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Profile of Patients with Decreased Bone Density Aged Over 50 Years Old with Cases of Femoral Neck Fracture, Thoracic Vertebral Compression Fracture, Lumbar Vertebral Compression Fracture, and Distal Radius Fracture in Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, in 2019-2020

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ABSTRACT

Introduction: Human life expectancy will increase over time, as will various chronic degenerative diseases, one of which is fracture caused by decreased bone mass density. This study described fracture features associated with decreased bone mass density in patients over 50 years old.

Methods: This study took place at the Polyclinic of Orthopaedics and Traumatology Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, using a quantitative design with a cross-sectional approach. The sample in this study consisted of 56 medical records collected using a questionnaire processed with Microsoft Excel.

Results: This study used 56 samples. Femoral neck fractures had the highest number of decreased bone mass density fractures (69.7%). The most common body mass index (BMI) found with fractures was obese patients (32.2%). Most fractures were experienced by females (64.3%). The location of the highest incidence of fractures was found in domestic accidents (66.1%) with low-energy trauma (67.9%).

Conclusion: Most of the fractures caused by decreased bone density in Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, were femoral neck fractures, with females being the most common gender. These fractures were also the most common in obese patients, and the highest incidence was found in domestic accidents with low-energy trauma.

Highlights:

1. Decreased bone density often progresses to osteoporosis, where osteoporosis is a degenerative disease characterized by low bone mass, bone tissue damage, and bone microarchitecture disorders that can lead to an increased risk of bone fracture.
2. Fractures often found in low bone density consist of fractures of the femoral neck, the thoracic and lumbar vertebrae, and distal radius fractures.

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Introduction

Aging in the human population is a trend in developed and developing countries. As humans age, they are also more susceptible to chronic degenerative diseases.[1] The occurrence of aging in humans is also associated with decreased bone density. Decreased bone density is a condition known as osteopenia. It often progresses to osteoporosis, which is a degenerative disease characterized by low bone mass, bone tissue damage, and bone microarchitecture disorders that can lead to an increased risk of bone fracture.[2]

Fractures often found in low bone density consist of fractures of the femoral neck, the thoracic and lumbar vertebrae, and the distal radius.[3] The incidence of these types of fractures in the elderly is also associated with domestic accidents and low-energy trauma. Domestic accidents are accidents that occur at home and surrounding areas due to the elderly, who spend most of their time at home.[4] Low-energy trauma fractures in the elderly are fractures that occur due to falls from standing heights, which are not expected to cause fractures in healthy conditions.[5]

Osteoporosis and fractures also relate to the patient's body mass index (BMI). Body mass index is a measure used in defining anthropometric height/weight characteristics in adults and classifying them into various groups. Low BMI can significantly increase the risk of fracture in patients because patients with low BMI have less subcutaneous fat as a buffer against damage.[6] However, it has also been found that there is a decrease in vertebral bone density as a patient's waist circumference increases.[7] This causes a contradiction between the two previously mentioned facts.

The limited digital experience analytics (DXA) quantitative tool, used in Indonesia as the gold standard for examining bone density reduction, prevents Indonesian people from receiving adequate measures to prevent fractures due to low bone density.[8] Moreover, the current guideline recommends that adults who experience fractures at or after 50 years old have a bone mineral density (BMD) test.[9,10] This is why this study was conducted on patients who were 50 years old or older.

Methods

A questionnaire was used to gather secondary data from medical records for this descriptive cross-sectional study. Cross-sectional studies are observational research studies examining data at a certain time.[11] Total purposive sampling was used to provide data from patients who were ≥50 years old and diagnosed with fractures of the femoral neck, fractures of the thoracic and lumbar vertebrae, and fractures of the distal radius in the Department of Orthopedics and Traumatology Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

Variables in this study were grouped into fracture type, age, BMI, gender, fracture incident location, and distribution of mechanism of injury. The fracture type was classified as femoral neck fractures, thoracic vertebral compression fractures, lumbar vertebral compression fractures, and distal radius fractures. The gender of the patients included was classified into males and females.[11]

The patients included were patients aged 50 years old and over who had fractures, and these patients were recommended to do a BMD test. The age group was classified into 50-64 years old, 65-79 years old, and 80 years old and above. The World Health Organization's (WHO) Asia Pacific BMI categorization was used to categorize the nutritional status, which is underweight (<18.5), normal (18.5-22.9), overweight (23-24.9), and obese (≥25).[12] The location of the fracture incident was divided into domestic accidents and non-domestic accidents. The mechanism of injury (MOI) was divided into low-energy fracture and high-energy fracture. A questionnaire with descriptive statistics was used to analyze each variable, and the results were displayed in a frequency distribution table.[12] All of the data were arranged in worksheets as digital data and were then processed by Microsoft Excel.[13]

Results

The number of fracture incidents with decreased bone density was collected in this study. Elderly patients with low bone mass density fracture aged ≥50 years old who were admitted to Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, in 2019-2020, amounted to a total of 56 patients. It was found that there were 39 patients (69.7%) with a diagnosis of femoral neck fracture, 8 patients (14.2%) with a diagnosis of thoracic and lumbar vertebral compression fracture, and 9 patients (16.1%) with a diagnosis of distal radius fracture.

Table 1. Age group distribution of patients with decreased bone density

Age (years old)	Femoral Neck Fracture	Thoracic and Lumbar Vertebrae Compression Fracture	Distal Radius Fracture	Total
	n (%)	n (%)	n (%)	n (%)
50-64	15 (38.5%)	5 (62.5%)	7 (77.8%)	27 (48.2%)
65-79	20 (51.3%)	2 (25%)	1 (11.1%)	23 (41.1%)
≥80	4 (10.2%)	1 (12.5%)	1 (11.1%)	6 (10.7%)
Total	39 (100%)	8 (100%)	9 (100%)	56 (100%)

Source: Research data, processed

Table 1 describes the age distribution of 56 patients with fractures of the femoral neck, compression fractures of the thoracic and lumbar vertebrae, and fractures of the distal radius aged ≥50 years old. Many patients were found in the 50-64 years old group, as many as 27 patients (48.2%). In the 65-79 years old group, 23 patients (41.1%) were found, while for patients aged 80 years and older, there were 6 patients (10.7%).

The distribution of BMI is presented in Table 2. As many as 11 (19.6%) patients were found to have an underweight BMI and 14 (25%) patients with a normal BMI. It was also

found that there were 13 (23.2%) patients with overweight BMI and 18 (23.2%) obese patients. Therefore, it can be concluded that the majority of patients were obese.

Table 2. Body mass index distribution of patients with decreased bone density

Body Mass Index	Femoral Neck Fracture	Thoracic and Lumbar Vertebrae Compression Fracture	Distal Radius Fracture	Total
	n (%)	n (%)	n (%)	n (%)
Underweight (<18.5)	10 (25.6%)	0 (0%)	1 (11.1%)	11 (19.6%)
Normal (18.5-22.9)	10 (25.6%)	3 (37.5%)	1 (11.1%)	14 (25%)
Overweight (23-24.9)	8 (20.6%)	3 (37.5%)	2 (22.2%)	13 (23.2%)
Obese (≥25)	11 (28.22%)	2 (25%)	5 (55.6%)	18 (32.2%)
Total	39 (100%)	8 (100%)	9 (100%)	56 (100%)

Source: Research data, processed

In Table 3, there were 20 male patients (35.7%) and 36 female patients (64.3%). However, compression fractures of the thoracic and lumbar vertebrae had a higher incidence in males than females. Female patients had the largest population in the incidence of femoral neck fractures and distal radius fractures.

Table 3. Gender distribution of patients with decreased bone density

Gender	Femoral Neck Fracture	Thoracic and Lumbar Vertebrae Compression Fracture	Distal Radius Fracture	Total
	n (%)	n (%)	n (%)	n (%)
Male	11 (28.2%)	7 (87.5%)	2 (22.2%)	20 (35.7%)
Female	28 (71.8%)	1 (12.5%)	7 (77.8%)	36 (64.3%)
Total	39 (100%)	8 (100%)	9 (100%)	56 (100%)

Source: Research data, processed

Table 4 presents the locations of fracture incidence. The total number of patients with fractures caused by domestic accidents was 37 (66.1%), and 19 (33.9%) were caused by non-domestic accidents. Therefore, domestic accidents were the most common incidents in this case. However, thoracic and lumbar vertebral compression fractures were found mainly in non-domestic accidents.

Table 4. Fracture incident location of patients with decreased bone density

Fracture Incident Location	Femoral Neck Fracture	Thoracic and Lumbar Vertebrae Compression Fracture	Distal Radius Fracture	Total
	n (%)	n (%)	n (%)	n (%)
Domestic	29 (74.4%)	2 (25%)	6 (66.7%)	37 (66.1%)
Non-Domestic	10 (25.6%)	6 (75%)	3 (33.3%)	19 (33.9%)
Total	39 (100%)	8 (100%)	9 (100%)	56 (100%)

Source: Research data, processed

Table 5 describes the distribution of the MOI of the fracture. The total number of patients with fractures caused by low energy was 38 patients (67.9%), and fractures caused by high energy were 18 patients (32.1%). Therefore, it can be seen that the highest number of causes of fractures found were low-energy fractures.

Table 5. Distribution of mechanism of injury in patients with decreased bone density

Mechanism of Injury	Femoral Neck Fracture	Thoracic and Lumbar Vertebrae Compression Fracture	Distal Radius Fracture	Total
	n (%)	n (%)	n (%)	n (%)
Low Energy	30 (76.9%)	2 (25%)	6 (66.7%)	38 (67.9%)
High Energy	9 (23.1%)	6 (75%)	3 (33.3%)	18 (32.1%)
Total	39 (100%)	8 (100%)	9 (100%)	56 (100%)

Source: Research data, processed

Discussion

A total of 39 (69.7%) patients were diagnosed with femoral neck fractures, 8 (14.2%) patients were diagnosed with thoracic and lumbar vertebral compression fractures, and 9 (16.1%) patients were diagnosed with distal radius fractures. The majority of fractures obtained in this study were femoral neck fractures. Low-energy falls, which become more common with age, are the leading cause of hip fractures. During such a fall, compressive stress is applied to the superior lateral cortex of the femoral neck, which is believed to be the primary injury mechanism in femoral neck fracture. Osteoporosis, loss of dense trabecular network, increased femoral neck diameter, and cortical thinness increase susceptibility to buckling.[14] On

the other hand, compression fractures of the thoracic and lumbar vertebrae were the fewest fractures found in this study. This is because vertebral compression fractures are not only associated with osteoporosis but are often associated with high-energy trauma events.[15] This study also found that various thoracic and lumbar vertebral compression fractures were not only caused by low-energy accidents but also high-energy accidents, such as falls from a height, traffic accidents, and so on. The incidence of osteoporotic fractures can multiply hip fracture morbidity by age group. Based on a study conducted by Raichandani, *et al*. (2021), a positive correlation was found between mortality rates and an increase in the age of patients. Hip fracture patients in the age group of 65 to 75 years old reported only 6.03% mortality, while those with the age of more than 85 years old reported it as 25.7%.[16]

This study divided the age distribution of patients into 3 groups, namely the age of 50 to 64 years old, the age of 65 to 79 years old, and the age of 80 years old and over. Based on the findings in Table 2, 27 (48.2%) patients experienced fracture incidents in the age range of 50 to 64 years old. A total of 23 (41.1%) patients experienced fracture incidents in the age range of 65 to 79 years old, and it was found that 6 (10.7%) patients had fractures at the age of 80 years old and over. The findings of this study are not similar to the study by Anthamatten, *et al*. (2019).[17] It was found that age was a significant risk factor.[17] Half of white females by the age of 60 years old had osteopenia or osteoporosis, and more than half of females over the age of 75 years old met bone density criteria for osteoporosis.[17] The study also found that fracture rates increased with age in all ethnic and racial groups.[17]

One of the possible reasons why patients over 80 years old have the lowest fracture incidence among all age groups is because the life expectancy of the Indonesian people has not yet reached 80 years old. The life expectancy in Indonesia has reached 70.84 years old.[18] This is one of the reasons why the distribution of data on patients aged over 80 years old and over is still very minimal. The BMI used in this study was grouped into 4 areas, namely underweight (<18.5), normal (18.5-22.9), overweight (23-24.9), and obese (≥25). Based on the findings in Table 3, it can be seen that the incidence of fracture was found in 11 (19.6%) underweight patients, 14 (25%) normal patients, 13 (23.2%) overweight patients, and 18 (32.2%) obese patients.[18]

The highest BMI group found in fracture patients was in obese patients. This finding is inversely proportional to the study conducted by Ha, *et al*. (2020).[19] The study discovered that a 1 kg/m^2 rise in BMI appeared to lower the incidence of osteoporosis by 28% for men and 13% for women.[19] An increase in body weight causes an increase in bone density. However, apart from the bone-strengthening seen with increased bone density, the fracture risk will be higher with increasing body weight. Various factors cause a greater risk of fracture in obese subjects. These factors can be divided into metabolic factors and an increased risk of falling. Fractures have an atypical distribution in obese individuals, with a lower incidence of typical osteoporotic fractures, such as fractures of the hip, spine, and wrist, and an increase in fractures of the ankle, upper leg, and humerus.[20]

Adiponectin hormone also influences bone density. It is a hormone produced and secreted by adipose tissue and is widely known for its antidiabetic, anti-inflammatory, antiatherogenic, and cardioprotective effects.[21] A study by Osteoporosis International found that higher adiponectin levels in females predicted a more significant reduction in hip bone density regardless of age, race, BMI, diabetes, baseline BMD, and changes in body weight.[21] This is supported by a cohort study conducted by Tai, *et al*. (2022), which found that increased serum adiponectin levels would accelerate the loss of bone density at the proximal femoral bone.[22]

Decreased bone density also correlates with the hormone leptin. Leptin is mainly secreted from adipocytes at a rate determined primarily by the number of adipocytes and the amount of body fat and food intake.[23] In vitro, leptin stimulates stromal cells to differentiate into osteoblasts and stimulates their proliferation, and inhibits osteoclastogenesis. Knockout of the leptin gene has also been shown to lead to BMD and bone loss. Negative effects appear to outweigh positive effects. This negative effect is exerted through the central nervous system. In mice lacking leptin or leptin receptors, a study found decreased femoral bone mass and increased femoral marrow fat.[20]

The mechanism of action of leptin in humans causes inhibition of bone resorption. One of them is by increasing osteoprotegerin (OPG), which will inhibit osteoclastogenesis through receptor activator mediators from nuclear factor-kB (RANK)/RANK ligand (RANKL)/OPG. Osteoprotegerin functions as a decoy receptor for RANKL and acts by competing with RANK, which is expressed on osteoclasts and dendritic cells that specifically bind to RANKL. The binding of RANKL to OPG will inhibit the binding of RANKL to RANK, which then inhibits osteoclastogenesis.[24] A current study has found differences regarding the effect of high BMI on BMD.[25] After adjusting for the effects of mechanical loading on BMI, the association appears to be negligible or negative. The relationship can be mediated by sex. The pro-inflammatory, pro-oxidative, and hypercalciuria environment of the body may contribute to the adverse effects of metabolic syndrome (MetS) on bone.[25]

Various findings regarding the effect of BMI on fracture and bone density are often debated among studies. Various other factors have been found that need to be studied more deeply than BMI, such as the influence of waist circumference and metabolic syndrome. Therefore, further research is needed. Based on the results of the study in Table 4, it was found that there were 20 (35.7%) male and 36 (64.3%) female patients with decreased bone density fracture. From the table, it can be seen that females had the highest number of fracture incidence. Fractures found in female patients were mainly associated with postmenopausal osteoporosis. Menopause occurs between 45 and 55 years old.[26] It will disrupt the normal cycle of bone turnover by estrogen deficiency. As a result of estrogen deficiency, osteoclastic resorption activity increases while osteoblast activity decreases. This results

in bone fragility in women aged over 50 years old and over.[26]

Males do not experience a rapid decline in bone density as females do after menopause. However, males experience a decrease in bone density with age. An epidemiological finding revealed that males experience the incidence of vertebral fractures after the age of 65 years old.[20] In contrast, females have a rapid increase in the prevalence of the condition after the age of 55 years old.[20] Regarding hip fractures, the incidence showed rapid growth for females after 65 years old and 75 years old for males.[20] This study divided the incidence of fracture in 2 locations, which were domestic and non-domestic accidents. In Table 5, patients with fractures caused by domestic accidents were 37 (66.1%) patients. Meanwhile, patients caused by non-domestic accidents amounted to 19 (33.9%) patients. Therefore, patients aged over 50 years old with decreased bone density fractures were experienced mainly by domestic accidents in and around the house. Domestic accidents are the leading cause of fractures with decreased bone density. A study in family medicine concluded that ⅓ of 500 elderly had one type of household accident or another in the previous 12 months.[27] Falls were the most frequent cause of unintended domestic injury, and females are affected the most. Those who were unwell and older than 70 years old had a higher prevalence of domestic injury. The study also concluded that the majority (50%) of the falls had occurred in the courtyard, bathroom (20%), living room (16%), kitchen (11%), and the remaining near the house (within 20 meters).[27] This is why most fractures due to decreased bone density occur mainly in or around the patient's house.[27]

Based on the results in Table 5, 38 (67.9%) patients with MOI fractures caused by low energy. This study also found 18 (32.1%) patients over 50 years old with fracture incidence due to high-energy fracture MOI. Fractures caused by low energy share most of the fracture incidence with decreased bone density because low bone density will cause bones to become brittle. Elderly people frequently fall, and as they get older, this occurrence rises dramatically. One in three patients aged 65 years old and older encounter one or more falls every year, resulting in fractures.[28] Zhu, *et al*. (2020) observed a significantly increasing incidence of low-energy fractures with increasing age in both males and females.[29] In males, advanced age, alcohol consumption, living on the second floor or above without an elevator, sleep duration <7 hours/day, and a history of past fractures were identified as significant factors associated with an increased risk of low-energy fracture.[29] In females, advanced age, living in the east, high latitude (40°N-49.9°N), alcohol consumption, more births, sleep duration <7 hours/day, and history of past fractures were associated with significant risk for low energy fracture.[29]

Fractures caused by high energy are often associated with compression fractures of the vertebrae. The lumbar spine is most likely injured by high-energy mechanisms, followed by the thoracic and cervical spine. The thoracolumbar junction is affected more frequently than the cervicothoracic junction in a 2:1 ratio. Males are more affected by spinal cord injuries associated with high-energy mechanisms.[30]

Strength and Limitations

This study discussed the newest profiles of specific fractures related to decreased bone density in the elderly. Its limitation was the lack of data in medical records, further hindering the data collection process.

Conclusion

This study showed that some groups of elderly people of a certain age, gender, BMI, fracture incident location, and distribution of MOI were at a higher risk of developing decreased bone density fractures. This study could have been biased, considering the close location and small sample sizes. Further research about decreased bone density fractures in the elderly with more prominent locations and samples is needed.

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Conflict of Interest

The authors declared there is no conflict of interest.

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Ethical Clearance

The ethical committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, approved this study with agreement number 1056/107/3/X/2021 on 25-08-2021 with a waiver of informed consent as this constituted a low-risk retrospective study.

Authors' Contributions

Developed the study design, gathered, examined, and summarized the data, created tables, and wrote the manuscript: AP. Reviewed, corrected, and approved the manuscript's final draft before publication: GMS, DNU.

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