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The Relation between Body Mass Index and Knee Osteoarthritis in Pre-Elderly to Elderly at Orthopedic Poly of Dr. Mohamad Soewandhie Regional Public Hospital Surabaya

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ABSTRACT Osteoarthritis is a degenerative joint disease characterized by painful joints, particularly prevalent in older individuals, attributed to mild inflammation resulting from bone-end friction. A study conducted in Surakarta revealed a 4.9-fold increase in osteoarthritis risk among individuals with a BMI >25 compared to those with a BMI of 18.5-25.0. This research aims to investigate the association between knee osteoarthritis and BMI among elderly patients at the orthopedic outpatient clinic of Sesyapdhio Hospital, Surabaya. Using cross-sectional observational analysis, osteoarthritis patients were identified. The findings indicate a correlation between higher BMI and increased severity of osteoarthritis, contrasting with milder cases observed in individuals with normal BMI. Spearman's rank correlation review revealed a strong positive correlation (r=0.554) between BMI and osteoarthritis severity at Sexygandhio Hospital Surabaya. This study's unique contribution lies in its focused exploration of the relationship between BMI and osteoarthritis severity in elderly patients, offering insights into potential interventions tailored to BMI-specific risk profiles.

INDEX TERMS Body Mass Index, Knee Osteoarthritis, Elderly

I. INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease in which the joints feel painful due to mild inflammation that arises from piercing the ends of the bones that make up the joints, which is especially common in elderly people. Current treatments only serve to reduce pain and maintain the function of the affected joint. There are three main goals to be achieved in the osteoarthritis therapy process, namely to control pain and other symptoms, to overcome interference with daily activities, and to inhibit the disease process. Treatment options may include exercise, weight control, joint protection, physical therapy and medications. If all of these therapy options do not provide results, consideration can be given to discontinuing the affected joint [1].

This disease causes pain and disability in sufferers, disrupting daily activities. Osteoarthritis is a joint disease that is most commonly found in the world. Based on the National Centers for Health Statistics, an estimated 15.8 million (12%) adults between the ages of 25-74 years have complaints of osteoarthritis. The prevalence and severity of osteoarthritis varies between the elderly and the elderly. Primary or generalized osteoarthritis is generally familial and can also attack the joints of the hand, especially the distal interphalangeal (DIP) and proximal interphalangeal (PIP) joints [2].

According to the World Health Organization (WHO) in 2016, it is known that 162 million people worldwide and up to 27 million people in Southeast Asia suffer from osteoarthritis. The total prevalence of osteoarthritis in Indonesia was 34.3 million people in 2011 and reached 36.5 million people in 2016. It is estimated that 40% of the population aged over 70 years suffer from osteoarthritis, and 80% of osteoarthritis patients have mobility limitations ranging from mild to severe. Resulting in reduced quality of life. Due to its chronic-progressive nature, osteoarthritis has a large socio-economic impact, both in developed and developing countries. Estimated 1 to 2 million elderly people in Indonesia suffer from disabilities due to osteoarthritis. According to the results of research conducted in Surakarta, it is stated that a Body Mass Index > 25 (overweight) has a

risk of developing osteoarthritis 4.9 times greater than elderly people with a Body Mass Index of 18.5-25.0 [1]. Osteoarthritis is caused by various factors, including age, mechanical stress or excessive use of joints, anatomical, humoral, genetic, metabolic, traumatic defects, body mass index (BMI), endocrine disorders, primary joint disorders, and cultural factors [3].

Body Mass Index (BMI) is one of the strongest modifiable risk factors for osteoarthritis, especially in the knee joint. Increased body weight will increase the load on the knee joints. Being overweight is a form of malnutrition that is often found among people with high socio-economic groups. Overweight is defined as a condition that is close to obesity. A person can be declared overweight if that person has a BMI between 25 and 39.9. Excess weight is the result of an imbalance between energy intake and energy used. This imbalance is influenced by consumption patterns, age, gender and physical activity. Accumulation of body fat generally occurs in the lower abdominal area, upper legs and upper arms [4]. Based on 2018 Basic Health Research (Riskesdas) data, the epidemiology of obesity in people over 18 years of age is around 21.8%. This figure is expected to continue to increase. Obesity is associated with a significant increase in mortality with a reduction in life expectancy of 5-10 years. The high rate of obesity sufferers aged >25 years, including old age, is caused by the passage of time as we get older, several changes occur in the body, the body's metabolism decreases (metabolic syndrome), and fat in the body increases. Being overweight (obese) has a high risk of developing osteoarthritis, especially those who become obese after the age of 50 and were thin when they were young [5]. Obesity is one of the drivers of osteoarthritis (calcification of the joints). This happens because fat deposits in the body can lie on the joints, hips, waist and especially the knees. The osteoarthritis experienced has a prognosis that can cause pain, where the joints feel painful due to mild inflammation that arises from piercing the ends of the bones that make up the joint, causing a decrease in daily activities that can result in death. A person's response to pain is different so that the nature of pain is subjective, and the degree of pain can only be measured through the confession of the person who feels it [6].

Based on the description above, it can be seen that osteoarthritis is a health problem that is very important to pay attention to because it has a fairly high morbidity rate and greatly affects a person's quality of life. Pain complaints experienced by osteoarthritis sufferers are thought to be related to their body mass index. However, until this research proposal was made, there had been no research at the Soewandhie Hospital Surabaya orthopedic clinic investigating this. Therefore, researchers are interested in conducting this research, as well as making this research important to research.

II. METHODS

The study was conducted at the orthopedic outpatient clinic of Soewandhie Hospital, Surabaya, from August to November 2022. The population comprised pre-elderly to elderly patients diagnosed with knee osteoarthritis and attending the clinic. Inclusion criteria included patients with available BMI records and a confirmed diagnosis of knee osteoarthritis. Exclusion criteria involved patients with incomplete medical records or comorbidities affecting BMI or osteoarthritis severity. A cross-sectional observational analysis was employed using non-probability purposive sampling. Medical records of eligible patients (n=38) were reviewed to collect data on age, gender, BMI, and degree of osteoarthritis. Collected data were organized into tabulated formats according to each variable. BMI categories were delineated based on standard classifications. Age was recorded in years, and the degree of osteoarthritis was categorized according to clinical assessments documented in medical records. The Spearman correlation method was utilized to analyze the association between independent variables (age, gender, BMI, and degree of osteoarthritis) and the dependent variable (severity of knee osteoarthritis). Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS). Ethical clearance for this study was obtained from the Institutional Review Board of Soewandhie Hospital Surabaya, with approval number [insert approval number].

III. RESULT

In this study, we will analyze the relationship between Body Mass Index and osteoarthritis in the pre-elderly to the elderly at the orthopedic clinic at RSUD dr. Mohamad Soewandhie Surabaya using medical record data for the period August – November 2022. The following is the distribution of characteristics of pre-elderly to elderly people suffering from osteoarthritis at the orthopedic polyclinic at RSUD dr. Mohamad Soewandhie Surabaya who used a sample of 38 people. Based on (TABLE 1), It shows that patients suffering from osteoarthritis at the orthopedic clinic at Soewandhie Hospital Surabaya August to November 2022 consisting of ages 45 years to 60 years and above. The majority of patients suffering from osteoarthritis are over 60 years old with a percentage of 65.8% (25 people). Meanwhile, patients aged 45 years – 59 years amounted to 34.2% (13 people). Female osteoarthritis patients amounted to 73.7% (28 people), which was more than male patients, only 26.3% (10 people). Osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya has various grades of osteoarthritis, namely grade I amounting to 18.4% (7 people), grade II amounting to 50% (19 people), grade III amounting to 23.7% (9 people) and grade 4 amounting to 7.9 % (3 people). Patients suffering from osteoarthritis at the orthopedic clinic at Soewandhie Hospital Surabaya August to November 2022, most of them have grade II osteoarthritis. Osteoarthritis sufferers have various characteristics of body mass index (BMI) from mild levels of underweight to severe levels of overweight. The majority of patients suffering from osteoarthritis had a BMI in the mild overweight category with a percentage of 36.8% (14 people). Patients suffering from osteoarthritis who had a normal BMI category and a severe level of overweight each had a percentage of 28.9% (11 people). The lowest number of patients suffering from

osteoarthritis who had a BMI in the mild underweight category was 5.3% (2 people). The following are the BMI characteristics of osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya August to November 2022 based on age, gender and osteoarthritis grade.

TABLE 1
Distribution of Characteristics of Osteoarthritis Sufferers in the Orthopedic Polyclinic, RSUD dr. M. Soewandhie Surabaya August to November 2022

Characteristics	Total	Percentage (%)
Age		
45-59 year	13	34,2
≥ 60 year	25	65,8
Gender		
Male	10	26,3
Female	28	73,7
Osteoarthritis Grade		
I	7	18,4
II	19	50,0
III	9	23,7
IV	3	7,9
BMI		
Mild underweight	2	5,3
Normal	11	28,9
Mild overweight	14	36,8
Severe overweight	11	28,9

A. CHARACTERISTICS OF RESEARCH SUBJECTS

TABLE 2
Characteristics of osteoarthritis sufferers at the orthopedic clinic at RSUD dr. M. Soewandhie Surabaya August to November 2022 based on BMI

Characteristics	IMT		
	Min	Max	Mean+ SD
Age	18,87	29,09	24,18 ± 3,23
45-59 year			
≥ 60 year	17,46	34,52	25,21 ± 4,85
Gender			
Male	18,87	34,52	26,70 ± 4,44
Female	17,46	32,02	24,20 ± 4,19
Osteoarthritis Grade			
I	17,46	24,89	22,03 ± 2,75
II	17,47	31,10	23,78 ± 4,03
III	23,32	31,77	27,24 ± 3,20
IV	26,89	34,52	31,14 ± 3,89
BMI			
Mild underweight	17,46	17,47	17,47 ± 0,01
Normal	18,87	22,85	20,84 ± 1,29
Mild overweight	23,28	26,96	24,80 ± 1,43
Severe overweight	27,70	34,52	30,29 ± 2,08

Based on (TABLE 2), it shows that osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya who is over 60 years old has a mean BMI of 25.21 + 4.85, which is higher than osteoarthritis sufferers aged 45-59 years who have a BMI of 24.18 + 3.23. Male osteoarthritis sufferers have a mean BMI of 26.70 + 4.44, which is higher than female osteoarthritis sufferers who have a lower BMI, namely 24.20 + 4.19.

B. THE RELATION BETWEEN BODY MASS INDEX AND OSTEOARTHRITIS

The relation between body mass index and osteoarthritis was analyzed using the Spearman method. This method was chosen because two variables have a categorical scale and are not paired. This hypothesis test was carried out in the SPSS version 22 application.

(TABLE 3) Shows that the proportion experiencing grades III and IV osteoarthritis in research subjects who were obese and had an excessive BMI was significantly greater than in research subjects with a normal and deficient BMI. The results of the analysis showed a relationship between BMI and osteoarthritis (p=0.001). The strength of the relationship shown is included in the strong category in the opposite direction (r = - 0.506). This shows that research subjects who have an obese BMI will tend to experience a more severe degree of osteoarthritis, while research subjects who have a lower BMI tend to experience a milder degree of osteoarthritis.

(TABLE 4) Shows that the proportion experiencing osteoarthritis grades III and IV in research subjects with overweight BMI, both severe and mild, was significantly greater than in research subjects with normal and deficient BMI. The results of the analysis showed a relationship between BMI and osteoarthritis (p = 0.009). The strength of the relationship shown is in the medium category with the opposite direction (r = -0.419). This shows that research subjects who have an excess BMI will tend to experience a more severe degree of osteoarthritis. This shows that research subjects who have an excess BMI will tend to experience a more severe degree of osteoarthritis while research subjects who have a normal BMI deficiency will tend to experience a milder degree of osteoarthritis.

(TABLE 5) shows that the results of the correlation test between BMI and osteoarthritis grade in osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya has a correlation coefficient value or r = 0.554 which is close to 1, indicating that the level of correlation relationship has a positive direction and is quite strong. The test results have a value (p = 0.000) < 0.05, which means there is a significant correlation between BMI and osteoarthritis grade in osteoarthritis sufferers at the orthopedic polyclinic at Soewandhie Hospital Surabaya. Based on the results of statistical tests, it shows that the relationship between the two is significant and positive, where if a person's BMI increases, the osteoarthritis grade has the potential to increase.

TABLE 3
Relationship between Body Mass Index Based on WHO Classification and Osteoarthritis

		Osteoarthritis				Total	*p*	*r*
		I	II	III	IV			
IMT Obesity	N	0	5	4	2	11	0,001	-0.506
	%	0	45,5	36,4	18,2	100		
Overweight	N	3	5	5	1	14		
	%	21,4	35,7	35,7	7,1	100		
Normal	N	3	8	0	0	11		
	%	27,3	72,7	0	0	100		
Underweight	N	1	1	0	0	2		
	%	50	50	0	0	100		
Total	N	7	19	9	3	38		
	%	18,4	50	23,7	7,9	100		

TABLE 4
Relationship between Body Mass Index Based on Indonesian Ministry of Health Classification and Osteoarthritis.

			Osteoarthritis				Total	*p*	*r*
			I	II	III	IV			
IMT	**Severe Overweight**	**N**	0	5	4	2	11	0,009	-0.419
	%		0	45,5	36,4	18,2	100		
	Mild Overweight	**N**	0	2	1	1	4		
	%		0	50	25	25	100		
	Normal	**N**	6	11	4	0	21		
	%		28,6	52,4	19	0	100		
	Underweight	**N**	1	1	0	0	2		
	%		50	50	0	0	100		
Total	**N**		7	19	9	3	38		
	%		18,4	50	23,7	7,9	100		

TABLE 5
Correlation of Spearman rank BMI and osteoarthritis grade at the orthopedic clinic at Soewandhie Hospital Surabaya

Variable	*r*	*p*	Note
IMT and Osteoarthritis grade	0,554	0,000*	Significant
IMT and Osteoarthritis grade (male)	0,110	0,762	Not significant
IMT and Osteoarthritis grade (female)	0,539	0,003*	Significant

Note: *p < 0.05 (significant)

IV. DISCUSSION

Osteoarthritis is a degenerative arthritis of the weight-bearing joints that is often found in the elderly population. Osteoarthritis of the knee is a major cause of joint pain and problems in daily function. This patient's knee pain and physical function were expected to worsen based on knee characteristics, clinical factors, and psychosocial factors. Excess body weight is one of the factors involved in the pathogenesis of this disease [7]. Considering the high morbidity rates of osteoarthritis and obesity accompanied by the increasing elderly population in Indonesia. This is important to analyze.

This research shows that the proportion of elderly who experience osteoarthritis genu grades III and IV in elderly with obese and excess BMI is significantly greater than in elderly with normal and deficient BMI. The results of the analysis showed a relationship between BMI and osteoarthritis genu (p = 0.001). The strength of the relationship shown is included in the strong category with the opposite direction (r = - 0.506). This shows that elderly people who have an obese BMI will tend to experience a more severe degree of genu osteoarthritis, while elderly people who have a deficient BMI will tend to experience a milder degree of genu osteoarthritis.

Another analysis in this study also found that the proportion experiencing genu osteoarthritis grades III and IV in elderly with overweight BMI, both severe and mild, was significantly greater than in elderly with normal and deficient BMI. The results of the analysis showed a relationship between BMI and osteoarthritis genu (p= 0.009). The strength of the relationship shown is in the medium category with the opposite direction (r = -0.419). This shows that elderly people who have an excess BMI will tend to experience a more severe degree of genu osteoarthritis, while elderly people who have a normal deficient BMI will tend to experience a milder degree of genu osteoarthritis.

These results are in line with a study conducted by Setyomukti (2015) in Jakarta. This study, with a cross-sectional design involving 83 patients, aimed to find a correlation between osteoarthritis and obesity. One of the results of this study found that there was a relationship between obesity and osteoarthritis (p = 0.035). Individuals who have a BMI > 30 kg/m2 will have a higher risk of experiencing bilateral genu osteoarthritis [8].

The reference group BMI is an important factor in establishing COPs for low muscle mass [9].This research coincide with a research that shows age-related pro-inflammatory mediators sources that affecting osteoarthritis include a combination of factor, such as adipose tissue, as well as reduced cell activity as we age within joint tissues (cell senescence). Although cell senescence mechanism can be linked with age, inflammation, and OA, there is only small evidence that it can occur together with normal aging in joint tissues. This study points out that since osteoarthritis is a chronic disease that prevalent increases as we age, it is not easy to separate age effect and that of a disease, especially that affect human tissue [10].

Similar results were also reported in research conducted by Duha (2019) in Yogyakarta. This research with a cross sectional design involving 33 patients aims to determine the relationship between individual factors such as age, gender, body mass index (BMI) and lifestyle in knee osteoarthritis sufferers at PKU Muhammadiyah Gamping Hospital. One of the results of this study found that there was a relationship between body mass index and osteoarthritis (p < 0.001). The greater the individual's BMI, the greater the possibility of experiencing more severe osteoarthritis genu [11].

Literature research conducted show that woman are more susceptible despite the weight because of hormonal factor such as progesterone. This research found that progesterone receptors are expressed in chondrocytes and inside of chondroprogenitor cells. This indicate that progesterone imbalance or uneven distribution load, cause changes in subchondral bone structure that affect the cartilage and promotes wear and tear that degrades cartilage which causes female to have higher chance to have this condition compared to men [12].

Another study conducted by Roy (2021) in Bangladesh also found similar results. Research with a cross sectional design involving. The aim of these 100 female patients was to determine the relationship between age and BMI and osteoarthritis genu in elderly women. One of the results of this research found that there is a relationship between body mass index and osteoarthritis, namely that elderly women who have a BMI ≥ 25 kg/m2 will have a greater chance of experiencing more severe osteoarthritis [13]. Another research made across ethnicities and type of gender shown that higher BMI is associated with greater visceral adiposity. Which altered metabolic and hormonal state that increased fragility of the bone. This altered structure shown to be more prevalent in female, even younger one that high central adiposity. Which causes female to have been impacted in higher number than men. [14]. A study to understand osteoarthritis susceptibility between male and female, shows possibly reproductive factor and sex hormone affect degeneration differently. But even so its uncertain whether it affect directly by hormonal factor or other factor that affect this factor. [15]

Anatomical differences between male and female also affecting the susceptibility with its smaller dimension and parameter on its joint. The likelihood of women to use healthcare may also affect how gender influences osteoarthritis in general [16]. Theoretically obesity become the main factor for osteoarthritis as it is increased both stress on the joint (mainly knee) and increasing inflammation which degenerates the cartilage at certain exposure. Each pound is stated to add 3 pounds of stress that pressurized weight bearing joint cartilage which increases the pain and the need to replace joint [17]. Studies show that metabolic factors might contribute substantially to pathogenesis of ostheoarthritis. There is significant relationship between knee OA and the metabolic syndrome [18]. High fat intake induces severe disorganization of tissue architecture in the synovium, along with macrophage infiltration [19]. Osteoarthritis is caused by many factors, namely age more than 57 years, female sex and menopause, obesity, genu varum or genu valgum, cardiovascular risk factors, were the main risk factors associated [20]

In theory, biological changes occur in the tissue in the genu. The first damage occurs to changes in the articular cartilage which is composed of hyaline cartilage, an avascular, aneural structure with a low coefficient of friction that allows compressibility. In the early stages of OA, fibrillation and swelling of the cartilage surface is associated with chondrocyte clustering, increased chondrocyte proliferation and increased production of extracellular matrix (ECM) proteins. As the disease progresses, cartilage destruction extends into deeper layers, resulting in delamination of hyaline cartilage and exposure of calcified cartilage and underlying subchondral bone. Increased BMI has been reported to be associated with impairment which is heavier in this hyaline cartilage tissue [21]. Obese conditions induce the accumulation of pro-inflammatory macrophages in the synovium and fat joint cushion tissue. The resulting macrophage population becomes pro-inflammatory increase the occurrence of OA [22].

Subsequent damage occurs in the osteochondral tissue, which is a gradient tissue between the stiff bone tissue and the softer viscoelastic articular cartilage in the osteochondral unit. Osteochondral tissue plays an important role in maintaining the integrity of the osteochondral unit by transmitting mechanical forces and preventing the movement of large molecules. However, this area is believed to be weak because there are no connecting collagen fibers between the calcified cartilage and the subchondral bone. Under high compression, for example in obesity, the articular cartilage can deform. This suggests that mechanical factors play a key role in the pathogenesis of obesity-related OA [21] Osteoarthritis (OA) is a multifactorial joint disease with pathological changes that affect whole joint tissue [23]

Increased weight also reduced the expression of certain protein which have a role of suppressing osteoarthritis. Studies of alpha klotho in mice in controlled environment, one is deprived of alpha klotho expression. Show that mice without alpha klotho show problems on its cartilage and bones. This concluded that alpha klotho have chondroprotective effect. [24]. Increased body weight and metabolic changes, contribute to the accelerated progression of OA in Rat [25]

In obese patients, the percentage of macrophages in adipose. Tissue can reach 50% of all adipose tissue cells, whereas in lean individuals there are only macrophages only 5%. [26]. There is a known important role of micro RNAs as mediators of obesity and IR related inflammation and how omega-3 polyunsaturated fatty acids can be used as a nutritional intervention for these disorders. [27]. Another study supported this by showing that depletion in certain protein show severe defect in homeostasis. Study suggest this protein might have the ability to delay the onset of OA by regulating weight gain. [28]. Despite that, another research show that relationship between protein expression and increased weight that affect OA is a two-way relationship. Research done on the effect of metabolism is shown that this protein called alpha klotho is essential in energy regulation, resulted in an opposite correlation between the secreted expression of alpha with BMI and increased body weight. [29]. However, despite the data suggest a link between this protein, weight and osteoarthritis in general, another analysis made by French research institute points out that the pathophysiology between alpha klotho is largely unknown. This suggest the worsening of OA grade might not be caused by weight alone on molecular level [30]

This research has several limitations. First, this study uses a cross-sectional design which is not appropriate for analyzing cause-and-effect relationships between variables. However, this design is the most superior design for determining the prevalence of a phenomenon in the population. Second, this research finds it difficult to get rid of research confounding variables because the various confounding variables are closely embedded and impossible to separate completely from the research subjects.

V. CONCLUSION

This study demonstrates a significant relationship between body mass index (BMI) and the severity of knee osteoarthritis in elderly individuals. Findings indicate that obese or overweight elderly patients tend to experience a more severe degree of knee osteoarthritis compared to those with a normal or lower BMI. Conversely, elderly individuals with a deficient BMI are prone to milder forms of knee osteoarthritis. These results underscore the importance of BMI management in the prevention and management of knee osteoarthritis among elderly populations. Implementing strategies to maintain a healthy BMI may potentially mitigate the progression of knee osteoarthritis and improve the quality of life for elderly individuals. Further longitudinal studies are warranted to validate these findings and explore targeted interventions tailored to BMI-specific risk profiles in knee osteoarthritis management.

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