



Temporal change in the diagnosis and treatment rates of osteoporosis: results from the Korea National Health and Nutrition Examination Survey

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Abstract

Summary To compare the diagnosis and treatment rates of osteoporosis and diabetes in Korea, a nationwide database was used. The results showed that although osteoporosis management is improving, it is still lower compared with that of diabetes; thus, further efforts are needed in this regard.

Introduction This study aimed to re-evaluate the diagnosis and treatment of osteoporosis from the KNHANES 2016–2017 and compare the temporal change of the rate with those of diabetes as another prevalent chronic disease in South Korea.

Methods The prevalence of osteoporosis in 2016 was estimated using the previous data classified by age groups (50–59, 60–69, and ≥70 years) and the 2016 Korean census data. The physician diagnosis and treatment rates of osteoporosis in adults aged ≥50 years were estimated using the 2016–2017 KNHANES data. The physician diagnosis and treatment rates of diabetes were evaluated using the KNHANES 2008–2009 and 2016–2017 data.

Results The estimated physician diagnosis rate of osteoporosis increased from 29.9% in females and 5.8% in males in 2008–2009 to 62.8% in females and 22.8% in males in 2016–2017. The treatment rate for the estimated total number of patients with osteoporosis increased from 14.4% in females and 3.8% in males in 2008–2009 to 32.2% in females and 9.0% in males in 2016–2017. An increasing trend in the estimated treatment rate of physician-diagnosed osteoporosis patients was not observed (48.3% [2008–2009] vs 51.5% [2016–2017] in females; 42.6% [2008–2009] vs 42.2% [2016–2017] in males). The physician diagnosis and treatment rates of diabetes were considerably better and more stable than those of osteoporosis.

Conclusion Osteoporosis management in South Korea is improving but is insufficient compared with diabetes management. More extensive efforts are needed to improve the diagnosis and treatment rates of osteoporosis.

Keywords Diagnosis · Korea · Osteoporosis · Treatment

Introduction

The estimated incidence of fracture and its economic burden are projected to rapidly increase in Asia [1]. South Korea is the

fastest aging country globally; having become an aged society in 2017, > 14% of its population is aged 65 years or older [2]. Accordingly, it is estimated that the total number of hip fractures will increase from 20,892 in 2018 to 59,466 in 2050 and that about 200 million USD will be spent on direct medical costs of hip fractures in 2050 in South Korea [1]. As such, intensive efforts are needed to improve the diagnosis and treatment of osteoporosis and, hence, prevent osteoporotic fracture.

We have previously reported the estimated nationwide prevalence, physician diagnosis rate, and treatment rate of osteoporosis in South Korea using data from the fourth Korea National Health and Nutrition Examination Survey (KNHANES) 2008–2009. We also suggested that the “National Screening Program for Transitional Ages (NSPTA)” for osteoporosis may have contributed to an

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increased diagnosis rate in older Korean women [3]. The NSPTA was a new national screening program initiated in 2007 to improve the quality of the national screening program for chronic disease launched in 1995 in Korea. It targeted individuals aged 40 and 66 years because these are important transition periods in a person's life [4]; particularly 66 years is regarded as the time of transition to old age. Through this screening program, bone mineral density (BMD) measurements were performed in women in the 66-year-old age group, at no extra cost [5].

It has been over 10 years since the NSPTA was launched, and it is expected that the national screening program would have affected the current management status of osteoporosis. In our previous study, the physician diagnosis rate was significantly higher in females aged 66–68 years who were the beneficiaries of the NSPTA than in females of other ages. However, there was no significant difference in treatment rate between females aged 66–68 years and females of other ages [3].

Diabetes is also one of the most prevalent chronic diseases in Korea. It was recently reported that, in Korea, the prevalence of total, diagnosed, and undiagnosed diabetes has increased steadily over the past 11 years [6] and that the physician diagnosis rate treatment rates of diabetes were higher, compared with those for other chronic diseases [7]. As a follow-up to our previous study on the management status of osteoporosis from the KNHANES 2008–2009, this study aimed to re-evaluate the diagnosis and treatment of osteoporosis from the KNHANES 2016–2017. Further, we also compared the secular trends of management status of osteoporosis with that of diabetes in elderly subjects.

Methods

Data source and study population

The Ministry of Health and Welfare of Korea has been conducting the KNHANES every 3 to 4 years since 1998 to examine the general health and nutrition status in South Korea. KNHANES is a cross-sectional, nationally representative survey using a stratified multistage sampling design. KNHANES consists of three different measures: a health interview, a health examination, and a nutrition survey [8].

The current study was performed using data from the KNHANES IV (2008 to 2009) and VII (2016–2017). Using a stratified, multistage, clustered, probability sampling method, participants were selected from sampling units and household registries based on geographical area, sex, and age groups. This sampling method was certified by the Korea Department of Statistics as a method that produced

representative statistics [8]. Among the participants, we included those aged 50 years and older.

This study was approved by the Institutional Review Board of Ajou University Hospital (AJIRB-MED-EXP-17-487). KNHANES was conducted according to the guidelines laid down in the Declaration of Helsinki. All the participants in the survey signed informed consent forms.

Physician diagnosis rate and treatment rate of osteoporosis in the KNHANES VII (2016–2017)

Those who answered “yes” to the question “Have you ever been diagnosed with osteoporosis by a physician?” were classified as physician-diagnosed cases of osteoporosis. BMD measurements were not obtained from the participants in KNHANES VII. Therefore, the total number of osteoporosis patients in the KNHANES 2016–2017 was estimated using the previous data on the prevalence of osteoporosis by age groups (50–59, 60–69, and ≥ 70 years) [3] and Korean census data in 2016 [9]. We assumed that the prevalence of osteoporosis in each age group in the KNHANES 2016–2017 would be similar to the prevalence in the KNHANES 2008–2009. Because the number of elderly people is rapidly increasing in South Korea [2], the estimated total number of osteoporosis patients was determined as the sum of the estimated number of osteoporosis patients by each age group obtained by multiplying the actual population number in each age group in the 2016 census data by the osteoporosis prevalence of each age group in the previous study [3]. The estimated physician diagnosis rate was determined as the number of physician-diagnosed cases divided by the estimated total number of people with osteoporosis. The treatment rate for estimated total number of patients with osteoporosis was determined as the number of patients who answered “yes” to the question “Are you currently taking osteoporosis medication?” divided by the estimated total number of osteoporosis patients. The estimated treatment rate for physician-diagnosed osteoporosis was also obtained.

Biochemical measurements

Blood samples were drawn from the antecubital vein in the morning after an approximately 8-hour fast. The samples were processed, refrigerated at +2°C to +8°C, and sent to the Central Testing Institute in Seoul, Korea, where the plasma was separated immediately via centrifugation. Plasma glucose was measured using the hexokinase method with an ADVIA 1650 (Siemens, New York, NY, USA) in 2008 and 2009 and a Hitachi Automatic Analyzer 7600 (Hitachi, Tokyo, Japan) in 2016 and 2017. HbA1C was measured using a Variant II high-performance liquid chromatography assay (Bio-Rad, Carlsbad, CA, USA) in 2008 and 2009 and a Tosoh G8 (Tosoh, Tokyo, Japan) in 2016 and 2017.

Definition of diabetes

Diabetes was defined as follows: (1) an answer of “yes” to whether the participants had ever been diagnosed with diabetes by a physician, (2) fasting plasma glucose (FPG) ≥ 126 mg/dL, or (3) taking oral hypoglycemic agents or insulin. Those identified in the health interview survey as having had a previous diagnosis of diabetes by a health care professional were classified as “known cases of diabetes.” We excluded HbA1c $\geq 6.5\%$ as a diagnostic criterion because the HbA1c level in all participants, regardless of whether or not they had diabetes, had only been examined since 2011. From 2005 to 2010, the HbA1c level was examined only in participants with diagnosed diabetes [6]. The physician diagnosis rate was determined as the number of known diabetes cases divided by the total number of people with diabetes. The treatment rate was determined as the number of patients who answered “yes” to the question “Are you currently taking diabetes medication?” divided by the total number of diabetes patients. The treatment rate for diagnosed diabetes was also obtained.

Covariates

The participants also answered standardized questionnaires on lifestyle, medical history, socioeconomic status, household income, and education. Household income was divided into quartiles. Educational background status was divided into elementary school, middle school, high school, and college graduate or above. Residential area was divided into urban and rural categories. Information on current smoking, alcohol drinking (≥ 6 units a day), having a general medical examination, and performing regular exercise (walking for over 30 min or undertaking moderate degree of physical activity, five times a week) was also obtained from the participant’s questionnaire.

Statistical analysis

All the statistical analyses were performed with complex-samples analysis procedures in SPSS version 25.0 (IBM Co., Armonk, NY, USA). We used the KNHANES stratification variables and sampling weights designated by the Korea Centers for Disease Control and Prevention, based on the sample design of each survey year. Nominal data were presented as percentage (standard error) and continuous variables as means \pm standard error. Continuous variables were compared between sexes using the SPSS complex-samples general linear models. Meanwhile, categorical or ordinal variables were compared using the SPSS complex-samples crosstabs procedure. *P* values of < 0.05 were considered statistically significant.

Table 1 Number of population and estimated osteoporosis patients in 2016 (age ≥ 50 years)

	Female	Male
Population number (≥ 50 years)		
Total	9,609,949	8,443,463
50	4,035,025	4,071,589
60	2,671,383	2,518,527
70	2,903,541	1,853,347
Estimated total osteoporosis population (≥ 50 years)		
Total	3,353,260 (36.8%) ^a	662,557 (7.8%) ^a
50	520,518 (12.9%) ^b	134,362 (3.3%) ^b
60	1,015,126 (38.0%) ^b	196,445 (7.8%) ^b
70	1,817,617 (62.6%) ^b	331,749 (17.9%) ^b

^a The estimated prevalence of osteoporosis in 2016.

^b The prevalence of osteoporosis by age group (50–59, 60–69, and ≥ 70 year) from our previous data (KNHANES 2008–2009) [3]

Results

The prevalence of osteoporosis in the KNHANES 2008–2009 was 35.5% in females and 7.4% in males [3], while in the KNHANES 2016–2017 it was 36.8% in females and 7.8% in males, with the latter being slightly higher than the former. Table 1 shows the estimated osteoporosis population based on the data from the KNHANES 2008–2009. The characteristics of the subjects in the KNHANES 2008–2009 and 2016–2017 are presented in Supplementary Table 1.

Figure 1 shows (a) the estimated physician diagnosis rates and (b) treatment rates for estimated numbers of patients with osteoporosis and diabetes, respectively, between 2008–2009 and 2016–2017. In total, 62.8% of females and 22.8% of males aged ≥ 50 years in the KNHANES 2016–2017 were estimated to be diagnosed with osteoporosis. These rates were increased compared with those in the KNHANES 2008–2009 (29.9% in females, 5.6% in males). Among women, the estimated physician diagnosis rate increased the most (46.0%) in the 50–59 age group and the least in the over 70 age group (31.3%). Among men, it increased the most (23.2%) in the 60–69 age group and the least (12.2%) in the over 70 age group. For diabetes, the physician diagnosis rate was almost similar between the KNHANES 2008–2009 and 2016–2017 (80.2% vs 81.8% in females, 76.9% vs 74.7% in males).

The treatment rate for the estimated total number of patients with osteoporosis in the KNHANES 2016–2017 was 32.3% for females and 9.0% for males. These rates were also elevated compared to the treatment rate of total osteoporosis patients in the KNHANES 2008–2009 (14.4% in females, 3.8% in males). Among women, the treatment rate of total osteoporosis patients increased the most (22.8%) in the 50–59 age group and the least in the 60–69 age group (14%). Among men, it increased the most (11.2%) in the 60–69 age group and the least (2.3%) in the

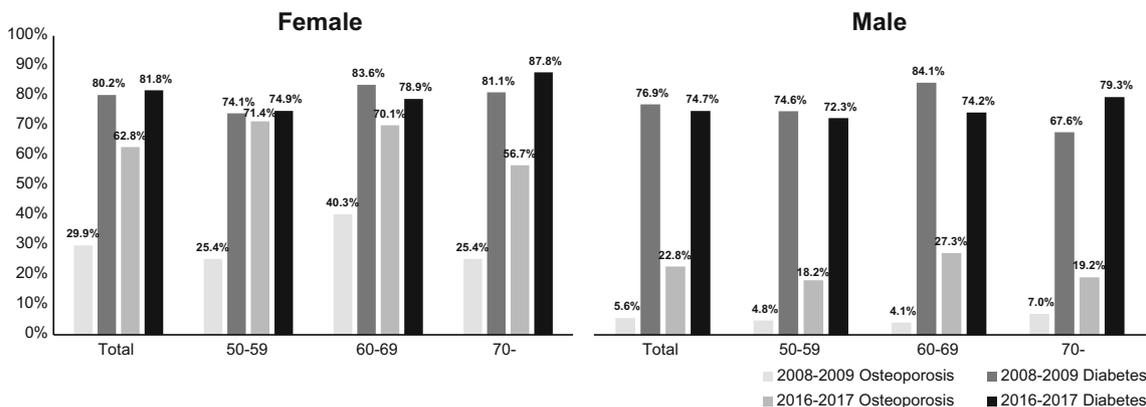
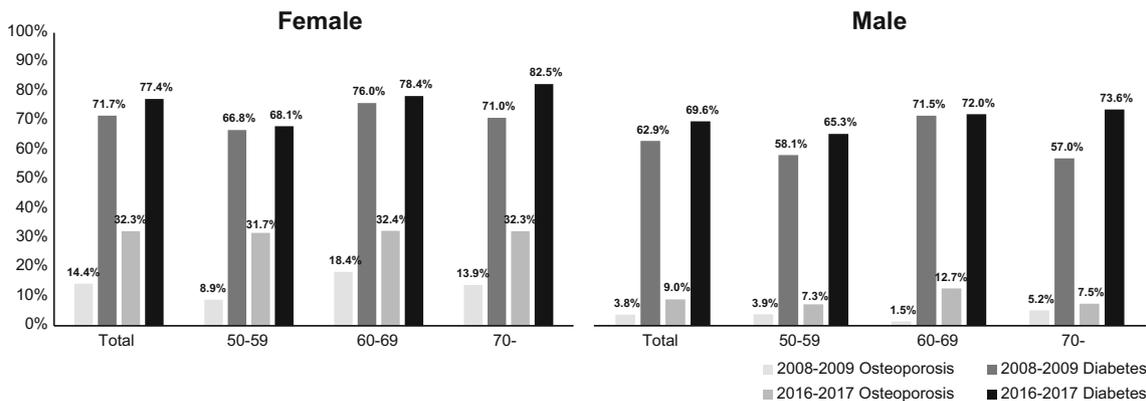
(a) Estimated physician diagnosis rate**(b) Treatment rate in the estimated total patients**

Fig. 1 Comparison of **a** estimated physician diagnosis rate and **b** treatment rates for estimated total numbers of patients with osteoporosis and diabetes, respectively, between 2008–2009 and 2016–2017. The

over 70 age group. The treatment rate of the total diabetes patients in the KNHANES 2016–2017 was slightly increased compared to that in the KNHANES 2008–2009 (71.7% vs. 77.4% in females, 62.9% vs. 69.6% in males).

Figure 2 shows the estimated treatment rate of osteoporosis and diabetes for the physician-diagnosed patients in the KNHANES 2008–2009 and 2016–2017. The treatment rate of diagnosed diabetes patients was also slightly increased in the KNHANES 2016–2017 than that in the KNHANES 2008–2009 (89.4% vs. 94.6% in females, 81.5% vs. 92.7% in males). In contrast, there was no significant increase in the estimated treatment rate of the physician-diagnosed osteoporosis patients between those in the KNHANES 2016–2017 and in the KNHANES 2008–2009 (48.3% vs 51.5% in females, 42.6% vs 42.2% in males). The patterns of estimated treatment rates of the physician-diagnosed osteoporosis patients according to the age groups were different from the patterns of the treatment rate for the estimated total number of patients with osteoporosis. Among women, the estimated treatment rate of the physician-diagnosed osteoporosis patients increased the most (9.5%) in the 50–59 age group and the least (2%) in the 60–69 age group. Among men, it

percentages were calculated from the SPSS complex-samples procedure using the stratification variables and sampling weights

increased the most (10.5%) in the 60–69 age group, whereas it decreased (–14%) in the over 70 age group.

Discussion

As a follow-up to our previous study on the management status of osteoporosis, we re-evaluated the diagnosis and treatment rates of osteoporosis in the KNHANES 2016–2017. The physician diagnosis and treatment rates for the estimated total number of patients with osteoporosis increased significantly compared with the rates in the KNHANES 2008–2009. However, compared with the rate in the KNHANES 2008–2009, there was no significant increase in the estimated treatment rate of the physician-diagnosed patients in the KNHANES 2016–2017. The physician diagnosis and treatment rates of diabetes were considerably better than those for osteoporosis during the study period.

South Korea is the fastest aging country worldwide [2], and its elderly population is also increasing. Osteoporosis and diabetes are among the most prevalent conditions in the elderly, and thus data on these conditions will be valuable to attenuate

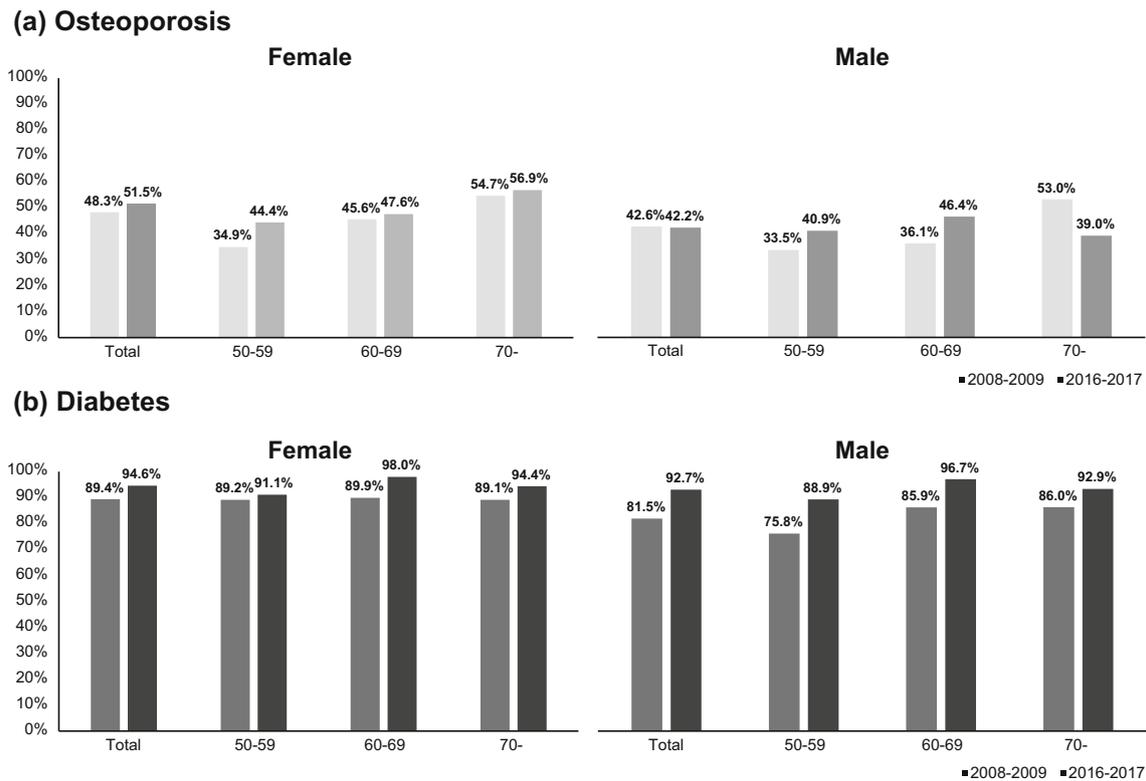


Fig. 2 Comparison of the estimated treatment rates of **a** osteoporosis and **b** diabetes in physician-diagnosed patients between 2008–2009 and 2016–2017. The percentages were determined as the number of patients who answered “yes” to the question “Are you currently taking

osteoporosis medication?” divided by the estimated number of physician-diagnosed osteoporosis patients from the SPSS complex-samples procedure using the stratification variables and sampling weights

their impact on health expenditure and quality of life. As such, we estimated the osteoporosis population based on the prevalence data from the KNHANES 2008–2009 and 2016–2017. Specifically, we estimated the osteoporosis population as the sum of the actual number of individuals with osteoporosis in each age group in the 2016 census data multiplied by the osteoporosis prevalence in each age group in the previous study [3]. The result showed that the estimated prevalence of osteoporosis increased by more than 1% in 2016, especially in women. Although the prevalence was extrapolated, it reflects the increase in the osteoporosis population concordant with the rapid aging of the population in South Korea.

Compared to the rate in KNHANES 2008–2009, the estimated physician diagnosis rate in KNHANES 2016–2017 increased from 29.9% to 62.8% in women and from 5.6% to 22.8% in men. BMD measurements have been performed in women aged 66 years as part of the NSPTA [3]. This screening policy may have influenced the increased utilization of BMD assessment among women in their 60s and 70s. However, among women, the estimated physician diagnosis rate increased the most (46.0%) in the 50–59 age group, which is comprised of people who are not the beneficiary of the NSPTA. The national screening program does not provide BMD measurements for men. However, the physician

diagnosis rate increased in all age groups among men. Therefore, we could speculate that overall screening for osteoporosis has improved during the period regardless of the national health policy. The 2013 IOF Audit showed that there are 24 dual-energy X-ray absorptiometry (DXA) scanners per million population in South Korea, which was the highest in the Asia-Pacific region [10]. The easy accessibility and reimbursement for BMD measurement might have contributed to the improved osteoporosis diagnosis rate. All individuals aged ≥ 40 years in Korea undergo a national health check-up every two years [6]. Although this does not include BMD assessment, the beneficiaries of national health check-up who are not eligible for the NSPTA can voluntarily undergo BMD measurement during the health check-up, paying extra out-of-pocket expenses. The overall awareness of osteoporosis could have been improved in the population, and this may, in turn, have influenced the improved diagnosis rate for osteoporosis.

The overall treatment rate for estimated total number of patients with osteoporosis was also improved during the period, along with the improvement of the estimated physician-diagnosed rate in osteoporosis. A recent study showed that DXA scan execution and osteoporosis diagnosis by DXA were associated with the use of medication for primary and

secondary prevention of fractures in postmenopausal women in primary care [11]. However, the patterns of treatment rates for estimated total number of patients with osteoporosis according to the age groups were different from the patterns of the estimated physician-diagnosed rate. The estimated treatment rate of physician-diagnosed osteoporosis patients increased the most in the 50–59 age group for females, whereas it increased the most in the 60–69 age group for males; this leads to speculation regarding the limited effectiveness of osteoporosis screening. Specifically, despite the improvement in the estimated physician diagnosis rate in men aged over 70 years, no significant increase in the treatment rate for estimated total number of patients with osteoporosis was noted in this age group. Notably, the estimated treatment rate of physician-diagnosed osteoporosis patients in this age group decreased during the period, and this might have caused the small improvement in the treatment rate of the estimated total male patients aged over 70 years. Although the overall incidences of osteoporotic fractures were higher in females, the mortality rates after hip and vertebral fracture in the first 12 months were 1.5 and 2.2 times higher in men than those in women in South Korea [12]. Paradoxically, the most at-risk population for mortality after osteoporotic fracture was treated the least even after the diagnosis. Apart from the treatment rate in the men aged over 70 years, we did not find a significant improvement in the overall estimated treatment rates of physician-diagnosed osteoporosis patients in both sexes in comparison to the overall improvement in the diagnosis and treatment rates of the estimated total patients. The estimated treatment rates of physician-diagnosed osteoporosis patients were about 40–50%, regardless of year, age, or sex. The limited effectiveness of osteoporosis screening is a challenge not only in South Korea but also in other countries. In the USA, DXA testing among male veterans was not associated with a reduction in fractures because of low treatment initiation and adherence rates [13]. Further, despite the differences in healthcare delivery systems and medication reimbursement plans, the use of osteoporosis medications for the secondary prevention of osteoporotic fracture was also low in the USA, Korea, and Spain [14].

Although the treatment rate of physician-diagnosed diabetes patients was not substantially improved compared to that of osteoporosis, the rate was over 90% (94.6% for females and 92.7% for males) in the KNHANES 2016–2017. The physician diagnosis rate and the treatment rate of total diabetes patients were also considerably better and more stable during the period. The proportion of physician-diagnosed cases of diabetes in patients aged ≥ 30 years was 23.2% in 1998, 41.2% in 2001, and 68.0% in 2005. The treatment rate of the total number of patients aged ≥ 30 years was 26.8% in 1998, 35.4% in 2001, and 48.8% in 2005 [15]. Currently, the physician diagnosis rate of diabetes is 71.5%, and the treatment rate, 66.2%, which are relatively high rates compared

with the rates of other diseases [7]. This indicates that the management of diabetes in the Korean has improved and stabilized compared to the management of osteoporosis. Although both diabetes and osteoporosis need long-term treatment, it is relatively more difficult for osteoporosis patients to identify the short-term therapeutic effects of medications, such as fracture prevention and increase of BMD, than diabetes patients. The lower treatment rate of osteoporosis may be related to the increasing concerns over potential side effects of bisphosphonates such as atypical femur fracture and osteonecrosis of the jaw [16–18]. It may be also attributed to a distortion in bone health behavior as well as a lack of proper osteoporosis education and instruction from healthcare providers [19]. Several randomized controlled trials have demonstrated that the provision of patient-specific feedback to health professionals could improve the detection and treatment of osteoporosis among primary care patients at risk of osteoporosis [20]. A study also showed that a national program that delivers patient-specific feedback to general physicians and tailored education can improve osteoporosis care at the national level [21]. It is encouraging that this study showed a better improvement in the treatment of diagnosed osteoporosis patients in the younger females (the 50s age group) and males (the 50s and 60s age groups). We could expect that the overall management of osteoporosis will be improved in Korea. However, more effort is needed to raise awareness on osteoporosis treatment. Further follow-up studies about the management status of osteoporosis are also required.

This study had some limitations. First, the BMDs of the patients in the KNHANES 2016–2017 were not available because BMD measurement was not performed in this survey. The prevalence of osteoporosis was extrapolated from the data of KNHANES 2008–2009 and the 2016 census. Therefore, the diagnosis and treatment rates of osteoporosis in the KNHANES 2016–2017 were also estimated values. We could not perform statistical comparisons for the rates between the KNHANES 2008–2009 and 2016–2017 because we could not know whether the individual participants had osteoporosis in the KNHANES 2016–2017. However, although there was no significant difference in the estimated prevalence of osteoporosis in the two surveys, we noted a small increase from 35.5% to 36.8% in women and from 7.4% to 7.8% in men, reflecting the aging in Korean society. We believe that the estimated prevalence of osteoporosis in this study could reflect the current real-world prevalence in Korea. Second, this study was performed based on the data of the KNHANES. The diagnosis and treatment rates were also estimated from the subjects' questionnaires, and these might not reflect the actual diagnosis and treatment rates. There have been studies on the management status of osteoporosis using the Korean National Health Insurance Service (KNHIS) [22, 23]. The KNHIS could provide a representative data of the total Korean population and minimize the selection bias.

However, there are disadvantages of insurance claim databases, such as failure to include prescriptions outside insurance coverage, incorrect diagnostic coding, and misclassification error by patient-defining algorithms [20]. Moreover, data based on the subjects' questionnaires could provide better information about the actual subjective awareness of osteoporosis among the Korean public [22].

In conclusion, the present study demonstrated that while the management of osteoporosis in South Korea is improving, it is still insufficient compared with the management of diabetes. Thus, more extensive efforts are needed to improve the diagnosis and treatment rates of osteoporosis in South Korea.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00198-021-05864-z>.

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Code availability Not applicable

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Data availability All data are available from the database of the Korea National Health and Nutrition Examination Survey (<https://knhanes.cdc.go.kr/>).

Declarations

Ethics approval This study was approved by the Institutional Review Board of Ajou University Hospital (AJIRB-MED-EXP-17-487). KNHANES was conducted according to the guidelines laid down in the Declaration of Helsinki.

Consent to participate Not applicable

Consent for publication Not applicable

Conflicts of interest None

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