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Ultrasonometric Profiling of Incidence and Risk of Osteoporosis in Rural Women

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Abstract — **It is estimated that over 200 million people worldwide have osteoporosis. The prevalence of osteoporosis is continuing to escalate with the increasingly elderly population. The major complication of osteoporosis is an increase in fragility fractures leading to morbidity, mortality, and decreased quality of life. This investigation aimed at profiling the incidence and risk of osteoporosis in adult women from a rural setting using ultrasonic bone scanning technology. Peri- and postmenopausal female subjects (n=234) were drawn from a convenience sample. After a non-radiative dual X-ray absorptiometric scanning, the bone mineral density was measured from the heel of the subjects using bone ultrasonometry, and their T-scores were recorded. Results of these scans indicate that in adult women in the age range of 32 and 87, 23.5% of the population had a heel ultrasonic T-score ≤ -1.0, implying a 1.5 to 2.0 fold increase in risk ratio of hip or spinal fracture for each standard deviational decrease. Age at menopause was positively correlated with T-scores (p= 0.032); the higher the age at menopause, the higher the T scores. Additionally, women who had taken estrogen had significantly higher T-scores (p = 0.038) than those who had not. That approximately 25% of this sample has low bone mass or osteoporosis underscores the importance of early screening in order to develop awareness and provide education on bone health management.**

Keywords —**Osteoporosis, Bone Mineral Density, Ultrasound, T-Score, Rural Women**

I. Introduction

The incidence of osteoporosis in peri- and postmenopausal women continues to increase with progressively aging populations. Currently, it is estimated that over 200 million people worldwide have osteoporosis [1] and 44 million of these are in the United States [2]. The reduction in bone strength associated with this disease markedly increases the risk of musculoskeletal fractures, and the consequent pain and loss of function impinge adversely on the quality of life. In the United States and the European Union, about 30% of all postmenopausal women have osteoporosis, and it has been predicted that more than 40% of them will suffer one or more fragility fractures during their remaining lifetime [3].

Osteoporotic fragility fractures impose a considerable financial burden on health services due to reduced mobility, hospitalization, and nursing home requirements [9]. In the European Union, in 1998, osteoporosis patients occupied 500,000 hospital bed-nights per year, and this was expected to double by 2050 [10]. Despite these impacts, osteoporosis is frequently not diagnosed even after the first vertebral fracture has occurred.

Here, we investigate the prevalence and risk of osteoporosis in females from a rural population using portable heel ultrasonometry.

II. Methods and Materials

A. Subjects and Study Design

Subjects for this study were a community-based convenience sample comprised of peri- and postmenopausal women from small towns in Pennsylvania and Upstate New York. The sample consisted of women who were attending community events such as public health fairs, outdoor recreational events, scheduled agricultural cooperative extension activities, department stores, physicians' offices, and two university campuses in rural or small town communities from 2001 to 2005. A smaller number were recruited as they shopped in the women's department of a large department store, as well.

B. Laboratory Instrumentation and Evaluation

The heels (*os calcis*) of all participants were scanned for bone mineral density using portable dual x-ray absorptiometry (DXA) technology that does not require radiation. For the first 100 participants, bone mineral density was measured in the heel using the portable Hologic Sahara clinical bone sonometer. More recent data were obtained using the improved ultrasound Achilles Insight Imaging Bone Ultrasonometer, which features a solid-state 2-D array transducer that offers a region of interest preview image of the heel measurement site for more reliable real-time imaging. An external printer provides a printout of patient measurement results, along with a World Health Organization (WHO) graph and a fracture risk graph. The Achilles equipment also provides an adjustable color-display report screen that can be viewed by the investigator and then tilted so that the individual can see his or her color display report as well. One copy of the report printout was stapled to each individual's data packet, and each was given another

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copy, with the suggestion that they take it to their physician at their next appointment. The Achilles Insight instrument reports a similar response to aging as found at the hip and spine, with an average decline of 30% by age 70. Both instruments provide T-scores that correspond to diagnostic criteria defined by the WHO.

C. Protocol and Data Analysis

Our study used a test packet that consisted of an informed consent form, the demographic information sheet, the 17-item Osteoporosis Screening Survey, the 17-item Osteoporosis Risk Assessment, and the 6-item Osteoporosis Evaluation SCORE Sheet. Two or three members of the research team carried out the individual protocol at each test site. Depending on the number of potential participants, one or two members were responsible for recruiting participants and obtaining signed consent, and for administering the questionnaires. Once the test packet was completed and their actual height was recorded, participants were escorted to the heel scanning station by one of the team members assigned to oversee the preliminary activities. The person manning the heel scanner scanned each participant's heel, and then provided the subject a copy of their T-score chart. When the T-score was lower than -1.5, the participant was counseled briefly, and encouraged to take their printout to the physician within the next few weeks. All the subject data were subsequently analyzed using SPSS descriptive and correlation statistical procedures with the level of statistical significance set at $p \leq 0.05$.

III. Results

This investigation reports the preliminary outcomes in the ongoing profiling of the incidence of osteoporosis in peri- and post-menopausal women in Pennsylvania and the Southern Tier of New York. Preliminary results of 234 women (mean age: 56.12; median age: 55; range: 32-87) found that nearly twenty-four percent (23.5%) of these women had heel ultrasound T-scores $\leq$ -1.0 (1.5 to 2.0 increase in RR of fracture of hip or spine for each SD decrease). Data were also analyzed for relationships among demographic variables, risk factors and T-Scores. Age ($p=.012$) and the final score on the Merck Osteoporosis Evaluation SCORE Sheet ($p<0.001$) were inversely correlated with T-scores; the older the subject and the higher the score on composite risk factors, the lower the T-scores. Age at menopause was positively correlated with T-scores ($p= 0.032$); the higher the age at menopause, the higher the T scores. In addition, women who had taken estrogen had significantly higher T-scores ($p = 0.038$) than those who had not. Comparison of self-report of height to the measured height on the day of data collection found that self-reported height was significantly lower than the measured height ($p <0.001$).

IV. Discussion

These preliminary findings have several implications for clinical practice. That approximately 25% of this sample has low bone mass or osteoporosis underscores the importance of early screening in order to develop awareness and provide education on bone health management. The high correlation of the SCORE questionnaire with T-scores suggests that this instrument may alone effectively identify "at risk" women for follow-up. This study also supports the unique contribution of estrogen to bone strength, and, in light of recent evidence of hormonal-replacement therapy risks, the need for research on alternative therapies. Lastly, the finding on height discordance mandates the accurate objective measurement of height and weight during health care visits, rather than relying on self-report.

V. Conclusion

The findings of this study demonstrate the utility of portable heel scanning technology as a reasonably inexpensive and effective screening device for assessing bone mineral density in a sample of primarily Caucasian perimenopausal and postmenopausal women. However, it is important to continue to develop techniques to assess bone mineral density in other populations at risk, such as men and non-white women. It is also important that reliable methods be developed for assessing bone quality in younger persons, making it possible to assess bone mass in children and teenagers, while there is still time to maximize their peak bone density. Finally, it is imperative that reimbursement schedules be amended to cover the cost of assessing bone mineral density for at risk individuals at an earlier age, before rather than after a fracture occurs.

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