THE EFFECTS OF ACCULTURATION, DIET, AND WORKLOAD ON BONE DENSITY IN PREMENOPAUSAL MEXICAN AMERICAN WOMEN

DISSERTATION

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By

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ABSTRACT

There are many factors that predict bone density in humans. This research examines cultural and biological factors that may affect bone density in a population of premenopausal Mexican American women in San Antonio, Texas. Although Mexican Americans are now the largest minority group in the United States, research specific to this population is limited. Also limited is research pertaining to bone density of premenopausal Mexican American women.

This study combines data regarding acculturation, diet, and workload to examine their influence, if any, on bone density. Anthropometric measures and bone density scans of the hip and spine determined physiological variability. Acculturation and generation levels, diet, and workload levels were determined by a dietary and lifestyle questionnaire.

Results of this study reveal that cultural and biological factors both interact to influence bone density, however specific risk factors are unclear at this time. Longitudinal studies are necessary in order to gain more specific data. Presently, results reveal that low bone density does occur in women prior to menopause, thus warranting earlier bone scans.
in women. This would allow for risk factors to be identified when intervention may be most crucial.
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CHAPTER 1

INTRODUCTION

1.1 Rationale for Bone Density Research

The purpose of this research project is to assess the effects of acculturation, diet, and workload on bone density in Mexican American women of reproductive age. Previous research addressing variation in bone density utilized cross-cultural comparisons to seek answers in a clinical framework but many of these studies did not include an evolutionary perspective (Heaney 1996). With respect to bone density and diet, studies often fail to recognize that generations of evolution have resulted in population differences in calcium requirements (Eaton and Nelson 1991; Heaney 1996). For example, populations that have adopted modes of subsistence providing low calcium intakes exhibit relatively low calcium requirements (Heaney 1996). Thus, as might be expected there are local population differences in the ability to absorb and conserve calcium; American Blacks do this well but European Whites do not (Abrams et al.1995).
The variation of a human biological feature is the result of the interaction between its genetic basis and the environment (which for humans includes cultural factors). As an anthropological study, this project incorporates an evolutionary perspective to the study of bone density variation within a premenopausal Mexican American population in San Antonio, Texas. Biocultural aspects of bone density have not been adequately examined in Mexican Americans. By focusing on intrapopulation variation, specific risk factors for osteopenia (low bone density) and/or osteoporosis can be identified. Risk factors usually include decreased activity patterns and dietary changes including low calcium intake (Avioli 1984; Drinkwater 1994; Recker 1984; Stini 1995).

A T-score between –1 to –2.5 will be classified as osteopenia and a T-score less than or equal to –2.5 will be classified as osteoporosis (WHO 1994). In order to standardize scores from various densitometers, results are reported as standard deviations (SD) above or below the mean peak bone mass for the participant’s sex-matched, normal young adult reference. This is the T-score. Reference curves (mean bone density values at various age groups for a given sex and ethnicity) are derived from the database of the third study of the National Health and Nutrition Examination Survey, 1988-1994, (NHANES III). This survey is a compilation of nationally representative cross-sectional studies involving Black, White, and Hispanic populations. Results of the recent study will
describe age associated bone loss in premenopausal Mexican American women and assess the effects of culture change, diet, and workload on bone density prior to menopause.

1.2 The Evolution of Bone

The development of bone density in humans as well as other terrestrial vertebrates is a function of calcium metabolism. Unlike other elements abundant in nature, calcium’s intermediate solubility allowed it to be ubiquitous in the oceans in which life evolved (Heaney 1996). This property permitted the independent evolution of teeth, dermal armor and an internal support system (bone and/or cartilage) in early marine vertebrates and specifically bone in terrestrial vertebrates (Heaney 1996; Urist 1964). Strength of the skeletal system is imperative in land animals for support of body weight. Although bones of larger marine and aquatic animals must support strong muscles, buoyancy aids in the support of their skeletal system (Heaney 1996).

As vertebrates evolved in a high calcium medium, the transition to land required an adaptation to a low calcium terrestrial environment (Nordin 1976). An adequate level of calcium is needed in the blood for a number of bodily functions including muscle contraction, blood clotting, and synaptic transmission. It is also needed for the mineralization of the skeleton. Because land mammals are not continuously bathed in
calcium, which is needed in constant supply for extracellular membranes, an adequate supply of calcium must be acquired through other means. Diet provides this supply, although not at a constant rate.

From the time most mammals first appeared on land around 250 million years ago until about 50 million years ago (mya), their diet consisted mostly of insects which contain high levels of calcium (Eaton and Nelson 1991). Calcium from an insectivorous diet is obtained both from the exoskeleton as chitin and from the larval forms (Eaton and Nelson 1991). Calcium continued to be extracted from an omnivorous diet of the first primates which appeared about 50 mya. The body requires a reservoir for calcium that can be drawn upon when needed. In land mammals, bone is this reservoir.

Along with calcium, phosphorus is a main component of bone with each playing a major role in bone mineralization. Almost all phosphorus in the human body (85%) is located in the skeleton with the remaining 15% located in cells throughout the body (Hunt and Groff 1990). Phosphorus is essential both intra and extracellularly and becomes incorporated in many molecules such as nucleic acids, proteins, lipids, and adenosine triphosphate (ATP) (Anderson and Barrett 1994; Heaney 1996). Phosphorus is only a trace element in sea water, and as a result, marine vertebrates have to acquire this element from simple, less complex organisms through ingestion (Heaney 1996). Because phosphorus is not as abundant as calcium, conservation in the body is
essential. Just as it does for calcium, bone acts as a reservoir for phosphorus for the body to draw upon as needed.

As a result of the body’s ability to conserve phosphorus and because adequate amounts of phosphorus are easy to maintain through diet (through meat, dairy, and enriched foods), a deficiency is unlikely in a normal, healthy human. In fact, hyperphosphatemia, an excessive amount of phosphorus in the body is more likely. This is not the case with calcium. Our distant evolutionary past in an environment with abundant levels of calcium has resulted in a biological system that not only does not conserve calcium in the blood, but it protects the body from an excessive concentration of calcium (hypercalcemia) which is detrimental to the body’s soft tissue, especially the kidneys. For example, calcification in the urinary tract (urolithiases) and subsequent impaired kidney function can lead to death.

This mechanism for calcium homeostasis in humans is the result of several factors within our evolutionary past. According to Eaton and Nelson (1991), the eating habits of contemporary non-human primates are most likely similar to the eating habits of primates in the past. This involves the consumption of large amounts of low energy/high calcium foods. The omnivorous diet of early human populations contained abundant calcium obtained from various plants, tubers, nuts, roots, meat, and bone of other animals. Dietary studies of the foods consumed by chimpanzees reveal high calcium content (Eaton and Nelson 1991), as
do dietary studies of contemporary hunters and gatherers. Estimated ingested calcium intakes of these groups ranges from 2,000-3,000 milligrams per day (Heaney 1996), while the average daily amount ingested for modern developed countries is roughly half this amount (NIH Consensus Panel 1994).

Differences in ingested calcium levels surround the practices of food procurement associated with agriculture as population growth is associated with the advent of agriculture, about 12,000 years ago. Grains became a large portion of food consumed which are not good sources of calcium. However, some early agriculturalists used limestone (calcium carbonate) for grinding grain which was consumed also. It was not until grains were milled using silicon-based minerals in large-scale milling that calcium intake in the diet fell to present levels (Heaney 1996).

1.3 Calcium and Phosphorus Homeostasis in Humans

Because of low concentrations of calcium in the environment, humans as well as all other land vertebrates must actively maintain adequate calcium levels in the body. This protects the neuromuscular system and promotes calcification of the skeleton (Nordin 1976). However, the importance of calcium levels in the skeletal system, which contains about 1200 grams of calcium or 99% of the body’s calcium, is secondary to the maintenance of adequate levels in other parts of the
body that contain calcium. Various soft tissues, blood, intracellular, and extracellular fluids contain the remaining 1% of the body’s calcium where vital regulatory functions are performed (Bronner and Pansu 1998; Dairy Council Digest 1984; Hunt and Groff 1990). As a result, in the case of a calcium deficiency, the body draws calcium from bone and levels are compromised in the skeletal system.

As an insoluble salt, calcium occurs in nature as a compound such as a carbonate, tartrate, or oxalate and must be broken down after ingestion into an ionized form where bioavailability becomes possible (Hunt and Groff 1990; Wilkinson 1976). The major calcium salt ingested through food is calcium phosphate. Others include calcium carbonate and calcium citrate usually ingested in a supplemental form. These all must be separated in the body during digestion so that the elemental calcium can be absorbed. In descending order, dairy products, sardines, tofu, green vegetables, and dried fruit are all good sources of calcium. In the United States, the average daily calcium intake ranges from 500-1200 milligrams which is highly dependent on the amount of dairy in the diet, which can contribute up to 72% of the daily calcium intake (Berdanier 1998).

As absorption is the first step to availability to the body, several factors influence the availability and retention of calcium (Hunt and Groff 1990). Calcium is absorbed mainly in the proximal region of the small intestine (duodenum), and to a lesser extent, farther down in the
jejunum. Calcium found in milk and milk products is easily absorbed because they contain the carbohydrate lactose, lactalbumin, and the proteins casein which bind to the calcium ions (Berdanier 1998). These calcium-binding agents are released from calcium once in the duodenum where absorption can occur. Even though there are other foods that contain calcium-binding agents such as phytate, (found in cereals and grain) and oxalate (found in some leafy vegetables such as spinach) these agents reduce the availability of calcium. These agents are not released from the calcium ions until they reach the distal regions of the small intestine and large intestine which are areas not conducive to calcium absorption so their impact remains unclear (Berdanier 1998).

There are other factors contributing to calcium absorption, availability, and retention. Calcium is lost daily in the excretion of urine, feces, sweat, and to a lesser extent, hair and nails (Allen 1982; Peacock 1991). Also, degree of physical activity, use of medications, calcium needs of the body such as pregnancy and lactation periods, disease, vitamin D status, and age are all factors affecting calcium homeostasis (Allen 1982; Heaney 1993). Younger, growing individuals have greater absorption efficiency than mature adults, who in turn have greater efficiency than older adults (Berdanier 1998). Hormonal status is also a factor. Premenopausal women have greater calcium absorption efficiency (especially during pregnancy and lactation) than postmenopausal women. Men have greater calcium absorption efficiency than women due
to testosterone (Berdanier 1998). Vitamin D-deficient individuals and also those who have insulin-dependent diabetes mellitus have impaired calcium absorption efficiency (Berdanier 1998).

As a result of obligatory losses, healthy individuals only absorb 20 to 50% of ingested calcium (Berdanier 1998; Dairy Council Digest 1984). Regardless of the calcium amount absorbed and/or lost, an adequate calcium concentration must be maintained in the blood in order for the regulatory functions for which calcium is responsible to be carried out. This concentration is regulated mainly by three hormones: active vitamin D (1,25-dihydroxycholecalciferol) also known as the metabolite calcitriol, calcitonin, and parathyroid hormone (PTH). When calcium levels in the blood decrease, calcitriol stimulates absorption through intestinal epithelial cells. Parathyroid hormone increases conservation of calcium by the kidneys, draws calcium from bone, and activates the production of calcitriol when levels in the blood are low (Dairy Council Digest 1984; Fitzpatrick and Bilezikian 1996). Produced by specialized cells in the thyroid gland, calcitonin removes excess calcium concentrations from blood and can either increase bone formation or decrease calcium loss from bone (Dairy Council Digest 1984; Smith 1983).

As phosphorus is ubiquitous in nature and abundant in food sources, it is unlikely that a nutritional deficiency will occur (Smith 1983). Although daily obligatory losses occur similar to that of calcium, phosphorus is absorbed more efficiently (Anderson and Barrett 1994;
Calvo 1993). Levels of absorption range from 70-90% which occurs throughout the duodenal and jejunal regions of the intestinal tract, but unlike calcium, absorption is not controlled by the needs of the body (Eastwood 1997; Hunt and Groff 1990; Smith 1983).

Although a major constituent of skeletal tissue, phosphorus is also located in the blood, soft tissue, and intracellular and extracellular fluids. Absorption and transport is partly controlled by active vitamin D (1,25-dihydroxycholecalciferol) and both the parathyroid hormone and calcitonin take part in regulating levels of phosphorus in the body as they do for calcium (Anderson and Barrett 1994; Hunt and Groff 1990). Phosphorus metabolism also involves the kidneys, as they reabsorb as much as 95% of the phosphorus normally filtered through the renal system (Hunt and Groff 1990).

1.4 Bone Density in Humans

Because the human skeleton is a living and highly specialized tissue, it is constantly changing in morphology and composition throughout the life of an individual. Cells that reside in the bone are continuously shaping and reshaping skeletal tissue. This rate of change varies within and among populations and is dependent on endogenous (genetic) factors as well as exogenous (environmental) factors. Genetic factors include sex and genetic background (hormones and ethnicity),
while environmental factors include diet, nutrition, workload (physical fitness and muscle strength), and body mass or composition.

According to Anderson (1996), genetic factors may dominate over the more “passive” environmental factors. In fact, research indicates that genetic factors may contribute up to 80% of the variation of an individual’s bone mass, while environmental factors contribute approximately 20% (Key and Key 1994; Matkovic and Ilich 1993; Pollitzer and Anderson 1989; Dr. Jan Bruder, personal communication 2002). More recent research indicates that environmental factors may contribute as much as 40% (Kelly et al. 1990) and even up to 54% (Krall and Dawson-Hughes 1993) of the variance in bone density and it is unlikely that factors or determinants contribute to bone density independent of one another.

Regardless of the exact percentage of genetic and environmental contribution to bone mineral density, both are important determinants of our physiology and research indicates that human stages of life may be affected differentially by each determinant. Krall and Dawson-Hughes (1993) state that genetic factors are more attributable earlier in life and environmental factors play a larger role later in life. As an individual gains more independence, life-style factors such as diet and exercise influence bone density. Skeletal development and bone mass particularly in an infant or young child are dependent on the health of
Life-span changes of bone density begin early in human ontogeny and continue until cessation of life. The skeletal system begins its development in utero, although little is known about factors affecting bone mineralization at this stage of life of the individual (Specker et al. 2001). However, it is known that effects on fetal bone are mediated through the maternal pathway (Namgung and Tsang 2000; Specker et al. 2001). In humans (as well as other mammals studied), the last third of pregnancy is characterized by a dramatic increase in the rate of calcium accretion in the fetus (NIH Consensus Panel 1994). Thus, the recommended daily allowance (in the United States) for calcium in pregnant females increases to 1200 milligrams as opposed to 1000 milligrams in non-pregnant adult females. Obviously, proper nutrition of the mother is essential during pregnancy if proper growth of the child is to occur in intrauterine as well as extrauterine life.

Upon birth, the skeleton continues its development as the infant increases in body weight and length. During the first year in particular, skeletal development depends on a balanced nutritional intake that is provided by breast milk or the equivalent for the first six months (Anderson 1996). Also, as bone tissue is increasing at this stage of growth, and solid foods are introduced, bone strength continues to increase as the individual begins to walk. Walking places stress on the
bone that encourages this increase. As muscles develop and strengthen, bone density must increase to support the growing body.

During childhood bone formation occurs by modeling. Formation of the bone is followed by resorption (removal of bone tissue) and remodeling, or reshaping in order to assure the proper shape and size of each bone. Modeling leads to net gain in bone thus allowing growth and attainment of proper bone mass. Children experience substantial bone growth leading up to age two, then encounter a period where bone growth levels off (Anderson 1996) until the body goes through the mid-growth spurt. This increased bone growth is a result of an endocrine event known as adrenarche, which is characterized by the secretion of androgen hormones. These hormones produce the increase of height at this time along with a transient acceleration of bone maturation, in addition to the appearance of axillary and pubic hair (Bogin 1999).

Recommended daily allowances for dietary calcium intakes for children in the United States range from 800 milligrams per day for ages one through five and 800-1200 milligrams per day for ages six to ten (NIH Consensus Panel 1994). This increase in requirement corresponds with the mid-growth spurt. Regardless of recommendations, calcium as well as vitamin D (which increases the efficiency of intestinal absorption of calcium) should be incorporated into the diet in order for the body to experience calcium homeostasis or balance. In healthy children daily calcium absorption is 200-400 milligrams. Adequate calcium should be
ingested to supply the body with this necessary amount as well as allowing for normal daily calcium excretion through urine, feces, and perspiration (Wilkinson 1976).

At puberty calcium recommendations in the United States remain at 1200 milligrams per day and increase to 1500 milligrams into adolescence (NIH Consensus Panel 1994). This high intake of calcium is necessary as the body begins reaching peak bone mass in some skeletal locations as early as twelve years (Personal communication, Dr. Sam Stout 2002). Also, absorption of calcium at this point increases to 400 to 500 milligrams per day.

The secretion of growth hormones further stimulates bone growth and subsequent accumulation of bone mass during the adolescent growth spurt. Females experience this spurt approximately two years before males as females also reach peak bone mass first. The age of attainment of peak bone mass remains a matter of debate. Some research indicates peak bone mass is reached at the age of eighteen (Slemenda et al. 1994) while other researchers insist this peak does not occur until the third decade of life (Calvo 1993; Ott 1991; Ralston 1997; Recker et al. 1992; Dr. Jan Bruder, personal communication 2003). Additional studies report that peak bone mass may be obtained in an individual by different skeletal locations at various times (Matkovic et al. 1994; Teegarden et al. 1995).
After adolescence and young adulthood, growth is complete and an individual progresses into adulthood where mineralization of the bone and absorption reach equilibrium. This balance allows bone mineral density (grams/cm²) also referred to as bone density, to be maintained which is dependent on lifestyle factors such as proper calcium intake (1000 milligrams per day) and regular exercise. Bone mass can be lost or maintained at this stage of life. Calcium absorption in adulthood is not as efficient as in younger individuals, therefore it is imperative that calcium be included in the diet and physical activity remain a regular part of life.

During the later adult years of an individual’s life, resorption rates increase and bone density decreases especially in females beginning with the onset of lower estrogen levels associated with menopause. Acute bone loss associated with menopause is known as postmenopausal or type I osteoporosis. Age-related or type II osteoporosis occurs with older age, usually around 70, and can affect both women and men.

As humans age, calcium absorption becomes even less efficient than in earlier years. Even though vitamin D aids in the absorption of calcium, with age, the process does not work as well (Allen 1982: Lane 1999). As a result, less calcium is available which triggers the production of additional parathyroid hormone that leaches calcium from the bone through absorption (Lane 1999). Although this process is ongoing in later years, it is slow. Type I osteoporosis can be slowed
further by hormone replacement therapy (HRT) after menopause (Lane 1999). If a woman decides against HRT, intake of daily dietary calcium should increase. At this stage of life, physical activity is very important since calcium absorption is not efficient. In addition, physical activity promotes balance and muscle strength that aids against falling and consequent fractures (Drinkwater 1994).

As mentioned earlier, both endogenous (genetic/biological) and exogenous factors (environmental/behavioral) contribute to bone density variation with endogenous factors determining a larger percentage than exogenous factors. Although endogenous factors are important and influential, the impact of exogenous factors is large. In fact, genetic variance may be overestimated in family studies since bone density can be the result of a shared environment (Krall and Dawson-Hughes 1993). Also, environmental or behavioral factors are important because they can be modified by the individual.

There are several behavioral factors that contribute to differences in bone density that include diet, physical activity, prescription drug use (including contraceptives), alcohol and caffeine intake, lactation practices, and smoking. Although prescription drug use, alcohol and caffeine intake, lactation practices, and smoking have been researched, their effect on bone density remains unclear (Valimaki et al. 1994). More studies should be conducted in order to determine association with bone density variation.
Studies of the effects of smoking regarding differences in bone density are not numerous however the majority indicate that smoking has a slightly negative impact on bone density (Mazes and Barden 1991; Valimaki et al. 1994). Researchers who did not find a negative effect on bone density (Fehily et al. 1992) failed to include amount of cigarettes smoked each day by the subjects and/or their length as a smoker. Although these studies indicate minimal association, more research should be conducted in order to clarify this issue.

1.5 **Diet, Workload, and Bone Density**

Research pertaining to the role of diet as it relates to differences in bone density is extensive (Agostoni et al. 1994; Anderson 1992; Calvo and Park 1996; Smith et al. 1985; Teegarden et al. 1998; Wyshak 2000) as is research pertaining to physical activity (Drinkwater 1994; Lloyd et al. 2000; Slemenda et al. 1994; Snow-Harter et al. 1990; Valdimarsson et al. 1999; Valimaki et al. 1994). Both diet and physical activity can be considered a confounder and/or enhancer. Diet can have both a positive and negative influence on differences in bone density. Proper nutrition is imperative for growth and development of the human skeletal system. Even in intrauterine life, diet of the mother determines health status of the child including bone formation before and after delivery (Namgung and Tsang 2000; Pitkin 1985; Specker et al. 2001).
Specifically, nutrient deficiency of the mother affecting placental mineral transfer can affect fetal bone mineralization (Namgung and Tsang 2000; Specker et al. 2001). Also, maternal dietary deficiency of calcium and/or vitamin D during pregnancy can negatively affect the neonate. Upon placental separation, calcium supply is halted therefore serum levels of calcium in the newborn decrease to a minimum and rise again to normal levels in a few days (Pitkin 1985). Therefore, it is important that maternal calcium intake remain adequate to provide the necessary amount needed by the neonate immediately after birth.

Just as diet of the mother is influential to bone mineralization of the child, so is the diet of the individual throughout life. Malnutrition and undernutrition are conditions that negatively affect the skeletal system. In order for peak bone density to be achieved and maintained, a proper diet is necessary. A proper diet consists of an amount of calories in the form of fat, protein, and carbohydrates along with vitamins and minerals.

Calcium and phosphorus are essential elements that are especially important regarding bone density since an ample supply of both is needed for the proper mineralization of the organic matrix (Garner et al. 1996). Bone tissue contains approximately 97-99% of calcium and 85% of the phosphorus in the body (Anderson and Garner 1996; Heaney 1996). The ideal ratio of serum calcium to phosphorus in humans is 1:1 (Anderson and Garner 1996; Calvo and Park 1996; Wyshak and Frisch 1996).
If the levels become off-balance with phosphorus exceeding calcium, parathyroid hormone acts to restore the ratio back to “normal” by removing calcium from stores in bone. Therefore, increased phosphorus in the diet is detrimental to the attainment and maintenance of bone density.

Carbonated beverages and processed foods contain high levels of phosphorus and are consumed at a high rate in the United States. (Anderson and Barrett 1994; Calvo 1993; Calvo and Park 1996). In the past three decades, carbonated beverage consumption has risen 300% in the U.S. while milk consumption has fallen (Wyshak et al. 1989). Physiologically, both calcium and phosphorus are absorbed within the intestines, however, absorption of calcium is not as efficient as phosphorus absorption. This aspect adds to the problem of increased phosphorus intake.

Other nutrients important in maintaining bone density include vitamins A and D. However, an excess of these two vitamins results in hypervitaminosis, which stimulates resorption and subsequent osteopenia or low bone density (Garner et al. 1996). Mineral deficiencies of magnesium, zinc, and iron can inhibit bone formation and accretion (Garner et al. 1996).

Unless conditions are present that inhibit nutrient absorption, for example, illness, maintaining a balanced diet that includes a variety of foods will insure proper bone health particularly the attainment and
maintenance of bone density. The inclusion of calcium, whether in the
diet or through supplements, is especially important since this is the
only method in which humans acquire calcium (Peacock 1991).
Bioavailability of calcium is inhibited by phosphorus, as mentioned
earlier, as well as phytate and oxalate which are found in whole wheat
products and spinach respectively (NIH Consensus Panel 1994).
Optimally, absorption of calcium is greatest if foods containing calcium
or supplements are ingested alone.

Along with diet, physical activity levels; workload and/or exercise
can enhance or inhibit the attainment and maintenance of bone density
depending on duration and type of activity. The positive aspect of
physical activity involves strengthening of muscle groups surrounding
bone that consequently maintains bone density and strength (Snow-
Harter et al. 1990; Valdimarsson et al. 1999). Weight-bearing activities
such as running and weight-lifting especially enhance bone density as
muscles work against gravity. The importance of this type of activity as
well as general physical activity is apparent as astronauts experience
muscle atrophy and decreased bone density while in microgravity
(Wronski and Morley-Holton 1987). Physical activity can negatively affect
bone density if strenuous or excessive. In these cases of extreme activity,
females can experience amenorrhea or cessation of the menstrual cycle,
which negatively affects estrogen levels and consequently, bone health is
compromised. Amenorrhea can also result from the diet disorder
anorexia nervosa (McMurray 1996). As with diet, individuals should engage in physical activity in adequate amounts that do not jeopardize health, but enhance it.

Interpopulational differences in bone density are apparent. Studies have identified variation in bone density between Black and White sub-groups (Garn 1970; Gilsanz et al. 1991; Stini 1995), with Blacks having higher bone density than Whites. Postmenopausal Mexican American women studied have decreased rates of hip fractures (Bauer 1988; Taaffe et al. 2000; Villa et al. 1995) and vertebral fractures (Bauer and Deyo 1987) as compared to White women in the United States. However, the majority of these studies suggest that lower incidence rates of hip and vertebral fractures may not be the result of these populations having higher bone density.

While differences in bone density have been observed in the populations above, contributing factors are not fully known. Black and White differences in bone density are attributed to Blacks having more lean muscle mass (Garn 1970; Gilsanz et al. 1991; Stini 1995). Studies of bone density in postmenopausal Mexican American women demonstrate dissimilar results. Although Bauer (1988) states that addition research is needed, he proposes that reduced rates of hip fractures in postmenopausal Mexican American women could be explained by the fact that this population is heavier and smokes less than Whites. Bauer and Deyo (1987) were unable to identify the causes
of reduced risk of vertebral fractures in postmenopausal Mexican American women. Taaffe et al. (2000) research revealed that postmenopausal Mexican American are at lower risk for osteoporotic fractures than Whites due to higher bone density, while Villa et al. (1995) propose that differences in bone density between these two groups may be the result of body composition and lower hip axes length found in Mexican Americans.

Other studies have identified low bone density in Asian females (Hu et al. 1993) and Arctic women and children (Mazess and Mather 1974). Hu et al. (1993) suggest that smaller body size may not warrant high bone density, while Mazess and Mather (1974) propose that populations in the Arctic may have lower bone density due to a high intake of animal protein. This has been shown to increase urinary calcium excretion (Metz et al. 1993).

Bone density research pertaining to postmenopausal women of various ethnic backgrounds is numerous. However, there are a limited number of studies that focus on premenopausal women. One study involving 200-300 White women aged 20-39 years found that there was no age related change of bone density (Mazess and Barden 1991). Another study completed by Lindsay et al. (1992), involving 74 premenopausal women revealed similar results. In other research, both premenopausal and postmenopausal Black women have higher bone
density (grams per centimeter squared (g/cm²)) than White women in the areas scanned (hip and spine).

Identifying inherited factors pertaining to differences in bone density in various populations is difficult. Environmental factors cannot be ignored since they interact with the genotype of the individual (Eisman 1996). Kelly et al. (1990) state that environment may act to allow or prevent bone to reach its genotypic potential, but the genotype determines the limit of these responses. Ferrari et al. (1998) see the genotype as the threshold responsible for bone density, but state that further studies should be conducted to confirm this hypothesis. Subtle variations in genes may be responsible for the manner in which each individual responds to their environment. Therefore, understanding gene-environmental interactions will lead to a better understanding of genetic predispositions in various populations (Eisman 1996).

Anderson (1992) states that environmental factors can have a negative effect on skeletal growth in periods of severe undernutrition. Conversely, even though bone mass acquisition has a strong hereditary component, it can be modified in a positive manner with respect to environmental factors such as dietary calcium intake as well as physical activity (Snow-Harter et al. 1990). Snow-Harter et al. (1990) suggest that increased skeletal loading by stronger, heavier muscles facilitated by physical activity is a contributing factor in increased bone density.
1.6 Rationale for Studying Mexican Americans

The Hispanic population is the fastest growing minority group in the United States (Council on Scientific Affairs 1991). Hispanic or Latino/a are terms used to describe several diverse subgroups that include Mexican Americans, Puerto Ricans, Cuban Americans, Central or South Americans, and other Caribbean Islanders (Rodriguez 1994). Mexican Americans, Puerto Ricans, and Cuban Americans are the three largest subgroups in the United States each generally living in a specific geographical location. For example, Mexican Americans are concentrated in the southwest United States including California, Arizona, New Mexico, Colorado, and especially Texas, while Puerto Ricans are concentrated in New York, and Cubans in Florida (Council on Scientific Affairs 1991; Knapp 1985). Although for the most part these populations are united by a common language and heritage (Spanish), religion (Catholic), and valued cultural persistence (Rodriguez 1994), they are diverse in many ways and should not be considered a homogeneous group when health policy and research are considered (Loria et al. 1995). Because the diversity of Hispanic communities is often overlooked within consolidated research, health factors specific to each subgroup may not be identified. Therefore, the importance of research specific to various Hispanic subgroups cannot be overlooked, as risk factors for morbidity and mortality vary among them (Council on Scientific Affairs 1991). Although there is a larger Mexican American population in the United
States, research and intervention regarding health issues including disease prevalence and prevention are lacking and not proportionate to the population.

Mexican Americans constitute the largest subgroup of Hispanics and will be the focus of this study. As the population of Mexican Americans in the United States has increased over the years, research agenda pertaining to health and health care are not proportionate. Although data sets from the Hispanic Health and Nutrition Examination Survey (HHANES) of the National Center for Health Statistics (NCHS) from 1982-1984 include important information, updated studies are needed.

1.6.1 Background

The United States and Mexico represent two dramatically different economies: one of the most industrialized nations in the world and a country full of poverty along with an exploding population. The border along these two countries is two thousand miles in length. Half of this distance includes Texas while the remaining border includes New Mexico, Arizona, and California. For the most part Mexicans migrate north to escape the hardships of their nation’s social and economic problems. Usually, the migrants settle along the United States-Mexico
border placing new constraints on the communities on each side of the
border (Nickey 1989).

Providing necessities such as clean water, sewage disposal, health
facilities, and an overall healthy living environment becomes very taxing
on area government bodies (Nickey 1989). Many of the border residents
live in coloñias, which are unincorporated settlements that develop
(usually illegally) outside the township or city (De Leon 1993; Nickey
1989; Warner 1991). These settlements lack necessities such as septic
tanks, sewers, or running water that consequently present serious health
problems (Nickey 1989; Warner 1991). Migrants who do not remain in
the border regions continue moving north with the hope of obtaining
employment in and around the larger cities in the United States.

Although cities retain the necessary facilities for living, conditions
in the cities for new immigrants may only be a slight improvement over
the colonias at the border. Many immigrants settle in areas known as
barrios which are neighborhoods or sections of town that are exclusively
inhabited by Mexican Americans (Haffner et al. 1985; Knapp et al. 1985).
These neighborhoods often retain old, dilapidated housing, roads
neglected by city governments, and some areas even lack proper sanitary
facilities (De Leon 1993). Although the barrios in the cities do not offer
optimal living conditions, and there are no laws restricting them to these
neighborhoods, many Mexican Americans find a sense of comfort and
belonging in these areas. Mexican cultural values and customs are maintained within these neighborhoods (Haffner et al. 1985; Knapp et al. 1985).

As years produce more generations of Mexican Americans who may experience more education and improved employment, individuals move out into other areas of the cities. As the barrio is an exclusively Mexican American low-income section of town, middle-income neighborhoods are transitional areas that are ethnically balanced. Increasing numbers of Mexican Americans today inhabit these middle income areas although many still remain in the barrios.

1.6.2 Previous Studies involving Hispanic Populations

Despite the fact that the Mexican American population in the United States continues to rise, studies pertaining to issues regarding health factors and health risk behaviors are limited (Furino 1991). Updated research is necessary in order to address current health issues of this growing population. Also, data specific to Mexican Americans is imperative for implementation of accurate health care and policy. Mexican Americans for the first time were included in the Hispanic Health and Nutrition Examination Survey (HHANES) of the National Center for Health Statistics (NCHS) from 1982-1984. Although this data set is used today, updated data are needed. Also, data including children
and adolescents is needed, although recent research has addressed birth weight in Hispanic infants (Siega-Riz et al. 1994; Popkin et al. 1996).

Studies have identified variation in levels of acculturation in Hispanic populations according to generational status (Negy and Woods 1992; Perez and Padilla 2000) and language (Marks et al. 1990). Researchers found that acculturation occurs at different rates for different individuals and families, and this adjustment to a new culture can be positive or negative. Dietary habits of Mexican Americans change as they become more accustomed to American foods such as those containing high amounts of fat (Loria et al. 1995), therefore increasing their risk for health related diseases.

Many researchers fail to include ethnicity identifiers, and subsequently the diversity of the populations included is overlooked (Furino 1991). Neglecting to specify ethnicity in health research only inhibits the process of identifying distinct health factors and health risk behaviors particular to each sub-group. Although studies including Hispanics are somewhat helpful when considering Mexican Americans, more research with sub-groups should be conducted.

Recent evidence reveals that the Mexican American diet contains high amounts of total fat, saturated fat, and monounsaturated fat along with high cholesterol intakes (Haffner et al. 1985; Loria et al. 1995). Knapp et al. (1985) found that mean intakes of calcium, vitamin A, and
vitamin C were low in Mexican Americans compared to Anglos in San Antonio, Texas. It has been suggested that dietary habits of Mexican Americans change significantly as they become more assimilated (Guendelman 1995; Rodriguez 1994). These dietary changes are sensitive to cultural change and resemble those of Whites. For example, white bread, margarine, ready to eat breakfast cereals, salad dressings, flour tortillas, and mayonnaise are some foods that are adopted that may not have been previously consumed before migration. For the most part, the dietary changes seen in Mexican Americans have a negative effect on health (Eveleth and Tanner 1990; Rodriguez 1994), especially in individuals of low socioeconomic status (Haffner et al. 1985; Rodriguez 1994).

1.6.3 Acculturation and Mexican Americans

As immigrant groups come in contact with the new culture of their host country, acculturation processes take place (Perez and Padilla 2000). These changes occur on a continuum from very little change seen in some immigrants while maintaining close cultural ties with their home country to total immersion in the culture of the host country by others. Acculturation encompasses both attitudinal and behavioral changes as individuals undergo new contact with the host group (Cuellar et al. 1980, 1995, 1997; Perez and Padilla 2000). While most immigrants maintain
some level of ethnic identity, changes in language, foods, music preference, customs, beliefs and values occur (Negy and Woods 1992).

Acculturation research suggests that there are no definitive models for explaining rates of change in immigrant groups (Perez and Padilla 2000). If an individual exhibits strong family ties or cultural identity, then the process of acculturation may occur more slowly. This not only occurs if the individual’s family remains in the country of origin, but it can be seen if an individual moves into an area of the host country that is comprised mostly of his or her ethnic group. The barrio is an example of a neighborhood where some characteristics of the Mexican community are maintained, therefore allowing an individual to maintain a close identity to their home country, in this case, Mexico.

Research on Mexican American populations has also revealed that acculturation is highly correlated with generational level; later generations (those who have been in the United States longer) are more acculturated than previous or earlier generations. More specifically, researchers found that adolescents transition to mainstream culture more quickly than older individuals (Cuellar et al. 1997). However, in both adults and adolescents if a transition to mainstream culture occurs, ethnic identity is usually maintained (Cuellar et al. 1997).
1.7 **Research Objectives**

The goals of this research are to answer the following questions:

I) Do premenopausal Mexican American women have distinct risk factors for osteoporosis?

II) What is the level of variation of bone density within premenopausal Mexican American women?

III) Within this age group of premenopausal Mexican American women, is there a pattern of decline in bone density over time?

IV) In premenopausal Mexican Americans, is the level or degree of acculturation, diet and workload significant factors influencing bone density?
2.1 Data Collection

Data collection was made possible by Dr. Jan Bruder at the University of Texas Health Science Center in San Antonio, Texas. Dr. Bruder served as the principal investigator for human subjects review in San Antonio and facilitated entrance into the Audie L. Murphy Veteran’s Hospital where data collection occurred. Data collected for this study included bone mineral densities of the hip and spine, weight, height, and information from participant’s answers to questionnaires.

Initially, the age range for data collection from premenopausal Mexican American women ranged from 21-50. After consideration of the timing of the occurrence of peak bone density, it was decided by Bruder, in San Antonio that minimum age should be 30. Individuals younger than 30 may still be acquiring bone mass, thus bone density measures may not be accurate. This decision was made after six individuals under the age of 30 had already been recruited and tested. Therefore, from
that point, a total of 109 women aged 30-51 were recruited via advertisement around the San Antonio area. The sample includes two women aged 51 who have not undergone menopause.

San Antonio, with a 2000 population of 1.14 million people is the eighth largest city in the United States. It is located in south-central Texas and is the second largest city in the state. According to the 2000 census, the Hispanic population in San Antonio was 54.3%.

Flyers were placed in and around the city at universities, churches, grocery stores, and other community areas in English and Spanish. Also, newspaper advertisements were placed in the local San Antonio paper as well as the local bilingual newspaper in English and Spanish. Recruitment continued until 109 women who met the inclusion criteria agreed to participate and complete the study. Although it was initially planned that 100 women were needed for the study, 109 individuals (10% over sampling) were recruited. This additional 10% will compensate for any participants who will be excluded from the study for any reason such as incomplete data. Inclusion criteria included: a) women who were premenopausal and/or had not experienced artificial menopause, b) women who did not have a pre-existing condition that is known to decrease bone density, c) women who were not taking medications known to decrease bone density, and d) women who were not pregnant or lactating at the time of the bone density test.
In an initial telephone interview conducted by Rice, it was determined if potential subjects met the inclusion criteria for this study. A screening questionnaire was utilized for this purpose to determine inclusion or exclusion (Appendix A). All women were asked if they considered themselves Mexican American. Only individuals from Mexico or the United States with Mexican ancestors were accepted. A premenopausal woman was one who had experienced at least one menstrual cycle in the last twelve months or who had been determined to be premenopausal by her personal physician. This determination would be the result of a blood test. Women were asked if they had any pre-existing condition known to affect bone density such as anorexia nervosa or cystic fibrosis. Also, women who had a chronic disease such as hyperparathyroidism, thyrotoxicosis, or renal disease were not accepted. Women routinely taking medications such as anticonvulsants, corticosteroids, thiazides, and thyroxine were not accepted as these medications are known to affect bone density. These medications increase excretion of calcium and if taken for long periods of time, may contribute to a low calcium concentration in the body and subsequent bone loss (Spencer and Kramer 1987). However, if women were taking small amounts of thyroid medication or sporadically taking asthma medication, they were accepted. Dr. Bruder, in San Antonio approved the few participants for whom this situation applied. Only ambulatory women were accepted and women weighing under 300 pounds as this is
the weight limit of the machine. Also completed by telephone interview was the Veterans Hospital (VA) form 10-10 which is standard procedure at the Veterans Hospital. This was necessary in order to place the participant in the computer system at the VA. Information taken for this form included basic personal information and the name and address of a person to notify in case of an emergency. In the case of Spanish-speaking individuals, a Spanish-speaking assistant completed the screening questionnaire and the VA form 10-10 on the telephone.

After it was determined that a participant was eligible for the study, an appointment was made for the subject to come in to the General Clinical Research Center (GCRC) at the Audie L. Murphy Memorial Veterans Hospital in San Antonio, Texas. Upon arrival at the GCRC, the consent form was read to the participant in a private room. Every consent form was signed by Rice, the participant, and a witness. All participants received a copy of their consent before leaving the hospital. Consent forms were available in English and Spanish. At the request of participants, a Spanish speaking assistant was available to read the consent form to the participant or assist them if needed. Only participants who had undergone a tubal ligation or partial hysterectomy were not given a urine pregnancy test. All others were asked to supply a urine sample. All samples were taken to the lab at the GCRC by the
author. Urine was tested using the QuickVue® One Step HCG combo set by Quidel.

Both weight (in pounds) and height (in inches) were recorded by the certified technician before the bone scan. Height was taken on a Stadiometer by Holtain Limited, and weight was taken on a Detecto® digital scale. Upon determination by the lab that the participant was not pregnant, the bone density scan was conducted. Participants were positioned by the technician and asked to lie still. Bone scans were taken of the left hip and spine using a Hologic® Delphi A Fan Beam bone densitometer (Dual X-Ray Absorptiometry-DXA). Radiation exposure during the tests is 5 millirems each for the hip and spine. Individuals who received a bone density test could return to receive the results of their tests or elect to have results mailed to them by the author. Only one visit was necessary. In addition to a copy of their consent, all participants were given literature that included information about osteoporosis and bone loss. Literature, in English and Spanish was donated by Merck and Company, Inc.

A T score of –1 to –2.5 was classified as osteopenia and a T score below –2.5 was classified as osteoporosis. If a participant was classified as having osteopenia or osteoporosis, they were instructed to take the results to a physician. All bone scan results were signed by the principle investigator in San Antonio before mailing or given to participants. A
letter thanking participants for their time and stating their bone density results was sent along with the result sheet. These letters were signed by the author, Jennifer Rice and Dr. Jan Bruder in San Antonio. There were four separate letters mailed depending on individual results: one for those women under 30 with low bone density (Appendix D), one for all women with normal results (Appendix E), one for women over age 30 with a T-score reflecting osteopenia (Appendix F), and one for women with a T-score reflecting osteoporosis (Appendix G). Literature was mailed along with the result letter and bone density printout defining osteopenia and osteoporosis and preventative measures to be taken to avoid bone loss. Literature was donated by Merck and Company, Inc. and was available in Spanish and English.

2.2 Dietary and Lifestyle Questionnaire

After the bone scan was complete, participants were taken to a private room in the GCRC to answer the dietary and lifestyle questionnaire that included questions pertaining to food intake, workload level, and cultural preferences. These categories were divided into age categories of the participant that included child (up to age 12), adolescent (age 13-19), and adult. Questions regarding dietary intake inquired about daily dairy consumption as well as other foods that may impact bone density. Workload questions inquired about daily physical
activity including exercise and any activity that was considered by the participant to be “physical.” Acculturation levels were determined based on information given from each participant including place of birth, preferred language, years in the United States, parental and grandparental place of birth and years in the United States (Appendix B). If requested by a participant, a Spanish-speaking assistant was available during any part of the study as necessary. Questionnaires were also available in Spanish. Subjects were given a form to take home and return to the author if they had forgotten any information that they considered to be important for the study (Appendix C). A stamped envelope with the author’s address was also given to all participants for this purpose.

Dietary Assessment

The dietary portion of the questionnaire was divided into the following sections: child (up to age 12), adolescent (age 13-19), and adult. Participants were asked about consumption of foods as well as the approximate number of servings eaten. Questions pertained to daily dairy intake, red meat and green vegetable consumption, soft-drink intake, and number of times a week they consumed fast foods and prepared or boxed food items. The adult food section inquired about daily calcium intake, and any other food product consumed containing
calcium such as calcium-fortified orange juice. Participants were also asked about preferred foods as an adult such as traditional (mostly native Mexican foods) such as chilies, beans, tortillas, and rice, or non-traditional foods (those foods that are considered to be traditionally American). Traditional and non-traditional diets are relative terms and vary according to personal views.

**Workload Assessment**

Information on personal workload was collected from questions regarding physical activity levels both at adolescent (age 13-19), and present adult levels. Early childhood stages of physical activity were not included in the questionnaire since activity level at the adolescent stage of development is most important in the acquisition of optimal bone density levels later in life. Additionally, early childhood activity may have been sporadic and not included as any part of organized physical activity. Physical activity was defined as sports or similar activity such as running and walking and “other activity” was defined as any other activity the participant felt involved physical work such as housework, fieldwork, and/or heavy lifting. Questions were separated into these two categories so that more detailed answers could be achieved. For example, participants may not have considered housework to be physical activity, but workload. Participants were also asked to provide
approximate time spent on each activity and whether the activity was part of a daily, weekly, monthly, or yearly regime.

Generation and Acculturation Assessment

Generation and acculturation levels were determined from several questions regarding family background and cultural preferences. Generation level was determined from a section of the Acculturation Rating Scale II for Mexican Americans (Cuéllar et al. 1995). Levels range from one to five with one being mostly Mexican and five being mostly American.

1. 1st generation= Participant born in Mexico.
2. 2nd generation= Participant born in the USA; either parent born in Mexico.
3. 3rd generation= Participant born in the USA; both parents born in the USA and all grandparents born in Mexico.
4. 4th generation= Participant and her parents born in the USA and at least one grandparent born in Mexico with remainder born in the USA.
5. 5th generation= Participant and parents born in the USA and all grandparents born in the USA.

Acculturation level was also determined for each participant from several cultural and lifestyle questions. Questions were taken from the Acculturation Rating Scale II for Mexican Americans (Cuéllar et al. 1995).
and from the author. Participant response from seventeen questions determined acculturation level (See Appendix B). These included inquiries pertaining to language preference for everyday conversation, radio, and television, and language most used in the household as a child and that of the present household. Participants were also asked how they perceive themselves culturally as well as how they believe their parents perceive themselves. These self-identifying terms included Mexican, Chicano, Hispanic, Mexican American, American, or Anglo American or other. After self-identification, participants were asked about their level of pride in this group. Additionally, they were asked to rate themselves as very Mexican, mostly Mexican, bicultural, mostly Americanized, or very Americanized. Participants were asked two questions pertaining to time spent in Mexico during their lifetime and in which country they were mostly raised. Questions dealing with ethnic makeup of both past and present neighborhoods and food preferences were also determinants of acculturation level.

2.3 Rationale for using Dual X-Ray Absorptiometry-DXA

Dual X-Ray Absorptiometry or DXA was used in this study to assess bone density of the hip and spine. This system is the standard in bone density research and is the most widely used in the clinical setting with advantages of high precision, minimum scan time, low radiation
levels, and stable calibration (Blake and Fogelman 1996; Dr. Jan Bruder, personal communication 2003). DXA is also preferred over other techniques because of the many areas of the body that may be scanned; hip, spine, and total body.

Although bone density measured by DXA is the best predictor of fractures available today, there are limitations. DXA does not provide a true volumetric calculation of the bone. DXA measures areal bone density and subsequently does not completely adjust for bone size (Seeman 1999) (See Appendix H). According to Seeman (1999), patients with bone fractures may have smaller bones than age-matched controls. A deficit in bone density may also be the result of a low peak areal bone density attainment, excessive bone loss, or a combination of these factors (Seeman 1999). Additionally, bone density is only one quality of bone that determines strength. There are additional factors that are difficult to quantitatively measure such as bone mineralization, connectivity, and bone turnover (Dr. Jan M. Bruder, personal communication 2004).

Quantitative Computer Tomography (QCT) provides three-dimensional, volumetric measurements (bone mineral content which are reported in mg/cc), but this method also contains limitations. This method involves much more radiation than DXA and is more expensive to operate. With higher radiation output, QCT requires special
accommodations whereas bone density tests performed by DXA can be completed within a normal office setting.

2.4 Sample Characteristics

Figure 2.1 illustrates the age distribution of the 106 women in the sample. There are six women whose ages range between 20 and 29 (6%), forty-two women whose ages range between 30 and 39 (40%), fifty-three women whose ages range between 40 and 49 (50%), and five women who are 50 and above, with age 51 being the oldest (5%). Figures 2.2 and 2.3 illustrate the distribution of hip total (g/cm²) and total spine (g/cm²) respectively, by age. Table 2.1 illustrates the characteristics of age, height, weight, and BMI (body mass index) for the sample population (N=106). The mean age of the sample is 39.9 years, mean height is 62.5 inches, and average weight is 159.7 pounds. Weight ranged from 88.5 pounds to 265 pounds. The median, standard deviation (average distance from the mean (SD), normality test of Omnibus (K²), K²= Z²g1+ Z²g2 (Zarr 1999: 115-120) and its associated probability (P) are also included in the table.
Figure 2.1: Age distribution for the sample population.
Figure 2.2: Scatter Plot of hip total (hipt) (g/cm²) with age
Figure 2.3: Scatter Plot of Total spine (spinet) (g/cm²) with age

<table>
<thead>
<tr>
<th></th>
<th>RANGE</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>S.D.</th>
<th>K²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>21-51</td>
<td>39.9</td>
<td>40</td>
<td>6.35</td>
<td>7.38</td>
<td>0.024*</td>
</tr>
<tr>
<td>HEIGHT (inches)</td>
<td>56.5-68.7</td>
<td>62.5</td>
<td>62.4</td>
<td>2.27</td>
<td>1.66</td>
<td>0.435</td>
</tr>
<tr>
<td>WEIGHT (pounds)</td>
<td>88.5-265</td>
<td>159.7</td>
<td>154</td>
<td>36.8</td>
<td>9.54</td>
<td>0.008*</td>
</tr>
<tr>
<td>BMI</td>
<td>16.4-48.1</td>
<td>28.7</td>
<td>27.43</td>
<td>6.24</td>
<td>8.34</td>
<td>0.015*</td>
</tr>
</tbody>
</table>

Table 2.1: Sample characteristics including range, mean, median, standard deviation (S.D.), omnibus test for normality (K²), and P is its associated probability. *significantly different from normality.
Figure 2.4: Histogram of weight (wt) (in pounds) distribution in the sample including the normal density line. Count=number of individuals
Figure 2.5: Histogram of height (ht) (in inches) distribution in the sample including the normal density line. Count=number of individuals
Weight and BMI were not normally distributed. Therefore, a logarithmic transformation was calculated for these two variables in NCSS® 2000 and descriptive statistics were run again. Age was not normally distributed after a logarithmic transformation was calculated, therefore descriptive statistics were not run again. Table 2.2 illustrates the characteristics of normally distributed weight and BMI using logarithmic transformation. The range, mean, median, standard deviation (average distance from the mean (SD), normality test of
Omnibus ($K^2$), $K^2= Z^2_{g1}+ Z^2_{g2}$ (Zarr 1999: 115-120) and its associated probability (P) are included in the table.

<table>
<thead>
<tr>
<th>WEIGHT (pounds)</th>
<th>RANGE</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>S.D.</th>
<th>$K^2$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.94-2.42</td>
<td>2.19</td>
<td>2.18</td>
<td>9.67</td>
<td>2.11</td>
<td>0.34</td>
</tr>
<tr>
<td>BMI</td>
<td>1.21-1.68</td>
<td>1.44</td>
<td>1.43</td>
<td>9.24</td>
<td>0.34</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Table 2.2: Normally distributed sample characteristics after logarithmically transformed.

2.5 Statistical Analyses

The statistical program NCSS® 2000 was utilized for all statistical analyses. Descriptive statistics for each variable were obtained. These include minimum and maximum values, mean, median, standard deviation, histograms, and measures of skew, kurtosis, and normality. Statistical significance was determined at $p<0.05$.

Areas tested for bone density were the lumbar vertebrae one through four, the total spine density average, the hip (or femur) neck, trochanter, intertrochanter, and the total hip density average. The resulting bone densities are the dependent variables in the statistical analyses that were tested for correlation with the following variables: age, weight, height, BMI (body mass index), generation and acculturation.
levels, teen and adult workload, child, teen, and adult dairy per day, soft
drinks per day, servings of green vegetables, and red meat per day,
frequency of at eating restaurants/fast foods, and adult calcium
supplement intake per day.

Univariate models of linear regressions were completed for the
pairs of variables for a total of 198 regressions. The slope was tested for
significance using a t-test. The square of the simple linear correlation
coefficients yield the percent of the variance in the dependent variables
explained by the independent variables. Multiple regressions were
completed for all variables mentioned above that yielded statistically
significant (probability less than .10) results in the univariate linear
regression analyses.

Within the sample population, T-scores of total spine, (L1-L4), hip
neck, and hip total were determined. These calculations were made at
the time of the bone scan by the DXA machine. These scores were tested
for the entire sample population using t-tests for low and normal scores
with all independent variables.
CHAPTER 3

RESULTS

3.1 Introduction

In order to achieve answers to the research objectives, this chapter summarizes the affect of biological, dietary, workload, and cultural factors on bone density of premenopausal Mexican American women in San Antonio, Texas. All data were collected utilizing individual questionnaires (see Chapter 2, Appendices A and B), bone density scans, and anthropometric measures. The total sample size was 106 after women who had missing data were eliminated from the original group of 109.

3.2 Description of Bone Density Averages

Descriptive statistics were run on all bone density measures. The following bone density measurements are the dependent variables: lumbar vertebrae one through four (L1-L4), total spine, hip neck, hip trochanter, hip intertrochanter, and hip total. Histograms were included
in all descriptive statistics of the dependent variables (Figures 3.1-3.10). The mean, range, standard deviation (average distance from the mean (SD), normality test of Omnibus ($K^2$), $K^2 = Z_{g1}^2 + Z_{g2}^2$ (Zarr 1999: 115-120) and its associated probability ($P$) are included in tables 3.1 and 3.2.

### 3.2.1 Lumbar Vertebrae

Table 3.1 illustrates descriptive statistics results for lumbar vertebrae one through four and the total spine (The total spine is the average of all scanned measures taken of lumbar vertebrae 1-4). The means and standard deviations (SD) are all very similar and the ranges overlap. All are normally distributed variables and are illustrated in separate histograms of L1 through L4 and the total spine (Figures 3.1-3.5).

Of the total sample (n=106), the mean bone density (grams per centimeter squared or g/cm²) of all L1 vertebrae = 0.93, median = 0.924, the standard deviation = 0.11, $K^2 = 1.79$ which is normally distributed, and the range of the values of g/cm² was 0.68 to 1.20. The mean bone density (grams per centimeter squared or g/cm²) of all L2 vertebrae =1.03, median = 1.00, the standard deviation = 0.12, $K^2 = 1.26$ which is normally distributed, and the range of the values of g/cm² was 0.74 to 1.30. The mean bone density (grams per centimeter squared or g/cm²) of all L3 vertebrae = 1.04, median = 1.01, the standard deviation = 0.12, $K^2$
= 4.84 which is normally distributed, and the range of the values of g/cm² was 0.74 to 1.45. The mean bone density (grams per centimeter squared or g/cm²) of all L4 vertebrae = 1.05, median = 1.03, the standard deviation = 0.12, $K^2 = 2.33$ which is normally distributed. The range of the values of g/cm² was 0.70 to 1.38. The mean bone density (grams per centimeter squared or g/cm²) of all total spines = 1.01, median = 0.99, the standard deviation = 0.11, $K^2 = 1.88$ which is normally distributed. The range of the values of g/cm² is 0.73 to 1.33.

<table>
<thead>
<tr>
<th>Area Scanned</th>
<th>Mean (g/cm²)</th>
<th>SD</th>
<th>Range</th>
<th>$K^2$</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 (g/cm²)</td>
<td>0.93</td>
<td>0.12</td>
<td>0.68-1.20</td>
<td>1.79</td>
<td>0.408</td>
</tr>
<tr>
<td>L2 (g/cm²)</td>
<td>1.03</td>
<td>0.12</td>
<td>0.74-1.30</td>
<td>1.26</td>
<td>0.531</td>
</tr>
<tr>
<td>L3 (g/cm²)</td>
<td>1.04</td>
<td>0.12</td>
<td>0.74-1.45</td>
<td>4.84</td>
<td>0.089</td>
</tr>
<tr>
<td>L4 (g/cm²)</td>
<td>1.05</td>
<td>0.12</td>
<td>0.70-1.38</td>
<td>2.33</td>
<td>0.312</td>
</tr>
<tr>
<td>Total spine</td>
<td>1.01</td>
<td>0.11</td>
<td>0.73-1.33</td>
<td>1.88</td>
<td>0.390</td>
</tr>
</tbody>
</table>

Table 3.1: Characteristics of Lumbar Vertebrae 1-4 and Total spine
Figure 3.1: Histogram of L1 bone density (g/cm²) including the normal density line. Count=number of individuals

Figure 3.2: Histogram of L2 bone density (g/cm²) including the normal density line. Count=number of individuals
Figure 3.3: Histogram of L3 bone density (g/cm²) including the normal density line. Count=number of individuals

Figure 3.4: Histogram of L4 bone density (g/cm²) including the normal density line. Count=number of individuals
3.2.2 Hip

Table 3.2 illustrates results of descriptive statistics for the hip. The mean bone density (grams per centimeter squared or g/cm²) of all hip neck totals = 0.84, median = 0.84, the standard deviation = 0.12, and \( K^2 = 1.28 \) which is normally distributed. The range of the values of g/cm² is 0.59 to 1.12. The mean bone density (grams per centimeter squared or g/cm²) of all hip trochanters in the sample = 0.70, median = 0.7, the standard deviation = 0.11, and \( K^2 = 7.00 \) which is not normally distributed. The range of the values of g/cm² is 0.48 to 0.94. The mean
bone density (grams per centimeter squared or g/cm²) of all hip intertrochanters in the sample = 1.13, median = 1.11, the standard deviation = 0.14, and $K^2 = 0.62$ which is normally distributed. The range of the values of g/cm² is 0.77 to 1.50. The mean bone density (grams per centimeter squared or g/cm²) of the hip total in the sample = 0.96, median = 0.95, the standard deviation = 0.12, and $K^2 = 0.46$ which is normally distributed. The range of the values of g/cm² is 0.65 to 1.29.

When descriptive statistics were run on the hip neck, hip trochanter, hip intertrochanter, and hip total, all variables were normally distributed except the hip trochanter. A logarithmic transformation was calculated for this variable in NCSS® 2000 and descriptive statistics were run again (Figure 3.10). The characteristics of the normally distributed hip trochanter after being logarithmically transformed are included in Table 3.2. The mean bone density (grams per centimeter squared or g/cm²) of the log of hip trochanter in the sample = -0.16, median=-0.15, the standard deviation=6.88, and $K^2=5.35$, which is now normally distributed. The range of the values of g/cm² is -0.32 to -2.87. Histograms of all hip variables (hip neck, hip trochanter, hip intertrochanter, and hip total) are illustrated in Figures 3.6-3.10.

The hip trochanter exhibits the lowest mean, then the hip neck and hip trochanter respectively. The standard deviations are all similar and the ranges overlap with the hip trochanter exhibiting the lower
ranges. With the exception of the hip intertrochanter, the means (g/cm²) of the hip are somewhat lower than the lumbar vertebrae.

<table>
<thead>
<tr>
<th>Area Scanned</th>
<th>Mean (g/cm²)</th>
<th>SD</th>
<th>Range</th>
<th>K²</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Neck (g/cm²)</td>
<td>0.84</td>
<td>0.12</td>
<td>.59-1.12</td>
<td>1.28</td>
<td>0.582</td>
</tr>
<tr>
<td>Hip Troch. (g/cm²)</td>
<td>0.70</td>
<td>0.11</td>
<td>.48-.94</td>
<td>7.00</td>
<td>0.301</td>
</tr>
<tr>
<td>Log Hip Troch. (g/cm²)</td>
<td>-0.16</td>
<td>6.88</td>
<td>-0.32-2.87</td>
<td>5.35</td>
<td>0.069</td>
</tr>
<tr>
<td>Hip Intertroch. (g/cm²)</td>
<td>1.13</td>
<td>0.14</td>
<td>0.77-1.50</td>
<td>0.62</td>
<td>0.733</td>
</tr>
<tr>
<td>Hip Total (g/cm²)</td>
<td>0.96</td>
<td>0.12</td>
<td>.65-1.29</td>
<td>0.46</td>
<td>0.794</td>
</tr>
</tbody>
</table>

Table 3.2: Characteristics of hip neck, hip trochanter, Log hip trochanter, hip intertrochanter, and hip total.
Figure 3.6: Histogram of the Hip Neck bone density (g/cm²) including the normal density line. Count=number of individuals
Histogram of the Hip Trochanter (hip_troch) bone density (g/cm²) including the normal density line. Count=number of individuals.
Figure 3.8: Histogram of Hip Intertrochanter (hip_inter) bone density (g/cm²) including the normal density line. Count=number of individuals
Figure 3.9: Histogram of Hip total (hipt) bone density (g/cm²) including the normal density line. Count=number of individuals
Figure 3.10: Histogram of normally distributed hip trochanter (lhiptroch) bone density (g/cm²) including the normal density line after logarithmically transformed. Count=number of individuals

3.3 Description of Biological Factors, Diet, Workload, and Cultural Variables

Descriptive statistics were performed on all biological, dietary, workload, and cultural variables. Biological variables include age, weight, height, and BMI (body mass index). Dietary variables include child, teen, and adult dairy per day, soft drinks per day, servings of green vegetables, servings of red meat per day, and frequency of eating at restaurants/fast foods. Dietary variables specific
to adults include calcium supplement intake per day and frequency of eating prepared foods per week. Workload variables include teen and adult workload, while cultural factors (variables) include generation and acculturation levels.
Figure 3.11 illustrates the number of child servings of dairy consumed each day. Of the total sample of 106, 2 women reported consuming no dairy as a child, 13 reported consuming up to one serving of dairy per day, while 29 reported consuming 1.1-1.9 servings of dairy per day. Those participants who consumed 2-3 servings of dairy per day and more than 3 servings of dairy per day totaled 31 in each category. More than half (62) of the women consumed at least 2 servings of dairy per day. The majority of women reported consuming milk and cheese more than other dairy products such as yogurt, ice cream, and cottage cheese in all age categories (child, teen, and adult).

Figure 3.11: Child servings of dairy per day
Figure 3.12 illustrates the number of servings of dairy consumed each day by each participant as an adolescent. Of the total sample of 106, 1 woman reported consuming no dairy as an adolescent, 25 reported consuming up to one serving of dairy per day, while 37 reported consuming 1.1-1.9 servings of dairy per day. Twenty-two women reported consuming 2-3 servings of dairy per day, while 21 reported consuming 3 or more servings of dairy per day. Dairy consumption of participants as adolescents was slightly lower than consumption as a child and higher than their adult stage of life.

Figure 3.12: Adolescent servings of dairy per day
Figure 3.13 illustrates the number of servings of dairy consumed each day by participants as an adult. In general, adults exhibited low dairy consumption. According to the Institute of Medicine (1997), the daily recommended servings of dairy per day for premenopausal women are two. Of the total sample of 106, 80 women consume lower than 2 servings of dairy per day, while only 26 consume 2 or more servings. The average daily serving of dairy is 1.55, with the range of servings being 0-7. Adult servings of dairy were lower than that of the child and adolescent stages of life.

Figure 3.13: Adult servings of dairy per day
Figure 3.14 illustrates the number of soft drinks consumed by participants as a child. In general, consumption of soft drinks was low with the majority of participants (74) consuming zero to part of 1 each day. Eighteen women reported consuming one soft drink each day, 10 reported consuming 1.1-2 per day, and women consuming 2.1-3 and more than 3 totaled 2 in each category. Soft drinks most often consumed in all categories (child, teen, and adult) were Big Red®, Coke®, Dr. Pepper®, 7Up® and Sprite®. Big Red® is a highly-caffeinated strawberry-flavored soft drink that is very popular among the Mexican American population in San Antonio. It is a locally-produced product.

![Bar chart](chart.png)

Figure 3.14: Child servings of soft drinks per day
Figure 3.15 illustrates the number of soft drinks consumed by participants as an adolescent. Consumption of soft drinks was low with the majority of participants (58) consuming zero to less than 1 each day. Twenty-one women reported consuming one soft drink each day, 19 reported consuming 1.1-2 per day, and women consuming 2.1-3 and more than 3 totaled 4 in each category. Generally, consumption of soft drinks as an adolescent is very similar to consumption as a child.

Figure 3.15: Teen servings of soft drinks per day
Figure 3.16 illustrates the number of soft drinks consumed by participants as an adult. Although consumption of soft drinks is low, participants drink more soft drinks as adults. The majority of participants (55) consume zero to less than 1 each day. Thirty women reported consuming one soft drink each day and 12 reported consuming 1.1-2 per day. Five women reported consuming 2.1-3 soft drinks each day and 3 women reported consuming more than 3 soft drinks per day.

Figure 3.16: Adult servings of soft drinks per day
Figure 3.17 illustrates the number of reported servings of green vegetables consumed each day as a child. Inquiry pertaining to green vegetables was included in the questionnaire due to the measurable amount of calcium content found in vegetables such as broccoli and green, leafy vegetables. As with dairy products and soft drinks, consumption of green vegetables was relatively low. The majority of participants (70) consumed zero to less than 1 serving each day.

Figure 3.17: Child servings of green vegetables per day
Figure 3.18 illustrates the number of reported servings of green vegetables consumed each day as an adolescent. As with vegetables consumed each day by participants as a child, consumption as an adolescent was low. Seventy-three participants reported consuming zero to less than 1 serving each day.

Figure 3.18: Teen servings of green vegetables per day
Figure 3.19 illustrates the number of reported servings of green vegetables consumed each day as an adult. As with green vegetables consumed each day by participants as a child and adolescent, consumption as an adult is low. Sixty-seven participants reported consuming an average of less than 1 serving of green vegetables each day. Generally, frequency of green vegetable consumption was similar in all age categories (child, teen and adult).

Figure 3.19: Adult servings of green vegetables per day
Figure 3.20 illustrates the number of reported servings of red meat per day during childhood. Most individuals reported a low consumption of red meat as a child. The majority of women (70) consumed zero to less than 1 serving of red meat per day. The remaining participants (36) reported consuming more than one serving of red meat per day.

Figure 3.20: Child servings of red meat per day.
Figure 3.21 illustrates the number of reported servings of red meat per day as an adolescent. As an adolescent, the majority of women (73) reported consuming zero to less than one serving of red meat per day. The remaining participants (33) reported consuming more than one serving of red meat per day as an adolescent.

Figure 3.21: Teen servings of red meat per day
Figure 3.22 illustrates the number of reported servings of red meat consumed as an adult. The majority of individuals (88) reported consuming zero to less than one serving of red meat per day. The remaining participants (16) reported consuming at least one serving of red meat per day as an adult. Consumption of red meat as an adult is slightly lower than that of both the child and adolescent stages of life.

Figure 3.22: Adult servings of red meat per day.
Figure 3.23 illustrates the frequency of eating at restaurants and/or fast food establishments by participants as a child. The majority (59) of women report eating at restaurants or fast food establishments zero to one time per week as a child. The remaining women (47) reported frequenting these establishments at least once a week.

Figure 3.23: Child restaurant and/or fast foods per week
Figure 3.24 illustrates the frequency of eating at restaurants and/or fast food establishments by participants as an adolescent. Eating out is more evenly-distributed in the adolescent category, with the majority (82) of women reporting eating out at least once a week. This is most likely the result of the ability to leave the home independently as an adolescent.

Figure 3.24: Teen restaurant and/or fast foods per week
Figure 3.25 illustrates the frequency of eating at restaurants and/or fast food establishments by participants as an adult. Eating out as an adult clearly increases in frequency as 99 women report eating at restaurants and/or fast food establishments at least once a week. Within this sample, eating-out steadily increases as age increases.

Figure 3.25: Adult restaurant and/or fast foods per week
Figure 3.26 illustrates the reported number of servings of prepared foods consumed each week as an adult. Prepared foods include frozen and/or boxed foods. One woman did not provide an answer for this question, therefore the total for this variable is 105. Of the remaining sample, the majority (58) reported eating prepared foods at least one time a week.

Figure 3:26:  Adult servings of prepared foods per week
Figure 3.27 illustrates the reported milligrams of calcium taken in supplemental form as an adult. Eight women failed to report on calcium supplement consumption. Of the remaining 98 women, the majority (76) report taking no calcium supplement. As adult dairy consumption is also low (Figure 3.13), it is probable that the women in this sample are not receiving the recommended 1000 milligrams of calcium per day.

![Figure 3.27: Adult milligrams of calcium taken each day](image-url)
Figure 3.28 illustrates total workload (number of hours) per week as an adolescent. Activities listed most were running, walking, biking, and physical education (PE) class. Activities such as housework and yard work were also listed. Generally, participants were moderately active during adolescence.

Figure 3.28: Teen total hours of workload per week
Figure 3.29 illustrates the reported number of adult hours of total workload per week. The individuals in this sample can be generally categorized as sedentary in the adult category. Most women reported little or no exercise of any kind in the period of a week. Examples of reported activities included walking, running, aerobics class, biking, housework, and yard work.

Figure 3.29: Adult hours of total workload per week.
Figure 3.30 illustrates acculturation levels of the individuals studied. Level 1 indicates very strong social ties with Mexico and level 5 indicates strong social ties with the United States. Women who spoke little or no English had an average acculturation level of 1 or 2. There were no individuals with an acculturation level of 5. Most women (62) had an average acculturation level of 3 which indicates having ties or social identification with both Mexican and American cultures.

![Acculturation Level vs Number of Individuals](image.png)

Figure 3.30: Acculturation levels of individuals in the sample.
Figure 3.31 illustrates the generation levels of the individuals in the sample. Generation levels range from 1 to 5 with level 1 containing participants born in Mexico and level 5 containing participants, their parents and grandparents born in the United States. The fourth generation level contains 32 women, while all other generation levels contain 20 or fewer individuals. Fourth generation is defined as a participant and her parents both born in the United States and at least one grandparent born in Mexico, with all other grandparents born in the United States (Cuéllar et al. 1995).
3.4 Results of Univariate Linear Regression Analyses of Biological Factors, Diet, Workload, and Cultural Variables

Univariate linear regression analyses were performed using the following as independent variables: age, weight, height, BMI (body mass index), generation and acculturation levels, teen and adult workload per week, child, teen, and adult dairy per day, soft drinks per day, servings of green vegetables, and red meat per day, and frequency of eating at restaurants/fast foods. Also included in the linear regression analyses were calcium supplement intake per day and frequency of eating prepared foods per week which were specific to the adult category.

Results are illustrated in Table 3.3 through Table 3.11. Tables are divided into biological factors, (Table 3.3 and 3.4), cultural variables (Table 3.5-3.6), workload level (Table 3.7), and child, adolescent, and adult diet (Tables 3.8-3.11). Analyses which resulted in no association between independent and dependent variables (lumbar vertebrae one through four (L1-L4), total spine, hip neck, hip trochanter, hip intertrochanter, and hip total) are not included in the tables.
3.4.1 Biological and Cultural Factors

In univariate linear regression analyses, age was not associated with any areas scanned including lumbar vertebrae one through four (L1-L4), total spine, hip neck, hip trochanter, hip intertrochanter, and hip total. Therefore, as age explained less than 2% of the variation in all areas scanned for bone density and was not associated with any scanned areas, the results are not presented in Table 3.3. Weight explained a significant amount of variation in bone density in all areas measured (p=<0.05). Height was significant on all bone density measurements of the spine but only one area of the hip; the hip neck. In univariate linear regression analyses, body mass index (BMI) (weight/H²) was significant on all bone density measurements. These results were acquired using the following univariate linear regression formula: for example, L1=.784+0.005(BMI). All linear regression formulae are included in Table 3.3

Even though there are statistically significant relationships with height, weight, and BMI with vertebral bone density, the amount of variation explained separately by height, weight, and BMI in the vertebrae is under 10%. Weight and BMI explain a somewhat greater amount of variation in the hip (13-19%) where height explains virtually no variation of bone density in the hip. Because weight and BMI were not normally distributed, a log transformation was calculated for both,
and univariate linear regressions were performed. However, the results were essentially the same as with the untransformed data. These results are illustrated in Table 3.4.

Although acculturation level exhibited a statistically significant relationship with both the hip and vertebrae, the amount of variation explained by acculturation is less than 10% (Table 3.5). Generation level does not have a statistically significant relationship with the hip, and only a small relationship with the vertebrae. Because generation level was ranked or ordinal, one-way Analysis of Variance (ANOVA) was performed (Table 3.6)
<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE</th>
<th>HEIGHT</th>
<th>WEIGHT</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.224+0.011(H)</td>
<td>0.767+0.001(W)</td>
<td>0.784+0.005(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.046</td>
<td>0.096</td>
<td>0.070</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>5.028</td>
<td>11.15</td>
<td>7.831</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.027</td>
<td>0.001</td>
<td>0.006</td>
</tr>
<tr>
<td><strong>L2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.278+0.012(H)</td>
<td>0.887+0.001(W)</td>
<td>0.906+0.004(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.049</td>
<td>0.070</td>
<td>0.045</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>5.435</td>
<td>7.855</td>
<td>5.011</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.021</td>
<td>0.006</td>
<td>0.027</td>
</tr>
<tr>
<td><strong>L3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.294+0.012(H)</td>
<td>0.894+0.000(W)</td>
<td>0.917+0.004(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.050</td>
<td>0.076</td>
<td>0.048</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>5.465</td>
<td>8.490</td>
<td>5.245</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.021</td>
<td>0.004</td>
<td>0.024</td>
</tr>
<tr>
<td><strong>L4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.459+0.009(H)</td>
<td>0.927+0.000(W)</td>
<td>0.943+0.004(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.032</td>
<td>0.053</td>
<td>0.036</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>3.417</td>
<td>5.840</td>
<td>3.891</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.067</td>
<td>0.017</td>
<td>0.050</td>
</tr>
<tr>
<td><strong>Total spine</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.315+0.011(H)</td>
<td>0.875+0.000(W)</td>
<td>0.893+0.004(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.050</td>
<td>0.081</td>
<td>0.054</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>5.581</td>
<td>9.196</td>
<td>5.937</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.020</td>
<td>0.003</td>
<td>0.016</td>
</tr>
<tr>
<td><strong>Hip Neck</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.242+0.009(H)</td>
<td>0.617+0.001(W)</td>
<td>0.617+0.008(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.034</td>
<td>0.193</td>
<td>0.172</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>3.716</td>
<td>24.99</td>
<td>21.63</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.056</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hip Trochanter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.347+0.006(H)</td>
<td>0.524+0.001(W)</td>
<td>0.051+0.007(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.013</td>
<td>0.139</td>
<td>0.136</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>1.445</td>
<td>16.80</td>
<td>16.50</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.232</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hip Intertroch.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.602+0.008(H)</td>
<td>0.888+0.001(W)</td>
<td>0.879+0.009(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.182</td>
<td>0.152</td>
<td>0.145</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>1.930</td>
<td>18.71</td>
<td>17.74</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.167</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hip Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation</td>
<td>0.494+0.007(H)</td>
<td>0.737+0.001(W)</td>
<td>0.073+0.008(B)</td>
</tr>
<tr>
<td>r²</td>
<td>0.018</td>
<td>0.173</td>
<td>0.167</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>2.011</td>
<td>21.78</td>
<td>20.88</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.159</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 3.3: Univariate linear regression results for height, weight and BMI (p=<.05)
<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE</th>
<th>LOG WEIGHT</th>
<th>LOG BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>0.070+0.391(LW)</td>
<td>0.0446+0.333(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.100</td>
<td>0.066</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>11.67</td>
<td>7.429</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.000</td>
<td>0.007</td>
</tr>
<tr>
<td><strong>L2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>0.264+0.348(LW)</td>
<td>0.620+0.281(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.076</td>
<td>0.045</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>8.554</td>
<td>4.927</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.004</td>
<td>0.028</td>
</tr>
<tr>
<td><strong>L3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>0.270+0.351(LW)</td>
<td>0.628+0.284(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.079</td>
<td>0.047</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>8.828</td>
<td>5.117</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.003</td>
<td>0.025</td>
</tr>
<tr>
<td><strong>L4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>0.423+0.285(LW)</td>
<td>0.711+0.232(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.053</td>
<td>0.032</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>5.791</td>
<td>3.457</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.017</td>
<td>0.065</td>
</tr>
<tr>
<td><strong>Total spine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>0.273+0.338(LW)</td>
<td>0.614+0.276(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.084</td>
<td>0.051</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>9.572</td>
<td>5.637</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.002</td>
<td>0.019</td>
</tr>
<tr>
<td><strong>Hip Neck</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>-0.335+0.536(LW)</td>
<td>0.108+0.506(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.196</td>
<td>0.159</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>25.35</td>
<td>19.75</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hip Trochanter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>-0.291+0.453(LW)</td>
<td>0.005+0.448(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.158</td>
<td>0.141</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>19.52</td>
<td>17.14</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hip Intertroch.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>-0.202+0.607(LW)</td>
<td>0.268+0.593(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.171</td>
<td>0.150</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>21.52</td>
<td>18.35</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hip Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reg. equation:</td>
<td>-0.262+0.556(LW)</td>
<td>0.167+0.546(LB)</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.192</td>
<td>0.170</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>24.86</td>
<td>21.32</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 3.4: Univariate linear regression results for Log weight and Log BMI
<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>R²</th>
<th>F-RATIO</th>
<th>PROB. LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L1</strong></td>
<td>0.068</td>
<td>7.598</td>
<td>0.006</td>
</tr>
<tr>
<td>Reg. equation: 0.784+0.044(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L2</strong></td>
<td>0.053</td>
<td>5.826</td>
<td>0.017</td>
</tr>
<tr>
<td>Reg. equation: 0.897+0.040(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L3</strong></td>
<td>0.074</td>
<td>8.238</td>
<td>0.004</td>
</tr>
<tr>
<td>Reg. equation: 0.888+0.046(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L4</strong></td>
<td>0.039</td>
<td>4.211</td>
<td>0.042</td>
</tr>
<tr>
<td>Reg. equation: 0.939+0.033(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total spine</strong></td>
<td>0.063</td>
<td>7.004</td>
<td>0.009</td>
</tr>
<tr>
<td>Reg. equation: 0.088+0.040(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hip Neck</strong></td>
<td>0.050</td>
<td>5.484</td>
<td>0.021</td>
</tr>
<tr>
<td>Reg. equation: 0.720+0.037(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hip Trochanter</strong></td>
<td>0.045</td>
<td>4.886</td>
<td>0.029</td>
</tr>
<tr>
<td>Reg. equation: 0.0594+0.033(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hip Intertroch.</strong></td>
<td>0.063</td>
<td>6.981</td>
<td>0.009</td>
</tr>
<tr>
<td>Reg. equation: 0.964+0.050(Acc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hip Total</strong></td>
<td>0.051</td>
<td>5.612</td>
<td>0.019</td>
</tr>
<tr>
<td>Reg. equation: 0.083+0.039(Acc)</td>
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</tbody>
</table>

Table 3.5: Univariate linear regression results for acculturation level
<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>F-RATIO</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>4.05</td>
<td>0.0043</td>
</tr>
<tr>
<td>L2</td>
<td>2.35</td>
<td>0.0597</td>
</tr>
<tr>
<td>L3</td>
<td>3.19</td>
<td>0.0164</td>
</tr>
<tr>
<td>L4</td>
<td>2.01</td>
<td>0.0993</td>
</tr>
<tr>
<td>Total spine</td>
<td>3.04</td>
<td>0.0207</td>
</tr>
<tr>
<td>Hip Neck</td>
<td>1.70</td>
<td>0.1556</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>2.15</td>
<td>0.0805</td>
</tr>
<tr>
<td>Hip Intertroch.</td>
<td>2.22</td>
<td>0.0722</td>
</tr>
<tr>
<td>Hip Total</td>
<td>2.08</td>
<td>0.0895</td>
</tr>
</tbody>
</table>

Table 3.6: Analysis of Variance (ANOVA) results for Generation 3.4.2

Physical Activity and Workload

Physical activity and workload answers from participants were combined into a single workload variable. The term *workload* was utilized on the questionnaire along with physical activity in order to extract all possible physical activities performed such as housework, heavy lifting, and yard-work. Total time of physical activity and workload were added together to make up one variable: workload per week. Both teen physical activity and workload failed to show any significant contribution to bone density in any areas scanned therefore a table was not generated.

Adult workload is significantly associated with bone density of the spine, however the association is negative. Even though there is a
statistically significant relationship between adult workload level and bone density of the spine, workload explains less than 5% of the variation in bone density and the negative association may be a statistical artifact (See Table 3.7). Women who are presently more active have a lower average bone density in all four lumbar vertebrae and therefore a lower average spine bone density total. Scanned areas of the hip (hip neck, hip trochanter, hip intertrochanter) were not significantly affected by workload.
Table 3.7: Univariate linear regression results for adult workload levels (p<.05)

<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>r²</th>
<th>F-Ratio</th>
<th>Prob. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.038</td>
<td>4.177</td>
<td>0.043</td>
</tr>
<tr>
<td>Reg. equation: 0.946-0.013(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>0.048</td>
<td>5.255</td>
<td>0.023</td>
</tr>
<tr>
<td>Reg. equation: 1.048-0.015(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>0.042</td>
<td>4.623</td>
<td>0.033</td>
</tr>
<tr>
<td>Reg. equation: 1.059-0.014(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L4</td>
<td>0.028</td>
<td>3.032</td>
<td>0.084</td>
</tr>
<tr>
<td>Reg. equation: 1.063-0.010(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total spine</td>
<td>0.044</td>
<td>4.797</td>
<td>0.030</td>
</tr>
<tr>
<td>Reg. equation: 1.033-0.013(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Neck</td>
<td>0.016</td>
<td>1.748</td>
<td>0.189</td>
</tr>
<tr>
<td>Reg. equation: 0.852-0.008(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.005</td>
<td>1.191</td>
<td>0.277</td>
</tr>
<tr>
<td>Reg. equation: 0.708-0.004(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Intertroch.</td>
<td>0.011</td>
<td>1.191</td>
<td>0.277</td>
</tr>
<tr>
<td>Reg. equation: 1.140-0.008(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.013</td>
<td>1.398</td>
<td>0.239</td>
</tr>
<tr>
<td>Reg. equation: 0.969-0.008(AdW)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.4.3 Dietary Variables

Of the three dairy sections (child, adolescent and adult), only adult dairy intake explained a significant amount of variation in bone density (Table 3.8). Adult dairy was the only dietary variable that had a significant effect on bone density of all areas scanned with the exception of the hip trochanter which had a probability level of .076. Adult dairy
was positively associated with bone density in all areas of bone scanned.

Again, although there is a statistically significant association, adult dairy consumption only explains 9% or less of the variation in bone density.

<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>r²</th>
<th>F-Ratio</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.054</td>
<td>5.977</td>
<td>0.016</td>
</tr>
<tr>
<td>L2</td>
<td>0.035</td>
<td>3.847</td>
<td>0.050</td>
</tr>
<tr>
<td>L3</td>
<td>0.054</td>
<td>5.913</td>
<td>0.016</td>
</tr>
<tr>
<td>L4</td>
<td>0.050</td>
<td>5.440</td>
<td>0.021</td>
</tr>
<tr>
<td>Total spine</td>
<td>0.052</td>
<td>5.798</td>
<td>0.017</td>
</tr>
<tr>
<td>Hip Neck</td>
<td>0.043</td>
<td>4.749</td>
<td>0.031</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.091</td>
<td>10.46</td>
<td>0.001</td>
</tr>
<tr>
<td>Hip Intertroch.</td>
<td>0.029</td>
<td>3.197</td>
<td>0.076</td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.063</td>
<td>7.025</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Table 3.8: Univariate linear regression results for adult dairy per day
Table 3.9 illustrates all remaining dietary variables that exhibited statistically significant results and those that exhibited probability levels less than .10 in at least one area scanned for bone density. These dietary variables include: child and adult red meat consumption, teen vegetable, and soft drink consumption. All are positively associated with bone density in all areas of scanned bone. Although these are statistically significant with bone density at various sites, the association explains less than 6% of the total variation of bone density. Linear regression equations are illustrated in Tables 3.10-3.12.
<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>CHILD RED MEAT/DAY</th>
<th>TEEN VEG/DAY</th>
<th>TEEN SOFT DRINKS/DAY</th>
<th>ADULT RED MEAT/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.035</td>
<td>0.004</td>
<td>0.006</td>
<td>0.020</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>3.812</td>
<td>0.464</td>
<td>0.597</td>
<td>1.981</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.053</td>
<td>0.497</td>
<td>0.441</td>
<td>0.162</td>
</tr>
<tr>
<td><strong>L2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.027</td>
<td>0.001</td>
<td>0.003</td>
<td>0.032</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>2.965</td>
<td>0.126</td>
<td>0.345</td>
<td>3.441</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.088</td>
<td>0.723</td>
<td>0.558</td>
<td>0.066</td>
</tr>
<tr>
<td><strong>L3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.034</td>
<td>0.002</td>
<td>0.008</td>
<td>0.021</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>3.727</td>
<td>0.230</td>
<td>0.882</td>
<td>2.191</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.056</td>
<td>0.631</td>
<td>0.350</td>
<td>0.142</td>
</tr>
<tr>
<td><strong>L4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.025</td>
<td>0.000</td>
<td>0.000</td>
<td>0.008</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>2.691</td>
<td>0.000</td>
<td>0.002</td>
<td>0.780</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.104</td>
<td>0.990</td>
<td>0.960</td>
<td>0.380</td>
</tr>
<tr>
<td><strong>Total spine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.034</td>
<td>0.001</td>
<td>0.003</td>
<td>0.021</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>3.699</td>
<td>0.150</td>
<td>0.343</td>
<td>2.187</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.057</td>
<td>0.699</td>
<td>0.560</td>
<td>0.142</td>
</tr>
<tr>
<td><strong>Hip Neck</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-Ratio</td>
<td>0.017</td>
<td>0.007</td>
<td>0.000</td>
<td>0.006</td>
</tr>
<tr>
<td>Prob. level</td>
<td>1.903</td>
<td>0.737</td>
<td>0.079</td>
<td>0.594</td>
</tr>
<tr>
<td></td>
<td>0.170</td>
<td>0.393</td>
<td>0.780</td>
<td>0.442</td>
</tr>
<tr>
<td><strong>Hip</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trochanter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.056</td>
<td>0.039</td>
<td>0.053</td>
<td>0.023</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>6.222</td>
<td>4.186</td>
<td>5.826</td>
<td>2.326</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.014</td>
<td>0.043</td>
<td>0.017</td>
<td>0.130</td>
</tr>
<tr>
<td><strong>Hip Intertroch.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.007</td>
<td>0.009</td>
<td>0.047</td>
<td>0.027</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>0.743</td>
<td>1.009</td>
<td>5.149</td>
<td>2.825</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.390</td>
<td>0.317</td>
<td>0.025</td>
<td>0.095</td>
</tr>
<tr>
<td><strong>Hip Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r^2 )</td>
<td>0.026</td>
<td>0.020</td>
<td>0.032</td>
<td>0.020</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>2.814</td>
<td>2.170</td>
<td>3.521</td>
<td>2.090</td>
</tr>
<tr>
<td>Prob. level</td>
<td>0.096</td>
<td>0.144</td>
<td>0.063</td>
<td>0.151</td>
</tr>
</tbody>
</table>

Table 3.9: Univariate linear regression results for dietary variables (p<=.05)
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Child Red Meat/Day Reg. Equations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.900+0.035(ChR)</td>
</tr>
<tr>
<td>L2</td>
<td>1.001+0.032(ChR)</td>
</tr>
<tr>
<td>L3</td>
<td>1.010+0.035(ChR)</td>
</tr>
<tr>
<td>L4</td>
<td>1.023+0.030(ChR)</td>
</tr>
<tr>
<td>Total spine</td>
<td>0.988+0.033(ChR)</td>
</tr>
<tr>
<td>Hip Neck</td>
<td>0.820+0.024(ChR)</td>
</tr>
<tr>
<td><strong>Hip Trochanter</strong></td>
<td>0.669+0.041(ChR)</td>
</tr>
<tr>
<td><strong>Hip Intertrochanter</strong></td>
<td>1.113+0.019(ChR)</td>
</tr>
<tr>
<td><strong>Hip Total</strong></td>
<td>0.932+0.031(ChR)</td>
</tr>
</tbody>
</table>

Table 3.10: Linear regression equations for Child Red Meat Consumption
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Teen Veg/day Reg. Equations:</th>
<th>Teen Soft Drinks/day Reg. Equations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.916+0.036(Tv)</td>
<td>0.912+0.008(Tsd)</td>
</tr>
<tr>
<td>L2</td>
<td>1.021+0.007(Tv)</td>
<td>1.020+0.006(Tsd)</td>
</tr>
<tr>
<td>L3</td>
<td>1.031+0.009(Tv)</td>
<td>1.030+0.009(Tsd)</td>
</tr>
<tr>
<td>L4</td>
<td>1.046+0.000(Tv)</td>
<td>1.046+0.000(Tsd)</td>
</tr>
<tr>
<td>Total spine</td>
<td>1.008+0.007(Tv)</td>
<td>1.009+0.005(Tsd)</td>
</tr>
<tr>
<td>Hip Neck</td>
<td>0.828+0.017(Tv)</td>
<td>0.837+0.003(Tsd)</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.067+0.037(Tv)</td>
<td>0.680+0.021(Tsd)</td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>1.110+0.024(Tv)</td>
<td>1.101+0.026(Tsd)</td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.936+0.030(Tv)</td>
<td>0.939+0.002(Tsd)</td>
</tr>
</tbody>
</table>

Table 3.11: Linear regression equations for Teen green vegetables and soft drinks per day.
Dependent Variable (Area Scanned) | Adult Red Meat/Day Reg. Equations:
--- | ---
L1 | 0.909 + 0.030(AdR)
L2 | 1.003 + 0.040(AdR)
L3 | 1.021 + 0.032(AdR)
L4 | 1.036 + 0.019(AdR)
Total spine | 0.996 + 0.030(AdR)
Hip Neck | 0.830 + 0.016(AdR)
Hip Trochanter | 0.683 + 0.025(AdR)
Hip Intertrochanter | 1.103 + 0.042(AdR)
Hip Total | 0.939 + 0.031(AdR)

Table 3.12: Linear regression equations for Adult Red Meat Consumption.

3.5 Multiple Regression Analyses

Multiple regression analyses were performed since univariate linear regressions explained so little of the variation in bone density of the areas scanned. Because additional variables are included in multiple regression analyses, more variation of bone density may be explained. Results of all multiple regression analyses are included in Section 3.5.1.

Univariate linear regression analyses were performed on all dependent variables including lumbar vertebrae one through four (L1-
L4), total spine, hip neck, trochanter, intertrochanter, and hip total. If any independent variable was statistically significant (<.05 or .10>p>0.05), they were included in the multiple regression analyses. Only weight, BMI and acculturation level were statistically significant (p= <.05) for all dependent variables. Generation level was statistically
significant (p= <.05) in L1, L3, hip intertrochanter, and hip total, while total spine, hip neck, and hip trochanter had probability levels less than .10.

Of the workload variables including physical activity/workload at the child, adolescent, and adult stages of life, only adult workload was statistically significant (p= <.05) at the scan sites of the spine including L1-L3, and total spine. The fourth lumbar (L4) was less than .10 and greater than .05. Although statistically significant, adult workload is negatively associated with these areas. Adult workload was not statistically significant for any of the scanned hip locations.

Of the dietary variables, only adult dairy per day was statistically significant (p= <.05) at numerous scanned sites. Adult dairy per day was significant (p= <.05) at L1, L2 and L4, total spine, hip neck and hip trochanter, and hip total. L3 and hip intertrochanter both had probability levels that were less than .10 and greater than .05.

Child red meat per day had probability levels that were less than .10 and greater than .05 at L1-L3, total spine, and hip total. Child red meat per day was significant (p= <.05) at only the hip trochanter. Adult
red meat per day had probability levels that were less than .10 and greater than .05 at L2 and the hip intertrochanter. Teen green vegetables per day was significant (p < .05) at only the hip trochanter.

Of the three sections (child, adolescent, and adult) inquiring about soft drink intake, only the adolescent age at consumption contained significant levels. Probability levels for the hip trochanter and hip intertrochanter were less than .05, while the probability level for the hip total was less than .10 and greater than .05. Soft drink intake was not significant at any other scan-sites of the hip or spine.

### 3.5.1 Multiple Regression Results for the Hip and Spine

Multiple regression analyses were performed on all areas scanned that revealed probability levels less than .10 and greater than .05 in the univariate linear regression analyses. Correlation (R²) and probability levels from multiple regression analyses are illustrated in Tables 3.14, 3.18 and 3.22. Associations between predicted values and independent variables in the multiple regression analyses were higher than those resulting from univariate linear regression analyses. Multicolinearity was not a problem in any multiple regressions. Because weight and BMI were not normally distributed variables, a log transformation was calculated and multiple regressions were run again (Tables 3.16, 3.20 and 3.24). These calculations did not prove to make any significant differences in probabilities, however they are included.
The multiple regression equation is as follows with $Y'$ being the area scanned or predicted value and $a$ being the intercept: $Y' = a + b_1X_1 + b_2X_2 + ... + b_kX_k$. The multiple regression equations for the lumbar vertebrae with weight and height are illustrated in Table 3.13. Table 3.13 illustrates probability levels from multiple regression analyses of the spine (L1-L4 and total spine) with weight, height, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day. There are statistically significant relationships with weight, height, acculturation level, adult dairy per day, and adult workload per day with bone density in all scanned areas of the spine. The amount of variation in bone density of these areas explained by the independent variables is 19% to slightly less than 30%.
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with Wt &amp; Ht</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>$0.127 + 5.616(wt) + 8.921(ht) + 3.545(acc) + 0.025(adairy) + 0.020(chrmeat) -1.686(amin/d)$</td>
</tr>
<tr>
<td>L2</td>
<td>$0.179 + 3.883(wt) + 0.010(ht) + 3.268(acc) + 2.269(adairy) + 2.083(chrmeat) -1.938(amin/d)$</td>
</tr>
<tr>
<td>L3</td>
<td>$0.166 + 4.056(wt) + 1.030(ht) + 3.891(acc) + 2.684(adairy) + 2.148(chrmeat) -1.846(amin/d)$</td>
</tr>
<tr>
<td>L4</td>
<td>$0.367 + 3.701(wt) + 7.976(ht) + 2.700(acc) + 2.449(adairy) + 1.903(chrmeat) -1.593(amin/d)$</td>
</tr>
<tr>
<td>Total spine</td>
<td>$0.214 + 4.181(wt) + 9.479(ht) + 3.245(acc) + 2.449(adairy) + 2.086(chrmeat) -1.756(amin/d)$</td>
</tr>
</tbody>
</table>

Table 3.13: Multiple Regression equations for the lumbar vertebrae with weight, height, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day.

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>WT</th>
<th>HT</th>
<th>ACCULT LVL</th>
<th>ADULT DAIRY/DAY</th>
<th>CHILD RED MEAT/DAY</th>
<th>ADULT MIN/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.071</td>
<td>0.065</td>
<td>0.017</td>
<td>0.003</td>
<td>0.213</td>
<td>0.015</td>
</tr>
<tr>
<td>L2</td>
<td>0.233</td>
<td>0.042</td>
<td>0.037</td>
<td>0.015</td>
<td>0.237</td>
<td>0.008</td>
</tr>
<tr>
<td>L3</td>
<td>0.198</td>
<td>0.037</td>
<td>0.010</td>
<td>0.004</td>
<td>0.210</td>
<td>0.009</td>
</tr>
<tr>
<td>L4</td>
<td>0.257</td>
<td>0.119</td>
<td>0.086</td>
<td>0.009</td>
<td>0.282</td>
<td>0.031</td>
</tr>
<tr>
<td>Total spine</td>
<td>0.155</td>
<td>0.039</td>
<td>0.022</td>
<td>0.004</td>
<td>0.190</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Table 3.14: Probability levels from multiple regression analyses of the spine with weight, height, acculturation level, adult dairy per day, child red meat per day, and adult minutes of activity per day. (Significance: p<.05)
In order to identify any significant differences in probability levels with weight and height and BMI included in the equations, separate regressions were run with those including weight and height, and those including BMI. Table 3.15 illustrates probability levels from multiple regression analyses of the spine (L1, L2, L3, L4 and total spine L1-L4) with BMI, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day. There are statistically significant relationships with BMI, acculturation level, adult dairy per day and adult minutes of workload per day. The amount of variation in bone density of the spine explained by the independent variables is 15% to slightly less than 23%. The multiple regression equations for the lumbar vertebrae with BMI are illustrated in Table 3.16.
<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>BMI</th>
<th>ACCULT LEVEL</th>
<th>ADULT DAIRY/DAY</th>
<th>CHILD RED MEAT/DAY</th>
<th>ADULT MIN/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 ( R^2 = 0.225 )</td>
<td>0.067</td>
<td>0.015</td>
<td>0.006</td>
<td>0.281</td>
<td>0.020</td>
</tr>
<tr>
<td>L2 ( R^2 = 0.183 )</td>
<td>0.042</td>
<td>0.033</td>
<td>0.023</td>
<td>0.310</td>
<td>0.011</td>
</tr>
<tr>
<td>L3 ( R^2 = 0.219 )</td>
<td>0.204</td>
<td>0.009</td>
<td>0.006</td>
<td>0.278</td>
<td>0.012</td>
</tr>
<tr>
<td>L4 ( R^2 = 0.159 )</td>
<td>0.245</td>
<td>0.080</td>
<td>0.013</td>
<td>0.338</td>
<td>0.036</td>
</tr>
<tr>
<td>Total spine ( R^2 = 0.215 )</td>
<td>0.050</td>
<td>0.019</td>
<td>0.006</td>
<td>0.256</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Table 3.15: Probability levels for multiple regression analyses of the spine with BMI, acculturation level, adult dairy per day, child red meat per day and adult minutes of activity per day.
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.678 + 3.397(BMI) + 0.036(acc) + 2.512(adairy) + 1.852(chrmeat) -1.665(amin/d)</td>
</tr>
<tr>
<td>L2</td>
<td>0.822 + 2.343(BMI) + 3.424(acc) + 2.184(adairy) + 1.837(chrmeat) -1.918(amin/d)</td>
</tr>
<tr>
<td>L3</td>
<td>0.806 + 2.325(BMI) + 0.040(acc) + 2.608(adairy) + 1.914(chrmeat) -1.836(amin/d)</td>
</tr>
<tr>
<td>L4</td>
<td>0.862 + 2.177(BMI) + 2.799(acc) + 0.023(adairy) + 1.171(chrmeat) -1.569(amin/d)</td>
</tr>
<tr>
<td><strong>Total spine</strong></td>
<td>0.802 + 2.456(BMI) + 3.396(acc) + 2.368(adairy) + 1.861(chrmeat) -1.741(amin/d)</td>
</tr>
</tbody>
</table>

Table 3.16: Multiple regression equations for the lumbar vertebrae with BMI, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day.
Table 3.17 illustrates probability levels from multiple regression analyses of the spine (L1-L4 and total spine) with LOG BMI, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day. The amount of variation in bone density of the spine explained by these independent variables is 15 to slightly less than 23%. The multiple regression equations for the lumbar vertebrae with LOG BMI are illustrated in Table 3.18.

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>LOG BMI</th>
<th>ACCULT LEVEL</th>
<th>ADULT DAIRY/DAY</th>
<th>CHILD RED MEAT/DAY</th>
<th>ADULT MIN/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 ( R^2=0.221 )</td>
<td>0.090</td>
<td>0.015</td>
<td>0.007</td>
<td>0.277</td>
<td>0.017</td>
</tr>
<tr>
<td>L2 ( R^2=0.182 )</td>
<td>0.236</td>
<td>0.032</td>
<td>0.025</td>
<td>0.309</td>
<td>0.010</td>
</tr>
<tr>
<td>L3 ( R^2=0.217 )</td>
<td>0.236</td>
<td>0.009</td>
<td>0.007</td>
<td>0.276</td>
<td>0.011</td>
</tr>
<tr>
<td>L4 ( R^2=0.156 )</td>
<td>0.320</td>
<td>0.078</td>
<td>0.014</td>
<td>0.328</td>
<td>0.032</td>
</tr>
<tr>
<td>Total spine ( R^2=0.212 )</td>
<td>0.188</td>
<td>0.019</td>
<td>0.007</td>
<td>0.251</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Table 3.17: Probability levels for multiple regression analyses of the spine with log BMI, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day.
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with Log BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.474 + 0.206(LBMI) + 0.037(acc) + 0.024(adairy) + 1.876(chrmeat) - 1.704(amin/d)</td>
</tr>
<tr>
<td>L2</td>
<td>0.671 + 0.150(LBMI) + 3.433(acc) + 0.021(adairy) + 1.843(chrmeat) - 1.939(amin/d)</td>
</tr>
<tr>
<td>L3</td>
<td>0.661 + 0.146(LBMI) + 4.070(acc) + 2.582(adairy) + 1.927(chrmeat) - 1.862(amin/d)</td>
</tr>
<tr>
<td>L4</td>
<td>0.742 + 0.125(LBMI) + 2.821(acc) + 2.358(adairy) + 1.761(chrmeat) - 1.161(amin/d)</td>
</tr>
<tr>
<td><strong>Total spine</strong></td>
<td>0.652 + 0.152(LBMI) + 3.410(acc) + 2.342(adairy) + 1.884(chrmeat) - 1.772(amin/d)</td>
</tr>
</tbody>
</table>

Table 3.18: Multiple regression equations for the lumbar vertebrae with LOG BMI, acculturation level, adult dairy per day, child red meat per day, and adult minutes of workload per day.
Table 3.19 illustrates probability levels from multiple regression analyses of the hip (hip neck, hip trochanter, hip intertrochanter, and hip total) with weight, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. Although statistically significant with hip trochanter in the univariate linear regression, child red meat per day exhibits no statistical significance in the multiple regression analyses. The amount of variation in bone density in scanned areas of the hip explained by these independent variables ranges from 25-31%. The multiple regression equations for the hip areas with weight are illustrated in Table 3.20.

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>WT</th>
<th>ACCULT LEVEL</th>
<th>ADULT DAIRY/ DAY</th>
<th>CHILD RED MT/ DAY</th>
<th>TEEN SD/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip neck</td>
<td>0.00</td>
<td>0.051</td>
<td>0.020</td>
<td>0.840</td>
<td>0.540</td>
</tr>
<tr>
<td>R²=0.2750</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.00</td>
<td>0.104</td>
<td>0.000</td>
<td>0.255</td>
<td>0.059</td>
</tr>
<tr>
<td>R²=0.3058</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>0.00</td>
<td>0.018</td>
<td>0.038</td>
<td>0.507</td>
<td>0.054</td>
</tr>
<tr>
<td>R²=0.2565</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.00</td>
<td>0.057</td>
<td>0.003</td>
<td>0.793</td>
<td>0.131</td>
</tr>
<tr>
<td>R²=0.2895</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.19: Probability levels from multiple regression analyses of the hip with weight, acculturation level, adult dairy per day, child red meat per day, and teen soft drink consumption per day. (Significance: p<.05)
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Neck</td>
<td>0.491 + 1.351(wt) + 2.847(acc) + 2.011(adairy) + 0.003(chrmeat) + 6.912(teendr)</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.390 + 9.871(wt) + 2.266(acc) + 2.857(adairy) + 1.707(chrmeat) + 0.021(teendr)</td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>0.697 + 1.395(wt) + 4.499(acc) + 0.024(adairy) - 1.375(chrmeat) + 3.465(teendr)</td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.585 + 1.282(wt) + 3.039(acc) + 2.750(adairy) + 4.208(chrmeat) + 2.253(teendr)</td>
</tr>
</tbody>
</table>

Table 3.20: Multiple regression equations for the hip with weight, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day.

Table 3.21 illustrates probability levels from multiple regression analyses of the hip (hip neck, hip trochanter, hip intertrochanter, and hip total with LOG weight, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. The amount of variation in bone density in scanned areas of the hip explained by these independent variables ranges between 26-31%. The multiple regression equations for the hip with Log weight are illustrated in Table 3.22.
Table 3.21: Probability levels from multiple regression analyses of the hip with Log Weight, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. (Significance: p<.05)

<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>LOG WT</th>
<th>ACCULT LEVEL</th>
<th>ADULT DAIRY/DAY</th>
<th>CHILD RM/DAY</th>
<th>TEEN SD/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip neck</td>
<td>0.000</td>
<td>0.057</td>
<td>0.038</td>
<td>0.863</td>
<td>0.805</td>
</tr>
<tr>
<td>R²=0.267</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.000</td>
<td>0.099</td>
<td>0.000</td>
<td>0.277</td>
<td>0.057</td>
</tr>
<tr>
<td>R²=0.315</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>0.000</td>
<td>0.016</td>
<td>0.049</td>
<td>0.462</td>
<td>0.052</td>
</tr>
<tr>
<td>R²=0.270</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.000</td>
<td>0.053</td>
<td>0.005</td>
<td>0.842</td>
<td>0.128</td>
</tr>
<tr>
<td>R²=0.301</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.22: Multiple regression equations for the hip with LOG weight, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day.

<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with Log Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Neck</td>
<td>-0.405 + 0.512(lwt) + 2.766(acc) + 1.761(adairy) + 2.855(chrmeat) + 2.441(teendr)</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>-0.303 + 0.392(lwt) + 2.163(acc) + 2.648(adairy) + 1.635(chrmeat) + 1.715(teendr)</td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>-0.282 + 0.560 (lwt) + 4.206(acc) + 2.008(adairy) - 1.467(chrmeat) + 2.325(teendr)</td>
</tr>
<tr>
<td>Hip Total</td>
<td>-0.308 + 0.509(lwt) + 2.866(acc) + 0.024(adairy) + 3.366(chrmeat) + 1.543(teendr)</td>
</tr>
</tbody>
</table>
Table 3.23 illustrates probability levels from multiple regression analyses of the hip (hip neck, hip trochanter, hip intertrochanter, and hip total with BMI, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. The amount of variation in bone density in scanned areas of the hip explained by these independent variables ranges between 24-29%. The multiple regression equations for the hip with BMI are illustrated in Table 3.24.

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>BMI</th>
<th>ACCULT LEVEL</th>
<th>ADULT DAIRY/DAY</th>
<th>CHILD RED MEAT/DAY</th>
<th>TEEN SOFT DRINKS/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip neck R²=0.248</td>
<td>0.000</td>
<td>0.054</td>
<td>0.034</td>
<td>0.869</td>
<td>0.974</td>
</tr>
<tr>
<td>Hip Trochanter R²=0.292</td>
<td>0.000</td>
<td>0.094</td>
<td>0.000</td>
<td>0.275</td>
<td>0.088</td>
</tr>
<tr>
<td>Hip Intertrochanter R²=0.242</td>
<td>0.000</td>
<td>0.016</td>
<td>0.047</td>
<td>0.485</td>
<td>0.084</td>
</tr>
<tr>
<td>Hip Total R²=0.275</td>
<td>0.000</td>
<td>0.050</td>
<td>0.005</td>
<td>0.833</td>
<td>0.193</td>
</tr>
</tbody>
</table>

Table 3.23: Probability levels from multiple regression analyses of the hip with BMI, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. (Significance: p<.05)
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Neck</td>
<td>0.500 + 7.549(BMI) + 2.837(acc) + 1.823(adairy) + 2.760(chrmeat) + 3.249(teendr)</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>0.398 + 5.508(BMI) + 2.233(acc) + 2.693(adairy) + 1.668(chrmeat) + 1.569(teendr)</td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>0.718 + 7.841(BMI) + 0.043(acc) + 2.072(adairy) + 1.418(chrmeat) + 2.117(teendr)</td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.597 + 7.258(BMI) + 2.951(acc) + 2.498(adairy) + 3.621(chrmeat) + 1.347(teendr)</td>
</tr>
</tbody>
</table>

Table 3.24: Multiple regression equations for the hip with BMI, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day.

Table 3.25 illustrates probability levels from multiple regression analyses of the hip (hip neck, hip trochanter, hip intertrochanter, and hip total with LOG BMI, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. The amount of variation in bone density in scanned areas of the hip explained by these independent variables ranges between 23-29%. The multiple regression equations for the hip with Log BMI are illustrated in table 3.26.
Table 3.25: Probability levels from multiple regression analyses of the hip with Log BMI, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day. (Significance: p<.05)

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE (AREA SCANNED)</th>
<th>LOG BMI</th>
<th>ACCULT LEVEL</th>
<th>ADULT DAIRY/DAY</th>
<th>CHILD RED MEAT/DAY</th>
<th>TEEN SOFT DRINKS/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip neck R²=0.232</td>
<td>0.000</td>
<td>0.054</td>
<td>0.049</td>
<td>0.865</td>
<td>0.929</td>
</tr>
<tr>
<td>Hip Trochanter R²=0.291</td>
<td>0.000</td>
<td>0.093</td>
<td>0.001</td>
<td>0.285</td>
<td>0.082</td>
</tr>
<tr>
<td>Hip Intertrochanter R²=0.243</td>
<td>0.000</td>
<td>0.016</td>
<td>0.060</td>
<td>0.468</td>
<td>0.078</td>
</tr>
<tr>
<td>Hip Total R²=0.273</td>
<td>0.000</td>
<td>0.050</td>
<td>0.007</td>
<td>0.851</td>
<td>0.181</td>
</tr>
</tbody>
</table>

Table 3.26: Multiple regression equations for the hip with Log BMI, acculturation level, adult dairy per day, child red meat per day, and teen soft drinks consumed per day.

<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>Multiple Regression Equations with Log BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Neck</td>
<td>1.792 + 0.482(LBMI) + 2.866(acc) + 1.714(adairy) + 2.878(chrmeat) + 8.927(teendr)</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>2.277 + 0.369(LBMI) + 2.241(acc) + 2.612(adairy) + 0.016(chrmeat) + 1.597(teendr)</td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>0.174 + 0.532(LBMI) + 4.313(acc) + 1.956(adairy) - 1.475(chrmeat) + 2.151(teendr)</td>
</tr>
<tr>
<td>Hip Total</td>
<td>0.102 + 0.486(LBMI) + 2.961(acc) + 2.391(adairy) + 3.240(chrmeat) + 1.384(teendr)</td>
</tr>
</tbody>
</table>
3.6 Level of Variation of bone density within the sample

Low versus Normal Bone Mineral Density

Scanned areas for determination of average bone mineral density (g/cm²), of an individual includes the total spine, hip neck, and hip total. Dual Energy X-Ray Absorptiometer (DXA) results include standardized scores or t-scores for low bone density determination of these locations. Of these scanned areas containing t-scores, 40 of the 106 participants (38%) had at least one t-score that is considered osteopenic (t-score = -1 to -2.5) and/or osteoporotic (t-score below -2.5).

For comparison of low and normal individuals, two groups were formed (low and normal) in NCSS® 2000 so that their associations with the independent variables could be identified. Two-Sample t-Tests were run on the two groups with the independent variables which include age, weight, height, BMI (body mass index), generation and acculturation levels, teen and adult workload per week, child, teen, and adult dairy per day, soft drinks per day, servings of green vegetables, and red meat per day, frequency of eating at restaurants/fast foods, and adult calcium supplement intake per day.

Tables 3.27-3.32 illustrate the mean, standard deviation, t-Value, degrees of freedom, and probability levels of the two sample t-test analyses. Variables that did not result in probability levels lower than .10 in the analyses are not included. These consist of adult dairy per...
day, teen soft drink consumption per day, and adult hours of workload per week.

The average weight of women with normal bone density (a t-score higher than -1 in the total spine, hip neck, and hip total) was 167.6 pounds. Women with low t-scores (lower than -1 in the areas above) have an average weight of 146.7 pounds (Table 3.27). The probability level is .0004.

<table>
<thead>
<tr>
<th>Weight</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>DF</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low BMD</td>
<td>146.7</td>
<td>30.84</td>
<td>-2.934</td>
<td>104</td>
<td>0.004</td>
</tr>
<tr>
<td>Normal BMD</td>
<td>167.6</td>
<td>38.12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.27: Results of Two-Sample t-Test of low and normal women by weight.
The average height of women with normal bone density (a t-score higher than -1 in the total spine, hip neck, and hip total) was 62.93 inches. Women with low t-scores (lower than -1 in the areas above) have an average height of 61.92 inches (Table 3.28). The probability level is .0026. In this sample, women who are taller and heavier have overall higher average bone density in the areas scanned.

<table>
<thead>
<tr>
<th>Height</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>DF</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low BMD</td>
<td>61.92</td>
<td>2.189</td>
<td>-2.258</td>
<td>104</td>
<td>0.026</td>
</tr>
<tr>
<td>Normal BMD</td>
<td>62.93</td>
<td>2.255</td>
<td>-2.258</td>
<td>104</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.28: Results of Two-Sample t-Test of low and normal women by height
The average BMI (body mass index) of women with normal bone density (a t-score higher than -1 in the total spine, hip neck, and hip total) was 29.8. Women with low t-scores (lower than -1 in the areas above) have an average 26.8 (Table 3.29). The probability level is .0017. Again, women who are taller and heavier (as calculated with BMI) have overall higher bone density in the scanned areas.

<table>
<thead>
<tr>
<th>BMI</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>DF</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low BMD</td>
<td>26.8</td>
<td>4.915</td>
<td>-2.421</td>
<td>104</td>
<td>0.017</td>
</tr>
<tr>
<td>Normal BMD</td>
<td>29.8</td>
<td>6.725</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.29: Results of Two-Sample t-Test of low and normal women by BMI
The average level of acculturation of women with normal bone density (a t-score higher than -1 in the total spine, hip neck, and hip total) was 3.403. Women with low t-scores (lower than -1 in the areas above) have an average level of acculturation of 3.048 (Table 3.30). The probability level is .0012. Therefore, women who identify themselves more closely with American culture have higher bone density in the areas scanned than those who are less associated with American culture.

<table>
<thead>
<tr>
<th>Acculturation Level</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>DF</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low BMD</td>
<td>3.048</td>
<td>0.799</td>
<td>-2.531</td>
<td>103</td>
<td>0.012</td>
</tr>
<tr>
<td>Normal BMD</td>
<td>3.403</td>
<td>0.628</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.30: Results of Two-Sample t-Test of low and normal women by Acculturation Level
The average generation level of women with normal bone density (a t-score higher than -1 in the total spine, hip neck, and hip total) was 3.353. Women with low t-scores (lower than -1 in the areas above) have an average generation level of 2.875 (Table 3.31). The probability level is 0.076 and therefore not statistically significant (p=<.05).

<table>
<thead>
<tr>
<th>Generation</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>DF</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low BMD</td>
<td>2.875</td>
<td>1.470</td>
<td>-1.786</td>
<td>103</td>
<td>0.076</td>
</tr>
<tr>
<td>Normal BMD</td>
<td>3.353</td>
<td>1.242</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.31: Results of Two-Sample t-Test of low and normal women by Generation level
Average servings of red meat per day (as a child) of women with normal bone density (a t-score higher than -1 in the total spine, hip neck, and hip total) was 0.908. Women with low t-scores (lower than -1 in the areas above) have an average of 0.631 servings of red meat per day (as a child) (Table 3.32). The probability level is 0.029. Women who reported eating more red meat as a child have higher bone density in the areas scanned.

<table>
<thead>
<tr>
<th>Child Red Meat/Day</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>DF</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low BMD</td>
<td>0.631</td>
<td>0.542</td>
<td>-2.208</td>
<td>104</td>
<td>0.029</td>
</tr>
<tr>
<td>Normal BMD</td>
<td>0.908</td>
<td>0.671</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.32: Results of Two-Sample t-Test of low and normal women by consumption of red meat per day as a child

Overall, women who are taller and heavier have higher bone density in the areas scanned. Also, those who reported a close association with American culture have higher bone density. Of the dietary variables, consumption of red meat as a child is positively associated with higher bone density.
Bone Density Pattern with Age

Although age was not associated with bone density in the regression analyses, the pattern of bone density with age is illustrated in Figure 3.33. Women were separated into four groups by age. Because there were only 6 women younger than the age of 30 in the sample, they were not included in the age groups. The remaining 100 women were categorized as follows: Group 1; ages 30-35 (n=16), Group 2; ages 36-40 (n=33), Group 3; ages 41-45 (n=32), Group 4; ages 45-51 (n=19) (Figure 3.33).

![Graph showing the number of individuals in age groups 30-35, 36-40, 41-45, and 46-51]

Figure 3.32: Groups 1-4 for ANOVA analysis
<table>
<thead>
<tr>
<th>Dependent Variable (Area Scanned)</th>
<th>DF</th>
<th>F-Ratio</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spine</td>
<td>3, 96</td>
<td>0.37</td>
<td>0.77</td>
</tr>
<tr>
<td>Hip Neck</td>
<td>3, 96</td>
<td>0.08</td>
<td>0.97</td>
</tr>
<tr>
<td>Hip Trochanter</td>
<td>3, 96</td>
<td>0.17</td>
<td>0.92</td>
</tr>
<tr>
<td>Hip Intertrochanter</td>
<td>3, 96</td>
<td>0.18</td>
<td>0.91</td>
</tr>
<tr>
<td>Hip Total</td>
<td>3, 96</td>
<td>0.07</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Table 3.33: One-way analysis of Variance results among age groups

One-way analysis of Variance was performed on average total spines, hip neck, hip trochanter, intertrochanter, and hip total with the four groups of women (Table 3.33). There is no significant pattern (decrease or increase) of bone density with age in this sample of 100 premenopausal women. Figure 3.34 illustrates the pattern of bone density of all total spines. Hip neck, hip trochanter, intertrochanter, and hip total all result in similar patterns of bone density with no significant differences among groups. The outlier in group 2 is a 38 year old woman with osteoporosis.
Figure 3.33: One-way analysis of Variance results of the total spine (spinet) (g/cm²) with age groups.
CHAPTER 4

DISCUSSION AND CONCLUSIONS

4.1 Introduction

Although the acquisition and maintenance of bone density in humans involves a substantial biological or genetic component, environmental factors such as behavior and culture also act as predictors of bone density. This study focuses on bone density in women between the time periods of acquisition of peak bone density in young adults, and bone loss that is a characteristic seen in most older adults. Clinical research pertaining to bone density focuses primarily on postmenopausal women, thus excluding premenopausal women who may be also at risk for low bone density. This study targeted premenopausal women thereby allowing risk factors to be identified when intervention may be most crucial.

In this study, the behavioral and cultural factors encompassing acculturation, diet, and workload were assessed and compared to bone density of the hip and spine in a sample of premenopausal Mexican American women. As an underrepresented sub-group in bone density
research in the United States, specific risk factors were identified for this population. Data presented as a result of this research project indicate that osteopenia can occur much earlier in life within the premenopausal years.

4.2 Summary of Major Results

Research Objective I:

What is the level of variation of bone density within premenopausal Mexican American women?

In order to reveal any pattern in bone density (g/cm²) within the sample, bone density results were divided into categories according to age two ways. First, three groups were generated from the sample in ten-year intervals: Group 1 (ages 20-29), Group 2 (ages 30-39), and Group 3 (ages 40-51). The average bone density (g/cm²) of all the areas scanned which included the lumbar vertebrae (L1-L4), total spine density, the femur neck, trochanter, intertrochanter, and total hip density were evaluated with age groups using a Student’s t-test.

Results reveal that there is a slight increase in average bone density with age. However, the increase in bone density for each scanned area is not statistically significant between the groups. Lower average bone density in the youngest group (Group 1; ages 20-29) may indicate that peak bone density has not been achieved. A larger sample
size would have possibly resulted in different average bone densities in areas of the hip and lumbar spine of this group.

Second, smaller groups were generated in five-year intervals without the inclusion of the youngest participants (those aged 20-29). These four groups were: Group 1 (ages 30-35), Group 2 (ages 36-40), Group 3 (ages 41-45), and Group 4 (ages 46-51). Again, after a Student’s t-test was utilized, the difference in average bone density (g/cm²) between the groups was not statistically significant. This is expected since the study group is premenopausal and changes in bone density at this stage of life are minimal in healthy individuals.

Research Objective II

How does the bone density of premenopausal Mexican American women compare to other ethnic groups?

The average bone density measurements (g/cm²) within this sample were compared to other study groups of approximately the same age. When bone density of the hip and lumbar spine areas are compared to premenopausal Caucasian women in the United States, the average bone densities of women within this study consistently exhibit lower average bone density (g/cm²) (Lindsay et al. 1992; Looker et al. 1997; Nieves et al. 1995; Riggs et al. 1981; Snow-Harter et al. 1990). Tables 4.1 through 4.4 illustrate the average bone densities (g/cm²) of the women in these studies as compared to the Mexican American women.
from this research. Bone density of the hip and lumbar spine areas of this sample exhibit lower average bone density (g/cm²) when compared to premenopausal Mexican women living in Mexico (Delezé et al. 2000) (Table 4.5).

<table>
<thead>
<tr>
<th>Dependent variable (area scanned)</th>
<th>20-29 year-old Mexican Americans in San Antonio (n=6)</th>
<th>Looker et al. 1997 Caucasian Aged 20-29 (n=409)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip neck (g/cm²)</td>
<td>.791</td>
<td>.860</td>
</tr>
<tr>
<td>Hip trochanter (g/cm²)</td>
<td>.651</td>
<td>.710</td>
</tr>
<tr>
<td>Hip Intertrochanter (g/cm²)</td>
<td>1.06</td>
<td>1.09</td>
</tr>
<tr>
<td>Hip Total (g/cm²)</td>
<td>.093</td>
<td>.940</td>
</tr>
</tbody>
</table>

Table 4.1: Bone density (g/cm²) of Caucasian and Mexican American women aged 20-29.
### Table 4.2: Bone density (g/cm²) of Premenopausal (aged 17-54) Caucasian and Mexican American women

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spine (g/cm²)</td>
<td>1.01</td>
<td>1.19</td>
<td>1.57</td>
</tr>
<tr>
<td>Hip neck (g/cm²)</td>
<td>.840</td>
<td>.850</td>
<td>No data</td>
</tr>
<tr>
<td>Hip trochanter (g/cm²)</td>
<td>.701</td>
<td>.710</td>
<td>No data</td>
</tr>
<tr>
<td>Hip Intertrochanter (g/cm²)</td>
<td>1.13</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Hip Total (g/cm²)</td>
<td>.958</td>
<td>No data</td>
<td>No data</td>
</tr>
</tbody>
</table>

### Table 4.3: Bone density (g/cm²) of Caucasian and Mexican American women aged 30-39

<table>
<thead>
<tr>
<th>Dependent variable (area scanned)</th>
<th>Mexican Americans in San Antonio: women aged 30-39 (n=42)</th>
<th>Nieves et al. 1995 Caucasian women aged 30-39 (n=139)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spine (g/cm²)</td>
<td>1.01</td>
<td>1.26</td>
</tr>
<tr>
<td>Hip neck (g/cm²)</td>
<td>.838</td>
<td>.897</td>
</tr>
<tr>
<td>Hip trochanter (g/cm²)</td>
<td>.695</td>
<td>.745</td>
</tr>
</tbody>
</table>

Table 4.2: Bone density (g/cm²) of Premenopausal (aged 17-54) Caucasian and Mexican American women

Table 4.3: Bone density (g/cm²) of Caucasian and Mexican American women aged 30-39
<table>
<thead>
<tr>
<th>Dependent variable (area scanned)</th>
<th>Mexican Americans in San Antonio: women aged 20-31 (n=11)</th>
<th>Snow-Harter et al. 1990 Caucasian women aged 18-31 (n=59)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spine (g/cm²)</td>
<td>.998</td>
<td>1.09</td>
</tr>
<tr>
<td>Hip neck (g/cm²)</td>
<td>.822</td>
<td>.930</td>
</tr>
<tr>
<td>Hip trochanter (g/cm²)</td>
<td>.674</td>
<td>.750</td>
</tr>
<tr>
<td>Hip Total (g/cm²)</td>
<td>.931</td>
<td>1.04</td>
</tr>
</tbody>
</table>

Table 4.4: Bone density (g/cm²) of Caucasian and Mexican American women aged 18-30

<table>
<thead>
<tr>
<th>Dependent variable (area scanned)</th>
<th>Premenopausal Mexican Americans in San Antonio: women aged 20-51</th>
<th>Premenopausal Mexican women in Mexico aged 20-49</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spine (g/cm²)</td>
<td>1.01</td>
<td>1.15</td>
</tr>
<tr>
<td>Hip neck (g/cm²)</td>
<td>.840</td>
<td>.928</td>
</tr>
</tbody>
</table>

Table 4.5: Bone Density (g/cm²) of Premenopausal women in San Antonio and Mexico

Research Objective III

Is there a pattern of decline in bone density with age in premenopausal Mexican Americans?

Within this sample of 106 women, bone density of the hip and lumbar region of the spine does not decrease with age. This was
expected, as levels of bone density throughout the body usually do not begin to decrease until hormonal changes associated with menopause occur. Again, a larger sample size may have produced a different outcome.

Results of other studies involving premenopausal women are varied. Riggs et al. (1981) reveal a decrease in bone density of the lumbar region of the spine in Caucasian premenopausal women. A decrease in bone density of the appendicular skeleton was observed in women within the same study after the age of fifty. Lindsay et al. (1992) report that bone density declined in the femoral neck and the Ward’s triangle region of the femoral neck in premenopausal Caucasian women but not in the lumbar region of the spine.

**Research Objective IV**

In Mexican Americans, is the level or degree of acculturation, diet and workload significant factors influencing bone density?

Several independent variables explained a significant amount (p<.05) of variation in bone density as a result of univariate linear regression analyses. Both cultural factors, acculturation and generation level were positively associated with bone density. With regard to acculturation level, the average bone density was highest in individuals in all areas scanned (lumbar vertebrae L1-L4, total spine density, the femur neck, trochanter, intertrochanter, and total hip density average).
with higher levels of acculturation. Women who reported being more closely associated with American culture had higher average bone density in all areas scanned. Being more closely associated with American culture translates as being more acculturated.

Generation level was also positively associated with bone density. The higher the generation level, the higher the bone density in the following areas scanned: lumbar vertebrae L1, L3, and total spine. The longer a participant and her family (including extended family) have lived in the United States, the higher the average bone density of the participant in those scanned areas.

Of the dietary variables tested, adult dairy consumption per day, consumption of red meat per day as a child, and consumption of soft drinks and green vegetables per day as a teen were all positively associated with bone density of at least one area scanned. Adult dairy consumption per day exhibited a statistically significant relationship with all areas scanned. There is a positive association between adults with a high dairy consumption and higher average bone density.

Women who reported consuming at least one serving of green vegetables per day as an adolescent exhibited higher bone density of the hip trochanter. Consumption of soft drinks during adolescence had an unexpected outcome. Bone density in two areas scanned, the hip trochanter and intertrochanter was higher in women who reported consuming a high amount of soft drinks during adolescence. However,
soft drink consumption explained less than 5% of the variation in bone density of these two areas.

Although there was a positive association with soft drink intake and bone density, results may be imprecise due to poor dietary recall. Also, soft drinks consumed may not have been high in caffeine which promotes urinary excretion and is known to reduce calcium in the body. More detailed questions regarding soft drinks regarding amount in ounces and whether the drink contained caffeine are warranted.

Of the dependent variables tested dealing with diet during childhood, only consumption of red meat was positively associated with bone density. The hip trochanter exhibited a higher level of bone density in these women. Women who reported consuming at least one serving of red meat per day had higher bone density levels in this area. Although positively associated, consumption of red meat as a child explains only 6% of the variation in the hip trochanter bone density.

The only dependent variable that is negatively associated with bone density is adult hours of activity per week. Women who reported having elevated activity levels (which included physical exercise and activities such as housework), had lower average bone density in the lumbar vertebrae L1-L3 and average total spine density. Therefore, as adult hours of activity rose, bone density in the areas above, decreased. The influence of physical activity on bone density has been researched extensively (Drinkwater 1994; Mazess and Barden 1991; Metz 1993;
Slemenda et al. 1994; Snow-Harter et al. 1990; Valdimarsson et al. 1999; and Valimaki et al. 1994). Studies reveal that proper amounts of physical activity enhance bone density in younger individuals as well as those who have experienced menopause.

This study suggests the opposite is true, however several factors may explain this contradiction. Because the “adult” section of the questionnaire covers such a long time span of life, variations in exercise and workload may not have been properly recalled. Exercise and workload may have been more extensive at different times in the adult stage of an individual’s lifetime. Additionally, individuals may have answered questions as to how they wished their exercise patterns would be, knowing that adequate exercise is essential to a healthy body.

Another aspect that was not explored in this study is the question of high physical activity levels and consequent amenorrhea. However, this is most likely not the case, since the majority of participants reported low physical activity patterns as adults and moderate levels as adolescents. As mentioned in chapter 3, the negative association between overall workload at the adult stage of life and low bone density may be the result of a statistical artifact.
4.2.1 Relationship of Biological and Cultural Factors, Workload, and Dietary Variables to Bone Density

Although there are statistically significant relationships with variation in bone density and the biological and cultural factors, workload, and dietary variables, these relationships are minimal. As a result of univariate linear regression analyses, acculturation level was statistically significant with all areas of the hip and spine, but explains less than 10% of the variation. Generation level failed to reveal any statistically significant relationship with scanned areas of the hip, but does reveal a statistically significant relationship with lumbar vertebrae one and three and the total spine.

Of the biological factors (age, weight, height, and BMI), age was not associated with bone density levels as a result of univariate linear regression analysis. Weight, height, and BMI all revealed a separate statistically significant relationship with vertebral bone density, but each variable explained under 10% of the variation in the lumbar area scanned. The relationship of the hip areas scanned with weight, height, and BMI reveal varied results. Height had a slightly significant relationship (.056) with the hip neck, however the amount of variation explained was only 3%. Weight was statistically significant (0.000) with all areas of the hip and explained 13-19% of the variation in bone density. Similarly, BMI was statistically significant (0.000) with all areas...
of the hip and explained 13-17% of the variation in bone density. These results were expected given that the weight-bearing pelvis plays a major role in the support of the body.

Although there is a statistically significant relationship with adult workload level and bone density of lumbar vertebrae 1-3 and the average total spine, workload level explains less than 5% of the variation in bone density. Similarly, dietary variables that exhibited statistically significant relationships with bone density explained less than 9% of the variation in bone density. These included adult dairy consumption per day, child red meat, and teen soft drink and green vegetable servings per day.

While more variation of bone density is explained as a result of multiple regression analyses, the percentage of variation explained remains relatively small. Multiple regression analyses with all areas of the lumbar spine (L1-L4 and total spine) and those variables exhibiting statistically significant relationships with these areas (weight, height, acculturation level, adult dairy consumption, and adult workload) together explain 19% to slightly less than 30% of the variation of bone density. Equally, more variation in bone density is explained resulting from multiple regression analyses of the hip and those variables exhibiting a statistically significant relationship in the univariate linear regression analyses. These variables included weight, BMI, acculturation level, adult dairy consumption, child red meat consumption, and teen
soft consumption. These variables together explain 25-31% of the variation of bone density of the hip. Weight and BMI were run in separate multiple regression analyses with the remaining variables since weight is included in the BMI formula. Also, although child red meat consumption only exhibited a statistically significant relationship (<.05) with the hip trochanter, it was included in the multiple regression analyses of the hip. When deleted from the multiple regression analyses, the amount of variation of bone density explained was slightly lower.

It is apparent from these results that more variation in bone density is explained as factors are combined in statistical analyses. Therefore, our understanding of the relationship of each variable with another may be critical if more specific results encompassing bone density are to be produced. It is also imperative that researchers recognize that the interaction between variables or predictors of bone density may be population specific and not universal.

4.3 The Complexity of Bone Density in Humans

Results of the minimal relationship of bone density with biological and cultural factors, workload, and dietary variables in this study, suggest that bone density is a biologically complex outcome. It is apparent that many factors contribute to bone density, therefore it is not to be expected that one factor would play a major role as a predictor. Additionally, genetic and environmental factors may influence
populations differently. This is apparent as research specific to bone density and subsequent contributing factors are varied. Therefore, factors that may contribute to bone density in one population may not contribute to bone density in another.

Beyond genetic factors, it is well established that calcium and physical activity play a major role in the maintenance of skeletal integrity however, their contribution remains ambiguous. In this study, reported calcium intake during early life stages (child and adolescence) was not associated with bone density. Only adult calcium intake was positively associated with bone density of the hip and lumbar spine. Also, as stated earlier, adult physical activity was negatively associated with bone density of the hip and lumbar spine, while physical activity at adolescence had no association.

4.4 Conclusions and Future Directions

Although low bone density in premenopausal women may not be the only contributing factor to osteoporotic fractures in postmenopausal women, low bone density remains to be the best predictor of later fractures in most populations. However, according to Villa et al. (1995), hip axis length (HAL) may be an additional factor to consider when assessing risk factors for osteoporotic fractures of the hip. Hip axis length is the distance from the lateral proximal femur, below the greater trochanter, to the inner pelvic brim (Nelson and Villa 2003). In
postmenopausal Mexican American women, Villa et al. (1995) report that due to a short HAL, there is a decreased risk of hip fracture in this population. Therefore, bone geometry should also be considered in the assessment of risk factors for osteoporotic fractures.

Results of this study reveal that in a sample of 106 premenopausal Mexican American women, 40 (38%) exhibit low bone density or osteopenia in at least one area scanned of the hip and lumbar spine. Again, low bone density corresponds to a T-score below -1. Because no other bone density studies of premenopausal Mexican American women can be found, it is difficult to estimate the impact of low bone density to later fracture risks in this population.

Specific risk factors for low bone density within this population are difficult to establish. A larger sample size may have resulted in more significant results in the statistical analyses. Additionally, a longitudinal study would be advantageous to determine if individuals with premenopausal osteopenia would in turn experience hip and/or vertebral fractures after menopause or later in life.

Although time consuming, a more detailed questionnaire would be advantageous to avoid ambiguity. As a widely used and accepted form of data collection, the questionnaire remains limiting. Recall is problematic and precise data is difficult to obtain.

As mentioned earlier, additional studies specific to ethnic background should be conducted in order to determine more precise risk
factors for disease. It is evident from this study that additional population-specific research pertaining to bone density should be conducted in order to identify distinct predictors of bone density. Consolidating sub-groups into one broad ethnic group in both anthropological and clinical research only limits our understanding of population-specific diseases and health issues. Additionally, for this purpose, specific populations as opposed to conglomerate groups should be included in the World Health Organization’s (WHO) standards.
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APPENDIX A
SCREENING QUESTIONNAIRE

UTHSCSA Principal Investigator: Jan M. Bruder  Subject ID#_________
Co-Investigator: Jennifer L. Z. Rice

Date and time of scheduled visit ________________________

Research Title: The Effects of Acculturation, Diet, and Workload on Bone Density in Premenopausal Mexican American Women

1. Date of phone conversation____________________________

2. Information taken by__________________________________

3. Name and phone of potential Subject
________________________________________________________

4. Primary language spoken______________________________

5. Age and Date of birth_______________________________

6. Does the subject identify herself as Mexican American? _______

7. Has the subject experienced artificial menopause?
   (full hysterectomy)________ partial (still has ovaries) _______

8. Is the subject premenopausal? (had a period within the past 12 months)________ OR
   If partial hysterectomy, has had blood work done that indicates she is premenopausal, or has menstrual symptoms. ________________

9. Is the subject currently breastfeeding an infant? ___________
10. Does the subject have any of the following chronic diseases?
   Hyperparathyroidism (high calcium in blood) ______

   Thyrotoxicosis (thyroid disease) ___________ Renal disease
   (kidney) ______

11. Is the subject taking any of the following medications?

   Anticonvulsants (for seizures) _________ Corticosteroids
   (such as an inhalant for asthma) __________

   Thiazides (diuretics; ex..for Edema) ________________ Thyroxines
   (for thyroid) ____________________________

12. Is the subject aware that they have any condition known
to affect bone density such as
   Anorexia Nervosa or Cystic Fibrosis? ______

   If yes, what is the condition? ______________________________

13. Is the subject aware that they are taking any medication that is
known to affect bone density?
   (for example Fosamax or Lupron) ______

   If yes, what is the medication? ______________________________
APPENDIX B

DIETARY AND LIFESTYLE QUESTIONNAIRE

UTHSCSA Principal Investigator: Jan Bruder
Co-Investigator: Jennifer Rice

Date of visit ___________________
Participant ID#________________

Study Title: The Effects of Acculturation, Diet, and Workload on Bone Density in Premenopausal Mexican American Women

Dietary and Lifestyle Questionnaire ---Participant Information

We would like to begin by asking you several questions about your background and that of your parents.

1. What is your date of birth? _________________ (month/day/year)

2. Where were you born?

City_________________________ State_________________________ Country_________________________

3. Would you consider this a rural area or urban area? ______________ How long did you live there? __________

4. If you were not born in the United States, how many years have you lived in the US? ______

5. What country was your mother born in? ______________________ What is (was) her occupation? ______________________

6. What country was your father born in? ______________________ What is (was) his occupation? ______________________

7. We would also like to know where your grandparents were born. List the country for each.
8. Mother’s mother__________________________ What is (was) her occupation?__________________________
Mother’s father__________________________ What is (was) his occupation?__________________________
Father’s mother__________________________ What is (was) her occupation?__________________________
Father’s father__________________________ What is (was) his occupation?__________________________

9. What language was most often spoken in your home when you were a child?__________________________

10. What was the first language you learned to speak? (If you learned 2 languages at the same time, state both)__________________________

11. What language is most often spoken in your home today?__________________________

12. What language do you prefer for the following?
   Listening to the Radio______________________,
   Reading _________________________________
   Watching television______________________,
   Everyday conversation__________________

13. What is your highest level of education? Check one: 8th grade or below_______ Some high school_______ High school diploma_______ Some college_______ College degree(2 year)_______ 4 (year)_______ Other degree (specify)__________

14. What is your current occupation?_________________________________________________________

15. Presently, how would you rate the socio-economic status of your household?
   Low income_______, lower-middle income_______, middle income_______,
   higher-middle income_______, high income_______
16. What was the ethnic makeup of your neighborhood or area where you lived when you were a child?
   **Check one:**
   Almost exclusively Mexicans, Mexican American/Hispanic ______ Mostly Mexicans, Mexican American/Hispanic ______ About equally Mexicans, Mexican American/Hispanic, Whites or other ethnic groups______ Mostly White, Blacks, or other ethnic groups_____ Almost exclusively Whites, Blacks, or other ethnic groups_____

17. What is the ethnic makeup of your neighborhood or area where you live now?
   **Check one:**
   Almost exclusively Mexicans, Mexican American/Hispanic ______ Mostly Mexicans, Mexican American/Hispanic ______ About equally Mexicans, Mexican American/Hispanic, Whites or other ethnic groups______ Mostly White, Blacks, or other ethnic groups_____ Almost exclusively Whites, Blacks, or other ethnic groups_____

**Next, we would like to ask you about your health, diet, and lifestyle.**

18. What was your age at your first menstrual period?__________

19. How many times have you been pregnant? (Include stillbirths and miscarriages) __________

20. How many of these pregnancies were live births?__________

21. How many abortions or miscarriages? __________

22. How many children have you breastfed? ________ For about how long did you breastfeed each child?
   child 1______________, child 2______________, child 3______________,
   child 4_____________

23. Were you breastfed as a child?________ For about how long?__________

24. Are you currently using birth control?________ If so, what method?
   ________________ (Ex. Oral, patch, or injection)

25. How long have you used birth control?______________ If not, how long has it been since you stopped using birth control?____________________________

**These next questions ask about your past and present exercise habits.**

26. When you were a **teenager** (age 13-19), were you involved in planned or regular exercise? Activities include but are not limited to: running, walking, or other sports__________ (yes or no)
27. If so, about how often did you engage in each activity? List each activity separately. Please be specific.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.

28. When you were a teenager, how often did you engage in other physical activities? Activities include but are not limited to: sweeping, raking, other housework, heavy lifting? List each activity separately. Please be specific.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.

_________________, _____ times per day, per week, per month, per year.
less than 10 minutes, 10-30 minutes, 30-60 minutes, more than 1 hour.
29. Currently, does your occupation require physical work? _______
   If so, what kind of work?______________________________________________

30. Are you currently involved in planned or regular exercise? Activities include but are not limited to: running, walking, weight-lifting, or other sports__________ (yes or no)

31. If so, about how often do you engage in each activity? List each activity separately. Please be specific.
   ________________, _____ times per day_____, per week _____, per month_____, per year_____
   less than 10 minutes______, 10-30 minutes______, 30-60 minutes______, more than 1 hour_____

   ________________, _____ times per day_____, per week _____, per month_____, per year_____
   less than 10 minutes______, 10-30 minutes______, 30-60 minutes______, more than 1 hour_____

   ________________, _____ times per day_____, per week _____, per month_____, per year_____
   less than 10 minutes______, 10-30 minutes______, 30-60 minutes______, more than 1 hour_____

   ________________, _____ times per day_____, per week _____, per month_____, per year_____
   less than 10 minutes______, 10-30 minutes______, 30-60 minutes______, more than 1 hour_____

   ________________, _____ times per day_____, per week _____, per month_____, per year_____
   less than 10 minutes______, 10-30 minutes______, 30-60 minutes______, more than 1 hour_____

32. Have you ever fractured a bone in your body?___________  If so, how?______________________________
33. Have you ever broken a bone?____________ If so, how?____________________________________

34. Has your mother ever fractured or broken a bone? If so, how? _______________________________________

These next questions ask about your dietary habits when you were a child.

35. When you were a **child** (up to age 12), how often did you consume milk? (any type, including goat, soy etc…) _______ times
   (check one)-- per day _____, per week _____, per month_____, per year _____, Never drank milk______

36. When you were a child, how often did you eat the following?
   Yogurt ______ times
   (check one)-- per day _____, per week_____, per month_____, per year _____, Never ______
   Cheese_______times
   (check one)-- per day _____, per week_____, per month_____, per year _____, Never ______
   Ice cream _______ times
   (check one)--per day _____, per week _____, per month_____, per year _____, Never ______
   Other dairy products (such as cottage cheese) _______times
   (check one)--per day _____, per week _____, per month_____, per year _____, Never ______

37. When you were a child, did you drink soft drinks on a regular basis? __________

38. List what type(s) (Coke, Dr. Pepper, etc…)
   _____________________________________________

39. How often did you drink these soft drinks when you were a child? ________times
   (check one)--per day _____, per week _____, per month_____, per year _____, Never ______

40. When you were a child, did you take a calcium supplement on a daily basis? __________

41. When you were a child, how often did you eat green vegetables? _______times
   (check one)--per day _____, per week _____, per month_____, per year _____, Never ______
42. When you were a child, how often did you eat red meat? ________times
   (check one)--per day _____, per week _____, per month_____, per year _____,
   Never______

43. When you were a child, how often did you eat out at restaurants or fast-food places?
   ________times
   (check one)--per day _____, per week _____, per month_____, per year _____,
   Never______

These next questions ask about your dietary habits when you were a teenager.

44. When you were a teenager (age 13-19), how often did you drink milk? (any type
   including goat, soy etc…)________ times
   (check one)--per day _____, per week _____, per month_____, per year _____,
   Never______

45. When you were a teenager, how often did you eat the following?
   Yogurt_________ times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

   Cheese________ times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ate cheese____

   Ice cream _______ times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ate ice cream____

   Other dairy products (such as cottage cheese) ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

46. When you were a teenager, did you drink soft drinks on a regular basis? _________

47. List what type(s) (Coke, Dr. Pepper, etc…)
   ___________________________________________________

48. How often did you drink these soft drinks when you were a teenager? ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

49. When you were a teenager, did you take a calcium supplement on a daily basis?
   __________
50. When you were a teenager, did you drink calcium-fortified orange juice on a regular basis?

51. When you were a teenager, how often did you eat green vegetables? ________ times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

52. When you were a teenager, how often did you eat red meat? ________ times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

53. When you were a teenager, how often did you eat out at restaurants or fast-food places?
_______ times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

These next questions ask about your current dietary habits.

54. **Presently**, how often do you drink milk? (any type including goat, soy etc…)_______
times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

55. Presently, how often do you eat the following?
Yogurt _______ times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

Cheese________times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

Ice cream _______ times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

Other dairy products (such as cottage cheese) ________times
(check one) --per day _____, per week _____, per month_____, per year _____,
Never ______

56. Presently, do you drink soft drinks on a regular basis? ________

57. List what type(s) (Coke, Dr. Pepper, etc…)

____________________________________________
58. Presently, how often do you drink these soft drinks? ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

59. Presently, do you take a calcium supplement on a daily basis? __________

60. If so, how many milligrams of calcium do you take per day? __________

61. Presently, do you drink calcium-fortified orange juice on a regular basis? _____

62. Presently, how often do you eat green vegetables? ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

63. Presently, how often do you eat red meat? ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

64. Presently, how often do you eat out at restaurants or fast-food places? ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

65. Presently, how often do you eat prepared foods? That is, boxed, and/or frozen dinners?
   ________times
   (check one) --per day _____, per week _____, per month_____, per year _____,
   Never ______

66. What is your food preference? Exclusively Mexican food______ Mostly Mexican food,
   some American_______ About equally Mexican and American ______ Mostly
   American______ Exclusively American or other_______

These next questions pertain to how you identify yourself.

67. How do you identify yourself culturally? Mexican_______, Chicano______, Mexican
   American_______, American _________, Anglo American or other______

68. How does (did) your mother identify herself? Mexican_______, Chicano______,
   Mexican American_______, Spanish, Hispanic, Latin American_______, American
   _________, Anglo American or other_______

69. How does (did) your father identify himself? Mexican_______ Chicano______
   Mexican American_______ Spanish, Hispanic, Latin American_______, American
   _________ Anglo American or other_______
70. Where were you raised? In Mexico only______ Mostly in Mexico, some in U.S.______
   Equally in U.S. and Mexico_____ Mostly in U.S., some in Mexico_______ In U.S. only______

71. What contact have you had with Mexico? Raised for one year or more in Mexico_____
   Lived for less than one year in Mexico________ Occasional visits to Mexico______
   Occasional communications (letters, phone calls, etc.) with people in Mexico______
   No communications or exposure with people in Mexico______

72. If you consider yourself a Mexican, Chicano, or Mexican American, how much pride do you have in this group?
   Extremely proud______ Moderately proud______ Little pride_____ No pride, but I don’t feel negative towards this group_____ No pride, and I feel negative toward this group______

73. How would you rate yourself? Very Mexican_______ Mostly Mexican______
   Bicultural______ Mostly Americanized______ Very Americanized_______

74. Growing up, how would you rate the socio-economic status of your household?
   Low income ________, lower-middle income______, middle income______,
   higher-middle income______, high income______

75. Growing up, how would you rate your level of physical activity?
   Inactive for the most part______, somewhat physically active______,
   moderately physically active______, physically active______, very physically active______

76. Presently, how would you rate your level of physical activity?
   Inactive for the most part______, somewhat physically active______,
   moderately physically active______, physically active______, very physically active______
APPENDIX C

TAKE-HOME INFORMATION FORM

The Effects of Acculturation, Diet, and Workload on Bone Density in Premenopausal Mexican American Women

Name and/or
ID#________________________________________________________

Can you think of any information (not included in the questionnaire) about yourself that you feel will contribute to this study? For example: Do you consume other foods not listed in the questionnaire that contain high amounts of calcium, or is there other information such as another activity or cultural aspect that you feel is important to list?
DATE

ADDRESS

Re: STUDY

Dear ____________________________,

Enclosed please find a copy of your bone mineral density that was done as part of the research project entitled “The Effects of Acculturation, Diet, and Workload on Bone Mineral Density in Premenopausal Mexican American Women” at the University of Texas Health Science Center at San Antonio. Your bone mineral density is low compared to a woman who is aged 30 years which is the age for peak bone mass. If you have no risk factors for low bone density this reflects a bone density that has not reached its peak because you are only ___ years of age and you are still in the process of increasing your bone mass. Please take this bone density to your physician for further evaluation of risk factors and to discuss adequate calcium and vitamin D intake and exercise. No treatment is needed at this time unless you have risk factors. I would recommend that your bone density be reassessed at the time of menopause. If your physician has any questions, he or she can contact me at (210) 567-4900.

Thank you for participating in this study.

Sincerely,

Jan M. Bruder, M.D.                                                        Jennifer L.Z. Rice
Assistant Professor                                                           Ph.D. Candidate
Dept. of Medicine/Endocrinology                                   Department of Anthropology
UTHSCSA                                                                       Ohio State University

Enclosures

JMB/cm
APPENDIX E

RESULT LETTER FOR WOMEN WITH NORMAL RESULTS

DATE

ADDRESS

Re: STUDY

Dear______________________________,

Enclosed please find a copy of your bone mineral density that was done as part of the research project entitled “The Effects of Acculturation, Diet, and Workload on Bone Mineral Density in Premenopausal Mexican American Women” at the University of Texas Health Science Center at San Antonio. Your bone mineral density is normal for your age and sex. Thank you for your participation.

Sincerely,

Jan M. Bruder, M.D.                                    Jennifer L. Z. Rice
Assistant Professor                                      Ph.D. Candidate
Dept. of Medicine/Endocrinology                  Department of Anthropology
UTHSCSA                                                   Ohio State University

Enclosures

JMB/cm
APPENDIX F

RESULT LETTER FOR WOMEN WITH OSTEOPENIA

DATE

ADDRESS

Re: STUDY

Dear ____________________________,

Enclosed please find a copy of your bone mineral density that was done as part of the research project entitled “The Effects of Acculturation, Diet, and Workload on Bone Mineral Density in Premenopausal Mexican American Women” at the University of Texas Health Science Center at San Antonio. Your bone mineral density fulfills the criteria for osteopenia (low bone density). Please take this bone density to your physician for further evaluation and to discuss treatment options to prevent further bone loss especially when you begin menopause. If your physician has any questions, he or she can contact me at (210) 567-4900.

Thank you for participating in this study.

Sincerely,

Jan M. Bruder, M.D.                                     Jennifer L.Z. Rice
Assistant Professor                                       Ph.D. Candidate
Dept. of Medicine/Endocrinology                  Department of Anthropology
UTHSCSA                                                     Ohio State University

Enclosures

JMB/cm
APPENDIX G

RESULT LETTER FOR WOMEN WITH OSTEOPOROSIS

DATE

ADDRESS

Re: STUDY

Dear______________________________,

Enclosed please find a copy of your bone mineral density that was done as part of the research project entitled “The Effects of Acculturation, Diet and Workload on Bone Mineral Density in Premenopausal Mexican American Women at the University of Texas Health Science Center at San Antonio. Your bone mineral density unfortunately fulfills the criteria for osteoporosis. Please take this bone density to your physician for further evaluation and to discuss treatment options to prevent further bone loss especially when you begin the menopause. If your physician has any questions, he or she can contact me at (210) 567-4900.

Thank you for participating in this study.

Sincerely,

Jan M. Bruder, M.D. Jennifer L.Z. Rice
Assistant Professor Ph.D. Candidate
Dept. of Medicine/Endocrinology Department of Anthropology
UTHSCSA The Ohio State University

Enclosures

JMB/cm
APPENDIX H

LIST OF TERMS AND MEASURES

Areal Bone Mineral Density: Grams per centimeter squared (g/cm²)

Bone Area: Measured in centimeters squared (cm²)

Bone Mass: The amount of material present in bone

Bone Mineral Content: The actual amount of mineral present in bone; usually measured in grams

Bone Mineralization: Occurs as calcium and phosphorus are deposited into the bone matrix