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Factors Impacting Bone Mineral Density (BMD) Results of Individuals with Intellectual and  
Developmental Disabilities (IDD)

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A thesis

presented to

the faculty of the Department of Allied Health Sciences

East Tennessee State University

In partial fulfillment

of the requirements for the degree

Master of Science in Clinical Nutrition

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by

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May 2018

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Keywords: Bone Mineral Density (BMD), individuals with intellectual and developmental  
disabilities (IDD), osteoporosis/osteopenia, calcium supplementation, risk factors

## ABSTRACT

### Factors Impacting Bone Mineral Density (BMD) Results of Individuals with Intellectual and Developmental Disabilities (IDD)

by

Rhonda M. McNabb

Individuals with intellectual and developmental disabilities (IDD) are prone to certain diseases in their lifetime, such as osteoporosis. Absorption of calcium is essential to maintaining good bone health and preventing osteoporosis. This study examined primary care providers' (PCPs) choice of calcium supplementation, as well as type of calcium supplementation, and the relationship between variables in the IDD population. Ten PCPs were asked to complete a 14-question web-based survey, with five surveys completed. Calcium citrate was the preferred supplement among respondents at 50%. Retrospective data was collected from patient records and included type of calcium supplement prescribed, bone density test results, and other variable factors. The type of calcium supplement prescribed did not affect bone density results in subjects with IDD. There was a weak significance between calcium supplement type and gender and vitamin D. It is of modest benefit to include vitamin D with calcium supplementation to enhance calcium absorption.

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## CHAPTER 1

### INTRODUCTION

Osteoporosis is a silent disease that can lead to skeletal fractures. Osteoporosis is characterized by low bone mass and a chronic and progressive deterioration of bone affecting almost the entire skeleton.<sup>1,2,3</sup> According to data from the 2005-2010 National Health and Nutrition Examination Survey (NHANES), 16.2% of U.S. adults aged 65 and older had osteoporosis at the lumbar spine or femur.<sup>4</sup> The prevalence of osteoporosis in the older adult with intellectual and developmental disabilities (IDD) is presumed much higher due to a combination of age-related and IDD-related risk factors for the disease.<sup>5</sup> Osteoporosis can also affect adults younger than 65 years of age, particularly those with intellectual and developmental disabilities.

Intellectual disabilities (ID) are defined as “a disability characterized by significant limitation both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills” occurring before the age of 18 years.<sup>6,7</sup> The term “developmental disability” refers to individuals who have a severe, chronic disability that is caused by a mental and/or physical impairment and who have substantial functional limitations in activities of daily living.<sup>8</sup> The prevalence of children, adolescents, and adults with IDD is estimated to be 10.37/1000 population.<sup>9</sup>

Adults with IDD are prone to experience health issues including changes in bone density, earlier in life than the general population.<sup>10,11</sup> Individuals with IDD are at increased risk for low bone mineral density (BMD).<sup>7,12</sup> Low BMD can lead to osteoporosis which contributes to high rates of low-trauma fracture for IDD.<sup>13</sup> Up to 78.5% of people with IDD living in institutions have bone mass density in the osteoporotic range.<sup>14</sup>

There are several risk factors that lead to low BMD. These risk factors for the general population include low vitamin D serum level, chronic malnutrition, physical inactivity, history of fracture as an adult, low body weight, low calcium intake (lifelong), race (Caucasian or Asian), and estrogen deficiency at an early age (<45 years).<sup>14,15</sup> In the population of adults with a non-ambulatory status, the prevalence of osteopenia and osteoporosis is higher.<sup>16</sup> For individuals with IDD, additional risk factors include living in a residential facility, female gender, immobility, diagnosis of Down syndrome, and use of anticonvulsant drugs.<sup>8,17,18,19,20,21</sup> Predictors of osteoporosis in the IDD population in a community dwelling were found to be age (greater than 45 years), race (Caucasian), and level of ambulation (non-ambulatory).<sup>22</sup> Poorer health status of individuals with IDD in comparison with the general population can be related to a combination of factors including genetic predispositions, less favorable social circumstances, reluctance or inability to use health services, omission from public health awareness campaigns, and residential circumstances that foster inactivity and poor lifestyle choices.<sup>23</sup>

Good nutrition is an essential overall health promotion strategy that helps reduce problems such as osteopenia and osteoporosis in individuals with IDD. Nutrition education for both individuals with IDD and their care givers is one way of promoting healthy aging in adults.<sup>7</sup> It is the position of the Academy of Nutrition and Dietetics that nutrition services provided by a dietitian are an essential component of comprehensive care for all adults with IDD.<sup>24</sup>

Healthy diets which include the recommended amount of calcium, as well as vitamin D and phosphorus, are key steps to preventing low BMD. Vitamin D aids in the absorption of calcium and phosphorus while protecting against the loss of bone.<sup>26</sup> Phosphorus and calcium combine in a delicate balance to protect the bones from osteoporosis.<sup>27</sup>

The National Osteoporosis Foundation (NOF) recommends daily amounts of calcium should be obtained from food first and supplement only as needed to make up for any shortfall.<sup>28</sup> Unfortunately, when adequate calcium is not obtained by diet and/or calcium needs are increased due to use of antiepileptic drugs, supplementation is a necessity. Moderate intake of calcium combined with adequate intake of other micronutrients obtained from the diet and/or supplementation is sufficient to meet the structural and functional demands of the skeleton.<sup>29</sup>

The recommended total daily calcium intake is 1,000 mg from all sources for women age 50 or younger; 1,200 mg for women age 51 and older; 1,000 mg for men age 70 and younger; and 1,200 mg for men age 71 and older.<sup>28,29,30,31,32,33,34,35,36,37</sup> According to Weaver et al., a meta-analysis of randomized controlled studies (RCS) supported the use of calcium plus vitamin D supplements as an intervention for fracture risk reduction in both community-dwelling and institutionalized middle-aged older adults.<sup>38</sup> Adequate intake of calcium and vitamin D, through diet and /or supplements, reverses secondary hyperparathyroidism and is recommended for the prevention of osteoporotic fractures.<sup>39</sup>

The most common type of calcium supplement generally consumed is either calcium citrate or calcium carbonate. A less common calcium supplement is calcium phosphate which has been found to be equally effective in supporting bone building as calcium carbonate.<sup>39</sup> Both calcium citrate and calcium carbonate when taken with a meal are effective.<sup>40</sup>

The efficiency of intestinal calcium absorption can vary from 7% to 75% and is influenced by multiple physiological factors (growth, pregnancy, lactation, and aging) and environmental variables (dietary calcium and vitamin D intakes).<sup>41</sup> Calcium absorption is also affected by stomach acid. If stomach acid is not properly secreted, calcium salts are minimally dissolved and, subsequently may not be properly and effectively absorbed.<sup>42</sup>

Gastroesophageal reflux disease (GERD) can affect many individuals including those with IDD.<sup>8,24</sup> Proton pump inhibitors and histamine H2 receptors which reduce stomach acid are often prescribed for GERD. Calcium carbonate requires a high acid environment to be absorbed.<sup>41,42</sup> Therefore, it may be beneficial to consider a more soluble calcium formulation such as calcium citrate for individuals with GERD.

Long-term use of antiepileptic drugs such as valproic acid, carbamazepine, or oxcarbazepine have unknown effects on skeletal mineralization and induce a state of decreased BMD.<sup>43,44</sup> Babayigit, Dirik, and Cakmakci found that healthy children with epilepsy taking antiepileptic drugs had bone density values significantly lower than the healthy control group.<sup>43</sup>

Some individuals with IDD may have a diagnosis of mental illness and/or depression and require antipsychotic (neuroleptic) or antidepressant medication. A secondary cause of osteoporosis is hyperprolactinemia which can result from long-term use of antipsychotic drugs.<sup>45,46,47</sup> Antidepressants such as selective serotonin reuptake inhibitors (SSRIs) may have a direct effect on decreasing bone metabolism.<sup>48</sup> Longitudinal studies have found that SSRI users have at least a 1.6-fold greater decline in BMD compared with those not taking SSRIs.<sup>49</sup>

The established need for elemental calcium is  $\geq 800$  mg per day.<sup>43</sup> Calcium carbonate provides 40% of elemental calcium and is better absorbed in an acid environment. Calcium citrate provides only 20% of elemental calcium but can be absorbed both in an acidic and a hypochlorhydric stomach.<sup>43,44</sup> This should be an important consideration when determining the appropriate calcium supplement for individuals with IDD who are not meeting the recommended calcium requirement with their diet and who take medication for GERD. Individuals who have GERD take medications to reduce stomach acid which in turn can affect the absorption of calcium carbonate.<sup>73,74</sup>

Adequate calcium intake throughout life and the absorption of calcium in the gut plays an important role in maintaining healthy bones.<sup>3,28,29,30,31,32,33,34</sup> Poor calcium and vitamin D intake leads to low BMD which can result in fractures.<sup>36,37,38,39</sup> If the diet does not provide adequate calcium and vitamin D, then calcium with vitamin D supplementation is recommended. Individuals with IDD appear to be at higher risk for osteoporosis and fractures due to a variety of health-related and/or environmental reasons.<sup>14,22</sup> The most common calcium supplement primary care providers (PCPs) order for individuals with IDD is calcium carbonate or calcium citrate.

## CHAPTER 2

### REVIEW OF LITERATURE

#### Overview of Intellectual and Developmental Disabilities

##### Diagnostic Criteria

There are three major criteria for diagnosing intellectual and developmental disability (IDD): 1) significant limitations in intellectual functioning; 2) significant limitations in adaptive behavior; and 3) onset before the age of 18.<sup>46</sup> Tests that determine limitations in adaptive behavior cover language and literacy, money, time and number concepts; interpersonal skills, social responsibility and self-esteem; and activities of daily living, occupational skills and healthcare.<sup>46,47</sup> IDD may result from physical causes, such as autism or cerebral palsy, or from nonphysical causes, such as lack of stimulation or lack of responsiveness to stimulation.<sup>47</sup> An Intelligence Quotient (IQ) test is not used in the criteria to determine IDD as this tool measures intellectual functioning.<sup>46</sup>

Developmental disabilities (DD), an umbrella that includes intellectual disabilities, are severe chronic disabilities that can be cognitive or physical or both, appear before the age of 22 and are likely to be lifelong.<sup>47,48</sup> Developmental disabilities may be solely physical from birth or involve both physical and ID stemming from genetic or other causes, such as Down syndrome and fetal alcohol syndrome.<sup>47</sup> Intellectual and developmental disabilities (IDD) often co-occur and is the medically correct term to use when referring to this population.<sup>47</sup>

##### Population, Statistics, and Screening

Recent estimates in the United States show that about one in six children aged 3 through 17 have one or more developmental disabilities.<sup>49,50</sup> Results from a meta-analysis of

population-based studies from 1980-2009 involving several countries revealed that the prevalence of intellectual disability was 10.37/1000 population.<sup>9</sup> Prevalence of IDD was higher in males in both adult and children/adolescent populations.<sup>9</sup> Common perinatal causes were birth injury, birth asphyxia, and intra-uterine growth retardation.<sup>9</sup> Genetic causes, including Down syndrome, were a common antenatal factor.<sup>9</sup>

The National Institutes of Health (NIH) is supporting the development of new technologies for newborn screening (NBS) and research into the causes and early diagnosis of IDD.<sup>47</sup> NBS has progressively expanded with additional metabolic and non-metabolic disorders in which early pre-symptomatic detection allows for better treatment of IDD.<sup>51</sup> The NIH is supporting studies to learn how best to use new technology to help prevent disabilities.

#### Residence: Institutions and Community Homes

According to the National Council on Disability, the institutionalization of people with IDD peaked nationally in 1967, when 194,650 people with IDD were housed in large designated state institutions.<sup>52</sup> By 2009, this number had been reduced to 32,909.<sup>52</sup> This only represents a portion of the people with IDD housed in institutions as an estimated 29,608 people with ID/DD are in nursing facilities and 18,485 people are in private intermediate care facilities (ICF) with more than 16 residents.<sup>52</sup>

Individuals with IDD today are transitioning from institutions to community homes otherwise known as group homes.<sup>52</sup> Individuals with IDD who live with aging parents or guardians eventually require residence in group homes when their parents or guardians are unable to provide care for their increased medical and/or physical problems. Group Homes for Persons with Intellectual Disabilities (GHPID) are licensed community residence facilities that maintain necessary staff, programs, support services, and equipment and that provide a home-



like environment for at least 4 but not more than 8 related or unrelated individuals with IDD who require specialized living arrangements.<sup>52</sup>

## Health and Medical Problems of Individuals with IDD

### General Health Issues

Individuals with IDD often experience health issues associated with aging and at higher rates than the general population.<sup>10,53, 54</sup> These health issues include: mobility limitations, changes in bone health, over- or under-nutrition, dental problems, decreases in vision/hearing, cardiovascular health risks, hypertension, type II diabetes, dementia, and depression.<sup>10, 53,55,56</sup>

Medical diagnoses in the individual with IDD include: swallowing difficulties known as dysphagia, gastrointestinal problems such as gastroesophageal reflux disease (GERD), constipation, peptic ulcer disease, pica, and metabolic disorders such as hypogonadism associated with Prader-Willi syndrome.<sup>8</sup>

Risk factors that are common among both the general population and in individuals with IDD that contribute to health issues include the lack of physical activity and unhealthy eating habits.<sup>8</sup> Other health risk factors among individuals with IDD include smoking and alcohol consumption. Smoking is a risk factor for both cardiovascular disease and lung cancer.<sup>8</sup> Cigarette smoking has been related to lower bone density, increased bone mineral loss, and increased risk of fracture in males and females.<sup>57,58,59</sup> Short-term health risk of alcohol consumption include alcohol poisoning and injuries, while long-term health risk of alcohol consumption are hypertension (HTN), heart disease, stroke, liver disease, and digestive problems.<sup>60</sup>

## Medical Issues

Bone mineral density (BMD) is a correlate of bone health, and osteoporosis is defined as a BMD that is 2.5 standard deviations below peak bone mass (20-year-old, healthy, gender-matched average).<sup>1,62</sup> Values between 1.0 and 2.5 standard deviations below the adult mean are termed osteopenia.<sup>19</sup>

Osteoporosis is more prevalent in adults with IDD than in the population without disabilities.<sup>6</sup> It has been reported that people with IDD are at an increased risk of low BMD.<sup>6</sup> Factors for low BMD in the individual with IDD that have been studied include gender, age, severity of ID, community versus institutionalized setting, mobility, body mass index (BMI), prior fractures, use of anticonvulsant drugs, vitamin D status, Down syndrome, and history of falls and fractures.<sup>5,19</sup>

Zylstra et al. found significant predictors in the rates of osteoporosis attributable to subject age, race, and level of ambulation.<sup>23</sup> There were no gender differences noted for the rate of osteoporosis and diagnostic differences were significant only for those individuals with a diagnosis of metabolic error, who had a significantly lower rate of osteoporosis than the rest of the study population.<sup>23</sup>

Adults with IDD have been found to be three times more likely to experience a low-trauma fracture than adults without IDD.<sup>13</sup> Some researchers estimate fractures occurring anywhere from 1.7 to 3.5 times more often in people with IDD, therefore it is important to have proper BMD screening.<sup>7</sup> Dreyfus et al. suggested a need for increased provider awareness about bone density screenings in high-risk adults with IDD, especially men, as well as men and women with Down syndrome, as overall screening rates were lower in the population of individuals with IDD compared to that of general population.<sup>7</sup>

BMD results are determined from the ratio of calcium and phosphorus in bones, therefore calcium is a major nutrient needed to form new bone cells and to maintain bone health.<sup>3</sup> Bones store more than 99 percent of the calcium in the human body.<sup>3,30</sup> Calcium works with other nutrients including vitamin D, vitamin K, potassium, fluoride and magnesium to increase bone density and strength.<sup>3</sup>

### Health Care and Life Span

The American Association on Intellectual and Developmental Disabilities has advocated that all people with IDD have timely access to high-quality, comprehensive, accessible, affordable, and appropriate health care that meets their individual needs for maximizing health, well-being, and function and increasing independence and community participation.<sup>61</sup> As a result of improved healthcare for individuals with IDDs, their lifespan has increased substantially over the last century yet remains lower than the general adult population.<sup>10</sup>

Registered dietitians (RD) play an important role in providing nutritional information to individuals with IDD to promote wellness and improving quality of life.<sup>25</sup> It is the position of the Academy of Nutrition and Dietetics (AND) that nutrition services provided by a registered dietitian nutritionist (RDN) and dietetic technician registered (DTR) who work under RDN supervision, are essential components of comprehensive care for all adults with IDD and children and youth with special health care needs.<sup>25</sup>

### Overview of Osteoporosis

#### Prevalence

The National Osteoporosis Foundation (NOF) estimates that more than 9.9 million Americans have osteoporosis and an additional 43.1 million have low bone density.<sup>29</sup> The age-

adjusted prevalence of osteoporosis at either lumbar spine or femur neck was higher among women (24.7%) than men (5.6%).<sup>4</sup>

Annually in the U.S., two million fractures are attributed to osteoporosis, resulting in more than 432,000 hospital admissions, almost 2.5 million medical office visits, and about 180,000 nursing home admissions.<sup>29</sup> Over 800,000 patients a year are hospitalized because of a fall injury, most often because of a broken hip or head injury.<sup>63</sup>

As the aging population increases each year, it is assumed that healthcare cost for osteoporosis related fractures will also increase. In 2015, costs for falls totaled over \$31 billion.<sup>61</sup> The cost of care for the aging population is expected to rise to \$25.3 billion by 2025.<sup>29</sup> In addition to monetary cost, a fracture reduces the quality of life.<sup>65</sup>

### Risk Factors

Osteoporosis is characterized by low bone mass and deterioration of bone tissue that is chronic and progressive, and can affect almost the entire skeleton.<sup>1,2,3</sup> The risk factors that lead to osteoporosis for the general population include low vitamin D serum level, chronic malnutrition, physical inactivity, history of fracture as an adult, low body weight, low calcium intake (lifelong), race (Caucasian or Asian), and estrogen deficiency at an early age (<45 years).<sup>14,15</sup> Additional risk factors include the use of antipsychotics, antidepressants, antiepileptics, and high-dose, long-term use of antisecretory drugs.

Low calcium intake and vitamin D deficiency result in a negative calcium balance.<sup>39</sup> This stimulates the secretion of parathyroid hormone (PTH) and induces age-associated secondary hyperparathyroidism, which enhances bone turnover and accelerates bone loss.<sup>66</sup> Adequate intake of calcium and vitamin D, through diet and/or supplements, reverses this

secondary hyperparathyroidism and is recommended in the prevention of osteoporotic fractures.<sup>67,68</sup>

Babayigit, Dirik, and Cakmakci examined the effects of antiepileptic drugs on the bone mineral density of children.<sup>43</sup> They found that patients receiving antiepileptic drugs had BMD values that were significantly lower than those of the healthy control group, indicating that antiepileptic drug treatment either with valproic acid, carbamazepine, or with oxcarbazepine which has unknown effects on skeletal mineralization, induces a state of decreased bone mineral density.<sup>43</sup>

### Bone Density Testing

A bone density test is the only test that can diagnose osteoporosis before a broken bone occurs.<sup>69</sup> NOF recommends a bone density test of the hip and spine by a central dual energy x-ray absorptiometry (DXA) to diagnose osteoporosis.<sup>69</sup> Bone density indicates normal bone density, low bone density (osteopenia) or osteoporosis. Other bone density tests, known as peripheral tests, measure bone density in the lower arm, wrist, finger or heel.<sup>69</sup> Types of peripheral tests are 1) peripheral dual energy x-ray absorptiometry (pDXA); 2) quantitative ultrasound (QIS); and 3) peripheral quantitative computed tomography (pQCT).

Bone density test results are reported using t-scores.<sup>69</sup> A t-score shows how much higher or lower one's bone density is than that of a healthy 30-year old adult.<sup>69</sup> Table 1 includes the definitions of t-scores according to the World Health Organization (WHO).

**Table 1.** World Health Organization T-Score Definitions (modified from World Health Organization).<sup>69</sup>

Level	Definition
<b>Normal</b>	Bone density is within 1 SD (+1 or -1) of the young adult mean. Examples: +0.5, 0.0
<b>Low bone mass</b>	Bone density is between 1 and 2.5 SD below the young adult mean (-1 to -2.5 SD). Examples: -1.1, -1.5, -2.4
<b>Osteoporosis</b>	Bone density is 2.5 SD or more below the young adult mean (-2.5 SD or lower). Examples: -2.5, -3.0, -4.0
<b>Severe (established) osteoporosis</b>	Bone density is more than 2.5 SD below the young adult mean, and there have been one or more osteoporotic fractures.

World Health Organization Definitions Based on Bone Density Levels

Once a patient is diagnosed with osteoporosis or found to have a low BMD, the patient should be evaluated to determine whether this condition is primary or secondary to some other disease or to drug use.<sup>69</sup> Treatment includes adequate daily calcium and vitamin D, regular weight-bearing exercise and muscle-strengthening exercise to reduce the risk of falls and fractures as well as increase bone density.<sup>70,71</sup>

Medication Commonly Used by Individuals with IDD that Affect Bone Density

Antisecretory Medication

Gastroesophageal reflux disease (GERD) is one of the many health problems that can affect individuals with IDD. One of the goals of treatment for GERD includes decreasing gastric acidity, thus decreasing the severity of symptoms.<sup>72</sup> Two classifications of medications often used to decrease gastric acid are proton pump inhibitors (PPIs) including omeprazole (Prilosec, Zegerid), lansoprazole (Prevacid), pantoprazole (Protonix), rabeprazole (Aciphex), and

esomeprazole (Nexium); and H<sub>2</sub> antagonists including cimetidine (Tagamet HB), famotidine (Pepcid AC), nizatidine (Axid AR), and ranitidine (Zantac 75).<sup>72</sup>

Proton pump inhibitors block gastric hydrogen potassium ATPase enzyme, a component in hydrochloric acid (HCL) production.<sup>72</sup> H<sub>2</sub> antagonists block histamine receptors that are a component of one of the stimulatory paths for acid secretion.<sup>72</sup> H<sub>2</sub> antagonists provide short-term relief and are effective for about half of those who have GERD symptoms.<sup>72</sup>

Acid induces dissolution of the calcium in the stomach as a calcium ion (Ca<sup>2+</sup>).<sup>44</sup> If the stomach does not secrete acid, calcium salts may not be effectively dissolved and ionized, and may be poorly absorbed in the proximal small intestines.<sup>44</sup> Complete dissolution of calcium requires an equivalent amount of hydrochloric acid to be secreted into the gastric juice as calcium is ingested.<sup>44</sup>

Acid-inhibitory or antisecretory drugs, decrease acid secretion significantly, and long-term use of these drugs in high doses may raise the risk of calcium malabsorption and traumatic bone fractures slightly, but significantly, as was considered in two recent meta-analysis.<sup>73,74</sup> Other researchers reported that the use of PPIs in high doses for longer than 1 year increase the incidences of hip fractures significantly.<sup>75,76,77,78</sup>

### Antiepileptic Medication

Epilepsy is a neurologic disorder associated with many established comorbidities, one of which is reduced bone health.<sup>79</sup> Antiepileptic drugs were first associated with disorders of bone metabolism in the late 1960s.<sup>43</sup> Long-term antiepileptic drug use is associated with low BMD, fractures, and abnormalities in bone metabolism.<sup>22</sup> The use of antiepileptic drugs can result in hypocalcemia, hypovitaminosis D, and secondary hyperparathyroidism all of which are risk

factors in the development of low BMD which contributes to the development of osteoporosis and increased fracture risks.<sup>22</sup>

Antiepileptic drugs may directly affect the function of bone cells.<sup>43</sup> Impaired absorption leads to hypocalcemia and hypersecretion of parathormone.<sup>43</sup> Carbamazepine, phenytoin, phenobarbital, and primidone increase vitamin D and its active metabolite catabolism by inducing cytochrome P450 enzyme system in the liver.<sup>43</sup> Decreased vitamin D may lead to a decrease in calcium absorption, secondary hyperparathyroidism, and decrease in bone density.<sup>81</sup> Beerhorst et al. suggested that long-term antiepileptic drugs use is associated with high prevalence of osteoporosis and osteopenia.<sup>22</sup>

Coppola et al. confirmed that epilepsy with cerebral palsy and mental retardation may worsen bone health in children and adolescents.<sup>21</sup> The impact of restricted physical activity imposed by seizures and the role of anticonvulsant drugs on bone metabolism are well known.<sup>21</sup> The effects of phenobarbital, phenytoin, carbamazepine, and valproic acid on bone demineralization have been repeatedly reported.<sup>82,83,84,85,86,87</sup>

### Antidepressant Medication

Depression is a major public health problem and a leading cause of disability.<sup>88</sup> Individuals with IDD can have depression and often require medication. Depression itself increases fracture risk, in relation to decreased BMD and an increase in falls.<sup>88</sup> Confounders of depression which could possibly contribute to low BMD and fractures include lifestyle (exercise, smoking, nutrition and vitamin D status), comorbidities (e.g., cardiovascular disease or primary osteoporosis), and concomitant treatments (e.g., sedatives or hypnotics).<sup>88</sup>

According to Rizzoli et al., the use of antidepressant medications that act on the serotonin system has been linked to detrimental impacts on BMD, and to osteoporosis.<sup>88</sup> Serotonin



receptors are found in all major types of bone cell (osteoblasts, osteocytes, and osteoclasts), indicating an important role of the neuroendocrine system in bone formation.<sup>88</sup> A form of medication that treats depression is selective serotonin reuptake inhibitors (SSRIs) or tricyclic agents. Current use of SSRIs and tricyclic agents increased risk as much as twofold compared to nonusers.<sup>88</sup>

Moura et al. examined data from the Canadian Multicentre Osteoporosis Study (CaMos) and found SSRIs and serotonin and noradrenaline reuptake inhibitors (SNRIs) use was associated with increased risk of fragility fracture.<sup>89</sup> The CaMos suggest there is a potential role for the serotonergic system in bone physiology, supporting the hypothesis that SSRIs may have long-term adverse effects on bone health, and therefore increase long-term fracture risk.<sup>89</sup> Functional 5-hydroxytryptamine transports and receptors are present in osteoblast, osteocytes, and osteoclast, and stimulation of these receptors influence bone cell activities.<sup>90,91</sup> Consistent with this, use of SSRIs, but not tricyclic antidepressants, was associated with increased rates of bone loss at the hip site in older women and men.<sup>92,93,94</sup>

### Antipsychotic Medication

Antipsychotics are often prescribed for long-term treatment for individuals with schizophrenia. Recent studies report an obvious link between anti-psychotic medications, hyperprolactinaemia, and osteoporosis.<sup>95,96,97,98, 99, 100, 101.</sup> A recent meta-analysis on decreased BMD in patients with schizophrenia revealed the overall pooled prevalence of osteopenia was 40.0% and osteoporosis was 13.2%.<sup>102</sup> Most antipsychotic medications act as D2 receptor antagonists which bind to the D2 receptors of lactotroph cell in the pituitary and lead to the release of prolactin and subsequent hyperprolactinemia.<sup>103</sup> Prolactin has been observed to

directly decrease osteoblast cell numbers by reduced proliferation, thus providing a “direct effect” mechanism explaining the reduction of BMD.<sup>104</sup>

High prolactin levels are known to induce osteopenia and osteoporosis, and antipsychotic medications induce hyperprolactinemia in over 70% of patients with schizophrenia, depending on the medications used.<sup>99,100</sup> Hyperprolactinemia creates an imbalance between bone reabsorption and bone formation.<sup>108</sup> Al-Omran et al. reported that 80% of the psychiatric patients who had been prescribed anti-psychotic and anti-depressant medications experienced bone loss.<sup>94</sup>

Hyperprolactinaemia is one of the most common adverse events reported in clinical trials and can be found in association with all antipsychotics.<sup>105</sup> The highest rates of hyperprolactinaemia are reported in association with risperidone and amisulpride, often as high as 80-90% of all female subjects and consistently greater than with the typical antipsychotics.<sup>105</sup> Lower rates of hyperprolactinaemia are found with olanzapine, quetiapine and aripiprazole.<sup>105</sup> The medication clozapine rarely induces hyperprolactinaemia.<sup>105</sup>

The consequences of hyperprolactinaemia are often not visibly apparent, and may occur much later after the onset of treatment.<sup>106</sup> Ideally, the prolactin level should be checked initially for baseline levels and then checked 3 months after antipsychotic initiation.<sup>106</sup> The management of hyperprolactinaemia involves careful consideration of risks and benefits, in which the importance of the mental health advantages of the antipsychotic need to be strongly considered before changing medication.<sup>106</sup>

## Nutrition for Good Bone Health: Diet and Supplements

### Diet

Calcium, the major nutrient needed to form new bone cells, is vital for bone health.<sup>3</sup> Bones store more than 99% of calcium in your body.<sup>3</sup> Calcium stored in the bone is continuously exchanged with calcium circulating in the bloodstream.<sup>15</sup> When calcium intake is sufficient, levels within the bone remain stable.<sup>15</sup> However, when calcium intake is insufficient, the body maintains the serum calcium level at the expense of the bones.<sup>15</sup>

When the diet is low in calcium, especially in the elderly, a negative calcium balance can occur.<sup>39</sup> Negative calcium balance stimulates the secretion of parathyroid hormone (PTH) and induces age-associated secondary hyperparathyroidism, which enhances bone turnover and accelerated bone loss.<sup>107</sup>

The NOF suggests getting daily recommended calcium from food first and supplement only as needed to make up for any shortfall.<sup>28</sup> The recommended daily calcium intake is 1,000 mg for 19-30 year olds; 1,000 mg for 31-50 years olds; 1,200 mg for women 51 and older; 1,000 mg for men 70 and younger, and 1,200 mg for men age 71 and older.<sup>28,29,30,31,32,33,34,35,36,37</sup> Table 2 provides a guide to the recommended dietary intake and upper intake level of calcium.<sup>33</sup>

**Table 2.** Recommended Dietary Allowances (RDAs) for Calcium.<sup>33</sup>

Age	Male	Female	Pregnant	Lactating
0 – 6 months*	200 mg	200 mg		
7 – 12 months*	260 mg	260 mg		
1 – 3 years	700 mg	700 mg		
4 – 8 years	1,000 mg	1,000 mg		
9 – 13 years	1,300 mg	1,300 mg		
14 – 18 years	1,300 mg	1,300 mg	1,300 mg	1,300 mg
19 – 50 years	1,000 mg	1,000 mg	1,000 mg	1,000 mg
51 – 70 years	1,000 mg	1,200 mg		
71+ years	1,200 mg	1,200 mg		
* Adequate Intake (AI)				
<i>Source:</i> Adapted from Calcium-Health Professionals Fact Sheet				

Groups at risk of calcium inadequacy in the diet include women who are postmenopausal or amenorrheic, women with the female athlete triad (FAT) condition, individuals with lactose intolerance or cow’s milk allergy, and vegetarians.<sup>39,109,110,111</sup>

Food sources rich in calcium include sardines, cheddar cheese, milk, yogurt, and fortified foods such as oatmeal and orange juice.<sup>33</sup> Calcium rich vegetables include collard greens, broccoli, turnip greens, kale, and cooked soybeans.<sup>112</sup> Table 3 details selected food sources of calcium.<sup>33</sup> Typically, a daily consumption of three calcium rich dairy foods such as milk, yogurt and cheese, in addition to fortified foods, and other food sources such as fruit and vegetables,

should allow an individual to meet their daily calcium needs. Individuals with lactose intolerance can consume calcium and vitamin D rich foods such as fortified soy or almond milk.<sup>108,112</sup>

**Table 3.** Selected Food Sources of Calcium<sup>33</sup>

Food	Milligram (mg) per Serving	Percent Daily Value (%DV)
Yogurt, plain, low fat, 8 ounces	415	42
Mozzarella, part skim, 1.5 ounces	333	33
Sardines, canned in oil, with bones, 3 ounces	325	33
Yogurt, fruit, low fat, 8 ounces	313-384	31-38
Cheddar Cheese, 1.5 ounces	307	31
Milk, nonfat, 8 ounces	299	30
Soy milk, calcium-fortified, 8 ounces	299	30
Milk, reduced-fat (2% milk fat), 8 ounces	293	29
Milk, buttermilk, low fat, 8 ounces	284	28
Milk, whole (3.25% milk fat), 8 ounces	276	28
Orange juice, calcium-fortified, 6 ounces	261	26
Tofu, firm, made with calcium sulfate, ½ cup	253	25
Salmon, pink, canned, solids with bone, 3 ounces	181	18
Cottage cheese, 1% milk fat, 1 cup	138	14
Tofu, soft, made with calcium sulfate, ½ cup	138	14
Ready-to-eat cereal, calcium-fortified, 1 cup	100-1,000	10-100
Frozen yogurt, vanilla, soft serve, ½ cup	103	10
Turnip greens, fresh, boiled, ½ cup	99	10
Kale, fresh, cooked, 1 cup	94	9
Ice cream, vanilla, ½ cup	84	8

Source: Adapted from Calcium-Health Professionals Fact Sheet

Beans contain calcium, magnesium, fiber and other nutrients, but they are also high in substances called phytates, which interfere with the body's ability to absorb the calcium.<sup>112,113</sup>

Phytates can be reduced by soaking beans in water several hours before cooking them in fresh water.<sup>112,113</sup>

Consumption of foods that contain a high amount of sodium can result in the body losing calcium and lead to bone loss via increased urinary calcium excretion and lead to bone loss.<sup>112,114,115</sup> It is recommended to limit foods including processed foods and luncheon meats,

which are high in sodium (20% or more of the daily value for sodium) to minimize urinary calcium excretion.

The presence of oxalates or oxalic acid in a food can result in the body not absorbing calcium from that food.<sup>112</sup> Foods that contain a high level of oxalates include spinach, rhubarb, beet greens and certain beans and should not be considered a good source of calcium.<sup>112</sup> Kale, a low oxalate food, exhibits excellent absorbability for its calcium.<sup>116</sup> Heaney and Weaver found that when a calcium rich food such as milk was consumed together with a high oxalate food such as spinach, there was no interference of oxalate in milk calcium absorption.<sup>117</sup>

One hundred percent wheat bran which contains phytates is the only food that appears to reduce the absorption of calcium in other foods when eaten at the same time.<sup>112</sup> Wheat bran in other foods like breads is much less concentrated and not likely to have a noticeable impact on calcium absorption.<sup>112</sup> The NOF recommends taking calcium supplements, two or more hours before or after eating 100% wheat bran.<sup>112</sup> Pronsky, Elbe, and Ayoob recommended that calcium carbonate supplement be taken separately from large amounts of high fiber, high oxalate, or high phytate foods.<sup>118</sup>

Fluids such as alcohol, coffee, tea, and soft drinks which contain caffeine, consumed in excess can lead to bone loss.<sup>112</sup> Alcohol can affect calcium status by reducing its absorption and by inhibiting enzymes in the liver that help convert vitamin D to its active form.<sup>119,120</sup> The stimulant caffeine in coffee and tea can modestly increase calcium excretion and reduce absorption.<sup>121</sup> Soft drinks containing caffeine should be consumed in moderation.<sup>112</sup>

## Calcium Carbonate

The need for calcium supplementation depends on the adequacy of dietary calcium intake and the balance between the potential benefits and harms of supplementation.<sup>36</sup> Determination of the dose of calcium required to meet daily requirements is based on the amount of elemental calcium.<sup>36</sup> Calcium carbonate is a good choice of calcium supplement because it provides a relative high elemental calcium content of 40%, and is inexpensive as well as widely available.<sup>36</sup> The disadvantage of calcium carbonate is that it is more likely to cause constipation and bloating and should be taken with meals, since gastric acidity is required for sufficient absorption.<sup>36, 122</sup>

Calcium is ingested in the form of salts and/or combined with other dietary constituents as calcium ion ( $\text{Ca}^{2+}$ ) complexes.<sup>35</sup> Ninety percent of calcium is primarily absorbed in the small intestines.<sup>35</sup> The capacity of the small intestine to absorb calcium salts depends not only on the amount of calcium ingested but also on the solubility and ionization of the salts, both which are pH dependent.<sup>35</sup> Most calcium salts or compounds need hydrochloric acid for conversion into soluble  $\text{Ca}^{2+}$ .<sup>123</sup> Calcium carbonate is relatively insoluble at high pH and needs gastric acid to be absorbed.<sup>124</sup>

Medications for GERD such as proton pump inhibitors reduce gastric secretions.<sup>35</sup> The medication omeprazole has been shown to significantly reduced absorption of calcium carbonate administered during fasting in postmenopausal women aged 65-89 years, which may help to explain the association described between the use of proton pump inhibitors and osteoporotic fractures.<sup>125,126,127</sup>

Calcium carbonate appears to be a good choice as a calcium supplement for individuals who do not have a hydrochloric stomach. Calcium carbonate should be taken with meals for increased absorption and ensure adequate fluid intake/hydration.<sup>118</sup>

## Calcium Citrate

Like calcium carbonate, calcium citrate is relatively inexpensive and widely available. Calcium citrate may be used with agents for long-term gastric acid suppression.<sup>35</sup> Taking calcium citrate between meals reduces the adverse effects of competition between its own absorption and that of other nutrients, minimizes the risk of renal calculus formation, and prevents abdominal distension and flatulence development from the formation of carbon dioxide.<sup>35</sup> Calcium citrate is also useful for people with achlorhydria, inflammatory bowel disease, or absorption disorders.<sup>128</sup>

Disadvantages of calcium citrate are the supplement provides less elemental calcium for absorption and if required in doses greater than 500 mg of elemental calcium, the doses need to be divided throughout the day to improve absorption and minimize gastrointestinal side effect.<sup>36</sup> Absorption of calcium is highest in doses  $\leq 500$  mg.<sup>128</sup> Overall, calcium citrate appears a good choice for those individuals who take medication that suppresses gastric acid.

## Vitamin D

Adequate daily calcium and vitamin D is a safe and inexpensive way to help reduce fracture risk.<sup>30</sup> Controlled clinical trials have demonstrated that the combination of supplemental calcium and vitamin D can reduce the risk of fracture.<sup>129</sup> Weaver et al. conducted a meta-analysis and reported that calcium plus vitamin D supplementation produced a 15% reduced risk of total fractures and a 30% reduced risk of hip fractures.<sup>38</sup>

Vitamin D is a fat-soluble vitamin technically encompassing two molecules- ergocalciferol and cholecalciferol.<sup>15</sup> Vitamin D facilitates calcium absorption and plays an integral part in building and maintaining healthy bone.<sup>15</sup> Vitamin D promotes calcium absorption



in the gut and helps to maintain adequate serum calcium concentrations to enable normal mineralization of the bone.<sup>38</sup> Vitamin D is needed for bone growth and bone remodeling by osteoblasts and osteoclasts.<sup>38</sup>

Vitamin D can be supplied three ways; through the sun, the diet, and supplements.<sup>128,129,130, 131, 132</sup> The skin can make vitamin D from the sun, but too much sun can be harmful.<sup>112</sup> Small amounts of vitamin D can be obtained from foods such as fortified milk, liver and fatty fish (e.g., wild mackerel, salmon, sardines and tuna).<sup>112</sup> Many people require a vitamin D supplement to ensure the intake of the recommended amount since very few foods naturally contain vitamin D.

According to the NOF, adults under 50 years of age need a total of 400-800 international units (IUs) of vitamin D every day; and adults age 50 or older need a total of 800-1,000 IUs of vitamin D every day.<sup>112</sup> Adults who are vitamin D deficient may be treated with 50,000 IU of ergocalciferol or cholecalciferol once a week or the equivalent daily dose of 7,000 IU for 8-12 weeks to achieve a 25-(OH)D blood level of approximately 30 ng/ml.<sup>30</sup>

People at high risk for vitamin D deficiency include individuals with malabsorption and other intestinal diseases (e.g., inflammatory bowel disease, gastric bypass surgery), chronic renal insufficiency, and those who are critically ill.<sup>30</sup> Other risk factors for vitamin D deficiency include the use of anti-seizure medication, limited sun exposure, very dark skin, and obesity.<sup>30</sup> There is a high prevalence of vitamin D deficiency in patients with osteoporosis, especially those with hip fractures, even in patients taking osteoporosis medications.<sup>131,132</sup>

The purpose of this research is to examine the results of bone density studies in comparison with the intake of either calcium carbonate or calcium citrate in combination with others factors that can affect BMD such as age, sex, weight bearing status, vitamin D levels and

use of proton pump inhibitors, antiepileptic, antipsychotic or antidepressant medication. Any improvement observed with one particular calcium supplement will be beneficial for the recommendation of the most effective calcium supplement that may improve bone health in persons with IDD.

## CHAPTER 3

### METHODS

#### Study Design and Data Collection

Data was collected from two sources. One was a retrospective medical chart review of 98 residents at the middle Tennessee and east Tennessee group homes for adults with intellectual and developmental disabilities (IDD). The group homes in west Tennessee were not included in this research. The second source of data was an online survey distributed to 10 primary care providers (PCPs) of residents at the middle Tennessee and east Tennessee group homes for adults with IDD adults through the State of Tennessee. (Appendix A)

#### Study Population

A retrospective medical chart review was conducted on every resident in the IDD group homes in middle Tennessee and east Tennessee. Data collection took approximately two days at the east Tennessee homes and one day at the middle Tennessee homes.

An internet-based survey was emailed to PCPs who provide medical services to residents in the IDD group homes in middle Tennessee and east Tennessee. Subject participation was voluntary. The number of PCPs providing services is very small, only 10 providers.

#### Inclusion Criteria

Retrospective medical chart review subjects were males and females age 18 and older with intellectual and developmental disabilities who live in group homes in middle Tennessee and east Tennessee.

The internet-based survey was emailed to all PCPs who provide medical services to residents that live in group homes in middle Tennessee and east Tennessee.

### Research Questions

The following questions guided this study:

RQ1: Do primary care providers (PCP) for individuals with IDD prefer a specific calcium supplement for maintaining or improving bone health?

RQ2: Does the type of calcium supplement (either calcium carbonate or calcium citrate) make a difference in bone mineral density (BMD) results?

RQ3: What effects do control variables (age, sex, diet, vitamin D level, weight bearing status, medications which includes proton pump inhibitors, antiepileptics, neuroleptics or antidepressants) have regarding BMD results?

### Institutional Review Board Approval

Approval for this study was obtained from the ETSU Office for the Protection of Human Research Subjects IRB.

### Variable Selection

Subject variables of the retrospective medical chart review included age, sex, osteopenia/osteoporosis diagnosis, calcium citrate prescription, calcium carbonate prescription, 1200 milligrams of calcium provided via diet, vitamin D prescription, weight bearing status, GERD medications, and other medications (Proton Pump Inhibitors, Histamine H2 Receptor Antagonist, Antiepileptic, Neuroleptics, and Selective Serotonin Reuptake Inhibitor (SSRIs)).

The PCP survey included demographics, treatment practices for osteoporosis or osteopenia, and recommendations of dietary calcium and calcium supplementation by PCPs of individuals with IDD.

### Data Analysis

Data analysis was conducted using the IBM Statistical Package for Social Sciences (SPSS), Version 23 software. Statistical tests conducted included frequencies, Pearson correlation coefficient, and independent samples t-tests. A confidence level of 95% (alpha value of  $\leq 0.05$ ) was used for all statistical tests.

## CHAPTER 4

### RESULTS AND DISCUSSION

#### Research Subject Demographics

Of the 98 research subjects included in the retrospective chart review, 55 (56.1%) were male, and 43 (43.9%) were female. Sixty-two (63.3%) reside in east Tennessee, and 36 (36.7%) reside in middle Tennessee. Three (2%) subjects were in the 20-29 age range, five (5.1%) were in the 30-39 age range, 13 (13.2%) were in the 40-49 age range, 33 (33.6%) were in the 50-59 age range, 31 (31.6%) were in the 60-69 age range, and 13 (13.2%) were in the 70 years or above range. Demographics for all participants are reported in Table 4.

**Table 4.** Demographics of Participants (n=98)

Variable		Number (n)	Percentage (%)
Gender	Male	55	56.1
	Female	43	43.9
Location	East Tennessee	62	63.3
	Middle Tennessee	36	36.7
Age	20-29 years old	3	3.0
	30-39 years old	5	5.0
	40-49 years old	13	13.1
	50-59 years old	33	33.7
	60-69 years old	31	31.6
	70 or older	13	13.1

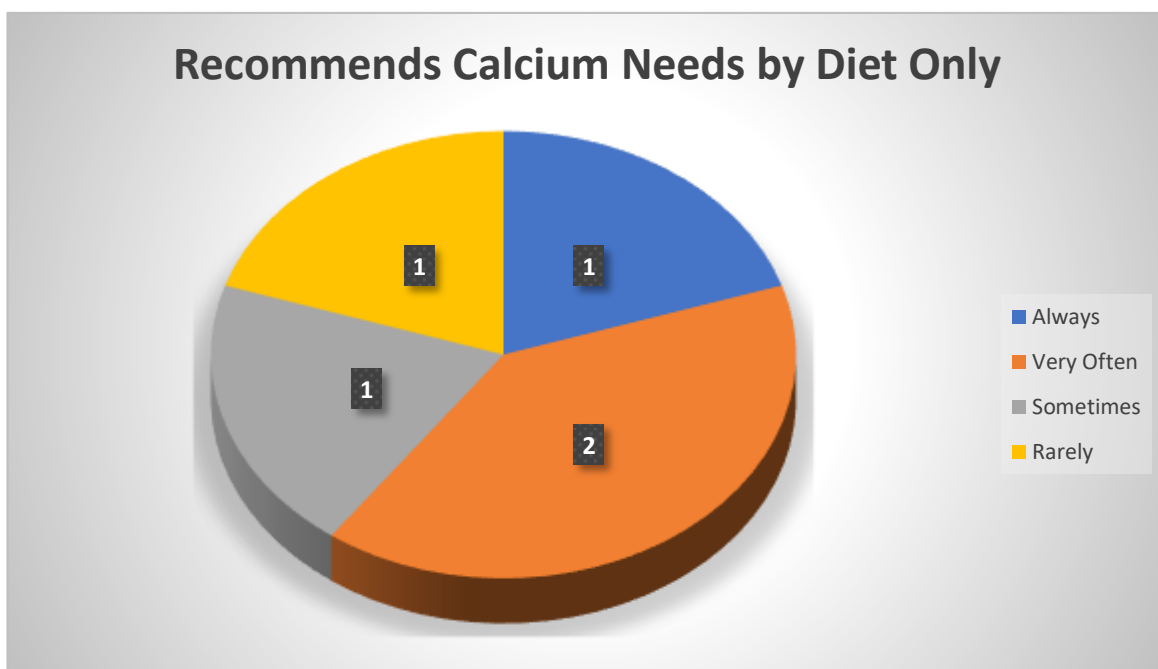
#### Primary Care Provider Demographics

The PCP survey was sent to the ten PCPs who provide medical services to patients with in the east and middle Tennessee group homes, five of whom returned the survey. Of the

respondents, 40% (n=2) were male and 60% (n=3) were female. One (20%) was in the 31-39 age range, three (60%) were in the 40-49 age range, and one (20%) was in the 50-59 age range. Two respondents were medical doctors, two (40%) were family nurse practitioners, and one (20%) was a D.O. (Doctor of Osteopathic Medicine).

### Primary Care Provider Survey Data

In response to the survey question “Do you treat patients with osteoporosis?” one reported always, three reported very often, and one reported sometimes. In response to the survey question “Do you recommend meeting calcium needs by diet only, if possible?” one reported always, one reported very often recommended, one reported sometimes recommended, and two reported rarely (Figure 1).



**Figure 1.** PCP Survey: Recommends Calcium Needs by Diet Only

In response to the survey question “If calcium cannot be met by diet, do you recommend calcium supplementation?” three reported very often, one reported sometimes, and one reported

rarely recommending a calcium supplement. In response to the survey question “When recommending calcium supplementation for your patients, do you take into consideration the use of medication for gastroesophageal reflux disease (GERD)?” one (20%) reported always considering if the patient took medication for GERD, two (40%) reported very often considering, and two (40%) reported sometimes considering use of GERD medication. When asked if they provide advice or information on food/medication interactions and calcium supplementation, one (20%) answered always, three (60%) reported very often providing advice or information on calcium-rich foods and one (20%) reported sometimes providing advice or information on calcium-rich foods.

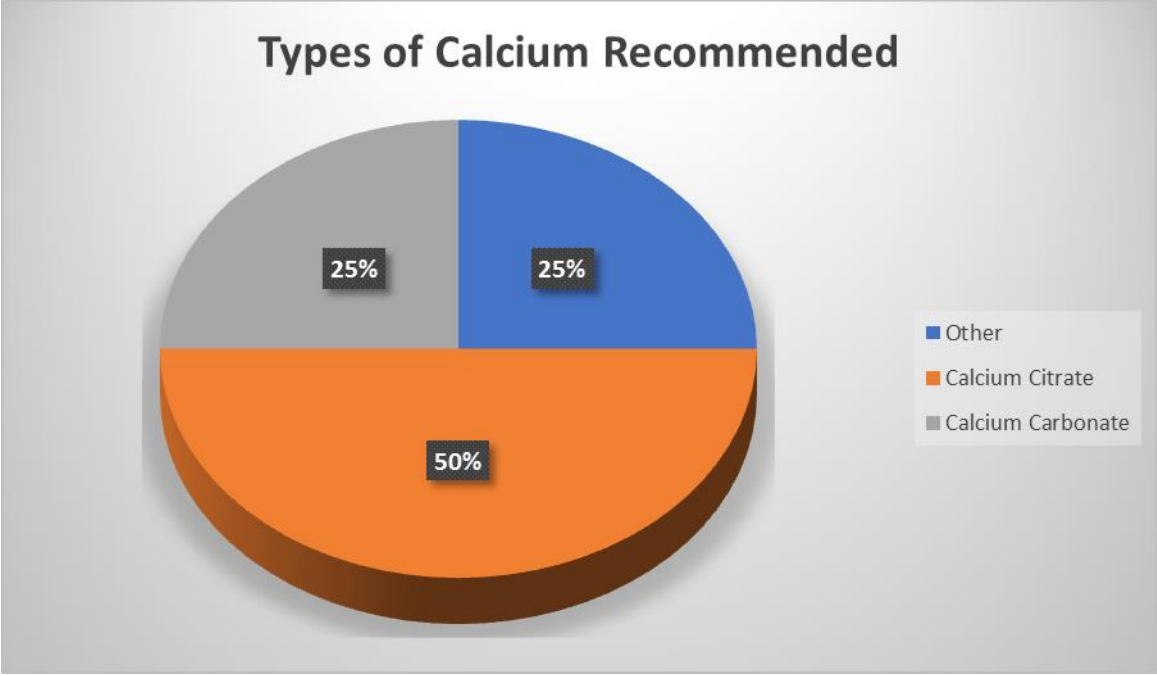
### Research Questions

#### Research Question 1

- 1) Do PCPs for individuals with IDD prefer a specific calcium supplement for maintaining or improving bone health?

Question 10 of the survey addressed this research question. Only four PCPs responded to the question with two (50%) recommending calcium citrate, one (25%) recommending calcium carbonate, and one (25%) recommending another form of calcium supplement (Figure 2).





**Figure 2.** Type of Calcium Supplement Recommended

The data suggests that calcium citrate is the preferred form of calcium supplementation. However, due to the small number of PCP survey respondents, generalizations cannot be made. I am interested in the type of calcium supplementation that is prescribed by PCPs in the individual with IDD since these individuals have many factors that could negatively affect how calcium is absorbed. Medications used to treat GERD decrease stomach acid which could hinder absorption of calcium in a carbonate form. Certain medications that are typically prescribed for seizures, depression and/or anxiety/psychosis have the potential for decreasing bone density, thus it is important to ensure increased intake of calcium and vitamin D through diet and if supplementation is needed.

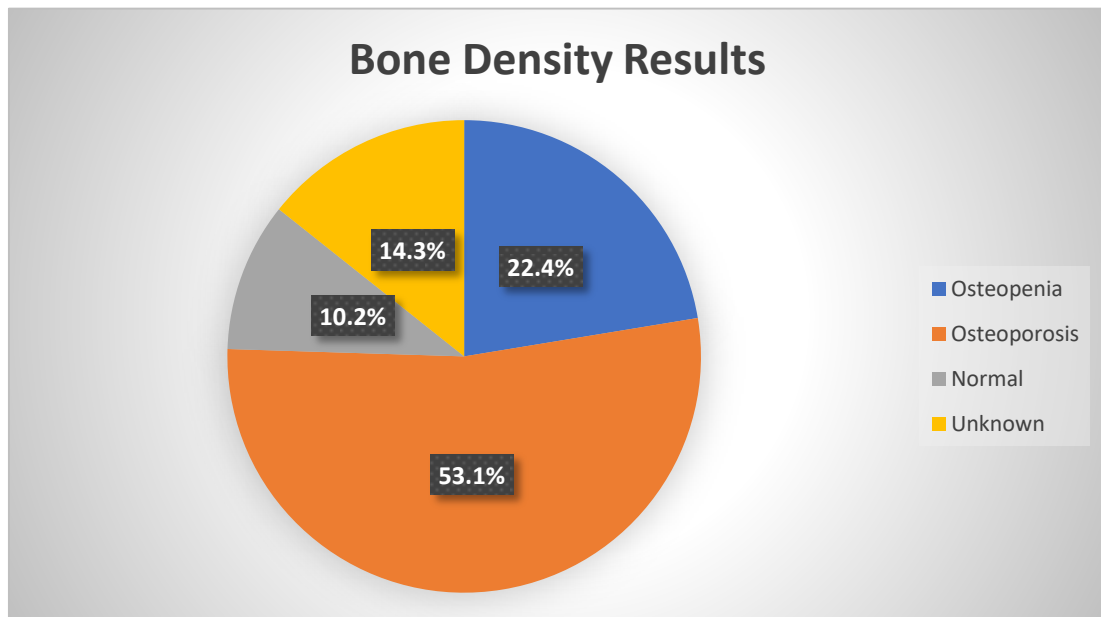
In response to the survey question “Are you familiar with calcium recommendations by the National Osteoporosis Foundation?” three (60%) reported being familiar with the Foundations’ recommendations and two (40%) were not familiar. In response to the survey question “Do you

recommend or refer your patients to a Registered Dietitian for nutrition advice?” three PCPs (60%) refer their patients to a Registered Dietitian and two do not (40%).

Research Question 2.

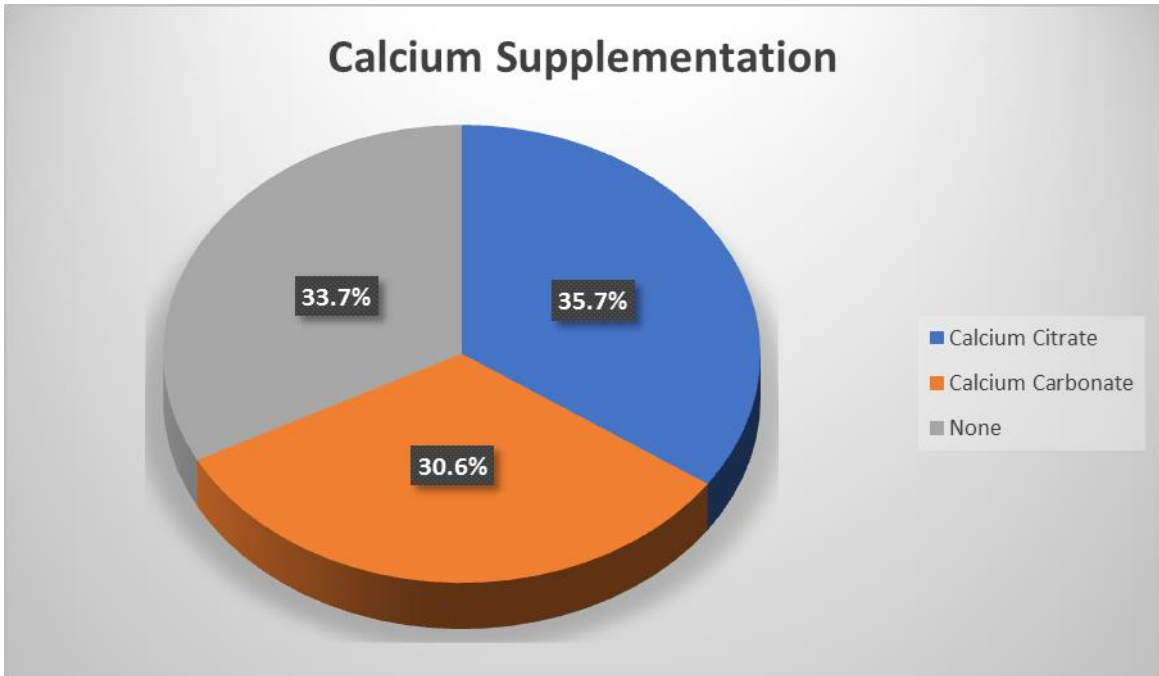
2) Does the type of calcium supplement (either calcium carbonate or calcium citrate) make a difference in bone mineral density (BMD) results?

The bone density results of subjects were: 22 (22.4%) had osteopenia, 52 (53.1%) had osteoporosis, 10 (10.2%) had normal bone density and 14 (14.3%) had unknown bone density results (Figure 3).

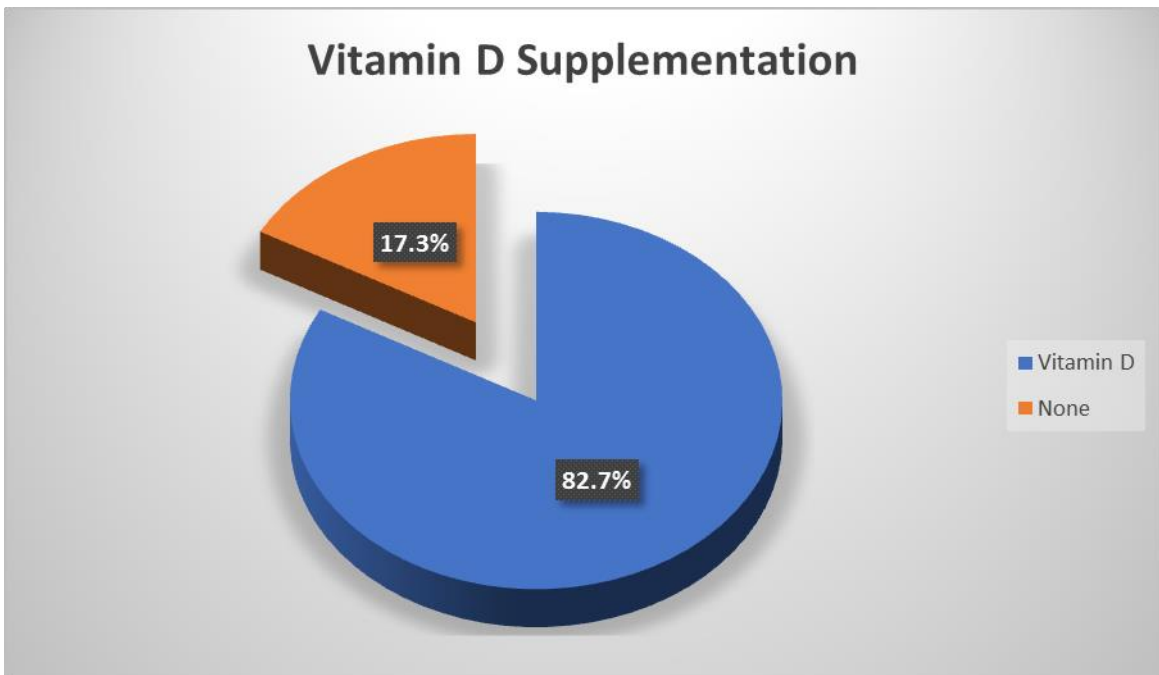


**Figure 3:** Bone Density Results

Thirty-five subjects (35.7%) took calcium citrate dietary supplement, 30 (30.6%) took calcium carbonate dietary supplement, and 33 (33.7%) did not take any type of dietary calcium supplement (Figure 4). Vitamin D dietary supplement was ordered for 81 (82.7%) of the subjects. Seventeen (17.3%) subjects did not take a vitamin D dietary supplement (Figure 5).



**Figure 4.** Calcium Supplementation.



**Figure 5.** Vitamin D Supplementation

Of the 98 subjects in the chart review, 35 (35.7%) were prescribed calcium citrate, 30 (30.6%) were prescribed calcium carbonate, and 33 (33.6%) were not prescribed a calcium supplement (Table 5). A Pearson correlation was conducted between calcium supplements and bone density results,  $r(96) = 0.37$ ,  $p = .000$ , and results indicated no relationship.

**Table 5.** Types of Calcium Supplement Prescribed

Calcium Type	Number (n)	Percentage (%)
Calcium Citrate	35	35.7
Calcium Carbonate	30	30.6
No Calcium Supplements	33	33.6

Independent samples t-test of calcium supplement type and bone density results indicate no significant difference noted ( $p=0.09$ ). Therefore, the type of calcium supplement prescribed had no significant influence on bone mineral density results for patients with IDD (Table 6).

**Table 6.** Independent Samples T-Test: Type of Calcium Supplement and BMD Results

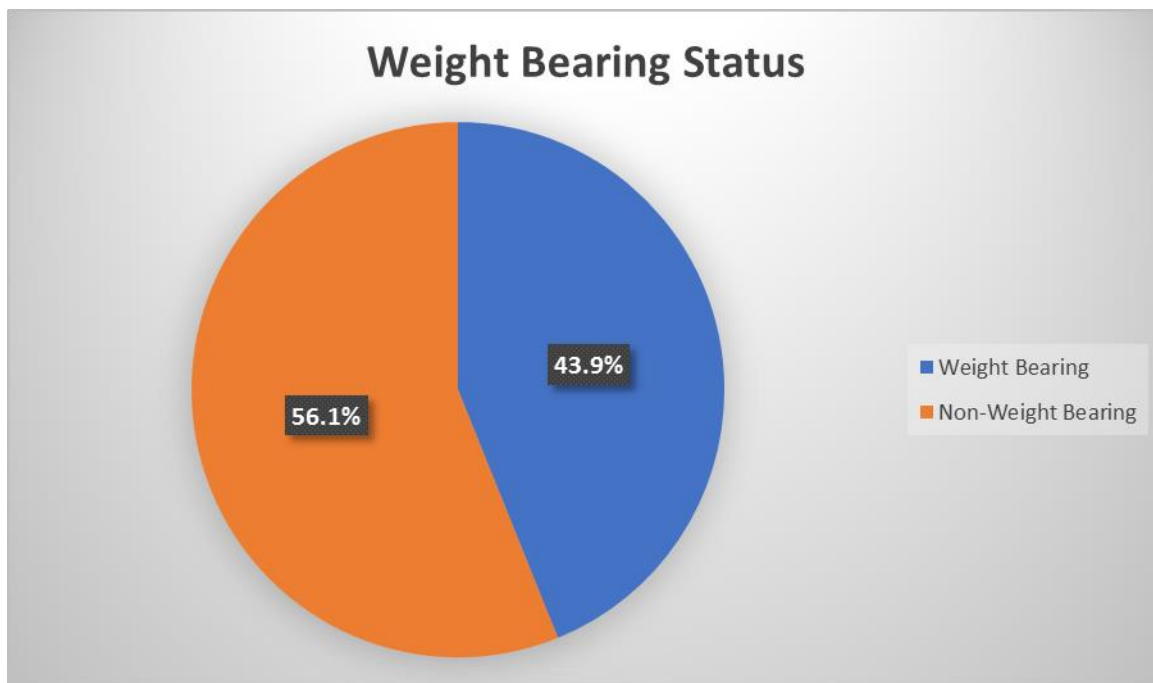
	Calcium	Frequency	Mean $\pm$ SD	Independent Samples T-Test P values <sup>a</sup>
Osteoporosis or Osteopenia Diagnosis	Calcium Citrate	35	1.80 $\pm$ .68	0.09
	Calcium Carbonate	30	2.07 $\pm$ .58	
<sup>a</sup> Significant at $p < 0.05$				

### Research Question 3

3)What effects do control variables (age, sex, diet, vitamin D level, weight bearing status, and medications which includes proton pump inhibitors, antiepileptics, neuroleptics or antidepressants) have regarding BMD results?

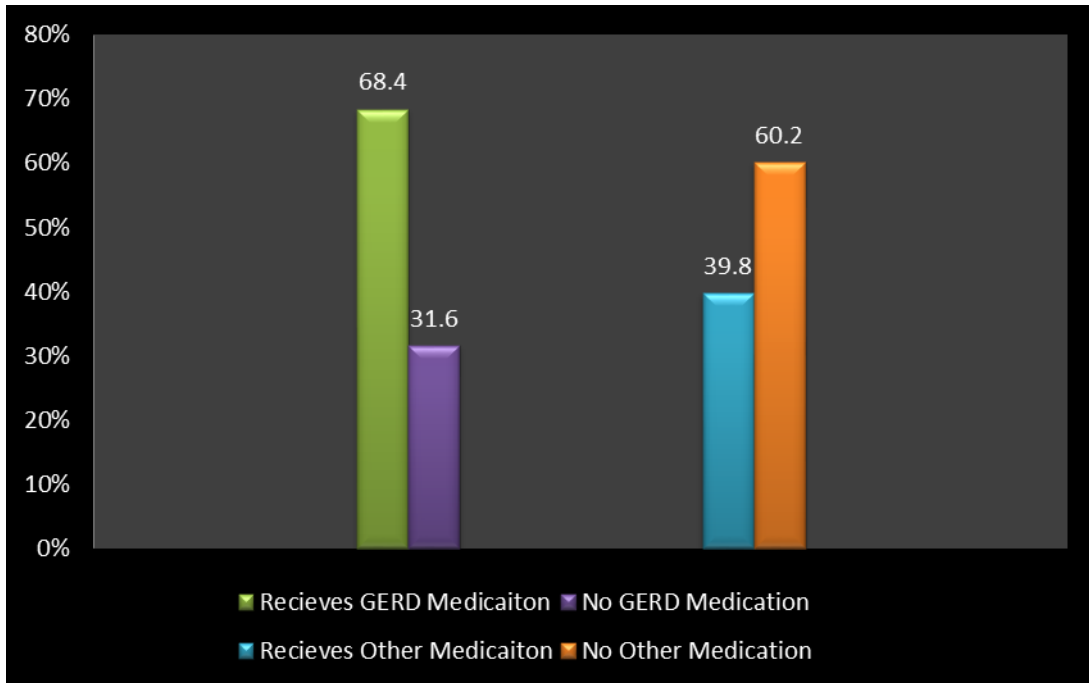
In regards to weight bearing status of subjects, 43 (43.9%) were weight bearing and 55 (56.1%) were non-weight bearing. For the purposes of the research study, those individuals placed in the weight-bearing category could carry 100% of their body weight while ambulating.

Individuals placed in the non-weight bearing category used a wheelchair for mobility and at best could only stand pivot, step 1-2 feet, and/or have alternate positioning that promotes weight bearing such as quadruped on forearms or a stander (Figure 6).



**Figure 6.** Weight Bearing Status

GERD medication was ordered for 67 (68.4%) subjects, while 31 (31.6%) did not have a GERD medication ordered. Other medications, specifically proton pump inhibitors, histamine H<sup>2</sup> receptor antagonist, antiepileptic, neuroleptics, and selective serotonin reuptake inhibitors (SSRIs) were ordered for 39 (39.8%) subjects; 59 (60.2%) did not take any of these medications. See Figure 7 data for GERD medications and other medications data.



**Figure 7.** GERD Medication and Other Medications

Pearson correlation coefficients were computed among variables including calcium supplement type, gender, dietary calcium, vitamin D levels, weight bearing status, GERD medication prescription, and other medication prescriptions. A *p* value of less than .05 was required for significance. Results show that two out of the seven correlations were statistically significant, though not strong. There was a correlation between calcium supplement type and vitamin D,  $r(96) = 0.21$ ,  $p = 0.042$ , and between calcium supplement type and gender,  $r(96) = 0.25$ ,  $p = 0.013$ . The correlations of calcium supplement type with the other variables tended to be lower and not significant.

After conducting an independent samples t-test, there was no significance between calcium supplementation in relation to gender or vitamin D levels of individuals with IDD (Table 7). However, it is of modest benefit to include vitamin D with calcium supplementation to enhance calcium absorption as supported in the literature.<sup>38,132</sup>

**Table 7.** Independent Samples T-Test: Type of Calcium Supplement and Gender

	Calcium	Frequency (n)	Mean $\pm$ SD	Independent Samples T-Test P values <sup>a</sup>
Gender	Calcium Citrate	35	1.52 $\pm$ .51	0.940
	Calcium Carbonate	30	1.53 $\pm$ .51	
Adequate Vitamin D	Calcium Citrate	35	1.14 $\pm$ .36	0.132
	Calcium Carbonate	30	1.03 $\pm$ .18	

\*Significant at  $\alpha \leq .05$

## CHAPTER 5

### CONCLUSION

For the individual with IDD there are many health problems that can develop in their lifetime. Osteoporosis and osteopenia are health problems often seen in the population with IDD. The individual with IDD can often be vulnerable to loss of bone mass by one or more variables that can lead to fractures, loss of mobility, and possibly a decrease in quality of life. Ensuring adequate calcium and vitamin D intake through the diet is one way to help slow or prevent the rate of bone loss. Calcium supplementation is required if the diet is lacking sufficient calcium and can be recommended in a variety of forms. The absorption of calcium supplementation has the potential to be hindered by a variety of factors from acid environment of the stomach to foods and medications consumed.

I investigated the preferred type of calcium supplementation recommended by primary care providers (PCPs) of individuals with IDD using an online survey tool. Due to the small sample of PCPs who completed the survey, the preferred type of calcium supplementation could not be determined. However, the literature recommends calcium citrate supplement to enhance calcium absorption.<sup>125,128</sup>

I obtained information about subjects' residential location, age, sex, bone density status, type of calcium supplement, diet, vitamin D, ambulatory status and consumption of GERD or other medications using a retrospective data collection form. I found no relationship between the type of calcium supplementation, regardless if it was calcium citrate or calcium carbonate, and bone density results of the subjects. Thus concluding that either supplement could be taken to maintain bone density.



After conducting a retrospective review of the charts of the subjects with IDD, there was no correlation between control variables and the type of calcium supplementation in the IDD population. However, including vitamin D with calcium supplement did suggest a modest benefit. There is no research regarding the best type of calcium supplementation to be used in the population with IDD.

### Limitations

One major limitation of this study was that there were only 10 PCPs in the population and only 5 of those responded to the survey. Therefore, the results are not generalizable. A larger PCP sample may help to overcome this limitation.

Additionally, data obtained from research did not include if the subjects started taking calcium supplementation before or after bone density diagnosis which could have impacted statistical results.

### Future Research

Based on my findings, I would suggest the following areas for further investigation: 1) the benefit of providing calcium through diet only compared to supplementation; 2) rates and initial diagnosis of osteopenia or osteoporosis in individuals with IDD; and 3) if early intervention of providing adequate calcium and vitamin D improves BMD results. There is very little research on the subject of preferred calcium supplementation in the individuals with IDD and basically no research regarding diet supplementation and bone mineral density result in the individual with IDD. Research in this area is needed and could potentially impact the quality of life in individuals with IDD.

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## APPENDIX

### 14 Question Anonymous Online Survey

Dear Participant:

My name is Rhonda McNabb, and I am a graduate student at East Tennessee State University. I am working on a Master of Sciences in Clinical Nutrition. In order to finish my studies, I need to complete a research project. The name of my research study is Factors impacting bone mineral density (BMD) results of individuals with intellectual and developmental disabilities (IDD). The purpose of this study is to explore the impact on BMD based on consumption of either calcium carbonate or calcium citrate in the individual with IDD, as well as explore primary care providers' choice of calcium supplementation. I would like to give a brief online survey to primary care providers using Qualtrics. It should only take about 5 minutes to finish. You will be asked questions about your practice of recommending calcium supplementation. Since this study deals with calcium supplementation recommendations, the risks are minor. Because we are only surveying a small number of providers and the survey includes demographic questions, it is possible that your survey answers could identify you. You will not be identified in any presentations or publications relating to this research because our data will be aggregated data only and no specific names of facilities or locations will be used. There are no direct benefits by participating in this survey.

Your confidentiality will be protected as best we can. Since we are using technology no guarantees can be made about the interception of data sent over the Internet by any third parties, just like with emails. We will make every effort to make sure that your name is not linked with your answers. Qualtrics has security features that will be used: SSL encryption software will be used. Although your rights and privacy will be protected, the East Tennessee State University (ETSU) Institutional Review Board (IRB) and people working on this research (Dr. Michelle Lee, Clinical Nutrition Graduate Coordinator) can view the study records.

Taking part in this study is voluntary. You may decide not to take part in this study. You can quit at any time. You may skip any questions you do not want to answer or you can exit the online survey form if you want to stop completely. If you quit or decide not to take part, the benefits or treatment that you would otherwise get will not be changed.

If you have any research-related questions or problems, you may contact me, Rhonda McNabb, at [mcnabbrm1@mail.etsu.edu](mailto:mcnabbrm1@mail.etsu.edu), or my research advisor, Dr. Michelle Lee, at [leeml2@etsu.edu](mailto:leeml2@etsu.edu) or 423-439-7524. Also, you may call the chairperson of the IRB at ETSU at (423) 439-6054 if you have questions about your rights as a research subject. If you have any questions or concerns about the research and want to talk to someone who is not with the research team or if you cannot reach the research team, you may call an IRB Coordinator at 423/439-6055 or 423/439-6002.

Sincerely,

Rhonda McNabb, RD, LDN

## PCP Questionnaire

1. What is your gender?
  - Male
  - Female
  
2. What is your professional title?
  - Medical Doctor
  - Physician Assistant
  - Family Nurse Practitioner
  - Other: \_\_\_\_\_
  
3. What is your age?
  - 20-29 years old
  - 30-39 years old
  - 40-49 years old
  - 50-59 years old
  - 60 years plus
  
4. How long have you been practicing in medicine?
  - <5 years
  - 6-10 years
  - 11-15 years
  - 16-20 years
  - 21-25 years
  - >25 years
  
5. Do you provide health services for individuals with intellectual and developmental disabilities?
  - Yes
  - No
  
6. Do you treat patients with osteoporosis?
  - Always
  - Very Often
  - Sometimes
  - Rarely
  - Never
  
7. Are you familiar with calcium recommendations by the National Osteoporosis Foundation?
  - Yes
  - No

8. Do you recommend meeting calcium needs by diet only, if possible?
- Always
  - Very Often
  - Sometimes
  - Rarely
  - Never
9. Do you recommend calcium supplementation if calcium needs cannot be met by diet?
- Always
  - Very Often
  - Sometimes
  - Rarely
  - Never
10. Which calcium supplement do you typically recommend?
- Calcium citrate
  - Calcium carbonate
  - Other: \_\_\_\_\_
11. When recommending calcium supplementation for your patients, do you take in consideration the use of medication for esophageal reflux disease (GERD)?
- Always
  - Very Often
  - Sometimes
  - Rarely
  - Never
12. Do you provide advice/information on food/medication interactions for calcium supplementation?
- Always
  - Very Often
  - Sometimes
  - Rarely
  - Never
13. Do you provide advice/information on calcium-rich foods?
- Always
  - Very Often
  - Sometimes
  - Rarely
  - Never

14. Do you recommend or refer your patients to a Dietitian for nutrition advice?

- Always
- Very Often
- Sometimes
- Rarely
- Never



