*Short Report*

# Determining Osteoporosis Risk in Older Colono Adults from Rural Amazonian Ecuador Using Calcaneal Ultrasonometry

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**Objective:** Low bone density and osteoporosis prevalence, while well-documented in wealthy nations, are poorly studied in rural, non-clinical contexts in economically developing regions such as Latin America. This study contributes preliminary osteoporosis risk data for a rural *Colono* (mestizo) population from Amazonian Ecuador.

**Methods:** Anthropometrics were collected for 119 adult participants (74 females, 45 males [50–90 years old]). Heel bone density and *T*-scores were recorded using calcaneal ultrasonometry

**Results:** Approximately, 33.6% of the participants had low bone density and were at high-risk for osteoporosis. Four times as many females as males were considered high-risk. Consistent with epidemiological literature, advancing age was significantly associated with lower bone density values ($P = 0.001$).

**Conclusions:** Low bone density and osteoporosis prevalence are expected to increase in this and other economically transitioning populations, yet infrastructure to monitor this changing epidemiological landscape is almost non-existent. Human biologists are uniquely positioned to contribute data from remote populations, a critical step toward initiating increased resource allocation for diagnosis and prevention. Am. J. Hum. Biol. 27:139–142, 2015. © 2014 Wiley Periodicals, Inc.

## INTRODUCTION

Osteoporosis is a skeletal disorder characterized by low bone mass, reduced bone micro-architecture and strength, and heightened fracture risk. An increasing global health problem, osteoporosis affects ~75 million people worldwide causing more than 8.9 million fractures annually (IOF, 2012). In terms of disability-adjusted life-years lost, the burden of osteoporosis is greater than for most other non-communicable diseases (IOF, 2012). While low bone density and heightened fracture risk are well-documented among wealthy nations, this issue has been poorly studied in rural, non-clinical contexts in economically developing regions such as in Latin America. Numerous explanations have been posited for this, including regional preoccupation with infectious disease, the assumption that bone loss is an inevitable component of aging, and limited diagnostic resources. However, as the total number of low bone mass-related fractures is projected to increase to 21.3 million worldwide by 2050, with a concomitant rise in socioeconomic impact (Gullberg et al., 1997), there is an urgent need to identify at-risk populations early in order to target preventative strategies that may attenuate these projections.

While data that are available from Latin America suggest that osteoporosis rates are similar to those in the US and Europe, these studies are biased in their focus on more economically developed countries such as Argentina and Chile that boast the highest life expectancy and standard of living in the region (Morales-Torres and Gutierrez-Urena, 2004). These countries also have comparatively better resources to provide patients with diagnoses and treatments. Therefore, the aim of this study is to provide preliminary data on bone health in a rural Ecuadorian *Colono* (mestizo) adult population and investigate age- and sex-associated risks of developing osteoporosis. This dataset provides a critical step toward improving knowledge of skeletal health in non-urbanized, economically transitioning contexts, thereby increasing osteoporosis awareness among participant populations and potentially stimulating regional investment in diagnostic tests and affordable treatment.

## PARTICIPANT POPULATION AND HYPOTHESES

Study participants include *Colono* adults living in rural communities in the Upano River Valley of Morona-Santiago, Ecuador. Historically, the Upano Valley was inhabited by indigenous populations; however, with agrarian reform policies beginning in the 1960s, increasing numbers of non-indigenous *Colonos* settled in the region. While *Colonos* here engage in animal husbandry and agricultural production, many simultaneously participate in the market economy through sale and consumption of goods and wage labor employment. The combination of rural, agrarian lifeways, and increasing market integration produces a distinct economic and nutritional landscape shared across many Latin American populations (Rivera et al., 2004). Compared to local indigenous groups, such as the Shuar however, *Colonos* are experiencing a later stage of this economic and nutrition transition (Liebert et al., 2013).

Due to greater market integration in general among *Colonos* compared to native Shuar, we hypothesize that *Colonos* will exhibit rates of low bone density that is more aligned with data from populations in more industrialized

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*TABLE 1. Descriptive statistics below are presented by sex and by T-score based on participant's risk of developing osteoporosis*

| | | Low-risk (*T*-score: $> -1.8$) | | High-risk/low BMD (*T*-score: $\leq -1.8$) | | Total population by sex and combined | |
|---|---|---|---|---|---|---|---|
| | | *n* | Mean (SD) | *n* | Mean (SD) | *n* | Mean (SD) |
| Female | | $n = 42$ | | $n = 32$ | | $n = 74$ | |
| | Age (years) | | 62.01 (8.08) | | 68.76 (9.11) | | 64.93 (9.12) |
| | Height (cm) | | 145.74 (14.29) | | 145.28 (5.73) | | 145.54 (11.40) |
| | Weight (kg) | | 63.55 (11.30) | | 58.75 (9.37) | | 61.45 (10.70) |
| | hBMD (g/cm$^2$) | | 0.482 (0.09) | | 0.312 (0.05) | | 0.409 (0.11) |
| | BMI (kg/m$^2$) | | 29.10 (4.74) | | 27.78 (4.37) | | 28.53 (4.60) |
| Males | | $n = 37$ | | $n = 8$ | | $n = 45$ | |
| | Age (years) | | 65.28 (10.44) | | 72.01 (11.43) | | 66.48 (10.81) |
| | Height (cm) | | 159.89 (6.0) | | 151.84 (9.23) | | 158.46 (7.26) |
| | Weight (kg) | | 69.46 (11.63) | | 54.68 (5.71) | | 66.83 (12.19) |
| | hBMD (g/cm$^2$) | | 0.498 (0.07) | | 0.291 (0.06) | | 0.461 (0.11) |
| | BMI (kg/m$^2$) | | 27.11 (3.96) | | 23.93 (3.83) | | 26.55 (4.08) |
| Total Population | | $n = 79$ | | $n = 40$ | | $n = 119$ | |
| by T-score and | Age (years) | | 63.50 (9.35) | | 69.41 (9.55) | | 65.51 (9.78) |
| Sex Combined | Height (cm) | | 152.37 (13.21) | | 146.63 (6.99) | | 150.47 (11.81) |
| | Weight (kg) | | 66.36 (11.77) | | 57.93 (8.85) | | 63.50 (11.54) |
| | hBMD (g/cm$^2$) | | 0.490 (0.08) | | 0.308 (0.53) | | 0.429 (0.11) |
| | BMI (kg/m$^2$) | | 28.16 (4.47) | | 26.99 (4.50) | | 27.77 (4.49) |

Low-risk participants had *T*-scores greater than the cut-off value, $-1.8$, while high-risk included those individuals with *T*-scores of $-1.8$ or lower. In clinical settings, where available, high risk participants would undergo a follow-up examination using DEXA to establish osteoporosis status

nations. Furthermore, based on epidemiological data, we anticipate bone density will decrease with advanced age and females will be at greater risk for low bone density and osteoporosis.

## METHODS

One hundred and nineteen older adults aged 50–90 years participated in the study (74 females, 45 males). For each participant, height and weight were recorded; body mass index (BMI) was then calculated as weight (kg)/height (m)$^2$. While dual energy X-ray absorptiometry (DEXA) scans are considered the standard for bone mass determination, high costs limit their use for osteoporosis screening in developing contexts; consequently, quantitative ultrasound (QUS) techniques have gained popularity. Bone mineral density (BMD; g/cm$^2$) was determined using a Sahara® Calcaneal Ultrasonometer, a portable device highly correlated with DEXA (Langton and Langton, 2000). Because of abundant research on the calcaneus compared to other bone segments, this technique is the only validated QUS measurement for indicating osteoporosis. However, only DEXA can confirm osteoporosis diagnosis; thus, QUS values predict risk of fracture and osteoporosis (Schousboe et al., 2013).

Device-generated measures (estimated heel BMD [hBMD] and *T*-scores) were recorded. hBMD is a comprehensive indicator of bone micro-architecture and trabecular connectivity; *T*-scores are a measure of the difference between participants' BMD and mean values for a healthy, young adult population in standard deviation units. Although numerous cut-off points for QUS bone health classifications are available, we adopt a calcaneal QUS-specific *T*-score threshold of $-1.8$ to identify individuals with clinically defined low BMD and increased risk of osteoporosis (Frost et al., 2000). Quality control scans of the manufacturer-provided phantom were performed daily. One-way ANOVA and linear regression analyses were conducted using SPSS 21.0.

## RESULTS

Anthropometrics and BMD data are presented in Table 1**.** Forty individuals (33.6%) were considered at high-risk for developing osteoporosis, with four times as many females (80.0%) than males (20.0%) in this category. A one-way ANOVA test confirmed a significant effect of sex on BMD, with females generally exhibiting lower values than males [$F$ (1, 117) = 6.311, $P = 0.013$]. Of 74 female participants, 72 (97.3%) were post-menopausal and, of these, 31 (43.1%) were considered high-risk for osteoporosis. Among 45 males, eight (17.8%) also exhibited BMD values in the high-risk category. While heightened risk was documented across participants, linear regression analyses indicated a strong association between advanced age and reduced bone mass ($p = 0.001$; $R^2 = 0.90$).

## DISCUSSION

While results are preliminary and sample size is small, this study represents one of the few that documents osteoporosis risk using calcaneal ultrasonometry from a non-industrialized, non-clinical context and, specifically, for any Amazonian Ecuadorian population. Normative skeletal health data are available for indigenous Amazonian Shuar (Madimenos et al., 2011), yet that sample is substantially younger than the *Colono* cohort; therefore, issues related to demographic differences prevent useful comparisons with *Colonos*.

Since DEXA is the only means of diagnosing osteoporosis, and QUS techniques do not permit a clinical distinction between individuals with low BMD and osteoporosis, most cross-population prevalence data are not directly comparable with the current study. While recognizing complexities in comparing these data, Table 2 presents an overview of low bone density (osteopenia) and osteoporosis rates across Latin American and US populations and includes *Colonos* who qualify as high-risk (*T*-score $\leq -1.8$). The rates of low

*TABLE 2. Comparison of osteopenia[a] and osteoporosis rates (in %) from other Latin American groups and US NHANES data for individuals > 50 years old*

| | Females Low BMD | | Males Low BMD | | Total population Low BMD | | | |
|---|---|---|---|---|---|---|---|---|
| | Osteopenia (%) | Osteoporosis (%) | Osteopenia (%) | Osteoporosis (%) | Osteopenia (%) | Osteoporosis (%) | Skeletal site | Source |
| Argentina | 50 | 25 | | | | | Lumbar spine and femoral neck | Schurman et al., 2007 |
| Bogota, Colombia | 49.7 | 15.7 | | | | | Lumbar spine | Ardila, 2001 |
| Brazil | 38–56.6 | 14.7–043.4 | 44.6 | 15.4 | | | Femoral neck | Lanzillotti et al., 2003 |
| Mexico | 43 | 17 | 30 | 9 | | | Lumbar spine | Clark et al., 2005 |
| | 41 | 16 | 56 | 6 | | | Proximal femur | |
| Peru | | 22 | | 12 | | | Lumbar spine | Beccera-Rojas and Jupari, 2001 |
| | | 18 | | 10 | | | Femoral neck | |
| USA (NHANES) | 61 | 16 | 38 | 4 | 49 | 9 | Proximal femur and lumbar spine | Looker et al., 2012 |
| USA Mexican American (NHANES) | 60 | 26 | 47 | 6 | | | | |
| Colonos | 43.2 | | 17.8 | | 33.6 | | Calcaneus (calcaneal ultrasound) | This study |

[a]According to the International Society of Clinical Densitometry (2013) official positions, the term "low bone density" is preferred instead of "osteopenia". However, the comparison presented here retains this term where it has been employed in the aforementioned studies.
Since osteoporosis diagnosis is only possible through DEXA, limited studies are available from Latin America that present calcaneal ultrasonometry-derived data on osteoporosis risk. DEXA is used to measure BMD in all studies below (except the current study). This chart is intended to provide an overview of bone health across Latin American countries but also includes data on *Colono* individuals who have low BMD and are considered high risk for developing osteoporosis ($T$-score $\leq -1.8$).

BMD among *Colono* females is within the range of other Latin American countries and the US, a trend that is less obvious in *Colono* males. Although additional conclusions must remain conservative due to limitations mentioned above, this overview emphasizes a larger, overarching issue. Lack of diagnostic tools has resulted in limited prevalence data for many global populations, and specifically in Latin American regions. Consequently, a disproportionate number of publications on osteoporosis risk as determined by DEXA are available from more economically developed areas. Cost-efficient and portable QUS techniques are the best alternative, and yet such devices are not widely utilized for determining osteoporosis risk across diverse and remote populations. This creates challenges for cross-population comparisons and for identifying and implementing prevention and treatment strategies for potentially high-risk demographics.

*Colono* participants in the present study are primarily from small, rural communities undergoing rapid economic and lifestyle change, characteristics that create unique epidemiological challenges that are not typically found among Western, industrialized populations. While it remains unclear the extent to which osteoporosis risk is associated with age and sex among "traditionally living" populations, among *Colonos* who are at the rural margins of the market economy, greater bone loss with advancing age and significantly lower BMD among females have been preliminarily demonstrated. This phenomenon may be partly a consequence of rapid adverse health effects of the socioeconomic and nutrition transitions.

The shifting socioeconomic and demographic landscape coupled with pervasive regional issues such as disparities in access to health care and diagnostic tools highlight that the burden of low bone density and osteoporosis, as with other non-communicable disease, may be ultimately hardest felt in these transitioning communities. Given the economic and societal costs of osteoporosis, Latin American health authorities will face enormous public health challenges in the coming years unless efforts are made toward increasing regional osteoporosis awareness. Human biologists who study health in non-Western groups are uniquely positioned to contribute epidemiological data from more remote, rural locales typically overlooked in clinical population-based studies, data that can highlight the regional need for resource allocation toward prevention and treatment of chronic disease.

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