AN ABSTRACT OF THE THESIS OF

Carrie M. Gramer for the degree of Master of Science in Exercise and Sport Science presented November 20, 2003.
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This study was designed to investigate the relationship between retinol intake, bone mineral density, and falls in 101 elderly women aged 72 to 90 years (78.6 yrs. $\pm$ 4.3 yrs.). Bone mineral density (BMD) (g/cm^2) of the left hip, anterior-posterior lumbar spine (L3), and lateral spine (L3) was measured using dual-energy x-ray absorptiometry. Dietary intake and physical activity were assessed by validated questionnaires (the 100-item Block Food Frequency Questionnaire and the Physical Activity Scale for the Elderly, respectively). Isometric hip abduction strength of the right and left legs was assessed using a hand-held dynamometer. Fall surveillance was collected using a "postcard" system at three-month intervals over a two-year period. Multiple regression analyses were used to show the predictability of retinol, vitamin D, calcium, years past menopause, years on hormone replacement therapy, and physical activity on BMD variables. Together, these variables explained 14% of the variance in total hip BMD at follow-up (R^2= 0.14, SEE= 0.12, p= 0.020),

26% of the variance in the anterior-posterior spine BMD at follow-up BMD (R^2= 0.26, SEE= 0.17, p= 0.051), and 33% of the variance in lateral spine BMD at follow-up (R^2= 0.33, SEE= 0.10, p= 0.009). Two-year changes in hip BMD were poorly predicted using the model with only 5% of total hip BMD variance being explained by the six independent variables (R^2= 0.05, SEE= 0.03, p= 0.558). Logistic regression was used to determine whether the likelihood of being a faller vs. a non-faller could be predicted from a model using retinol, vitamin D, average hip strength, and physical activity. It was shown that 11.5% of the variability in fall status could be explained by the model (Cox & Snell's R^2= 0.115). Using an ROC curve analysis, the model correctly classified 69% of the individuals into the correct "fall category". We conclude that retinol, although not an independent predictor of BMD or fall status, is an important component in the prediction of both BMD and falls. Further interventional research is needed to determine the effects of retinol on BMD and falling.

Retinol Intake, Bone Mineral Density and Falls in Elderly Women

by
Carrie M. Gramer

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Carrie M. Gramer, Author

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CONTRIBUTION OF AUTHORS

The data used in this research project was the work of Dr. Kathy Gunter's dissertation project entitled "A Prospective Study of Functional Performance, Balance Self-Efficacy, and Bone Mineral Density in Community-Dwelling Elderly Women".

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DEDICATION

I would like to dedicate this thesis to my grandmother, Joanne M. Richards. Just the memory of your constant encouragement to finish was all I needed to get my "rear in gear". This is for you, "G".

RETINOL INTAKE, BONE MINERAL DENSITY AND FALLS IN ELDERLY WOMEN

Chapter One: Introduction

Background

Osteoporosis and Fractures

Osteoporosis is a disease of the skeletal system that is characterized by low bone mineral density (1). Low bone mineral density decreases the strength of bone and increases fracture risk (1,2). In the United States, it is estimated that approximately 10 million individuals have osteoporosis and an estimated 18 million have low bone mass, defined as osteopenia (2). Annual health care costs attributed to osteoporosis and related fractures are estimated to be $10 to $15 billion (2). One-third of women, over the age of 65, will have at least one osteoporosis-related fracture (3). Altogether, approximately 1.5 million osteoporosis-related fractures occur each year in the United States (4).

The elderly population is the fastest growing segment of the population; therefore, osteoporosis is becoming an increasing public health problem (3). Due to the many physical and financial burdens osteoporosis places on its victims and society as a whole, there is a pressing need to define strategies to prevent osteoporosis. Osteoporosis is defined by the World Health Organization (WHO) as a bone mineral

density measurement greater than or equal to 2.5 standard deviations below the normal peak bone mass reference range (2).

Osteoporosis is known as a "multi-factorial" disease (5). A multitude of factors, both non-modifiable and modifiable, play a part in an individual's susceptibility to osteoporosis. The non-modifiable risk factors for osteoporosis include sex, ethnicity, age, and family history (2). Modifiable risk factors include nutrition, physical activity level, body weight, alcoholic beverage consumption, caffeine consumption and smoking status (2,5). Another powerful risk factor for osteoporosis, modifiable depending on age, is peak bone mass. Peak bone mass is achieved when skeletal development reaches its full potential and strength, between 20 and 30 years of age (6).

Falls and Fractures

Falls among the elderly population are a common occurrence. More than one-half of institution-dwelling individuals, aged 65 years and older, will experience a fall within a one-year period. One-third of community-dwelling elderly will experience a fall within the same time period. Of these fallers, about 50% of them will experience multiple falls. Approximately 5% of those falls will result in a fracture (7,8).

Myers and Hayes (1994) reported that 9 out of 10 hip fractures in the elderly are the result of a fall (9). In the United States alone, more than 250,000 Americans will fracture their hip each year (10). Dennison and Cooper (2000) report that changes in the world demographics will account for an almost 3-fold increase in the number of hip fractures by the year 2050 (11).

Nutritional Aspects of Osteoporosis

Nutrition plays an important role in bone development and maintenance throughout the lifespan (5). To support normal growth and development of all tissues, including bone, a balanced diet containing adequate calories, macronutrients, and micronutrients must be consumed (2).

There has been considerable research in the area of protein and bone metabolism (6). Protein is integrated into the organic matrix of bone, which provides the collagen structure for bone mineralization to take place (5). However, to date, researchers have been unable to agree on a recommended level of protein consumption to optimize bone health. Rizzoli et al (2001) concluded that both deficient and excessive amounts of protein in the diet could negatively affect the balance of calcium levels in the body, which ultimately determines the fate of bone (13).

Micronutrients that are documented as having a high importance to bone health include calcium, vitamin D, phosphorus, vitamin K, and vitamin A (5,12,14). Calcium and phosphorus make up approximately 80 to 90% of the mineral content in bone (5). Calcium mineralizes newly synthesized bone (1), while vitamin D plays a significant role in calcium absorption and bone turnover (3,5). With age, vitamin D stores decline due to reduced sun exposure and the decreased capability of the kidneys and liver to hydroxylate vitamin D (5). Thus, vitamin D deficiency is common in the elderly and is thought to play a part in the pathogenesis of osteoporosis (3). Phosphorus makes up about 50% of the mass in bone mineral and is used in the form of phosphate in the body to aid in the mineralization and maintenance of the skeleton (6). Most Americans receive adequate amounts of phosphorous in their diets (6). Vitamin K plays an important role in bone metabolism as a coenzyme for glutamate carboxylase (5). This enzyme converts glutamate to gamma carboxyglutamate, a Gla protein. Three of the Gla proteins are involved in bone metabolism. The most researched Gla protein is osteocalcin. Osteocalcin is incorporated into the bone matrix during formation and is also a marker for bone turnover status (5). Vitamin A also plays an important role in the growth and development of bone. Specifically,

vitamin A is important in the cyclic act of growth, maturation and degeneration of bone (15).

Vitamin D is essential to maintain bone homeostasis (16) and helps to maintain both plasma calcium and phosphorus levels in order for skeletal mineralization to occur (4). Vitamin D is not considered a "vitamin" in traditional terms because it is synthesized in the skin by way of sunlight exposure. However, we also obtain vitamin D from the diet and through dietary supplements (3).

Silverberg et al. (1996) have shown that vitamin D status declines as age increases (3). This is due to a variety of factors, including changes in dietary patterns, lack of sunlight exposure and decreased vitamin D absorption and synthesis (3). If vitamin D status is inadequate, bone homeostasis will be disrupted, leading to changes in BMD (4,20). It is recommended by the Institute of Medicine that men and women over the age of 70 have an adequate intake (AI) level of 15 micrograms or 600 IU of vitamin D per day (18).

Given that muscle mass and strength are greater in those with adequate vitamin D intake and that muscle mass and strength are associated with falls (19), it has been reported that elderly individuals with adequate vitamin D intake also have a reduced incidence of falling

(19,20). Bischoff et al. (2003) examined the effects of vitamin D and calcium supplementation on falls in the elderly. They reported that frail elderly women, who were vitamin D deficient (at baseline) and supplemented, with a combination of vitamin D and calcium, reduced their incidence of falling by an average of 49% per person within the first 3 months of treatment (19).

Vitamin A is a fat-soluble vitamin that is stored in the liver. It is secreted into the circulation as needed. Excessive intakes of vitamin A, even in the short term, can lead to hypervitaminosis A, or vitamin A toxicity (21). Several symptoms of vitamin A toxicity exist including anorexia, skin rash, vomiting, weight loss, bone pain, brittle nails, and fatigue (22).

The term "vitamin A" includes both preformed vitamin A and pro-vitamin A carotenoids. Preformed vitamin A is found only in foods derived from animal origin such as liver, kidney, butter, egg yolk, whole milk, cream and fortified skim milk. Preformed vitamin A includes retinol, retinal and retinoic acid. Pro-vitamin A carotenoids are found in colorful fruits and vegetables. Pro-vitamin A carotenoids are dietary precursors of retinol. Although more than 600 forms of carotenoids exist; only about 50 exhibit pro-vitamin A potential (11). Of the few carotenoids

that have pro-vitamin A activity, nutritional composition data are only available for three; beta-carotene, alpha-carotene and beta-cryptoxanthin (18). Of these three, beta-carotene is the most biologically available of the pro-vitamin A carotenoids (23).

Vitamin A can be obtained from both dietary and supplemental sources. Supplemental sources, such as those found in "multi-vitamins" contain vitamin A as retinol, beta-carotene or both (14). Due to the different absorption rates of pre-vitamin A and pro-vitamin A carotenoids, the bioavailability of each supplement may differ (14,18). Pre-vitamin A and pro-vitamin A differ markedly in absorption rate. While 70-90% of preformed A is absorbed in the intestine, the absorption of pro-vitamin A is far less (18). For example, approximately only 9% of the pro-vitamin A in 45 micrograms of beta-carotene will cross the intestinal wall to be absorped (18). Furthermore, the absorption of pro-vitamin A decreases as the consumption increases (18). Therefore, an "excess" intake of pro-vitamin A is not possible (18).

The biologically active form of vitamin A is retinol; thus, recent dietary recommendations use Retinol Activity Equivalents (RAE) as a replacement for total vitamin A. Retinol Activity Equivalents (RAE) is measured using micrograms. This is the accurate method for calculating

and reporting the amount of total vitamin A (from both pre-vitamin A and pro-vitamin A) that is consumed through any diet and supplement sources (18). The Recommended Dietary Allowance (RDA) for vitamin A is expressed using the RAE. The RDA for vitamin A is 900 and 700 micrograms RAE for men and women, respectively (18). The Tolerable Upper Intake Level (UL) for adults is set at 3,000 micrograms per day of preformed vitamin A (18). The UL is the highest level of preformed vitamin A that can be ingested by almost all individuals without the risk of adverse health effects (18). One retinol activity equivalent (RAE) is equal to 1 microgram of retinol (3.33 IU vitamin A from retinol), 2 micrograms of supplemental beta-carotene, 12 micrograms of dietary beta-carotene, and 24 micrograms of other dietary pro-vitamin A carotenoids (18).

Studies to date report that high intakes of vitamin A are detrimental to bone (14,15,28). More specifically, it is the retinol component of vitamin A that negatively effects bone (24,25). By contrast, beta-carotene has not been shown to adversely affect bone (24,25,26). Although the mechanisms are poorly understood, vitamin A appears to have both indirect and direct effects on bone. Evidence indicates that retinol interacts with vitamin D and thus has an indirect effect on bone (16,21,27). Vitamin A has been shown to have an antagonistic

relationship with vitamin D (16,21,27). Johansson & Melhus (2001) determined that vitamin A (as retinyl palmitate) interfered with the action of vitamin D to increase the absorption of calcium in the intestine (21). In addition, vitamin A has been shown to stimulate osteoclasts (cells that break down bone) and suppress osteoblasts (cells that build up bone); exhibiting a direct effect on bone turnover that results in increased resorption and thus, bone loss (31).

In the last 5 years, 3 studies have reported significant findings regarding excess vitamin A intake and bone in humans (24,25,26). Melhus and colleagues (1998) found that vitamin A, consumed in excess of 1,500 micrograms per day, was associated with low bone mineral density in women aged 28-74 years (25). The Nurse's Health Study (NHS), conducted by Feskanich et al. (2002), examined vitamin A intake and hip fracture incidence in postmenopausal women. The researchers suggested a "dose-dependent" response; higher levels of retinol were associated with a greater risk of hip fracture (24). In the most recent study, Promislow et al. (2002) specifically examined retinol intake and BMD in elderly men and women. They reported that increasing retinol intake had a detrimental effect on bone (26). Surprisingly, the intake level of retinol that exhibited negative effects was found to be not far above the

RDA and much lower than the current Tolerable Upper Limit (UL). It was determined that BMD values (men and women) peaked at a retinol intake level between 600-840 micrograms of retinol per day. As retinol intakes increased, BMD subsequently decreased (26).

Since foods of animal origin (milk, cheese, liver) and vitamin supplements have high amounts of preformed vitamin A, they contain the highest levels of retinol. Thus, the typical western diet may lead to an excess consumption of retinol. Indeed the evidence that 5% to 10% of the population consumes 2 to 3 times the RDA for vitamin A puts many individuals at risk for bone loss (28).

Effect of Vitamin A on Muscle Mass and Falls

Given the evidence that vitamin A has an antagonistic effect on vitamin D in both human and animal studies and that vitamin D is related to falls, it is possible that vitamin A may also play a role in falls in the elderly. As discussed earlier, adequate vitamin D intake is linked to increased muscle mass and strength in the elderly, which reduces their risk of falling. The possible interaction between excessive vitamin A intake and insufficient vitamin D intake may contribute to reduced muscle mass and strength in the elderly. Therefore, excessive vitamin A consumption may play a role in falls. Furthermore, the relationship between vitamin A

and vitamin D may be even more important than either vitamin independently in preserving muscle strength and muscle mass and thus, reducing falls in the elderly.

To our knowledge, there are no reports of the relationship between vitamin A intake and falls in the elderly. Moreover, it has been shown that approximately 40% of the US population consumes a dietary supplement (29). The mean intake of vitamin A (both retinol and pro-vitamin A sources) for US men and women over the age of 70 is approximately 1,225 micrograms RE (30). As a result, the excessive consumption of this potent fat-soluble vitamin may therefore be contributing to lower BMD, a greater likelihood of falling, and a higher risk of hip fracture in the elderly.

Purpose

Many modifiable and non-modifiable risk factors are associated with osteoporosis (2,5). Perhaps the most modifiable risk factor for osteoporosis is nutritional status. Nutrition plays an important role on bone throughout the lifespan, from development of bone to the maintenance of bone mass during adulthood (5). Macronutrients and micronutrients are important in order for normal growth and development of bone to occur (2).

Given the results to date, there is evidence that the micronutrient, vitamin A, consumed in excess of 1,500-2,000 micrograms of retinol per day, has a negative effect on BMD and is also related to hip fractures in postmenopausal women (24,25,26). However, our current understanding of the relationship between vitamin A and bone remains unclear. Further, to our knowledge, there are no reports on the effect of vitamin A on falls, though, it has been shown that retinol interferes with the action of vitamin D (16,21,27,31), which has an effect on muscle mass and falls.

Therefore, the purpose of this study is to examine the relationship between retinol, BMD and fall status in postmenopausal women.

Specific Aims and Hypotheses

Research Question 1:

Does retinol intake predict BMD of the left hip (total hip), lumbar spine (L3), and lateral spine (L3) in postmenopausal women?

Hypothesis 1: Retinol intake predicts BMD at the left hip, lumbar spine, and lateral spine in postmenopausal women.

Aim 1: To evaluate this research question we will use regression analysis to determine if retinol predicts BMD of the left hip (total hip) and lumbar spine (L3) in both the anterior-posterior and lateral positions. Retinol intake was assessed at follow-up in our sample of 101 postmenopausal women using the Block Food Frequency Questionnaire. BMD of the left hip (n=101), lumbar spine (n=47), and lateral spine (n=47) were assessed using the Hologic QDR 4500A Elite. We will control for the following confounding variables: estrogen status, years past menopause, physical activity level, calcium intake, and vitamin D intake.

Research Question 2:

Does retinol intake predict 2-year changes in hip BMD in postmenopausal women?

Hypothesis 2: Retinol intake at follow-up will predict changes (from baseline to follow-up) in hip BMD in postmenopausal women.

Aim 2: To test this hypothesis, regression analysis will be used to determine if retinol intake is predictive of BMD delta scores at the hip (total hip). Dietary and supplemental retinol was assessed using the Block Food Frequency Questionnaire, collected at follow-up. BMD delta scores will be computed and expressed in g/cm^2. In the regression analysis, we will control for years past menopause, estrogen status, physical activity level, calcium intake, and vitamin D intake.

Research Question 3:

Does retinol intake predict falls in postmenopausal women?

Hypothesis 3: Retinol intake predicts falls in postmenopausal women.

Aim 3: To address this research question, we will use the Block Food Frequency dietary data collected at follow-up to determine whether or not retinol intake is able to predict fall status during the previous year, in a group of postmenopausal women (n=101). To examine this question,

logistic regression will be used. We will control for the following confounding variables in our analyses: estrogen status, years past menopause, physical activity, calcium intake, average hip strength and vitamin D intake.

Chapter Two: Retinol Intake, Bone Mineral Density, and Falls in Elderly Women

Retinol Intake, Bone Mineral Density, and Falls in Elderly Women

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Abstract

The aim of this study was to investigate the relationship between retinol intake, bone mineral density, and falls in 101 elderly women aged 72-90 years (78.6 yrs. $\pm$ 4.3 yrs.). Bone mineral density (BMD) (g/cm^2) of the total left hip, anterior-posterior lumbar spine (L3), and lateral spine (L3) were measured using dual-energy x-ray absorptiometry (Hologic QDR 4500 A). Dietary intake and physical activity were assessed by validated questionnaires (the 100-item Block Food Frequency Questionnaire and the Physical Activity Scale for the Elderly, respectively). Isometric hip abduction strength of the right and left legs was measured by hand-held dynamometry. Fall surveillance was conducted using a "postcard" system at 3-month intervals over a 2-year time period. Results of multiple regression analyses that included retinol, vitamin D, calcium, years past menopause, years on hormone replacement therapy, and physical activity as predictor variables and BMD as the dependent variable, indicated that the combination of predictor variables explained 14% of the variance in total hip BMD (R^2= 0.14, SEE= 0.12, p= 0.02), 26% of the variance in the anterior-posterior lumbar spine (L3) BMD (R^2= 0.26, SEE= 0.17, p= 0.051), and 33% of the variance in lateral spine (L3) BMD (R^2= 0.33, SEE= 0.10, p= 0.009). Furthermore, the

model was not significant without the contribution of retinol. In logistic regression, to determine the likelihood of being a faller vs. a non-faller, results demonstrated that a model including retinol, vitamin D, hip strength, and physical activity accounted for 11.5% of the variability in fall status (Cox & Snell's $R^2 = 0.115$). Using a Relative Operating Characteristic (ROC) curve analysis, we demonstrated that the model classified 69% of the individuals into the correct "fall category". We conclude that retinol makes an important contribution to both BMD and falls. Since the relationship between retinol and BMD is inverse, these data lend more credence to the notion that excessive retinol may contribute to risk of osteoporosis-related fracture.

Introduction

Osteoporosis is a disease of the skeletal system that is characterized by low bone mineral density (1). Low bone mineral density decreases the strength of bone and increases fracture risk (1,2). In the United States, it is estimated that approximately 10 million individuals have osteoporosis and an estimated 18 million have low bone mass, defined as osteopenia (2). Annual health care costs attributed to osteoporosis and related fractures are $10 to $15 billion (2). One-third of women, over the age of 65, will have at least one osteoporosis-related fracture (3).

However, low bone mineral density (BMD) is not the only, and may not be the most important risk factor for fracture. It has become increasingly clear that falls among the elderly are a leading cause of osteoporosis-related fracture. Myers and Hayes (1994) reported that 9 out of 10 hip fractures in the elderly are the result of a fall (4). In the United States alone, more than 250,000 individuals will fracture their hip each year (5).

Nutrition plays an important role in bone development and maintenance throughout the lifespan (6). To support normal growth and development of all tissues, including bone, a balanced diet containing

adequate calories, macronutrients and micronutrients must be consumed (2). Micronutrients that are documented as having a high importance to bone health include calcium, vitamin D, phosphorus, vitamin K and vitamin A (6,7,8).

To date, much of the research has focused on the effect of calcium and vitamin D in building bone and preventing fractures. However, vitamin A also plays an important role in the growth and development of bone. Specifically, vitamin A is central to the cyclic act of growth, maturation and degeneration of bone (9).

Studies to date report that high intakes of vitamin A are detrimental to bone (10,11,12). More specifically, it is the retinol, not the beta-carotene, component of vitamin A that negatively interacts with bone (10,11). By contrast, beta-carotene has not been shown to adversely affect bone (10,11,12). Evidence indicates that retinol interacts with vitamin D and thus has an indirect effect on bone (13,14,15). Vitamin A has been shown to have an antagonistic relationship with vitamin D (13,14,15). Johansson and Melhus (2001) determined that vitamin A (as retinyl palmitate) interfered with the action of vitamin D to increase the absorption of calcium in the intestine (13). Foods of animal origin (milk, cheese, liver, eggs), fortified products (milk, margarine, cereal, energy

bars) and vitamin supplements have high amounts of vitamin A. Thus, the typical western diet may lead to an excess consumption of retinol. Indeed the evidence that 5% to 10% of the population consumes 2 to 3 times the RDA for vitamin A suggests that many individuals may be at risk for bone loss (16).

Even more convincing with respect to fractures, is a recent report from Feskanich et al. (2002) indicating a higher hip fracture risk among those consuming high levels of retinol from foods and/or supplements (10). The relative risk of individuals consuming retinol in excess of 2,000 micrograms per day was doubled compared to those with intakes less than 500 micrograms per day (10). However, in this study there were no data on falls and thus, it is unclear how many fractures occurred as the result of a fall.

Given that muscle mass and strength are greater in those with adequate vitamin D intake and that muscle mass and strength are associated with falls (17), it has been reported that elderly individuals with adequate vitamin D intakes also have a reduced incidence of falling (17,18). It has been established that vitamin A has an antagonistic effect on the actions of vitamin D in both human and animal studies and since vitamin D is related to falls, it is possible that vitamin A may also

contribute to falls among the elderly. The possible interaction between excessive vitamin A intake and insufficient vitamin D intake may contribute to reduced muscle mass and strength in the elderly. Therefore, excessive vitamin A consumption may result in increased falls.

To our knowledge, there are no reports of the relationship between vitamin A intake and falls in the elderly. The Recommended Dietary Allowance (RDA) for vitamin A is expressed using the Retinol Activity Equivalents (RAE). The RAE is the accurate method for calculating and reporting the amount of total vitamin A (from both previtmain A and pro-vitamin A) that is consumed through any dietary and supplemental sources. The RDA for vitamin A is 900 and 700 micrograms RAE for men and women, respectively (19). The mean intake of total vitamin A for US men and women over the age of 70 is approximately 1,225 micrograms Retinol Equivalents (RE) (21). Moreover, it has been shown that approximately 40% of the US population consumes a dietary supplement (20). As a result, the excessive consumption of this potent fat-soluble vitamin may be contributing to lower BMD, a greater likelihood of falling, and a higher risk of hip fracture in the elderly.

In the current study, we examined data from a larger, two-year prospective study on falls in the elderly conducted in our laboratory and addressed the following research questions: (1) Does vitamin A intake predict BMD of the hip and spine (anterior-posterior and lateral) in elderly women? and (2) Does vitamin A intake predict falls in elderly women?

Methods

Subjects

This study was part of a larger project that examined bone mineral density, physical performance and falls in postmenopausal women. Of the 129 women in the original study, we had falls surveillance over a two-year period and both BMD and dietary data (collected at 2-year follow-up) on 107 women. Of these, four were removed due to insufficient nutritional data (n=4) and two were outliers with values on one of more of the independent variables exceeding a Z-score of 3.29 (n=2). Therefore, for this study, 101 elderly women aged 72-90 years (78.6 yrs. $\pm$ 4.3 yrs.) were included in analysis.

All participants resided within the mid-Willamette Valley of Oregon. Women were included if they were >70 years of age, could participate in physical performance tests and were willing to commit to two years of participation. Subjects were excluded if they had a metabolic disease that may affect bone metabolism and/or took medication (other than hormone replacement therapy (HRT)) that is known to interfere with calcium and/or bone metabolism. The study was reviewed and approved by the Oregon State University Institutional Review Board (IRB) (Appendix B) and all subjects involved gave written informed consent

prior to participation (Appendix C). Table 1 illustrates subject's anthropometric, strength, BMD and nutritional characteristics at baseline and at 24 months.

Table 1. Anthropometric, strength, BMD and nutritional status of subjects at baseline and 24 months (Mean ± SD). Nutritional status and spine (AP and lateral) BMD were only measured at 24 months.

	N	**Baseline (Month 0)**	**Follow-Up (Month 24)**
Age (yrs.)	101	76.70 ± 4.30	78.60 ± 4.30
Height (cm)	101	160.50 ± 6.20	160.20 ± 6.20
Weight (kg)	101	66.70 ± 13.00	66.80 ± 13.10
Hip Strength (kg)	101	17.80 ± 4.30	15.00 ± 15.20
Total Hip BMD (g/cm^2)	101	0.80 ± 0.10	.78 ± .13
L3 AP BMD (g/cm^2)	47	N/A	.97 ± .18
L3 Lateral BMD (g/cm^2)	47	N/A	.63 ± .12
Retinol (mcg)	101	N/A	1262.50 ± 669.60
Calcium (mg)	101	N/A	1416.70 ± 589.80
Vitamin D (IU)	101	N/A	418.90 ± 207.40

Data Collection

General health and physical activity. Participants completed a health history questionnaire regarding general health, presence of disease, past medical history, medication use, menopausal status, hormone replacement therapy use, hysterectomy operation status, smoking history,

and alcohol consumption (Appendix D). Physical activity was also assessed by questionnaire using the Physical Activity Scale for the Elderly (PASE) (New England Research Institute, Inc., Watertown, MA) (Appendix E).

Nutrition. Dietary intake was assessed using the 2000 version of the Block Food Frequency Questionnaire (FFQ, Appendix F). The Block Food Frequency Questionnaire is a computer-scored assessment that examines an individual's "usual" eating pattern (within the past 1-year period) including the amount and frequency of 100 commonly consumed foods (Block Dietary Data Systems; Berkeley, CA) (22). Following completion of the FFQ, all subjects were interviewed to check for accuracy. The completed questionnaires were then sent to Block Dietary Data Systems for analysis. The information acquired from the Block questionnaire was used to obtain average dietary vitamin A (total vitamin A, retinol, beta-carotene, cryptoxanthin, alpha-carotene), calcium and vitamin D intake. Supplement status was also obtained to gain information regarding any additional vitamin A, calcium and/or vitamin D estimates of intake that were being consumed via supplemental sources.

Fall surveillance. To track falls over the years, each subject was sent a "postcard" (Appendix H) every 3 months asking whether or not they

had experienced a fall. On the self-addressed, stamped postcards subjects could circle either "yes", they had experienced a fall, or "no", they had not experienced a fall and drop the completed postcard in the US mail. Returned postcards were logged into the research study database as either a "fall" or a "no fall". Women who had experienced a fall were contacted (via phone) by a research assistant and interviewed as to the circumstances of the fall (Appendix G). Information from the completed fall surveillance form was then entered into the research database.

Hip strength. Isometric hip abduction strength was measured using a hand-held dynamometer. Three trials were completed on each leg.

Bone mineral density. BMD measurements (g/cm^2) were collected during baseline and follow-up visits on the left hip (femoral neck region, greater trochanter, total hip) in 101 elderly women, anterior-posterior (AP) lumbar spine (L3) and lateral spine (L3) in 47 elderly women who were representative of the study sample, using dual-energy x-ray absorptiometry (DXA) conducted using the Hologic QDR 4500A Elite (Hologic Inc., Waltham, MA) (23). The participant bone scans were performed using the identical operator for the duration of the research study. The operator of the QDR 4500A was trained and licensed by the State of Oregon to administer bone scans of the type described above.

Subject scans were analyzed at baseline and follow-up visits using Hologic Software (Version 6.10.01 Rev A). Repeated adult BMD measurements (hip and lumbar spine), completed at the Bone Research Laboratory at Oregon State University, have a precision error of 1-1.5% (24).

Statistics

SPSS version 11.0 was used for data analysis (25). Data were cleaned and double-checked for violations of the assumptions of normality, linearity, homoscedasticity and collinearity, as well as accuracy of data entry. All data were normally distributed. Descriptive statistics were conducted to compute group means and standard deviations. Correlation analyses were run to help determine the appropriate variables (in addition to retinol) to include in the multiple and logistic regression models. Those variables having correlations $p = <0.05$ were included in the regression analyses (Table 2).

Table 2. Significant Pearson Correlations between variables. Variables were considered significant at $p<0.05$.

Variables	**Pearson Correlation ($p<0.05$)**
Total Hip at Follow-Up vs. L3 AP BMD	.53
Total Hip at Follow-Up vs. Average Hip Strength	.20
L3 AP BMD vs. L3 Lateral BMD	.44
L3 Lateral BMD vs. Years Postmenopause	-.31
Retinol vs. Vitamin D	.74
Retinol vs. Calcium	.39
Retinol vs. Years on HRT	.21
Vitamin D vs. Calcium	.37
Physical Activity vs. Average Hip Strength	.35
Years Postmenopause vs. Years on HRT	.28

For research question one, multiple regression analysis was used to determine if retinol predicted BMD (g/cm^2) of the hip, the anterior-posterior lumbar spine (L3) and the lateral lumbar spine (L3). In this model, we controlled for estrogen status, years past menopause, physical activity level, vitamin D intake, and calcium intake.

For research question 2, logistic regression was used to determine whether the likelihood of being a faller vs. a non-faller could be predicted from retinol intake, total vitamin D intake, average hip strength, and physical activity level. A Relative Operating Characteristic (ROC) curve

analysis was then performed to further evaluate the sensitivity and specificity of the logistic model. In this model, we controlled for vitamin D intake, average hip strength, and physical activity level.

The sample size needed to demonstrate adequate power was determined using an equation developed by Stevens (1995). Using 15 data points per predictor, it was estimated that a sample size of 90 subjects would provide adequate power (26).

Assumptions

The average multi-vitamin supplement carries 80% of its total vitamin A content as retinol (pre-formed vitamin A) and 20% as beta-carotene (pro-vitamin A). Therefore, in this study, we assumed that all supplement users ingested a similar combination of retinol and beta-carotene in their multi-vitamin.

Results

Total hip BMD (n=101) was predicted by a model that included retinol intake, vitamin D intake, calcium intake, years past menopause, years on hormone replacement therapy (HRT), and physical activity. Together these variables explained 14% of the variance in total hip BMD (R^2=0.14, SEE=0.12, p=0.020). In the model ($\hat{Y}$=0.806-(0.138 * years postmenopausal) + (0.310 * years on HRT) + (0.105 * total calcium intake) + (0.111 * vitamin D intake) - (0.373 * retinol intake) + (0.192 * physical activity)), years on HRT and retinol, with retinol showing an inverse relationship to hip BMD, were the only variables contributing significantly to the prediction of total hip BMD (p=0.004 and p=0.015, respectively). However, when any one variable was removed from the model, the contribution of retinol and years on HRT was negated and the model was no longer significant. When hip strength was added into the model, there was no observed significant change in the prediction of total hip BMD (R^2= 0.15, SEE=0.12, p=0.026). Thus, only in with the unique combination of the predictors did retinol and years on HRT predict total hip BMD.

These same predictors together explained 26% of the observed variability in L3 AP spine BMD (n= 47) (R^2=0.26, SEE=0.17, p=0.05). In

the model ($\hat{Y}$=1.171-(0.317 * years postmenopausal) + (0.387 * years on HRT) + (0.128 * total calcium intake) + (0.419 * vitamin D intake) - (0.684 * retinol intake) + (0.124 * physical activity)), retinol intake was inversely related to BMD and was the most significant predictor of AP spine (L3) BMD (p=0.007), followed by years on HRT and years past menopause (p=0.018 and p=0.033, respectively). Again, when any of the variables in the model were removed the model was no longer significant. When hip strength was added to the model, there was no significant change (R^2=0.28, SEE=0.17, p=0.054).

The observed variability in lateral spine (L3) BMD (n= 47) explained by the above model was 33% (R^2=0.33, SEE=0.10, p=0.009). Retinol, again, displayed an inverse relationship to lateral spine BMD. In the model ($\hat{Y}$=0.823 - (0.460 * years postmenopausal) + (0.452 * years on HRT) + (0.021 * total calcium intake) + (0.335 * vitamin D intake) - (0.491 * retinol intake) + (0.255 * physical activity)), the most significant predictors of lateral spine (L3) BMD were years on HRT (p=0.004) followed by retinol intake (p=0.037). However, when any one of the predictors were removed from the model, the model was no longer significant. When hip strength was added to the model, there was no

significant change in the prediction of lateral spine (L3) BMD (R^2=0.34, SEE=0.10, p=0.016).

In order to determine whether the likelihood of being a faller or a non-faller was predicted from retinol intake, vitamin D intake, average hip strength and physical activity, a binary logistic regression model was run. Using these variables as independent factors, the proportion of variability in falling that is explained by the unique combination of variables in our model indicates that approximately 11.5% of the variability in fall status can be explained by the model (Cox & Snell's R^2=0.115). In our sample, 40 individuals did not fall and 61 individuals fell, contributing to a total of 171 falls. Over the 2-year fall surveillance period, height, weight, and hip strength did not significantly change.

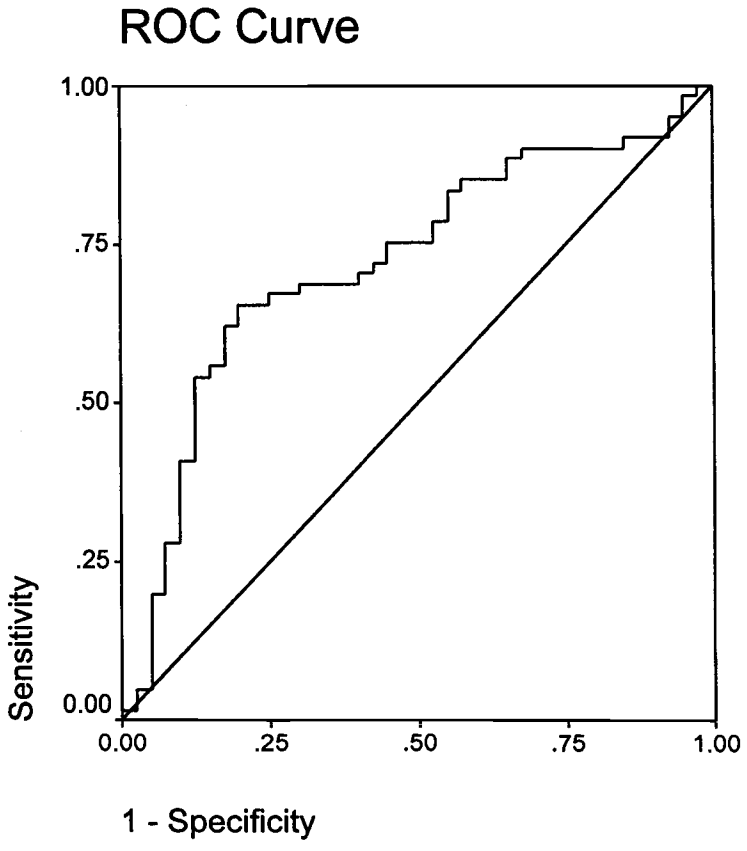
The logistic regression model that best predicted whether or not an elderly women was going to have a fall included four coefficients: physical activity, vitamin D intake, retinol intake, and average hip strength (p= .002). If μ=Pr (y=1), which is the probability of an elderly women having a fall, then the logistic equation from the above maximum likelihood estimate is:

$\text{Log}(\mu/1-\mu)) = 2.950 + (0.001 * \text{physical activity}) - (0.003 * \text{vitamin D intake}) + (0.000 * \text{retinol intake}) - (0.129 * \text{average hip strength})$.

The signs of these estimates indicate that elderly women are more likely to fall if they are less physically active, consume lower amounts of vitamin D and have lower hip strength. Retinol had no impact on the model.

A Relative Operating Characteristic (ROC) curve analysis (27) was conducted on the present research data to verify correct classification of "fallers" and "non-fallers" (Figure 1). It was shown that the model was able to correctly predict 69.3% of the individuals into the correct "fall category" (using a "cut" point of 0.60). Sensitivity (the ability to correctly classify fallers) was 70% and specificity (the ability to correctly classify non-fallers) was 69%. The analysis shows an area under the curve = .72 ($p = .000$). Thus validating that the model we selected was significantly better at classifying individuals into fall category than chance alone.

Figure 1. Relative Operating Characteristic (ROC) curve for our model to predict "fall category" among subjects. The ROC curve compares the sensitivity (true positive prediction) and 1-specificity (false positive prediction) of the logistic regression model to predict an individual's "fall category", depending upon the cut-point used to define the subject's "fall category". The optimal cut-point for defining an individual's "fall category" would be 0.60, with a sensitivity = 0.70 and specificity = 0.69 (1-specificity = 0.31). Area under the curve = 0.72 (p = .000).



Discussion

The aims of this study were to determine the relationship between retinol intake, BMD and falls in postmenopausal women. We report that retinol, vitamin D, calcium, years past menopause, years on hormone replacement therapy, and physical activity explained 14% of the variance in total hip BMD, 26% of the variance in the anterior-posterior lumbar spine, and 33% of the variance in lateral spine. Retinol was inversely related to BMD at all three sites (hip, AP lumbar spine, AP lateral spine). Specifically, increasing retinol is associated with a decrease in BMD.

Furthermore, a model including retinol, vitamin D, average hip strength, and physical activity correctly classified 69% of individuals into the correct "fall category" (fall or no fall). Additionally, this model explained 11.5% of the variability in fall status. As retinol levels increased, BMD decreased and fall risk increased. Thus, while retinol intake was not an independent predictor of either BMD or fall status, it significantly contributed to the prediction of both BMD and falls.

This study has several strengths. First, to our knowledge, we were the first to examine the relationship between retinol intake and falling in elderly women. Furthermore, results confirm the importance of hip abduction strength to fall risk. Previous research has shown that

increasing hip abduction strength was significantly related to improving dynamic balance (28). Lastly, our study supports the growing body of literature regarding vitamin A and bone.

Our study also had several limitations. First, the women who were a part of this project volunteered and may not be representative of the general population, thus reducing generalizability. Volunteers are usually more interested in their health status and are more likely to seek ways to gain knowledge about their health. In addition, since we did not manipulate retinol, our results do not represent cause and effect. However, high retinol intake is likely more damaging over a long period of time because of the large storage capacity for the vitamin in the liver and though we did not follow subjects prospectively, nor did we intervene, the reported retinol intake probably reflected long-term intakes. Lastly, blood levels more accurately represent both retinol and vitamin D status. However, our study was designed to assess only these intakes through questionnaires. Therefore, had we designed the study to measure blood levels of vitamin A and vitamin D, the vitamin status of the participant's in this study would be more accurate.

As previously reported, excessive intakes of retinol have been shown to contribute to lower BMD (12) and a higher risk of hip fracture

(10,11). However, our data suggest that retinol may also affect fracture risk by increasing fall risk. This study, believed to be the first to examine the association between retinol and falling in elderly women, found that retinol might be a potentially important modifiable risk factor affecting both BMD and falls. Falls are a common occurrence in the elderly population. It has been reported that 9 out of 10 hip fractures in the elderly are the result of a fall (4) and thus, individuals with low BMD who experience a fall are at a higher risk of fracturing than those with higher BMD who fall. Thus, to reduce fractures, we must address factors influencing both BMD and fall risk.

Melhus et al. (1998) investigated whether excessive dietary intake of retinol is associated with decreased BMD and increased risk for hip fracture in a group of northern European women aged 28 to 74 years at entry (11). Northern Europeans have the highest osteoporotic fracture incidence and unusually high intakes of retinol due to their frequent consumption of cod liver oil, milk and other dairy products (29). They reported a 10% reduction in BMD at the femur and a doubled risk of hip fracture when dietary intake of retinol exceeded 1,500 micrograms per day compared to those with intakes less than 500 micrograms per day (11). Forty-five percent of our sample population had intakes of retinol between

1,500 micrograms and 2,000 micrograms per day. Recently, Feskanich and colleagues (2002) reported a doubled relative risk for participants in the Nurses' Health Study when retinol intakes exceeded 2,000 micrograms per day compared to those with intakes less than 500 micrograms per day (10). Six percent of our sample population consumed more than 2,000 micrograms of retinol per day. The women in our project had an average intake of 1,262 micrograms of retinol per day. This is similar to the daily intakes of retinol by the participant's of The Rancho Bernardo study conducted by Promislow et al (2002). (12). Promislow and colleagues (2002) found that BMD values peaked at retinol levels of 600 to 840 micrograms per day and then began to decline with further increases in retinol. This value is much lower than that of Melhus et al. (1998), however, Promislow et al. (2002) distinguished between supplemental users and non-users. Promislow et al. (2002) did, however, indicate that dietary and supplemental retinol intake had similar associations with BMD, therefore indicating that total retinol consumed was more important than its origin (12), though, it has been suggested that the bioavailability of retinol ingested as a supplement may differ from retinol ingested through the diet (19).

Similar to Promislow et al. (2002), we examined a group of elderly women. This is in contrast to the studies of Melhus et al. (1998) and Feskanich et al. (2002) who investigated the effects of vitamin A in a younger population. With aging, the ability to metabolize high levels of ingested retinol declines (19). Furthermore, vitamin D status has been shown to decline as age increases (3). This is due to a variety of factors including changes in dietary patterns, lack of sunlight exposure and decreased absorption and synthesis of vitamin D (3). Independently, these two factors have been shown to reduce BMD in the elderly population (6,30,12) and thus the combination of inadequate vitamin D and high intakes of retinol appear to be detrimental to bone.

It has been shown that vitamin A and vitamin D are antagonistic to one another (13,14,15). Johansson and Melhus (2001) determined that vitamin A interferes with the action of vitamin D to absorb calcium in the intestine (13). Although not the main question, it was shown through our logistic regression model that hip strength was a significant independent predictor of fall status. This corresponds with other preliminary data showing that hip strength is a significant predictor of fall risk (28). Thus, given the relationship between retinol and vitamin D and evidence showing that muscle mass and strength are greater in those with adequate

vitamin D intake and contribute to a reduced likelihood of falling (17), it is important that these relationships be investigated in greater detail.

Participants in this study consumed an average of 1,262 $\pm$ 670 micrograms of retinol per day from dietary and supplemental sources. These intake levels are comparable to that found in the Third National Health and Nutrition Examination Survey (NHANES) (1988-1994) for men and women 70 years of age and older (21), which concluded that the mean intake of vitamin A for the general population in this age category was 1,225 micrograms Retinol Equivalents (RE). Given that the Recommended Dietary Allowance (RDA) for all sources of vitamin A is 700 micrograms RAE for women (19), data from our study and others indicate that older women are consuming retinol in excess of the RDA, which may be affecting skeletal health.

Although the intake levels for our sample were comparable to the general population, 87% of our population consumed dietary supplements compared to 40% of the general population that reported taking a supplement (20). Furthermore, 70% of our sample consumed a supplement that included vitamin A. The average supplement contains 1,501 micrograms of vitamin A, 80% as retinol and 20% as beta-carotene.

Thus, it appears that our sample population consumed the majority of its retinol from supplemental sources.

The Tolerable Upper Limit (UL) for retinol, defined as the highest intake to which no adverse health effects are present, is currently at 3,000 micrograms per day (19). This value is far above the limit that Melhus et al. (1998) (11), Promislow et al. (2002) (12), and Feskanich et al. (2002) (10) have shown to be associated with a lower BMD and a subsequent higher risk of hip fracture.

It is especially important that the elderly take caution when consuming foods and supplements rich in retinol. As the body ages, the hepatic uptake of retinol from the bloodstream is slowed (19). Based on data from our study and the results of the NHANES survey (21), it is clear that many elderly individuals are consuming supplements and, therefore, are exceeding the recommendations for vitamin A.

As stated previously, the average multi-vitamin supplement carries 80% of its vitamin A content as retinol and 20% as beta-carotene. Beta-carotene and other carotenoids do not contribute to hypervitaminosis A (10,11,19). Therefore, by lowering the retinol content and raising the beta-carotene content in supplements, total vitamin A would not change but the risk of bone loss and falling may be reduced. Due to the

widespread use of supplements in this population, merely adjusting the ratio of retinol to beta-carotene levels may lower the average consumption of vitamin A in the general population.

Our findings suggest that, although not an independent predictor of either BMD or fall status, retinol is an integral part of the model that was able to significantly predict both BMD and falls. Furthermore, the amount of retinol in the common multi-vitamin supplement may be contributing to the fact that individuals are consuming vitamin A in levels that exceed the current recommendations of the National Research Council.

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Chapter Three: Conclusion

The elderly population is the fastest growing segment of the population; therefore, osteoporosis is becoming an increasing public health problem (3). Due to the many physical, psychosocial and financial burdens osteoporosis places on its victims, their families and society as a whole, there is a pressing need to define strategies to prevent osteoporosis.

Falls among the elderly population are common. It has been reported that 9 out of 10 hip fractures in the elderly are the result of a fall (9). Individuals with low BMD who experience a fall are at a higher risk of fracturing than those with high BMD who fall. Thus, to reduce fractures, we must address factors influencing both BMD and fall risk.

Nutrition plays an important role in bone development and maintenance throughout the lifespan (5). To support normal growth and development of all tissues, including bone, a balanced diet containing adequate calories, macronutrients and micronutrients must be consumed (2). Specifically, calcium, vitamin D, phosphorus, vitamin K, and vitamin A are of high importance (5,12). Recently, vitamin A has been reported to be detrimental to bone when consumed in high amounts (24,25,26). More specifically, it is the retinol component of vitamin A that interacts with bone (24,25).

Evidence suggests that vitamin A has an antagonistic relationship with vitamin D (16,21,27) and that vitamin D is related to muscle mass and fall status in the elderly (19). However, it is still unclear how retinol may affect fall status in the elderly.

In conclusion, retinol is linked to fracture risk in two ways; through its affects on (1) BMD and (2) falls. Our findings suggest that retinol is an important predictor, along with vitamin D intake, calcium intake, years past menopause, years on hormone replacement therapy, and physical activity at predicting hip BMD, AP spine BMD and AP lateral spine BMD. Furthermore, retinol was inversely related to BMD at all sites. Additionally, a model including retinol, vitamin D, average hip strength and physical activity correctly classified 69.3% of individuals into the correct "fall category" (fall or no fall). However, two-year changes in hip BMD were poorly predicted using our model, with only 5% of total hip BMD variance being explained by retinol, vitamin D intake, calcium intake, years past menopause, years on hormone replacement therapy and physical activity (R^2=0.05, SEE=0.03, p=0.56).

Based on these results and results of previous studies (24,25,26) examining the effects of vitamin A on bone mineral density and hip fracture risk, it is clear that amounts in excess of the RDA for vitamin A

may have a detrimental affect on bone and in turn, a higher risk of suffering a fracture.

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Appendicies

Appendix A: Literature Review

Osteoporosis and Fractures

Osteoporosis is a disease of the skeletal system that is characterized by low bone mineral density (1). Low bone mineral density decreases the strength of bone and increases fracture risk (1,2). In the United States, it is estimated that approximately 10 million individuals have osteoporosis and an estimated 18 million have low bone mass, defined as osteopenia (2). Annual health care costs attributed to osteoporosis and related fractures are $10 to $15 billion (2). One-third of women, over the age of 65, will have at least one osteoporosis-related fracture (3). Altogether, approximately 1.5 million osteoporosis-related fractures occur each year in the United States (4).

The elderly population is the fastest growing segment of the population; therefore, osteoporosis is becoming an increasing public health problem (3). Due to the many physical and financial burdens osteoporosis places on its victims and society as a whole, there is a pressing need to define strategies to prevent osteoporosis. Osteoporosis is defined by the World Health Organization (WHO) as a bone mineral density measurement greater than or equal to 2.5 standard deviations below the normal peak bone mass reference range (2).

Osteoporosis is known as a "multi-factorial" disease (5). A multitude of factors, both non-modifiable and modifiable, play a part in an individual's susceptibility to osteoporosis. The non-modifiable risk factors for osteoporosis include sex, ethnicity, age, and family history (2). Modifiable risk factors include nutrition, physical activity level, body weight, alcoholic beverage consumption, caffeine consumption and smoking status (2,5). Another powerful risk factor for osteoporosis, modifiable depending on age, is peak bone mass. Peak bone mass is achieved when skeletal development reaches its full potential and strength, between 20 and 30 years of age (6).

Falls and Fractures

Falls among the elderly population are a common occurrence. More than one-half of institution-dwelling individuals, aged 65 years and older, will experience a fall within a one-year period. One-third of community-dwelling elderly will experience a fall within the same time period. Of these fallers, about 50% of them will experience multiple falls. Approximately 5% of those falls will result in a fracture (7,8).

Myers and Hayes (1994) report that 9 out of 10 hip fractures in the elderly are the result of a fall (9). In the United States alone, more than 250,000 Americans will fracture their hip each year (10). Dennison and

Cooper (2000) report that changes in the world demographics will account for an almost 3-fold increase in the number of hip fractures by the year 2050 (11).

Nutritional Aspects of Osteoporosis

Nutrition plays an important role in bone development and maintenance throughout the lifespan (5). To support normal growth and development of all tissues, including bone, a balanced diet containing adequate calories, macronutrients, and micronutrients must be consumed (2).

There has been considerable research in the area of protein and bone metabolism (13). Protein is integrated into the organic matrix of bone, which provides the collagen structure for bone mineralization to take place (5). Much research has taken place to determine the dietary consumption levels of protein and its effects on bone mineral density. There is controversy concerning the levels of protein consumption that are detrimental to bone. Rizzoli et al. (2001) concluded that both deficient and excessive amounts of protein in the diet could negatively affect the balance of calcium levels in the body, which ultimately determines the fate of bone (12).

Micronutrients that are documented as having a high importance to bone health include calcium, vitamin D, phosphorus, vitamin K, and vitamin A (5,13,14). Calcium and phosphorus make up approximately 80 to 90% of the mineral content in bone (5). Calcium mineralizes newly synthesized bone (1), while vitamin D plays a significant role in calcium absorption and bone turnover (3,5). With age, vitamin D stores decline due to reduced sun exposure and the decreased capability of the kidneys and liver to hydroxylate vitamin D (5). Thus, vitamin D deficiency is common in the elderly and is thought to play a part in the pathogenesis of osteoporosis (3). Phosphorus makes up about 50% of the mass in bone mineral and is used in the form of phosphate in the body to aid in the mineralization and maintenance of the skeleton (6). Most Americans receive adequate amounts of phosphorous in their diets (6). Vitamin K plays an important role in bone metabolism as a coenzyme for glutamate carboxylase (5). This enzyme converts glutamate to gamma carboxyglutamate, a Gla protein. Three of the Gla proteins are involved in bone metabolism. The most researched Gla protein is osteocalcin. Osteocalcin is incorporated into the bone matrix during formation and is also a marker for bone turnover status (5). Vitamin A plays an important role in the growth and development of bone. Specifically, vitamin A is

important in the cyclic act of growth, maturation and degeneration of bone (15).

Vitamin D. Vitamin D is essential to maintain bone homeostasis (16). Vitamin D helps to maintain both plasma calcium and phosphorus levels in order for skeletal mineralization to occur (5). Vitamin D is not considered a "vitamin" in traditional terms because it is synthesized in the skin by way of sunlight exposure. However, we also obtain vitamin D from the diet and through dietary supplements (3).

Silverberg et al. (1996) has shown that vitamin D status declines as age increases (3). This is due to a variety of factors, including changes in dietary patterns, lack of sunlight exposure and decreased vitamin D absorption and synthesis (3). If vitamin D status is inadequate, bone homeostasis will be disrupted, thus leading to changes in BMD (5,17). It is recommended by the Institute of Medicine that men and women over the age of 70 have an adequate intake (AI) level of 15 micrograms or 600 IU of vitamin D per day (18).

Given that muscle mass and strength are greater in those with adequate vitamin D intake and that muscle mass and strength are associated with falls (19), it has been reported that elderly individuals with adequate vitamin D intake also have a reduced incidence of falling

(19,20). Bischoff et al. (2003) examined the effects of vitamin D and calcium supplementation on falls in the elderly. They reported that frail elderly women, who were vitamin D deficient (at baseline) and supplemented, with a combination of vitamin D and calcium, reduced their incidence of falling by an average of 49% per person within the first 3 months of treatment (19).

Vitamin A. Vitamin A is a fat-soluble vitamin that is stored in the liver. It is secreted into the circulation as needed. Excessive intakes of vitamin A, even in the short term, can lead to hypervitaminosis A, or vitamin A toxicity (21). Several symptoms of vitamin A toxicity exist including anorexia, skin rash, vomiting, weight loss, bone pain, brittle nails, and fatigue (22).

The term "vitamin A" includes both preformed vitamin A and pro-vitamin A carotenoids. Preformed vitamin A is found only in foods derived from animal origin such as liver, kidney, butter, egg yolk, whole milk, cream and fortified skim milk. Preformed vitamin A includes retinol, retinal and retinoic acid. Pro-vitamin A carotenoids are found in colorful fruits and vegetables. Pro-vitamin A carotenoids are dietary precursors of retinol. Although more than 600 forms of carotenoids exist; only about 50 exhibit pro-vitamin A potential (11). Of the few carotenoids

that have pro-vitamin A activity, nutritional composition data are only available for three; beta-carotene, alpha-carotene and beta-cryptoxanthin (18). Of these three, beta-carotene is the most biologically available of the pro-vitamin A carotenoids (23).

Vitamin A can be obtained from both dietary and supplemental sources. Supplemental sources, such as those found in "multi-vitamins" contain vitamin A as retinol, beta-carotene or both (14). Due to the different absorption rates of pre-vitamin A and pro-vitamin A carotenoids, the bioavailability of each supplement may differ (14,18). Pre-vitamin A and pro-vitamin A differ markedly in absorption rate. While 70-90% of preformed A is absorbed in the intestine, the absorption of pro-vitamin A is far less (18). For example, approximately only 9% of the pro-vitamin A in 45 micrograms of beta-carotene will cross the intestinal wall to be absorped (18). Furthermore, the absorption of pro-vitamin A decreases as the consumption increases (18). Therefore, an "excess" intake of pro-vitamin A is not possible (18).

Bioavailability of Vitamin A. The biologically active form of vitamin A is retinol; thus, recent dietary recommendations use Retinol Activity Equivalents (RAE) as a replacement for vitamin A. Retinol Activity Equivalents (RAE) is measured using micrograms. This is the

accurate method for calculating and reporting the amount of total vitamin A (from both pre-vitamin A and pro-vitamin A) that is consumed through any diet and supplement sources (18). The Recommended Dietary Allowance (RDA) for vitamin A is expressed using the RAE. The RDA for vitamin A is 900 and 700 micrograms RAE for men and women, respectively (18). The Tolerable Upper Intake Level (UL) for adults is set at 3,000 micrograms per day of preformed vitamin A (18). The UL is the highest level of preformed vitamin A that can be ingested by almost all individuals without the risk of adverse health effects (18). One retinol activity equivalent (RAE) is equal to 1 microgram of retinol (3.33 IU vitamin A from retinol), 2 micrograms of supplemental beta-carotene, 12 micrograms of dietary beta-carotene, and 24 micrograms of other dietary pro-vitamin A carotenoids (18).

Excess Vitamin A on Bone. Studies to date report that high intakes of vitamin A are detrimental to bone (24,25,26). More specifically, it is the retinol component of vitamin A that negatively interacts with bone (24,25). By contrast, beta-carotene has not been shown to adversely affect bone (24,25,26). Although the mechanisms are poorly understood, vitamin A appears to have both indirect and direct effects on bone. Evidence indicates that retinol interacts with vitamin D

and thus has an indirect effect on bone (16,21,27). Vitamin A has been shown to have an antagonistic relationship with vitamin D (16,21,27). Johansson and Melhus (2001) determined that vitamin A (as retinyl palmitate) interfered with the action of vitamin D to increase the absorption of calcium in the intestine (21). In addition, vitamin A has been shown to stimulate osteoclasts (cells that break down bone) and suppress osteoblasts (cells that build up bone); exhibiting a direct effect on bone turnover that results in increased resorption and thus, bone loss (26,28).

In the last 5 years, 3 studies have reported significant findings regarding excess vitamin A intake and bone in humans (24,25,26). Melhus and colleagues (1998) found that vitamin A, consumed in excess of 1,500 micrograms per day, was associated with low bone mineral density in women aged 28-74 years (25). The Nurse's Health Study (NHS), conducted by Feskanich et al. (2002), examined vitamin A intake and hip fracture incidence in postmenopausal women. The researchers suggested a "dose-dependent" response; higher levels of retinol lead to a greater risk of hip fracture (24). In the most recent study, Promislow et al. (2002) specifically examined retinol intake and BMD in elderly men and women. They reported that increasing retinol intake had a detrimental

effect on bone (26). Surprisingly, the intake level of retinol that exhibited negative effects was found to be not far above the RDA and much lower than the current Tolerable Upper Limit (UL). It was determined that BMD values (for both men and women) peaked at a retinol intake level between 600-840 micrograms of retinol per day. As retinol intakes increased, BMD subsequently decreased (26).

Since foods of animal origin (milk, cheese, liver) and vitamin supplements have high amounts of preformed vitamin A, they contain the highest levels of retinol. Thus, the typical western diet may lead to an excess consumption of retinol. Indeed the evidence that 5% to 10% of the population consumes 2 to 3 times the RDA for vitamin A puts many individuals at risk for bone loss (31).

Effect of Vitamin A on Muscle Mass and Falls. Given the evidence that vitamin A has an antagonistic effect on vitamin D in both human and animal studies and that vitamin D is related to falls, it is possible that vitamin A may also play a role in falls in the elderly. As discussed earlier, adequate vitamin D intake is linked to increased muscle mass and strength in the elderly, in turn, this reduces their risk of falling. The possible interaction between excessive vitamin A intake and insufficient vitamin D intake may contribute to reduced muscle mass and

strength in the elderly. Therefore, excessive vitamin A consumption may play a role in falls. Furthermore, the relationship between vitamin A and vitamin D may be even more important than either vitamin independently in preserving muscle strength and muscle mass and thus, reducing falls in the elderly.

To our knowledge, there are no reports of the relationship between vitamin A intake and falls in the elderly. It has been shown that approximately 40% of the US population consumes a dietary supplement (30). Moreover, the mean intake of vitamin A (as retinol) for US men and women over the age of 70 is approximately 1,225 micrograms Retinol Equivalents (RE) (31). As a result, the excessive consumption of this potent fat-soluble vitamin may therefore be contributing to lower BMD, a greater likelihood of falling, and a higher risk of hip fracture in the elderly.

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Appendix B: IRB Proposal and Modification

OREGON STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
312 Kerr Administration Building · Corvallis, Oregon · 97331-2140
E-MAIL: IRB@oregonstate.edu · PHONE: (541) 737-3437 · FAX: (541) 737-3093

REPORT OF REVIEW

TO: Christine Snow,
Exercise and Sport Science

RE: The Side Fall Risk Index as a Predictor of Bone Density and Side Falls (Student Researcher: Katherine Gunter)

Protocol No. 1402

The referenced project was reviewed under the guidelines of Oregon State University's Institutional Review Board (IRB). The IRB has approved the post hoc modification request. This modification request was reviewed at the Expedited level. This project was closed on August 30, 2002. This approval does not renew the approval period for this project; it remains closed.

If you have any questions, please contact the IRB Human Protections Administrator at IRB@oregonstate.edu or by phone at (541) 737-3437.

Dr. Anthony Wilcox
Institutional Review Board Chair

Date: 2/21/03

pc: 1402 file

OREGON STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
MODIFICATION REQUEST FORM

Submit this form to request changes to an existing approved protocol. Be sure to allow adequate time for review and comments. All material, including this cover sheet, must be typed and submitted to the Human Protections Administrator, Office of Sponsored Programs and Research Compliance, 312 Kerr Administration Bldg. ***Incomplete applications will be delay the review process.*** Send an e-mail to *IRB@oregonstate.edu* or call (541) 737-3437 with any questions.

Principal Investigator: Christine Snow **E-mail:** Christine.Snow@orst.edu

Department: EXSS **Telephone:** 737-6788

Project Title: The Side Fall Risk Index as a Predictor of Bone Density and Side Falls

Student Researcher (if any): Katherine B. Gunter and Carrie Gramer

IRB Protocol No. _____ **Funding Source:** Erkkila Foundation

Most Recent Approval Date: November 2000

If this modification is being made due to a participant safety issue or the addition of risks, attach a completed copy of the OSU IRB ADVERSE EVENT FORM (available at: http://osu.orst.edu/research/RegulatoryCompliance/HumanSubjects.html).

1. **How many participants have been enrolled to date?** 129
2. **How many future participants are you planning to enroll in this study?** 0
3. **Please give a detailed list of any proposed modification(s) (this includes a change of principal investigator or research staff) and justification for the proposed revision(s) (attach a separate sheet if necessary):** We have completed data collection and are now in the process of analyzing data. The modification we propose is post hoc. During data collection, participants filled out a nutrition questionnaire which we neglected to include in our IRB proposal (Block Brief Food Questionnaire, Block Dietary Systems, Berkeley CA). This questionnaire was omitted from the informed consent document as well. We estimate it took subjects approximately 15 minutes to complete the questionnaire. The purpose of the questionnaire was to obtain information regarding dietary calcium intake in order to control for this variable in our analyses of bone mineral density (primary outcome measure.) We regret that we did not include this questionnaire in our original IRB documents and would ask that our file be updated to include this document. This document has been previously aproved by the IRB and utilized in studies in the Bone Research Laboratory.

Furthermore, though it was not part of the original proposal, Carrie Gramer (added to the above student researcher line), a graduate student in the Bone Research Laboratory, is interested in studying the relationship between preformed vitamin A and bone mineral density (BMD) in older adults and is hoping to investigate this question as part of her master's thesis. There is evidence that high vitamin A intake is related to reduced BMD and increased incidence of hip fracture To study this relationship, she would use data from the nutrition questionnaires and determine whether vitamin A intake predicts the BMD, using bone data that we collected as part of the original study. This would not require additional testing or data collection. Confidentiality of participants will be preserved because this particular graduate student has been involved with the study since 2001 helping with both data collection and data entry. Thus, no additional personnel will be accessing the data. We have attached a copy of the Block Brief Food Questionnaire. We thus request IRB permission to analyze the nutrition data as it relates to this question without re-consenting our subjects to do so. Please let us know if you require any additional materials prior to our analyzing the nutrition data.

4. Please attach any modified documents or instruments (such as informed consent document, surveys, questionnaires, etc.) and insert proposed changes in the complete protocol, indicating the changes with a colored highlighter.

APPLICATION FOR APPROVAL OF THE OSU INSTITUTIONAL REVIEW BOARD (IRB) FOR THE PROTECTION OF HUMAN SUBJECTS

Principal Investigator: Christine Snow E-mail: christine.snow@orst.edu

Co-Investigator: Katherine Gunter (Ph.D. student)

Source of Funding: Erkkila Foundation

Department: Exercise and Sport Science

Project Title: The Side Fall Risk Index as a Predictor of Bone Density and Side Falls

Type of Project: ___XX___ Student Research Project

Type of Review Requested: _____Exempt _____Expedited ___XX___Full Board

Signed: _____

Principal Investigator

Significance of the Study

Hip fractures in the elderly account for a large portion of the disability and mortality experienced by older Americans. Of the 350,000 hip fractures that occur annually, over 90% are the result of a fall and falling to the side on or near the hip raises the risk of hip fracture 6-fold. We have recently developed and refined a *Side Fall Risk Index*, a battery of tests developed specifically for the identification of sideways fallers. Preliminary data indicate that individuals with a history of falling to the side perform more poorly than other-direction fallers on the performance variables included in the index. Specifically, a linear combination of tandem gait, hip abduction strength, lateral step velocity asymmetry, and sway variables while standing in a semi-tandem stance position distinguished elderly subjects who fell to the side from those who fell in other directions.

Decreases in bone mineral density (BMD) are a normal consequence of aging, and the loss of BMD is estimated to account for as much as 80% of the decrease in skeletal strength. Average losses of 2% per year have been shown in studies of later stage postmenopausal women (15-30 years postmenopausal) (28). However, few longitudinal data exist that examine rate of change in BMD for this population. Additionally, there are no data relating changes in fall risk factors and changes in bone. Therefore, investigating changes in variables known to be associated with an increased risk of sideways falls, such as medial-lateral balance, strength, and mobility, in association with changes in bone mineral density will help identify those at greatest risk of hip fracture. The aim of this study is twofold: 1) to test whether the Side Fall Risk Index predicts side falls in a population of independently living adults over 70 years of age and 2) to examine the rate of change in bone density and its relationship to changes in performance on the Side Fall Risk Index.

Subjects : We propose a longitudinal follow-up study on 150 independently living adults who are seventy years of age and older. All subjects are currently participants in a fall risk study and were recruited from the Mid-Willamette Valley in western Oregon. All individuals who participated in the fall risk study are capable of completing the required paperwork and are free from diseases or conditions that would prohibit their participation in the testing. Baseline data on Side Fall Risk Index components and bone health were collected between January 1998 and March 2000. In addition, we have collected falls surveillance data that include the direction and circumstances of all falls that have occurred since baseline.

Methods and Time Line: We will measure individuals once who have previously been assessed to identify changes in performance on the Side Fall Risk Index and changes in bone. Data collection will occur between November 2000 and November 2001. Additionally, we will continue to collect quantitative data on fall frequency and fall direction as well as qualitative information regarding the circumstances of falls through controlled falls surveillance using regular monthly mailings and follow-up phone interviews with individuals reporting a fall through the mail.

Measures: ***Side Fall Risk Index.*** The Side Fall Risk Index (SFRI) includes five measures. The Tandem Gait test is used to measure dynamic balance and mobility and requires subjects to walk heel-to-toe as fast as possible for 3.05 meters. At every step, the heel of the stepping foot must make contact with the toe of the stance foot. The Quick Step measures reaction time while subjects step to the side as quickly as possible. The Accu-Sway force platform measures postural sway. Subjects will stand as still as possible in a semi-tandem position for 20 seconds. A hand-held dynamometer will be used to measure isometric hip abduction with subjects completing four trials with each leg. The Up and Go test will be

used as an additional measure of mobility given its utility as a screening tool for individuals likely to fall.

Bone Density Measurements. Bone mineral density (BMD, in g/cm2) of the left hip and spine will be assessed by dual energy x-ray absorptiometry. A licensed radiological technician will perform all bone scans.

Benefits and Risks From Participation: One hip and spine scan delivers approximately 5-10 mrem per scan, less than the radiation exposure from being outside in the sunshine for a day. The risk involved in performance of the Side Fall Risk Index tests is small. To further minimize the risk a trained "spotter" will assist subjects during all mobility tests. Subjects may experience mild discomfort one to two days following the hip strength test, but to date, we have no reports of soreness. Benefits include free bone scans and information on physical function changes.

Informed Consent: Please refer to the attached informed consent document.

Method of Obtaining Consent: Subjects will be contacted initially through a mailing including a detailed description of the study and the measures as well as the risks and benefits. When subjects are contacted by telephone, they will be given a verbal description of the study and an opportunity to ask questions. Those interested subjects will be given an informed consent document to read and sign when they come to the Bone Research Laboratory for testing.

Confidentiality: Subjects have been previously assigned a subject number, which is used on all computer output and is stored in a separate file. Only the investigators have knowledge of each subject's name and identification number.

Appendix C: Informed Consent Form

Informed Consent

Title: The Side Fall Risk Index as a Predictor of Hip Fracture Risk

Investigators: Christine Snow, Ph.D., Associate Professor, 737-6788
Katherine Gunter, Ph.D. Student, 737-5935

Purpose: Of the 350,000 hip fractures annually, over 90% are the result of direct impact to the hip due to a fall to the side. We have identified variables known to be associated with an increased risk of sideways falls. These include medial lateral (side to side) balance, strength, and mobility. Poor performances on these tasks in association with reductions in bone mineral density which are a normal consequence of aging, increase one's risk of experiencing a hip fracture. The purpose of this study is to compare the changes in medial lateral strength, balance and mobility, as well as changes in bone density among individuals over 70 to determine whether side fallers differ from other direction fallers or non-fallers on these variables.

I have been invited to participate in this study because I am currently a participant in the falls surveillance study at the Bone Research Laboratory. I am only required to come into the lab one time and the testing session will take approximately 2 hours.

Procedures:

1. **Bone Mineral Density Assessment.** Bone mass of my spine and left hip will be measured using an x-ray. This technique gives an accurate measure of bone density with a very low exposure to radiation.

2. **Leg Strength Assessment:** The strength of my right and left hips will be measured with a simple device that I will press the side of my leg against.

3. **Balance**: I will be asked to stand on a stationary platform, with one foot in front of the other, while computer sensors under the platform measure how much I sway.

4. **Reaction and Movement Time:** I will stand in a relaxed position in front of a light signal. When the light turns red I will step to the side as quickly as possible. The test will be repeated 5 times on each leg. I will perform a second test where I will begin standing in a relaxed position and step forward across my body onto a target placed on the floor in response to the light turning red. This test will also be repeated 5 times for each leg.

5. **Mobility**: I will be asked to walk heel to toe as quickly as possible and to stand up walk a short distance then return to my seat as quickly as possible.

Risks and Benefits: Measurement of bone mineral density will provide an accurate assessment of my bone mass. Evaluation is diagnostic and questions regarding my bone mineral density report should be directed to my physician. **I will be given copies of both my baseline and follow-up scans on the day of my testing appointment that I can share with my physician.** It has been explained to me that an additional benefit of participating in this study is to help identify simple procedures to predict men and women who may be at risk for a side fall.

I understand that the risks involved in performing these tests are minimal. To further reduce any fall risk, I will be assisted by a trained "spotter" at all times. Also, I may experience some minor muscle soreness. This should clear up completely in a day or two. X-ray exposure from bone scans is extremely low. The amount of radiation that I will receive is less than the amount of radiation an average individual receives in one day from background sources (sun, etc).

Confidentiality
I understand that my confidentiality will be maintained and that only the researchers will have access to my results. I have been informed that the results of this study may be published in scientific literature, and that these data will not reveal my name.

Participation and Questions
I understand that participation is voluntary and that I may stop doing a test if it is uncomfortable or may withdraw at any time without penalty. I may contact the researchers Dr. Christine Snow at 541-737-6788, 106 Women's Building, Oregon State University or Kathy Gunter at 541-737-5935, 13 Women's Building, Oregon State University if I have any questions or concerns regarding the study. Any questions that I may have regarding my rights as a research subject should be directed to the IRB Coordinator, OSU Research Office, 541-737-3437.

I have read the above consent form and I agree to participate.

Subject Signature_____ Date_____

Investigator's Signature_____ Date_____

Appendix D: Health History Questionnaire

OREGON STATE UNIVERSITY BONE RESEARCH LABORATORY
Health History Questionnaire

Last name _____ First name _____ Middle _____ Date of birth _____

Address, street _____ City, State _____

phone work/home _____ email address _____ Occupation _____

Weight _____pounds Height ____ft_____inches

Please list your present medications and dosages
(include birth control pills/vitamins):

****

PAST HISTORY (Check if yes)
Have you ever had?

High cholesterol	___
Rheumatic fever	___
Heart murmur	___
High blood pressure	___
Heart trouble	___
Disease of arteries	___
Varicose veins	___
Lung disease	___
Operations	___
Back injury	___
Other musculoskeletal injury or problems	___
Epilepsy	___

If yes to any of the above, please explain

FAMILY HISTORY (Check if yes)
Have your grandparents, parents or siblings had?

Diabetes	___
Heart attacks	___
High blood pressure	___
High cholesterol	___
Congenital heart disease	___
Heart operations	___

Other _____

_____

Date of last medical exam? _____

Physician: _____

Which describes your racial/ethnic identify? (Please check all that apply)

___ White, European American, Non Hispanic
___ Asian, Asian American
___ Black, African American, Non Hispanic
___ Middle Eastern or Middle Eastern American
___ North African or North African American
___ Pacific Islander
___ Hispanic of Latino American
___ American Indian or Alaskan Native
___ If none of the above choices apply to you, please use your own description:

_____

___ Decline to respond

PRESENT SYMPTOMS REVIEW (Check if yes)

Have you recently had?

Chest pain ___
Shortness of breath ___
Heart palpitations ___
Cough on exertion ___
Coughing blood ___
Back pain ___
Painful, stiff or swollen joints ___

Other_____

_____

HEALTH HABITS

Smoking	YES	NO		
Do you smoke?	___	___		
Cigarettes	___		How many/day? _____	How many years? _____
Cigar	___		How many/day? _____	How many years? _____
Pipe	___		Times/day? _____	How many years? _____

If you have quit smoking, when did you quit? _____ How many yrs did you smoke? ___

Alcohol Consumption
Do you drink alcohol daily? Y N (circle one) If yes, how many drinks/week? _____

Consumption of calcium-rich daily products
How many 8 oz glasses of milk do you drink per day? _____ per week? ____
How many servings of cheese (1 oz) do you eat per day? _____ per week? ____
How many servings of yogurt (1 cup) do you eat per week? _____

Body Weight
What was your weight 1 month ago? _____ What was your weight 2 months ago? _____

Cola Beverages
How many cola beverages do you drink daily? _____
How many years have you been drinking cola beverages on a regular basis? _____

Activity History

I. In high school, would you describe yourself as:

___ active ___ moderately active ___not active (please check one)

Were your activities predominately swimming or cycling? (if yes, circle one)
If not, please describe:

II. Since high school, would you describe yourself as:
___ active ___ moderately active ___not active (please check one)

Were your activities predominately swimming or cycling? (if yes, circle one)
If not, please describe:

OSTEOPOROSIS RISK FACTORS

Please circle true or false for the following. If you think a statement may apply to you but are not sure, place a question mark (?) by that statement.

1. true false I have a history of rheumatoid arthritis.
2. true false I have been treated with cortisone or similar drugs.
3. true false I have a close relative with osteoporosis.
4. true false I have a history of an overactive thyroid gland.
5. true false I have a history of overactive parathyroid gland.
6. true false I have a history of alcoholism.
7. true false I have a history of chronic liver disease.
8. true false I have a history of multiple myeloma.
9. true false I have a history of the blood tumor, leukemia.
10. true false I have a history of stomach ulcers.
11. true false I have lactase deficiency (inability to digest milk).
12. true false Some of my stomach has been surgically removed.
13. true false I take anabolic steroids now or have in the past.
14. true false I avoid milk and other dairy products.
15. true false I usually eat meat at least twice a day.
16. true false I drink more than 2 cups of coffee or tea daily.
17. true false On average, I drink 2 or more soft drinks daily.
18. true false I have about 3 or more alcoholic beverages daily.
19. true false I follow a vegetarian diet and have so for years.
20. true false I am not very physically active most of the time.
21. true false I have lost more than 1 inch in height.
22. true false I take or have taken thyroid hormone pills.
23. true false I took phenobarbitol or dilantin for over a year.
24. true false I use Maalox or Mylanta antacids frequently.
25. true false I have taken furosamide (Lasix) for over one year.
26. true false I have been treated with lithium for over one year.
27. true false I have been treated with chemotherapy for cancer.
28. true false I take or have taken cyclosporin A (Sandimmune).
29. true false I have received an organ transplant (kidney, etc.).
30. true false I have had trouble with anorexia nervosa or bulimia.

(Women only)

35. true false I lost my period for a year or more before it came back.
36. true false I have had irregular menstrual periods.
37. true false My menstrual period did not begin until after age 16.
39. true false I have a medical history of endometriosis.
40. true false I lost my periods when I was exercising heavily.
41. true false I have had both ovaries surgically removed.
42. true false I have breast fed a baby for one month or more.
43. true false I take tamoxifin as treatment for breast cancer..
44. true false I went through menopause before age 50.
45. true false I have gone through menopause (change of life).
46. true false I have received estrogen treatment after menopause.

If you take estrogen, for how many years? _____
How many children have you given birth to? _____
What was the date of your last menstrual period? _____

Appendix E: Physical Activity Scale for the Elderly (PASE)

PHYSICAL ACTIVITY SCALE FOR THE ELDERLY

(P A S E)

INSTRUCTIONS:

Please complete this questionnaire by either circling the correct response or filling in the blank. Here is an example:

During the past 7 days, how often have you seen the sun?

[0.] NEVER	[1.] SELDOM (1-2 DAYS)	[2.] SOMETIMES (3-4 DAYS)	[3.] OFTEN (5-7 DAYS)

Answer all items as accurately as possible. All information is strictly confidential.

LEISURE TIME ACTIVITY

1. Over the past 7 days, how often did you participate in sitting activities such as reading, watching TV or doing handcrafts?

[0.] NEVER → GO TO Q.#2

[1.] SELDOM (1-2 DAYS)

[2.] SOMETIMES (3-4 DAYS)

[3.] OFTEN (5-7 DAYS)

1a. What were these activities?

_____

1b. On average, how many hours per day did you engage in these sitting activities?

[1.] LESS THAN 1 HOUR

[2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS

[4.] MORE THAN 4 HOURS

2. Over the past 7 days, how often did you take a walk outside your home or yard for any reason? For example, for fun or exercise, walking to work, walking the dog, etc.?

[0.] NEVER → GO TO Q.#3

[1.] SELDOM (1-2 DAYS)

[2.] SOMETIMES (3-4 DAYS)

[3.] OFTEN (5-7 DAYS)

2a. On average, how many hours per day did you spend walking?

[1.] LESS THAN 1 HOUR

[2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS

[4.] MORE THAN 4 HOURS

3. Over the past 7 days, how often did you engage in light sport or recreational activities such as bowling, golf with a cart. shuffleboard, fishing from a boat or pier or other similar activities?

[0.] NEVER → GO TO Q.#4

[1.] SELDOM (1-2 DAYS)

[2.] SOMETIMES (3-4 DAYS)

[3.] OFTEN (5-7 DAYS)

3a. What were these activities?

_____

3b. On average, how many hours per day did you engage in these light sport or recreational activities?

[1.] LESS THAN 1 HOUR

[2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS

[4.] MORE THAN 4 HOURS

4. Over the past 7 days, how often did you engage in moderate sport and recreational activities such as doubles tennis, ballroom dancing, hunting, ice skating, golf without a cart, softball or other similar activities?

[0.] NEVER → GO TO Q.#5

[1.] SELDOM (1-2 DAYS)

[2.] SOMETIMES (3-4 DAYS)

[3.] OFTEN (5-7 DAYS)

4a. What were these activities?

_____

4b. On average, how many hours per day did you engage in these moderate sport and recreational activities?

[1.] LESS THAN 1 HOUR

[2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS

[4.] MORE THAN 4 HOURS

5. Over the past 7 days, how often did you engage in strenuous sport and recreational activities such as jogging, swimming. cycling, singles tennis, aerobic dance, skiing (downhill or cross-country) or other similar activities?

[0.] NEVER → GO TO Q.#6

[1.] SELDOM (1-2 DAYS)

[2.] SOMETIMES (3-4 DAYS)

[3.] OFTEN (5-7 DAYS)

5a. What were these activities?

_____

5b. On average, how many hours per day did you engage in these strenuous sport and recreational activities?

[1.] LESS THAN 1 HOUR

[2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS

[4.] MORE THAN 4 HOURS

6. Over the past 7 days, how often did you do any exercises specifically to increase muscle strength and endurance, such as lifting weights or pushups, etc.?

[0.] NEVER → GO TO Q.#7

[1.] SELDOM (1-2 DAYS)

[2.] SOMETIMES (3-4 DAYS)

[3.] OFTEN (5-7 DAYS)

6a. What were these activities?

_____

6b. On average, how many hours per day did you engage in exercises to increase muscle strength and endurance?

[1.] LESS THAN 1 HOUR

[2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS

[4.] MORE THAN 4 HOURS

HOUSEHOLD ACTIVITY

7. During the past 7 days, have you done any light housework, such as dusting or washing dishes?

   [1.] NO [2.] YES

8. During the past 7 days, have you done any heavy housework or chores, such as vacuuming, scrubbing floors, washing windows, or carrying wood?

   [1.] NO [2.] YES

9. During the past 7 days, did you engage in any of the following activities?

   Please answer YES or NO for each item.

		NO	YES
a.	Home repairs like painting, wallpapering, electrical work, etc.	1	2
b.	Lawn work or yard care, including snow or leaf removal, wood chopping, etc.	1	2
c.	Outdoor gardening	1	2
d.	Caring for an other person, such as children, dependent spouse, or an other adult	1	2

WORK-RELATED ACTIVITY

10. During the past 7 days, did you work for pay or as a volunteer?

[1.] NO [2.] YES

10a. How many hours per week did you work for pay and/or as a volunteer?

_____ HOURS

10b. Which of the following categories best describes the amount of physical activity required on your job and/or volunteer work?

[1] Mainly sitting with slight arm movements. **[Examples:** office worker, watchmaker, seated assembly line worker, bus driver, etc.]

[2] Sitting or standing with some walking. **[Examples:** cashier, general office worker, light tool and machinery worker.]

[3] Walking, with some handling of materials generally weighing less than 50 pounds. **[Examples:** mailman, waiter/waitress, construction worker, heavy tool and machinery worker.]

[4] Walking and heavy manual work often requiring handling of materials weighing over 50 pounds. **[Examples:** lumberjack, stone mason, farm or general laborer.]

Appendix F: Food Frequency Questionnaire (FFQ)

RESPONDENT ID NUMBER

TODAY'S DATE

	DAY	YEAR
○ Jan		
○ Feb		
○ Mar		2000 ○
○ Apr		2001 ○
○ May		2002 ○
○ Jun		2003 ○
○ Jul		2004 ○
○ Aug		2005 ○
○ Sep		2006 ○
○ Oct		2007 ○
○ Nov		2008 ○
○ Dec		2009 ○

BRIEF FOOD QUESTIONNAIRE

This form is about the foods you usually eat. It will take about 15 - 25 minutes to complete.

- **Please answer each question as best you can. Estimate if you aren't sure.**
- **Use only a No. 2 pencil.**
- **Fill in the circles completely, and erase completely if you make any changes.**

Please print your name in this box.

SEX
○ Male
○ Female

If female, are you pregnant or breast feeding?
○ No
○ Yes
○ Not female

AGE

WEIGHT pounds

HEIGHT ft. in.

This form is about your usual eating habits in the past year or so. This includes all meals or snacks, at home or in a restaurant or carry-out. There are two kinds of questions for each food.

HOW OFTEN, on average, did you eat the food during the past year?
*Please DO NOT SKIP any foods. Mark "Never" if you didn't eat it.

HOW MUCH did you usually eat of the food?
*Sometimes we ask how many you eat, such as 1 egg, 2 eggs, etc., ON THE DAYS YOU EAT IT.
*Sometimes we ask "how much" as A, B, C or D. LOOK AT THE ENCLOSED PICTURES. For each food, pick the picture (bowls or plates) that looks the most like the serving size you usually eat. (If you don't have pictures: A=1/4 cup, B=1/2 cup, C=1 cup, D= 2 cups.)

EXAMPLE: This person drank apple juice twice a week, and had one glass each time. Once a week he ate a "C"-sized serving of rice (about 1 cup).

TYPE OF FOOD	HOW OFTEN IN THE PAST YEAR									HOW MUCH EACH TIME SEE PORTION SIZE PICTURES FOR A-B-C-D				
	NEVER	A FEW TIMES per YEAR	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	TWICE per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY					
Apple juice	○	○	○	○	○	●	○	○	○	How many glasses each time	● 1	○ 2	○ 3	○ 4
Rice	○	○	○	○	●	○	○	○	○	How much each time	○ A	○ B	● C	○ D

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TYPE OF FOOD	HOW OFTEN IN THE PAST YEAR									HOW MUCH EACH TIME SEE PORTION SIZE PICTURES FOR A-B-C-D				
	NEVER	A FEW TIMES per YEAR	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	TWICE per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY					
How often do you eat each of the following foods all year round?														
Eggs, including egg biscuits or Egg McMuffins (Not egg substitutes)	○	○	○	○	○	○	○	○	○	How many eggs each time	○ 1	○ 2	○ 3	○ 4
Bacon or breakfast sausage, including sausage biscuit	○	○	○	○	○	○	○	○	○	How many pieces	○ 1	○ 2	○ 3	○ 4
Cooked cereals like oatmeal, cream of wheat or grits	○	○	○	○	○	○	○	○	○	Which bowl		○ B	○ C	○ D
Cold cereals like Corn Flakes, Cheerios, Special K, fiber cereals	○	○	○	○	○	○	○	○	○	Which bowl		○ B	○ C	○ D
Which cereal do you eat most often? **MARK ONLY ONE:** ○ Product 19, Just Right, Total ○ Bran Buds, Raisin Bran, Fruit-n-Fiber, other fiber cereals ○ Other cold cereal, like Corn Flakes, Cheerios, Special K														
Cheese, sliced cheese or cheese spread, including on sandwiches.	○	○	○	○	○	○	○	○	○	How many slices	○ 1	○ 2	○ 3	○ 4
Yogurt (not frozen yogurt)	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
How often do you eat each of the following fruits?														
Bananas	○	○	○	○	○	○	○	○	○	How many each time	○ 1/2	○ 1	○ 2	○ 3
Apples or pears	○	○	○	○	○	○	○	○	○	How many	○ 1/2	○ 1	○ 2	○ 3
Oranges, tangerines, not including juice	○	○	○	○	○	○	○	○	○	How many	○ 1/2	○ 1	○ 2	○ 3
Applesauce, fruit cocktail, or any canned fruit	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Any other fruit, like grapes, melon, strawberries, peaches, applesauce	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D

TYPE OF FOOD	HOW OFTEN IN THE PAST YEAR									HOW MUCH EACH TIME SEE PORTION SIZE PICTURES FOR A-B-C-D				
	NEVER	A FEW TIMES per YEAR	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	TWICE per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY					
How often do you eat each of the following vegetables, including fresh, frozen, canned or in stir fry, at home or in a restaurant?														
French fries, fried potatoes or hash browns	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
White potatoes not fried, incl. boiled, baked, mashed & potato salad	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Sweet potatoes, yams, or sweet potato pie	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Rice, or dishes made with rice	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Baked beans, chili with beans, pintos, any other dried beans	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Refried beans	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Green beans or green peas	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Broccoli	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Carrots, or stews or mixed vegetables containing carrots	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Spinach, or greens like collards	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Cole slaw, cabbage	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Green salad	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Raw tomatoes, including in salad	○	○	○	○	○	○	○	○	○	How much	○ 1/4	○ 1/2	○ 1	○ 2
Catsup, salsa or chile peppers	○	○	○	○	○	○	○	○	○	How many TBSP.	○ 1	○ 2	○ 3	○ 4
Salad dressing or mayonnaise (Not lowfat)	○	○	○	○	○	○	○	○	○	How many TBSP.	○ 1	○ 2	○ 3	○ 4
Any other vegetable, like corn, squash, okra, cooked green peppers, cooked onions	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Vegetable soup, vegetable beef, chicken vegetable, or tomato soup	○	○	○	○	○	○	○	○	○	Which bowl		○ B	○ C	○ D

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TYPE OF FOOD	HOW OFTEN IN THE PAST YEAR: NEVER	A FEW TIMES per YEAR	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	TWICE per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH EACH TIME SEE PORTION SIZE PICTURES FOR A-B-C-D
MEATS										
Do you ever eat chicken, meat or fish? ○ Yes ○ No IF NO, SKIP TO NEXT PAGE										
Hamburgers, cheeseburgers, meat loaf, at home or in a restaurant	○	○	○	○	○	○	○	○	○	How much meat ○ 1/8 lb. ○ 1/4 lb. ○ 1/2 lb. ○ 3/4 lb.
Tacos, burritos, enchiladas, tamales	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Beef steaks, roasts, pot roast, or in frozen dinners or sandwiches	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Pork, including chops, roasts, or dinner ham	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
When you eat beef or pork, do you ○ Avoid eating the fat ○ Sometimes eat the fat ○ Often eat the fat ○ I don't eat meat										
Mixed dishes with meat or chicken, like stew, corned beef hash, chicken & dumplings, or in frozen meals	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Fried chicken, at home or in a restaurant	○	○	○	○	○	○	○	○	○	# medium pieces ○ 1 ○ 2 ○ 3 ○ 4
Chicken or turkey not fried, such as baked, grilled, or on sandwiches	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
When you eat chicken, do you ○ Avoid eating the skin ○ Sometimes eat the skin ○ Often eat the skin ○ N/A										
Fried fish or fish sandwich, at home or in a restaurant	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Any other fish or shellfish not fried, including tuna	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Hot dogs, or sausage like Polish, Italian or Chorizo	○	○	○	○	○	○	○	○	○	How many ○ 1 ○ 2 ○ 3 ○ 4
Boloney, sliced ham, turkey lunch meat, other lunch meat	○	○	○	○	○	○	○	○	○	How many slices ○ 1 ○ 2 ○ 3 ○ 4
When you eat lunch meats, are they ○ Usually low-fat ○ Sometimes ○ Rarely low-fat ○ N/A										

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TYPE OF FOOD	HOW OFTEN IN THE PAST YEAR: NEVER	A FEW TIMES per YEAR	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	TWICE per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH EACH TIME — SEE PORTION SIZE PICTURES FOR A-B-C-D				
Pasta, breads, spreads, snacks														
Spaghetti, lasagna, or other pasta with tomato sauce	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Cheese dishes without tomato sauce, like macaroni and cheese	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Pizza, including carry-out	○	○	○	○	○	○	○	○	○	How many slices	○ 1	○ 2	○ 3	○ 4
Biscuits, muffins	○	○	○	○	○	○	○	○	○	How many each time	○ 1	○ 2	○ 3	○ 4
Rolls, hamburger buns, English muffins, bagels	○	○	○	○	○	○	○	○	○	How many each time	○ 1/2	○ 1	○ 2	○ 3
White bread or toast, including French, Italian, or in sandwiches	○	○	○	○	○	○	○	○	○	How many slices	○ 1	○ 2	○ 3	○ 4
Dark bread like rye or whole wheat, including in sandwiches	○	○	○	○	○	○	○	○	○	How many slices	○ 1	○ 2	○ 3	○ 4
Tortillas	○	○	○	○	○	○	○	○	○	How many each time	○ 1	○ 2	○ 3	○ 4
Margarine on bread, potatoes or vegetables	○	○	○	○	○	○	○	○	○	How many pats (Tsp.)	○ 1	○ 2	○ 3	○ 4
Butter on bread, potatoes or vegetables	○	○	○	○	○	○	○	○	○	How many pats (Tsp.)	○ 1	○ 2	○ 3	○ 4
Peanuts or peanut butter	○	○	○	○	○	○	○	○	○	How many TBSP.	○ 1	○ 2	○ 3	○ 4
Snacks like potato chips, corn chips, popcorn (Not pretzels)	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
Doughnuts, cake, pastry, pie	○	○	○	○	○	○	○	○	○	How many pieces	○ 1	○ 2	○ 3	○ 4
Cookies (Not lowfat)	○	○	○	○	○	○	○	○	○	How many	○ 1-2	○ 3-5	○ 6-7	○ 8+
Ice cream, frozen yogurt, ice cream bars	○	○	○	○	○	○	○	○	○	How much	○ A	○ B	○ C	○ D
When you eat ice cream or frozen yogurt, is it	○ Usually low-fat	○ Sometimes	○ Rarely low-fat	○ N/A										
Chocolate candy, candy bars	○	○	○	○	○	○	○	○	○	How many bars	① small	① medium	① large	② large

TYPE OF BEVERAGE	HOW OFTEN IN THE PAST YEAR: NEVER	A FEW TIMES per YEAR	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	TWICE per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH EACH TIME SEE PORTION SIZE PICTURES FOR A-B-C-D				
How often do you drink the following beverages?														
Real orange or grapefruit juice, Welch's grape juice, Minutemaid juices, Juicy Juice	○	○	○	○	○	○	○	○	○	How many glasses each time	○ 1	○ 2	○ 3	○ 4
Hawaiian Punch, Sunny Delight, Hi-C, Tang or Ocean Spray juices	○	○	○	○	○	○	○	○	○	How many glasses each time	○ 1	○ 2	○ 3	○ 4
Kool Aid, Capri Sun or Knudsen juices	○	○	○	○	○	○	○	○	○	How many glasses each time	○ 1	○ 2	○ 3	○ 4
Instant breakfast milkshakes like Carnation, diet shakes like Slimfast, or liquid supplements like Ensure	○	○	○	○	○	○	○	○	○	How many glasses or cans	○ 1	○ 2	○ 3	○ 4
Glasses of milk (any kind)	○	○	○	○	○	○	○	○	○	How many glasses	○ 1	○ 2	○ 3	○ 4
When you drink glasses of milk what kind do you usually drink? **MARK ONLY ONE:**	○ Whole milk ○ Reduced fat 2% milk ○ Low-fat 1% milk				○ Non-fat milk ○ Rice milk ○ Soy milk				○ I don't drink milk or soy milk					
Cream, Half-and-Half or non-dairy creamer in coffee or tea	○	○	○	○	○	○	○	○	○	Total TBSP. on those days	○ 1	○ 2	○ 3-4	○ 5+
Regular soft drinks, or bottled drinks like Snapple (Not diet drinks)	○	○	○	○	○	○	○	○	○	How many bottles or cans	○ 1	○ 2	○ 3-4	○ 5+
Beer	○	○	○	○	○	○	○	○	○	How many bottles or cans	○ 1	○ 2	○ 3-4	○ 5+
Wine or wine coolers	○	○	○	○	○	○	○	○	○	How many glasses	○ 1	○ 2	○ 3-4	○ 5+
Liquor or mixed drinks	○	○	○	○	○	○	○	○	○	How many drinks	○ 1	○ 2	○ 3-4	○ 5+

During the past year, have you taken any vitamins or minerals regularly, at least once a month?

○ No, not regularly ○ Yes, fairly regularly →

(IF YES) WHAT DID YOU TAKE FAIRLY REGULARLY?

VITAMIN TYPE	HOW OFTEN					FOR HOW MANY YEARS?					
	DIDN'T TAKE	A FEW DAYS per MONTH	1-3 DAYS per WEEK	4-6 DAYS per WEEK	EVERY DAY	LESS THAN 1 YR.	1 YEAR	2 YEARS	3-4 YEARS	5-9 YEARS	10+ YEARS
Multiple Vitamins. Did you take...											
Regular Once-A-Day, Centrum, or Thera type	○	○	○	○	○	○	○	○	○	○	○
Stress-tabs or B-Complex type	○	○	○	○	○	○	○	○	○	○	○
Antioxidant combination type	○	○	○	○	○	○	○	○	○	○	○
Single Vitamins (not part of multiple vitamins)											
Vitamin A (not beta-carotene)	○	○	○	○	○	○	○	○	○	○	○
Beta-carotene	○	○	○	○	○	○	○	○	○	○	○
Vitamin C	○	○	○	○	○	○	○	○	○	○	○
Vitamin E	○	○	○	○	○	○	○	○	○	○	○
Folic acid, folate	○	○	○	○	○	○	○	○	○	○	○
Calcium or Tums, alone or combined with vit. D or magnesium	○	○	○	○	○	○	○	○	○	○	○
Zinc	○	○	○	○	○	○	○	○	○	○	○
Iron	○	○	○	○	○	○	○	○	○	○	○
Selenium	○	○	○	○	○	○	○	○	○	○	○
Vitamin D, alone or combined with calcium	○	○	○	○	○	○	○	○	○	○	○

If you took vitamin C or vitamin E:

How many milligrams of **vitamin C** did you usually take, on the days you took it?

○ 100 ○ 250 ○ 500 ○ 750 ○ 1000 ○ 1500 ○ 2000 ○ 3000+ ○ don't know

How many IUs of **vitamin E** did you usually take, on the days you took it?

○ 100 ○ 200 ○ 300 ○ 400 ○ 600 ○ 800 ○ 1000 ○ 2000+ ○ don't know

How often do you use fat or oil in cooking?

○ Less than once per week ○ A few times per week ○ Once a day ○ Twice a day ○ 3+ per day

What kinds of fat or oil do you usually use in cooking? MARK ONLY ONE OR TWO

○ Don't know, or Pam ○ Butter/margarine blend ○ Lard, fatback, bacon fat
○ Stick margarine ○ Low-fat margarine ○ Crisco
○ Soft tub margarine ○ Corn oil, vegetable oil
○ Butter ○ Olive oil or canola oil

Did you ever drink more beer, wine or liquor than you do now? ○ Yes ○ No

Do you smoke cigarettes now? ○ Yes ○ No

IF YES, On the average about how many cigarettes a day do you smoke now?

○ 1-5 ○ 6-14 ○ 15-24 ○ 25-34 ○ 35 or more

What is your ethnic group? (MARK ONE OR MORE)

○ Hispanic or Latino ○ Black or African American ○ American Indian or Alaska Native
○ White, not Hispanic ○ Asian ○ Native Hawaiian or Other Pacific Islander

Thank you very much for filling out this questionnaire. Please take a minute to go back and fill in anything you may have skipped.

PLEASE DO NOT WRITE IN THIS AREA

Appendix G: Fall Surveillance Form

FALL SURVEILLANCE SURVEY **QDR / SFRI**

Completed By: _____ Subject Unit #: _____

Date Completed: _____ Subject Name (last, first): _____

Address Change: _____

FRACTURE INFORMATION

Did subject fracture hip? _____

1 = yes
2 = no

IF NO, GO TO NEXT SECTION

Date of fracture: _____ Associated Injuries: _____

Time of fracture (24 hrs): _____ _____

Affected side (please circle): RIGHT LEFT _____

Fracture Type: _____

0 = unknown 2 = intertrochanteric
1 = cervical 3 = subtrochanteric

How did the fracture occur? _____

1 = fall 3 = possible spontaneous fracture
2 = accident other than fall (car, etc.) 4= other _____

IF SPONTANEOUS FRACTURE OR TRAUMA OTHER THAN FALL ... PLEASE STOP HERE!

FALL CHARACTERISTICS

Date of Fall: _____

Fall description:

Fall was: _____

0 = unknown
1 = witnessed
2 = unwitnessed

Events at the onset of the fall:

Activity at time of fall: _____

0 = unknown
1 = lying still
2 = sitting still
3 = standing still
4 = transferring or changing position
5 = slow walk
6 = fast walk
7 = ascending steps or curb
8 = descending steps or curb
9 = vigorous recreational activity
10 = other

Fall height: _____

0 = unknown
1 = fall in horizontal position from bed (18")
2 = fall from seated position (chair, toilet, stairs, 17")
3 = fall from height inbetween sitting and standing
4 = fall from standing height
5 = standing fall from height of one step (8")
6 = standing fall from height of two steps (16 ")
7 = standing fall from chair or stool (18-20")

Was there warning prior to the fall? _____

0 = unknown
1 = no
2 = dizziness
3 = weakness
4 = limp

Events during the fall:

Fall direction: _____

0 = unknown
1 = forward
2 = sideways - right
3 = sideways - left
4= backwards
5 = straight down
6 = other

Did you grab onto something when you fell? _____

0 = unknown
1 = yes
2 = no

Did you attempt to break the fall with arm or hand? _____

0 = unknown
1 = yes
2 = no

Did you try to recover from falling with quick steps? _____

0 = unknown
1 = yes
2 = no

Characteristics of the impact:

Impact surface: _____

0 = unknown	5 = ceramic tile
1 = thick, padded rug/carpet	6 = concrete, cement, asphalt
2 = rug without padding	7 = dirt/grass
3 = bare wood floor	8 = ice/snow
4 = linoleum or soft tile	9 = other _____

Impact location (which body part hit the hardest): _____

0 = unknown	7 = back	14 = unilateral buttock
1 = head	8 = hip or side leg	
2 = neck	9 = buttocks	
3 = shoulder	10 = groin	
4 = arm/hand	11 = front of legs	
5 = chest/ribs	12 = back of legs	
6 = abdomen	13 = knee	

Second impact location: _____

0 = unknown	5 = chest/ribs	10 = groin
1 = head	6 = abdomen	11 = front of legs
2 = neck	7 = back	12 = back of legs
3 = shoulder	8 = hip or side leg	13 = knee
4 = arm/hand	9 = buttocks	14 = unilateral buttock

INJURY SCREENING

Injury location

01 = no injury
02 = face
03 = back of head
04 = right side of head
05 = left side of head
06 = neck
07 = right shoulder
08 = left shoulder
09 = right arm
10 = left arm
11 = right hand
12 = left hand
13 = chest (front)
14 = back
15 = abdomen
16 = right flank
17 = left flank
18 = right hip
19 = left hip
20 = buttocks
21 = right thigh
22 = left thigh
23 = right knee
24 = left knee
25 = right shin (calf)
26 = left shin (calf)
27 = right foot
28 = left foot
29 = pelvis
30 = prosthesis

Type of injury

01 = not applicable
02 = abrasion - scraping of skin
03 = laceration -skin tear
04 = bruise, swelling
05 = fracture
06 = dislocation
07 = other

	Location	Type		Location	Type
Injury 1:			Injury 4:		
Injury 2:			Injury 5:		
Injury 3:			Injury 6:		

Have you fallen previously this year? _____

0 = unknown 1 = yes 2 = no

Previous fracture history: _____

1 = hip
2 = pelvis
3 = humerus
4 = distal radius
5 = spine
6 = other _____
7 = none
8 = unknown

Mental Status: _____

1 = normal
2 = mild impairment
3 = moderate impairment
4 = severe impairment

Residence: _____

1 = designated senior housing
2 = apartment buiiding (> 2 stories)
3 = other home
4 = nursing home

Appendix H: Postcard Example

Bone Research Laboratory
Oregon State University
Women's Building Room 13
Corvallis, OR 97331

Participant Address

↗ tear here

Your name _____
Your subject ID # (found on the cover of your falls diary): _____
Your phone number _____

****

Using your falls diary, please tell us if you have fallen in the past 3 months? (circle one) YES NO
If yes... How many times?_____

****

If you have fallen, we will call you for the details.

★When you have completed this side of the postcard, tear at the perforation and deposit in a mailbox.

Oregon State University Fall Prevention Study

Thank you for your participation in this study. This postcard will replace calling you for fall information. You will receive this postcard every 3 months. Please record the requested fall information inside and return the postcard to us by placing it in the mail (no postage required).

Remember that a fall is defined as accidentally coming to rest on the ground, floor, or other lower level.

Thanks again, and be looking for this bright orange postcard in 3 months!

No Postage Necessary
Postage Prepaid by Addressee

Department of Exercise and Sport Science
Oregon State University
Women's Building Room 13
Corvallis, OR 97331