ASSOCIATION BETWEEN OSTEOPOROSIS AND AGE, PHYSICAL ACTIVITY AND OBESITY IN ELDERLY OF TULIKUP VILLAGE, GIANYAR

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Abstract

The proportion of elderly population in Tulikup Village, Gianyar Regency is 0.72%. One of the potential diseases affecting this aging population is osteoporosis. Morbidity of osteoporosis could impose future burden to community and government in terms of medical, social and financial implications. The present study determined prevalence and risk factors of osteoporosis to provide solid basis for the development of screening model. Cross-sectional study was conducted and 221 of 649 people aged ≥45 were randomly sampled by multi-stage random sampling method. Examined variables were osteoporosis treated as dependent variable and several independent variables: age groups, gender, personal history of fracture, dietary calcium intake, physical activity, alcohol & phosphorus intake, body mass index (BMI), and parental history of fracture, diabetes mellitus, and smoking habit. Data were analyzed statistically by univariate, bivariate (chi square), and multivariate (logistic regression) analysis. The prevalence of osteoporosis in eldery was 28.1% (26.0% in women and 30.6% in men) and the rest was osteopenia (54.3%). Multivariate analysis showed that prevalence ratio (PR) of osteoporosis in relation to obesity, elderly group, post-elderly group, and vigorous physical activity were 0.3 (CI 95%: 0.1-0.9), 4.5 (CI 95%: 1.4-1.9), 6.2 (CI 95%: 1.8-20.9), and 0.5 (CI 95%: 0.2-0.9) respectively.

In general, obesity and vigorous physical activity significantly decreased the risk of osteoporosis. Obesity decreased the risk of having osteoporosis by 70% and vigorous physical activity deceased the risk of osteoporosis by 50% . Being elderly and post-elderly increased the risk of having osteoporosis significantly. Elderly group was 4.5 times more likely to have osteoporosis, and post-elderly group increased the risk of osteoporosis by 6.2 times.

Keywords: elderly, osteoporosis, obesity

Abstrak

Desa Tulikup yang terletak di Kabupaten Gianyar, Provinsi Bali merupakan desa dengan proporsi usia lanjut sebesar 0,72%. Salah satu penyakit yang rentan dialami pada kelompok usia ini adalah osteoporosis. Kesakitan yang dapat ditimbulkan dari osteoporosis dapat menjadi beban masyarakat dan pemerintah karena memberikan implikasi medis, sosial dan finansial di kemudian hari. Studi ini untuk mengetahui prevalensi osteoporosis dan faktor risikonya sebagai data dasar dalam pengembangan model skrining penyakit osteoporosis. Penelitian ini menggunakan rancangan analitik potong lintang dengan populasi penduduk kelompok lansia (≥45 tahun) sebesar 649 orang. Sampel sebanyak 221 orang dipilih secara multi stage random sampling. Variabel dependen adalah osteoporosis, variabel independennya adalah kelompok usia, jenis kelamin, riwayat fraktur, defisiensi kalsium, aktivitas fisik, alkohol, indeks massa tubuh (IMT), riwayat fraktur, riwayat penyakit diabetes melitus dan merokok. Analisis dilakukan secara univariat dan bivariat dengan uji chi-square serta analisis multivariat dengan uji regresi logistik. Prevalensi osteoporosis adalah sebesar 28,1%. Hasil analisis multivariat prevalen rasio (PR) untuk varibel obesitas adalah 0,3 (95%CI: 0,1-0,9), kelompok lansia PR 4,5 (95%CI: 1,4-14,9), post lansia PR 6,2 (95%CI: 1,8-20,9) dan akitivitas fisik berat dengan PR 0,5 (95%CI: 0,2-0,9).

Dari hasil statistik analisis multivariat, didapatkan bahwa variabel yang secara signifikan menurunkan risiko osteoporosis adalah variabel obesitas yang menurunkan risiko osteoporosis sebesar 0,3 kali dan aktivitas fisik berat yang menurunkan risiko 0,5 kali pada lansia. Variabel yang secara signifikan meningkatkan risiko osteoporosis adalah variabel kelompok lansia sebesar 4,5 kali dan variabel kelompok post lansia sebesar 6,2 kali pada penduduk usia lansia di Desa Tulikup, Gianyar.

Kata kunci*: usia lanjut, osteoporosis, obesitas*

INTRODUCTION

Osteoporosis is a bone metabolic disorder characterized by reduction of bone mass density and degradation of bone micro-architectures. The decreased bone mass density and deteriorated bone microarchitecture can lead to skeletal fragility and increase the risk of fracture. Osteoporosis is known as a silent killer since it is asymptomatic and the medical diagnosis is usually too late to prevent its complications. [1]

Osteoporosis is one of major public health problems worldwide and it is said that 1 in 4 women and 1 in every 6 men aged over 65 years old sustain osteoporosis. In Indonesia, 19.7% of elderly population (3.6 million people) suffered from osteoporosis. In 2005, there were 18 million elderly in Indonesia and this figure will rise to 33 million in 2020 with life expectancy of 70 years. Thirty percent of women aged ≥50 is predicted to experience osteoporosis, 37-54% is likely to have osteopenia, and 54% is at risk of having fracture complications. Morbidity of osteoporosis could impose future burden to community and government in terms of medical, social and financial implications. Patients of osteoporosis mostly experienced vertebral fracture, hip fracture, and femur fracture. Mortality rate caused by fracture is estimated to be 20%, and 50% among them suffered from physical disability. [3,4,5,6].

There are two risk factors of osteoporosis: (1) non-modifiable risk factors (age, gender, family history, premature menopause, and history of fracture), (2) modifiable risk factors (physical activity, calcium deficiency, phosphorus deficiency, inadequacy of vitamin D, body mass index, alcohol intake, and smoking habit). [5,6].

Although osteoporosis causes considerable morbidity, mortality, and disability, it can be prevented by early screening of its risk factors. Accordingly, the aim of this study is to develope an education-and-community-participatory-based model to prevent risk factors of osteoporosis. As the first step of this model development, we conducted formative research to examine the incidence and risk factors of osteoporosis in community. The result of this study would then be used as recommendation for further development of osteoporosis prevention program

METHOD

The study design was analytical cross sectional involving elderly (over 45 years old) collected from cohort data of Tulikup Village Office, Gianyar. Of 649 elderly residents, 221 were required to meet WHO minimum sample size and multiple stage random sampling was carried out in selecting the participants. Data were collected by interview based on structured questionnaire and the measurement of risk factors was delivered by well-trained officers.

Osteoporosis as the dependent variable was measured by bone density test using Achilles Express Bone Densitometer. Bone density was classified into normal (t-score>-1), osteopeni (-2≤t-score≤-1) and

osteoporosis (t-score<-2). Independent variables are gender, age groups, alcohol consumption, history of diabetes mellitus, and history of fracture, body mass index, calcium intake, phosphorus intake, physical activity, and smoking habit. Age groups were classified into pre-elderly (45-59 y/o), elderly (60-74 y/o), dan post elderly (≥75y/o); Calcium and phosphorus intake were measured by SQ-FFQ, which were categorized into adequate (≥ 100% RNI), insufficient (70%-99.9% RNI), and deficiency (<70% RNI); Physical activity was measured by Physical Activity Level (PAL) which categorized into mild (PAL ≤ 1.69), moderate (1.7 ≤ PAL ≤ 1.99), and vigorous (PAL ≥ 2.0).

Univariate analysis was carried out to examine the frequency distribution of each variable; bivariate analysis using chi-squared was done to measure the association between each independent variable and dependent variable, while multivariate analysis with logistic regression aimed to examine the association after adjustment to all significant independent variables.

RESULTS

Characteristics of sample based on each variable are presented in Table:

Table 1. Characteristics of samples

Characteristics	Frequency	%
Gender:		
- Men	98	44.3
- Women	123	55.7
Age groups		
- Pre-elderly (45-59 y/o)	49	22.2
-Elderly (60-74 y/o)	120	54.3
Post elderly (≥75 y/o)	52	23.5
Education		
School		
- No Education	127	57,5
School		
- Elementary	84	38,0
School		
- Junior High	7	3,2
School		
- Senior High	3	1,4
Occupation		
- Laborer	95	43,0
- Farmer	30	13,6
- Driver	2	1,0
- Retired	1	0,5
- Entrepreneur	8	3,6
- Unemployed	85	38,5

Incidence of osteoporosis in population aged ≥45 years old was higher in women (55.7%) than in men (44.3%). In terms of age groups, the highest proportion was observed in elderly (54.3%), followed by post elderly (23.5%), and pre elderly (22,2%). Most of the participants did not have formal education (57,5%); while, 38% of the subjects were elementary school graduates, 3,2% graduated from junior high school and 1.4% held senior

high school degree. The majority of subjects' occupations was laborer (43%), followed by unemployed (38.5%), farmer (13.6%), driver (1.0%), and retired (0.5%). Occupation distribution based on age groups are illustrated by Graph 1.
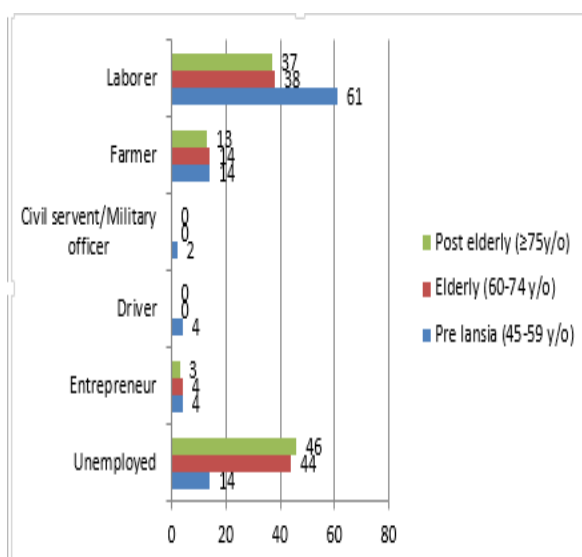
Graph 1. Proportion of Occupation Types Based on Elderly Group

As shown by the Graph 1, most of the pre elderly were laborers (61%) and only small proportion were civil servants/ military officers. In elderly group, 44% were unemployed and 4% were entrepreneurs. Whereas, in post elderly group, the subjects were mostly retired, followed by laborers (37%), farmers (13%), and entrepreneurs (3%). In general, the residents of Tulikup Village started their retirement at age group of elderly (60 – 74 y/o).

Bone density was classified into normal (t-score>-1), osteopeni (-2≤t-score≤

-1) dan osteoporosis (t-score<-2). As shown by Table 2 normal bone density was observed only in 17.6% of the population, while, most of the subjects sustained osteopenia (54.3%), and considerable proportion of the subjects was having osteoporosis (28.1%). The highest proportion of osteoporosis was observed in post-elderly group. The characteristics of subjects with osteoporosis were: no history of diabetes mellitus (93.5%), no history of bone fracture (88.7%), non-smoker (82.2%), not regularly drinking alcohol (93.5%), obese (6.4%), having calcium deficiency (98.3%), and doing mild physical activity (66.1%). Of all characteristics observed, it is evident that proportion of calcium deficiency was quite high, reached to 98.3%.

Calcium intake was analyzed by nutri-survey program and the results are shown in Table 3. Most of the subjects did not have adequate intake of calcium as recommended. As many as 92.3% of the subjects were classified into people with calcium deficiency, observed both in men and women in all age groups.

Table 4 shows that 54.1% of subjects were having phosphorus deficiency, both in men and women. Based on age groups, phosphorus deficiency in pre elderly, elderly, and post elderly groups was 46.9%, 55.8%, 56.9%, respectively.

Calcium and phosphorus intake in the community of Tulikup Village were considered to be related with the type of food consumed. The calcium-rich food, such as cheese and sardine, were not common food sources in this village.

Table 2. Bone density measurement related to the risk factors

| Sample Group | n | Bone density | | |
| | | Osteoporosis | Osteopeni | Normal |
		t-score < - 2	-2≤t-score≤-1	t-score >-1
Total	221	62 (28.1%)	120 (54.3%)	39 (17.6%)
Gender				
- Men	98	30 (30.6%)	48 (49.0%)	20 (20.4%)
- Women	123	32 (26.0%)	72 (58.5%)	19 (15.4%)
Age groups				
- Pre elderly (50–59 y/o)	49	3 (6.1%)	29 (59.2%)	17 (34.7%)
- Elderly (60–74 y/o)	120	22 (30.8%)	69 (57.5%)	14 (11.7%)
- Post elderly (≥75 y/o)	52	37 (42.3%)	22 (42.3%)	8 (15.4%)
History of diabetes mellitus				
- Yes	9	1(11.1%)	7(77.8%)	1(11.1%)
- No	212	61(28.8%)	114(53.8%)	37(17.5%
History of fracture				
- Yes	26	7(26.9%)	14(53.8%)	5(19.2%)
- No	195	55(28.2%)	107(54.9%)	33(16.9%)
Smoking habit				
- Yes	11	11(22.4%)	31(63.3%)	7(14.3%)
- No	172	51(29.7%)	90(52.3%)	31(18.0%)
Alcohol consumption regularly				
- Yes	12	4(33.3%)	4(33.3%)	4(33.3%)
- No	209	58(27.8%)	117(56.0%)	34(16.3%)
Obesity				
- Yes	47	4(8.5%)	27(57.4%)	16(34.1%)
- No	174	58(33.4%)	94(54.0%)	22(12.6%)
Calcium deficiency*				
- Yes	204	61(29.9%)	111(54.4%)	32(15.7%)
- No	17	1(5.9%)	10(58.8%)	6(35.3%)
Physical activity				
- Vigorous	68	12(17.6%)	44(64.7%)	12(17.6%)
- Moderate	39	9(23.1%)	23(59.0%)	7(17.9%)
- Mild	114	41(36.0%)	54(47.4%)	19(16.7%)

Table 3. Calcium intake in population aged over 45 years of Tulikup Village

Population groups	n	Calcium intake		
		Normal (≥ 100% RNI)	Insufficient (70-99% RNI)	Deficiency (< 70% RNI)
Total	221	7 (3.2%)	10 (4.5%)	204 (92.3%)
Based on gender:				
Men	98	1 (1.0%)	3 (3.1%)	94 (95.9%)
Women	125	6 (4.9%)	7 (5.7%)	110 (89.4%)
Based on age groups:				
Pre elderly	49	3 (6.1%)	1 (2.0%)	45 (91.8%)
Elderly	120	2 (2.5%)	4 (4.9%)	75 (92.6%)
Post elderly	52	2 (2.2%)	5 (5.5%)	84 (92.3%)

Note: RNI is recommended nutrition intake (WHO)

Table 4. Phosphorous intake in population aged over 45 years of Tulikup Village

Population groups	n	Phosphorous intake		
		Normal (≥ 100% RNI)	Insufficiency (70-99% RNI)	Deficiency (< 70% RNI)
Total	221	41 (18.6%)	60 (27.3%)	119 (54.1%)
Based on gender:				
Men	98	18 (18.4%)	27 (27.6%)	53 (54.1%)
Women	125	23 (18.9%)	33 (27.0%)	66 (54.1%)
Based on age groups:				
Pre elderly	49	13 (26.5%)	13 (26.5%)	23 (46.9%)
Elderly	120	21 (17.5%)	32 (26.7%)	67 (55.8%)
Post Elderly	52	7 (13.7%)	15 (29.4%)	29 (56.9%)

Table 5. Consumption of calcium and phosphorus-rich food in population aged 45 years of Tulikup Village

Foods	Content mg/100 g	Number of consumers (%)	Mean (±sd) consumption g/day
Calcium sources:			
• Shrimp paste	3812	34	5.5(±3.4)
• Seafood	1422	82	21.2(±40.9)
• Skim milk	1300	0	
• Dried shrimp	1209	1	8± (0)
• Dried anchovies	1200	41	4.0 (±4.5
• Powder milk	904	21	28.4(±11.0)
• Cheese	772	0	
• Sardine (can)	354	0	
• Sweetened condensed milk	275	1	10.0(±0)
• Spinach	265	85	8.6(9.4)
• Soybean	227	99	30.3(±24.3)
Phosphorus sources:			
• Dried anchovies	1500	41	4.0(±4.5)
• Powder milk	694	21	28.4 (±11.0)
• Soybean	585	99	30.3 (±24.3)
• Sardine (can)	434	0	
• Red bean	400	7	2.9(±2.8)
• Mung bean	320	15	4.9(±6.6)
• Sweetened condensed milk	209	1	10(±0)
• Chicken	200	85	8.2(±16.8)
• Spinach	64	85	8.6 (±9.4)

Table 5 shows that the food source for calcium consumed daily by the community were soybean (30.3 g/day), spinach (85 g/day), and seafood (82 g/day); while the least frequent food sources of calcium consumed by the community were cheese, sardine, and sweetened condensed milk (0 g/day). The most consumed of phosphorus-rich food were soybean (99 g/day), chicken (85 g/day), and spinach (85 g/day); while the least phosphorus food source consumed was sardine (0 g/day).

The community of Tulikup village mostly consumed local agricultural commodity such as beans and vegetables. The food source of calcium and phosphorus was obtained from what they produced in their farm. The description of calcium and phosphorus intake of Tulikup Village community can be seen on table 5.

Prevalence of calcium deficiency was higher in men (95.9%) than in women (89.4%); and based on age groups, calcium deficiency was mostly evident in elderly group (92.6%).

Table 4 shows that proportion of phosphorus deficiency in male elderly was the same as in the female elderly which is 54.1%. Based on age groups, post-elderly group had higher proportion of having phosphorus deficiency (56.9%).

Data of physical activity is shown in Table 6:

Table 6. Distribution of physical activity in population aged over 45 years old, Tulikup Village

Population groups	n	Physical activity		
		Mild	Moderate	Vigorous
Total	221	114 (51.6%)	39 (17.6%)	68 (30.8%)
Based on gender:				
- Men	98	48 (49.0%)	15 (15.3%)	35 (35.7%)
- Female	125	66 (53.7%)	24 (19.5%)	33 (26.8%)
Based on age groups:				
- Pre elderly	49	25 (51.0%)	9 (18.4%)	15 (30.6%)
- Elderly	120	65 (54.2%)	20 (16.7%)	35 (29.2%)
- Post elderly	52	24 (46.2%)	10 (19.2%)	18 (34.6%)

Physical activity analyzed with PAL showed that both men and women mostly did mild physical activities (49% and 53.7%, respectively). In each age group, subjects mostly did mild physical activities.

The results of bivariate and multivariate analysis can be seen in Table 7.

Table 7. Risk factors of osteoporosis in Tulikup Village

Risk factor	Bivariate PR (CI 95%)	Multivariate PR (CI 95%)
Gender		
Women	Baseline	Baseline
Men	1,17 (0,77–1,79)	0,9 (0,5-1,6)
Age		
Pre elderly (45–59 y/o)	Baseline	Baseline
Elderly (60 –74 y/o)	5.0 (1.6–16.3)*	4.5 (1.4-14.9)*
Post elderly (≥75 y/o)	6.9 (2.1–23.1)*	6.2 (1.8-20.9)*
Obesity	0.3 (0.1–0.8)*	0.3 (0.1-0.9)*
History of diabetes mellitus	2.6 (0.4–16.6)	0.5 (0.1-3.5)
History of fracture	1.1 (0.6–2.1)	1.0 (0.5-2.2)
Alcohol consumption	0.9 (0.3–2.4)	0.8 (0.2-2.9)
Smoking habit	0.7 (0.4–1.2)	1.4 (0.7-3.1)
Physical activity		
Mild (PAL ≤ 1,69)	Base line	Base line
Moderate (1,7 ≤ PAL ≤ 1,99)	0.6 (0.3–1.3)	0.7 (0.3-1.4)
Vigorous (PAL ≥ 2,0)	0.5 (0.3–0.9)*	0.5 (0.2-0.9)*
Calcium deficiency (<70% AKG)	1.3 (1.2–1.6)*	3.8 (0.5-27.9)
Phosphorus deficiency (< 70% AKG)	1.1 (0.6–1.4)	1.1 (0.7-1.9)

* p value ≤ 0,05

Note:

PR   : *Prevalence of Risk*

PAL   : *Physical Activity Level*

CI   : *Confident Interval*

RNI   : Recommended Nutrient Intake

Bivariate analysis shows that there were 4 variables significantly associated with osteoporosis: age groups, obesity, physical activity, and calcium deficiency. Elderly group had prevalence ratio of 5.0 (95%CI 1.6-16.3), whereas post elderly group had prevalence ratio of 6.9 (95%CI 2.1–23.1). Prevalence ratio of obese to non-obese was 0.3 (95%CI 0.1–0.8). Vigorous physical activity had prevalence ratio of 0.5 (95%CI 0.3–0.9). Calcium deficiency had prevalence ratio of 1.3 (95%CI 1.2–1.6). After adjusting for all variables by cox regression, variables that were significantly associated with osteoporosis were age groups, physical activity, and obesity as shown by table 7.

DISCUSSION

Prevalence of osteoporosis in elderly of Tulikup village was relatively high, accounted for 28.1% of the elderly population, whereas osteopenia was found to be as high as 54.3%, and the prevalence of normal bone density was 17.6%. The risk of having osteoporosis increased as the age increased, where post elderly group significantly had a higher possibility of having osteoporosis by 6.2 times compared to pre-elderly group. This is coherent with aging theory which stated that in bone remodeling process, the peak bone mass is reached during age of 30s. After 30 years old, bone mass density decreases as a result of the increase of osteoclast activity which outnumbers the osteoblast. As

consequence, bone remodeling process failed to achieve optimum bone strength. This event causes the likelihood of getting bone density deterioration (osteopenia) and higher risk of experiencing bone degradation (osteoporosis). [10].

Obese people have lower risk of osteoporosis compared to non-obese ones. The present study concludes that being obese decreases the risk of having osteoporosis by 70%, with PR 0.3 (CI 95%; 0.1-0.9). This result is consistent with several studies stating that there is significant association between body mass index and osteoporosis. Body mass index has protective effect against osteoporosis; an increased mechanical pressure by muscles, such as osteoblast activity stimulation on skeletal, will increase the osteogenesis stimulation. The mechanical pressure, gravitation, and stretching can maintain mineral homeostasis and stimulate bone formation by decreasing apoptosis and increasing proliferation of osteoblast and osteocyte. [10,11].

Most of people aged over 45 years old did relatively mild to moderate physical activities. Statistical analysis showed that vigorous physical activities (PAL≥2) decreased the risk of having osteoporosis by 2 times compared to mild physical activities. Vigorous physical activities were found to have prevalence risk of osteoporosis by 0.5 (0.3-0.9). After adjusting for confounders, prevalence ratio of osteoporosis in elderly who did vigorous physical activities was 0.5 (0.2-0.9). Meanwhile, moderate physical activities did not significantly affect the risk of having osteoporosis. The prevalence ratio of osteoporosis in elderly who did moderate physical activity was 0.6 (0.3-1.3), and its multivariate analysis showed PR of 0.7 (0.3-1.4). As the physical activities getting more intense, the less likely to get osteoporosis.

Despite there was 18.6% of elderly who had adequate phosphorus intake, there were quite a lot of participants experienced phosphorus deficiency. This situation was found in both men and women and in all age groups of elderly residents. The intake of calcium and phosphorus in elderly residents was related to the type of foods consumed daily. Calcium and phosphorus rich foods such as cheese and milk were infrequently consumed by residents of age over 45 years old in Tulikup Village. Thus, most of the elderly residents experienced phosphorus deficiency. The recommended nutrient intake of calcium and phosphorus is about 1000 g/day to maintain daily balance of calcium serum. If the calcium intake is inadequate, the bone resorption will take place to meet the calcium serum concentration. If the imbalance calcium persist, the bone calcium will be deteriorated and leads to osteoporosis [11].

Based on this study, prevention measures needed to preempt the bone mass deterioration in elderly people in Tulikup Village of Gianyar are as below:

a. Increasing calcium and phosphorus intake by consuming calcium and phosphorus-rich food.

b. Promoting physical activities by doing exercises regularly.

c. Initiating specific targeting work out (*weight bearing dan muscle stretching*) for osteoporosis patients by professional trainers.

d. Developing osteoporosis prevention programs for younger age group focusing on health promotion, screening, and intensifying physical activi-

ties.

e.   Avoiding smoking and alcohol consumption.

REFERENCES

1.   Permana, Hikmat.Patahunogenesis of Osteoporosis.Jurnal pdf.

2.   Jacobs, Dana et all. Osteoporosis. Available from:http://emedicine.medscape.com/article/330598-overview#aw2aab6b2b2.Updated:Oct

3.   Sabrina NM. Transisi epidemiologi dan dampaknya terhadap JKN, Available:ww.academia.edu/6051977/, (Acces: Agust 22, 2014).

4.   BPS. 2011. Proyeksi penduduk berdasarkan umur dan jenis kelamin tahu 2000-2025. Balai Pusat Statistik, Jakarta.

5.   Limpaphayom, Khunying Kobchitt ; Taechakraichana, Nimit; Jaisamrarn, Unnop; Bunyavejchevin, Suvit; Chaikittisilpa, Sukanya; Poshyachinda, Makrumkrong; Taechamahachai, Cheun; Havanond, Piyalamporn; Ontahunuam, Yupha; Lumbiganon, Pisake; Kamolratanakul, Pirom. (2001). Prevalence of osteopenia and osteoporosis in Tahunai women. Menopause: January 2001 - Volume 8 - Issue 1 - pp 65-69

6.   Siregar KN dan Swandono A, 1992.Transisi Demografi Indonesia Se Abad, Media Penelitian dan pengembangan Kesehatan, Vol 2, No.1 Mar (1992).

7.   BPS, 2013.Proyeksi Penduduk Indonesia (Indonesia Population Projection) 2000-2015, Badan Pusat Statistik, Jakarta-Indonesia.

8.   Fikawati, Sandra dkk. Faktor-Faktor yang Berhubungan dengan Asupan Kalsium pada Remaja di Kota Bandung. Jurnal Medicina;Vol.24 nomor 1, Januari 2005. 4,2013.25 Mei 2014.

9.   Kawiyana, Siki. Patogenesis Diagnosis dan Penanganan Terkini Osteoporosis. Jurnal Penyakit Dalam 2009;Vol.10 Nomor 2, Mei 2009.

10.   Yamaguchi, Toru. Plasma Lipids and Osteoporosis in Postmenopausal Women. Japan Endocrine Journal. Accepted October, 17 2008. Available from: http://www.jstage.jst.go.jp/article/endocrj/49/4/49_2_211/ article. Accesed May, 27 2014.

11.   Reza, Salamat,et al. Relationship between weight, body mass index, and bone mineral density in men refereed for dual=energy x-ray absorptiometry scan in Isfahan, Iran. Journal of osteoporosis. Volume 2013, Article ID 205963,7 pages. Accepted 29 August 2013. Available from: http://www.hindawi.com/journals/jos/2013/205963/.Accesed May,27 2014.