

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis and results in the degeneration of joint cartilage, often leading to loss of joint function. More than 32.5 million adults in the United States are diagnosed with the disease, and in 2019, it affected approximately 528 million people worldwide.^{1,2} OA is recognized as a leading cause of disability in those aged 60 and older, and is projected to grow in cases by 74.9% for knee OA and by 78.8% for hip OA by 2050.³ Affliction with OA can be attributed to a variety of risk factors, including older age, sex, genetics, obesity, occupation, and prior joint injury.¹ It can occur in any joint in the body, most commonly the knees, spine, hands, or hips.⁴ Lifestyle modifications such as exercise, weight loss, or increasing joint mobility can make patients less susceptible to the disease.⁵ Hip osteoarthritis is a common diagnosis for chronic hip pain symptoms. It can result in decreased quality of life for those diagnosed due to pain, immobility, and potential increases in comorbidities.⁷ In women, it has been found to lead to other negative health outcomes such as significantly short sleep duration or long sleep duration, which is linked to increased risk for all-cause mortality, hypertension, and type 2 diabetes.⁸ The need for total hip arthroplasties is expected to increase by 174% by 2030, a number that was previously underestimated.⁹

Treatment Types

Prescribed physical therapy is often the first line of conservative treatment. Pharmaceutical treatment for the disease includes non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, acetaminophen or the prescription drug meloxicam.¹⁰ In more severe hip OA cases, a corticosteroid, depo-medrol, or hyaluronic acid joint injection may be used. A corticosteroid injection may provide short-term pain relief for a few months, with repeated injections when needed, and potentially prolong the need for a total hip arthroplasty. However, for patients with worsening cases of hip OA, pain relief from the injection may be inconsistent, and surgery may be necessary soon after beginning injection treatment.^{6,11} The most invasive stage of treatment for hip OA is a total or partial hip arthroplasty. This treatment is recommended primarily for patients whose daily life is heavily impacted by their hip OA, those who experience pain even when resting, and when other treatments have not been successful.¹²

Rural Healthcare

In rural areas, qualities such as having older populations, lower socioeconomic class, further distances from healthcare facilities, and higher obesity rates can alter health outcomes and make rural populations more susceptible to forms of osteoarthritis. Approximately one third of those living in rural areas have one of the many forms of arthritis, and more than one half are limited in their daily lives by the condition.¹³ Out-of-pocket treatment costs are also substantial for those living with OA.¹⁴

Travel Time and Treatment Type

Distance is perceived to have a role in impeding completed and effective treatment for certain diseases and disorders, such as cancer, and should be recognized as an access barrier to healthcare.¹⁵ Residents of rural areas see increased travel distances of around 2-3 times farther to healthcare facilities when compared to their urban counterparts.¹⁶ This difference is most prominent for those needing complex procedures and for those with heart disease, cancer, or depression, as well as in the type of healthcare visit patients took part in – those with increased rurality tended towards general practitioners over specialists.^{17,18} Rural patient are also farther from hospitals, living an average of 10.5 miles away and patients in urban areas living an average of 4.4 miles away.¹⁹ From 2013-2018, the number of orthopedic surgeons practicing in urban areas increased, but the number of these physicians in rural areas decreased.²⁰ As the older population in the United States increases, primarily in rural areas, the risk of musculoskeletal disease and injury will increase alongside it, as old age is a risk factor for common problems like osteoarthritis.²¹ Orthopedic surgeons earlier in their careers as well as those that sub-specialize tend to practice more in metropolitan areas, while orthopedic surgeons in rural areas tend to be older than their urban counterparts.^{20,22}

Hypothesis

Significant differences in treatment types utilized between patients with longer and shorter travel times might suggest distance plays a role in a patient's choice of management of a chronic disease. The distinct treatment types we used are (1) physical therapy, (2) corticosteroid intraarticular injections, (3) hyaluronic acid intraarticular injections, and (4) total hip replacement surgery. Our primary hypothesis is that patients with a shorter travel time will use more invasive, variable, and costly treatment types, and that patients with a longer travel time will use less invasive, fewer, and less costly treatment types. Although these are the most intuitive hypotheses, after further consideration, an alternative hypothesis could also be possible. In this hypothesis, patients with a shorter travel time will use less invasive, fewer, and less costly treatment types, while patients with a longer travel time will use more invasive, fewer, and more costly treatment types.

METHODS

This observational study was conducted utilizing data retrieved from the Med Center Health patient database, a healthcare branch spanning Southcentral Kentucky. Patients were categorized into treatment groups based on the type of treatment(s) they received for hip OA (Figure 1).

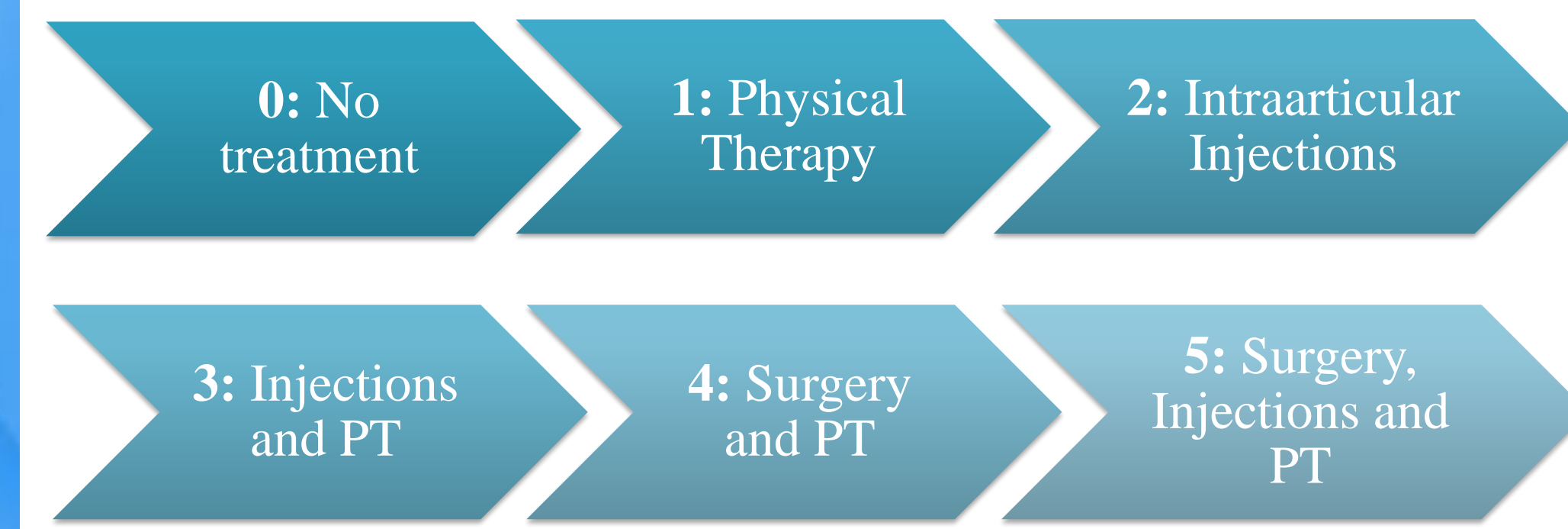


Figure 1: Treatment groupings for patients with hip OA. All surgery patients also received PT. These categories were chosen based on how often treatments were seen combined or separate in the dataset, the invasiveness of treatment, and the time burden of the treatment.²³

Travel Time and Rural-Urban Distinction

The sample was limited to only Bowling Green, Kentucky providers, who saw 95% of patients in the original data set. Distance in miles and travel time in minutes were then calculated using the county of each patient zip code to Bowling Green. Rural-urban continuum codes, developed by the United States Department of Agriculture, form a classification scheme for metropolitan and non-metropolitan counties.²⁴ There are nine rural-urban codes, but for this research study, the codes were grouped into three areas from most urban to most rural to better serve the statistical analysis and sample: most urban (codes 1-3), urban-rural (codes 4-6), and most rural (codes 7-9).

Statistical Analysis

Statistical analysis was conducted using SPSS. A Kruskal-Wallis nonparametric ANOVA was used to determine the effect of travel time on treatment group and to test the null hypothesis that there is no significant difference in travel time among treatment groups. A chi-square association test was used for group associations between sex and treatment group and rural-urban group and treatment group. Bivariate correlations were used to determine potential confounding factors that may influence the effect of travel time.

RESULTS

The sample consisted of 930 patients from the past five years diagnosed hip OA. Patients were selected from those who utilized Med Center Health healthcare facilities in the state of Kentucky. The sample was 52% female and 48% male, with an age range of 25 to 97.

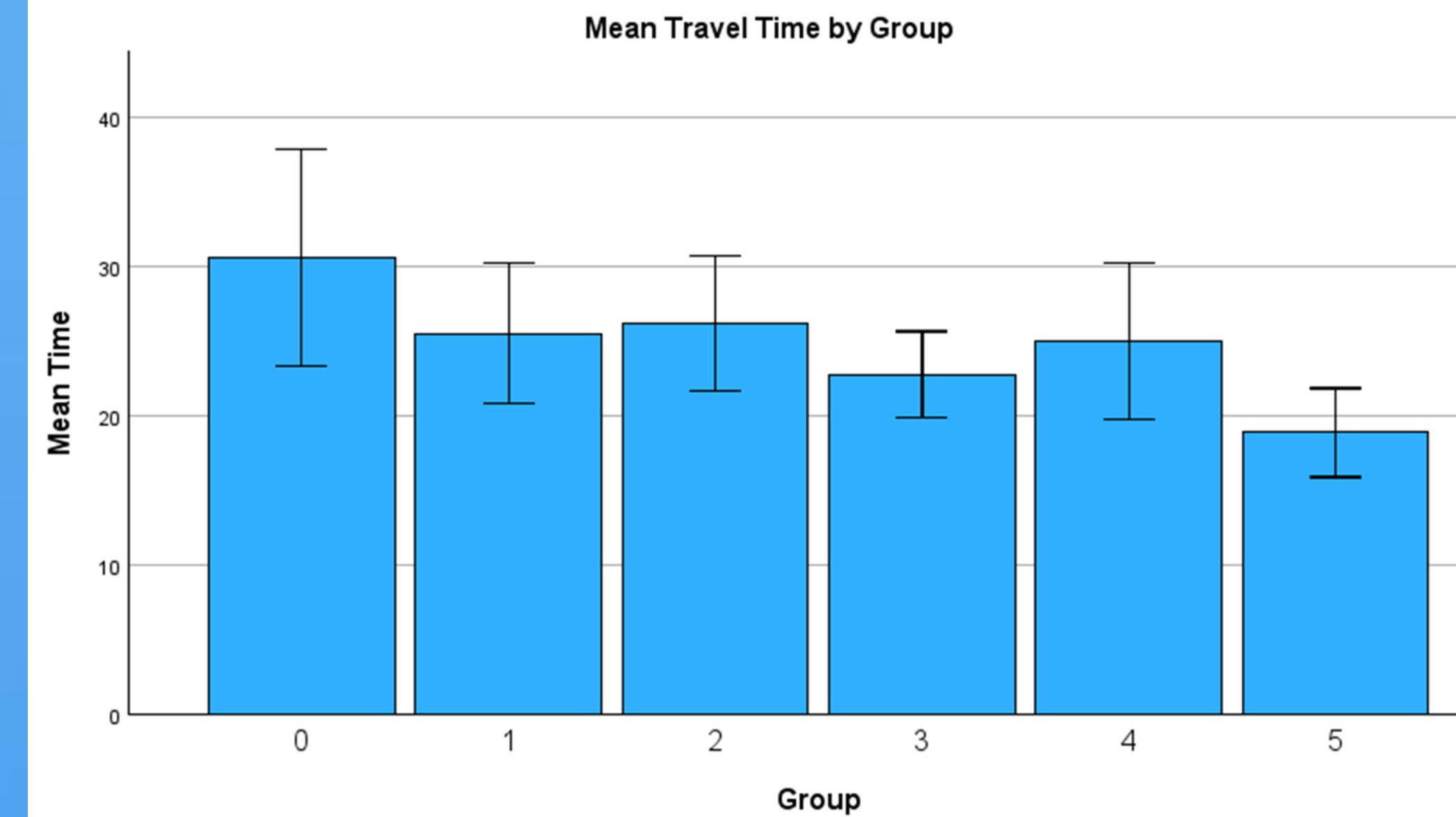
Analysis

The Kruskal Wallis test determined that age and travel time have significantly different means across treatment groups. Travel time produced a significant p-value of 0.023 and significant coefficient of 13.065 (Table 1, Graph 1). Travel time, although a significant factor in treatment group, was less significant than the effect of age (Table 1) on treatment group, which had a $p < 0.001$ and a coefficient of 26.806.

	Age	Travel Time	Mean BMI	Total Visits
Kruskal-Wallis	26.806	13.065	4.576	2.511
df	5	5	5	5
Asymp. Sig.	<0.001	0.023	0.470	0.775

Table 1: Kruskal Wallis test between treatment group and age, travel time, mean BMI, and total visits.

Average patient BMI, however, was an insignificant factor in treatment group, with a value of $p = 0.470$ (Table 1). Total number of visits was also insignificantly different across treatment groups.



Graph 1: Bar graph of mean travel time by treatment group. Group 0 had a significantly higher mean travel time than group 5.

The Chi-Square associations determined that the rural-urban group was significantly associated with treatment group, with a significance value of $p = 0.008$. Sex was not associated with treatment group (Table 2).

	Sex	Rural-Urban Group
Pearson Chi-Square	9.850	23.681
Asymp. Sig.	0.080	0.008

Table 2: Chi-Square association test results between treatment group and sex and treatment group and rural-urban group (N = 3).

Relationship tests determined that travel time is not correlated with age, BMI, total visits, and sex. However, an ANOVA test showed that it is related with rural-urban group (Table 3).

	Age	Mean BMI	Total Visits*	Sex**	Rural-Urban^
Sig. (2-tailed)	0.990	0.714	0.672	0.868	<0.001
Test Statistic	r = 0.000	r = 0.014	r = -0.012	t = 1.990	F = 393.438
df	928	928	928	928	28

Table 3: Relationship tests, including correlation, t-tests (*), and an ANOVA (^), between travel time and age, BMI, total visits, sex, and rural-urban group to identify potential confounding variables. For total number of visits, (N=1198) due to data transformation of top 32 providers.

The Chi-Square for treatment group and rural-urban group determined differences in observed and expected patient counts per treatment group. More rural patients than expected received no treatment, and more urban patients than expected received multiple treatments (Table 4).

	Urban (1-3)	Between (4-6)	Rural (7-9)
Group 0 (O/E)	46 / 54.8	23 / 19.6	20 / 14.5
Group 5 (O/E)	159 / 139.9	47 / 50.0	21 / 37.1

Table 4: Chi-square observed (O, top) and expected (E, bottom) values for treatment groups and rural urban groups (N = 3).

DISCUSSION

Statistical results determined that patients with a higher travel burden, or a longer travel time, were more likely to receive no treatment for their hip OA, while those with a lower travel burden were more likely to choose multiple and more invasive treatment types. Rural patients were more likely to receive no treatment, only physical therapy, or only intraarticular injections, while urban patients were more likely to receive a combination of surgery, physical therapy, and intraarticular injections. Our findings align with this previous research emphasizing the challenges faced by rural populations in accessing healthcare services, particularly for a chronic, mobility-limiting condition like osteoarthritis.

These data indicate support for our primary hypothesis and are inconsistent with our alternative hypothesis. Patients with a lower travel burden from more metro areas receive more comprehensive, long-term care, which may be a result of closer access to a clinic that can provide more treatment variety. Patients with a higher travel burden and those from more rural areas may be less likely chose to receive any treatment for at all. This suggests that shorter travel times do not necessarily determine usage of more conservative or more invasive care but determine if a patient will try a multitude of treatments. Patterns in rural patient treatment utilization were similar, with higher rates of no treatment and usage of a singular treatment type. Urban patients were more likely to receive a combination of treatments. Therefore, rural-urban designation also indicates preference for the multitude of treatments received. In line with our results, studies have shown that rural residents face increased travel distances to healthcare facilities, which can impact their access to specialized care, leading to poorer outcomes.^{15,16} Our findings further emphasize the importance of considering geographic factors in healthcare planning, especially for conditions with various treatment modalities like hip OA.

CONCLUSION

Our study found that utilized treatment for hip osteoarthritis differs based on age, travel time, and rural-urban designation. Patients in the no treatment group have longer travel times, while patients in the surgery, physical therapy, and injections treatment group have shorter travel times. Patients in the no treatment group also tended to be rural and patients in the surgery, physical therapy, and injections group tended to be urban. A limitation was that assumptions for patterns in treatment types were made to group patients. Some Bowling Green physicians used also have scheduled times at specialty clinic locations in smaller areas, meaning patients living further away may have attended these clinics instead.

REFERENCES

- Osteoarthritis (OA). (2020, August 4). CDC. <https://www.cdc.gov/arthritis/basics/osteoarthritis.htm>
- WHO. W. H. O. (2023, July 14). Osteoarthritis. World Health Organization: WHO. <https://www.who.int/news-room/facts-sheets/detail/osteoarthritis>
- (2023). Global, regional, and national burden of osteoarthritis, 1990–2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*, 5(9), E508–E522. [https://doi.org/10.1016/S2665-9913\(23\)00163-7](https://doi.org/10.1016/S2665-9913(23)00163-7)
- U.S. Department of Health and Human Services. (n.d.). Osteoarthritis. National Institute on Aging. <https://www.nia.nih.gov/health/osteoarthritis>
- Ali, S. A., Walsh, K. E., & Kloosek, M. (2018). Patient perspectives on improving osteoarthritis management in urban and rural communities. *Journal of pain research*, 11, 417–425. <https://doi.org/10.2147/JPR.S150578>
- Uris, J., Orhurko, V., Powell, J. et al. Minimally Invasive Therapies for Osteoarthritic Hip Pain: a Comprehensive Review. *Curr Pain Headache Rep* 24, 37 (2020). <https://doi.org/10.1007/s11916-020-00874-8>
- Yocum, D., Fleischmann, R., Dalgin, P., Caldwell, J., Hall, D., & Roszko, P. (2000). Safety and efficacy of meloxicam in the treatment of osteoarthritis: a 12-week, double-blind, multiple-dose, placebo-controlled trial. *The Meloxicam Osteoarthritis Investigators. Archives of internal medicine*, 160(19), 2947–2954. <https://doi.org/10.1001/archinte.160.19.2947>
- Park, H. M., Kwon, Y. J., Kim, H. S., & Lee, Y. J. (2019). Relationship between Sleep Duration and Osteoarthritis in Middle-Aged and Older Women: A Nationwide Population-Based Study. *Journal of clinical medicine*, 8(3), 356. <https://doi.org/10.3390/jcm8030356>
- Nho, Shane J. MD, MS; Kymes, Steven M. PhD; Callaghan, John J. MD; Felson, David T. MD, MPH. The Burden of Hip Osteoarthritis in the United States: Epidemiologic and Economic Considerations. *Journal of the American Academy of Orthopaedic Surgeons* 21(0):p S1–S6, | DOI: 10.5435/JAAOS-21-07-S1
- Katz, J. N., Arant, K. R., & Looser, R. F. (2021). Diagnosis and Treatment of Hip and Knee Osteoarthritis: A Review. *JAMA*, 325(6), 568–578. <https://doi.org/10.1001/jama.2020.22717>
- Lai, W.C., Arshi, A., Wang, D. et al. Efficacy of intraarticular corticosteroid hip injections for osteoarthritis and subsequent surgery. *Skeletal Radiol* 47, 1635–1640 (2018). <https://doi.org/10.1007/s00256-018-3035-2>
- Total hip replacement - orthoInfo - AAOOF. OrthoInfo. (n.d.). <https://orthoinfo.aaos.org/en/treatment/total-hip-replacement/>
- Arthritis in Rural America. (2023, April 21). CDC. <https://www.cdc.gov/ruralhealth/arthritis/Arthritis.html>
- Kotlarz, H., Gunnarsson, C. L., Fang, H., & Rizzo, J. A. (n.d.). Insurer and out-of-pocket costs of osteoarthritis in the US: Evidence from national survey data. *Arthritis & Rheumatism*, 60(12), 3546–3553. <https://doi.org/10.1002/art.24984>
- Spees, L. P., Brewster, W. R., Varia, M. A., Weinberger, M., Baggert, C., Zhou, X., Petermann, V. M., & Wheeler, S. B. (2019). Examining Urban and Rural Differences in How Distance to Care Influences the Initiation and Completion of Treatment among Insured Cervical Cancer Patients. *Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research*, sponsored by the American Society of Preventive Oncology, 28(5), 882–889. <https://doi.org/10.1158/1055-9965.EPI-18-0945>
- Chan L, Hart LG, Goodman DC. Geographic access to health care for rural Medicare beneficiaries. *J Rural Health*. 2006;22(2):140-146. doi:10.1111/j.1748-0361.2006.00022.x
- Segel, J. E., & Lengerich, E. J. (2020). Rural-urban differences in the association between individual, facility, and clinical characteristics and travel time for cancer treatment. *BMC Public Health*, 20(1), 1–10. <https://doi.org/10.1186/s12889-020-8282-z>
- Chan, L., Hart, L. G., & Goodman, D. C. (2006). Geographic access to health care for rural Medicare beneficiaries. *The Journal of rural health : official journal of the American Rural Health Association and the National Rural Health Care Association*, 22(2), 140–146. <https://doi.org/10.1111/j.1748-0361.2006.00022.x>
- Lam, O., Broderick, B., & Toor, S. How far Americans live from the closest hospital differs by community type. (12 December, 2018). Pew Research Center. <https://www.pewresearch.org/short-reads/2018/12/12/how-far-americans-live-from-the-closest-hospital-differs-by-community-type/>
- Wu, V. S., Schmidt, J. E., Jella, T. K., Cwalina, T. B., Freidl, S. L., Pumo, T. J., & Kamath, A. F. (2023). Rural Communities in the United States Face Persistent Disparities in Access to Orthopaedic Surgical Care. *The Iowa orthopaedic journal*, 43(1), 15–21. <https://www.census.gov/library/stories/2010/03/graying-america.html>
- Vespa, J. The Graying of America: More Older Adults Than Kids by 2035. (13 March, 2018). The United States Census Bureau. <https://www.census.gov/library/stories/2010/03/graying-america.html>
- Fu, M. C., Buersa, R. A., Gruskay, J., & Grauer, J. N. (2013). Longitudinal urban-rural discrepancies in the US orthopaedic surgeon workforce. *Clinical orthopaedics and related research*, 471(10), 3074–3081. <https://doi.org/10.1007/s11999-013-3131-3>
- Kolasinski SL, Neogi T, Hochberg MC, et al. 2019 American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee [published correction appears in *Arthritis Care Res (Hoboken)*. 2021 May;73(5):764]. *Arthritis Care Res (Hoboken)*. 2020;72(2):149-162. doi:10.1002/acr.24131
- Rural-Urban Continuum Codes. (15 September, 2023). USDA. <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/>

ACKNOWLEDGEMENTS

Thank you to Dr. Natalie Mountjoy and Dr. Doug McElroy for advising this project and to Dr. Melinda Joyce for obtaining the medical records used for this research.