Using DEXA Technology to Compare Rural and Urban Bone Mass Density of Women

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Abstract— **Dual-energy x-ray absorptiometry (DEXA) is a major imaging technology for measuring Bone Mineral Density (BMD) which in turn is as an important predicting factor for fractures. Previous studies reported a different trend in BMD among rural residents was higher than urban residents. The aim of this study was to compare BMD between rural and urban citizen in Iran. This cross-sectional study was conducted between 2016 and 2017 in Ghaem Hospital, Mashhad, Iran. All women between the age of 30 and 85 years old who referred for BMD measurement based on dual-energy x-ray absorptiometry (DEXA) were assessed for sociodemographic and anthropometric characteristics other than BMD assessment. Serum vitamin D levels were also measured for each subject. A total of 233 subjects (103 rural and 103 urban women) participated in the study. Rural residents had a significantly higher incidence of smoking ($p<0.001$) and low education level ($p<0.001$). The mean T score for spinal BMD was not statistically different between rural and urban groups (-2.33 ± 2.16 and -1.96 ± 1.03 respectively, $p= 0.11$). There was a significant difference in mean hip BMD T score between rural and urban groups (-3.09±1.06 and -2.63±1.90 respectively, $p=0.02$).**

Keywords- Bone mineral density; DEXA technology; image processing, rural and urban women

I. INTRODUCTION

Various risk factors exist for predicting the risk of fractures in adults among which the bone mineral density (BMD) and bone mineral content (BMC) are of great importance [1-3]. Dual-energy x-ray absorptiometry (DEXA) is the gold standard for the assessment of BMD in healthy and diseased populations [4]. It comes with a software with image processing capabilities that computes and displays the bone density measurements. The BMD is affected by various individual, genetic and environmental factors including gender, age, diet, sun exposure and type and amount of physical activity [5-7]. Regardless of genetic differences, environmental factors have been shown to play an important role in determining the BMD [5-7]. Early detection and treatment of osteopenia/osteoporosis may prevent further bone loss and fractures [8]. Previous studies have shown a relationship between urbanization and BMD indicating that the mean BMD of rural residents are significantly higher than their urban counterparts [9-11]. These observations were due to the differences in exposure to the sources of vitamin D, physical activity and social factors based on the different patterns of diet, lifestyle and environment of rural and urban population [9,11].

Modernization has not only affected the lifestyle of the urban population, but studies have shown that the rural population have also been affected by modernization and that this effect might have been greater than that happened in the urban area [12-16]. Based on these rapid changes, it can be hypothesized that the rural population might become more vulnerable to osteoporosis and lower BMD. Iran is among the developing countries that has experienced modernization in lifestyle and agriculture during the past decades and it seems that the rate of modernization in the rural areas of Iran has improved recently [17-19]. The aim of this study was to assess and compare BMD in a sample of rural and urban female population of Razavi Khorasan, Iran.

II. METHOD

This cross-sectional study was conducted on rural and urban women aged between 30 and 83 (mean 46.3 years) in the Rheumatology Unit of Gheam Hospital from June 2016 to February 2017. The study was approved by the Mashhad University of Sciences Ethical Committee.

Urban subjects were selected from the women who were living in Mashhad city while the rural subjects were selected from female farmers of the areas in the region of Mashhad within 75 km distance from the city. All subjects signed a written informed consent prior to participation in the study.

Demographic data, including age, place of residence, marital status, education level, smoking and breastfeeding history, was extracted from the medical records of each subject. Weight and height of the subjects were measured and the body mass index (BMI) was calculated based by dividing body weight (kg) to the square height (m). Venous blood samples were obtained from each subject and the serum level of vitamin D was assessed in the hospital lab. Laboratory technician was blinded about the group allocation of the subjects. The BMD was assessed for all subjects based on DEXA scan in the lumbar spine (L2-L4) and femoral neck (Lunar DPX-1Q, Medison, W1 USA) with an accuracy of 0.001 gr/cm2). The WHO criteria and local reference values of BMD were used to identify osteopenia and

osteoporosis. The T scores for the lumbar and hip of the study subjects were calculated and used in the statistical analysis.

A. *Statistical analysis*

Data was analyzed using the statistical package for social sciences (SPSS) software version 22 (IBM Inc, Chicago, Il, USA). Mean and standard deviation were used to describe continuous data while frequency and percentage were used to describe categorical data. Comparison of the mean T scores between study groups was performed using the independent sample t-test. Comparison of categorical data distribution between study groups was performed using the chi-square test. The value of p smaller than 0.05 was considered as statistically significant.

III. RESULTS

A total of 233 subjects participated in the study. The mean age of study subjects was 46.3 years. Mean serum vitamin D was higher in rural subjects compared to urban subjects (23 ng/ml vs 21 ng/ml respectively). The mean BMI of the subjects in the urban group was 26 kg/m2 while the mean BMI in the rural group was 29 kg/m2. Comparison of demographic characteristics of the subjects between studied groups are shown in Table 1. There was a significant difference between urban and rural groups in terms of education level ($p<0.001$) and tobacco smoking ($p<0.001$) (Table 1).

TABLE I. COMPARISON OF DEMOGRAPHIC SUBJECTS CHARACTERISTICS

		Urban (n=103)	Rural (n=130)	p
Marital status	Married	96 (93%)	116 (89%)	0.29
	Single/Widowed	7 (7%)	14 (11%)	
History of breast feeding		20 (19%)	30 (23%)	0.49
Low education level		34 (33%)	108 (83%)	<0.001**
Tobacco smoking		42 (41%)	96 (74%)	<0.001**

** Significant at α=0.01

There was no significant difference in mean T score of lumber spine BMD between rural and urban groups (-2.33 ± 2.16 in rural vs -1.96 ± 1.03 in urban group, p= 0.11). There was a significant difference in mean hip BMD T score between rural and urban groups (-3.09±1.06 in rural vs -2.63±1.90 in urban group, p=0.02) (Figure 1).

IV. DISCUSSION

The findings of this study revealed that the mean T score for hip BMD was -2.33 and -1.96 in rural and urban subjects while the mean T score for hip BMD was -3.09 and -2.63 in rural and urban subjects respectively. These values indicate that majority of the rural subjects have mean hip BMD T scores in the osteoporosis range definition while majority of the urban subjects have BMD in the range of osteopenia. It was previously reported that nearly 50% of the Iranian women have osteoporosis and that the prevalence of osteopenia/osteoporosis was higher in the hip region compared to spinal region [20]. The findings of our study provide evidence for the higher risk of bone fracture and osteopenia/osteoporosis among Iranian women.

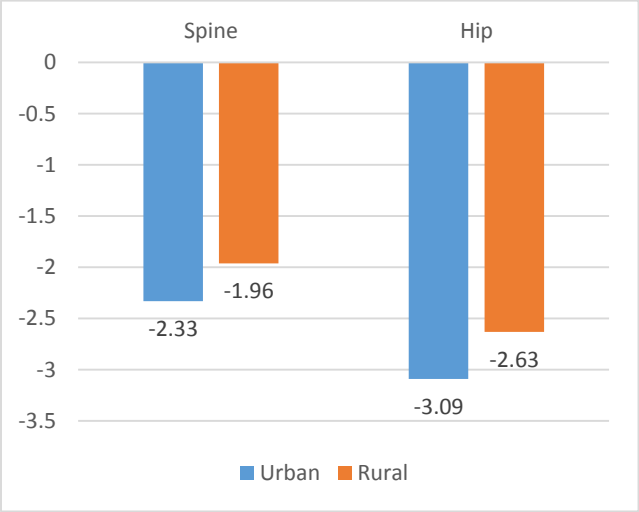

Figure 1. Figure 1. Mean spinal and hip T scores among study group

The findings of this study also revealed that the mean T score for hip BMD was significantly lower in rural compared to urban subjects. The spinal BMD T score was also lower in rural subjects compared to urban subjects but this difference was not statistically significant. This finding was in contrast with the findings of previous studies that reported higher BMD in rural population [9,11,21]. On the other hands some recent studies have identified a paradoxical finding which indicates higher prevalence of osteoporosis and osteopenia among rural residents compared to urban residents [22-25].

A recent systematic review and meta-analysis also revealed heterogeneous findings and related the differences between urban and rural area to the clinical evaluation and economic status of the regions [26]. For instance a higher BMD was observed in rural residents of low income countries compared to urban residents but this difference was not detectible in higher income regions [26]. Various criteria have been named for the observed differences in BMD between rural and urban population including higher serum vitamin D levels and higher calcium intake among rural residents compared to urban residents [9-11].

In this study, the mean serum vitamin D levels in both groups were indicative of insufficient vitamin D levels. This may also indicate lack of adequate sun exposure and consumption of nutritional vitamin D sources in foods in both urban and rural subjects. A previous study on 8024 rural Chinese showed that healthy eating behavior was seen only in 21% of the subjects [27].

Another study on Chinese urban and rural population also had similar rational for the observed higher BMD among urban residents compared to their rural counterparts as dietary and lifestyle habits of their population is influenced by the Western culture [25]. Food insecurity was reported to exist in 42.3% of rural households in a low income district of Iran [28]. Another study showed that household food choices of Iranian rural residents has changed in a way that rural households consumed more fat and oil, rice and sugar and dairy products and consume less bread in 1995 compared to 1985 [29]. In a study on rural Indian, the BMD was observed to be lower than urban values [23]. They found that the BMI of the rural residents decrease with the increment in age and that the effect of weight on the BMD is reduced among these subjects. In contrast the findings of the current study on Iranian rural women revealed higher BMI (mostly in the overweight/obesity range based on the world health organization BMI category) [30]. This study also revealed a significantly poorer educational level in rural subjects which might have contributed to inadequate nutritional knowledge in proper food choices.

These findings indicate the existence of obesity paradox among Iranian rural women which might be due to the unhealthy food choices and reduced physical activity. In another study on Indian women, osteoporosis was observed in a higher rate among rural females using heel ultrasound scan [31]. They also observed that social support and psychological factors may have a role in the lower BMD among rural residents [31]. These findings may add to the rational for the hypothesis of this study that rural residents may not have the traditionally believed better bone health compared to the urban citizens due to socio-economical and lifestyle changes.

Another finding of this study was the higher incidence of tobacco smoking among rural subjects. It was previously shown that tobacco smoking was associated with increased risk of osteoporosis in women [32-33]. The identified mechanisms for the adverse effects of tobacco smoking on BMD were higher receptor activator of nuclear factor-B ligand (RANKL-positive), CD4 (+) and CD8 (+) T cells and lower periosteal gene expression of bone morphogenetic proteins (BMP-2, BMP-4, and BMP-6). Furthermore, the mean concentration of bone marrow progenitor cells (BMPCs) were lower in smokers compared to non-smokers [33].

Considering the proximity of the studied rural subjects, the nutrition and lifestyle trends of these subjects might follow a much-accelerated urbanization trend compared to farther villages, therefore the observed findings of this study might only be generalizable to the suburban villagers of large cities.

One of the limitations of this study was lack of assessment of nutritional risks of the study subjects. It is recommended for further researchers to assess the nutritional status of rural and urban residents. Furthermore, the findings of this study revealed that the patterns of BMD among rural residents might be affected by their socioeconomic status and distance from urban centers. It is recommended for further researchers to compare BMD of rural residents based on their socioeconomic status.

V. CONCLUSION

Lifestyle risk factors might contribute to the observed reduced BMD in rural subjects compared to urban population. The observed lower BMD in rural subjects might be due to the effect of modernization in suburban rural areas.

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