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Osteoporosis in Mongolian Population: Prevalence and Risk Factors

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Objectives: The purpose of this study was to evaluate the prevalence of osteoporosis and investigate some of its risk factors among Mongolian adults. **Methods:** The subjects comprised of 2001 adults (age ranged from 20 to 87) were recruited from 5 ecological zones of Mongolia. After applying exclusion criteria, 1990 subjects were selected. Speed of sound (SOS) ultrasonic bone mineral density was measured in the distal one third of radius of the non-dominant arm using the Sunlight Omnisense (Sunlight Medical, Rehovot, Israel). The data were used to calculate mean SOS and T-score by WHO osteoporosis criteria. **Results:** The average age was 49.1±13.5 (men: 48.6±14.6, women: 49.4±13.0). The prevalence of osteoporosis in men and women from 20-35 years of age was 4.7% vs 6.2%, from 36-45 years of age was 7.2% vs 8.0%, from ages 46-55 was 11.4% vs 25.5%, from ages 56-65 was 21.9% vs 58.3%, and from those over 65 years of age was 35.6% vs 75.5%. The prevalence of osteoporosis was lowest in Ulaanbaatar city. The independent predictors of osteoporosis in Mongolian adults were female sex, menopause, lower education level, physical inactivity and low BMI (BMI<18.5). **Conclusion:** Compared to neighboring and industrialized countries, the prevalence of osteoporosis in Mongolia is significantly higher. Female sex, lack of exercise, lower education level, menopause and being underweight were identified as risk factors in Mongolian adults.

Keywords: Osteoporosis, Prevalence, Mongolia, T-score

Introduction

It is estimated that over 200 million people worldwide are suffering from osteoporosis and prevalence is escalating with increasing age. About 1.5 million fractures associated with osteoporosis occur yearly in the USA; and among those incidences, hip fractures carry the greatest risk of morbidity. Up to 20% of patients who suffer from hip fractures die within the first 12 months from related complications [1].

Osteoporosis is a widespread disease characterized by changes in bone micro architecture [2, 3]. It is a multi factorial condition associated with an increased risk of fracture and can be caused by low Vitamin D levels, lack of physical activity, insufficient sun exposure all year round, and other physical

and lifestyle risk factors. In the mainland of China, the overall prevalence of osteoporosis based on nationwide surveys ranged from 6.6% to 19.3% (average=13.0%) [4]. In developing countries, the prevalence of osteoporosis ranges from 2% to 8% in men and 9% to 38% among females [5]. Osteoporosis prevalence is high in Asians and Europeans and is low in Africans [6]. Mongolia is located in the center of Euroasia, bordering with China, yet we are unable to find data reporting its osteoporosis prevalence.

Several vitamin D studies suggest vitamin D deficiency is common in Mongolia [7]. This might be associated with the Mongolia's northern geographical location (latitude of 46º North), which frequently contributes to low Vitamin D levels in both sexes and all age groups of the population. In urban populations of other developing countries, air pollution, limited outdoor activity, sedentary behaviors further compounds hypovitaminosis D and osteoporosis [8].

The peak bone mineral density (BMD) is achieved in the early to mid-twenties and maintained until around the age 40. Older men and women experience bone loss associated with decline of sex steroids. Some studies prove that older men with osteoporosis were more likely to have total testosterone and estradiol deficiency [9]. However, estradiol deficiency causes both the early and late forms of osteoporosis in postmenopausal women [10].

We suspect that with the aging of Mongolia's population, its osteoporosis prevalence may increase in the near future, but we are unable to find any data on its current prevalence. This initial study was conducted to aid in developing a practical strategy to improve the bone health of Mongolia's people. Our aim was to evaluate the osteoporosis prevalence and investigate some of its risk factors among Mongolian adults.

Materials and Methods

Study population

In this study, the 2001 adults (age ranged from 20 to 87) were randomly recruited from 5 ecological zones (Dundgovi-45.7ºN 106.3ºE, Sukhbaatar-46.6ºN 113.3ºE, Uvs- 49.9ºN 92.0ºE, Arkhangai-46.3ºN 102.7ºE, and Ulaanbaatar city-47.8ºN 106.9º E) of Mongolia from June 2013 to September 2015. (Figure 1)

The regions include urban and rural populations situated at different latitudes. The participants were recruited at the outpatient clinics of provincial medical centers and the family clinics of Ulaanbaatar. All participants were asked to complete a questionnaire to collect basic information about occupation, medical and reproductive history and lifestyle factors including activity level, intake of soda, caffeine, alcohol and tobacco smoking. Eleven participants were excluded from the study because they reported chronic diseases (renal, hepatological, endocrinological), were on medications, had hypogonadism, or had incomplete data. After screening speed of sound (SOS) in 1990 subjects, participants were stratified into 3 classes according to WHO osteoporosis criteria [24]. A total of 507

Figure 1. Map of Mongolia showing the geographic location of the study population

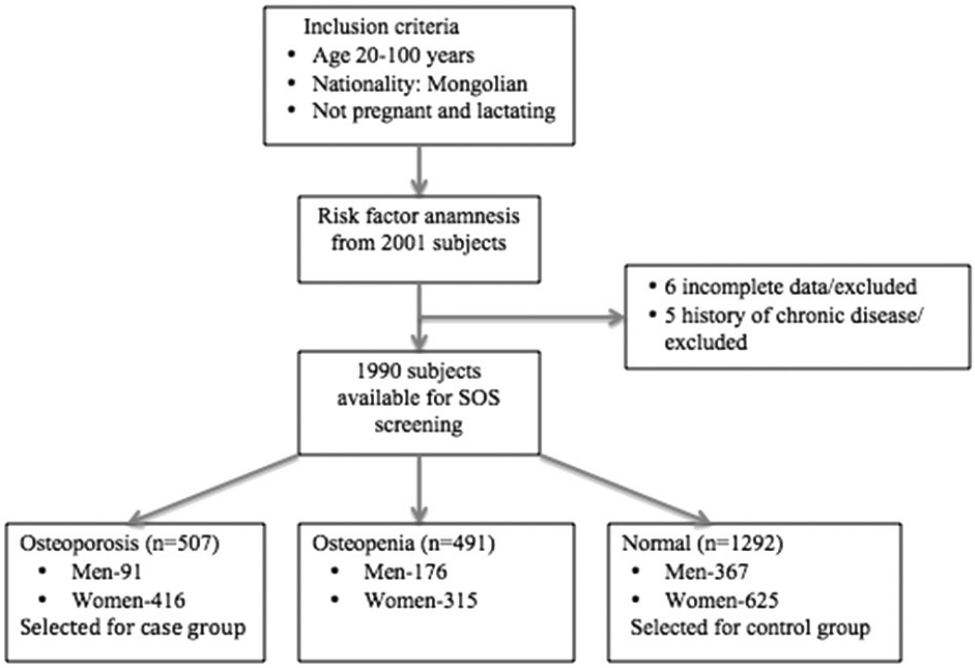

Figure 2. Flow chart of the subject selection

subjects were diagnosed with osteoporosis and were included in the study group and 1292 subjects with normal bone mineral density were included in the age and sex matched control group (Figure 2). All participants were stratified into 5 age groups (18-35, 36-45, 46-55, 56-65, and over 65yr).

Quantitative ultrasound assessment of bone

SOS was measured in distal one third of radius of the non-dominant hand in 1990 subjects using the Sunlight Omnisense (Sunlight Medical, Rehovot, Israel). The device was calibrated daily before testing in a temperature-controlled environment. Body weight and height were measured before assessment of bone density. Age and gender specific SOS for the radius was compared with the built-in original values (Asian) from the Beammed reference database. Two experienced physicians evaluated the osteoporosis data. These data were used to calculate mean SOS and T-score using WHO osteoporosis criteria. The T-score is the number of standard deviations that the subject's bone density is above or below the average of a healthy young 30 year old reference population. The SOS T-score threshold for the diagnosis osteoporosis was -2.6; the value between -2.5 and -1.1 indicated osteopenia and over -1.0 was considered within normal. Measurements were obtained using Sunlight Omnisense, which is an inexpensive, non-invasive portable, quantitative ultrasound device that was very easy to operate, and thus reduced the time required to gather the data from the 5 Mongolian provinces.

Statistical analysis

All data were analyzed using SPSS 17.0 software and the descriptive data are presented as the mean±SD or the percentages. Non-parametric tests were used to determine whether parameters were consistent with normal distribution. Differences between categories were assessed by t-tests. To identify the factors that were associated with osteoporosis, we performed binary logistic regression analysis. A univariate analysis was performed to calculate the crude odds ratio (OR) with a 95% confidence interval (CI). A p-value ≤ 0.05 was considered statistically significant.

Ethical consideration

All participants were informed about purpose of the study, the safety of SOS measurements, the measures taken to protect their privacy and other benefits of study participation. Informed

Table 1. The prevalence of osteoporosis in Mongolian adults

Age (years)	Men (n=634)		Women (n=1356)	
	Osteoporosis prevalence	CI 95%	Osteoporosis prevalence	CI 95%
Age 20-35 years (n=322)	4.7% (n=6)	1.0%-8.5%	6.2% (n=12)	2.8%-9.6%
Age 36-45 years (n=451)	7.2% (n=10)	2.9%-11.8%	8.0% (n=25)	5.1%-11.2%
Age 46-55 years (n=598)	11.4% (n=19)	6.7%-16.6%	25.5% (n=110)	22.2%-30.8%
Age 56-65 years (n=385)	21.9% (n=25)	14.4%-29.9%	58.3% (n=158)	53.7%-65.6%
Age over 66years (n=234)	35.6% (n=31)	25.4%-45.9%	75.5% (n=111)	69.6%-83.5%

Table 2. Comparison of osteoporosis prevalence in some provinces of Mongolia

Province	Male (n=634)			Female (n=1356)		
	N	Osteoporosis prevalence	CI 95%	N	Osteoporosis prevalence	CI 95%
Arkhangai	121	18.8%	11.8%-25.9%	274	32.4%	26.8%-37.9%
Uvs	122	13.8%	7.6%-20.0%	273	36.1%	30.4%-41.8%
Dundgovi	135	18.4%	11.8%-24.9%	254	34.5%	28.6%-40.4%
Sukhbaatar	125	12.7%	6.8%-18.6%	260	27.5%	22.1%-33.0%
Ulanbaatar	117	8.5%	3.4%-13.6%	261	25.9%	20.6%-31.3%

Table 3. Binary logistic regression analysis of various risk factors of osteoporosis

Variables	Unadjusted odds ratio	Lower 95% CI	Higher 95% CI	p -value
Sex (Female/Male)	2.6	2.0	3.4	<0.001
Weight bearing exercises (20 minutes daily/less than 20 minutes)	2.4	1.6	3.6	<0.001
Lower education level (Lower/Higher)[a]	1.4	0.7	2.6	<0.05
Menopause (postmenopause/premenopause)	21.7	15.4	30.6	<0.001
Age in 1 year increments after menopause	1.02	1.007	1.045	<0.01
Underweight (BMI<18.5/ BMI≥18.5)[b]	3.5	1.1	10.5	<0.05

[a]Lower education level represents participants who has graduated middle school only, Higher education level represents whose education level is more than Bachelor degree [b]only for women

consent was obtained from all of the participants. The research proposal was reviewed and approved by the Ethical committee of Ministry of Health of Mongolia.

Results

A total of 634 men and 1356 women were involved in the survey. Eleven were excluded based on the the exclusion criteria mentioned previously. The average age was of all participants was 49.1±13.5 (men: 48.6±14.6, women: 49.4±13.0) with 16.2% from ages 20 to 35 years, 22.7% from ages 36 to 45, 30.1% from ages 46 to 55, 19.3% from ages 56 to 65, and 11.8% were age 66 or older.

Sex and age specific groups

The overall prevalence of osteoporosis was 14.4% (n=91) in men and 30.7% (n=416) in women. The prevalence of osteoporosis increased with ageing every age group and osteoporosis prevalence was highest in group of over 65 years of age (Table 1). The prevalence of osteoporosis in females over 45 years of age was higher than age-matched males due to menopause. Mean menopause age was 49.1±3.8. According to

the regression model, osteoporosis prevalence was 21.7 times more likely [95% CI: 15.4-30.6] in postmenopausal women than in premenopausal women (p<0.001).

Region and area

Osteoporosis prevalence data for some provinces are summarized in Table 2. The prevalence of osteoporosis was significantly lower in urban rather than in rural areas (men: 15.9% vs 8.4%; women: 32.7% vs 25.9%). Compared with participants in urban areas, participants in rural areas had 1.4 times higher prevalence [95% CI: 1.1 to 1.9]. Participants from Ulaanbaatar city had the lowest prevalence for both sexes, while participants from Arkhangai (male osteoporosis) and Dundgovi provinces (female osteoporosis) demonstrated the highest prevalence.

Some risk assessment of osteoporosis

In our study, osteoporosis prevalence was 2.6 times higher in women than in men [95% CI: 2.0-3.4]. Moreover, it increases to 3.4 times [OR=3.4, 95% CI 2.6-4.8] in participants who are older than 45 years. The risk of osteoporosis in postmenopausal women was 21.7 times higher [OR=21.7, 95% CI: 15.4-30.6] than premenopausal women according to our logistic regression model.

Some variables were significantly associated with osteoporosis only in women. Women who were underweight (Body mass index (BMI) <18.5) were much more likely to develop osteoporosis [OR=3.5, 95% CI: 1.1-10.5] compared to normal and overweight women. We found that 58.3% (n=70) of the underweight women had osteoporosis. But, the effect being overweight (25<BMI<30) or obese obesity (BMI>30) was negligible.

From our socio-economic and daily activity data, we found that the risk factors for osteoporosis were lower education [OR=1.4; 95% CI: 0.7-2.6, p<0.05] and physical inactivity [OR=2.4; 95% CI: 1.6-3.6, p<0.001]. Other potential variables such as family income, daily alcohol intake, current smoking, calcium and Vitamin D supplement were not significantly associated with the development of osteoporosis (Table 3).

Discussion

Aging is one of the main risk factors for developing osteoporosis in both males and females. A meta-analysis in China showed the prevalence of osteoporosis increased with age [11]. Current study findings revealed the same results. Our data indicate that overall prevalence of osteoporosis in Mongolian adults is 14.4% in men and 30.7% in women. For people aged 50 years or older the prevalence was 23.8% for men and 53.7% among women, which is slightly higher than data reported for mainland of China (22.5% in men and 40.1% in women older than 50 years) [12]. In contrast, the prevalence of osteoporosis in Mongolia is lower than some industrialized countries such as United Kingdom, where the prevalence among 50 years and older is 68% in women and 55% in men [13]. In United States, the prevalence was 13-18% in women and 3-6% among men age 50 years or older, which is lower than Mongolia [14]. Compared with Filipino women, the prevalence of osteoporosis in post-menopausal Mongolian women is significantly higher, 9.9% vs 40.8% in women aged 50-59 years, 13.8% vs 63.7% in women age 60-69, and 68.3% vs 83.3% in women ages 70-79 years [15]. No previous data on osteoporosis prevalence among Mongolians were found and research needs to be done in this field. The high prevalence of Vitamin D deficiency may contribute to of osteoporosis in Mongolian population. Low mean serum 25(OH)D concentrations in the summer (22.5 ng/ml) and in winter (7.7 ng/ml), emphasizes the urgent need for effective vitamin D interventions [7].

Gender is another main factor for the developing fragile bones. We found the prevalence rates of osteoporosis were significantly higher in women than in men including all age groups. Several studies conducted in China indicate large gender variances in the prevalence of osteoporosis; prevalence of osteoporosis is 50% higher in women than in men [4,15]. China is a neighbor to Mongolia and several studies on osteoporosis have been carried there. All studies reported similar findings for the both genders. Similar results have been reported in U.S. where the prevalence of osteoporosis was 3.8% for men versus 26.1%for women [17]. Estrogen deficiency associated with menopause leads to rapid bone loss in women. Our analysis shows that after onset of menopause (50 years and older), the prevalence of osteoporosis increases 21.7 times higher. Thus, older women are the target group that needs osteoporosis screening and intervention. The same trend with aging can be seen in men, but its effect is less pronounced. In contrast, older men with testosterone deficiency are more likely to be osteoporotic [9].

There are many studies that explain urban-rural differences of osteoporosis prevalence [8, 14]. In our study, the urban area of Ulaanbaatar had lowest prevalence. Mongolia's urban and rural residents likely have different diets and levels of physical activity. In Ulaanbaatar, which is the capital city, the majority of people follow a more western lifestyle. However, in rural areas many people still maintain traditional nomadic lifestyle. Rural residents seem to be more active and more likely to participate in outdoor activities compared to urban residents, and thus should have more sun exposure, yet the prevalence of osteoporosis in rural areas is significantly higher in the rural areas than in the city. Although rural people often lead a nomadic life and consume more dairy products, they are less educated about healthy lifestyles, which might cause changes in SOS [8, 15]. In contrast, some meta-analysis data from China shows the prevalence of osteoporosis was higher in South China due to life style and food culture differences. However, the prevalence of osteoporosis in North Iraq was higher than South, and the regional difference was attributed to differences in latitude of regions and Vitamin D level [11].

The independent predictors of osteoporosis we identified in Mongolian adults were female sex, physical inactivity and lower educational attainment. In a systematic review of risk factors of osteoporosis in men, physical activity was positively associated with BMD; however, the association was weak, <1% decreased in BMD per standard deviation of physical activity score. Furthermore, men with lower limb disability or who were confined to a chair or bed had increased risk of osteoporosis [18]. Some exercise-intervention trials concluded that moderate daily walking for 30 minutes combined with weight-bearing exercises twice weekly prevented bone loss in women [19].

Varenna M et al. showed that educational level was an independent protector against osteoporosis in women and same trend was observed in our study. The indirect protective role played by educational level may be due to use of health care resources, healthier eating habits, and appropriate BMI. Although the mechanism of association between education and bone mineral density is still unexplained, many studies show higher educational level is protective factor against the development of non-communicable diseases [20].

In our study, some risk factors (menopause, low BMI) were only significant in women. In a systematic review of osteoporosis in postmenopausal women, increasing age, low weight, and physical inactivity were consistently associated with increased risk of low bone density [21]. Moreover, Zhao et al. found that body fat had a beneficial effects on bone density, possibly through a common precursor stem cell that leads to the differentiation both adipocytes and osteoblasts, as well as secretion of adipocyte-derived hormones that affect bone. But contrasting studies, suggest that excessive fat mass may not protect against osteoporosis [22]. We found that 58.3% of the underweight women were osteoporotic. This may be caused by hormone or mineral imbalance and further research is needed.

Our study has some limitations. First, we have not accurately identified the reasons for differences in osteoporosis prevalence observed between the urban and rural areas of the country. Ethnic and racial differences might have had affect the accuracy of our study. Second, we while we compared the findings of our study with international data, the bone mineral density measurement devices employed in these studies were different. In our study, we used an ultrasound bone mineral density measurement device which was inexpensive and easy to operate. To our regret, we could not find a similar study utilizing the same measurement device.

The age composition of the Mongolian population is rapidly changing and life expectancy increased to 64 years in 2000 and is expected to increase to 73 years by 2030. As a result, the prevalence of age-related disease including osteoporosis will increase in near future [23]. Our study indicates that current prevalence of osteoporosis is higher than bordering countries and some other Asian countries. In conclusion, future national studies are needed to estimate the burden of osteoporosis in Mongolia to adequately access and mitigate its economic impact.

Conflict of Interest

The authors state no conflict of interest.

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