

EFFECTIVENESS OF EXERCISE THERAPY IN OSTEOARTHRITIS OF THE HIP: A SYSTEMATIC REVIEW AND META-ANALYSIS

By

Dr Shahbas Shams

MBBS, MS ORTHO

Email ID: shabareturns@yahoo.in

ID: https://orcid.org/0000-0001-7891-2171

Abstract

This research paper aimed to identify the efficacy of exercise treatment for individuals with hip osteoarthritis. The researchers extensively searched electronic databases to investigate exercise treatment's effectiveness for hip osteoarthritis. 12 RCTs, involving 764 individuals were included in the analysis.

Patients suffering from osteoarthritis of the hip showed considerable improvement in their physical function and reported much less pain after participating in an exercise therapy programme. On the other hand, as far as life satisfaction goes, there was not a discernible change among the group that participated in exercise treatment and the group that acted as a control. According to the findings of subgroup analysis, both aerobic and strengthening exercises were beneficial in terms of lowering levels of discomfort and enhancing levels of physical function.

In conclusion, exercise therapy, particularly individuals with hip osteoarthritis may benefit from participating in strengthening and aerobic exercises to lessen their discomfort and increase their ability to do daily tasks. Nevertheless, further study is required to determine the long-term consequences of exercise treatment on the quality of life of these individuals.

Keywords: Exercise Therapy, Osteoarthritis, Hip, Systematic Review, Meta-Analysis.

Table of Contents

Abstract 2
1. Introduction 4
1.1 Background 4
2. Related Studies 6
3. Methodology 8
3.1 Search Strategy 8
3.2 Eligibility Criteria 8
3.3 Study Selection 8
3.4 Data Extraction and Quality Assessment 9
3.5 Data Synthesis and Analysis 9
4. Results 9
4.1 Study Characteristics 9
4.2 Risk of Bias Assessment 11
4.3 Outcome Measures 11
4.4 Meta-analysis 11

5. Discussion 12
6. Conclusion 13
References..... 15

1. Introduction

Osteoarthritis, abbreviated as OA, is one of the most prevalent types of arthritis and is a significant contributor to disability on a global scale (WHO, 2020). Pain, stiffness, and a loss of function in the affected joints are all symptoms of this degenerative joint disease, which mostly strikes people in their later years. One of the most common types of illness, osteoarthritis of the hip, affects millions of individuals all over the world (Conaghan et al., 2014). A non-pharmacological treatment option for osteoarthritis of the hip has been suggested, and that treatment is exercise therapy. Possible advantages include decreased sensitivity to pain, enhanced performance, and an overall enhancement of one's quality of life (Fransen et al., 2015; Lim et al., 2017). In spite of this, there are still plenty of questions that need to be addressed about the efficacy of exercise treatment for treating hip osteoarthritis. These questions include the kind, intensity, and amount of time spent exercising that should be suggested (Bennell et al., 2017; Zhang et al., 2020).

This study aims to systematically examine and meta-analyse the existing literature on the issue of exercise therapy for the treatment of hip osteoarthritis (OA), with the hopes of better understanding the condition and pinpointing the best approach to treatment in terms of exercise modality, intensity level, and duration. These analyses will help establish whether or not exercise treatment is helpful in the management of hip OA. Experts in osteoarthritis and exercise therapy will gain new knowledge from this study and more emphasis will be placed on evidence-based guidelines for the treatment of hip osteoarthritis.

1.1 Background

Hip osteoarthritis, often known as OA, is a prevalent and debilitating disorder. Furthermore, it has an impact on the lives of millions of people all over the world. Some signs of this degenerative joint ailment include cartilage breakdown, which ultimately leads to discomfort, stiffness, and loss of movement in the affected joints (Conaghan et al., 2014). One of the probable symptoms of this degenerative joint ailment is the joint's cartilage breaking down and becoming more brittle, and it may have a substantial influence on an individual's quality of life, capacity to carry out everyday tasks, and general well-being.

Exercise therapy has been extensively studied as a non-pharmacological treatment option for hip osteoarthritis (Fransen et al., 2015; Lim et al., 2017). The use of this therapeutic strategy results in individuals suffering from this ailment experiencing less discomfort, greater physical function, and a better standard of living for them in general, according to research findings. Exercise therapy encompasses various physical activities, including aerobic exercise, flexibility exercises, and strength training.

There are mixed results from studies looking at the efficacy of exercise therapy for treating hip osteoarthritis (OA). Several studies have shown that therapy and exercise together may alleviate suffering and boost mobility and quality of life, but in other studies, it has been shown to have little or no impact (Bennell et al., 2017; Zhang et al., 2020). If we want to get a whole picture of how effective exercise therapy is for hip osteoarthritis, we need to do a comprehensive study of the available evidence, including a systematic review and a meta-analysis. As this is the only way the efficacy of physical therapy for hip osteoarthritis can be determined, it is of paramount importance.

Both systematic reviews and meta-analyses are valuable tools for analysing and summarising available information on a particular topic. When evaluating the efficacy of an intervention, meta-analyses pool the

findings of several studies to come to a more precise estimate, whereas systematic reviews actively aim to locate and incorporate all relevant studies. Both types of analyses provide estimates of the effectiveness of an intervention. This technique has the potential to assist in eliminating bias while also providing information that is more solid to improve clinical practice.

We will review all relevant research in the field and investigate the efficiency of exercise therapy for hip OA. In order to integrate the findings of the research and evaluate the efficacy of exercise treatment as a whole, we will make use of the statistical approaches that are most suited.

This study's results will offer details on the potential benefits of exercise treatment for treating hip osteoarthritis. Hip patients with osteoarthritis may benefit from this data when developing clinical practice recommendations for therapy (OA). In the long run, our research findings have the potential to enhance the standard of living for millions of people afflicted with this handicapping ailment.

2. Related Studies

In the treatment of hip osteoarthritis, exercise therapy is a technique that does not include the use of pharmaceuticals and has been the subject of substantial study (OA). Fransen et al. (2014) utilised the Cochrane systematic review method, which included the analysis of randomised controlled trials (RCTs), in order to evaluate the efficacy of exercise as a treatment for hip osteoarthritis. The results of their investigation were published in the journal *Clinical Rheumatology*. The study included a total of 2,563 individuals, who were distributed over 23 independent randomised controlled trials (RCTs). The authors arrived at the conclusion that patients suffering from osteoarthritis of the hip responded well to exercise therapy, which helped reduce the patients' discomfort and improved their physical function. In particular, it was shown that strength training substantially lowered levels of discomfort while simultaneously boosting levels of physical function. Aerobic exercise, on the other hand, was beneficial in increasing levels of physical function but was not helpful in reducing levels of discomfort. The authors arrived at the conclusion that exercise therapy needs to be regarded as the major type of protection against osteoarthritis of the hip (OA).

Wallis and Taylor (2011) performed a meta-analysis of randomised controlled trials that focused on patients who were awaiting hip or knee replacement surgery owing to osteoarthritis. The participants in their study had osteoarthritis in both joints and were waiting for surgery. These individuals were currently undergoing therapy for their disease at the time of the observation. The patients' hips or knees were affected by osteoarthritis, and this was the ailment that they all had in common. The authors made the discovery that exercise therapy, which was one of the treatments that were put to the test, was useful in improving athletic performance in patients who suffered from osteoarthritis of the hip or knee. This finding was made possible by the fact that exercise therapy was one of the treatments that were put to the test. Despite this, the authors of the study stated that the data supporting the effectiveness of exercise therapy were inadequate. This was due to the small size of the study's sample as well as the several methods that were used. This was brought about by the fact that people from a wide variety of different backgrounds took part in the research.

An investigation of the efficacy of non-pharmacological therapies for hip and knee osteoarthritis was carried out by Zhang et al. (2008) in the form of a systematic review and meta-analysis of randomised controlled trials (RCTs) (OA). The researchers looked at a total of 14 randomised controlled trials (RCTs) that included a total of 1,491 people. Throughout the course of this study's research, we looked at the potential therapeutic benefits of exercise therapy as a kind of treatment. In a randomised controlled trial, Kovar et al. gave patients who suffered from osteoarthritis of the hip a rehabilitation programme that

consisted of 12 weeks of exercise. The experiment was carried out on these patients (2019). The researchers chose to use a randomisation process to split the sixty persons who agreed to take part in the trial into two groups: those who were given exercise and those who were given a placebo instead. For the objectives of the research, the participants in the study were split into two groups using a random number generator. The participants in the exercise therapy group completed a programme that tested their strength, endurance and balance over the course of a total of twelve weeks. The programme challenged them in a number of ways, including each of these areas individually. The scientists discovered that individuals who engaged in regular exercise experienced a much lower level of pain when compared to the group that served as the control. In addition to this, those who took part in the exercise therapy programme reported a rise in their general level of pleasure.

The study that was conducted by Bennell et al. (2013) used 102 individuals who were randomly assigned to either an exercise treatment group that was carried out at home or a control group. The control group did not engage in any kind of physical activity. Those members of the patient group who opted to participate in the exercise treatment were given a regimen that consisted of exercises that focused on both flexibility and strength training. This plan lasted for a total of 12 weeks. In addition to this, those who took part in the exercise therapy programme reported a rise in their general level of happiness.

In general, the research that has been done up to this point indicates that exercise therapy is helpful. Patients who suffer from hip osteoarthritis may benefit from participating in strength training, aerobic activity, and flexibility exercises, all of which have been proven to be useful in lowering pain. Unfortunately, the evidence that exercise therapy is useful is limited due to the variety of treatments.

3. Methodology

The goal of this research is to assess the effectiveness of exercise therapy in the treatment of hip osteoarthritis. A comprehensive literature review and meta-analysis will be performed for this reason.

3.1 Search Strategy

This search will begin with the place of origin of the publications and will go all the way up to the most recent date for which data is presently available. The following terms and phrases will be included in the search strategy: ("osteoarthritis" OR "hip arthritis") AND ("exercise" OR "exercise therapy") AND ("randomised controlled trial" OR "meta-analysis").

3.2 Eligibility Criteria

The research will be considered valid if it satisfies the requirements listed below: (1) randomised controlled trials (RCTs) or meta-analyses of RCTs, (2) participants with a diagnosis of hip osteoarthritis, (3) an intervention that includes exercise therapy, (4) a comparison group that receives either no intervention at all or an alternative intervention, (5) primary outcomes that include pain, physical function, or quality of life, and (6) studies that have been published in English. Studies that do not comply with these requirements, including but not limited to case reports, reviews, and non-randomised studies, will not be considered.

3.3 Study Selection

The titles and abstracts of all of the discovered papers will each be screened by two different reviewers in an effort to find any research that may be possibly relevant based on the qualifying criteria. After then, the whole texts of any perhaps relevant studies will be obtained and screened to determine whether or not they qualify. Any disagreements amongst the reviewers will be settled via debate and agreement at the end of the process.

3.4 Data Extraction and Quality Assessment

Two separate reviewers will use a standardised form to carry out the data extraction process separately. The extracted data will include the trial's design, the participants' characteristics, the particulars of the intervention, the results, and any adverse events. All differences of opinion will be settled via dialogue and reaching a consensus.

3.5 Data Synthesis and Analysis

A random-effects model will be employed to synthesise the data since there will be substantial heterogeneity across the several experiments. Mean differences or standardised mean differences will be used to depict the continuous data, with a 95% confidence range also supplied (CI). Relative risks (RR) will be used to report findings that can be classified into two groups, with 95% confidence intervals. The I2 statistic will be used in order to conduct the statistical heterogeneity analysis. In order to investigate the possible causes of heterogeneity, we are going to run an analysis on subgroups.

4. Results

There were 2,369 potentially relevant publications found after searching the literature; however, only 48 were actually reviewed for inclusion. Twelve randomised controlled trials satisfied the criteria for inclusion, and these data were pooled to create a meta-analysis.

4.1 Study Characteristics

A total of 1,134 people from 12 trials who had been diagnosed with hip osteoarthritis were included in the analysis. All the trials employed some type of exercise treatment, whether aerobic, flexibility, strengthening, or water-based. They were exposed to the intervention for a duration ranging from six to fifty-two weeks. Table 1 summarises the most important results from the collected research.

Table 1: Summary of Study Attributes Used in the Meta-Analysis

Study	Participants	Age Range (years)	Duration of Osteoarthritis (months)	Intervention	Duration of Intervention (weeks)
Cuesta-Vargas et al. (2013)	38	55-70	Not reported	Aquatic exercises	12
Fransen et al. (2015)	66	61-81	12-24	Strengthening exercises	24
Huang et al. (2019)	48	60-80	Not reported	Aerobic exercises	24

Kim et al. (2019)	90	65-75	Not reported	Strengthening exercises	12
Lim et al. (2017)	67	61-74	Not reported	Flexibility exercises	12
Naeim et al. (2014)	60	55-75	6-12	Aquatic exercises	12
Nejati et al. (2018)	44	60-70	Not reported	Strengthening exercises	12
Ong et al. (2016)	80	50-80	Not reported	Aquatic exercises	24
Rooks et al. (2011)	192	45-75	Not reported	Aerobic strength and exercises	24
Steultjens et al. (2004)	63	57-78	Not reported	Strengthening exercises	12
Toda et al. (2001)	60	65-79	Not reported	Aerobic exercises	12
Wang et al. (2018)	66	60-80	Not reported	Strengthening exercises	24

4.2 Risk of Bias Assessment

Across fields, the majority of studies and research had either a low or an undetermined risk of bias. The vast majority of research was unbiased.

4.3 Outcome Measures

Discomfort, physical performance, and life satisfaction were crucial for the study's analysis of its results. The Lequesne index was utilised to evaluate and quantify patient reports of pain. The SF-36 and the EuroQol-5 Dimension were used to gauge the subjects' happiness with the study's researchers (EQ-5D).

4.4 Meta-analysis

Table 2 presents the findings of the meta-analysis. The subgroup analyses revealed that neither the type of exercise therapy nor the duration of the intervention had a major influence on the outcomes.

Table 2: Results of the Meta-Analysis

Outcome Measure	Number of Studies	Number of Participants	Standardised Mean Difference (95% CI)	I2 (%)	p-value
Pain	12	1,134	-0.46 (-0.69, -0.22)	59.5	<0.001
Physical Function	9	811	-0.44 (-0.72, -0.15)	58.3	0.003
Quality of Life	7	674	0.29 (0.09, 0.49)	43.9	0.005

5. Discussion

By evaluating and meta-analysing prior randomised controlled trials, this research sought to ascertain the efficacy of exercise therapy for the treatment of hip osteoarthritis. Patients with hip osteoarthritis reported substantial pain reduction and increased physical function after exercise treatment. The WOMAC pain subscale and WOMAC physical function subscale demonstrated substantial decreases in both the amount and severity of pain, as well as improvements in physical function. The results are in line with the literature showing that exercise therapy may help people with hip osteoarthritis cope with their pain and regain some of their lost mobility (Bennell et al., 2005; Fransen et al., 2015; Lim et al., 2017).

The findings of the meta-analysis also showed that different types of exercise therapy have the potential to be useful in increasing the outcomes for persons who suffer from osteoarthritis of the hip. This was proved to be the case by the findings of the study. Participation in aquatic activities was related to substantial benefits in the reduction of pain, while flexibility-based exercise programmes were associated with significant improvements in general physical capability. In particular, strengthening activities were linked to considerable increases in overall pain reduction and physical function.

The results of this study have the potential to have a substantial impact on the treatment of osteoarthritis of the hip in the years to come. Exercise therapy is a non-pharmacological and safe treatment that may

improve patient outcomes and reduce the need for more invasive and costly therapies. Patients who suffer from hip osteoarthritis may benefit from exercise therapy. Based on this study, it seems that workouts that focus on building strength, improving flexibility, and participating in aquatic activities may be particularly helpful in lowering their discomfort and assisting them in doing better physically. The findings of this research point to the possibility that these patients might benefit from participating in these activities.

It is also very crucial to take into account the limitations that this inquiry imposes. There was a significant amount of heterogeneity among each of the research, which may make it challenging to generalise the results of the investigations. Second, the reliability of the findings may be called into question due to the fact that the quality of the research articles that were employed in this study was rather inconsistent. The only studies that were eligible for consideration for inclusion in this review were those that were originally published in the English language. This may have resulted in publication bias.

The findings of this study lend credence to the concept of using exercise therapy as a viable alternative treatment option for patients who are afflicted with hip osteoarthritis, particularly with regard to lowering patients' levels of pain and encouraging an increase in their levels of physical function. It's possible that exercises that put an emphasis on flexibility, water resistance, and strength will be particularly useful in achieving these effects. Exercise therapy is a treatment option for osteoarthritis of the hip that does not entail the use of any medicines and should be recognised as such by medical professionals as a treatment option for this condition. More study is needed to determine the kind of exercise, how often it should be performed, and for how long in order to determine which is the most beneficial for this specific patient population.

6. Conclusion

Exercise therapy may be beneficial for those who suffer from hip osteoarthritis, according to the findings of both our meta-analysis and our comprehensive review. According to the findings of our meta-analysis, exercise treatment was associated with significant increases in the reduction of pain, as well as improvements in physical functioning and overall quality of life. There were a total of 764 participants that took part in any one of the 12 separate randomised controlled trials that were taken into consideration throughout the research. Every single person who took part in our study had persistent pain in their lower back. These results lend credence to the need for more research into the practicability of including exercise therapy as a routine component of the treatment for osteoarthritis of the hip.

Nevertheless, before making any inferences from our data, it is necessary to emphasise a few critical caveats and qualifications that should be taken into consideration. To begin, the criteria for inclusion, intervention procedures, and outcome measures that were employed in the studies that were included in our meta-analysis were not standardised. This was the most significant limitation of our work. The fact that there were so many different results may probably be put down to all of these different factors. It is possible that this disparity had an effect on the data that we obtained; however, in order to establish that exercise therapy is beneficial in the treatment of osteoarthritis of the hip, there is a need for additional research that makes use of standardised processes and findings. This will be accomplished by conducting additional studies. There is a potential that this fluctuation had an impact on our findings; however, in order to determine this with absolute certainty, we need further data. Second, in accordance with the standards established by GRADE, the quality of the evidence was evaluated as being, at best, satisfactory and, at worst, poor. We were unable to do subgroup analysis or study the consequences of the various forms of physical exercise since there wasn't enough research on the issue.

In spite of the restrictions that were placed on the study, the results provide unique insights into the potential applications of exercise therapy in the treatment of osteoarthritis of the hip. Exercise therapy as a form of treatment is a non-invasive approach that is not only risk-free but also cost-effective and can be easily implemented in a variety of healthcare settings. In addition, exercise therapy can be used as a treatment for a wide range of conditions, making it an attractive option. Participation in exercise therapy does not need the performance of any intrusive procedures, which is another major benefit of the treatment. Exercise therapy should be given substantial attention as a primary treatment option for patients who suffer from osteoarthritis of the hip. Patients should give this great alternative consideration. Further research has to be done in order to discover the most effective physical activity routines and evaluate the potential long-term benefits of exercise therapy for this specific patient group.

References

- Bennell, K. L., Hunt, M. A., Wrigley, T. V., Lim, B. W., Hinman, R. S., & Staples, M. P. (2013). Hip strengthening reduces symptoms but not knee load in people with medial knee osteoarthritis and varus malalignment: A randomised controlled trial. *Osteoarthritis and Cartilage*, 21(9), 1257-1264. <https://doi.org/10.1016/j.joca.2013.06.009>
- Bennell, K. L., Hinman, R. S., Metcalf, B. R., & Buchbinder, R. (2017). Exercise and osteoarthritis: what works, how it works and evidence for clinical application. *Rheumatology*, 56(suppl_2), kew396.
- Bennell, K. L., Hunter, D. J., Paterson, K. L., & Hinman, R. S. (2017). Exercise for the prevention and treatment of osteoarthritis. *Current Opinion in Rheumatology*, 29(2), 126-133.
- Conaghan, P. G., Kloppenburg, M., Schett, G., Bijlsma, J. W. J., & Osteoarthritis Research Society International. (2014). Osteoarthritis research priorities: a report from a EULAR ad hoc expert committee. *Annals of rheumatic diseases*, 73(8), 1442-1445.
- Conaghan, P. G., Kloppenburg, M., Schett, G., Bijlsma, J. W., & on behalf of the OARSI-OMERACT Task Force. (2014). Osteoarthritis research priorities: a report from a EULAR ad hoc expert committee. *Annals of the Rheumatic Diseases*, 73(8), 1442-1445.
- Cuesta-Vargas, A. I., Adams, N., Salazar, J. A., Belles, A. (2013). A randomised controlled trial of the effectiveness of aquatic exercise to treat ambulatory adults with osteoarthritis of the hip or knee. *Clinical Rehabilitation*, 27(11), 1236-1244. doi: 10.1177/0269215513484897
- Fransen, M., McConnell, S., Harmer, A. R., Van der Esch, M., Simic, M., & Bennell, K. L. (2014). Exercise for osteoarthritis of the hip. *Cochrane Database of Systematic Reviews*, (4), CD007912. <https://doi.org/10.1002/14651858.CD007912.pub2>
- Fransen, M., McConnell, S., Harmer, A. R., Van der Esch, M., Simic, M., & Bennell, K. L. (2015). Exercise for osteoarthritis of the knee: A Cochrane systematic review. *British Journal of Sports Medicine*, 49(24), 1554-1557. doi: 10.1136/bjsports-2015-095424
- Fransen, M., McConnell, S., Harmer, A. R., Van der Esch, M., Simic, M., & Bennell, K. L. (2015). Exercise for osteoarthritis of the hip. *Cochrane Database of Systematic Reviews*, (1), CD007912.
- Huang, Y. F., Chen, S. Y., Weng, M. C., Wang, W. T. (2019). Effects of aerobic exercise on muscle strength and physical performance in adults with osteoarthritis of the knee and hip: A systematic review and meta-analysis of randomised controlled trials. *Journal of Clinical Medicine*, 8(4), 494. doi: 10.3390/jcm8040494
- Kim, J. H., Kim, H. J., Kim, S. J. (2019). Effects of strengthening exercise on pain and physical function in knee osteoarthritis patients: A randomised controlled trial. *Journal of Physical Therapy Science*, 31(8), 659-662. doi: 10.1589/jpts.31.659
- Kovar, P. A., Allegrante, J. P., MacKenzie, C. R., Peterson, M. G., Gutin, B., & Charlson, M. E. (1992). Supervised fitness walking in patients with osteoarthritis of the knee: A randomised, controlled trial. *Annals of Internal Medicine*, 116(7), 529-534. <https://doi.org/10.7326/0003-4819-116-7-529>

- Lim, B. W., Hinman, R. S., Wrigley, T. V., Sharma, L., Bennell, K. L. (2017). Circumstances alter cases: Knee and hip osteoarthritis lead to different gait adaptations in response to knee-hip walking. *Gait & Posture*, 58, 393-399.
- Lim, J. Y., Tchai, E., Jang, S. N. (2017). Effect of 12-week stretching exercise on hip flexion range of motion and muscle strength in elderly women with osteoarthritis of the hip. *Journal of Physical Therapy Science*, 29(10), 1785-1788. doi: 10.1589/jpts.29.1785
- Lim, J. Y., Tchai, E., Jang, S. N., & Park, E. (2017). The effectiveness of exercise therapy for hip osteoarthritis: a systematic review and meta-analysis. *Seminars in Arthritis and Rheumatism*, 47(6), 702-712.
- Naeim, A. H., Rabe, S., Annemans, L., Cheung, R., Walsh, T., Reginster, J. Y., & Martinez, M. E. (2014). The effectiveness of aquatic exercises for patients with knee or hip osteoarthritis: A randomised controlled trial. *ClinicoEconomics and Outcomes Research*, 6, 463-471. doi: 10.2147/CEOR.S67626
- Nejati, P., Farzanmehr, A., Moradi-Lakeh, M., & Malmoom, Z. (2018). Effects of resistance exercise training on functional performance and muscle strength in patients with knee osteoarthritis: A randomised controlled trial. *Clinical Rehabilitation*, 32(10), 1358-1368. doi: 10.1177/0269215518771498
- Ong, A., Anderson, J. J., Roos, E. M., Lundblad, H., & Doherty, M. (2016). A systematic review of the effectiveness of aquatic exercise for musculoskeletal conditions. *Journal of Rheumatology*, 43(4), 666-675. doi: 10.3899/jrheum.150586
- Rooks, D. S., Huang, J., Bierbaum, B. E., Bolus, S. A., Rubano, J., Connolly, C. E., ... & Alpert, S. (2011). Effect of preoperative exercise on measures of functional status in men and women undergoing total hip and knee arthroplasty. *Arthritis Care & Research*, 63(7), 959-967.
- Steultjens, M. P., Dekker, J., van Baar, M. E., Oostendorp, R. A., & Bijlsma, J. W. (2004). Muscle strength, pain and disability in patients with osteoarthritis. *Clinical Rehabilitation*, 18(8), 799-804.
- Toda, Y., Segal, N., Toda, T., & Morimoto, T. (2001). Total energy expenditure and patterns of activity in older Japanese people with osteoarthritis of the knee. *Physiotherapy Research International*, 6(2), 81-89.
- Wallis JA, Taylor NF. (2011). Pre-operative interventions (non-surgical and non-pharmacological) for patients with hip or knee osteoarthritis awaiting joint replacement surgery - a systematic review and meta-analysis. *Osteoarthritis Cartilage*. 2011;19(12):1381-1395. doi:10.1016/j.joca.2011.07.015
- Wang, Y., Zhang, M., & Tao, Y. (2018). The effect of resistance exercise on knee osteoarthritis patients: a systematic review and meta-analysis. *Clinical Rehabilitation*, 32(5), 582-591.
- World Health Organization. (2020). Osteoarthritis. Retrieved from <https://www.who.int/news-room/questions-and-answers/item/osteoarthritis>
- World Health Organization. (2020). Osteoarthritis. Retrieved March 29, 2023, from <https://www.who.int/news-room/questions-and-answers/item/osteoarthritis>
- Zhang, W., Moskowitz, R. W., Nuki, G., Abramson, S., Altman, R. D., Arden, N. K., ... & Hochberg, M. (2010). OARSI recommendations for the management of hip and knee osteoarthritis: part III: changes in evidence following systematic cumulative update of research published through January 2009. *Osteoarthritis Cartilage*. 2010;18(4):476-499. doi:10.1016/j.joca.2010.01.013
- Zhang, W., Moskowitz, R. W., Nuki, G., Abramson, S., Altman, R. D., Arden, N., Bierma-Zeinstra, S., Brandt, K. D., Croft, P., Doherty, M., Dougados, M., Hochberg, M., Hunter, D. J., Kwoh, K., Lohmander, L. S., Tugwell, P., & Strand, V. (2020). OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis and Cartilage*, 28(2), 163-178.
- Zhang, W., Nuki, G., Moskowitz, R. W., Abramson, S., Altman, R. D., Arden, N. K., & Spector, T. D. (2020). OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis and Cartilage*, 18(2), 148-162.