Correlation Between Kellgren-Lawrence Grade and Timed Up and Go Test and Quality of Life of Knee Oateoarhtritis Patients In H. Abdul Manap Hospital, Jambi City

Maudy Rominar Br. Tobing(✉), Humaryanto, and Nyimas Natasha

Department of Medicine, Faculty of Medicine and Health Sciences, Universitas Jambi, Jambi, Indonesia
maudytobing19@gmail.com

Abstract.
Background Knee Osteoarthritis (OA) causes significant chronic pain and difficulty in daily activities because it affects locomotive function, a simple test to assess functional mobility can be performed with timed up and go (TUG) test. Severity of knee OA on general radiographs was assessed by Kellgren-Lawrence criteria. Imbalance and instability of gait causes physical limitations to disability which affects the patient's quality of life. Based on these, a study was conducted to assess the strength of the relationship between physical activity function and severity of knee OA that affects the patient's quality of life. Method: Using observational analytic with cross sectional design, a total of 100 respondents were obtained by consecutive sampling method at RSUD H. Abdul Manap, Jambi City. Data obtained from interviews and observations of TUG test. Results: Spearman's analysis performed there was a significant correlation between grade of OA knee and the patient's quality of life ($p = 0.000$, $r = -0.428$) and a significant correlation between TUG test and the patients' quality of life ($p = 0.000$, $r = -0.649$). Conclusion: The more severe grade of knee OA and longer time of TUG test were moderately correlated with a decrease in the patient's quality of life.

Keywords: Knee osteoarthritis · TUG test · Quality of life

1 Introduction

Osteoarthritis (OA) is the most common form of arthritis and endemic worldwide. Knee and hip OA is usually more common because it becomes the joints most involved in bearing heavy loads with increasing activity [1, 2]. Knee OA causes a complex peripheral joint disorder with multiple risk factors resulting in progressive pain, loss of function, and stiffness and often affects about 25% of adults and over 50 years of age [3]. By 2040, it is estimated that 78.4 million (25.9% of the total projected adult population) people aged 18 years and over will be diagnosed with arthritis, most of whom will develop OA [4]. Based on the 2018 National Riskesdas report, OA or arthritis is a common joint disease in Indonesia with a percentage of around 73% [5].

D. A. Kurniawan (Ed.): GDIC 2022, ASSEHR 772, pp. 169–178, 2023.
https://doi.org/10.2991/978-2-38476-110-4_18

The prevalence of osteoarthritis increases because of the risk factors that play a role, namely age 50 years and over, women, especially have menopause, obesity and joint injury [6].

Osteoarthritis patients have typical clinical symptoms, such as severe joint pain, stiffness, swelling and joint instability, muscle weakness, and a significant decrease in range of motion (ROM), causing a decrease in patient productivity and quality of life as well as an increase in the socioeconomic burden for patients and society [2, 7].

The diagnosis of knee OA is generally based on the clinical and radiographic features of the patient. According to the recommendations of the European League Against Rheumatism, radiographs are often used as the gold standard for the assessment of knee with clinical evidence of OA and the Kellgren-Lawrence criteria have been used generally to assess the grade of knee OA [8].

The presence of knee pain, decreased functional mobility, stiffness and decreased quadriceps strength have been associated with knee OA and can lead to physical disability. In optimizing the patient's functional mobility to perform activities of daily living, a valid and reliable tool is needed to assess the patient's functional mobility at the beginning and after the intervention [9]. Assessment of functional mobility of knee OA patients can be done in two ways, namely using a questionnaire and observing. Observational measures that focus on assessing physical function are important in assessing the patient's ability to perform both single and multiple tasks [10, 11]. Osteoarthritis Research Society International (OARSI) recommends performance-based physical function tests in individuals diagnosed with hip or knee OA, one of which is the Timed Up and Go (TUG) test [12].

The TUG test is a reliable and adequate observational test in clinical use to assess the risk of falls and the development of disability in individuals with knee OA [9, 12]. In a previous study that assessed the risk of falls in patients with knee OA using the TUG test, it was reported that younger OA patients underwent significantly better TUG tests than older patients but there was no comparison with radiological grades of knee OA [9].

The experience of pain that interferes with functional activities can also affect physical and mental health, social relationships, and interactions with family, work environment, and society. This problem can have an impact on decreasing productivity and ultimately affecting the quality of life of patients with OA [13]. The Short-Form (SF-36) The Short-Form (SF-36) is a common instrument for measuring the quality of life for various chronic diseases and is one of the most popular questionnaires for people with musculoskeletal diseases. This questionnaire measures a person's health status based on eight domains, including physical function, role physical, body pain, general health, vitality, social function, role emotional, and mental health [14]. Assessment of the severity of knee OA and decreased physical activity function that indirectly affects the quality of life of OA patients is important to assess to know how much they influence each other.

2 Method

The research design used was analytic observational with a cross sectional design. This study was conducted involving 100 of knee OA patients who came to the Orthopedic Surgery Polyclinic at H. Abdul Manap Hospital Jambi City in the period June 2021 -

September 2021. Patients who were used as research subjects with the inclusion criteria were new and/or old knee OA patients who has been clinically and radiographically diagnosed with knee OA according to the American College of Rheumatology (ACR), aged over 50 years and willing to be a research respondent by signing an informed consent.

Exclusion criteria in this study were knee OA patients who at the time of history and physical examination had impaired cognitive function such as dementia, neuromuscular disorders such as Parkinson's and stroke, uncorrected visual disturbances, history of diseases such as cardiopulmonary and severe trauma to the head and spine, history of lower extremity fractures, had undergone total knee arthroplasty and were unable to communicate and read were excluded from the study. The sampling method used was consecutive sampling with primary data collected, namely age, sex, weight, height, TUG test, radiology expertise and quality of life questionnaire. Data in the form of age and gender were obtained from interviews with patients. Body weight and height were used to measure the Body Mass Index (BMI) value obtained by dividing the body weight in kilograms (kg) by the squared height in meters (m). The TUG test was carried out to measure the time required to complete the test using a stopwatch with the nearest 1/100 s, recorded from the patient starting to stand up from the chair, walking 3 m at a comfortable and safe pace, turning around, walking back to the chair, and sitting down. The instructions are to walk at normal speed. Radiology expertise is the result of X-ray readings made by a radiology specialist. The SF-36 questionnaire regarding the quality of life was filled in by the respondents.

Radiological evaluation is used to make a diagnosis of knee OA with the most frequently used radiographic scoring system is Kellgren-Lawrence. The Kellgren-Lawrence classification system divides knee OA into 5 grades, grade 0 means no radiological changes were found, grade 1 means OA is doubtful, grade 2 means mild OA, grade 3 means moderate OA and grade 4 means severe OA. Grade 0 is normal, there is no joint space narrowing and significant changes; Grade 1 is characterized by doubtful joint space narrowing and possible osteophytic lipping; Grade 2, definite osteophytes and possible joint space narrowing on anteroposterior load-bearing radiographs; Grade 3, moderate osteophytes, narrowing of certain joint spaces, multiple sclerosis, and possible bone deformities; Grade 4, by large osteophytes, marked joint fissures, severe sclerosis, and definite bone deformity [15].

Descriptive analysis was used to describe the demographic characteristics of the subject with baseline measurements on primary data that has been collected which will then be processed using Microsoft® Excel 2019 software to be displayed in tabular form. Then the data was entered and processed with IBM® SPSS® software version 25 for bivariate analysis using the Spearman Rho correlation test (one of the variables tested was the ordinal variable), p value < 0.05 was considered statistically significant.

3 Results and Discussion

The results of this study are presented in two forms of data analysis, univariate and bivariate analysis. The univariate data analysis was about the description of the respondent's characteristics, the grade of knee OA, the TUG test, and the respondent's quality

Table 1. Characteristics of Respondents

Respondents (n = 100)		(n)	(%)	Mean ± Std	Minimum-Maximum
Descriptive Statistics					
Gender	Man Woman	17 83	17 83		
Age	45–55 years old 56–65 years old > 65 years old	19 48 33	19 48 33	63 ± 7.3	50–82
Body Mass	17.1–18.4 18.5–25.0	1 44	1 44		
Index (kg/m^2)	25,1–27.0 >27.0 Grade I	15 40 21	15 40 21	26,21 ± 3.96	17,2–38.8

of life-based on the SF-36 questionnaire. Meanwhile, bivariate analysis was conducted to determine the correlation between the grade of knee OA according to the Kellgren-Lawrence classification and the quality of life of knee OA patients and the correlation between the Timed Up and Go (TUG) test and the quality of life of knee OA patients.

Table 1. Found the frequency of female as many as 83 respondents (83%) while male as many as 17 respondents (17%) from 100 respondents. All respondents are more than 50 years old with an average age of 63 years, the largest frequency of knee OA respondents is in the late elderly category (56–65 years) as many as 48 respondents (48%). The average BMI value was 26.21 ± 3.95, which indicates that most of the patients in this study were overweight but with the greatest frequency in the normal BMI category (18.5–25.0) as many as 44 respondents.

In the distribution grade of knee OA, the largest frequency of respondents of knee OA is in grade II according to the Kellgren-Lawrence classification as many as 47 respondents (47%), while the lowest frequency is respondents in grade IV according to the Kellgren-Lawrence classification as many as 7 respondents (7%). The distribution of the TUG test, the largest frequency of OA knee respondents has a travel time of 10.1–20.0 s (low fall risk) as many as 71 respondents (71%), while the smallest frequency is respondents who have time of > 30 s (fall risk). High) as many as 6 respondents (6%) and the average value of the TUG test was 18.30 ± 6 [17].

Distribution of patient's quality of life found that the frequency of knee OA respondents had a good quality of life greater as many as 54 respondents (54%) compared to poor quality of life as many as 46 respondents (46%) and obtained a quality of life score with the largest SF-36 questionnaire reaching 85.83, while the smallest score is 19.86 with a mean value 51.68 ± 13.8.

Table 2. The results of the Spearman correlation test show that there are five domains, physical function, role physical, general health, social function, and role emotional from the SF-36 questionnaire which correlate with the grade of knee OA according to Kellgren-Lawrence with a negative relationship with The correlation level is moderate-weak, this indicates that the more severe grade of knee OA according to Kellgren-Lawrence is

Table 2. Correlation Between K/L Degree and TUG Test with Quality of Life

	K/L Grade	TUG
SF-36		
Physical function	-0.468^{**}	-0.645^{**}
Role Physical	-0.337^{**}	-0.393^{**}
Body Pain	−0.008	-0.383^{**}
General Health	-0.260^{**}	-0.370^{**}
Vitality	−0.074	-0.210^{*}
Social function	-0.216^{*}	-0.319^{**}
Role Emotional	-0.230^{*}	-0.445^{**}
Mental Health	−0.062	-0.232^{*}

** $p < 0.01$, * $p < 0.05$, K/L: *Kellgren-Lawrence*, TUG: *Timed Up and Go* Test, SF-36: Short Form 36

associated with a decrease in the quality of life of knee OA patients. While the Spearman correlation test between the TUG test and quality of life showed that all domains of the SF-36 questionnaire were statistically significant with a negative relationship direction and a strong-weak correlation level, this indicates that the longer time of the TUG test is associated with a decrease in quality of life of knee OA patients. The results of the Spearman correlation test show that there are 5 domains namely physical function, physical limitations, general health, social function, and the emotional role of.

From the results of the study, it was found that the characteristics of the respondents included gender, age, and body mass index (BMI). There is a significant difference in the proportion of gender frequency distribution where the majority of knee OA patients in this study were female 83%, compared to men 17%. The results of this study are in line with and slightly higher percentage compared to the results of research conducted by Nurhalimah at Mitra Medika Clinic Cirebon, where the percentage of female respondents with OA knee is 81.5%, while men are 18.5% of 65 patients16 and the percentage is slightly lower than the results of a study conducted by Salma et al. et al.-Islam Hospital Bandung from 85 patients, the percentage of female respondents with knee OA were 87% while male respondents were 13% [17].

Men are less likely to develop OA than women, which makes gender a risk factor associated with the development of OA. Factors such as the process of patellar cartilage degradation in women three times faster than men who have a larger patellar volume.16 Narrower femur, thinner patella, larger quadriceps angle and difference in tibial condylus size make women's knee anatomy different from men's, cause different kinematics and predispose women to be more likely to develop OA, which ultimately leads to prevalence higher OA in women [18].

Previous studies have shown that the risk of knee OA in women will increase with age leading to menopause, which underlies that hormonal factors, especially a significant decrease in the hormone estrogen, make an important role in both endogen and exogen in the process of knee OA.6 Estrogen receptors are not only in joint cartilage but also

in various periarticular tissues including subchondral bone, synovium, periarticular ligaments, and muscles. Therefore, changes in sex hormone concentrations throughout the menstrual cycle can be large enough to affect collagen metabolism, and may indirectly affect knee structure and function. Sex hormones also have a pleiotropic effect in bone metabolism and in maintaining chondrocyte hemostasis. In one study, low estradiol levels were associated with the pathogenesis of OA in postmenopausal women. Increased levels of IL-1, IL-6, TNF- and other inflammatory factors in serum and synovial fluid after menopause can increase and worsen the occurrence of osteoarthritis [19].

Age is an important risk factor for OA, OA rarely affects people younger than 40 years old and more often in people over 60 years old [20]. Knee OA is closely related to age because radiographic evidence of OA occurs in most people over 65 years of age and in more than 75% of people over 75 years of age [15]. The results of this study found that respondents who suffered from knee OA were in the group late elderly (56–65 years) as much as 48% and the average age is 63 years. Many research results are in line with the results of this study, such as the research conducted by Jonathan et al. at RSUP Dr. Hasan Sadikin Bandung where patients suffering from knee OA are often found in the 55–64 year age group [21]. Research by Bimo Sasono et al. in RSUD Dr. Mohamad Soewandhie, Surabaya, as many as 705 patients were involved. The results showed that 38.8% were aged 61–70 years with an average age of 62 years.6 This is because with increasing age, the muscles that strengthen joints weaken, there is a degradation of the cartilage matrix due to the secretion of matrix metalloproteinases by chondrocytes, there is a decrease in the ability to synthesize and repair the cartilage matrix by chondrocytes due to decreased secretion of growth factors so that the cartilage will become thinner and cause osteoarthritis [21].

It is important to remember that joint aging and osteoarthritis are not the same but the aging process can make the development of OA more likely. Oxidative stress occurs with aging in the articular cartilage and promotes imbalances in catabolic and anabolic signaling in the development of OA. IGF-1 (insulin-like growth factor 1) and OP-1 (osteogenic protein 1) are major cartilage growth factors and a decreased response of articular chondrocytes to IGF-1 and OP-1 results in reduced matrix gene expression and matrix protein synthesis. This reduced response to growth factors is due to changes in cell signaling mediated by oxidative stress. Mitochondrial dysfunction resulting from cellular aging can increase levels of reactive oxygen species (ROS), ROS have normal physiological functions to regulate cell signaling including IGF-1 signaling but the increase in ROS that occurs under conditions of oxidative stress inhibits IGF-1-mediated Akt activation required for chondrocyte synthesis and survival and enhances mitogen-catabolic activation of the activated protein kinase pathway. Usually, the production of ROS is offset by the activity of various anti-oxidants. Glutathione is a major intracellular anti-oxidant but an increase in the relative oxidized amount will reduce glutathione which is consistent with an increase in age-related ROS. Oxidative inactivation of the anti- oxidant system allows an increase in intracellular ROS levels leading to impaired physiological signaling that can have an impact on the development of OA [22].

Most of the knee OA patients who were respondents in this study had a body mass index (BMI) with an average value of 26.21 ± 3.96 and most of the respondents were in the obese category. The same thing was also found in research by Ilham et al. and

Alghadir et al. which showed that more than 50% of respondents had a BMI in the obesity category (25.1–29.9) [9, 23]. However, different results were found in a cross sectional study by Nurhalimah at Mitra Medika Clinic Cirebon which involved 65 respondents and Sahrudi et al. at Ana Medika Hospital Bekasi which involved 96 respondents, in the results of the study most of the respondents had normal BMI [16, 24].

Obesity is a well-known risk factor for the development of OA. The exact mechanism by which obesity increases the risk of OA remains unclear. Several authors have suggested that an increased risk of OA is associated with an increased joint load. On the other hand, several studies have shown that a combination of biomechanical and metabolic factors is responsible for the association between obesity and knee OA. The results suggest that adipokines play an important role in the pathogenesis of OA but not yet fully understood [25].

The experience of pain that interferes with functional activities can also affect physical and mental health, social relationships and interactions with family, work environment and society. This problem can have an impact in decreasing productivity and ultimately affecting the quality of life of people with OA [13]. The results of this study found that there were 5 domains, physical function, role physical, general health, social function, and role emotional from the SF-36 questionnaire which correlated with the grades of knee OA according to Kellgren-Lawrence with a negative relationship direction with a moderate-weak correlation level but not correlated with the other 3 domains, body pain, vitality, and mental health. This shows that the more severe grade of knee OA (grades 1 – 4) is associated with a decrease in the quality of life of knee OA patients, especially affecting the function of physical activity, social function, emotional role and general health.

Different things were obtained from the results of research conducted by Fatih et al. It showed that there were only two domains in the SF-36 questionnaire, physical function and general health which correlated with radiographs of the degree of OA.26 The results of this study showed that patients suffering from knee OA on average still had a quality of life that was said to be good even though the highest number of patients was at the grade 2 of knee OA.

The presence of knee pain, decreased functional mobility, stiffness and decreased quadriceps strength have been associated with knee OA and can lead to physical disability [9]. The limitations of functional mobility experienced by patients with knee OA are associated with changes in quality of life and function of work capacity. In other studies, changes in the quality of life of OA patients are a direct result of limited range of motion and physical function, pain, and muscle imbalance [27]. The correlation between the TUG test and quality of life in this study showed that the entire domain of the SF-36 questionnaire was correlated with the direction of the negative relationship and the level of strong-weak correlation, this indicates that the longer travel time of the TUG test is associated with a decrease in the patient's quality of life. Research conducted by Marcio et al. concluded that OA patients have a low quality of life in the domains of physical function, role physical, and pain and there is a strong relationship between low education level and low quality of life and the fact that individuals with low education have high levels of physical activity [28].

4 Conclusion

Knee osteoarthritis has an impact on quality of life, risk factors for knee OA including gender, weight, age, physical activity, and severity of knee OA affect the quality of life. The existence of a significant correlation between the quality of life with the degree of knee OA and the assessment of physical activity function using the TUG test can provide input to health professionals in an additional assessment of the patient's health status and can be used in selecting a better treatment modality for patients with knee OA.

References

1. Abramoff B, Caldera FE. Osteoarthritis: Pathology, Diagnosis, and Treatment Options. Med Clin North Am. 2020; 104(2): 293–311.
2. Zampogna B, Papalia R, Papalia GF, Campi S, Vasta S, Vorini F, et al. The Role of Physical Activity as Conservative Treatment for Hip and Knee Osteoarthritis in Older People: A Systematic Review and Meta-Analysis. J Clin Med. 2020 Apr 18; 9(4): 1167.
3. Hong JW, Noh JH, Kim DJ. The prevalence of and demographic factors associated with radiographic knee osteoarthritis in Korean adults aged ≥ 50 years: The 2010–2013 Korea National Health and Nutrition Examination Survey. PLoS One. 2020; 15(3).
4. Kraus VB, Sprow K, Powell KE, Buchner D, Bloodgood B, Piercy K, et al. Effects of Physical Activity in Knee and Hip Osteoarthritis: A Systematic Umbrella Review. Med Sci Sport Exerc. 2019; 51(6): 1324–39.
5. Kemenkes RI. laporan Nasional Riskesdas 2018 [Internet]. Badan Penelitian dan Pengembangan Kesehatan. 2018. p. 198. Available from:http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL.pdf
6. Sasono B, Dewi DN, Amanda NA. Faktor Dominan Pada Penderita Osteoarthritis di RSUD Dr. Mohamad Soewandhie, Surabaya, indonesia. J Med Udayana. 2020; 9(11): 3–8.
7. Chow YY, Chin K-Y. The Role of Inflammation in the Pathogenesis of Osteoarthritis. 2020;
8. Hong JW, Noh JH, Kim DJ. The prevalence of and demographic factors associated with radiographic knee osteoarthritis in Korean adults aged ≥ 50 years: The 2010–2013 Korea National Health and Nutrition Examination Survey. Vol. 15, PLoS ONE. 2020.
9. Alghadir A, Anwer S, Brismée JM. The reliability and minimal detectable change of Timed Up and Go test in individuals with grade 1 - 3 knee osteoarthritis. BMC Musculoskelet Disord. 2015; 16(1): 1–7.
10. Aree-Ue S, Kongsombun U, Roopsawang I, Youngcharoen P. Path model of factors influencing health-related quality of life among older people with knee osteoarthritis. Nurs Heal Sci. 2019; 21(3): 345–51.
11. Hsieh CY, Huang HY, Liu KC, Chen KH, Hsu SJP, Chan CT. Subtask segmentation of timed up and go test for mobility assessment of perioperative total knee arthroplasty†. Sensors (Switzerland). 2020; 20(21): 1–17.
12. Dobson F, Bennell K, Hinman R, Abbott J, Roos E. Recommended Performance-Based Tests to Assess Physical Function in People Diagnosed with Hip or Knee Osteoarthritis. OARSI. Australia: The University of Melbourne;
13. Puspitaningrum G, Fisioterapi PS, Kesehatan FISurakarta UM. Hubungan antara intensitas nyeri dengan kualitas hidup pada pasien osteoarthritis knee. 2020.
14. Beaudart C, Biver E, Bruyère O, Cooper C, Al-Daghri N, Reginster JY, et al. Quality of life assessment in musculo-skeletal health. Vol. 30, Aging Clinical and Experimental Research. Springer International Publishing; 2018. pp. 413–8.

15. Lespasio MJ, Piuzzi NS, Husni ME, Muschler GF, Guarino A, Mont MA. Knee Osteoarthritis: A Primer. Vol. 21, The Permanente journal. Kaiser Permanente; 2017. pp. 16–183.
16. Nurhalimah MM. Hubungan antara panjang langkah dengan keseimbangan dinamis pada pasien lanjut usia dengan kondisi knee osteoarthritis (OA) grade II. J Ilm Fisioter E-ISSN, 2528, 3235. 2020; 20(1): 32–9.
17. Afina SN, Yuniarti L, Masria S, Rathomi HS, Dharmmika S. Hubungan Derajat Nyeri dan Klasifikasi Radiologik dengan Kualitas Hidup Pasien Osteoartritis Lutut. J Integr Kesehat Sains. 2019; 1(2): 91–6.
18. Primorac D, Molnar V, Rod E, Jeleč Ž, Cukelj F, Matiši´cmatiši´c V, et al. Knee Osteoarthritis: A Review of Pathogenesis and State-Of-The-Art Non-Operative Therapeutic Considerations. Genes (Basel) [Internet]. 2020 [cited 2021 Apr 17]; 11: 854. Available from: www.mdpi.com/journal/genesGenes2020,11,854
19. Liu YP, Li J, Xin SB, Xu J. Study the relevance between inflammatory factors and estradiol and their association with knee osteoarthritis in postmenopausal women. Eur Rev Med Pharmacol Sci. 2018; 22(2): 472–8.
20. Soeroso J, Isbagio H, Kalim H, Broto R, Pramudiyo R. Osteoarthritis. In: Setiati S, Alwi I, Sudoyo aru W, Simadibrata M, Setyohadi B, Syam AF, editors. Buku Ajar Ilmu enyakit Dalam. VI. Jakarta: InternaPublishing; 2014. pp. 3199–210.
21. Jonathan JS, Kuntara A, Renaldi PHNR. Korelasi Usia dan Derajat Osteoartritis Sendi Lutut Berdasarkan Sistem Klasifikasi Kellgren-Lawrence di RSUP Dr . Hasan Sadikin Bandung Tahun 2019–2020 Correlation Between Age and Primary Knee Osteoarthritis Grade According to Kellgren- Lawrence Classifica. J Med Heal. 2021; 3(1): 16–25.
22. Loeser RF. The Role of Aging in the Development of Osteoarthritis. Trans Am Clin Climatol Assoc. 2017; 128: 44–54.
23. Ilham ahmad wildan, Rahmawati lita diah, Wardhana teddy heri. Demographic Profile, Clinical and Analysis of Osteoarthritis Patients in Surabaya. Biomol Heal Sci J. 2018; 1(1): 34.
24. Sahrudi S, Maria R, Herawati T. Nyeri Lutut Berpengaruh terhadap Kemampuan Fungsi Fisik Pasien dengan Osteoarthritis Lutut. J Ilmu dan Teknol Kesehat. 2019; 7(1): 39–46.
25. Primorac D, Molnar V, Rod E, Jeleč Ž, Čukelj F, Matišić V, et al. Knee osteoarthritis: A review of pathogenesis and state-of-the-art non-operative therapeutic considerations. Vol. 11, Genes. MDPI AG; 2020. pp. 1–35.
26. Özden F, Nadiye Karaman Ö, Tuğay N, Yalın Kilinç C, Mihriban Kilinç R, Umut Tuğay B. The relationship of radiographic findings with pain, function, and quality of life in patients with knee osteoarthritis. J Clin Orthop Trauma. 2020; 11: S512–7.
27. Putu N, Pande A, Dewi A, Subawa W, Wiguna AA. Hubungan status kesehatan berdasarkan WOMAC dengan kualitas hidup berdasarkan WHOQOL-BREF pada pasien osteoartritis lutut di Rumah Sakit Sanglah tahun 2016-2017. Intisari Sains Medis. 2018; 9(1): 71–5.
28. Kawano MM, Araújo ILA, Castro MC, Matos MA. Assessment of quality of life in patients with knee osteoarthritis. Acta Ortop Bras. 2015; 23(6): 307–10.