BMJ Open

Osteoporosis management in a rural community hospital in Japan: a cross-sectional retrospective study

Sayaka Mabuchi [1,2,3], Ryuichi Ohta [4], Chiaki Sano [1]

To cite: Mabuchi S, Ohta R, Sano C. Osteoporosis management in a rural community hospital in Japan: a cross-sectional retrospective study. *BMJ Open* 2024;**14**:e086845. doi:10.1136/bmjopen-2024-086845

► Prepublication history for this paper is available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-086845).

Received 24 March 2024
Accepted 25 October 2024

[1]Department of Community Medicine Management, Shimane University Faculty of Medicine, Izumo, Shimane, Japan
[2]Department of Human Resources Development for General Practitioner, Shimane Prefectural Central Hospital, Izumo, Shimane, Japan
[3]General Medicine, Iinan Hospital, Shimane, Japan
[4]Community Care, Unnan City Hospital, Unnan, Shimane, Japan

Correspondence to
Dr Sayaka Mabuchi;
m14121sy@jichi.ac.jp

ABSTRACT

Objectives Osteoporosis is a condition characterised by decreased bone strength and an increased risk of fragility fractures. Its prevalence is increasing in developed countries, highlighting the need for appropriate diagnosis and intervention. However, in practice, adequate testing and treatment are not often provided. Therefore, in this study, we investigated the status of osteoporosis management in a rural community hospital in Japan.

Design Cross-sectional retrospective study.

Setting Department of General Medicine from a rural community hospital in Japan.

Participants A total of 984 women aged≥65 years who were recommended to undergo osteoporosis screening were included.

Primary and secondary outcome measures Bone mineral density (BMD) testing rates and characteristics of patients who underwent these tests, including diagnosis and treatment rates for osteoporosis.

Results The BMD testing rate was 14%. Despite being at risk of osteoporosis, older patients and those requiring nursing care had a lower rate of testing. The proportion of patients diagnosed with osteoporosis was 41%, and the treatment rate was 19%.

Conclusions The management of osteoporosis in a rural Japanese community hospital was found to be inadequate. The rate of BMD testing was low, particularly among older adults and those requiring nursing care. This finding suggests that osteoporosis may be underdiagnosed in many cases in this population or diagnosed but not appropriately followed up. Further cohort studies and intervention strategies are needed to fully investigate these issues.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study was conducted in the only hospital in the region, allowing the collection of a large amount of patient data representative of the community.
⇒ This was a cross-sectional study rather than a cohort study, and the use of a retrospective design allowed for assessment of real-world screening practices and treatment rates over a substantial period.
⇒ This study investigated only one rural area in Japan, which may not fully represent screening practices or treatment rates in other regions or countries.

INTRODUCTION

Osteoporosis is characterised by decreased bone strength and increased fragility fracture risk.[1] Bone strength depends on the density of bone as well as the integrity of the tissue, both of which decrease with increasing age and disuse.[1] As population ageing has accelerated in developed countries, this condition is becoming more of a concern. For example, in the USA, the prevalence of osteoporosis in adults aged ≥50 years in 2010 was 10.2% and is estimated to reach 13.6% by 2030.[2] Among Japanese women aged ≥40 years, the prevalence of osteoporosis in the femoral neck was 26.5%. Osteoporosis is defined as a bone mineral density (BMD) of ≤70% of peak bone mass according to the criteria of the Japanese Society for Bone and Mineral Research, and its prevalence in the lumbar spine (L2–L4) was previously reported to be 19.2%.[3] To complicate this situation, when patients with osteoporosis develop fragility fractures, their health-related quality of life decreases. Moreover, the morbidity rate at 1 year following a hip fracture is quite high at 36%.[4]

A key aspect of the Japanese diagnostic criteria for osteoporosis is the inclusion of fracture events that should be prevented as part of the diagnosis. A medical history of a hip or vertebral fracture, which are the most typical fragility fracture sites, is sufficient for diagnosing osteoporosis, regardless of BMD.[1] However, it is essential to intervene in patients with osteoporosis before the development of these fractures by assessing BMD. In the presence of other fragility fractures, osteoporosis is diagnosed if BMD is less than 80% of the young adult mean (YAM). In the absence of a history of fragility fractures, osteoporosis is diagnosed at a YAM of 70% or less.[1] Many patients with low BMD remain underdiagnosed, and those diagnosed with osteoporosis often do not take appropriate medications.[5] Moreover, while patients aged ≥65 years are screened for osteoporosis using BMD,[6] the rate of screening for those aged ≥

66 years is only 56%, with screening rates among physicians and hospitals varying widely at 19–97% and 26–91%, respectively.[7]

As osteoporosis risk significantly increases with age, an appropriate approach for its treatment is needed to address Japan's super-ageing society (ageing rate >21%). As Japan is undergoing a more rapid ageing process than other developed nations, it currently has over 30 million people aged ≥65 years (one in four people), and this number is predicted to peak at approximately 39 million by 2042.[8] However, osteoporosis screening tests and treatments are insufficient despite the large number of patients in Japan. BMD screening in Japan is performed in only 4–5% of the population, coupled with a low target age (>40 years).[9 10] There are limited data on how many women aged ≥65 years are screened using BMD tests.

Early diagnosis can mitigate osteoporosis and prevent fragility fractures through proper treatment, and timely identification and treatment may help patients increase their health-related quality of life. In this study, we investigated how many women aged ≥65 years were examined using BMD tests and how many people are treated for osteoporosis in a rural community hospital in Japan, representing a progressively ageing society. Additionally, we aimed to clarify who tended to be examined. As Japan is a global pioneer in terms of an ageing society, our results may be of value beyond the Japanese population.

METHODS

Design

This cross-sectional retrospective study included older female patients from a rural community hospital in Japan.

Setting

Iinan Hospital is a rural community hospital located in the mountains of the Shimane Prefecture in Japan. This is the only hospital in Iinan town and offers three satellite clinics, all of which were included in the study. The hospital staff consists of six full-time physicians. The total population in Iinan town in September 2023 was reported to be 4507 (2142 men and 2365 women),[11] with 46.2% of people aged ≥65 years in 2020.[12] For example, Akita Prefecture has the highest proportion of older adults (37.5% of the population aged ≥65 years), while Shimane Prefecture ranks third (with 34.2% of the population aged ≥65 years).[13] Unnan city, located in the mountains, is adjacent to Iinan town, where the proportion of people aged ≥65 years is 40.0%.[14] We can consider Iinan town as a representation of the ageing society in rural Japan.

Its total land area is 242.88 km^2.[12] The closest tertiary hospital is more than 1 hour away by car; there are no train stations in the town. In 1955, there were 148 002 residents in Iinan town; however, the population is decreasing. After 1975, the number of people aged 15–64 years began decreasing; specifically, there were 2864 fewer people aged ≥35 years. Additionally, the number of people aged <15 years is decreasing. Iinan town has four elementary schools, two junior high schools and one high school at present. The number of stores (grocery stores, beauty salons, cleaning shops and gas stations) is also decreasing. The average distance from a residence to a store $((\text{town area}/\text{the number of stores}/3.14)^{(1/2)} \times 1000)$ was 1875 m in 2012.[15]

The equipment used for BMD testing was introduced to Iinan Hospital in 2017. For BMD tests, we used dual-energy X-ray absorptiometry (DXA). The coefficient of variation is 0.45%. Preferably, the BMD of both the vertebra and the proximal femur should be measured for diagnosing osteoporosis,[1] but when these measurements are difficult, the radius (1/3 distal part) is used. Since Iinan Hospital can only measure the BMD of the radius, this technique was used in this study. Only one technician is needed for the BMD test. Accuracy control was performed separately from system calibration, using the phantom provided with the DXA system.[1]

Participants

We included female patients aged ≥65 years who had visited the Department of General Medicine of Iinan Hospital regularly between September 2017 and August 2021, with visits occurring every 1–3 months considered regular. The exclusion criteria included women who opted for house-call medical services and resided in nursing homes with physician access because they did not have the opportunity to undergo BMD testing in the hospital, as well as those visiting other hospital departments or attending annual medical check-ups or emergencies only. Patient data were retrospectively collected from the electronic medical records of the hospital. Ultimately, 984 participants were included (figure 1). We compared participants who underwent BMD tests with those who did not.

Clinical data included age, height, body weight, body mass index, patient information (smoking history, nursing care requirement, and alcohol intake), comorbidities (diabetes, rheumatoid arthritis, collagen diseases apart from rheumatoid arthritis, chronic kidney disease and Basedow disease), medications (corticosteroids, methotrexate, proton pump inhibitors (PPIs), selective serotonin reuptake inhibitors, warfarin, bisphosphonates, denosumab, teriparatide, calcium, vitamin D and selective oestrogen receptor modulators) and polypharmacy (use of more than five medications).

We also collected data on the diagnosis of osteoporosis; medication for osteoporosis before and after seeing an orthopaedist; and history of fragility fractures (proximal femur, vertebra, rib, pelvis, proximal humeral, distal radius and leg), hip fractures, vertebral fractures and fractures other than fragility fractures. Height and weight data were often not included in the electronic medical records. Additionally, we were unable to collect data on the family history of osteoporosis of the participants despite this being a known risk factor for osteoporosis.

Under the Japanese long-term care insurance system, long-term care need levels are determined based on the

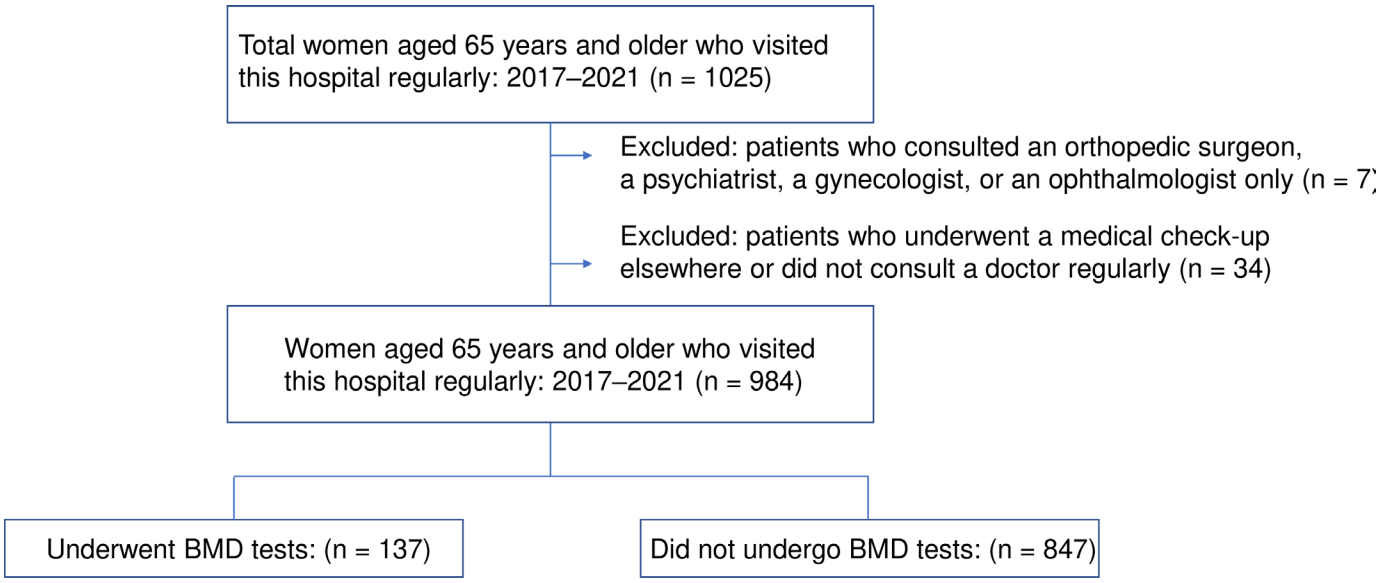

Figure 1 Flowchart of participant selection for the study. BMD, bone mineral density.

standard time required for care and are certified across seven categories as follows: care support levels 1–2 indicate the need for preventive care, while care need levels 1–5 indicate the need for long-term care, with higher levels signifying greater need for care. Care support levels do not require long-term care services but indicate a risk of motor function deterioration. Deterioration in care need level signifies an increase in the required care time and serves as a feasible indicator for detecting changes in care needs.[16] In this study, we defined requirement for nursing care as care need levels 1–5.

When patients were transferred from their previous hospital to our clinic, they were more likely to continue their ongoing osteoporosis medications. Therefore, we called the item 'prior' if the previous hospital had also prescribed osteoporosis drugs in this study.

Statistical analysis

Continuous variables are presented as means and SD or medians and interquartile ranges, and categorical variables are presented as numbers and percentages. Continuous variables were compared using Student's t test or Wilcoxon's rank-sum test based on the distribution, and categorical variables were compared using the χ^2 test or Fisher's exact test. The variables evaluated in the multivariate logistic model, such as age; requiring nursing care; use of steroids, methotrexate, and PPIs; fragility fractures; vertebral fractures; or orthopaedic assessment, were found to be risk factors for the BMD test in the univariate analysis. After constructing the model with all the variables, we conducted backward selection to ensure that all the variables had significant associations in the exploratory analyses. All statistical analyses were performed using JMP and Stata 17 software (StataCorp LLC, College Station, TX, USA). Two-tailed p values <0.05 were considered statistically significant.

Ethical considerations

This study was approved by the institutional review board of Iinan Hospital (R-0401) in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. Participants were given the option to opt out if they wished.

Patient and public involvement

This was a retrospective study including electronic medical records, and an opt-out approach was used for patient participation. The research question was to first ascertain the current status of osteoporosis, since internal medicine physicians felt that osteoporosis care was inadequate in their daily practice. Results were analysed using statistical software. Since this was not an intervention study, there were no new time or physical constraints on the study participants. The results of this study will be presented at a community health forum.

RESULTS

Patient background

A total of 984 patients were included in this study, with a median age of 81 (73–87) years, average height of 147.3±6.6 cm and average body weight of 47.9±9.8 kg. There were 695 participants aged ≥75 years (71%), 137 (14%) who underwent BMD tests, 134 (14%) who required nursing care, 21 (2.1%) who had a habit of drinking, five (0.5%) who smoked, 39 (4.0%) who took steroids and 466 (47%) who used polypharmacy. Regarding comorbidities, 221 (22%) had diabetes mellitus, 33 (3.4%) had rheumatoid arthritis, 226 had chronic kidney disease, and 21 (2.1%) had Basedow disease.

A total of 404 participants (41%) were diagnosed with osteoporosis. Among these patients, 186 (19%) started medication for osteoporosis, 214 (22%) had already taken medications for osteoporosis, and 111 (11%) had

Table 1 Characteristics of the study participants

	n=984
Height (cm)	147.3±6.6 (n=763)
Body weight (kg)	47.9±9.8 (n=616)
Age (years)	81 (73–87)
Alcohol consumption	21 (2.1)
Current smoker	5 (0.5)
Steroid	39 (4.0)
Methotrexate	10 (1.0)
Proton pump inhibitor	416 (42)
Selective serotonin reuptake inhibitor	29 (2.9)
Warfarin	18 (1.8)
Polypharmacy	466 (47)
Diabetes mellitus	221 (22)
Rheumatoid arthritis	33 (3.4)
Collagen diseases	29 (2.9)
Chronic kidney disease	226 (23)
Basedow disease	21 (2.1)
Osteoporosis	404 (41)
Osteoporosis drugs	214 (22)
Bisphosphonate	128 (13)
Denosumab	8 (0.8)
PTH	17 (1.7)
Calcium	78 (7.9)
Vitamin D	137 (14)
SERM	9 (0.9)
Prior	111 (11)
Fragility fractures	274 (28)
Hip fracture	41 (4.2)
Vertebral fracture	155 (16)
Other fractures	84 (8.5)
Orthopaedists	78 (7.9)

PTH, parathyroid hormone; SERM, selective oestrogen receptor modulator.

visited another hospital and had received medication before visiting this hospital.

Regarding medication type, 128 participants (13%) received bisphosphonates, eight (0.8%) received denosumab, 17 (1.7%) received teriparatide, 78 (7.9%) received calcium, and 137 (14%) received vitamin D. Seventy-eight participants (7.9%) visited an orthopaedist in addition to a generalist at this hospital (table 1).

Univariate association with BMD testing rate

Age (p=0.046); requirement for nursing care (p=0.0072); use of bisphosphonates (p<0.0001), teriparatide (p<0.0001), calcium (p<0.0001) and vitamin D (p<0.0001); fragility fractures (p<0.0001); vertebral fractures (p<0.0001); and orthopaedic status (p<0.0001) significantly differed between patients who underwent BMD testing and those who did not (table 2).

Table 2 Univariate analysis of the BMD test results

	Have taken a BMD test (n=137)	Never taken a BMD test (n=847)	P value
Height (cm)	148±6.9 (n=104)	147±6.5 (n=659)	0.1
Body weight (kg)	47.5±9.1 (n=85)	48.0±9.9 (n=531)	0.7
Age (year)	80 (73–85)	81 (73–87)	0.046
Requiring nursing care	9 (6.6)	125 (15)	0.007
Alcohol consumption	3 (2.2)	18 (2.1)	1.0
Current smoker	2 (1.5)	3 (0.4)	0.1
Steroid	10 (7.3)	29 (3.4)	0.03
Methotrexate	3 (2.2)	7 (0.8)	0.2
Proton pump inhibitor	68 (50)	348 (41)	0.06
Selective serotonin reuptake inhibitor	5 (3.7)	24 (2.8)	0.6
Warfarin	2 (1.5)	16 (1.9)	1.0
Polypharmacy	69 (50)	397 (47)	0.4
Diabetes mellitus	35 (26)	186 (22)	0.4
Rheumatoid arthritis	6 (4.4)	27 (3.2)	0.4
Collagen diseases	11 (8.0)	18 (2.1)	0.001
Chronic kidney disease	34 (25)	192 (23)	0.6
Basedow disease	3 (2.2)	18 (2.1)	1.0
Osteoporosis	126 (92)	278 (33)	<0.0001
Osteoporosis drugs	78 (57)	136 (16)	<0.0001
Bisphosphonate	53 (39)	75 (8.9)	<0.0001
Denosumab	3 (2.2)	5 (0.6)	0.09
PTH	9 (6.6)	8 (0.9)	0.0001
Calcium	30 (22)	48 (5.7)	<0.0001
Vitamin D	50 (37)	87 (10)	<0.0001
SERM	3 (2.2)	6 (0.7)	0.1
Prior	34 (25)	77 (9.1)	<0.0001
Fragility fractures	75 (55)	199 (23)	<0.0001
Hip fracture	5 (3.7)	36 (4.3)	0.7
Vertebral fracture	60 (44)	95 (11)	<0.0001
Other fractures	10 (7.3)	74 (8.7)	0.6
Orthopaedists	38 (28)	40 (4.7)	<0.0001

BMD, bone mineral density; PTH, parathyroid hormone; SERM, selective oestrogen receptor modulator.

Multivariate associations with BMD testing rate

The multivariate logistic model revealed that age (OR 0.95; 95% CI 0.94 to 0.97, p=0.0002), requirement for nursing care (OR 0.38; 95% CI 0.16 to 0.90; p=0.027), bisphosphonate use (OR 4.02; 95% CI 2.37 to 6.84; p<0.0001), vertebral fractures (OR 3.58; 95% CI 1.77 to 7.25; p=0.0004) and orthopaedists (OR 4.65; 95% CI 2.60

Table 3 Multivariate analysis of the BMD testing rate and influencing factors

	OR (95% CI)	P value
Age	0.95 (0.94 to 0.97)	0.0002
Requiring nursing care	0.38 (0.16 to 0.90)	0.03
Steroid	1.69 (0.71 to 4.05)	0.2
Bisphosphonate	4.02 (2.37 to 6.84)	<0.0001
PTH	2.15 (0.64 to 7.28)	0.2
Calcium	1.10 (0.48 to 2.49)	0.8
Vitamin D	1.86 (0.91 to 3.81)	0.09
Fragility fractures	1.62 (0.84 to 3.13)	0.2
Vertebral fracture	3.58 (1.77 to 7.25)	0.0004
Orthopaedists	4.65 (2.60 to 8.32)	<0.0001

BMD, bone mineral density; PTH, parathyroid hormone.

to 8.32; p<0.0001) were significantly associated with BMD testing rates (table 3).

DISCUSSION

This study reported the incidence of osteoporosis in a rural community hospital in Japan and revealed that the rate of BMD tests for women aged ≥65 years was as low as 14%, despite the members of this age group being the target group for osteoporosis screening. Furthermore, old age and a high requirement for nursing care were associated with a low screening rate. This raises the question of whether ageism is the cause of the low screening rates among older rural people.[17]

Low testing rate

The low screening rate for BMD may be attributed to various factors, including physician (generalists and orthopaedists) and patient unawareness or disinterest in the risk factors for osteoporosis,[18–21] patients being afraid of the side effects of osteoporosis medication,[22 23] a lack of equipment for measuring BMD[24] and the difficulty of performing BMD tests in rural areas due to poor transportation facilities.[18]

There are few hospitals in rural areas, such as Iinan, despite the presence of a large older population, and the per capita rate of physicians is low. As a result, physicians in rural hospitals grapple with the task of managing a high volume of patients within restricted time frames. In Japan in 2018, the average doctor-to-population ratio was 329 per 100 000 people. Iinan Hospital is located in the Unnan area in Shimane Prefecture, where the average number of doctors is 151 per 100 000 people; this number is substantially lower than the national average.[25] As rural areas in Japan navigate the challenges of an ageing population, a limited number of physicians must manage a significant elderly demographic. Given that older patients are more likely to have multiple morbidities, physicians must prioritise and address immediate health issues, leaving them with insufficient time to treat osteoporosis. Old age and the need for nursing care are risk factors for osteoporosis development[1] ; therefore, BMD testing should be recommended for these patients.

Relevance of testing and treatment rates

In this study, there were several possible explanations for the differences between the testing and treatment rates. The higher rate of osteoporosis treatment compared with that of patients undergoing tests may stem from physicians diagnosing osteoporosis without relying solely on BMD tests (commonly performed for patients with a history of hip or vertebral fractures or based on clinical judgement) or not adhering to BMD testing protocols properly. BMD tests are recommended for diagnosis and osteoporosis follow-up.[6 26] If most patients are not diagnosed using BMD tests but rather by a history of fragility fractures, the proportion of patients who undergo tests will surpass that of those who undergo treatments. However, if a significant number of patients diagnosed with a history of fragility fractures pass away before their first scheduled BMD test for follow-up, this can lead to a situation where the proportion of patients undergoing treatments exceeds that of those undergoing tests.

Relevance of old age, high requirement for nursing care and low testing rate

Although advanced age and a high requirement for nursing care are risk factors for osteoporosis,[1] we found that patients with these risk factors tended not to undergo BMD tests. The concept of ageism is attracting increasing attention in medicine and refers to the tendency of older adults to be undertriaged or treated with inappropriate medication.[27] In osteoporosis treatment, old age and a high requirement for nursing care can lead to low treatment rates.[8 18 28–31] In the USA, older patients do not receive interventions (tested or treated) for osteoporosis (age >74 years; OR 0.49; 95% CI 0.43 to 0.55).[29] Similarly, in this study, we found that older patients or those requiring nursing care were less likely to undergo testing. Furthermore, it is possible that patients were not diagnosed with or adequately followed up for osteoporosis because the treatment rate surpassed the test rate. Gill and Hoffman[28] reported that among women aged ≥55 years who had not been diagnosed with osteoporosis, 27.4% had been treated for the condition. Among women aged 50–89 years with a history of fragility fractures, 2% underwent tests and were treated; however, 40.4% of patients were not tested but were treated.[32] Owing to advanced age, patients may refrain from voicing symptoms or seeking treatment, even if they have been previously diagnosed with osteoporosis (self-ageism).[17] Informed consent and personalised treatment should be provided regardless of age.

Improvement of testing rates

The multivariate logistic regression model revealed a statistically significant association between bisphosphonates

and vertebral fractures. Additionally, patients with a history of vertebral fractures are tested more often than those with a history of hip fractures.[29 32]

The screening tests conducted by specialists (eg, orthopaedists) are insufficient,[19] especially in older patients or those requiring nursing care, as it was found that they are less likely to undergo testing. Therefore, clinicians must consciously intervene, using strategies such as increased awareness among general practitioners, government-sponsored screening initiatives, implementation of clinical decision support systems to identify candidates for testing and establishment of liaison services. These measures can potentially increase osteoporosis screening rates.[33]

Limitations

This study had several limitations. First, it was not a cohort study but instead a cross-sectional study, which presents the possibility of incomplete data. Second, we could not collect complete patient data, as some patients visited other hospitals. However, as this was the only hospital in town and transportation to other hospitals was inconvenient, it can be inferred that this study collected a considerable amount of patient data. Third, external validity was insufficient because this was a single-centre study. However, we look forward to future research with larger sample sizes to validate what has been suggested by our results. Fourth, the BMD equipment used in this study targeted the radius. Generally, the proximal femur and vertebral bones are targets for BMD tests. However, if measurement of the proximal femur and vertebral bones is difficult, measuring the radius may suffice, despite the BMD of the proximal femur and vertebral bones being more strongly correlated than the radius in bone fractures.[1 34 35] Introducing equipment targeting the proximal femur and vertebral bones is difficult because such equipment is large and expensive for small hospitals, such as the one used as this study's setting. Measurement of the radius is permitted for BMD tests, and it may be worthwhile to provide equipment targeting the radius to small hospitals in rural areas that have no equipment for measuring BMD.[23] This may increase testing rates, and people living in such areas may become interested in osteoporosis if BMD tests are easily accessible. Fifth, the BMD test rate in this study did not distinguish between the diagnoses and follow-up. To investigate the screening rate, only the BMD test data for diagnosis should have been collected. However, data on the rate of BMD tests in rural areas or in general medicine are limited. Therefore, we investigated the number of people who had undergone BMD testing. As expected, the proportion of screening tests was extremely low. Moreover, we found that follow-up for osteoporosis patients was inappropriate, as the rate of tests surpassed the rate of treatment. Finally, we aimed to determine how many patients diagnosed with osteoporosis were adequately followed up with BMD. However, it is difficult to determine this number in this study. We can determine the rate of BMD tests in rural areas, and we aim to investigate the follow-up rate of osteoporosis in future research.

In Japan, osteoporosis diagnosis relies on BMD assessment and includes a history of fragility fractures, such as vertebral or hip fractures.[1] However, osteoporosis is defined only based on BMD according to the WHO criteria.[36] In our study, we defined osteoporosis as a BMD ≤70% or a history of vertebral or hip fractures.

CONCLUSION

This study revealed the inadequate management of osteoporosis in a rural community hospital in Japan. The BMD testing rate was low, particularly among older adults and those requiring nursing care. Discrepancies were also observed between testing and treatment rates, indicating potential age-related biases and underscoring the necessity for personalised healthcare irrespective of age. Additional cohort studies and intervention strategies are needed to validate these results.

Acknowledgements We wish to thank Mr. Katsuhiro Takahashi and Dr. Koki Sumita for their timely help in analyzing the large number of samples. We would also like to thank the staff of Iinan Hospital for their support for this study.

Contributors SM and RO designed the study, the main conceptual ideas and the proof outline. SM collected the data. CS supervised the project. SM wrote the manuscript. All authors discussed the results and commented on the manuscript. SM is responsible for the overall content as guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, conduct, reporting or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

ORCID iDs
Sayaka Mabuchi http://orcid.org/0000-0001-5754-9457
Ryuichi Ohta http://orcid.org/0000-0003-2593-091X
Chiaki Sano http://orcid.org/0000-0002-9796-5161

REFERENCES

1 Orimo H, Nakamura T, Iki M, *et al*. 2015 guidelines for prevention and treatment of osteoporosis. tokyo: japan osteoporosis society, the japanese society for bone and mineral research, japan osteoporosis foundation. 2015.
2 Wright NC, Looker AC, Saag KG, *et al*. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. *J Bone Miner Res* 2014;29:2520–6.
3 Yoshimura N, Muraki S, Oka H, *et al*. Prevalence of knee osteoarthritis, lumbar spondylosis, and osteoporosis in Japanese men and women: the research on osteoarthritis/osteoporosis against disability study. *J Bone Miner Metab* 2009;27:620–8.

4 Bhandari M, Swiontkowski M. Management of Acute Hip Fracture. *N Engl J Med* 2017;377:2053–62.
5 Åkesson KE, McGuigan FEA. Closing the Osteoporosis Care Gap. *Curr Osteoporos Rep* 2021;19:58–65.
6 Harris K, Zagar CA, Lawrence KV. Osteoporosis: Common Questions and Answers. *Am Fam Physician* 2023;107:238–46.
7 Cohen K, Maier D. Osteoporosis: evaluation of screening patterns in a primary-care group practice. *J Clin Densitom* 2008;11:498–502.
8 Inoue N, Matsumura T, Sakai H. Area-Based Medicine in the Super-Ageing Society in Japan. *J Med Invest* 2020;67:40–3.
9 Yamauchi H, Arai K, Ishii N, *et al*. Association between the current status of osteoporosis screening tests fragility fractures, requiring nursing care. *J Jap Osteoporos Soc* 2018;4:513–22.
10 Osteoporosis screening ratio, 2020. Available: https://www.jpof.or.jp/Portals/0/pdf/screening_rate/Screening%20rate%20for%20op%202020.pdf [Accessed 29 Mar 2023].
11 Iinan-town official homepage, Available: https://www.iinan.jp [Accessed 12 Sep 2023].
12 Population of Iinan-town in 2020. Japan Medical Analysis Platform, 2020. Available: https://jmap.jp/cities/detail/city/32386 [Accessed 29 Mar 2023].
13 Census, 2020. Available: https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200521&tstat=000001049104&cycle=0&tclass1=000001049105&stat_infid=000032143614&tclass2val=0 [Accessed 18 Jan 2024].
14 Ohta R, Yakabe T, Sano C. Addressing health challenges in rural Japan: a thematic analysis of social isolation and community solutions. *BMC Prim Care* 2024;25:26.
15 Population vision of Iinan-town in 2015, Available: https://www.iinan.jp/uploaded/attachment/1118.pdf [Accessed 13 Jan 2024].
16 Tsuchiya-Ito R, Hamada S, Iwagami M, *et al*. Association of housing adaptation services with the prevention of care needs level deterioration for older adults with frailty in Japan: a retrospective cohort study. *BMC Health Serv Res* 2023;23:916.
17 Ohta R. Self-ageism among older rural people. *Br J Gen Pract* 2023;73:110.
18 Tay CL, Ng WL, Beh HC, *et al*. Screening and management of osteoporosis: a survey of knowledge, attitude and practice among primary care physicians in Malaysia. *Arch Osteoporos* 2022;17:72.
19 Dreinhöfer KE, Anderson M, Féron J-M, *et al*. Multinational survey of osteoporotic fracture management. *Osteoporos Int* 2005;16 Suppl 2:S44–53.
20 Lems WF. Fracture risk estimation may facilitate the treatment gap in osteoporosis. *Ann Rheum Dis* 2015;74:1943–5.
21 Merle B, Chapurlat R, Vignot E, *et al*. Post-fracture care: do we need to educate patients rather than doctors? The PREVOST randomized controlled trial. *Osteoporos Int* 2017;28:1549–58.
22 Kanis JA, Svedbom A, Harvey N, *et al*. The osteoporosis treatment gap. *J Bone Miner Res* 2014;29:1926–8.
23 Solomon DH, Johnston SS, Boytsov NN, *et al*. Osteoporosis medication use after hip fracture in U.S. patients between 2002 and 2011. *J Bone Miner Res* 2014;29:1929–37.
24 Yu F, Xia W. The epidemiology of osteoporosis, associated fragility fractures, and management gap in China. *Arch Osteoporos* 2019;14:32.
25 Japan Medical Research Institution, 2018. Available: https://www.jmari.med.or.jp/download/WP419/wp419-32.pdf [Accessed 16 Nov 2023].
26 LeBoff MS, Greenspan SL, Insogna KL, *et al*. The clinician's guide to prevention and treatment of osteoporosis. *Osteoporos Int* 2022;33:2049–102.
27 Amano S, Ohta R, Sano C. Recognition of Anemia in Elderly People in a Rural Community Hospital. *Int J Environ Res Public Health* 2021;18:11179.
28 Gill JM, Hoffman MK. Prevention and Treatment of Osteoporosis in Primary Care Offices. *J Womens Health (Larchmt)* 2003;12:473–80.
29 Solomon DH, Brookhart MA, Gandhi TK, *et al*. Adherence with osteoporosis practice guidelines: a multilevel analysis of patient, physician, and practice setting characteristics. *Am J Med* 2004;117:919–24.
30 Sloane PD, Gruber-Baldini AL, Zimmerman S, *et al*. Medication undertreatment in assisted living settings. *Arch Intern Med* 2004;164:2031–7.
31 Giangregorio L, Papaioannou A, Cranney A, *et al*. Fragility fractures and the osteoporosis care gap: an international phenomenon. *Semin Arthritis Rheum* 2006;35:293–305.
32 Feldstein A, Elmer PJ, Orwoll E, *et al*. Bone mineral density measurement and treatment for osteoporosis in older individuals with fractures: a gap in evidence-based practice guideline implementation. *Arch Intern Med* 2003;163:2165–72.
33 Wu C-H, Tu S-T, Chang Y-F, *et al*. Fracture liaison services improve outcomes of patients with osteoporosis-related fractures: A systematic literature review and meta-analysis. *Bone* 2018;111:92–100.
34 Leib ES, Lewiecki EM, Binkley N, *et al*. Official positions of the International Society for Clinical Densitometry. *J Clin Densitom* 2004;7:1–6.
35 Hamdy RC, Petak SM, Lenchik L, *et al*. Which central dual X-ray absorptiometry skeletal sites and regions of interest should be used to determine the diagnosis of osteoporosis? *J Clin Densitom* 2002;5 Suppl:S11–8.
36 Kanis JA. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: synopsis of a WHO report. WHO Study Group. *Osteoporos Int* 1994;4:368–81.