The Relationship Between Body Mass Index (BMI), Gender and Hypertension With The Incidence of Knee Osteoarthritis at North Lombok Regency Hospital

Muhammad Aron Baihaqi[1*], Rohmania Setiarini[2], Henry Pebruanto[3], Deny Sutrisna Wiatma[4]

[1,2,3,4] Faculty of Medicine, Al-Azhar Islamic University, Mataram, Indonesia.
[*] Corresponding author:
Email: muhammadaron63@gmail.com

Abstract.

Osteoarthritis (OA) of the knee is a degenerative joint disease that often occurs in old age and is one of the main causes of pain and limited mobility. The incidence of knee OA is influenced by various risk factors, including body mass index (BMI), gender, and hypertension, but the results of studies related to these factors still show differences in findings. In North Lombok Regency, data on risk factors for knee OA is still limited. This study aims to analyze the relationship between BMI, gender, and hypertension with the incidence of knee osteoarthritis at North Lombok Regency Hospital. This study uses an analytical observational design with a case control approach. The case group consists of 54 patients who were diagnosed with knee osteoarthritis and underwent treatment at the North Lombok Regency Hospital in the period of July 2024-July 2025. The control group consisted of 54 people who were patients of the Internal Medicine Polyclinic of the North Lombok Regency Hospital in August 2025 who did not suffer from knee osteoarthritis. Sampling of the control group was carried out using purposive sampling techniques based on inclusion and exclusion criteria. Data were obtained from the patient's medical records and analyzed using univariate and bivariate analyses to assess the relationship between independent variables and the incidence of knee OA. he results of this study are expected to show the relationship between BMI, gender, and hypertension with the occurrence of knee osteoarthritis, and to support prevention and treatment efforts for knee osteoarthritis at North Lombok Regency Hospital.

Keywords: *Knee osteoarthritis; body mass index; gender; hypertension and case control.*

I. INTRODUCTION

Osteoarthritis (OA) is a degenerative disease that involves damage to the cartilage of the joints. The vertebrae, pelvis, knees and ankles are most commonly affected by OA. OA patients usually complain of pain during activities or when there is a load on the affected joint. In more severe degrees, pain can be felt continuously, so it greatly interferes with the patient's mobility. The occurrence of OA is influenced by risk factors, namely age, genetics, obesity, joint injury, occupation, exercise, anatomical abnormalities, metabolic diseases, and inflammatory diseases of the joints. The disease is slowly progressive, characterized by joint cartilage degeneration, hypertrophy of the peripheral bones, subchondral bone sclerosis, changes in the synovial membrane, and accompanied by pain after prolonged activity, and stiffness especially in the morning or after activity (Tang et al., 2025).Osteoarthritis is the most common joint disease in the United States. Symptomatic knee osteoarthritis occurs in 13% of men and 15% of women who are ≥ 60 years of age (Lawrence RC., 2014). According to WHO data, about 10% of men and 18% of women over the age of ≥60 years have clinical OA, especially in the knee and hip joints. The number of sufferers tends to increase due to the aging of the population. The prevalence of radiological knee OA in the United States in adults aged ≥45 years was 19.2% of respondents who participated in the Framingham study and 27.8% of respondents who participated in the project Johnston County OA. In addition, The National and Nutrition Examination Survey (NHANES III), about 37% of respondents aged ≥60 years also had radiologic knee OA (Tang et al., 2025)

There are several therapeutic options that can help reduce the symptoms of knee osteoarthritis but few change the biochemical condition or degree of degeneration. However, conservative therapy in osteoarthritis includes muscle-strengthening exercises, lifestyle changes, analgesics (non-steroidal anti-inflammatory drugs), intraarticular supplement injections, (chondroitin sulfate and glucosamine). For severe pain, opioids can also be given. If conservative management does not provide a good enough symptom reduction, there are surgical therapy options including total joint replacement (Rohmania Setiarini, 2021).

Clinical manifestations of knee OA are slow development of joint pain, tenderness, stiff ness, joint swelling, limited mobility and joint deformities. There were 20 million individuals suffering from knee OA in the USA, and this f igure is expected to double over the next two decades. Knee pain was reported by up to a half of the individuals aged over 50, among which severe and disabling knee pain accounted for approximately 50%. The high prevalence and substantial impact on quality of life of knee OA calls for more high-quality research in this area (Huaqing Zheng, 2015). The prevalence of knee OA based on radiology in Indonesia According to the Ministry of Health of the Republic of Indonesia, the elderly population in 2019 was around 25.9 million people and will continue to increase every year. The prevalence of osteoarthritis in Indonesia is 55 million people (24.7%).

According to Basic Health Research (RISKESDAS), the prevalence of osteoarthritis based on age is 5% at the age of <40 years, 30% at the age of 40-60 years, and 65% at the age of >61 years (Astri Wahyuni et al., 2024). In West Nusa Tenggara, the prevalence of OA was 33.6% (BPS., 2020). This study was conducted in North Lombok because there has been no previous research at North Lombok Regency Hospital examining the variables investigated in this study.Being overweight is a condition that is closely related to an increased risk of osteoarthritis, especially in the body's supporting joints, such as the knees. A study related to the relationship between Body Mass Index and the incidence of knee osteoarthritis showed results that a person with BMI >23 (*overweight)* have a 2000 times greater risk of developing osteoarthritis compared to people who have a normal BMI (Mutiwara et al., 2016). Excess mechanical load on the joints due to excess weight accelerates cartilage degeneration, especially in heavy-supporting joints such as the knee. In addition, adipose tissue also produces inflammatory mediators such as leptin and adiponectin that can accelerate inflammatory processes and joint damage. Another meta-analysis by Jin et al. (2023) also reinforces that generalized obesity and central obesity are strong predictors of knee OA. However, research by (Widhiyanto et al., 2019) stated that there was no significant relationship between BMI and knee OA degree. This study states that it is not only BMI that determines the degree of knee OA. Gender also affects the incidence of OA. Some studies show that women have a higher prevalence of knee OA than men, especially after menopause. This is thought to be related to a decrease in estrogen levels, which previously served as a protection for cartilage tissue.

According to Zhang et al. (2022), postmenopausal women have a 1.27 times higher risk of knee OA than men, even after adjusting for BMI and age factors. Meanwhile, research by Filippo Migliorini (2022) stated that men who are active under the age of 60 actually have a higher risk of OA than women. Hypertension is part of a metabolic syndrome that is also associated with an increased risk of OA. Hypertension can cause vascular disorders of joint tissue, increase systemic inflammation and accelerate joint degeneration. In a meta-analysis by Wang et al. (2022), hypertension was associated with a 62% increased risk of radiographic knee OA and this association remained significant even though it had been controlled against BMI. These three factors often interact with each other and contribute to an increased risk of OA, especially in the knees. However, research (Francisco & Widjaya, 2024) said that there was no association between hypertension and knee OA and that it was not a meaningful risk factor. Based on the data on the incidence of osteoarthritis, there is no research at the North Lombok Hospital and there is a gap between research studies on the relationship between BMI, gender and hypertension and the incidence of knee osteoarthritis, therefore researchers are interested in researching more about the relationship between these things.

II. METHODS

The research design in this study is observational with a type of quantitative analysis, namely this study aims to explain the circumstances or situations to determine whether there is a relationship between variables at one time. This study uses *the case control method*, which is a retrospective observational design that compares two groups, namely individuals with a specific disease or condition (cases) and individuals without diseases (controls). The target population for the case group is all individuals who have been diagnosed with knee OA and received treatment at the North Lombok Regency Hospital in July 2024 – July 2025 totaling 54 people. As for the population control group, it was taken from patients who were treated at

the internal polyclinic Hospital of North Lombok Regency in August 2025. For the control group, samples were taken from patients who were treated at the polyclinic in the North Lombok Regency Hospital totaling 54 people. The sampling technique for the control group in this study is purposive sampling based on inclusion and exclusion criteria. The sample size was added into two groups with a large sample ratio between cases: control = 1:1, each group 54 samples, so that the total was 108 samples. The instruments used in this study were stationery (books and pens), mobile phones, laptops, and patient medical record data. Data analysis was carried out in two stages, namely univariate and bivariate analysis.

III. RESULT AND DISCUSSION

Univariate Analysis

Table 1. Characteristics of respondents by age and occupation

Age	Quantity (n)	Percentage (%)
30-45	24	22,2
46-85	84	77,8
Total	108	100,0
Jobs		
Farmer	69	63,9
Labor	21	19,4
ASN	7	6,5
Self-employed	11	10,2
Total	108	100,0

(Source: Secondary Data, 2025)

Table 1 shows the age and occupation characteristics of the 108 respondents. The age range of respondents was taken from 30 years old to 85 years old. The highest distribution of respondents was at the age of 46-85 years with a total of 84 people (77.8%), while the lowest distribution of respondents was at the age of 30-45 years with a total of 24 people (22.2%). In the distribution of respondents by occupation, respondents with farmer jobs were the highest, namely 69 people (63.9%), followed by labor jobs with 21 people (19.4%), self-employed with 11 people (10.2%) and finally civil servants with 7 people (6.5%).

Table 1. Knee Osteoarthritis Distribution Data, Body Mass Index, Gender, and Hypertension Status

Knee osteoarthritis	Quantity (n)	Percentage (%)
OA	54	50,0
Non-OA	54	50,0
Body Mass Index		
<18.5 (*Underweight)*	14	12,9
18.5-22.99 (Normal)	46	42,6
≥23 (*Overweight)*	48	44,4
Gender		
Male	47	43,5
Female	61	56,4
Hypertension		
Yes	56	51,8
No	51	49,2
Total	108	100,0

(*Source: Secondary data, 2025)*

Table 2 shows the results of the study that of the 108 respondents diagnosed with knee osteoarthritis and undiagnosed knee osteoarthritis, the number of respondents who had a body mass index underweight namely 14 people (12.9%), and normal BMI which is 46 people (42.6%) while respondents who experience overweight more with 48 people (44.4%). For respondents with male gender, it was 47 people (43.5%) while for female gender, it was 61 people (56.4%). Then for respondents with hypertension, the results were obtained with a total of 56 people (51.8%) while respondents who did not experience hypertension were fewer with a total of 52 people (48.2%).

Table 3. Comparison of Knee Osteoarthritis by BMI, Gender, and Hypertension Status

Variable	Category	Knee OA n (%)	Non-OA n (%)	Total n (%)
Body Mass Index	Underweight (<18.5)	x	x	**14 (12.9)**
	Normal (18.5–22.99)	x	x	**46 (42.6)**

	Overweight (≥23)	x	x	**48 (44.4)**
Gender	Male	x	x	**47 (43.5)**
	Female	x	x	**61 (56.4)**
Hypertension	Yes	x	x	**56 (51.8)**
	No	x	x	**52 (48.2)**
Total		54 (50.0)	54 (50.0)	**108 (100.0)**

Table presents the distribution of knee osteoarthritis according to body mass index, gender, and hypertension status among 108 respondents. Based on body mass index, respondents were classified into underweight, normal, and overweight categories, with the largest proportion found in the overweight group. The comparison between respondents with and without knee osteoarthritis across BMI categories provides an initial overview of the potential role of body weight in the occurrence of knee osteoarthritis. In terms of gender, the table shows that female respondents outnumbered male respondents. The comparison of knee osteoarthritis cases between males and females suggests a difference in the proportion of knee osteoarthritis based on gender, which may be related to biological and hormonal factors.Regarding hypertension status, the number of respondents with hypertension was slightly higher than those without hypertension. The comparison of knee osteoarthritis occurrence between hypertensive and non-hypertensive respondents indicates that hypertension may be associated with knee osteoarthritis as a comorbid condition. Overall, this comparison table provides a preliminary description of the relationship between body mass index, gender, and hypertension with knee osteoarthritis. These findings serve as the basis for further bivariate analysis to determine whether the observed relationships are statistically significant.

Bivariate Analysis

Table 4. Bivariate Analysis of Body Mass Index with the Incidence of Osteoarthritis

IMT	Knee osteoarthritis				Total	P	OR
	Diagnosed		Undiagnosed				
	N	%	N	%			
<18.5	5	9,3	9	16,7	14	0,001	13,000
18,5-22,99	10	21,7	36	66,7	46		
≥23	39	72,2	9	16,7	48		
Total	54	100	54	100	108		

Table 3 shows that out of 108 data, in the case group there were 39 (72.2%) people with BMI overweight, for normal BMI as many as 10 (21.7%) people and the remaining 5 (9.3%) people have BMI underweight. The highest control group had a normal BMI of 36 (66.7%), for overweight and underweight have the same number of people, namely 9 (16.7%) people. Test results Chi-square show p-value 0,001 (p-value <0.05), which means that there is a significant relationship between Body Mass Index (BMI) and the incidence of knee osteoarthritis at North Lombok Regency Hospital. The results of the risk analysis (odds ratio) at a 95% CI with a range of 5.124-32.982 indicates that a person with a BMI overweight (>23) are 13,000 times more at risk of developing knee osteoarthritis compared to someone with BMI underweight (<18.5) or normal BMI (18.5-22.99).

Table 5. Bivariate Analysis of Sex with the Incidence of Osteoarthritis

Gender	Knee osteoarthritis				Total	P	OR
	Diagnosed		Undiagnosed				
	N	%	N	%			
Male	11	20,4	36	66,7	47	0,000	0,128
Female	43	79,6	18	33,3	61		
Total	54	100	54	100	108		

Table 4 bivariate analysis demonstrated a significant association between sex and the incidence of knee osteoarthritis. Among participants diagnosed with knee osteoarthritis, females accounted for 79.6%, while males represented 20.4%. Conversely, in the non-osteoarthritis group, males predominated (66.7%) compared with females (33.3%).The chi-square test indicated a statistically significant relationship between sex and knee osteoarthritis ($p < 0.05$). Odds ratio analysis showed that males had a lower likelihood of developing knee osteoarthritis than females (OR = 0.128).

Table 6. Bivariate Analysis of Hypertension with the Incidence of Knee Osteoarthritis

Hypertension	Knee osteoarthritis				Total	P	OR
	Diagnosed		Undiagnosed				
	N	%	N	%			
Yes	29	53.7	27	50,0	56	0.847	1,160
No	25	46.3	27	50.0	51		
Total	54	100	54	100	108		

Table 5 shows that out of a total of 108 data, in the case group the majority of patients with hypertension were diagnosed with OA, namely 29 (53.7%) people, while 25 (46.3%) people with hypertension were not diagnosed with knee osteoarthritis. In the control group, hypertensive patients with non-hypertensive had the same number of 27 (50.0%) undiagnosed knee osteoarthritis. Test results *Chi-*square Obtained *p-value* 0,847 (*p-value* >0.05), which shows that there is no significant association between hypertension and the incidence of knee osteoarthritis at North Lombok Hospital. The results of the risk analysis (*odds ratio*) at a 95% CI with a range of 0.545-2.469 is 1.160, which suggests that a person with hypertension is not at risk of 1.160 times developing knee osteoarthritis.

Discussion

The Relationship of Body Mass Index with the Incidence of Knee Osteoarthritis

Body Mass Index (BMI) or *Body Mass Index* (BMI) is a simple tool or way to monitor the nutritional status of adults, especially those related to underweight and overweight. Being overweight will increase the risk of degenerative diseases. With BMI, it will be known whether a person's weight is declared normal, thin or obese (Ministry of Health, 2017). The knee joint is a weight-supporting joint that works to support weight every time a person stands, walks, or does physical activity. When a person is overweight, the load that the knee joint has to support will increase significantly. Then the cartilage that functions as a cushion in the joint will work harder. In the long term, this excessive load causes the joint cartilage to undergo abnormal pressure, accelerating the process of wear and degeneration. Cartilage structures that are supposed to be elastic and supple will become thin, cracked, and eventually damaged (Shumnalieva R., 2023). In addition, overweight individuals will produce disproportionate amounts of adipokine. Some adipokines such as leptin and adiponectin play a role in the inflammatory process. Excess leptin stimulates chondrocytes (cartilage cells) to produce enzymes that damage the cartilage matrix (Raud, B., Gay, C., 2023). In addition, fat tissue also produces pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α). These substances create low-level chronic inflammatory conditions throughout the body, including in the joints.

This chronic inflammation accelerates the degradation of proteoglycans and type II collagen which are the main components of joint cartilage (Godziuk, K., Prado, 2024).This degradation process occurs because pro-inflammatory cytokines activate matrix metalloproteinase (MMP) enzymes and aggrekanase. These enzymes work to break down the structure of cartilage. When damage occurs faster than the body is able to repair it, osteoarthritis occurs. In the advanced stage, the cartilage is almost completely lost so that the surface of the bone rubs directly with the rest of the bone, causing severe pain and limited movement (Jin, X., Wang, B. H., 2025).The results of bivariate analysis using *the Test-Square* obtained a value of 0.001 where the results showed that there was a significant relationship between BMI and the incidence of knee osteoarthritis at the North Lombok Regency Hospital. This result is in line with a study conducted by Endang *et al,* (2016) showing that there is a relationship between BMI (*overweight*) and the incidence of knee osteoarthritis with the test result of p = 0.003 (p<0.05). Similar results are also shown by the research of Jordi Martinez *et al.* (2019) with a result of p = 0.000 (p<0.05) so that there is a significant relationship between obesity and knee osteoarthritis.In contrast to the research conducted by Wynanda et al. (2020) stated that there was no significant relationship between BMI and the incidence of knee osteoarthritis p = 0.057. In this study, BMI was not related to knee osteoarthritis due to limitations in the completeness of the data.

Sex Relationship with the Incidence of Knee Osteoarthritis

Gender is a difference determined by genetic, hormonal, anatomical, and physiological factors that distinguish men and women. Biological sex is determined by sex chromosomes inherited from parents, males have XY chromosomes while females have XX chromosomes. Genes on the Y chromosome (specifically the

SRY gene) trigger testicular development and male hormone production. The dominant male hormone is testosterone which affects the development of male reproductive organs, muscle growth, heavier voice, and hair growth. Women are dominated by the hormones estrogen and progesterone which regulate the menstrual cycle, breast development, and pregnancy (Short et al. 2013). The hormone estrogen has a protective role in joint health. Estrogen helps in the synthesis of chondrocytes (cartilage cells) present in the bone matrix. These chondrocytes are responsible for producing proteoglycans and collagen which are important components for maintaining the structure and function of cartilage (Faber, B.G et al. 2024) When women enter menopause, there is a drastic decrease in estrogen levels. This decrease has a direct impact on joint cartilage health. Without enough estrogen, the production of proteoglycans and collagen decreases, so the cartilage loses its ability to maintain its structure and elasticity. In addition, estrogen also has anti-inflammatory effects by modulating the production of pro-inflammatory cytokines such as IL-1β and TNF-α, resulting in inflammation and damage to joint cartilage.

When estrogen levels drop, the control over these cytokines is weakened, resulting in faster processes of cartilage inflammation and degradation (Hernandez, P.A et al 2024) (Colbath, A., 2023). In addition to hormonal differences, men and women also have anatomical differences in the pelvic area and lower extremities that affect the biomechanics of the knee. Women have a larger q-angle than men. The Q-angle is the angle formed between the line drawn from the superior anterior iliac spina to the center of the patella and the line from the middle of the patella to the tuberosity of the tibia. A woman's wider pelvis leads to a larger q-angle. This greater angle results in an uneven distribution of the load on the knee joint, with greater pressure on the lateral or medial compartments, depending on the alignment. This uneven distribution of the load accelerates cartilage wear on areas that receive greater pressure (Mödinger, Y., et al. 2022).While men have a larger volume and area of joint cartilage than women. Larger cartilage can spread the load more effectively, so damage from mechanical stress occurs more slowly in men (Martino *et al.,*2024). In addition, research shows that there is a difference in the molecular composition of synovial fluid between men and women.

Men tend to have more banuak *Growth Factor* and protective factors that help bone repair and remodeling (Demario S *et al.,*2023). The difference in muscle mass is also the difference in why men are more protective, where muscle mass and male muscle strength are greater, especially around the knee joint, this will help support the joints better, reduce the direct load on cartilage, and stabilize the joints when moving (Jingkai DI *et al.,*2024). The results of bivariate analysis using the test *Chi-Square* obtained a value of p=0.000 where the results showed that there was a significant relationship between sex and the incidence of knee osteoarthritis at the North Lombok Regency Hospital. These results are in line with Bashekah's research *et al*. (2023) which states that men have a lower chance of experiencing knee OA than women p=0.001. Similar results were also shown by Nugraha W.R et al (2023) stating that there was a significant influence between sex and the incidence of knee osteoarthritis p=0.032. Meanwhile, a study conducted by Sananta P et al., (2022) stated that there was no meaningful relationship between sex and knee osteoarthritis p=0.051. This study stated that it was not related due to limitations in the study, where the number of samples was only small and the research was conducted only in one specific place or was limited.

Relationship of Hypertension with the Incidence of Knee Osteoarthritis

Hypertension can cause damage to small blood vessels (microvascular) and reduce blood flow to tissues, including subchondral bones. Articular cartilage is an avascular tissue (it has no blood vessels). Cartilage nutrition is obtained through diffusion from synovial fluid, not from blood vessels. Vascular disorders due to hypertension have an impact on subchondral bones that have blood vessels, but there is a correlation between changes in subchondral bones and cartilage degradation (Zhang, X., et al.2024) (Alenazi, A et al., 2023). Hypertension causes systemic endothelial dysfunction (decreased bioavilability NO). Damaged endothelium will reduce micro-perfusion in tissues *periarticular* and *Subcolonal Bone Plate* thus causing local hypoxia. For a long timewill hypoxia interfere with homeostasis *osteocartilaginous* and triggers subcolonal remodeling that is predisposed to cartilage damage. Hypertension is often accompanied by RAAS activation (*Renin-Angiotensin-Aldosterone System*) that are systemic in nature. Angiotensin II will cause fibrosis, local inflammation and bone remodeling via oxidative pathways and NF-kB (*Nuclear factor*

*kappa-B)*which is the main transcription factor regulating the inflammatory response, thereby accelerating osteochondral changes and extracellular matrix degradation (Ching K, et al. 2021).The results of bivariate analysis using the test *Chi-Square* obtained a value of p=0.847, the results show that there is no significant relationship between hypertension and the incidence of knee osteoarthritis at the North Lombok Regency Hospital.

These results are the same as a study conducted by Wynanda et al (2020) which showed that there was no relationship between hypertension and the incidence of knee osteoarthritis p=0.797. These results are also in line with the research of Wijayanti (2017) which stated that there was no significant relationship between hypertension and knee osteoarthritis p = 0.543. In contrast to the study conducted by Priyanto et al., (2025) which found a relationship between hypertension and the incidence of osteoarthritis with the test results p=0.002. Hypertension is one of the risk factors for the occurrence of various other diseases including osteoarthritis (Sudoyo et al. 2014). However, in this study, different results were obtained, this shows the absence of significance of the existing theory with the results obtained. In studies that stated that hypertension is related to osteoarthritis, there are several factors that affect the results of the study, namely in the study of Yao Liu, (2024) who said that hypertension is related, the use of anti-hypertensive drugs such as ACE inhibitors, calcium channel clockers (CCB), and thiazide diuretics, was evaluated 30 days before the study. Metabolic factors such as blood glucose and hypercholesterolemia also have an influence on the results of the study (Yi-Min Zhang et al. 2017). This study also only took from the patient's medical records and did not directly check the patient's blood pressure as was done in the study (Yao Liu., 2024).

IV. CONCLUSION

Patients with knee osteoarthritis were 54 people (50.0%) and those who did not have knee osteoarthritis were 54 people (50.0%). There was a significant association between BMI and the incidence of knee osteoarthritis at North Lombok Regency Hospital (*p-value* = 0.001, OR = 13,000). There was a significant relationship between sex and the incidence of knee osteoarthritis at North Lombok Regency Hospital (*p-value* = 0.000 OR = 0.128). There was no significant association between hypertension and the incidence of knee osteoarthritis at North Lombok Regency Hospital (*p-value* = 0.847 OR = 1.160).

REFERENCES

[1] Adiputra, I. M. S., Trisnadewi, N. W., Oktaviani, N. P. W., & Munthe, S. A. (2021). *Health Research Methodology*.

[2] Alberto Di Martino, Francesca Barile, Claudio D'Agostino, Vanita Castafaro, Tosca Cerasoli, Paolo Mora. (2024). Are there gender-specific in hip and knee cartilage composition and degeneration ? A systematic literature review. ***European Journal of Orthopedic. Surgery & Traumatology***. 34:1901-1910.

[3] Alenazi, A. M., Alothman, S., Alshehri, M. M., Rucker, J., Sharma, N., Dunleavy, K., & Kluding, P. M. (2023). Hypertension Is Associated with Joint Pain Severity Among Individuals with Osteoarthritis. *Pain Management Nursing*, 24(6), 692-697. https://doi.org/10.1016/j.pmn.2023.07.003

[4] Astri Wahyuni, Imran Safei, Prema Hapsari Hidayati, Sultan Buraena, & Shulhana Mokhtar. (2024). Characteristics of Genu Osteoarthritis in the Elderly Who Receive Medical Rehabilitation at Hajjah Andi Depu Hospital. ***Fakumi Medical Journal: Journal of Medical Students***, *4*(1), 62–72. https://doi.org/10.33096/fmj.v4i1.437

[5] Bashekah, K. A., Zagzoug, M. E., Banaja, A. W., Alghamdi, A. A., Mishiming, O. S., Jan, M. A., Kemawi, O. A., Alharbi, B. A., Althagafi, A. A., & Aljifri, S. M. (2023). Prevalence characteristics of and knee osteoarthritis among the general public in Saudi Arabia. https://doi.org/10.7759/cureus.47 666

[6] Biscaldi, E., Barra, F., Evangelisti, G., & Ferrero, S. (2018). Radiological assessment. *Endometrial Cancer: Risk Factors, Management and Prognosis*, *3*, 113–144. https://doi.org/10.2307/3578513

[7] Cherfan, M., Vallée, A., Kab, S., Salameh, P., Goldberg, M., Zins, M., & Blacher, J. (2020). Unhealthy behaviors and risk of uncontrolled hypertension among treated individuals—the conStAnce population-based study. Scientific Reports. https://doi.org/10.1038/s41598-020-58685-1

[8] Ching, K., Houard, X., Berenbaum, F., & Wen, C. (2021). Hypertension meets osteoarthritis — revisiting the vascular aetiology hypothesis. Nature Reviews Rheumatology, 17(9), 533–549. https://doi.org/10.1038/s41584-021-00650-x

[9] Colbath, A., & Haubruck, P. (2023). Closing the gap: sex-related differences in osteoarthritis and the ongoing need for translational studies. *Annals of Translational Medicine*, *11*(10), 339–339. https://doi.org/10.21037/atm-23-1546

[10] Cruz, C.J., et al. (2025). Hypertension is associated with knee osteoarthritis pain in an age-dependent manner.

[11] Dhaifullah, M. R., Meregawa, P. F., Aryana, I. G. N. W., & Subawa, I. W. (2023). The relationship between age, sex, and occupation to the severity of knee osteoarthritis patients based on Kellgren-Lawrence at Sanglah Denpasar Hospital. ***Udayana Medical Journal*****,** *12*(1), 107. https://doi.org/10.24843/mu.2023.v12.i01.p18

[12] Demario S. Overstreet, Larissa J. Strath, Mackensie Jordan, Johanna M. Hobson, Michael A. Owens, Adrian C. Williams, Robert R. Edwards and Samantha M. Meints. (2023) A Brief Overview: Sex Differences in Prevalent Chronic Musculoskeletal Conditions. Int J. Approximately. Res. Public Health, 20(5), 4521.

[13] Duarsa, A. B. S., Arjita, I. P. D., Ma'ruf, F., & Aena Mardiah, Fachrudi Hanafi, Jian Budiarto, S. U. (2021). *Al-Azhar Islamic University Textbook*.

[14] Eitner, A., Hofmann, G. O., & Schaible, H. G. (2020). The pathophysiology of osteoarthritis pain. In *Tagliche Praxis* (Vol. 61, Issue 1).

[15] Faber, B. G., Macrae, F., Jung, M., Zucker, B. E., Beynon, R. A., & Tobias, J. H. (2024). Sex differences in the radiographic and symptomatic prevalence of knee and hip osteoarthritis. *Frontiers in Endocrinology*, *15*(October), 1–11. https://doi.org/10.3389/fendo.2024.1445468

[16] Francisco, M. M., & Widjaya, I. F. (2024). The relationship between hypertension and osteoarthritis genu (conventional radiography) at Royal Taruma Hospital, West Jakarta. ***Tarumanagara Medical Journal***, *6*(1), 87–92. https://doi.org/10.24912/tmj.v6i1.30842

[17] Godziuk, K., Prado, C. M., & Beaupre, L. A. (2024). Obesity and body mass index: Past and future considerations in osteoarthritis research. Osteoarthritis and Cartilage, 32(8), 950-960. https://doi.org/10.1016/j.joca.2024.02.894

[18] Gustina, E., Handani, M. C., & Sirait, A. (2020). Factors Affecting Osteoarthritis A Control Case Study at the Kindergarten II Putri Hijau Medan Hospital in 2017. ***Journal of Mitrahusada*****,** *3*(1), 88–103.

[19] Hernandez, P. A., Bradford, J. C., Brahmachary, P., Ulman, S., Robinson, J. L., June, R. K., Cucchiarini, M., & Madry, H. (2024). Unraveling sex-specific risks of knee osteoarthritis before menopause: Do sex differences start early in life? Osteoarthritis and Cartilage, 32(9), 1032-1044. https://doi.org/10.1016/j.joca.2024.04.015

[20] Huether, S. E., & McCance, K. L. (2013). Understanding Pathophysiology (5th ed.). St. Louis, MO: Elsevier.

[21] James, P. A., Oparil, S., Carter, B. L., Cushman, W. C., Dennison-Himmelfarb, C., Handler, J., Lackland, D. T., LeFevre, M. L., MacKenzie, T. D., Ogedegbe, O., Smith, S. C. Jr., Svetkey, L. P., Taler, S. J., Townsend, R. R., Wright, J. T. Jr., Narva, A. S., & Ortiz, E. (2014). 2014 evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA, 311(5), 507–520.

[22] Jin, X., Wang, B. H., Wang, X., Antony, B., Zhu, Z., Han, W., Cicuttini, F., Wluka, A. E., Winzenberg, T., Blizzard, L., Jones, G., & Ding, C. (2025). Revealing the mediating mechanisms between BMI and osteoarthritis: a Mendelian randomization and mediation analysis. Aging Clinical and Experimental Research, 37, 52. https://doi.org/10.1007/s40520-025-03035-2

[23] Jingkai Di, Jiang Bai, Junrui Zhang, Jiaoyang Chen, Yuxuan Hao, Jiaqi Bai and Chuan Xiang. (2024). Regional disparities, age-related changes and sex related diffrences in knee osteoarthritis. Di et al. BMC Musculoskeletal Disorders 25-66.

[24] Jordi Martinez N., Captain, Su Djie To Rante, Sicily Ratna Tallo. (2019) The Relationship between Obesity and the Degree of Genu Osteoarthritis in the Elderly at Prof. Dr. W. Z. Johannes Kupang Hospital. Cendana Medical Journal Issue 18, No.3

[25] Kartini, A., Al-Choeriyyah, M., Tasikmalaya, C., & Maulana, A. (2019). Redefinition of Gender and Sex. ***Journal of Women's and Islamic Studies***, *12*(2), 217–239.

[26] Ministry of Health of the Republic of Indonesia. (2015). General Guidelines for Obesity Control. In *Ecuadorian Gastronomy and Local Tourism.* (Vol. 1, Issue 69).

[27] Kim, H. C., Lee, H., Lee, H. H., Son, D., Cho, M., Shin, S., Seo, Y., & Kim, E. J. (2024). Korea Hypertension Fact Sheet 2023: analysis of nationwide population-based data with a particular focus on hypertension in special populations. *Clinical Hypertension*, *30*(1), 1–11. https://doi.org/10.1186/s40885-024-00262-z

[28] Kohn, M. D., Sassoon, A. A., & Fernando, N. D. (2016). Classifications in Brief: Kellgren-Lawrence Classification of Osteoarthritis. *Clinical Orthopaedics and Related Research*, *474*(8), 1886–1893. https://doi.org/10.1007/s11999-016-4732-4

[29] Lo, K., Au, M., Ni, J., & Wen, C. (2022). Association between hypertension and osteoarthritis: A systematic review and meta-analysis of observational studies. ***Journal of Orthopaedic Translation***, *32* (May 2021), 12–20. https://doi.org/10.1016/j.jot.2021.05.003

[30] Mescher, A. L. (2018). Junqueira's Basic Histology: Text & Atlas (15th Edition). New York: McGraw-Hill.

[31] Mödinger, Y., Rapp, A. E., Vikman, A., Holzmann, K., Zaucke, F., & Hennig, F. F. (2022). Roles of Hormone Replacement Therapy and Menopause on Osteoarthritis and Cardiovascular Disease Outcomes: A Narrative Review. Frontiers in Rehabilitation Sciences, 3, 825147. https://doi.org/10.3389/fresc.2022.825147

[32] Mutiwara, E., Najirman, N., & Afriwardi, A. (2016). The Relationship between Body Mass Index and the Degree of Joint Damage in Knee Osteoarthritis Patients at Dr. M. Djamil Padang Hospital. ***Andalas Health Journal***, *5*(2), 376–380. https://doi.org/10.25077/jka.v5i2.525

[33] Nugraha, R. W., Kurniati, M., Detty, A. U., & Marlina, D. (2023). The relationship between age, occupation and gender with the incidence of osteoarthritis at Dr. H. Abdul Moeloek Hospital, Lampung Province. ***Journal of Medical and Health Sciences***, *10*(10), 3073–3082. https://doi.org/10.33024/jikk.v10i10.12728

[34] Pitaloka Kusuma, D., Vemilia Warlisti, I., & Widiastuti, L. P. (2019). *Diah Pitaloka Kusuma, Ika Vemilia Warlisti*. *8*(3), 947–954.

[35] Pradono, J., Hapsari, D., Supardi, S., & Budiarto, W. (2018). Quantitative Research Management Handbook. In Publishing Institution of the Health Research and Development Agency (Vol. 53, Issue 9). www.journal.uta45jakarta.ac.id

[36] Prasasty, G.D., & Legiran. (2023). Control Case Study. ***Kuala Shia Medical Journal,*** 23(1), 232-236. https://doi.org/10.24815/jks.v23il.25496

[37] Pratama, A. D. (2019). Physiotherapy Intervention in Genu Osteoarthritis Cases at Gatot Soebroto Hospital. ***Journal of Applied Humanities***, *1*(2). https://doi.org/10.7454/jsht.v1i2.55

[38] Priyanto, O. A., Abdillah, A., Meilina, E., Gerontik, K., Ngudia, S., & Madura, H. (2025). The relationship between obesity and hypertension rates and the incidence of knee osteoarthritis in the elderly using the Womac (Western Ontario and McMaster Universities Osteoarthritis Index). ***Journal of Innovation Research and Knowledge***, *4*(8), 5751–5758.

[39] Raud, B., Gay, C., Guiguet-Auclair, C., Bonnin, A., Gerbaud, L., Pereira, B., Duclos, M., Boirie, Y., & Coudeyre, E. (2023). Level of obesity is directly associated with the clinical and functional consequences of knee osteoarthritis. Scientific Reports, 10, 3601. https://doi.org/10.1038/s41598-020-60587-1

[40] Ratna Dila, S. (2023). Factors that cause hypertension in adult patients at the Dinoyo Health Center, Malang City. ***Sainsbertek Scientific Journal of Science & Technology***, *3*(2), 19–27. https://doi.org/10.33479/sb.v3i2.217

[41] Sananta, P., Qurotu'ain, N. A., Rahmanda, A., Widasmara, D., & Fuzianingsih, E. N. (2022). Correlation between Grade of Knee Osteoarthritis and Quality of Life of Patient in Secondary Referral Hospital in Indonesia. Open Access Macedonian Journal of Medical Sciences / repository copy.

[42] Savitri, G. A. D. (2020). The Relationship of Physical Activity with the Recurrence of Osteoarthritis in the Elderly in the Work Area of Upt Kesmas I Sukawati. ***Journal of Nursing***.

[43] Short, S. E., Yang, Y. C., & Jenkins, T. M. (2013). Sex, gender, genetics, and health. ***American Journal of Public Health***, *103*(SUPPL.1), 93–101. https://doi.org/10.2105/AJPH.2013.301229

[44] Shumnalieva, R., Kotov, G., & Monov, S. (2023). Obesity-Related Knee Osteoarthritis-Current Concepts. Life, 13(8), 1650. https://doi.org/10.3390/life13081650

[45] Sobotta, J. (2008). Sobotta Atlas of Human Anatomy, General Anatomy and System of Motion. In ***Journal of Chemical Information and Modeling*** (Vol. 53, Issue 9).

[46] Solomon, L. (2010). In Solomon, S., Marwick, D., & Nayagam, S. (Eds.), Apley's 66 System of Orthopaedics and Fractures (9th ed., pp. 87–93). United Kingdom: Hodder Arnold.

[47] Sudoyo, A. W., Setiati, S., Alwi, I., Simadibrata, M. K., & Setiyohadi, B. (Eds.). (2014). Osteoarthritis. In the Textbook of Internal Medicine (Volume III, Edition VI, pp. 3197–3209). Jakarta: FKUI Publishers, Central.

[48] Tang, S., Zhang, C., Oo, W. M., Fu, K., Risberg, M. A., Bierma-Zeinstra, S. M., Neogi, T., Atukorala, I., Malfait, A. M., Ding, C., & Hunter, D. J. (2025). Osteoarthritis. *Nature Reviews. Disease Primers*, *11*(1), 10. https://doi.org/10.1038/s41572-025-00594-6

[49] Tortora, G. J., & Derrickson, B. H. (2017). Principles of anatomy and physiology (15th ed.). Wiley.

[50] Widhiyanto, L., Desnantyo, A. T., Djuari, L., & Kharismansha, M. (2019). Correlation between Knee Osteoarthritis (Oa) grade and body mass index (Bmi) in outpatients of Orthopaedic and Traumatology Department Dr. Soetomo Hospital. ***Journal of Orthopaedics and Traumatology Surabaya***, *6*(2), 71. https://doi.org/10.20473/joints.v6i2.2017.71-79

[51] Wijaya, S. (2018). Osteoarthritis of the knee. *Cdk*, *45*(6), 424–429.

[52] Wynanda L, Iin Novita N.M., Safari Wahyu J., Sulistyani. (2020) The relationship between age, sex, BMI, and hypertension to the degree of osteoarthritis of the knee joint based on Kellgren Lawrence radiology. Faculty of Medicine, University of Muhammadiyah Surakarta.

[53] Yao Liu., & Guiying Du. (2024). Blood Pressure is Associated with Knee Pain Severity in Middle-aged and eldeerly individuals with or at risk for osteoarthritis: data from the Osteoarthritis Initiative. BMC Musculoskeletal Disorders.

[54] Yi-Min Zhang, Jun Wang, Xiao-guang Liu. (2017). Association Between Hypertension and Risk of Knee Osteoarthritis. Meta-Analysis of Observational Studies in Epidemiology. MEDICINE

[55] Zainuddin, I., & Wardhana, A. (2023). Research Methods. In Quantitative Approach Research Methods (Vol. 14, Issue 1).

[56] Zhang, X., Li, Y., Wang, H., Chen, M., Liu, J., & Wu, D. (2024). Osteoarthritis and hypertension: observational and Mendelian randomization analyses. Arthritis Research & Therapy, 26, 84. https://doi.org/10.1186/s13075-024-03321-w

[57] Setiarini, R. (2021). **Proloterapi dekstrosa pada osteoartritis lutut**. ***Medika Kartika: Jurnal Kedokteran dan Kesehatan***, 4(5),

[58] Zheng, H., & Chen, C. (2015). Body mass index and risk of knee osteoarthritis: A systematic review and meta-analysis of prospective studies. ***BMJ Open***, *5*, e007568.