Artikel Penelitian

HUBUNGAN AKTIVITAS FISIK DAN KEBIASAAN MEROKOK TERHADAP MASSA TULANG PADA PEKERJA INDUSTRI LAKI-LAKI DI PADANG, SUMATERA BARAT

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Abstrak

Sebagian besar waktu yang dihabiskan oleh pekerja industri lebih banyak dihabiskan pada lingkungan kerja, sehingga seluruh aktivitas fisik dan gaya hidup seperti kebiasaan merokok, sangat mempengaruhi kualitas kesehatan pekerja. Massa tulang merupakan salah satu faktor yang mempengaruhi kualitas kesehatan seseorang. Penelitian ini ditujukan untuk menilai pengaruh aktivitas fisik dan kebiasaan merokok terhadap massa tulang, terutama pada pada pekerja industri laki-laki. Selain itu, penelitian ini ditujukan sebagai studi awal untuk mengidentifikasi variabel-variabel yang mempengaruhi massa tulang dan dasar untuk menentukan batas berat yang direkomendasikan oleh NIOSH Lifting Equation. Jumlah sampel yang diteliti sebanyak 93 orang pekerja laki-laki pada bidang industri manufaktur di Padang, Sumatera Barat. Penelitian dilakukan dengan menggunakan kuesioner untuk menentukan aktivitas fisik yang dilakukan pada tempat kerja, serta kebiasaan merokok, sedangkan pengukuran massa tulang dihitung menggunakan alat pengukur massa tulang. Hasil penelitian menunjukkan bahwa aktivitas fisik dan kebiasaaan merokok secara signifikan berpengaruh terhadap massa tulang ($p<0,05$), tertama untuk orang dewasa pada kategori umur yang lebih muda, khususnya pada pekerja industri laki-laki di Padang, Sumatera Barat.

Kata kunci: Aktivitas fisik, Kebiasaan merokok, Massa tulang

THE RELATIONSHIP OF PHYSICAL ACTIVITIES AND SMOKING HABIT ON BONE MASS AMONG MALE INDUSTRIAL WORKERS IN PADANG, WEST SUMATRA

Abstract

Labors, especially in industry, spend most of their time in the workplace. Several factors including physical activity and lifestyle of workers such as smoking habit in the workplace that will affect labors health. Besides that, bone mass is one of the factors that influence the health quality of workers, especially for hand-operated labor. This research aims to define the relationship between physical activity and smoking habit on bone mass in male industrial labors. The study is a preliminary study to recognize variables that influence bone mass and the base for defining the weight limit for lifting activities. This investigation was purposed determining physical activity and smoking habit of labors in the workplace, as well as calculating the bone mass of workers. The respondents required were 93 male labors in Padang, West Sumatra. Bone mass measuring tools were used to calculate labor's bone mass, while questionnaires were used to define the smoking habit of labors and physical activity. Physical activity, as well as smoking habit, were significantly affected the bone mass ($p<0.05$) of the workers. This study result explains that physical activity and smoking habit are factors that are associated with bone mass status for young male workers in Padang, West Sumatra.

Keywords: Physical activity, Smoking habit, Bone mass

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Introduction

The manufacturing industry in Indonesia is one of the essential industries that contribute to the country's economy. In the past years, the proportion of workers in the manufacturing sector has increased from 12.5 percent (2006) to 13.1 percent (2016). During this period around 3.7 million workers entered the manufacturing industry.[1] In small and medium industries, the manual labors often used in carrying out work activities; this is due to the inappropriate workstation design and the lack of use of manual material handling (MMH) aids for work. Furthermore, most of the time spent by industrial workers are in their workstations. Therefore, physical activity and smoking habit of industrial workers significantly affect their health quality including bone mass. It gives a negative and positive impact on the workers which is currently debated by researchers. The adverse effect is that if more work is done manually in an inappropriate way, it can cause injury to industrial workers.[2,3] That's why it is needed a suitable design of workstations and MMH tools to avoid the risk of musculoskeletal disorders. However, there is still a positive impact resulting from work activities conducted by workers. It can keep the bones healthy and prevent the decline in bone mass.

Skeletal muscles that performed human body action interpreted as physical activity.[4] It also means that raised physical fitness and energy expenditure, resulting from physiological characteristics based on behavior and affects human action.[5] According to the previous researcher, there was a clear observable indication that physical activity had a significant influence on bone strength. A relationship between physical activities with bone density disturbances had been carried out by Dimyati [6] where these results affirm that regular physical activity can influence bone mass. Bone requires pressure from exercise so that the process of bone formation is comparable to bone erosion. A simple movement such as walking does increase strong muscles and help build normal bone status. [7] Lower back pain tends to occur in people who rarely do a physical activity by 80.04 times more significant than respondents who are active in applying. [8]

Today, smoking as one of the crucial problems in occupational [9] and identified as an essential risk factor for health status in industrialized workers. [10] It has been explained that tobacco smoke can increase the risk of low back pain. [6,7,8] Research conducted by Patrianingrum, et al. [9] investigated that the smokers had a chance of 1,348 times for lower back pain compared with nonsmokers. The nicotine content in cigarettes causes thickening of the blood vessel walls which aggravates blood supply and nutrients to the tissues. Malnutrition cells due to nutritional supply will be disrupted and potentially damage due to reduced bone mineral density. [8] Dimyati [6] investigated the relationship between smoking habit and bone density disorders caused by the content of nicotine in cigarettes will inhibit estrogen secretion, stimulate estrogen damage in the organ, and accelerate the menopause. Besides that, the smoking habit will disrupt this protective effect of calcium on the bones because the content of heavy metal cigarettes will prevent the consumption of calcium and inhibit the work of osteoblasts and eliminate them from the blood circulation. [7]

Based on the previous studies it can be explained that physical activity and smoking habit affect bone mass and bone density. [6,7,8] Physical activity can increase bone mass while smoking habit has the opposite effect on bone mass. Donelly [11] investigated that structure, and attributes of tissue component provided to bone architectural integrity. An amount is the density of bone, while quality is bone size, mineral content and bone microarchitecture. Several factors including age and sex can affect bone mass factors. [12] Increasing with age shows the high proportions vertebrae degeneration. [13] Genetic factors, calcium consumption, exercise, hormonal, and a healthy lifestyle will influence bone mass. [14] Besides that, bone mass is also affected by age where the more a person ages, the higher the risk of bone degeneration. Mardiyah and Sartika [7] and Alghadir et al. [8] investigated that in early 30 years; the bone mass began to decline with a small amount of bone reduction in the spine which can cause musculoskeletal disorders. Besides, at the age of

50 years, there is 2.6 times chance to experience bone density disorders compared to respondents aged less than 50 years. Bones that have decreased mass can increase the likelihood of fractures. [15,16] Today, osteoporosis prevalence advances to expand throughout the world. Osteoporosis appears advanced in both gender and age, especially at the age of 50 years. [17,18]

Based on the elaboration, a hypothesis can be formulated to analyze the influence of smoking habit and physical activity in bone mass. It aims to determine the impact of the smoking habit and regular physical activity in bone mass status, especially for male industrial workers. The research can be used as a preliminary investigation to recognize variables that influence bone mass and the base for defining the weight limit during lifting activities. Also, as a consideration for the industrial world regarding the limitations of physical activity, especially manual material handling activities, which are carried out by workers to minimize the risk of injury as well as to prevent the occurrence of bone mass reduction.

Methods

The study was conducted out from June to August 2018 on male labors in Padang, West Sumatra, who most often carried out physical activities at the workplace. The chosen labors are ones who have high physical activity at work and have a smoking habit. The age of the labors was in the range of 18 to 50 years, which divided into two groups:(1)18–29 years, n=50, (2) 30-49 years, n=43.

The data collection started by distributing the physical activity and smoking habit questionnaires to the subjects. Questionnaires used were Smoking Habit and Baecke's questionnaire. A total score was the amount of Baecke's questionnaire scores from the past 12 months as the index of physical activity. Smoking Habits Questionnaires were answered with yes/no questions; data were obtained to analyze the specific, kind, and frequencies of smoking. Then, the body composition data (bone mass) were obtained using the Tanita Innerscan Model BC-541 scale. Based on the elaboration, it can be formulated to analyze the influence of smoking habit and physical activity on bone mass of young male industrial workers in Padang. All components of the respondents are presented in Table 1

$$\mathbf{n} = \frac{N}{1+Ne^2}$$

Where:
n= Samples
N= Population
E= Error tolerance

Population was 1.416 male labors in Padang. The study took a sampling error of 10%, and the sample size was:

n = 1416/1+1416 (0.10*0.10)
n = 1416/ 1+1416*0.01
n = 1416/1+14.16
n = 1416/15.16
n = 93

Then, the sample size was 93 samples.

The questionnaire assessed two components of lifestyle behaviors: physical activities (Baecke's questionnaire) and smoking habit. There are 16 questions in Baecke's questionnaire including three categories: (1) occupational (8 queries), (2) leisure score (4 queries), (3) leisure and locomotion (4 queries) from the past 12 months. Form the research, the respondents were male labors, this total score is the sum of three categories scores from the past 12 months as the index of physical activity. The category of physical activity was assessed from this total score into, (1) physically inactive (<7.5 physical activity score), (2) physically active (<7.5 physical activity score). [20] Smoking Habits Questionnaires were answered with yes/no questions; data were obtained to analyze the specific, kind, and frequencies of smoking.

Statistical analyses used SPSS Software version 16.0. Variables were assessed in determining means and standard deviations. Nonparametric parameters determining the Mann Whitney test, Student's t-test, and ANOVA. Verifying correspondences of physical activity, smoking habit, and bone mass were used Spearman Rank (ρ). Therefore, at the level of significance P-value < 0.05, the null hypothesis was rejected.

Results

Table 1 displays the distribution of respondent frequency based on research variables. Ninety-three subjects were participated from the total of 1416 workers in Padang, West Sumatera, with a tolerance limit of 10% using the Slovin formula. Tanita Innerscan Model BC-541 used for determining body weight (kg) and measuring tape used for determining body height (cm). Bodyweight (kg) divided by body height (m2) determined as Body mass index (BMI) (kg/m2). According in BMI category from Ministry of Health of Indonesia, every respondent was categorized into four groups: (1) underweight: <18.5 kg/m2 (2) normal weight; 18.5 to <25 kg/m2 (3) pre-obese; 25 to <27 kg/m2 (4) obese; ≥ 27 kg/m2. [20] Bone mass was measured based on their body weight, which are: (1) normal bone mass (bodyweight < 45 kg, normal bone mass = 2.5 kg; body weight = 45 kg – 60 kg, normal bone mass = 2.9 kg, and body weight > 60 kg, normal bone mass= 3.2 kg), (2) low bone mass (underweight of normal bone mass). According to bone mass status, the male respondents were categorized into two groups.

The respondents were categorized into two groups based on age; (1)18–29 years, n=50,(2)30-49 years, n=43. More than 82% of subjects (younger subjects) had a low bone mass, while 18% of the subjects were found to have normal bone mass. Associated with group 1, 79% of group 2 also had a low bone mass, and only 21% of the subjects were found to have normal bone mass.

In this study, almost all subjects had low bone mass. It caused by the classification of bone mass based on the participant's body mass and BMI. Based on body mass and BMI, almost all of the subjects had a low bone mass category. Based on Table 1, the mean of body weight in younger subjects was 56.12 ±11.06 kg, compared with older subjects with body weight was 60.87± 12.9 kg. From this study, there are significant effects of BMI status in abnormal BMI for both of group

The study also found that the ratios of younger subjects with a normal BMI (63%) were lower than those of older subjects (65%) respectively. Though, abnormal BMI profiles were related in group 2 (obesity=16%; pre-obesity=7%) compared with younger men (obesity=6%; pre-obesity=4%). Based on Table 2, it was shown that there was correlated positively by bone mass and osteoporosis. However, a younger group showed the highest proportions of low bone mass, body weight, and BMI. This could be the reason why there were the highest proportions of low bone mass of the young man from this research.

Table 2 displays the relationship matrix between the independent and dependent variables. According to BMI, age, body weight, physical activity level, and smoking habit, it shows that the bone mass of the respondents performed to increase. All these factors explain a significant association ($p<0.01$) in the overall sample also low bone mass sample. Furthermore, among the factors affected to bone mass in normal level, both BMI and body weight was correlated with bone mass ($p<0.01$), and the other variables such as smoking habit, physical activity, and age were correlated positively by normal bone mass sample ($p<0.05$). It can cause any sample of normal bone mass is about 18 samples from the total respondents, so if we add some data may affect the result. However, it shows that all variables correlated positively with bone mass variation ($p<0.05$) of the studied subjects and explained from 0.47 to 0.55 with a moderate positive correlation. Table 3 shows a significant increase in bone mass and physical activity for young male respondents (group 1) compared with old male respondents (group 2) ($p<0.01$). Furthermore, it shows that smoking habit correlated positively with age ($p<0.05$).

Table 4 shows that there is a relationship between smoking habit and physical activity with the bone mass ($p<0.05$). These results were suited with the previous study that reported the association between bone mass with persons with physically active. [6,7,8] Regular physical activity performed more critical as a determinant of bone mass. Bone mass of a physically active subject is significantly higher than the bone mass of a physically inactive subject ($p<0.05$). Furthermore, the data shows that smoking habit correlated positively with bone mass ($p<0.01$).

Table 1 Distribution of Respondent Frequency Based on Research Variables

Respondent Frequency Distribution Based on Research Variables		Group 1 (18–29 years) n=50		Group 2 (30-49 years) n = 43	
		Number	Mean ± Std. Deviation	Number	Mean ± Std. Deviation
Age (years)		50	23.16 ± 3.51	43	39.83 ± 7.96
Body Weight (kg)		50	56.12 ±11.06	43	60.87± 12.9
Body Height (cm)		50	163.9 ± 6.88	43	162.79 ± 6.2
Body Mass Index (kg/m2)		50	20.79 ±3.32	43	22.94± 4.58
Underweight (< 18.5 kg/m2)		14 (27%)	16.9 ± 0.86	5 (12%)	16.85 ± 1.67
Normal weight (18.5 to < 25 kg/m2)		31 (63%)	21.3 ± 1.6	28 (65%)	21.67 ± 1.67
Pre-obese (25 to < 27 kg/m2)		2 (4%)	25.5 ± 0.78	3 (7%)	25.6 ± 0.6
Obese (≥ 27 kg/m2)		3 (6%)	28.9 ± 1.12	7 (16%)	31.2 ±3.18
Bone Mass (kg)	Normal	9 (18%)	3.05 ± 0.25	9 (21%)	2.98 ± 0.257
	Low Bone Mass	41 (82%)	2.37 ± 0.21	34 (79%)	2.58 ± 0.231
Physical Activities	Inactive	2 (3%)	9.13 ± 0.00	6 (14%)	8.58 ± 0.398
	Active	48 (97%)	8.60 ± 0.385	37 (86%)	8.86 ± 0.347
Smoking Habit	No	19 (39%)	2.00 ± 0.00	27 (63%)	2.00 ± 0.00

Table 2 Correlation Matrix between Age, Body Weight, BMI, Physical Activity, Smoking Habit, Based on Bone Mass Status of the 93 Subjects.

Category	Bone Mass		
	Overall Sample	Low	Normal
Age (year)	0.256a	0.449a	0.33b
Body Weight (kg)	0.524a	0.60a	0.748a
Body Mass Index (kg/m2)	0.418a	0.457a	0.722a
Smoking Habit	0.715a	0.709a	0.467b
Physical activity	0.450a	0.554a	0.082b
Overall	0.47	0.55	0.47

a p<0.01
b p<0.05

Table 3 Statistical Test Results of Bone Mass, Smoking Habit, and Physical Activity with Age

Test Statistics(a)	Bone Mass	Smoking Habit	Physical Activity
Mann-Whitney U	679.00	808.50	739.50
Wilcoxon W	1954.00	2083.50	2014.50
Z	-3.07	-2.37	-2.61
Asymp. Sig. (2-tailed)	0.00	0.02	0.01

Table 4 Statistical Test Results of Smoking Habit and Physical Activity with Bone Mass

Test Statistics (a)	Physical Activity	Smoking Habit
Mann-Whitney U	461.50	345.00
Wilcoxon W	3311.50	3195.00
Z	-2.09	-3.71
Asymp. Sig. (2-tailed)	**0.04**	**0.00**

a Grouping Variable: Bone Mass category

Discussion

The study has found a relationship between physical activity and smoking habit on bone mass, especially for young male industrial workers in Padang, West Sumatra. The results show a difference in the overall sample based on age. Regular activity, smoking habit, and bone mass have a significant association with age. A significantly greater bone mass status was advised for young male labors who physically active ($p<0.05$) and did not smoke ($p<0.01$).

From the research, almost all subjects had low bone mass. It can be caused by classification of bone mass based on the participant's body weight and BMI. However, the younger groups showed the highest proportions of low bone mass, body weight, and BMI. It could be the reason why it was found the highest portions of low bone mass in this study. Some current researches have identified bone loss in young age. [21,18] Compiling data from the investigations indicates that immediate the loss of bone mass [21] influenced by different factors, such as lifestyle and hormonal. [21,18]

The study found a significantly normal bone mass for young male labors, who physically active ($p<0.01$). The influence of physical activity was different depending on age. In older subjects, the influence of physical activity on bone mass was smaller and less consistent. [29,31]) This study supports the other research that found there is an increase in bone status with various frequencies of physical activity in pre and peripubescent children. Most studies confirmed that activity at more young ages shows to have an important purpose in blocking bone loss in the old ages. [8] The results of the study that in early periods of age, exercise has a significant impact on bone improvement and maintain bone health status or prevent bone loss disorder in adulthood. [32]

The results of the subjects showed a correlation between regular physical activity and bone mass. There was a significant correlated and positively affected bone mass ($p<0.01$). In this study, almost all subjects had a high score for physical activity index. It was caused by the chosen subjects were ones who had high physical activity at work. They lifted and lowered the 19 kg load repetitively more than 8 hours of work a day. Muslimah [33] investigated that load constant for Indonesian people is 18.7 kg for lifting activities. The most commonly complained pain by workers is musculoskeletal disorders or low back pain [34] if there is not an improvement of the work system, such as the work shift, work rotation, manual material handling aids and equipment design to maintenance operator workloads. [35] Therefore, this could be the reason why the study resulted in a high score for physical activity index.

According to Mardiyah and Sartika, [7], we know that a substantial correlation between bone density and physical activity. Besides, Dimyati [6] studied the relationship between physical activities with bone density. It confirmed that exercise could prevent bone erosion. Other studies suggested that most adolescents and adults increase physical activity associated with bone density [36] The study also found that reductions the chance of falling among older adults. [37] Simple exercise such as walking can help build and maintain bone mass. [7] Lower back pain tends to occur in people who rarely do a physical activity by 80.04 times more significant than respondents who are active in applying it. [9]

The study shows the correlation between normal bone mass status among young male labor who did not smoke ($p<0.01$). However, bone

mass, physical activity, and smoking habit showed a significant association with age. Other studies suggested that most adolescents and adults who had a smoking habit associated with bone density. (38,39) This study shows an adverse influence on the smoking habit of bone mass among older subjects ($p<0.01$). Lately, previous research has been confirmed that smoking habit has the adverse result of smoking among labors, while indicated by a reduction in bone density. An effect of smoking habit on bone mass occurs mainly in trabecular bone and influence with hormones, where cigarettes produce significant anti-estrogenic effects among smoker women [40] whereas an increase in testosterone levels occurs in male smokers. [41-44] Based on the previous research, the smoking habit was a factor affecting bone mass.

According to the dependent variable (bone mass), and age, body weight, BMI, physical activity level, and smoking habit as independent variables, shows the significant correlation between dependent and independent variables. All these variables explained a correlation ($p<0.01$) in the overall sample also low bone mass sample. Furthermore, among the factors affected to bone mass in normal level, both BMI and body weight was associated with bone mass ($p<0.01$), and the other variables such as age, physical activity and smoking habit associated with normal bone mass ($p<0.05$). It can cause the sample of normal bone mass is about 18 samples from the total respondents, so if we add some data may affect the result. However, it shows that all variables correlated positively with all bone mass variation ($p<0.05$) of the studied subjects.

Bodyweight, BMI, age, smoking, and physical activity explained from 0.47 to 0.55 of the bone mass variation of the studied subjects. The components of physical activity, smoking habit, and body weight showed a moderate positive correlation across the studied groups. Compiling result from previous research, it shows that the immediate of bone loss has been published. (21) It is affected by different factors, such as lifestyle and hormonal. [21,28] This conclusion is confirmed by other research that there was a relationship between physical activity [6,7,9,39] and smoking habit affecting bone mass on male labors. [38,44] Furthermore, bone mass is correlated with the bodyweight which is obesity decreased the risk of osteoporosis and related to the low back pain risk factor. [45-47]

Conclusion

According to age, the results of the studied subjects showed a variation in the overall sample. Most studies confirmed that physical activity at a younger age seems to have an important purpose in preventing bone loss in the elderly. [21] The results of the study that in early periods of age, exercise has a significant impact on bone improvement and maintain bone health status or prevent osteoporosis in adulthood, [32] This research found the highest proportions of low bone mass in young age. Also, immediate bone loss in young age affected by different factors, such as lifestyle and hormonal. [21-28]

The study confirms that physical activity was associated with normal bone mass status. This result indicates that smoking habit and physical activity were associated with the bone mass ($p<0.05$) of the male industrial workers. Physical activity can build bone mass and restrict bone loss, while smoking habit can reduce bone mass due to nicotine contained in cigarettes. In summary, this study confirmed that body weight, BMI, age, physical activity, and smoking habit were variables that correlate with bone mass status in young male industrial workers in Padang, West Sumatra. The most commonly complained pain by workers is musculoskeletal disorders or low back pain [34] if there is not an improvement of the work system, such as the work shift, work rotation, manual material handling aids and equipment design to maintenance operator workloads. [35]

Decreased bone mass that occurs can cause injury to workers. The most commonly complained pain by workers is musculoskeletal disorders or low back pain. There are several injury preventions such as increasing food nutrition and improve the work system, by organizing the work shift, work rotation, manual material handling aids and equipment design to maintenance operator workloads. [35]

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References

1. Indonesia Jobs Outlook. Harnessing Technology For Growth And Job Creation ISBN: 978-92-2-030689-5. Jakarta: ILO. 2017.
2. Zadry HR, Dawal SZ. Future Research On Muscle And Mental Fatigue In Industry: A Mini Review. Proc 4th Kuala Lumpur Int Conf on Biomedical Engineering. Springer, Berlin, Heidelberg. 2008:794-797.
3. Zadry HR, Dawal SZ, Taha Z. Investigation Of Upper Limb Muscle Activity During Repetitive Light Task Using Surface Electromyography (SEMG). Conf Science and Technology for Humanity. Toronto: IEEE. 2009:230-233.
4. Taylor HL, Jacobs DR, Schucker B, et al. A Questionnaire For The Assessment Of Leisure Time Physical Activities. J Chronic Dis. 1978;3(12):741–755.
5. Paffenbarger Jr RS, Wing AL, Hyde RT. Physical Activity As An Index Of Heart Attack Risk In College Alumni. Am J Epidemiol. 1978;108(3):161–175.
6. Dimyati FK. Correlations Between Physical Activity, Smoking Habit And Attitude In Elderly With Incidence of Osteoporosis. J Epidemiology. 2017;5:1107-117.
7. Mardiyah S, Sartika ADR. Bone Density Disorders in Adults in Urban and Rural Areas. J National Public Health. 2014;8:6.
8. Alghadir H, Ahmad H, Gabr Sami A, et al. Physical Activity And Lifestyle Effects On Bone Mineral Density Among Young Adults: Sociodemographic And Biochemical Analysis. J Phys. 2015;27(T):2261–2270.
9. Patrianingrum M, Oktaliansah E, Surahman E. Prevalence and Risk Factors for Lower Back Pain in the Anesthesiology Workplace of Dr Hasan Sadikin Bandung. J Perioperative Anesthesia. 2015;1:47-56.
10. Parrott S, Godfrey C, Raw M. Costs Of Employee Smoking In The Workplace In Scotland. J Tob Control. 2000;9:187-192.
11. Donelly, E. Methods for Assessing Bone Quality. Symp. Bone Quality from Bench to Bedside. J Clin Orthop Relat. 2010;469:2128-2138.
12. Sorensen G, Pechacek T. Occupational And Sex Differences In Smoking And Smoking Cessation. J Occup Med. 1986;28:360-364.
13. Brinjikji W, Luetmer PH, Comstock B, et al. Systematic Literature Review of Imaging Features of Spinal Degeneration in Asymptomatic Populations. J Neuroradiol. 2015;36(4):811–816.
14. Davies JH, Evans BAJ, Gregory JW. Bone Mass Acquisition In Healthy Children. J Arch Dis Child. 2005;90:373–378.
15. Ralston SH. Bone Mass Through The Lifespan In Women's Health Medicine. J Elsevier. 2006;3(4):145–148.
16. Korkmaz N, Tuto□lu A, Korkmaz I, et al. The Relationships Among Vitamin D Level, Balance, Muscle Mass, And Quality Of Life In Postmenopausal Patients With Osteoporosis. J Phys Ther Sci. 2014;26:1521–1526.
17. Melton LJ 3rd. Epidemiology Worldwide. J Endocrinol Metab Clin North Am. 2003;32:1–13.
18. Bonura F. Prevention, Screening, And Management Of Osteoporosis: An Overview Of The Current Strategies. J Postgrad Med. 2009;121:5–17.
19. Patarianto P. Service Quality Analysis of Customer Satisfaction at Pt.Bank Mandiri (Persero) Tbk. Sidoarjo Gedangan Branch. J. Maksipreneur. 2015;6(2):28-37.
20. Baecke JAH, Burema J, Frijters ER. A Short Questionnaire For The Measurement Of Habitual Physical Activity In Epidemiological Studies. J Clin Nutr. 1982;36:936-942.
21. Specker LB, Wey E, Howard M, et al. Rates Of Bone Loss In Young Adult Males. J Clin Rheumatol. 2010;5(2):215–228.
22. Emaus N, Berntsen GKR, Joakimsen RM, et al. Longitudinal Changes In Forearm Bone Mineral Density In Women And Men Aged

25–44 Years. J Epidemiol. 2005;162:633–643.
23. Lauretani F, Bandinelli S, Griswold ME. Longitudinal Changes In BMD And Bone Geometry In A Population-Based Study. J Bone Miner Res. 2008;23:400–408.
24. Khosla S, Amin S, Orwoll E. Osteoporosis In Men. J Endocr. 2008;29:441–464.
25. Riggs BL, Melton JIII, Robb RA, et al. Population-Based Study Of Age And Sex Differences In Volumetric Bone Density, Size, Geometry, And Structure At Different Skeletal Sites. J Bone Miner Res. 2004;19:1945–1954.
26. Bakker I, Twisk JWR, Mechelen W, et al. Fat-Free Body Mass Is The Most Important Body Composition Determinant Of 10-Yr Longitudinal Development Of Lumbar Bone In Adult Men And Women. J Clin Endocrinol Metab. 2003;88:2607-2613.
27. Nordstrom P, Neovius M, Nordstrom A. Early And Rapid Bone Mineral Density Loss Of The Proximal Femur In Men. J Clin Endocrinol Metab. 2007;92:1902–1908.
28. Tervo T, Nordstrom P, Neovius M, et al. Constant Adaptation Of Bone To The Current Physical Activity Level In Men: A 12-Year Longitudinal Study. J Clin Endocrinol Metabol. 2008;93:4873–4879.
29. Gunter K, Baxter-Jones AD, Mirwald RL, et al. Jump Starting Skeletal Health: A 4-Year Longitudinal Study Assessing The Effects Of Jumping On Skeletal Development In Pre And Circum Pubertal Children. J Bone. 2008;42:710–718.
30. Wallace BA, Cumming RG. Systematic Review Of Randomized Trials Of The Effect Of Exercise On Bone Mass In Pre- And Postmenopausal Women. J Calcif Tissue Int. 2000;67:10–18.
31. Kim IG, So WY. The Relationship Between Household Income And Physical Activity In Korea. J Phys Ther Sci. 2014;26:1887–1889.
32. Bass S, Pearce G, Bradney M, et al. Exercise Before Puberty May Confer Residual Benefits In Bone Density In Adulthood: Studies In Active Prepubertal And Retired Female Gymnasts. J Bone Miner Res. 1998;13:500–507.
33. Muslimah E. Analysis of Constant Load (LC) in the Revised NIOSH Lifting Equation. Yogyakarta: Gadjah Mada University Press 2008.
34. Mutia, M. Measurement of Physiological and Psychological Workload on Tea Picking Operators and Green Tea Production Operators in Mitra Kerinci. J Optimizations of Systems at Industries. 2014:13(1):503-517.
35. Arimnas. Work Posture Analysis of Sack Lifting Activities at PT. Indofood CBP Sukses Makmur Tbk. Makassar Branch. J Optimizations of Systems at Industries. 2017;16(1):58-67.
36. Nordström A, Karlsson C, Nyquist F, et al. Bone Loss And Fracture Risk After Reduced Physical Activity. J Bone Miner Res. 2005;20:202–207.
37. Tanaka R, Ozawa J, Umehara T. Exercise Intervention To Improve The Bone Mineral Density And Bone Metabolic Markers As Risk Factors For Fracture In Japanese Subjects With Osteoporosis: A Systematic Review And Meta-Analysis Of Randomized Controlled Trials. J Phys Ther Sci. 2012;24:1349–1353.
38. Daniell HW. Osteoporosis Of The Slender Smoker. Vertebral Compression Fractures And Loss Of Metacarpal Cortex About A Postmenopausal Cigarette. J Arch Intern Med. 1976;136(3):298-304.
39. Andersen FS, Transbøl I, Christiansen C. Is Cigarette Smoking A Promotor Of The Menopause?. J Acta Med Scand. 1982;212:137–139.
40. Sneve M, Emaus N, Joakimsen RM, et al. The Association Between Serum Parathyroid Hormone And Bone Mineral Density, And The Impact Of Smoking: The Tromso Study. J Endocrinol. 2008;158:401–409.
41. Hannan MT, Felson DT, Dawson-Hughes B, et al. Risk Factors For Longitudinal Bone Loss In Elderly: The Framingham Osteoporosis. Study. J Bone Miner Res. 2000;15: 710–720.
42. Ward KD, Klesges RC. A Meta-Analysis Of The Effects Of Cigarette Smoking On Bone Mineral Density. J Calcif Tissue Int. 2001;68:259–270.
43. Kapoor D, Jones TH. Smoking And Hormones In Health And Endocrine Disorders. J Endocrinol. 2005;152:491–499.

44. Lorentzon M, Mellström D, Haug E, et al. Smoking Is Associated With Lower Bone Mineral Density And Reduced Cortical Thickness In Young Men. J Clin Endocrinol Metab. 2007;92:497–503.
45. Shiri R, Karppinen J, Leino-Arjas P, et al. The Association Between Obesity and Low Back Pain: A Meta-Analysis. J AJE. 2009;171(2):135-151.
46. Vismara L, Menegoni F, Zaina F, et al. Effect Of Obesity And Low Back Pain On Spinal Mobility: A Cross-Sectional Study In Women. J NeuroEngineering and Rehabilitation. 2010;73.
47. Purnamasari H, Gunarso U, Rujito L. Overweight as a Low Back Pain Risk Factor in Poly Nerve Patients at RSUD Prof. Dr. Margono. J Mandala of Health. 2010;4(1):26-32.