kholsa 2012). Bone remodeling begins with bone resorption, where osteoclasts eat away bone tissue. Then osteoblasts are recruited via a number of mechanisms to deposit new bone into the resorbed cavity (Considine 1995).

Bone grows by the process of adding new bone to old bone, with new bone beginning as immature, soft bone which gradually becomes more rigid through the process of calcification (Considine 1995). In trabecular bone, deposition of new bone occurs within the meshes of the lamellae network, whereas in cortical bone, the new bone is deposited primarily on the outer surface (Considine 1995). The long, hollow bones of the arms and legs grow in circumference when new bone is deposited on the outer shaft while, simultaneously; the inner cavity becomes enlarged through resorption. Lengthening of long bones occurs only at the ends of the bone at an area called the *epiphyseal cartilage*, located between the sponge-like, trabecular end of the bone

and the lengthy bone shaft. The area where the epiphyseal cartilage is located is called the growth plate. It is at this location where pre-existing cartilage turns to bone (See Figure 2 below).

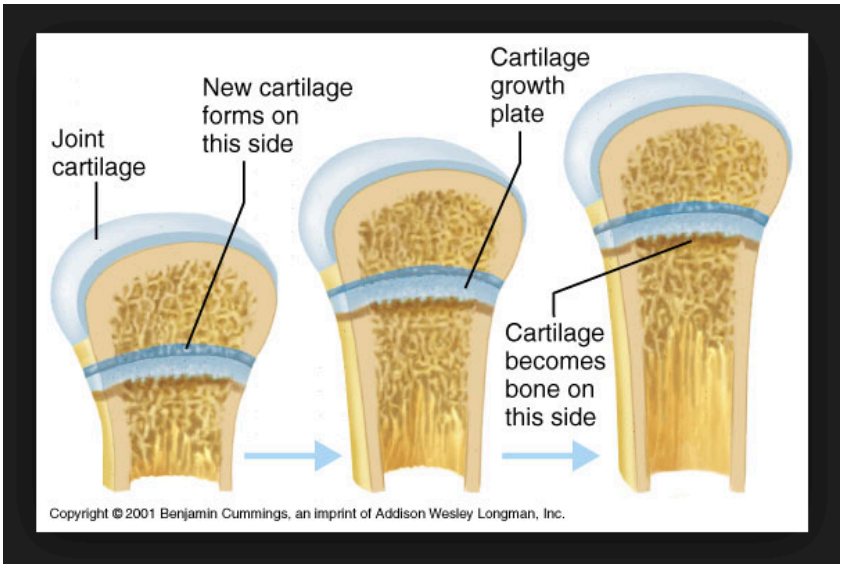

Figure 2 shows a lengthening long bone, where the epiphyseal cartilage turns to bone at the area known as the growth plate. Source: http://www.naturalheightgrowth.com/2012/08/18/epiphyseal-plates-and-height/

Bone ceases to grow in length when the epiphyseal cartilage is completely replaced by bone tissue. Normally, in humans, this growth is completed by age 25, but physiological disturbances are capable of accelerating, retarding, stopping, or prolonging bone growth (Considine 1995). Among current human populations, one of the most common and dangerous conditions affecting bone tissue that may arise as a result of genetic and mal-adaptive developmental factors is osteoporosis.

Literature Review: Osteoporosis

Osteoporosis continues to assert itself as a major health problem in the United States as well as in other nations (Lein et al. 2011). It is associated with painful fractures as bones become weak and brittle—so brittle that even mild stresses can cause bones to break (Gonzalez-Jimenez and Alvarez-Ferre 2011). In severe cases, victims find themselves bed-ridden and permanently disabled, because their bone is too fragile to be repaired (Gonzalez-Jimenez and Alvarez-Ferre

2011). As humans age, bone density decreases and osteoporosis arises when the biological process of bone deposition fails to keep pace with bone resorption (Ceausu 2010).

Attaining a healthy bone mass density prior to elderly years is one of the most important factors for decreasing the likelihood of developing osteoporosis. Acquiring adequate bone mineralization is dependent upon both developmental and genetic factors and their interplay (Gonzalez-Jimenez and Alvarez-Ferre 2011). Any imbalance between resorption versus deposition of bone leads to overall bone loss, which in time leads to osteopenia and then osteoporosis (Schettler 2004). The years ranging from childhood to early adulthood mark a crucial period during development where nutritional habits and activity-related mechanical factors greatly impact an individual's risk for developing osteoporosis later in life (Gonzalez-Jimenez and Alvarez-Ferre 2011). Researchers have identified multiple environmental and developmental factors that influence whether or not humans in today's society achieve sufficient bone mineralization (Gonzalez-Jimenez and Alvarez-Ferre 2011). These factors, combined with genetic factors, play a significant role in determining osteoporosis risk.

Additionally, the common perception that osteoporosis is an "old person's" disease is erroneous (Eyigor et al. 2007). Instead, osteoporosis ought to be described as a geriatric disease with an *adolescent onset.* Because women in particular must attain peak bone mass during the critical limited years for development, it is imperative that adolescent females are educated about factors affecting their bone health at an early age in order to facilitate development of healthy bones during the age when women still have the opportunity to do so. Previous research indicates that a knowledge deficiency exists about osteoporosis among female college students (Ailinger *et al.* 2005). This is alarming, because this age demographic ought to be aware of factors affecting osteoporosis because, at this age, they can participate in practices that contribute to long-term bone health. Nutrition and lifestyle factors account for around 20% of the variability in those who

develop low bone density (Schettler 2004). Therefore, even in the presence of predisposed genetic risk factors, a healthy lifestyle established early in life that includes adequate calcium intake and appropriate physical activity will reduce osteoporosis risk through helping the individual acquire peak bone mass prior to age-related deterioration. For women, after about age 30-35, bone mass naturally begins to decline at a rate of 0.3% per year, and by two years post-menopause, bone mass declines at an average rate of 3% per year until it slows to 1% of bone per year, after about the seventh year following menopause (Schettler 2004) (See Figure 3 below).

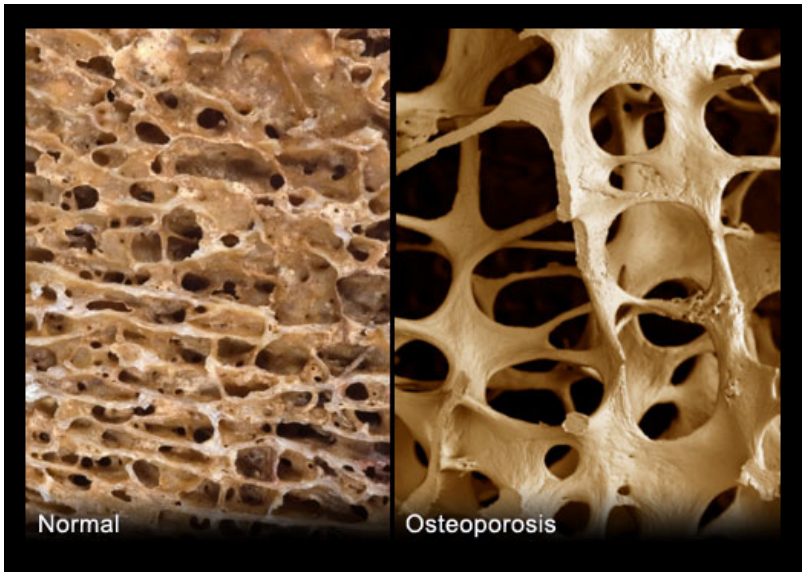

Figure 3 compares normal bone matrix (left) with osteoporotic bone matrix (right).
Source:http://www.webmd.com/osteoporosis/ss/slideshow-osteoporosis-overview

I believe that if the parents of young girls, in addition to young women themselves, were aware of these facts, more proactive practices would be performed to ensure the acquisition of adequate bone density prior to age thirty. Strategies to prevent geriatric development of osteoporosis are best undertaken during childhood and adolescence when the greatest amount of bone mineral density is acquired (Fleming and Patrick 2002). Medical professionals and public health officials need to educate these age demographics about osteoporosis and the factors

affecting individual risk in hopes of preventing the onset of the disease in elderly years. Given its debilitating nature, research aiming to understand the multiple causes and factors that play into the epidemiology of osteoporosis is of utmost importance in order to prevent the disease and to produce effective cures. Medical professionals need to employ the best possible methods for determining an individual's risk for developing osteoporosis, which involves assessment of both biocultural processes and genetic factors. Health care professionals and public health administrators also have the responsibility to educate and raise awareness regarding osteoporosis among the public.

Literature Review: Genetic Factors

One major question currently being researched is the degree to which an individual's genotype protects or predisposes them to osteoporosis. Some estimates state that heredity accounts for up to 60% of the total risk factors influencing the likelihood for developing osteoporosis (Gonzalez-Jimenez and Alvarez-Ferre 2011). Additional studies within families demonstrate that genetic factors are responsible for around 60-85% of individual variability of bone mass density (Marini and Brandi 2010). Research shows that across world populations, females are more prone to osteoporosis than males because of the rapid rate at which bone density deteriorates in the years following menopause due to decreases in estrogen (Lein *et al.* 2011). This fact is typically not disputed, because sufficient evidence exists supporting estrogen as a key factor for maintaining the balance between resorption and formation of bone (Sonada et al. 2012). Several genes, with some exerting a higher degree of influence than others, regulate bone metabolism and research on these multiple candidate genes is ongoing (Tural, Nurten, and Gamze 2011). However, it is generally accepted that fluctuations in estrogens signal changes in genes that control for bone metabolism (Marini and Brandi 2010). Given estrogen's important influence on

bone, it makes sense then that menopause, or mutations in estrogen-related genes, would therefore affect bone mass density.

Although individuals do not inherit "osteoporosis" as a disease in itself, individuals do inherit specific genes that control distinct risk factors. Studies show that the most common factors that are genetically inherited are bone mineral densities and bone geometry (Cauley 2011). Literature suggests that there are variations in the frequency of osteoporosis and subsequent fractures based upon ethnicity, or according to some articles, differences in "race." Use of the term "race" ought to be limited in scientific writing since race has no biological basis. Race is a social construct that applies to the governing of social behavior, not an individual's genetic lineage (Brace 2005). Genetic diversity exists in all human populations. Pure "races," in the sense of genetically homogenous populations, do not exist in modern human species, and there is no evidence that they ever existed in past history (Hagen 2009). However, past racial conceptions persist in society as social conventions that can cultivate institutional discrimination, which may ultimately impact an individual's health and undermine their well-being. For example, those belonging to disadvantaged classes might experience increased incidence of certain health problems because of the resulting inequities in access to healthcare, income, etc (Navarro *et al*. 2009). "Race" as a social construct is frequently used to classify people, but it does not in and of itself place an individual at increased or decreased risk for osteoporosis at the biological level. The social perceptions surrounding race can impact health. Thus, it may be valid for scientists to discuss social "racial" categories in their research as long as they acknowledge that it is a cultural factor at play and not a biological, genetically linked factor. Categorizing or profiling individuals into a "race" within the context of medical treatment has significant limitations and potentially serious implications if healthcare providers are misinformed and believe that race relates to an individual's genotype. Misdiagnoses or decisions to perform, or not perform certain medical tests and screenings, based on

misattribution of “race” could harm patient care. In the U.S., social categories of race typically refer to people from entire continents, and natural selection is not known to operate on such a large scale. However, discrete populations sharing the same environment may experience a specific set of shared selective pressures. These selective pressures are not tied to entire continents, but rather can be experienced by different populations living in similar environments on different continents. For example, high altitude adaptations can be found among people living in East African highlands, the Himalayas, or the Andes in South America (Beall 2007). Specific populations from discrete geographical regions or, in the case of humans, cultural groups may experience an increase in certain genotypes due to the effects of natural selection or genetic drift operating at this population level. Hereafter, the term, “ancestry” will refer to people descended from specific populations. Thus, ancestry, like sex, is a non-modifiable, genetic risk factor that influences chances for developing osteoporosis (Cauley 2011).

Major efforts are currently underway to identify specific genes and allele variations that are suspected to influence an individual’s risk for osteoporosis (Zintzaras *et al*. 2011). What may be concluded is that the heritability of osteoporosis involves the interactions of numerous genes, which are influenced by environmental factors such as physical activity, calcium and vitamin D intake, medications, alcohol consumption, and smoking status (Vidal and Xuereb-Anastasi 2009). Additional confounding factors include heterogeneity, phenocopies, genetic penetrance, and genetic imprinting, all of which further complicate the task of identifying the genes that make an individual vulnerable to osteoporosis (Vidal and Xuereb-Anastasi 2009). Currently, the candidate genes most frequently studied include those coding for receptors, cytokines, growth factors, and structural proteins (Vidal and Xuereb-Anastasi 2009). Specific receptors include VDR (vitamin D receptor), ERb and ERa (estrogen receptors beta and alpha), and LRP5 and LRP6 (low-density lipoprotein receptors). Cytokines include IL6 (interleukin 6). Growth factors include TGF-b and IGF-

1 (transforming growth factor beta and insulin-like growth factor). Specific structural proteins under research include COL1A1 (collagen type 1) (Marini and Brandi 2010). Findings from Vidal and Xuereb-Anastasi's (2009) study of a Maltese population indicated a number of candidate genes affecting osteoporosis risk factors, and one underlying commonality was that the protein products of almost all of the identified genes were involved in osteoclast differentiation and activation. To date, candidate gene association studies have identified several polymorphisms associated with bone mineral density and bone characteristics pertaining to fracture risk. However, limitations exist that prevent decisive identifications, because these studies often generate conflicting results which could be due to issues like inadequate population sampling, ancestry, age, confounding interactions, non-standardized genotyping methods, gene-gene interactions, and epigenetics (Vidal and Xuereb-Anastasi 2009).

The exact evolutionary reason behind why women of certain descent are more susceptible to osteoporosis than women of other ancestries remains unclear. Research is complicated by poor research methods aimed at identifying "race" variation at the continental level. This would easily obscure variation and traits present in the multitudes of populations present on an entire continent. In order to provide a much more powerful analysis, research methods should aim at identifying genetic variation at the population level, not at a continental level. In depth ethnographic research utilizing multifaceted approaches is needed to determine the exact stressors that selected for or against the genes, or mutated genes, present in populations with low bone mineral densities and those that experience osteoporosis-induced fractures. However, scientists are still working to identify these exact genes, so comparing them across different populations is not possible yet. Environmental stressors, developmental stressors, cultural habits, or all three factors may greatly impact the expression of the so-far identified candidate genes.

Literature Review: Developmental Factors

In addition to genetic factors, multiple developmental factors affect an individual's chances for developing osteoporosis. Some of the most notable lifestyle factors influencing osteoporosis risk include: calcium and vitamin D intake, amount of weight-bearing physical activity, cigarette smoking status, alcohol consumption status, caffeine intake, use of corticosteroids, and low body weight (Ailinger *et al.* 2005, Ali 2001, Dhanwal et al. 2011, Flemming 2002, Gonzalez-Jimenez and Alvarez-Ferre 2011, Lein et al. 2011, Phillips 2012, Schettler and Gustafson 2004). Diet is one of the key factors involved with developing healthy bones, and calcium is an especially vital mineral (Phillips 2012, Schettler and Gustafson 2004). Adequate calcium intake is essential to maintain physical homeostasis (Stini 1995), and it is required for normal growth of the skeleton and acquirement of peak bone mass (Phillips 2012). Approximately 99% of total body calcium is found in the skeleton, and the primary need for dietary intake of calcium is for bone deposition (Greer and Krebs 2006). Therefore, individuals need to consume a sufficient amount of calcium in their diets in order to maximize their bone mass. The most important cofactor involved in calcium absorption is vitamin D, considering that in its absence, less than 10% of dietary calcium is absorbed (Schettler and Gustafson 2004). Vitamin D is not found naturally in very many foods; instead, it must be synthesized through the action of sunlight on the skin or alternately obtained through a vitamin supplement (Phillips 2012). A deficiency in this nutrient is associated with an increased risk of fracture (Schettler and Gustafson 2004). Cultural factors can affect an individual's levels of vitamin D. For example, people who are housebound or who cover up their skin for cultural reasons diminish their exposure to sunlight and are more likely to be vitamin D deficient. Another factor at play, particularly in developed countries, is the widespread use of high protection sunscreen products in response to concerns about skin cancer (Phillips 2012). Experts also suggest that another reason vitamin D deficiency is on the rise is a result of the increased hours that children spend indoors playing computer games or watching television (Phillips 2012).

Another lifestyle factor that affects bone health is the amount of physical activity that an individual participates in through the course of their life (Drenjancevic and Cvetko 2013, Schettler and Gustafson 2004). To increase bone mineral density, exercise must be weight bearing, because osteogenesis only occurs through impact, or mechanical strain (Schettler and Gustafson 2004). Growing bone has a higher sensitivity to weight-bearing exercise than mature bone, which is why it is important for children to participate in physical activity and avoid overly sedentary lifestyles (Schettler and Gustafson 2004). Cigarette smoking, excessive alcohol consumption, use of corticosteroids, and excessive caffeine consumption are all additional lifestyle practices that can be harmful to bone health. Heavy alcohol consumption hinders calcium absorption and damages bone cells (Schettler and Gustafson 2004). Additionally, cigarette smoking and a diet high in sodium, protein, phosphorous (frequently found in carbonated beverages), alcoholic beverages, and dietary fiber all increase the amount of calcium excreted from the body, and consequently, from bones (Bachrach 2000). Choosing to smoke cigarettes or consume alcohol in excess may be harmful to bone health at any age; however, it is particularly damaging during adolescent years when bone is forming, which is unfortunately a time when some individuals choose to partake in these two practices (Schettler and Gustafson 2004). Corticosteroids suppress bone formation, which may lead to what has been termed “steroid osteoporosis” (Stini 1995).

Low body weight, defined as a BMI below 19 kg/m^2, is another significant risk factor for osteoporosis (Elliot 2011). The resulting increase in osteoporosis risk, as well as the significantly increased risk for bone fracture, is thought to be partly related to the decreased production of estrogen –some of which is produced in fatty tissue—in combination with the reduced mechanical strain on the bones, both as a result of low body weight (Elliot 2011). For women, amenorrhea, a complication of severe eating disorders, has been shown to be as detrimental to bone health as the menopausal period (Schettler and Gustafson 2004). Concern about bone growth and development

is particularly important in light of the frequency with which adolescents perceive the need to diet and lose weight, perhaps unaware that too low of body weight is harmful, both short-term and long-term, to their bones (Kreipe and Forbes 1990).

An individual's socioeconomic status is a factor to consider when evaluating osteoporosis risk. Current research demonstrates that postmenopausal women living in poverty have lower values of bone mineral density measured at the lumbar spine and have a higher risk of total and vertebral fractures compared to women not living in poverty (Navarro *et al*. 2009). It is important to recognize that this does not mean that poverty in itself directly causes osteoporosis, but rather that the lifestyle and habits often demonstrated by women living in poverty may contribute to the cause for this correlation. Research regarding socioeconomic factors that influence developmental behaviors which put individuals at risk for osteoporosis is important for disease prevention, education, and awareness.

Literature Review: Osteoporosis through Human History

A common goal among anthropologists is to understand changes in human behavior over time and to grasp how people from distant parts of the world and dissimilar cultures respond to their local environment. Numerous studies document the bone quality of past human populations from different geographic regions (Agarwal 2012, Agarwal *et al*. 2004, Dhanwal *et al*., Larsen 2002, Ruff 2006). Comparisons of this nature are useful, particularly within the realm of understanding how culture combined with different environmental pressures can change the biological features of an individual human through their life course, as well as affect biological change in broad-scale human populations. The study of osteoporosis in past populations should inform researchers about the origins of patterns and the prevalence of osteoporosis in current societies. Environmental and cultural changes that occurred in past societies often are reflected in the biological composition of human skeletons. Assessment of bone mass in ancient skeletal remains is of particular interest,

because it is highly indicative of lifestyle and nutritional stress and can be used to determine relative osteoporosis and osteoarthritis frequencies in different populations (Gonzalez-Reimers *et al.* 2004).

Osteoporosis is a disease that develops as a result of a combination of genetic and biocultural processes, and factors like diet, mechanical stress, and reproductive behaviors, are as relevant to today's world populations as they were to ancient populations. Regarding skeletal health, one of the time periods analyzed most critically is the Neolithic Revolution, when many human populations shifted from a lifestyle of hunting and gathering to one of agriculture. For populations that shifted toward agriculture, it typically meant inhabitants were living a more sedentary lifestyle, which is generally regarded to have resulted in an increase in morbidity including conditions like osteoporosis (Agarwal *et al.* 2004). One conclusion that has been reached is that the skeletons of humans have become less robust and more gracile over the past 2 million years (Ruff 2006). Furthermore, comparisons between earlier and later hominids reveal changes in skeletal morphology indicating that overall bone strength has declined dramatically in the last several million years, and it continues up to the present day (Larsen 2002). From roughly 2 million years ago to about 5,000 years ago, human bones have become nearly 15% weaker (Ruff 2006). Additionally, bone strength appears to have decreased even more rapidly during the past 5,000 years than it did over the previous 2 million years (Ruff 2006). This trend is consistent with the idea that with agriculture, people became increasingly sedentary, ultimately resulting in decreased bone strength. It is interesting to note, however, that although reduced bone mass is prevalent in past populations, possibly as a response to nutritional stress, incidence of osteoporosis is so far not a common finding. An additional important observation from archaeological remains is that there is a rare, borderline absent, incidence of osteoporotic fractures in past populations, particularly with regard to hip fractures (Agarwal *et al.* 2004). Elderly members of ancestral populations suffered

significantly fewer hip fractures than senior citizens do today, even after controlling for the shorter life expectancies of humans in the past (Ruff 2006).

Essentially, what multiple studies are finding is that the pattern of bone loss and fragility observed in age-related and post-menopausal osteoporosis today, is not evident in earlier human populations. Some researchers hypothesize that the gracilization of the human skeleton through history is probably a direct result of the emergence of advanced technology that has produced less physically active human populations (Ruff 2006). This decrease in physical activity could be contributing to increased development of osteoporosis, since weight-bearing activity is known to benefit bone health and help prevent osteoporosis (Ceausu 2010). Most humans living in technologically advanced societies no longer need to have skeletons adapted for heavy, physically demanding workloads like our ancient ancestors did. This evolutionary change appears to have contributed to an increase in the prevalence of osteoporosis and fragility fractures. In a number of today's human populations, hip fractures are one of the most rampant crises affecting the elderly (Ceausu 2010). Current studies show that hip fracture rates, one of the indicators of osteoporosis, are seen most highly in Northern Europe and the United States and lowest in Latin America and Africa (Dhanwal *et al.* 2011). Figure 4 illustrates the distribution of hip fracture probability for men and women worldwide for the year 2012.

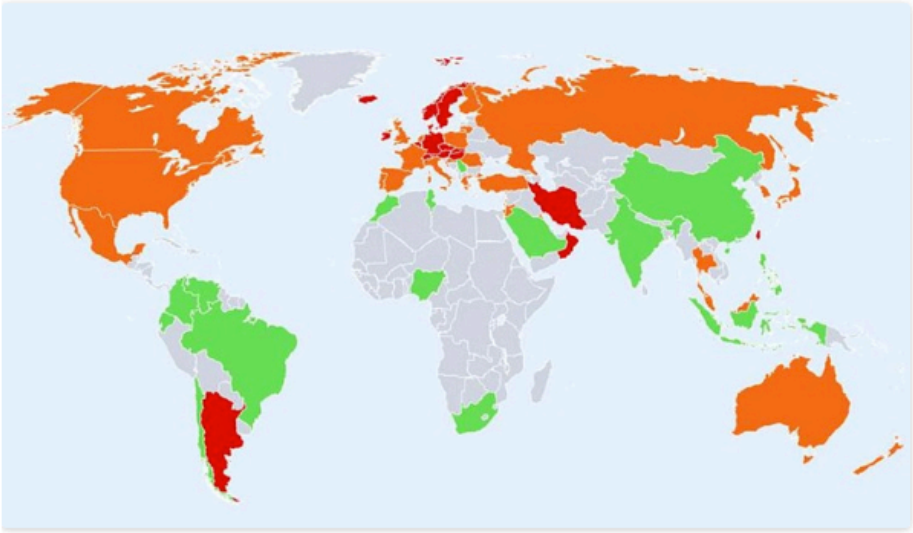

Figure 4 is a map showing hip fracture rates for men and women based on a systematic review of hip fracture incidence and probability of fracture worldwide in 2012. Red (annual incidence >250/100,000), orange (150-250/100,000), green (<150/100,000). Source: http://fanaticcook.com/2014/01/20/if-milk-builds-strong-bones-why-do-people-in-countries-who-consume-the-most-have-higher-fracture-rates/

There is also currently a north-south gradient in hip fracture frequency in both the United States and Europe, where fractures occur more frequently at more northern latitudes (Dhanwal *et al.* 2011). Factors accountable for this variation include population demographics, ethnicity, and environmental factors, including socioeconomic status and physical activity levels (Dhanwal *et al.* 2011). Some hypotheses propose that vitamin D deficiencies, a risk factor known to contribute to osteoporosis, are more common in northern latitudes where human populations generally spend less time in the sun (Dhanwal *et al*. 2011). In latitudes above 40 degrees north, synthesis of vitamin D from sunlight occurs little if at all during the months from October to April, so people who are not supplementing this deficiency through their diet are at risk for low vitamin D levels (Phillips 2012).

Currently, among the numerous populations originating from geographic locations around the world, it is generally accepted that females descending from northern Europe are at the highest risk for osteoporosis and various associated fractures (Cauley 2011). Hip fractures, in particular,

were found to be highest in Northern European countries compared to numerous other countries around the world (Cauley 2011). There is less variability worldwide regarding the frequency with which women of different ancestries exhibit vertebral fractures. Factors contributing to this lack of variability compared to hip fractures; however, remain unknown (Cauley 2011). Perhaps the lengthier hip axis characteristic of women descended from Northern European is more susceptible to fractures. A study performed in California, where researchers chose to categorize women based on skin color and the culturally associated "race," found that hip fracture rates are present from highest to lowest among White, Native American, Asian, African American, and Hispanic women respectively (Silverman 1988). However, this study, like many others, did not analyze the physical activity levels, socioeconomic status, or diets of each of these groups of women. Other studies have also noted that women of "White" and "Asian" race are at an elevated risk for developing osteoporosis (Ailinger *et al.* 2005). The results of studies such as these should be analyzed critically, since they aim to classify and find patterns among groups of women at the continental level, as opposed to focusing on patterns between populations of people that experience similar environmental pressures. Not much is known about whether rates of bone loss differ between populations descended from different geographic regions, and the rate of bone loss following menopause appears to be similar across ethnicities (Cauley 2011).

It is worthwhile to investigate the underlying causes for poor bone health and increased osteoporosis risk based on geographic location, and more studies ought to be done to link occurrence of osteoporosis in geographically dispersed ancient populations with the occurrence of osteoporosis in current populations around the world. The etiology of low bone mass and osteoporosis is far from completely understood. Questions still remain as to the factors responsible for the decrease in bone mass in the human skeleton from ancient times until now and what it means in terms of understanding bone maintenance in today's populations. Nutritionally based

hypotheses and physical activity hypotheses have been focused on most thoroughly, but more complex and holistic hypotheses are needed to better interpret reasons for decreases in bone mass through time in addition to the seemingly absent occurrence of osteoporosis in past populations.

Methodology: Thesis Questions

I. How are health care professionals assessing individuals for their risk of developing osteoporosis? Specifically, which methods are used and what risk factors are most critically analyzed?

Hypothesis: I predict that health care professionals rely on a comprehensive approach that incorporates developmental, genetic, and social factors and the interplay between all three to determine a patient's osteoporosis risk. I suspect that there are discrepancies within the realm of determining genetic risks, which originate from the inconsistent/incorrect distinctions between a person's race and their ancestry upon the part of medical professionals as well as the patient. I predict the most critically analyzed factors will be the patient's age, sex, family history of osteoporosis, diet, and cigarette smoking status.

II. Are medical professionals and media sources (i.e. magazines and Twitter accounts) adequately educating at-risk populations about the factors that affect their chances for developing osteoporosis? Is the appropriate age-demographic being targeted for proper education regarding facts about osteoporosis?

Hypothesis: I predict that medical professionals are adequately educating post-menopausal women and women who are approaching menopause about their osteoporosis risk, but I suspect that girls and young women under age 25 are not receiving an adequate education regarding their osteoporosis risk and about ways to build bone mass. I believe there are multiple important age demographics to target, each necessitating a different type of education; however, I predict that specifically the under-25 age range is not being properly educated. I predict that the

magazines and Twitter accounts analyzed that market to young women about being “healthy” and “fit” do not adequately educate young women about the importance of acquiring bone mass or about their osteoporosis risk.

Methodology: Research Design

In an effort to understand the reasons for why the somewhat largely preventable disease of osteoporosis continues to assert itself as a major health issue, even in developed societies, I examined which risk factors health care professionals consider to be the most important for evaluating a patient’s osteoporosis risk. Additionally, I investigated the age demographics targeted most intensely by health care providers and also by media sources with regard to osteoporosis risk and general bone health education. I hoped to gain an understanding about health care professionals’ and the general public’s perceptions about osteoporosis and practices that promote bone health. In order to evaluate how medical professionals assess their patients for osteoporosis risk, as well as measure bone health education and osteoporosis awareness efforts put forth by the medical professionals, a structured survey consisting of a combination of multiple choice and open-ended questions was distributed to medical professionals at a variety of health care facilities. The surveys aimed to collect both quantitative and qualitative data for analysis. An additional component of my research involved an analysis of how media sources educate the public about osteoporosis and bone health. Specifically, I analyzed how magazines and Twitter accounts that target young women promoted practices that benefit verses harm bone health.

A survey and consent form was developed and distributed to clinics located in the cities of Denver and Colorado Springs, CO and the city of Casper, WY. These locations were chosen based on convenience and proximity to my own location at Colorado College in Colorado Springs and also my hometown of Casper, WY. Both an online and paper version of the survey was developed so that professionals could choose their preferred method for responding, should they

choose to participate. The online survey was constructed using a website that Colorado College subscribes to called Qualtrics.com. Professionals (MD, DO, PA, NP, or other) who worked at the medical facilities completed the surveys. Survey questions addressed which genetic, developmental, and socioeconomic factors were considered to be the most important when assessing a patient's osteoporosis risk. Survey questions also evaluated professionals' understanding of the difference between an individual's *ancestry* verses their *race*. Additional questions assessed the current methods used to educate patients about osteoporosis and raise awareness about bone health. Several questions on the survey investigated the age demographic at which most clinics tended to target their education efforts, in addition to which risk factors were emphasized most heavily among different female age groups. (See Appendix A for the complete survey and consent form, page 55). The survey was twenty questions in length, and the estimated time to complete the survey was between ten and fifteen minutes.

To distribute the survey to Colorado clinics, contact was established with 32 clinics in the Colorado Springs and Denver area on October 7, 2013. Efforts were focused on clinics that specialized in orthopaedics, women's health, family practice, and pediatrics. The goal was to acquire answers from a range of general and subspecialty medical professionals. (See Appendix B for listing of specific Colorado clinics that were contacted, page 63) Generally, administrative assistants at the front offices of these clinics provided a general email address of where to forward the survey. None of the administrative assistants were willing to provide the medical professionals' private email addresses. I pursued this strategy for three days, distributing surveys via email to a total of 28 clinics. For distributing surveys to medical professionals in Casper, I either emailed the Qualtrics survey or mailed paper versions of the Qualtrics survey and consent form to a total of 43 medical professionals (See Appendix C for listing of medical professionals that were contacted, page 64). An effort was made to include clinics that treat patients from a variety of socioeconomic

backgrounds by including both public and private practices for survey distribution; however, I could not predict from which clinics I would receive completed surveys. The approximate sample size was dependent upon how many professionals completed the survey. The goal was to obtain 30 responses from the medical professionals working at the selected clinics. In addition to responses from Colorado and Wyoming medical professionals, I obtained survey responses from two doctors from Tübingen, Germany who are family friends and were staying in my home over winter break. I also interviewed them, informally, about their experiences evaluating bone health. I believe their survey responses and interview responses helped to add diversity to the sample.

For the media analysis component of my research, I created a Twitter account and followed eight separate accounts, each of which promoted general health education and awareness for women. Five magazines that marketed towards young women were also analyzed for articles pertaining to aspects of health (Appendix D lists Twitter accounts followed and magazines analyzed, page 65). For the Twitter analysis, tweets from each account were analyzed from the dates of December 1, 2013 through January 12, 2014. For the magazines, issues for December and January were purchased, except for in the case of SHAPE magazine, where a January issue could not be located for analysis. I established groups to categorize each tweet and magazine article that pertained to health. Some tweets were categorized into multiple groups, although most fell fairly strictly within one category. The groups established to categorize media source content included: *osteoporosis*, *exercises and bone health*, *diet and bone health*, *general bone health*, *cardiovascular health and exercise*, *cardiovascular health and diet*, *exercise and weight loss/body toning*, *diet and weight loss/body toning*, *skin health*, *breast health*, *sexual health*, *cancer (skin, breast, ovarian, etc…)*, and *other*. For the *other* section, the content of the tweet or the magazine article was specified. Topics that appeared three or more times are listed in the results section of this paper (see page 23). For the media analysis, the frequency of the

appearance of each health category, either in a tweet or in an article was recorded in an Excel document. Responses from the surveys completed by medical professionals were also collectively recorded in an Excel document.

Results: Medical Professional Survey

For the survey distributed to medical professionals 33 responses were received (See Appendix E for types of specialty clinics and the types of medical professional respondents, page 66). Results for general patient information are summarized in Figure 5. The most important factors for determining risk were: age, family history, and sex. The least important factor was skin color.

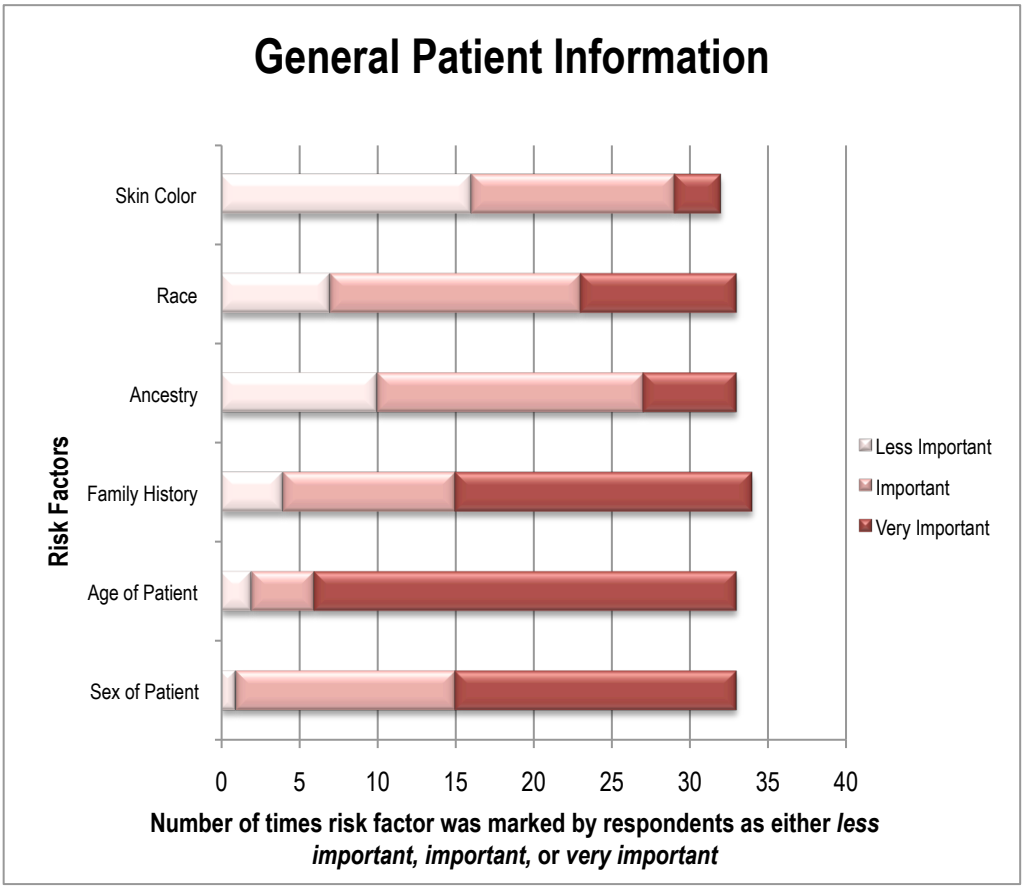

Figure 5 illustrates the distribution of responses for the importance of general patient risk factors.

Results for patient medical history are summarized in Figure 6. Each factor was frequently considered very important for determining risk.

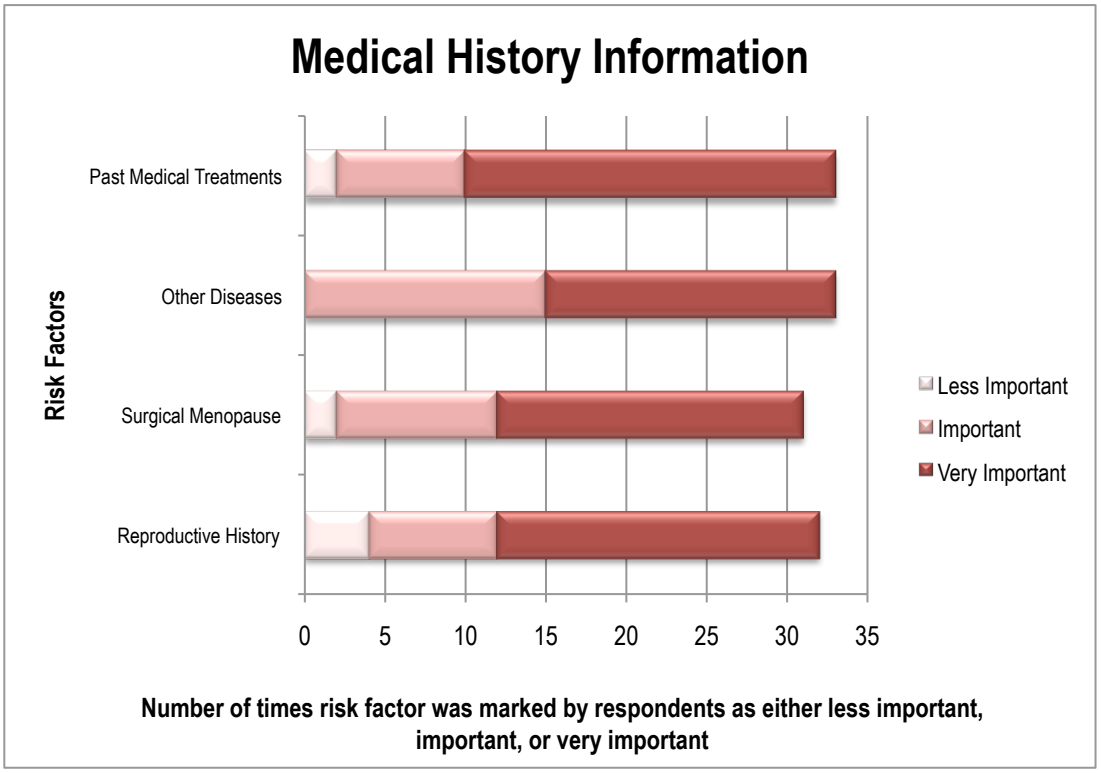

Figure 6 illustrates the distribution of responses for the importance of medical history risk factors.

Figure 7 illustrates the frequency of specific other diseases and conditions that were considered to be associated with increased osteoporosis risk. Malabsorption disorders were considered to be the most important factor, HIV the least important factor.

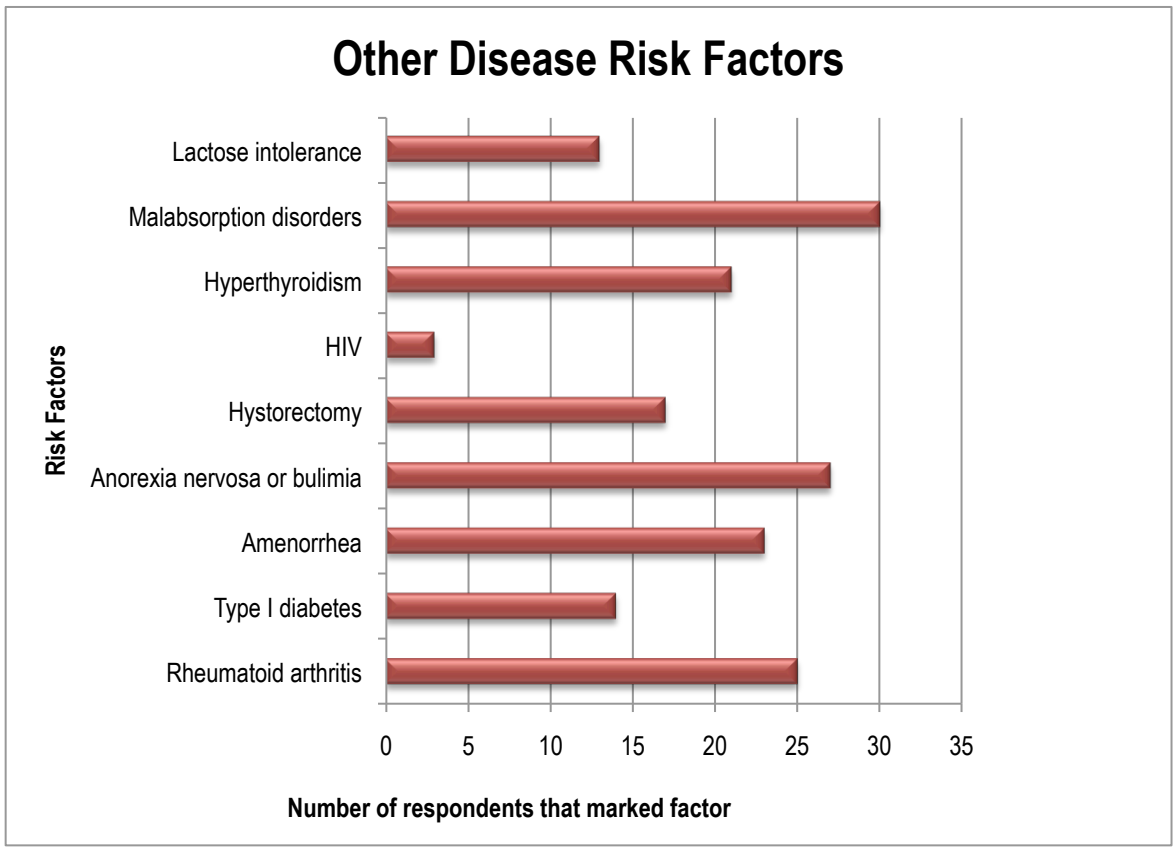

Figure 7 illustrates the frequency of responses for different diseases that were associated with increased osteoporosis risk.

Results for which past medical treatments were considered most important for osteoporosis risk assessment are summarized in Figure 8. Gastric bypass surgery and excision of portions of the stomach or intestine were other conditions that three respondents specified in the “other” section as something they link to increased osteoporosis risk.

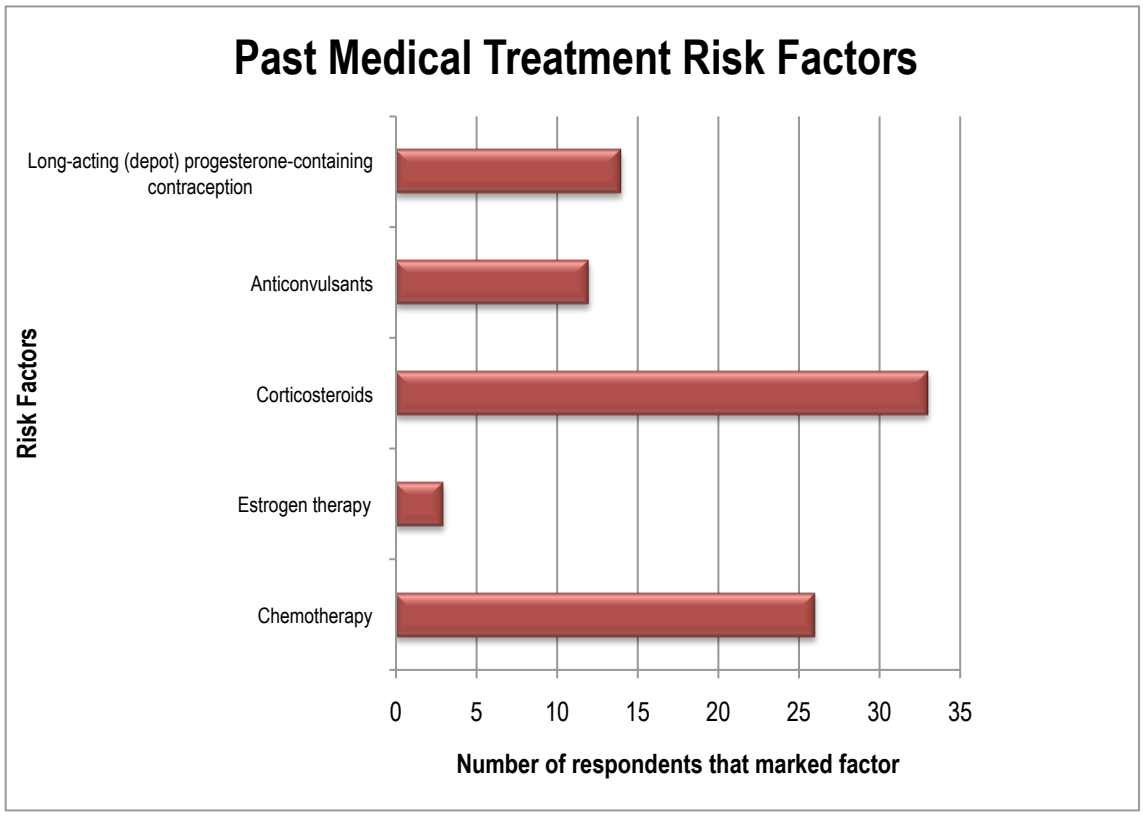

Figure 8 illustrates the frequency of responses for past medical treatments that were associated with increased osteoporosis risk.

The current factors (i.e. practices/conditions occurring after age 35) that respondents most frequently considered to be associated with increased osteoporosis risk are summarized in Figure 9. The most important factors were physical activity level, intake of a multivitamin with calcium and vitamin D, cigarette smoking status, diet, underweight BMI, and type of physical activity. Caffeine intake, normal BMI, obese BMI, and socioeconomic status were considered less important factors.

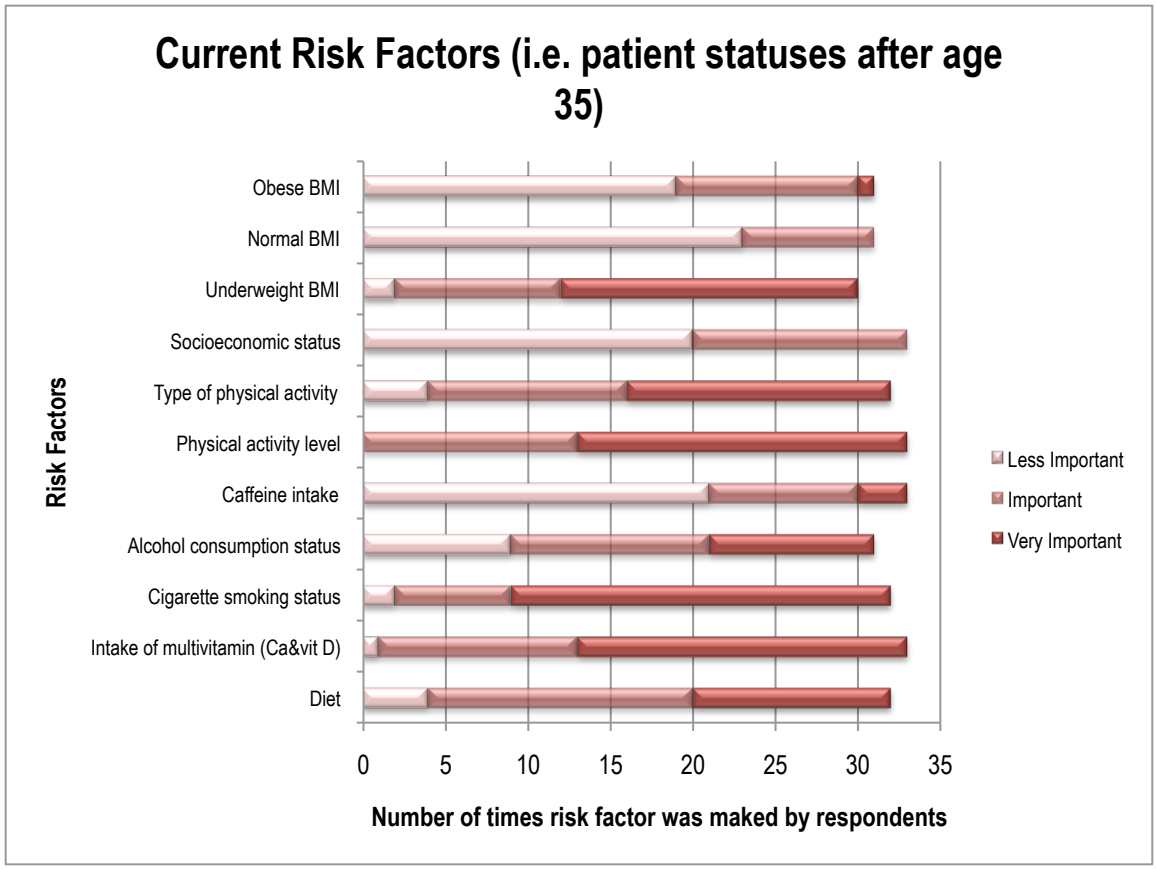

Figure 9 illustrates the distribution of osteoporosis risk factors that occurred or were occurring after age 35 that were considered *less important, important,* or *very important* for assessing patient risk according to respondents.

The past factors (i.e. practices/conditions occurring prior to age 35) that respondents most frequently considered to be associated with increased osteoporosis risk are summarized in Figure 10. The most important factors were physical activity level, underweight BMI, diet, intake of a multivitamin with calcium and vitamin D, cigarette smoking status, and type of physical activity. Again, factors marked less important were caffeine intake, normal BMI, obese BMI, and socioeconomic status. Additional risk factors that some respondents specified in the "other" section included: immobilization for an extended period of time, carbonated beverages, skin color and the patient's use of sunscreen, and also where an individual lives as it relates to sun exposure.

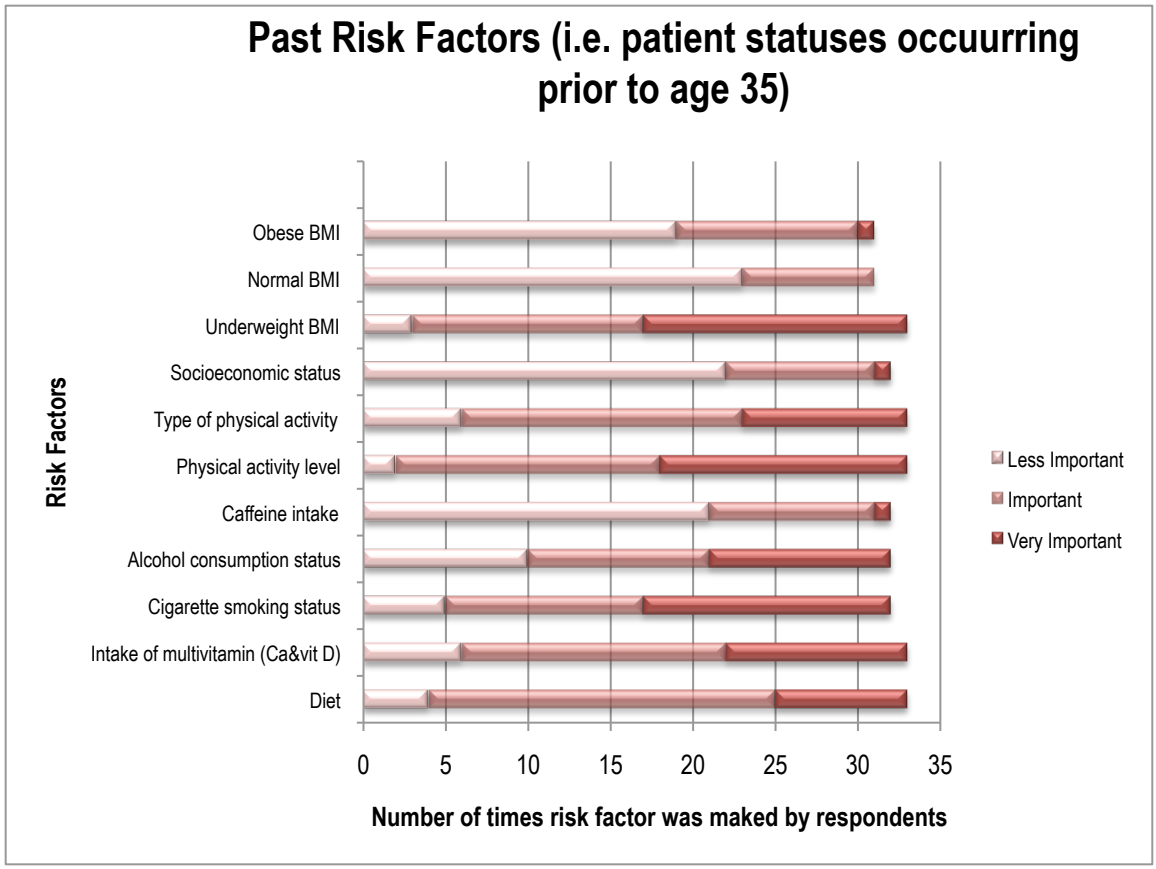

Figure 10 illustrates the distribution of osteoporosis risk factors that occurred prior to age 35 that were considered *less important, important,* or *very important* for assessing patient risk according to respondents.

The most commonly used methods used to by respondents to evaluate their patients for osteoporosis risk were: bone mineral density tests (i.e. DEXA, DPA, SPA) (30), discussion of patient's medical history including past treatments and medications (30), history of fragility fractures (26), and physical examination (16). In the "other" section, three respondents specified using lab tests to measure blood chemistry, particularly vitamin D levels. Another three specified using X-rays. Two respondents specified that they consider FRAX scores. The FRAX tool was developed by the World Health Organization to evaluate patient fracture risk based on integrating clinical risk factors as well as bone mineral density at the femoral neck (https://www.shef.ac.uk/FRAX/). One respondent reported utilizing a CT densitometry test.

Twenty-four respondents considered there to be a difference between the terms *race* and *ancestry*. Five marked that there was no difference, and four marked that they were unsure. Descriptions from respondents about these two terms varied. Seventeen respondents reported that they were unsure if their patients perceived a difference between *race* and *ancestry*; nine reported that they thought their patients did not perceive any difference between the terms, and seven reported that they thought their patients did perceive a difference between the terms. Regarding socioeconomic status being a risk factor for osteoporosis, 13 professionals reported that they considered this factor when assessing risk and 19 reported that they did not consider this factor when assessing risk. One respondent did not choose either option.

All 33 respondents reported counseling their patients about how to decrease future osteoporosis risk. Methods used to educate patients about osteoporosis and bone health included: discussion (32), pamphlets (11), websites (11), books/magazines/journals (3), and seminars (1). No respondents reported using social networks, such as Facebook or Twitter, as means towards educating their patients. The age group of *women undergoing menopause* was the one marked most consistently by respondents for being "the age group that should be targeted most intensely for an education about osteoporosis and bone health," however, respondents could mark more than one age group for this question. Figure 11 shows the number of times each age category was marked by respondents.

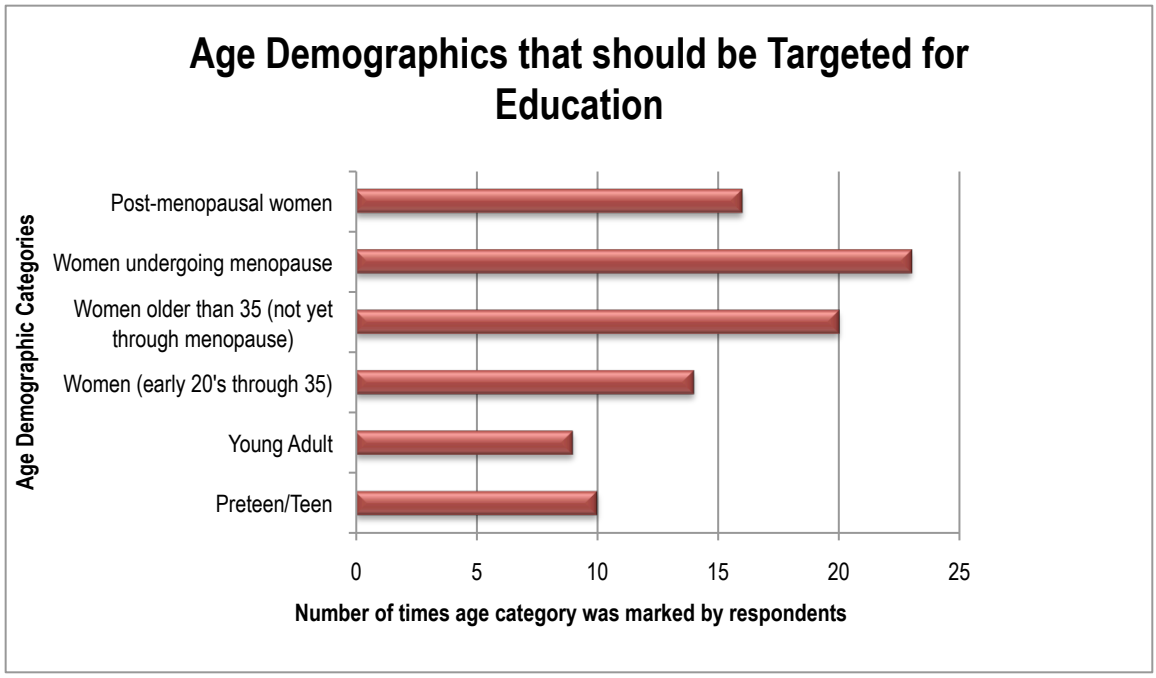

Figure 11 shows the number of times each age category was marked by respondents as being most important for receiving an education about osteoporosis and bone health.

For each of the age-demographic categories, respondents indicated which risk factors ought to be emphasized most heavily. Figure 12 illustrates the amount of times each risk factor was marked by respondents for each age demographic.

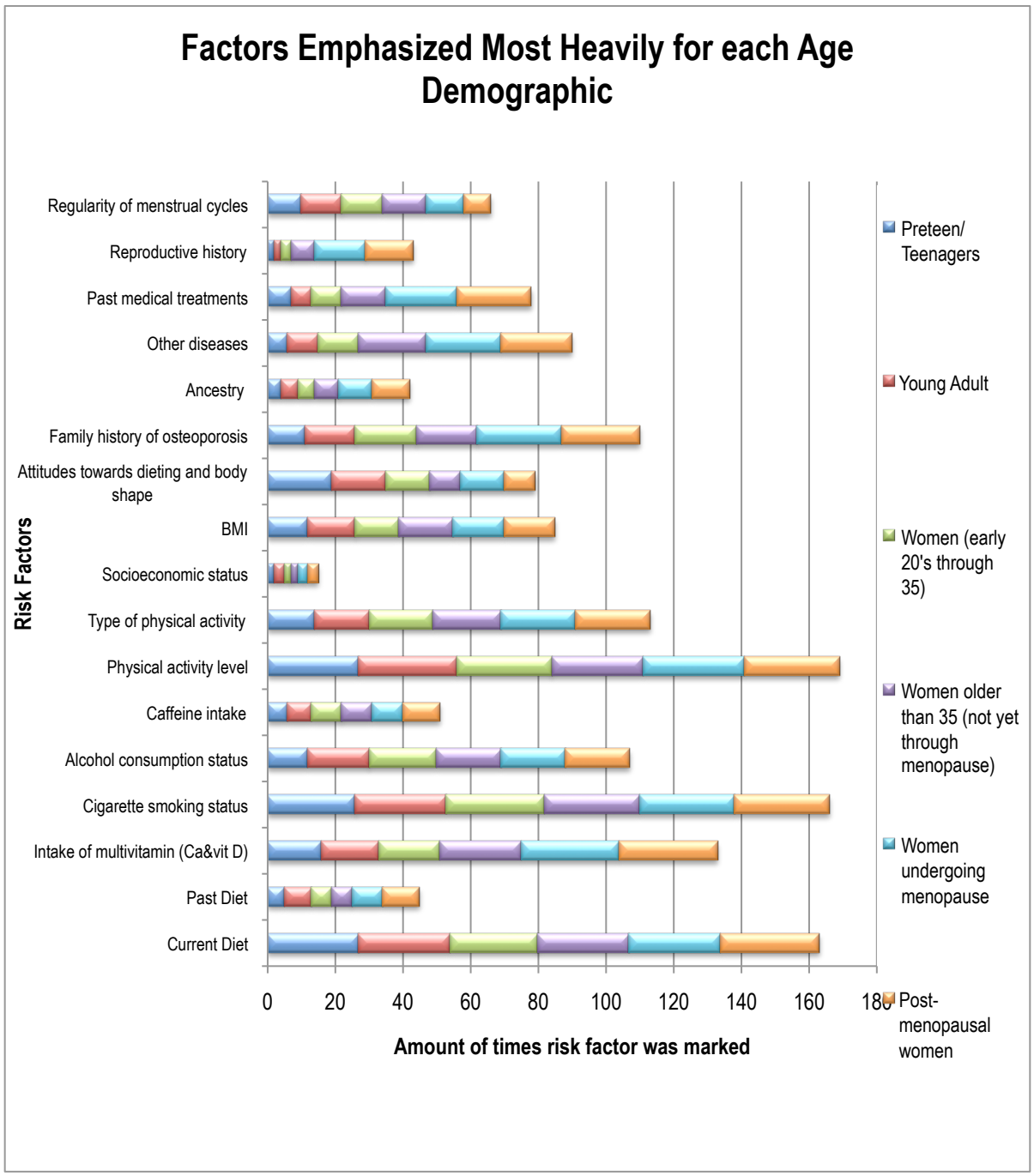

Figure 12 shows the number of times each risk factor was marked for each age group by respondents as being important for heavy emphasis during discussions.

The factors of *other diseases, past medical treatments, family history of osteoporosis, type of physical activity,* and *intake of a multivitamin* were all marked more frequently as the categories progressed in age. The factor of *attitudes toward dieting and body shape* was marked less frequently as the age categories progressed. Figure 13 illustrates trends as certain risk factors either increased or decreased in importance for discussion as the age categories increased.

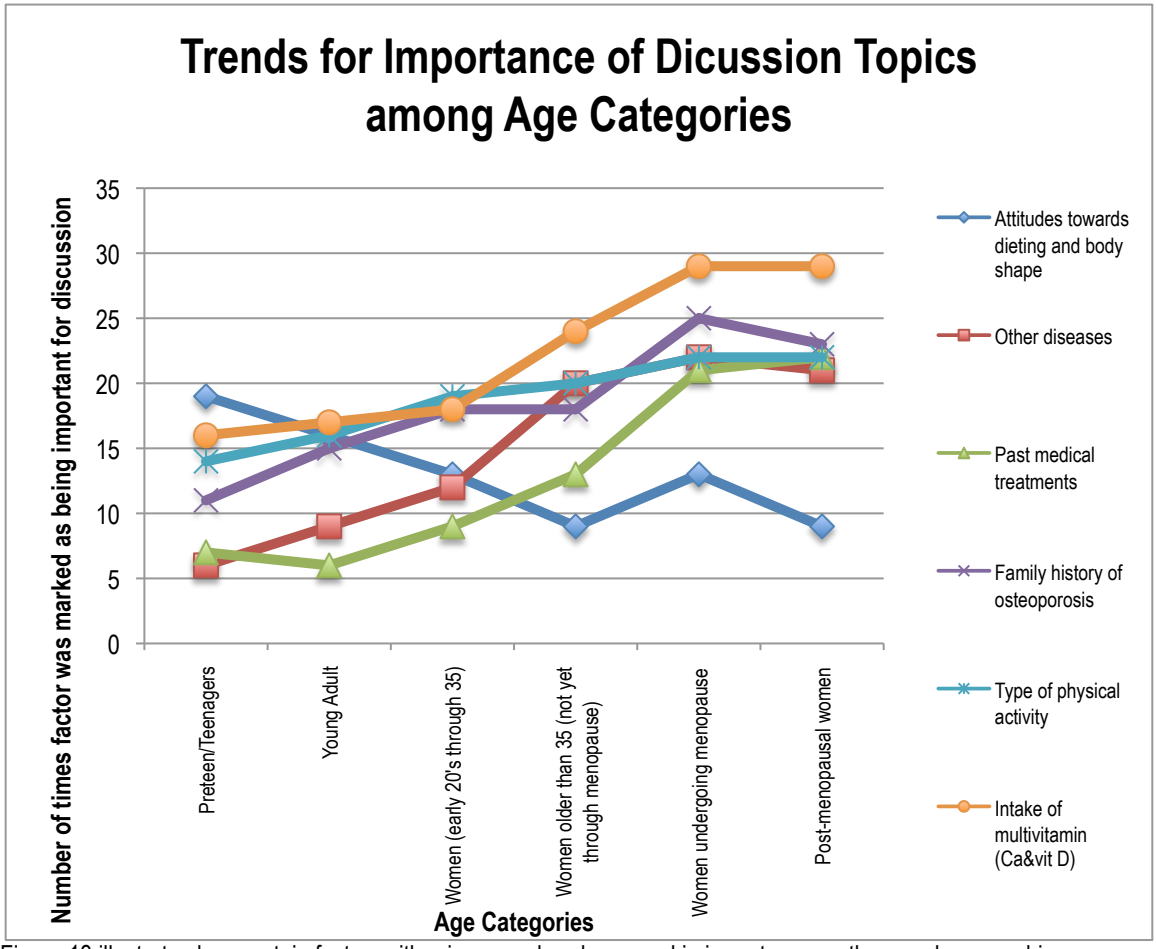

Figure 13 illustrates how certain factors either increased or decreased in importance as the age demographic categories progressed.

Out of the pre-listed types of physical activity that respondents could recommend to increase bone density, 29 marked walking, 23 marked weight lifting, 21 marked running/jogging, and 10 marked swimming. Additional activities that were listed by individual respondents in the “other” section

included: tennis, step aerobics, skiing, dancing, rowing, horseback riding, the stair-step machine, and hiking.

Results: Media Analysis

Results from six weeks of analysis of the eight Twitter accounts followed indicated that out of multiple tweets pertaining to aspects of health, only four directly mentioned and related to bone health. One out of the four tweets specifically mentioned osteoporosis. The other three either discussed general bone health, or exercise and diet as they related to bone health. There were 165 tweets about exercise as it related to physical appearance, particularly weight loss and muscle toning, and there were 74 tweets about diet as it related to physical appearance, weight loss, and/or body toning. Other notable health-related topics that were tweeted about at least three or more times included: the flu, common colds, mental health, contraceptives, Alzheimer's disease, obesity, diabetes, the importance of sleep, and PMS prevention and management. Figure 14 illustrates the frequency of tweets about each category.

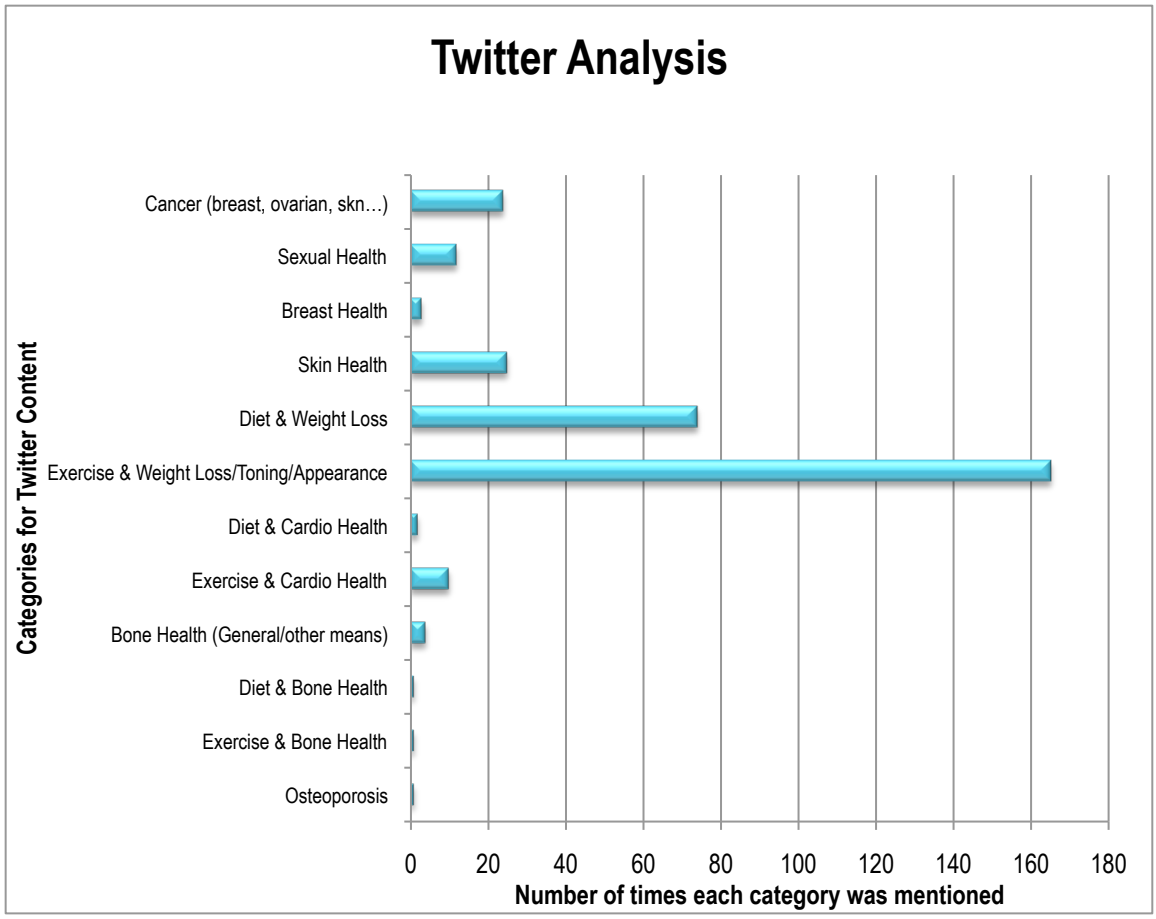

Figure 14 shows the frequency of tweets for each content category.

Out of the five magazines analyzed for the months of December and January, not a single article discussed osteoporosis. Overall, there were two references about the important relationship between exercise and skeletal health. One lengthier article discussed joint health and osteoarthritis in depth (Erdmann 2013). It described some exercises to perform to increase muscular strength and stability; however, no mention was made regarding how these exercises would also benefit bone health and aid with osteoporosis prevention. None of the articles discussed diet as it related to developing and maintaining healthy bones. Other notable health-related topics that were written about at least three or more times included: the importance of sleep, dental health, contraceptive methods, and there were several articles that discussed different types of medications, ranging

from antibiotics to Tylenol. Figure 15 illustrates the frequency of mentions for each category within the magazines analyzed.

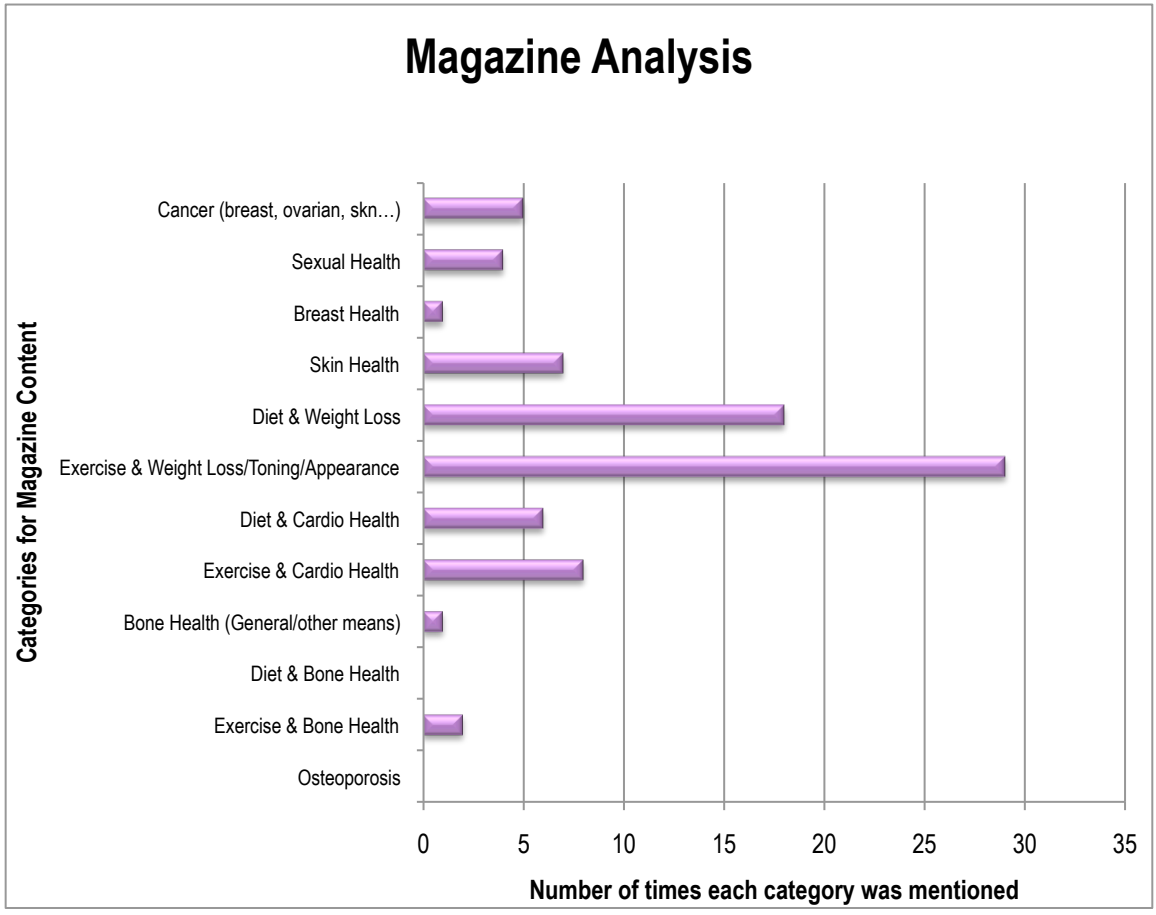

Figure 15 shows the frequency each category was mentioned in the magazine analysis.

Discussion: Medical Professional Survey Results

Results from the survey supported the hypothesis that medical professionals rely on a comprehensive approach that incorporates developmental, genetic, and social factors and the interplay between all three to determine a patient's osteoporosis risk. All of the respondents designated a variety of possible factors that they considered when assessing patient risk, although the significance of each factor varied from one respondent to another. As predicted, age, sex, cigarette smoking status, diet, multivitamin intake, and family history of osteoporosis were some of

the risk factors considered to be most important. Additional factors that were not initially predicted but that were consistently marked as being very important included physical activity level, the type of physical activity, past medical treatments, an underweight BMI, and other diseases. Previously reviewed literature indicates that these factors considered most important by survey respondents are indeed some of the most relevant risk factors to be considered when assessing patient risk. It was reassuring to see that over 90% of all respondents considered age, sex, family history of osteoporosis, other diseases, past medical treatments, diet, intake of multivitamin, past physical activity level, the type of physical activity, and past and present cigarette smoking status to be either "important" or "very important" risk factors. Also, for the factors of having a past history of a low BMI and also the factor of current physical activity level, 100% of respondents considered them to be either "important" or "very important" risk factors.

Past and present socioeconomic status was considered a "less important" factor by 67% and 61% of respondents respectively. Additionally, only 41% of respondents reported considering socioeconomic status at all when evaluating patient osteoporosis risk. It is interesting that so few considered this factor, because literature indicates that low socioeconomic status may be linked with lower bone density and increased total and vertebral fracture risk (Navarro *et al.* 2009). Reasons for this include that those living in poverty typically have limited access to healthy foods and dietary supplements, and may be more likely to partake in harmful health habits, like cigarette smoking, which might elevate their osteoporosis risk (Navarro *et al.* 2009). Other respondents elaborated in the extra space provided that their reasoning for not considering socioeconomic status as a factor was that they typically cared for patients from the same general socioeconomic background. One respondent also reported that she did not consider socioeconomic status because she felt that members of high socioeconomic class often lived more sedentary lifestyles than those of low socioeconomic class. Even though members of low socioeconomic class might

be malnourished, members of higher class may be lacking physical activity, so she felt that overall, socioeconomic status was only capable of linking patients with other, more physical risk factors. This indicated to me that socioeconomic status should be considered assuming that the healthcare provider recognizes the limitations of this category and focuses discussion with the patient towards physical risk factors that may result as a product of either high or low socioeconomic status. The other types of diseases and conditions that were considered most important for assessing risk included: malabsorption disorders, anorexia nervosa or bulimia, rheumatoid arthritis, amenorrhea, hyperthyroidism, and hysterectomy. The past medical treatments considered most important included: corticosteroids, chemotherapy, long-acting (depot) progesterone-containing contraception, and anticonvulsants. Each of the condition's association with increased osteoporosis risk is supported by previous research.

It is interesting to note that only 70% of respondents considered ancestry to be either "important" or "very important," whereas 79% considered race to be "important" or "very important." This could be indicative of confusion among medical professionals and the public regarding the difference between ancestry and race, which supported the hypothesis which stated that there would be inconsistent and incorrect distinctions between a person's race and their ancestry upon the part of medical professionals. Although 73% of respondents marked that they considered there to be a difference between a patient's race and their ancestry, descriptions of the perceived differences varied greatly. Several respondents provided examples of what they considered *race* and *ancestry* to be, writing "race = Black, Hispanic, Caucasian, etc… Ancestry = country of origin (i.e. Sweden, German, etc…)." Others provided their own definitions for the terms, for example, "race is what people perceive, ancestry relates to actual family tree genetics" or "ancestry is country of origin, race many times refers to skin color in cultural practice" or "race relates to genetic characteristics and ancestry tends to be historical." Some respondents left the box blank where

they were instructed to describe the difference between the two terms. Regardless, it became clear that the majority of respondents did not consider *race* to be a culturally constructed concept. A few respondents specifically wrote that a person's race was associated with their genotype, which is entirely incorrect (Brace 1995). I think that the discrepancies regarding a patient's *race* verses their *ancestry* are problematic considering most of the respondents reported that their healthcare clinics required patients to specify their "race" on a health and physical form. It is not a patient's *race* that predisposes them to certain medical conditions; however, their ancestry is a factor that medical professionals should consider. Studies demonstrate that throughout history, human populations from geographically diverse areas of the world are sometimes more prone to certain conditions and diseases than others. Scientists and anthropologists do not always know the exact reasons why some people are genetically more predisposed to certain conditions, but the fact that descendents of different geographic areas have evolved differently warrants consideration. More research needs to be carried out to determine the exact genetic differences between populations that account for the disparities demonstrated regarding osteoporosis incidence.

In most cases, a lack of knowledge among healthcare providers regarding the difference between race and ancestry is likely not detrimental for patient care, mainly because results show that there are numerous other factors that are considered when assessing risk. However, hypothetically, if a doctor was caring for two patients that shared all identical risk factors except for that one patient self-identified their race as "Black," and the other self-identified as "Caucasian," the doctor should NOT use this difference to determine whether one patient should receive osteoporosis screening over the other. Taken as a whole, it might prove dangerous for medical professionals to profile patients into categories that are either "at-risk" or "not at-risk." In reality, each patient needs to be assessed individually, because evidence overwhelmingly suggests that a complex interplay of multiple factors contributes to an individual's bone health and osteoporosis

risk. Professionals should acknowledge patterns and prevalence of osteoporosis among certain populations, but they also need to be aware of the limitations of such patterns and avoid generalizations that group people into expected and seemingly predictable medical paradigms.

Results from the surveys supported the hypothesis that medical professionals are adequately educating post-menopausal women and women who are approaching menopause about their osteoporosis risk. All respondents reported counseling their patients about osteoporosis and bone health. It is important to note, however, that the most common age range of patients cared for by the providers surveyed was 55 years and older, followed closely by patients aged 36-54. This could indicate that women over age 35 are receiving adequate counseling regarding how to maintain bone health by means of discussion and counseling from their medical providers. However, these results leave in question whether a large number of young females are still not receiving adequate educations about bone health and osteoporosis from medical providers. If young women tend to visit clinics less frequently than aging women, medical professionals may not encounter the opportunity to educate young women in a clinical context. Further research should be performed at clinics where the majority of patients are women under age 35, as opposed to over age 35. Respondents in this study consistently marked relevant risk factors for being important points to discuss with patients in all the female age demographics, ranging from pre-teen girls through post-menopausal women. This indicates that although respondents cared for young women less frequently as patients, the young women who were seen as patients were counseled about bone health.

A few patterns regarding which factors were rated most important for discussion with each different age group category is worth observing. For all six of the established age demographics, respondents consistently marked that cigarette smoking status, physical activity level, and current diet were factors they would discuss with patients. For the preteen and young adult age groups, the

majority of respondents also marked that they believed a discussion about attitudes towards dieting and body shape was important; however, this topic was marked less frequently as the categories increased in age. It is interesting that discussion about this topic diminished in importance as the patient's age increased. Perhaps this sample of respondents felt that young girls need counseling about their attitudes and perceptions about body image more so than middle-aged women. Results showed that medical professionals waited until their female patients were older before questioning about past medical treatments, other diseases, and family history of osteoporosis, which I found logical. Results from this study left me questioning why the factors of *type of physical activity* and *intake of a multivitamin* were not considered equally important to discuss with the preteen/teenager and young adult age groups. Literature indicates that in order to increase bone mineral density and promote bone health, physical activity must be weight-bearing (Schettler and Gustafson 2004). Numerous studies confirm the connection of weight-bearing physical activity in youth to better bone density in older age (Drenjancevic and Cvetko 2013). I believe that medical professionals ought to emphasize the importance of weight-bearing physical activity to their preteen, teenage, and young adult patients, as much as they do to their older patients. The case is similar for the factor of *intake of a multivitamin.* It is crucial that young women are receiving enough calcium and vitamin D while their bones are still developing so that they acquire peak bone mass during their limited window of opportunity, because, as mentioned previously, after about age 30-35, bone mass naturally begins to decline for women. Again, I think that medical professionals ought to place equally important emphasis on the importance of the intake of a multivitamin that provides sufficient amounts of calcium and vitamin D when discussing bone health to their preteen, teenage, and young adult patients, not only their older female patients.

So what can be gained from the results of the surveys distributed to medical professionals in this study? Perhaps one of the most important revelations to be emphasized is that there is not

one specific factor that overrides others in terms of predicting an individual's risk for osteoporosis. This is demonstrated by the fact that respondents consistently marked several factors that they considered to be indicative of osteoporosis risk. Additionally, past anthropological research shows that even though ancient human populations may have suffered from poor bone quality as a result of malnutrition, many of these same populations did not show signs of osteoporosis or experience fragility fractures. Based on this evidence, it would be incorrect to conclude that malnutrition alone is a definitive cause of osteoporosis, even though a correlation exists between malnutrition and osteoporosis in some current populations (Agarwal 2012). Combining findings from previous, peer-reviewed research with the results from the survey in this study support the hypothesis that a holistic, comprehensive approach involving the interplay between developmental, genetic, and social factors is the best method for determining a patient's osteoporosis risk.

Research for this study was motivated by the question of why the condition of osteoporosis, as serious and common as it is, is not one of the major health topics discussed with girls and young women. Survey results showed that in a clinical context, medical professionals provide their young female patients with overall adequate counseling about osteoporosis and bone health. However, results also indicated that less than half of the respondents considered *type of physical activity* and *intake of a multivitamin* to be topics that they discussed with their preteen, teenage, and young adult patients. This result is concerning since habits surrounding both of those factors are very important for attaining peak bone mass while the skeleton is still developing. Overall, results indicated that the providers, regardless of their specialty, discussed almost all of the major osteoporosis risk factors with all of their patients, regardless of patient age. The fact that such a range of health issues was discussed is encouraging, because many of the risk factors for osteoporosis, such as cigarette smoking status or current and past diet, are also relatable to other diseases and conditions. I believe the majority of the surveyed medical professionals effectively

educated their patients about bone health and osteoporosis through discussion that took place in a clinical visitation setting. Based on these results, women of all ages who regularly visit a medical professional ought to be receiving adequate counseling about how to best care for their bones. However, not all young women, particularly those in their late teenage years through late twenties visit a medical professional frequently (Kirzinger *et al.* 2012). Low incomes and temporary jobs that often are available for young women after they graduate from high school or college often provide limited or no health care benefits (Kirzinger *et al.* 2012). The Center for Disease Control determined that 77.9% of women aged 19-25 reported attending a usual place for healthcare; however, the "usual place" could have been either a *clinic/health center*, a *doctor's office/HMO*, a *hospital emergency room*, a *hospital outpatient department*, or *some other place* (Kirzinger *et al.* 2012). Additional surveying would be needed to determine if the healthcare providers at these locations consistently counsel their young female patients about bone health and osteoporosis risk. If medical professionals are not consistently providing patient counseling, it could mean that females of this younger age demographic are not receiving an adequate education about how to help prevent geriatric osteoporosis, simply because they are not making regular visits to a healthcare provider. Regardless, it still remains that 22% of females aged 18-25 do not regularly (i.e. once a year) visit any type of healthcare facility in the first place. I believe women in this younger age range who live in modern, well-developed societies are typically very influenced by media sources. Thus, in hopes that the media might help to fulfill the bone health and osteoporosis education deficit among young women, the additional component this study aimed to investigate whether media sources (i.e. magazines and Twitter accounts) adequately educated young women about bone health and the factors that affect chances for developing osteoporosis.

Discussion: Media Analysis Results

I determined that the magazines and Twitter accounts followed in this study which targeted young women did not provide an adequate education about the importance of acquiring bone mass or about osteoporosis risk. Specifically, discussion of bone health and osteoporosis facts was minimal in comparison to the amount of content provided on other aspects of health and the amount of material that focused on attaining a certain physical appearance. This finding supported the initial hypothesis. Among the magazines analyzed, there was only one definitive reference of the importance of physical activity as it related to bone health, and for the Twitter accounts followed, there were only four tweets about bone health. One was specifically about calcium and vitamin D as they relate to bone health, and the link provided ways to achieve recommended amounts of both nutrients (Health Magazine 2013). Another tweet was about exercise relating to bone health (WebMD 2013), and another was about bone health in general that included a link that discussed the importance of diet and weight-bearing exercise (Health Magazine 2013). There was also one tweet that specifically discussed osteoporosis (Health Magazine 2013). Figure 16 shows the only four tweets that contained content about bone health.

Figure 16 shows the only four tweets that contained content about bone health. Source: https://twitter.com/WebMD, https://twitter.com/goodhealth

Each of these tweets was accurate and informative to followers about bone health and the related facts. However, what is concerning and must be acknowledged is that these were the only four tweets among eight Twitter accounts over the span of six weeks that ever mentioned bone health. Comparatively, other topics such as skin health, breast health, sexual health, cardiovascular health, and cancer risks were discussed more frequently. Why osteoporosis, as common and as detrimental of a condition as it is, was not considered as important of topic for discussion among young women is problematic. Additionally, the frequency with which tweets focused on diet and exercise solely as means towards obtaining a certain physical appearance, as opposed to obtaining genuine physical health, was overwhelming. It is not bad to desire a certain physical appearance; however, I think that the media should place more emphasis on eating healthy and staying active for the purpose of the known health benefits and for the prevention of harmful diseases and conditions. For example, many of the Twitter health accounts wrote tweets

about exercising, and they regularly described new routines to perform at the gym. However, they typically promoted these routines by saying that they will burn fat in order to obtain a slim figure. Even when the routine described to consumers was specifically a weight or strength training routine (i.e. one that stimulates osteoblast activity and benefits bone health), it was marketed with the goal of, "toning your thighs" or "sculpting your butt." Typically, no mention was made about how important strength training and high-impact exercise is for long-term bone health or for building muscle mass. Rarely were routines promoted as a way to benefit an aspect of physical health, such as skeletal or cardiovascular health.

The situation regarding diet was similar. Almost all of the tweets and magazine articles focused discussions of diets on foods that were low calorie and would help women to attain a "smaller waist" or "flatter belly." Separately from the Twitter accounts and magazine articles followed in this study, the media seems to have successfully emphasized that calcium is necessary to build strong bones. One study performed at a Midwestern high school found that 94% of the adolescent females either strongly agreed or agreed that calcium-rich foods built strong bones (Ali 2001). However, this seemingly common knowledge is undermined by the fact that most women are not consuming the recommended amounts of calcium. Another studied sample of adolescent females found that the women's calcium consumption was only 35% of the recommended level of 1,300 mg by the National Institute of Health (Ali 2001). A different study performed in 1996 found that only 20% of U.S. females were meeting the recommended dietary intake (RDI) for calcium (Schettler 2004). A study conducted in California surveyed 82 pediatricians and found that less than 25% knew the correct U.S. RDI for calcium for children under ten years; less than 33% knew the RDI for teenagers; and less than half knew the calcium content of foods like broccoli, spinach, and yogurt (Fleming 2002). These statistics are sobering when one considers that this knowledge deficit is representative of a sample of pediatricians, not even the general public. I think that the

media could help to fix this problem if it produced articles and wrote tweets on a consistent basis that promoted ways to obtain calcium through an appropriate diet.

Many of the foods recommended to young women in the articles and tweets to achieve certain physical ideals were also beneficial for other aspects of health and were important for bone development. However, if young women are choosing to consume these recommended foods, the consumption might be motivated by a desire to achieve a certain body type. Research demonstrates that the majority of adolescent and young women are not taking sufficient measures to reach peak bone mineral density (Schettler and Gustafson 2004). What is even more alarming is that dietary trends indicate that low bone density is likely to escalate rapidly among young adults, particularly among females, due to a combination of factors. Since 1965, milk consumption has decreased 74% and consumption of sugary juices and carbonated beverages has increased 118% (Schettler 2004). These statistics are alarming, since both positively affect the population's likelihood for development of osteoporosis. Milk is one of the most common sources for calcium in the Western diet (Greer and Krebs 2006), so the fact that its consumption has decreased so markedly is cause for concern. Carbonated beverages not only take the place of calcium-containing beverages, like milk and citrus juices, but theses carbonated drinks are also hypothesized to degrade bone mineral (Schettler and Gustafson 2004, DeBar *et al.* 2004, Gonzalez-Jimenez and Alvarez-Ferre 2011).

Young women are also at a sensitive age where they are especially susceptible to eating disorders. The study that surveyed 293 girls at a Midwestern high school found that almost 50% of girls reported skipping one meal per day, over 50% were trying to lose weight, about 75% were avoiding gaining weight, and 33% perceived themselves as overweight relative to their peers (Ali and Siktberg 2001). As previously mentioned, multiple studies confirm that eating disorders, like anorexia nervosa and bulimia, place women at a significantly increased risk for developing

osteoporosis (DeBar *et al.* 2004, Greer and Krebs 2006, Kreipe and Forbes 1990, Lein *et al.* 2011, Schettler and Gustafson 2004). Every medical professional respondent surveyed in this study considered a low BMI to be either an “important” or “very important” risk factor for osteoporosis.

Adolescents are also confronted with lifestyle choices that include alcohol consumption and cigarette smoking, both of which can negatively affect bone density. Compounding these factors with potential pressure from the media to be thin, young girls and women may unknowingly be stripping their body of necessary nutrients that promote development of adequate bone density. Adolescents may partake in practices like extreme dieting, excessive alcohol consumption, and cigarette smoking without ever knowing the short-term or long-term damage they are causing to their bones. These cultural pressures perpetuated by some media sources, combined with the general knowledge deficiency about the modifiable behaviors to benefit bone health and help prevent osteoporosis is an alarming, yet hidden problem that is affecting girls and young women in current society. Further analysis of what the media is promoting to young women about exercise and diet as it relates to both physical appearance and to genuine physical health is important. Studying perceptions and attitudes women possess about their activity levels and diets can identify subtle habits and intangible ideologies that produce a culture that could be affecting a population’s bone health.

Discussion: Limitations

It is important to acknowledge the inherent bias and limitations in this study. For the surveys that were completed by the medical professionals, one problem encountered was that respondents left portions of the survey blank for some of the surveys returned by mail. For example, pediatricians typically only filled out the areas that were applicable to patients under age eighteen and left blank any areas that pertained to factors affecting women older than eighteen, writing that they did not care for that patient range. This affected the total number of factors that

were marked by respondents for one age category relative to others. Additionally, there were some instances on the surveys that were mailed and completed by hand where the medical professional's handwriting was almost impossible to decipher which meant that some answers could not be recorded. For this study, 33 responses were obtained from medical professionals practicing in Wyoming and Colorado, in addition to the two doctors from Germany. If this study were to be repeated, a larger and more geographically distributed sample size in the US should be obtained to help to add diversity to the sample and to eliminate potential bias.

For the media analysis, there was an inherent bias, because much of this portion of the study was qualitative analysis that relied on my own interpretations. I strived to make the categories for documenting the content of the health magazines and Twitter accounts as straightforward as possible. However, when it came to categorizing specific articles and tweets, much of the interpretation was left to my own discretion regarding what constituted relationships between exercise, diet, and physical appearance verses relationships between exercise, diet, and genuine physical health. Additionally, I was responsible for deciding which articles were considered educational for each of the health categories that I established (skin health, breast health, bone health, cardiovascular health, etc.). It is possible that if another individual had performed this media analysis, they might have categorized the content of some articles and tweets differently than I chose.

An important factor to consider that could have significantly influenced the results for the magazine and Twitter analysis was the time of year that the content was analyzed. Analysis took place during the months of December and January, and during those months I think that content may have been especially focused on preventing weight gain and obtaining weight loss because of the holiday season. This could have contributed to the substantial amount of content that pertained to weight loss and physical appearance in comparison to the amount that focused on genuine

health. If this aspect of the study were to be repeated, a more representative sample could be obtained from an entire year's recording of media content. Also, if the Twitter analysis portion of this study were to be repeated, the total number of tweets produced by each account should be recorded, including tweets that did not fit into any of the pre-established categories. This would provide an exact percentage out of the total number of tweets for how many fell within the categories of bone health or osteoporosis. The magazines chosen for analysis were picked because they were easily found in magazine aisles at supermarkets and convenience stores. All of the magazines featured young women on the front and appeared to advertise both health *and* beauty tips. I did not find any magazines that appeared to focus solely on health education, excluding things like beauty tips, fashion trends, and makeup advertisements. Given that each of the analyzed magazines appeared to advertise the inclusion of beauty tips, as well as health tips, it was expected that some portion of the content would pertain to obtaining a certain physical appearance. The Twitter accounts were picked because the same makers as some of the magazines produced them, or alternately because they had a name that seemed to connote health tips, like "WebMD" or "DailyHealthTips" for example.

Conclusion

I believe that the prevalence of osteoporosis in our society reflects an insidious crisis within the U.S. population as well as others. It is crucial to understand the inherent complexities regarding the etiology of osteoporosis in order to help prevent it. In general, I think young women are not receiving adequate educations during the age range most crucial for acquiring peak bone mineral densities. Results from this study indicated that medical professionals adequately educate patients of all age demographics about bone health and osteoporosis risk in a clinical context through methods that mainly included discussion and the occasional pamphlet or website referral. However, the age demographic of women in their late teens through late twenties does not

necessarily visit a healthcare provider to supply them with an education on a regular basis, which could mean that a significant number of women at this age are not receiving adequate educations about bone health by means of a medical professional. Results from this study further indicate that young women also may not be obtaining any significant education, and surely not receiving consistent reminding, from media sources regarding the importance of developing healthy bones in order to help prevent geriatric osteoporosis. The danger of this potential knowledge deficit is compounded by some cultural pressures to partake in behaviors like extreme dieting, excessive alcohol consumption, cigarette smoking, sedentary physical activity levels, or the constant application of highly protective sunscreen while outdoors. All of these behaviors can inhibit development of adequate bone mineral density. Adolescent girls and young women are representative of an age demographic that must receive an education about how to best care for their bones in hopes of decreasing their chances for developing osteoporosis. Based on the results of this study, health-oriented magazines and Twitter accounts ought to take a more proactive role with regard to educating young women about bone health and osteoporosis risk factors. Additionally, researchers should investigate whether young women are aware of their osteoporosis risk and examine the percentages of young women who purposefully monitor their behaviors to benefit their bone health.

References Cited

Agarwal S, Dumitriu M, Tomlinson G, Grynpas M. 2004. Medieval Trabecular Bone Architecture: The Influence of Age, Sex, and Lifestyle. *American Journal Of Physical Anthropology* 124(1):33-44.

Agarwal, SC. 2012. The Past of Sex, Gender, and Health: Bioarchaeology of the Aging Skeleton. *American Anthropologist* 144(2):322-335.

Ailinger R, Braun M, Lasus H, Whitt K. 2005. Factors Influencing Osteoporosis Knowledge: A Community Study. *Journal of Community Health Nursing* 22(3):135-142.

Ali N, Siktberg L. 2001. Osteoporosis Prevention in Female Adolescents: Calcium Intake and Exercise Participation. *Pediatric Nursing*27(2):132-139.

American Anthropological Association. 2013. What is Anthropology? http://www.aaanet.org/about/WhatisAnthropology.cfm. (accessed December 15, 2013).

Bachrach LK. 2000. Making an impact on pediatric bone health. *Journal of Pediatrics* 136(2):137-139.

Beall CM. 2007. Two Routes to Functional Adaptation: Tibetan and Andean High-Altitude Natives. *Proceedings of the National Academy of Sciences of the United States of America* 104:8655-8660.

Brace CL. 2005. *"RACE" Is a Four-letter Word*. New York: Oxford University Press.

Cauley JA. 2011. Defining ethnic and racial differences in osteoporosis fragility fractures. *Clinical Orthopaedics and Related Research* (469):1891-1899.

Ceausu I. 2010. Education and information: important tools in assessing the risks and prevention of osteoporosis fractures. *Climacteric* 13:530-533.

Condisine DM. 1995. Bone. In *Van Nostrand's Scientific Encyclopedia*. 8th edition. Van Nostrand Reinhold, ed. Pp.429-435. New York: New York.

DeBar LL, Ritenbaugh C, Vuckovic N, Stevens VJ, Aickin M, Elliot D, Moe E, Orwoll E, Ernst D, Irving LM. 2004. YOUTH: decisions and challenges in designing an osteoporosis prevention intervention for teen girls. *Preventive Medicine* 39(5):1047–1055.

Dhanwal DK, Dennison EM, Harvey NC, Cooper C. 2011. Epidemiology of Hip Fracture: Worldwide geographic variation. *Indian Journal of Orthopaedics* 45(1):15-22.

Drenjančevic I, Cvetko E. 2013. Influence of physical activity to bone metabolism. *Medicinski Glasnik* 10(1):12-19.

Elliot M. 2011. Taking control of osteoporosis to cut down on risk of fracture. *Nursing Older People* 23(3):30-35.

Erdmann J. 2013. How Old Are Your Knees? *Women's Health*, December.

Fleming R, Patrick K. 2002. Osteoporosis Prevention: Pediatricians' Knowledge, Attitudes, and Counseling Practices. *Preventative Medicine* 34:411-421.

Gonzalez-Jimenez E, Alvarez-Ferre J. 2011. Osteoporosis in childhood: related factors and prevention. *Colombia Medica* 42:111-116.

Gonzalez-Reimers E, Mas-Pascual M, Arnay-de-la-Rosa M, Velasco-Vázquez J, Santolaria Fernández F, Machado-Calvo M. 2004. Noninvasive Estimation of Bone Mass in Ancient Vertebrae. *American Journal Of Physical Anthropology* 125(2):121-131.

Greer FR, Krebs NF. 2006. Optimizing Bone Health and Calcium Intakes of Infants, Children, and Adolescents. *American Academy of Pediatrics* 117:578-585.

Hagen E. 2009. Biological Aspects of Race. *American Journal of Physical Anthropology* 101:569-570.

Health Magazine [goodhealth]. (2013, December 16). When it comes to building strong #bones, there are two key nutrients: calcium & vitamin D. Here's how to get them→ ow.ly/rY9tc [Tweet]. Retrieved from https://twitter.com/goodhealth

Health Magazine [goodhealth]. (2013, December 18). Did you know that bones are a living tissue? Yup! That and more surprising facts about healthy #bones. ow.ly/rTEdF [Tweet]. Retrieved from https://twitter.com/goodhealth

Health Magazine [goodhealth]. (2013, December 22). Most people know that calcium strengthens #bones. But there are more than a dozen other ways to fight #osteoporosis: ow.ly/rO6z2 [Tweet]. Retrieved from https://twitter.com/goodhealth

Khosla S , Oursler M, Monroe DG. 2012. Estrogen and the Skeleton. *Trends in Endocrinology and Metabolism* 23(11):576-581.

Kirzinger WK, Cohen RA, Gindi RM. 2012. Health care access and utilization among young adults aged 19–25: Early release of estimates from the National Health Interview Survey, January–September 2011. Center for Disease Control: National Center for Health Statistics 1-9.

Kreipe R, Forbes G. 1990. Osteoporosis: A "New Morbidity" for Dieting Female Adolescents? *Pediatrics* 86 (3):478-480.

Larsen CS. 2002. Bioarchaeology: The Lifes and Lifestyles of Past People. *Journal of Archaeological Research* 10(2):119-166.

Lein D, Clark D, Turner L. 2011. Osteoporosis Prevention Among Premenopausal Women: A Review of Bone Enhancement Interventions. *American Journal of Health Studies* 26(2):60 75.

Marini F, Brandi ML. 2010. Genetic determinants of osteoporosis: common bases to cardiovascular disease? *International Journal of Hypertension* (1):1100-1116.

Navarro MC, Sosa M, Saavedr P, Lainez P, Marrero M, Torres M, Midina CD. 2009. Poverty is a risk factor for osteoporosis fractures. *Osteoporosis International* 20:393-398.

Phillips F. 2012. Nutrition and Bone Health in the UK Calcium and vitamin D from cradle to grave. *Practice Nurse* 42(16):26-30.

Ruff CB. 2006. Gracilization of the Modern Human Skeleton: The latent strength in our slender bones teaches lessons about human lives, current and past. *American Scientist* 94(6):508 514.

Schettler A, Gustafson E. 2004. Clinical Practice: Osteoporosis Prevention Starts in Adolescence. *Journal of the American Academy of Nurse Practitioners* 16(7):274-282.

Schoenfeld E, Henderson K, Suh-Yuh W. 2010. Using the Internet to Educate Adolescents About Osteoporosis: Application of a Tailored Web-Education System. *Health Promotion Practice* 11(1):104-111.

Sonoda T, Takada J, Kousuke I, Asakura S, Yamashita T, Mori M. 2012. Interaction between ESR∂ polymorphisms and environmental factors in osteoporosis. *Journal of Orthopaedic Research* (1)1529-1534.

Stini WA. 1995. Osteoporosis in Biocultural Perspective. *Annual Review ofAnthropology* 24:397-421.

Tural S, Nurten K, Alayli G. 2011. Genetics of osteoporosis. *Turkish Journal of Osteoporosis* (17):100-109.

Vidal C, Xuereb-Anastasi A. 2009. Genetic studies of osteoporosis in Malta: a review. *Malta Medical Journal* 21(4):6-11.

WebMD [WebMD]. (2013, December 11). Bike or swim to stay fit? As you age, add walking or dancing to the mix to protect bones and joints. wb.md/1cB3pff #fitness [Tweet]. Retrieved from https://twitter.com/WebMD

World Health Organization Collaborating Centre for Metabolic Bone Diseases, University of Scheffield, UK. https://www.shef.ac.uk/FRAX/ (accessed March 8, 2014).

Zintzaras E, Doxani C, Koufakis T, Kastanis A, Rodopoulou P, Karachalios T. 2011. Synopsis and meta-analysis of genetic association studies in osteoporosis for the focal adhesion family genes: the CUMAGAS-OSTEOporosis information system. *BMC Medicine* (9):9-18.

Appendix A - Consent form and survey distributed to medical professionals

COLORADO COLLEGE
A UNIQUE INTELLECTUAL ADVENTURE

Hello, my name is Claire Smith, and I am currently a senior at The Colorado College in Colorado Springs, CO. I am conducting research for my honors thesis and would greatly appreciate your time and expertise in completing this brief survey.

My research aims to 1.) investigate how health care professionals assess individual patients for their risk of developing osteoporosis and 2.) evaluate how adequately at-risk populations are being educated about the factors that affect their chance for developing osteoporosis. Specifically, I want to understand which risk factors are most commonly analyzed to assess a patient's risk. I also want to investigate whether the appropriate age-demographics are being targeted for proper education regarding osteoporosis and bone health.

If you have any interest in helping me complete my research, please fill out the attached survey. Upon completion, your survey and this consent form may be returned using the pre-addressed and stamped envelope enclosed. If you would prefer to complete this online, please access the following link:

http://coloradocollege.qualtrics.com/SE/?SID=SV_4YJYsuy68kvU9GB

Consent Form

You are being asked to take part in research for my honors thesis project by completing the enclosed survey about osteoporosis risk factors and osteoporosis education and awareness.

Taking part in this research is voluntary. You may refuse to answer any questions on the survey, and you may choose not to participate at any time.

Your answers will remain completely confidential. In any sort of report made public I will not include any information that will make it possible to identify you. This consent form with your signature will be separated from your survey response sheet in order to ensure that your answers remain anonymous.

If you have any questions, please contact Claire Smith at claire.smith@coloradocollege.edu or at (307)-277-8854.

Statement of Consent: ***I have read the above information, and have received answers to any questions for which I contacted Claire. I consent to participate in the research.***

Your Signature_____ Date _____

Your Name (printed) _____

Signature of person obtaining consent_____ Date _____

Printed name of person obtaining consent_____

CONTINUE TO NEXT PAGE FOR SURVEY

COLORADO COLLEGE
A UNIQUE INTELLECTUAL ADVENTURE

CONSENT: Your responses to questions on this survey will remain anonymous. In any sort of report made public I will not include any information that will make it possible to identify you. By completing this survey, you are consenting to participation in my research. If you have any questions, please do not hesitate to contact me via email, claire.smith@coloradocollege.edu, or by phone (307)-277-8854.

General Information/Clinic Description:

1.) What is the name of the health care facility where you work?

_____

2.) Please select the category within which you classify your clinic.
- ( ) Orthopaedic
- ( ) Women's Clinic
- ( ) Family Practice
- ( ) Internal Medicine
- ( ) Pediatric
- ( ) Other (specify) _____

3.) Please indicate the highest medical health degree that you have obtained.
- ( ) MD
- ( ) DO
- ( ) PA
- ( ) NP
- ( ) Other (specify) _____

4.) What is your current age?
- ( ) 20-35 years
- ( ) 36-50 years
- ( ) 50+ years

5.) What is the age range of patients for which you provide care? (Mark all that apply)
- ( ) 0-18 years
- ( ) 19-35 years
- ( ) 36-55 years
- ( ) 55 years and older

6.) Out of the above categories, which ages do you care for most frequently?
- ( ) 0-18 years
- ( ) 18-35 years
- ( ) 36-55 years
- ( ) 55 years and older

Osteoporosis Risk Assessment:

7.) Please mark the osteoporosis risk factors you consider when evaluating a patient for risk. Specify which factors you consider most seriously by rating them as either "less important," "important," or "very important" with regard to a patient's osteoporosis risk.

A.) General Patient Information and Family History:

	Less important	Important	Very important
Sex of Patient	○	○	○
Age of Patient	○	○	○
Family History (i.e. immediate family member who has osteoporosis or has experienced a fracture after age 50)	○	○	○
Ancestry (i.e. geographic origin of parents)	○	○	○
Race	○	○	○
Skin Color	○	○	○

B.) Medical History:

	Less important	Important	Very important
Reproductive History (i.e. age at menopause)	○	○	○
Surgical Menopause (i.e. oophorectomy)	○	○	○
Other diseases (i.e. rheumatoid arthritis, diabetes…)	○	○	○
Past medical treatments (i.e. chemotherapy, estrogen therapy, steroid pills...)	○	○	○

Other diseases: Please specify any diseases/conditions that you link with increased risk for osteoporosis:

( ) Rheumatoid arthritis
( ) Type I diabetes
( ) Amenorrhea
( ) Anorexia nervosa or bulimia
( ) Hysterectomy
( ) HIV
( ) Hyperthyroidism
( ) Malabsorption disorders (i.e. Crohn's disease, coeliac disease, cystic fibrosis...)
( ) Lactose intolerance
( ) Other (specify) _____

Past medical treatments: Please specify any past medical treatments/medications that you link with increased risk for osteoporosis:

( ) Chemotherapy
( ) Estrogen therapy
( ) Corticosteroids
( ) Anticonvulsants
( ) Long-acting (depot) progesterone-containing contraception
( ) Other (specify) _____

C.) Current Factors (i.e. practices/habits/situations after age 35):

	Less important	Important	Very important
Diet	○	○	○
Intake of multivitamin, calcium, and vitamin D supplements	○	○	○
Cigarette smoking status	○	○	○
Alcohol consumption status	○	○	○
Caffeine intake	○	○	○
Physical activity level	○	○	○
Type of physical activity	○	○	○
Socioeconomic status	○	○	○
Underweight BMI (i.e. low ideal body weight)	○	○	○
Normal/Mildly overweight BMI	○	○	○
Obese BMI	○	○	○

D.) Past Factors (i.e. practices/habits/situations prior to age 35):

	Less important	Important	Very important
Diet	○	○	○
Intake of multivitamin, calcium, and vitamin D supplements	○	○	○
Cigarette smoking status	○	○	○
Alcohol consumption status	○	○	○
Caffeine intake	○	○	○
Physical activity level	○	○	○
Type of physical activity	○	○	○
Socioeconomic status	○	○	○
Underweight BMI (i.e. low ideal body weight)	○	○	○
Normal/Mildly overweight BMI	○	○	○
Obese BMI	○	○	○

8.) If there are any different additional factors you take into consideration when evaluating a patient for osteoporosis risk, please list them below and briefly describe why you consider them.

_____
_____
_____
_____

9.) Select which methods you use to evaluate osteoporosis risk.

( ) BMD test (i.e. DEXA, DPA, SPA)
( ) History of fragility fracture
( ) Physical exam
( ) Discussion of patient's medical history
( ) Other (specify) _____

10.) Does the health and physical form that your patients fill out include a question asking them to identify themselves as a particular "race"?

( ) Yes
( ) No
( ) Unsure

11.) Do you consider there to be a difference between the terms *race* and *ancestry*?

( ) Yes
( ) No
( ) Unsure

12.) Please describe what you consider to be the difference between the terms race and ancestry, or why you consider there to be no difference.

_____
_____
_____
_____

13.) Do you believe that most of your patients consider there to be a difference between the term *race* and the term *ancestry*?

( ) Yes
( ) No
( ) Unsure

14.) Do you take into account a patient's past and present socioeconomic status when evaluating their osteoporosis risk? Why or why not?

( ) Yes
( ) No

Why/why not:

_____
_____
_____
_____

Osteoporosis Education and Awareness:

15.) Do you counsel your patients and/or their parents about how to decrease future osteoporosis risk?

( ) Yes
( ) No

16.) If yes, what specific methods do you use to educate your patients about osteoporosis? Mark all that apply.

( ) Pamphlet
( ) Discussion
( ) Seminars
( ) Websites
( ) Books/Magazines/Journals
( ) Social Networks (i.e. Facebook, Twitter, etc...)
( ) Other (specify)
_____
( ) N/A - Do not counsel patients about preventing osteoporosis

17.) Of these methods, which do you consider to be the most effective with regard to patient education? You may select multiple answers.

( ) Pamphlet
( ) Discussion
( ) Seminars
( ) Websites
( ) Books/Magazines/Journals
( ) Social Networks (i.e. Facebook, Twitter, etc...)
( ) Other

18.) Which age demographics do you believe should be targeted most intensely to receive an education about osteoporosis and bone health? You may select multiple age groups.

( ) Pre-teen and teenage girls who are about to go through puberty or who are currently going through puberty
( ) Young adults (female) who have completed puberty for the most part, and are entering their early twenties
( ) Women in their twenties and up through age 35
( ) Women older than 35 who have yet to begin menopause
( ) Women undergoing menopause
( ) Post-menapausal women

19.) For each of the age demographics described above, select the points you would emphasize most heavily in a discussion about bone health and osteoporosis risk factors.

A.) Pre-teen and teenage girls who are about to go through puberty or who are currently going through puberty:

( ) Current diet
( ) Past diet
( ) Intake of multivitamin, calcium, and vitamin D supplements
( ) Cigarette smoking status
( ) Alcohol consumption status
( ) Caffeine intake
( ) Physical activity level
( ) Type of physical activity
( ) Socioeconomic status
( ) BMI
( ) Attitudes towards dieting and body shape
( ) Family history of osteoporosis/osteopenia
( ) Ancestry (i.e. geographic origin of parents)
( ) Other diseases
( ) Past medical treatments
( ) Reproductive history (i.e. age at menopause)
( ) Regularity of menstrual cycles
( ) Other (specify) _____

B.) Young adults (female) who have completed puberty for the most part, and are entering their early twenties:

( ) Current diet
( ) Past diet
( ) Intake of multivitamin, calcium, and vitamin D supplements
( ) Cigarette smoking status
( ) Alcohol consumption status
( ) Caffeine intake
( ) Physical activity level
( ) Type of physical activity
( ) Socioeconomic status
( ) BMI
( ) Attitudes towards dieting and body shape

( ) Family history of osteoporosis/osteopenia
( ) Ancestry (i.e. geographic origin of parents)
( ) Other diseases
( ) Past medical treatments
( ) Reproductive history (i.e. age at menopause)
( ) Regularity of menstrual cycles
( ) Other (specify) _____

C.) Women in their twenties and up through age 35:
( ) Current diet
( ) Past diet
( ) Intake of multivitamin, calcium, and vitamin D supplements
( ) Cigarette smoking status
( ) Alcohol consumption status
( ) Caffeine intake
( ) Physical activity level
( ) Type of physical activity
( ) Socioeconomic status
( ) BMI
( ) Attitudes towards dieting and body shape
( ) Family history of osteoporosis/osteopenia
( ) Ancestry (i.e. geographic origin of parents)
( ) Other diseases
( ) Past medical treatments
( ) Reproductive history (i.e. age at menopause)
( ) Regularity of menstrual cycles
( ) Other (specify) _____

D.) Women older than 35 who have yet to begin menopause:
( ) Current diet
( ) Past diet
( ) Intake of multivitamin, calcium, and vitamin D supplements
( ) Cigarette smoking status
( ) Alcohol consumption status
( ) Caffeine intake
( ) Physical activity level
( ) Type of physical activity
( ) Socioeconomic status
( ) BMI
( ) Attitudes towards dieting and body shape
( ) Family history of osteoporosis/osteopenia
( ) Ancestry (i.e. geographic origin of parents)
( ) Other diseases
( ) Past medical treatments
( ) Reproductive history (i.e. age at menopause)
( ) Regularity of menstrual cycles
( ) Other (specify) _____

E.) Women undergoing menopause:
( ) Current diet
( ) Past diet
( ) Intake of multivitamin, calcium, and vitamin D supplements
( ) Cigarette smoking status
( ) Alcohol consumption status
( ) Caffeine intake
( ) Physical activity level
( ) Type of physical activity
( ) Socioeconomic status

( ) BMI
( ) Attitudes towards dieting and body shape
( ) Family history of osteoporosis/osteopenia
( ) Ancestry (i.e. geographic origin of parents)
( ) Other diseases
( ) Past medical treatments
( ) Reproductive history (i.e. age at menopause)
( ) Regularity of menstrual cycles
( ) Other (specify) _____

F.) Post-menapausal women:
( ) Current diet
( ) Past diet
( ) Intake of multivitamin, calcium, and vitamin D supplements
( ) Cigarette smoking status
( ) Alcohol consumption status
( ) Caffeine intake
( ) Physical activity level
( ) Type of physical activity
( ) Socioeconomic status
( ) BMI
( ) Attitudes towards dieting and body shape
( ) Family history of osteoporosis/osteopenia
( ) Ancestry (i.e. geographic origin of parents)
( ) Other diseases
( ) Past medical treatments
( ) Reproductive history (i.e. age at menopause)
( ) Regularity of menstrual cycles
( ) Other (specify) _____

20.) Select which types of physical activity, if any, you recommend to your patients to increase bone density.
( ) Walking
( ) Running/jogging
( ) Swimming
( ) Weight lifting
( ) Other (specify) _____

Thank you so much for your time completing this survey. Your willingness to help me complete research for my thesis is greatly appreciated, because investigating the risk factors and awareness levels regarding osteoporosis is something important and interesting to me.

Additionally, if you would be willing to participate in a brief (~10 minute) interview conducted over the phone regarding this topic, please provide contact information below. I would greatly appreciate your additional participation, as an interview will allow me to clarify any additional questions I have and enhance the quality of my research. Please know that contact information will be used only for the purpose of contacting you for a phone interview. No information will be shared, and your responses will remain anonymous should any information be made public. I will contact you by email in order to schedule a phone interview, if you choose to provide contact information to participate.

Name: _____

Email Address: _____

Phone number: _____

Appendix B - Methods: List of contacts for Colorado Clinics
Date: October 7, 2013 – October 9, 2013

1.) Colorado Springs Orthopaedic Group, 6011 East Woodmen Road, Suite 120 Colorado Springs, CO 80923, 719-632-7669, on 10/7/13 email to Ashley who said she would distribute the survey (apenman@csog.net)
2.) Colorado Center of Orthopaedic Excellence, 1625 Medical Center Point #110, Colorado Springs, CO 80907, 719-632-1050, 10/7/13 left message for Karen
3.) Denver Internal Medical Group, 155 S Madison St. Denver, CO 80209, 303-333-5456 msauer@denverimgroup.com - emailed survey on 10/7/13
4.) Advanced Orthopaedics Denver, 8101 Lowry Blvd. Denver, CO 803230, Left message for Alison, 303-344-9090
5.) Orthopaedic Surgery Associates, Parker, CO 80138, left message 303-750-102
6.) St. Anthony Hospital, Lakewood, CO, left message with Betty Bush 720-321-0000
7.) Colorado Springs Family Practice, Colorado Springs, CO 80909, emailed survey to cbird@csfpmd.com, 719-634-8891
8.) Premier Urgent Care, Monument, CO 80132, 719-481-2335, emailed survey to premierurgentcare@gmail.com after talking to doctor who gave me this email to send to Linda
9.) Front Range Orthopaedic, Longmont, CO 80501, left msg with Larry 719-473-3332, sent survey
10.) Blue Skies Center for Women, Colorado Springs, CO 8910, 719-471-3471, left message
11.) Academy Women's Healthcare, 719-442-0808, sent survey
12.) Pediatric Associates, Colorado Springs, CO 80922, sent survey to Leary6@hotmail.com
13.) ABC Pediatrics, Colorado Springs, CO 80920, left message for Denise inquiring about sending survey, 719-574-9191
14.) Mountain View Medical Group, Woodland Park, CO 80863, 719-687-6022
15.) Mountain View Medical Group, Colorado Springs, CO 80918, 719-598-9446
16.) Mountain View Medical Group, Monument, CO 80132, 719-488-9860
17.) Colorado Springs, CO 80907, 719-635-3355 emailed surveys to mcichello@mtviewmedgroup.com Dr. Norton's office
18.) Kids are Great Pediatrics, Colorado Springs, CO, 80907 kidsaregreatpediatrics@gmail.com - sent email to general address
19.) Wee Care Pediatrics, Colorado Springs, CO 80920, sent surveys to weecarepediatrics@gmail.com 719-266-5944
20.) Colorado Springs Gynecology Associates, Colorado Springs, CO 80918, 719-598-0500, called and left message for Anna the office manager
21.) The Dream Center of Colorado Springs Women's Clinic, 4360 Montebello Drive, Suite 900 , Colorado Springs, CO 80918 , 719-388-1594, left phone message
22.) Peak Vista Community Health Center, Colorado Springs, CO 80910, 719-632-5700, left msg for Ellen
23.) UCCS Women's Clinic, Colorado Springs, CO 80918, 719-388-1594 info@dreamcenterscos.org -sent email on 10/8/13
24.) Denver Pediatrics, 9141 Grant St. Thornton, CO, 303-920-9000 denpeds@aol.com - sent email
25.) Mountainland Pediatrics, 720-449-2486, left message with Juan

26.) Pediatrics 5280, Englewood, CO 80112, 855-487-6443, left message with Mike (Practice Manager)
27.) Southeast Denver Pediatrics, Parker, CO 80134, 303-471-5060
28.) Steadman Hawkins Clinic, Greenwood Village, CO 80111, 303-694-3333, left message with Megan
29.) Steadman Hawkins Clinic, Lone Tree, CO 80124, 303-586-9500
30.) Downtown Women's Healthcare, 1201 East 17th Ave. Denver, CO 80218, 303-298-0222
31.) UC OB/GYN Denver Clinic, 8111 E. Lowry Blvd. Suite 120, Denver, CO 80230,720-316-7375
32.) Premier Urgent Care, 8115 State Hwy 83, Colorado Springs, CO 80920, 719-344-2389- email sent 10/9/13

Appendix C - Names of medical professionals in Casper, WY that received survey:

1.) Dr. Tom Burke
2.) Dr. Mary Burke
3.) Dr. Daniel Cummings
4.) Dr. Cheryl Edwards
5.) Dr. David Ellbogen
6.) Dr. Rita Emch
7.) Dr. David Irk
8.) Dr. Sherrill Fox
9.) Dr. Mike Granum
10.) Dr. Richard Green
11.) Dr. Matt Gorman
12.) Dr. Matt Mitchell
13.) Star Bartlette-Rone, PA
14.) Dan Fedore, PA
15.) Dr. John Bailey
16.) Dr. Jerry Behrens
17.) Dr. Demian Yakel
18.) Dr. Robert Allaire
19.) Annie Haack, PA
20.) Dr. Craig Smith
21.) Dr. Dana Ideen
22.) Dr. Jodi Kaigh
23.) Dr. Sharon Karnes
24.) Dr. Eric Lawrence
25.) Dr. Jason Lloyd
26.) Dr. Joe Michelson
27.) Nancy Potter, NP
28.) Mary Behrens, NP
29.) Dr. Michael Quinn
30.) Dr. Tom Radosevich
31.) Dr. Beth Robitaille
32.) Dr. Jamie Rupp
33.) Dr. Sam Scaling

34.) Dr. Joe Schoeber
35.) Dr. Laura Smothers
36.) Dr. Cora Salvino
37.) Dr. Susan Sheridan
38.) Dr. Renee Stirling
39.) Dr. Cory Stirling
40.) Dr. Jason Strand
41.) Dr. Bob Vigneri
42.) Dr. Cindy Works
43.) Dr. Drew Woodward

Appendix D

Twitter accounts followed for media analysis:

1. FITNESS Magazine - @FitnessMagazine
2. Womenshealth.gov - @womenshealth
3. WebMD - @WebMD
4. Girlshealth.gov - @girlshealth
5. SELF Magazine - @SELFmagazine
6. Health magazine - @goodhealth
7. SHAPE magazine - @Shape_Magazine
8. Women's Health - @WomensHealthMag

Magazines analyzed:

1. Women's Health Magazine (December and January issues)
2. SHAPE Magazine (December issue)
3. SELF Magazine (December and January issues)
4. Health Magazine (December and January issues)
5. FITNESS Magazine (November/December and January/February issues)

Appendix E

See Figure 17 (below) for number of responses received from each type of clinic.

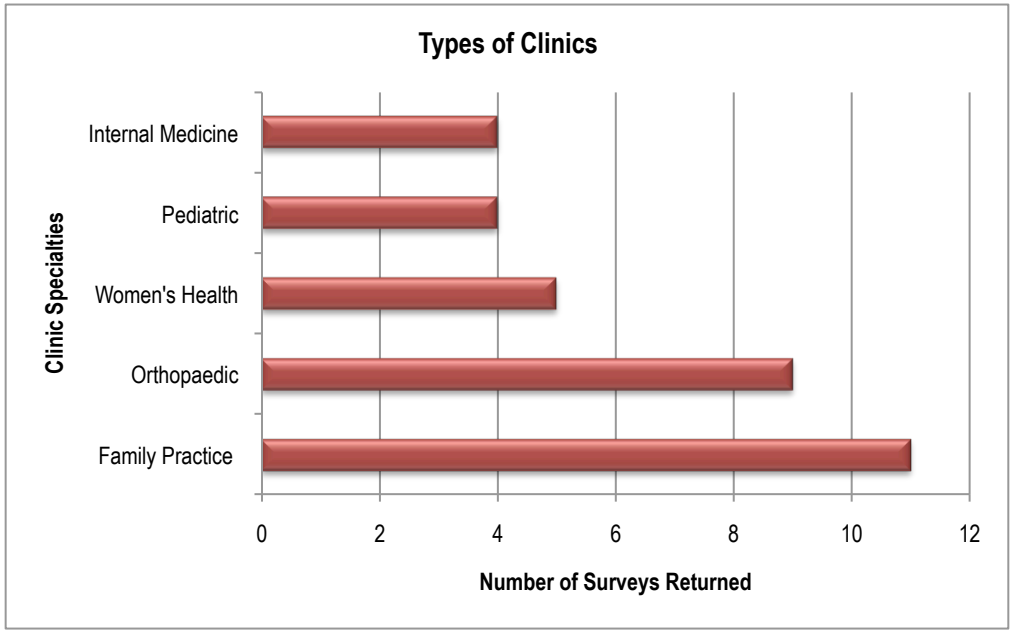

Figure 17 shows how many survey responses were received from each type of medical clinic.

See Figure 18 (below) for number of responses received from each type of medical professional.

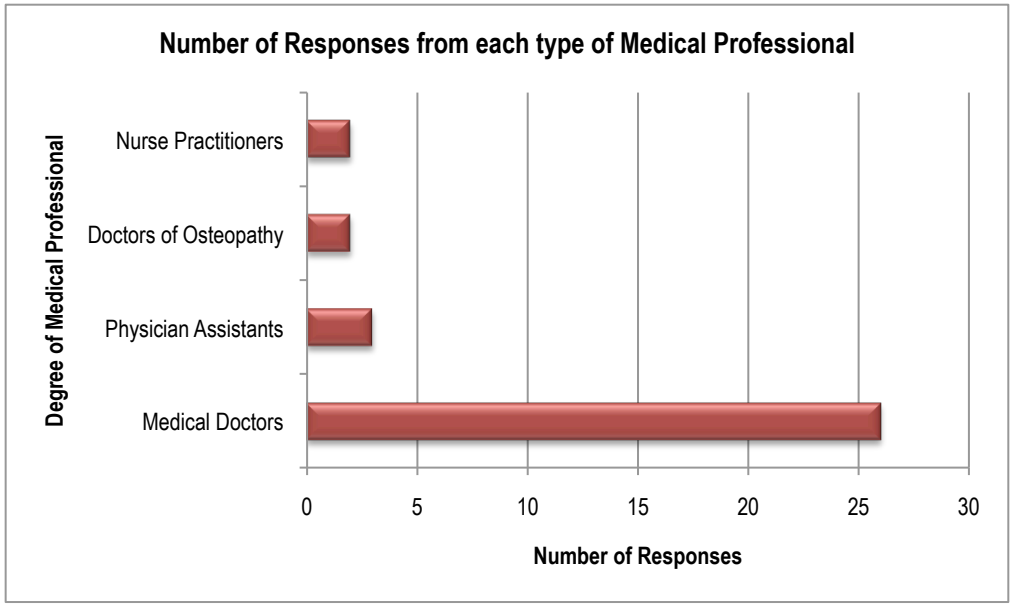

Figure 18 shows how many survey responses were received from each type of medical professional.