ORIGINAL RESEARCH

Quantitative Ultrasound - An Epidemiological Tool to Uncover the Influence of Lifestyle Factors & its Associated Co Morbidities on Bone Density

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Published on 1st June 2020

ABSTRACT

Osteoporosis, the metabolic disorder has become a global epidemic¹ with increase in life expectancy and changing life style. Quantitative ultrasound is a cheap, non invasive, portable and convenient method to estimate bone strength without any radiation hazard.²⁻⁵ The aim of our study is to estimate the bone mineral density by using quantitative ultrasound, look for the influence of parameters like lifestyle factors, comorbidities, chronic drug intake, and other risk factors on BMD; and compare the results with those in the literature done with DEXA scans. In our study of 516 subjects, (i) BMD measures varied from -5.6 to +5.55 with a mean of -1.8. (ii) BMD decreased significantly with age ($r=.351$, $p<0.0001$), (iii) Low BMD was associated with increase in Fragility fractures ($p=.007$) (iv) Antacid intake, which was pretty common in our subjects (28.7%) led to decrease in BMD ($p<.005$). (v) Diabetes significantly reduced BMD ($p<.005$). (vi) Increase in BMI led to significant increase in BMD ($r=.166$, $p<.0001$). (vii) BMD increased significantly with increase in physical activity ($r=.148$, $p<.001$). Most of the associations found in our study, except that with diabetes, were similar to those consistently associated with BMD as measured with DEXA scans.⁶⁻¹⁵ Our study suggests the use of Quantitative ultrasound as powerful epidemiological tool with similar outcome measures to DEXA scan without any radiation hazards.

Key Words: Quantitative Ultrasound, BMD, Lifestyle Diseases, BMI, Drug Intake

INTRODUCTION

Osteoporosis, the metabolic disorder has become a global epidemic¹ with increase in life expectancy and changing life style. There is an increase in the prevalence of osteoporosis and low bone mass of younger adults¹⁶ in recent times owing to increasing substance abuse and sedentary lifestyle.¹⁷ Osteoporosis, being a silent epidemic,¹⁸ receives much less attention than it deserves and remain asymptomatic till a fracture occurs. Lack of affordability and access to available preventive treatment options leads to major gaps in the diagnosis and management of osteoporosis.^{19,20} Quantitative ultrasound is a cheap, non invasive, portable and convenient method to estimate bone strength without any radiation hazard.²⁻⁵ The objective of our study is to estimate the bone mineral density by using quantitative ultrasound, and to look for the influence of parameters like lifestyle factors,

comorbidities, chronic drug intake, and other risk factors on BMD; and compare the results with those done with DEXA scan²¹ which is the gold standard.

MATERIALS AND METHODS

The study data were taken from subjects attending the orthopaedic outpatient clinic and underwent Quantitative Ultrasound measurement of calcaneus. Ultrasound (US) technique for evaluating skeletal status used Speed of sound (SOS) and broadband ultrasound attenuation (BUA) properties assess bone strength and fragility. Census method was used on the specified days assigned for the study. Their anthropometric measurements, information on lifestyle factors (physical activity, alcohol intake, smoking, fragility fractures) and Co-morbidities like asthma, epilepsy, diabetes, hypothyroidism were documented as a structured questionnaire. Data was entered in excel

Cite this article as: Krishnan J, Raffic MK, S K. Quantitative Ultrasound - An Epidemiological Tool to Uncover the Influence of Lifestyle Factors & its Associated Co Morbidities on Bone Density. KJOrth. 2020 Jun 1;33(01):8-12.

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<https://doi.org/10.52314/kjo.2020.v33i01.7>

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Table 1. Gender distribution

Sex	Frequency	Percent
Male	284	55
Female	232	45
Total	516	100

Table 2. Distribution of Study Parameters

Parameters	N	Mean	Min	Max
Age	516	52.2	18	84
BMI	516	25.8	15.42	45.49
Speed of Sound	516	1548	1421	1649
Age at menopause	232	46.19	30	59
Physical Activity	516	2.06	0	10
BMD	516	-1.8	-5.6	5.55

Table 3. BMD Patterns

BMD	Frequency	Percent
<-2.5	191	37.0
-2.5 - - 1	190	36.8
>-1	135	26.2
Total	516	100.0

sheet and analysed using SPSS software. Characteristics of study subjects were depicted as numbers (percentages) for categorical variables, and mean $\pm$ SD for continuous variables. Chi-square test (χ^2), Pearsons correlation and binary logistic regression analysis was used to look for associations as appropriate. $p < .05$ was considered statistically significant for all statistical tests.

RESULTS

There were 516 subjects in our study, of which 55% were males and 45% females (**Table 1**). Mean age of study population was 52 years (18 yrs-84 yrs). Physical activity varied from no exercise to maximum of 10 hrs/day (mean of 2 hours). BMI varied from 15.4 to 45 (mean of 25.8). The age at menopause for women varied from 30 years to 59 years with mean of 46 yrs (**Table 2**). The BMD measures varied from -5.6 to +5.55 with a mean of -1.826 % (35 subjects) had normal BMD whereas osteoporosis and osteopenia were seen in 37% each (**Table 3**).

BMD and Age

Pearson correlation to look for association of BMD with age showed that BMD decreased significantly with age ($r = -.351$, $p < 0.0001$) (**Table 3a**). This was however significantly different for males and females $p < 0.016$ (**Figure 1**). After the age of 40, we found that the BMD decreases rapidly in females as compared to males. Binary logistic regression model for BMD also showed strongest association of decrease in BMD with increasing age

Table 3a. Correlation of BMD to Parameters

Parameters	Persons Correlation (r)	P Value
Age	-.351**	0.000
BMI	.166**	0.000
Speed of sound	.106*	0.016
Physical activity	.148*	0.001

Table 4. Distribution of Comorbidities & Lifestyle

	Number of patients	Percent
Asthma/COPD	60	11.6%
Hypothyroidism	41	7.9%
Epilepsy	5	1%
Diabetes	130	25.2%
Smoking	31	6%
Alcohol	36	7%
Antacid intake	148	28.7%

Table 5. Association of Comorbidities to BMD

Factors	N	BMD		P Value
		Mean	SD	
Gender	Male	126	-1.537	0.016
	Female	390	-1.934	
Smoking	Absent	485	-1.844	0.688
	Present	31	-1.724	
Alcohol	Absent	480	-1.857	0.307
	Present	36	-1.572	
Antacid Intake	Absent	368	-1.710	0.004
	Present	148	-2.153	
History of Fragility #	Absent	377	-1.721	0.007
	Present	139	-2.150	
Asthma/ COPD	Absent	456	-1.835	0.943
	Present	60	-1.851	
Hypothyroidism	Absent	475	-1.850	0.545
	Present	41	-1.624	
Epilepsy	Absent	511	-1.830	0.355
	Present	5	-2.500	
Diabetes	Absent	386	-1.951	0.005
	Present	130	-1.498	

($p < 0.0001$). Though BMD decreased significantly after menopause, there was no significant association of age at menopause and BMD trends.

BMD and Fragility Fractures

There was significant association between decrease in BMD with increase in Fragility fracture occurrence ($p = .007$). The average BMD of patients sustaining fragility fractures was -2.150, as compared to -1.721 in subjects without fragility fractures. The common fragility fractures noted were at wrist, hip & spine.

Figure 1. BMI v/s Age (In Males & Females)

BMD and Antacid Intake

Antacid intake, which was pretty common in our subjects (28.7%) led to decrease in BMD. The mean BMD value of subjects with regular antacid intake was -2.153 as compared to -1.710 in subjects without antacid intake; and the association was significant ($p=.004$), suggesting that chronic antacid intake would weaken our bones (Figure 1a).

Figure 1a. Association of BMD to Antacid Intake

BMD & Risk Factors

Diabetes (25.2%) was the most common co morbidity (Figure 2). The mean BMD of the diabetic group was -1.95 as compared to -1.49 in non-diabetic group, suggesting that diabetes significantly reduced BMD ($p<.005$). Alcohol intake and smoking were seen in only 6% & 7% respectively as the study population had only 25% males. Other co morbidities observed were asthma/COPD, hypothyroidism, epilepsy & diabetes (Table 4). However, their numbers being small were not enough to show any statistical significance (Table 5).

BMD, Physical Activity & Body Mass Index (BMI)

Increase in BMI led to significant increase in BMD ($r=.166$, $p<.0001$) Figure 4. The scatter plot showing

Figure 2. Distribution of Comorbidities in Subjects

increase in BMD with BMI is shown in fig X. Available studies have provided contrasting findings: some authors suggest that obesity has detrimental effects on bone health, while others have revealed its potential protective role.^{14,15}

BMD increased significantly with increase in physical activity ($r=.148$, $p<.001$). ROC curve with optimum cut off at .75 hours (45mts) showed area under the curve 57.4% with 95% confidence interval of .53 to .617, suggesting that physical activity of more than 45 minutes per day led to significant increase in BMD (Figure 3).

Figure 3. ROC Curve: Physical Activity-BMD

DISCUSSION

In our study, we found that the bone strength measured using calcaneal ultrasound had significant positive association with physical activity (>45 mts/day), and Body mass index.

Figure 4. Scatter diagram to show changes of BMD with physical activity and BMI

Increasing age, antacid intake, fragility fractures & diabetes showed inverse association with Bone strength. QUS measurements were in the direction of higher values in men as compared to women. Most of the associations found in our study, except with diabetes, were similar to those consistently associated with BMD as measured with DEXA scans.⁶⁻¹⁵ Diabetes and bone strength depends on the type of diabetes, T1DM presenting with decreased BMD while patients with T2DM presenting with normal to increased BMD.^{22,23} Our study, which included T1DM and T2DM in a single group, showed decrease in BMD as an association to diabetes.

Despite its proven advantages including simplicity of use, low cost, portability and safety; the use of QUS remains controversial and has its limitations. Bone size and geometry, soft tissue thickness, and anthropometric findings have its effect on QUS values.^{24,25} This is the major limitation of our study.

CONCLUSION

Quantitative ultrasound (QUS) is a cheap, non invasive, portable and convenient tool to estimate bone strength in our community. Our study suggests the use of Quantitative ultrasound as powerful cost effective epidemiological surveillance tool, with similar outcome measures to DEXA scan, without any radiation hazards. Considering the availability and cheap nature of this technique, it can be used as an ideal tool for mass screening of osteoporosis in our setup.

END NOTE

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Conflict of Interest: None declared

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