Arthritis, Health Care Access, and Health Disparity in the Largest U.S. Cities.

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Abstract

The objective is to evaluate the relationship between U.S. cities' socio-economic factors, doctors' visits, and arthritis. We analyze how regular doctors' visits act as a mediating factor by which arthritis prevalence and related health disparities can be reduced. We use 500 Cities Project and American Community Survey data spanning from 2014 to 2017 and a path analysis model in this paper. Our results suggest that the previous year doctors' visits lower arthritis prevalence by 0.03 percent (p value 0.04). The indirect results support this notion as cities with higher median income, insurance coverage, and certain percentages of races present are associated with lower arthritis prevalence. We also observe a higher prevalence of doctors' visits in cities according to such socio-economic factors. Lower arthritis prevalence was seen in cities with higher black percentage populations due to such cities having more prevalent doctors' visits. Policies should address awareness of the importance of regular doctor visits to limit the impact on the future chronic condition.

Keywords

Arthritis prevalence; Doctors' visits; Socio-economic factors; Path analysis; Cities

1. Introduction

The goal of this research is to study the joint relationship between U.S. cities' socio-economic factors, doctors' visits, and arthritis. A better-understood relationship will help mitigate the health hazard and its growing influence on the U.S. population. Specifically, the differences in the prevalence of doctors' visits due to health disparity have an indirect effect on arthritis prevalence.

Arthritis is an umbrella term for diseases related to chronic pain and inflammation impacting an individual's joints and surrounding tissue. There are more than 100 forms of arthritis, with the most common being osteoarthritis (OA), rheumatoid arthritis (RA), gout, and fibromyalgia (CDC 2022a). Common arthritis symptoms include swelling, pain, stiffness, and a decreased range of motion in the joints (CDC 2022a; Litwic, Edwards, Dennison et al. 2013). Between 2013 and 2015, 54.4 million U.S. adults were diagnosed with some form of arthritis. 23.7 million of those diagnosed reported arthritis-attributable activity limitations (Barbour, Helmick, Boring et al. 2017). By 2040, arthritis cases are expected to increase to 78.4 million, with 34.6 million adults having related limitations (Hootman, Helmick, Barbour et al. 2016).

This is a cause of concern, not only due to the discomfort of affected individuals but also the cost entitled to its medical spending (Liang, Moore, and Soni 2020; Murphy, Cisternas, Pasta et al. 2018). In 2013, the total national medical expenditure specifically associated with arthritis management or treatment was $139.8 billion, with all other related costs totaling up to $609.8 billion. Based on these other costs, the average medical spending of individual arthritis was the highest among all citizens at $9,233 per person (Murphy et al. 2018). The treatment for OA was one of the most expensive treatments for any condition seen in U.S. hospitals in 2017, second only to septicemia, and accounted for 4.6 percent of the aggregate cost of all hospitalizations. It

was also the most expensive condition billed to private insurance and the second most expensive billed to Medicare (Liang et al. 2020).

Arthritis is more prevalent among certain demographics and is seen more often in women than men and older and less active individuals (Barbour et al. 2017). Those with no high school education are also more likely to have arthritis than those who have completed college or higher (Barbour et al. 2017). Research on racial arthritic prevalence suggests that minorities such as blacks or Hispanics are more likely to develop arthritis (Dunlop, Manheim, Song et al. 2001). There are similar trends between the actual prevalence of arthritis and its related inactivity or disability, meaning that racial minorities with arthritis would be more likely to be disabled compared to whites with arthritis (Barbour et al. 2017). This inflicted disability was also more pronounced in women compared to men and among undereducated, unemployed, obese, and less active individuals. Recent events concerning Covid-19 has broadcasted the awareness of health disparity in the U.S. (Pierce, Harrington, McCabe et al. 2021; Young, Stahlman, Clausen et al. 2021). It is necessary to address such disparities to prevent similar situations in the future. These mentioned studies validate the inequality seen in arthritis according to socio-economic factors.

Compared to the extensively researched prevalence of arthritis and related health disparities (Barbour et al. 2017), literature on factors that can prevent or limit the condition is rare, possibly due to a lack of complete understanding of its development (CDC 2022a; Lawrence, Discussants, Dieppe et al. 2000). However, there are certain risk factors known to be associated with the condition. According to the CDC, these include obesity, infection, joint injuries, certain occupations, and smoking (CDC 2022a). These risk factors could explain the trends seen in arthritis prevalence and its associated disability. Socio-economic factors consisting of income, employment rate, and percentage of educated adults have an inverse relationship with

obesity (Janssen, Boyce, Simpson et al. 2006), with blacks being more likely to be obese (Ogden, Carroll, Curtin et al. 2006). Additionally, a higher smoking rate was associated with individuals without a high school education and those below the poverty level (CDC 2022a). Obesity has a positive association with arthritis (Leveille, Wee, and Iezzoni 2005; Sahyoun, Hochberg, Helmick et al. 1999), specifically with OA, the most common form of arthritis (CDC 2022a; Lawrence et al. 2000). Maintaining a healthy weight is crucial in minimizing pressure on the hips, spine, and knees, where much of the symptoms are located. OA mainly impacts the hips and knees, most likely disabling the individual (CDC 2022a; Lawrence et al. 2000). Women who lost 5 kilograms on average decreased the odds of OA by 50 percent (Felson, Zhang, Anthony et al. 1992). Arthritis can also develop from a bacterial or viral infection of the joints (Mathews, Weston, Jones et al. 2010). These forms of arthritis, such as septic arthritis, can be treated with medication or surgical intervention (Mathews et al. 2010). OA of the knee is also associated with prior knee injuries and occupations requiring repetitive bending and squatting, which can cause or aggravate the condition (Palmer 2012). Smoking, another serious risk factor, impacts the victim's immune system via different channels and is primarily associated with RA (CDC 2022a; Chang, Yang, Kim et al. 2014). According to one study concerning postmenopausal women, one in six cases of RA can be attributed to smoking (Criswell, Merlino, Cerhan et al. 2002). Regular doctors' visits can generally address these risk factors. Patients who received advice to reduce weight, quit smoking, and start exercising from their doctors were likely to comply (Kreuter, Chheda, and Bull 2000). Patients who received advice on losing weight were able to lose 1 kilogram after a year, whereas patients who were not given advice gained 0.3 kilogram (Rodondi, Humair, Ghali et al. 2006). Individuals with personal primary care physicians have lower mortality rates and are less susceptible to cancer, heart attack, arteriosclerosis, and heart

disease (Franks, and Fiscella 1998). Given the substantial influence of these risk factors, doctors' visits play a critical role in mitigating the onset of the condition and reduce arthritis prevalence. However, factors such as gender, genetics, and aging cannot be controlled. Women are more likely to have OA, RA, and fibromyalgia, while gout is more common in men (CDC 2022a).

The Institute of Medicine (IOM) defines health access as "the timely use of personal health services to achieve the best possible health outcomes." This definition links the use of health services to their impact on health outcomes that do not discriminate according to race, income, or geographical location (Millman 1993). The "*timely use of personal health services*" is essential to detect any issue, if any, as soon as possible for a patient to receive the correct treatment (Millman 1993). Previous studies have examined the importance of health care access (Basu Roy, Olsen, and Tseng 2020; Shi, Starfield, Kennedy et al. 1999). In our study, the impacts of socio-economic factors and prevalence of doctors' visits on arthritis prevalence of the largest U.S. cities are observed. We are the first to study the relation between socio-economic factors, prevalence of doctors' visits, and arthritis prevalence at the city level.

According to one IOM report, disparities in health care access lead to worse health outcomes (Smedley, Stith, and Nelson 2003). Health care access depends on socio-economic factors such as race, income, and education (Anderson, and Ray-Warren 2022; Fletcher, and Frisvold 2009; Kanter, Segal, and Groeneveld 2020; Kirby, and Kaneda 2005; Palmer, Geiger, Felder et al. 2013; Smedley et al. 2003). The American Medical Association (AMA) established the Commission to End Health Care Disparities spanning 2004-2016, to not just reduce but end such disparities. The AMA works to increase the number of minority physicians and increase health literacy among patients (AMA 2022). One motive for increasing the amount of minority physicians is to encourage the minority population of the U.S. to visit health care providers more

often. Much of the minority population in the U.S. do not visit or follow up with primary care physicians due to discrimination in the health care facilities (Lee, Ayers, and Kronenfeld 2009). Organizations are trying to reduce these disparities in health care facilities to improve poor health outcomes (AMA 2022).

We use the city level data from the 500 Cities Project (CDC 2022b). This data offers variables on arthritis, doctors' visits, and arthritis risk factors. The city data from the American Community Survey is used for the socio-economic factors (ACS 2022). We perform path analysis using this data to evaluate the relationship between socio-economic factors, the prevalence of doctors' visits, and arthritis prevalence. The article is organized as follows: we next introduce the data and methods. These are followed by the results and finally the discussion.

2. Data description

The 500 Cities Project dataset provides indicators for chronic disease, preventive care, and unhealthy behavior for the city and census tract level in the U.S (CDC 2022b). The 500 Cities Project was replaced by the PLACES project during the 2020 release data (PLACES 2022). The 500 Cities Project includes information on diseases that are most common and preventable, according to the CDC. The study at the city level would help the policy makers design intervention and improve the overall health of the residents. Estimates for each tract were developed by the data from the Behavioral Risk Factor Surveillance System (BRFSS), a survey that collects information on the behavioral health variables for adults 18 years or older. The project used information from the BRFSS along with the U.S. Census Bureau's American Community Survey (ACS) to predict the risk of health behavior and disease for various demographics including age, gender, and ethnicity. With further adjustment of location, individual, and area-level data were combined to predict the probability of each indicator. The

500 Cities Project is a pioneering analysis that provides estimates at the city and census tract level on such a large scale (Payton, Kathryn, Pettit et al. 2017). Previous research has used the 500 Cities Project in the analysis (Donovan, Landry, and Gatziolis 2021; Fitzpatrick, Shi, Willis et al. 2018; Liu, Liu, and Li 2018).

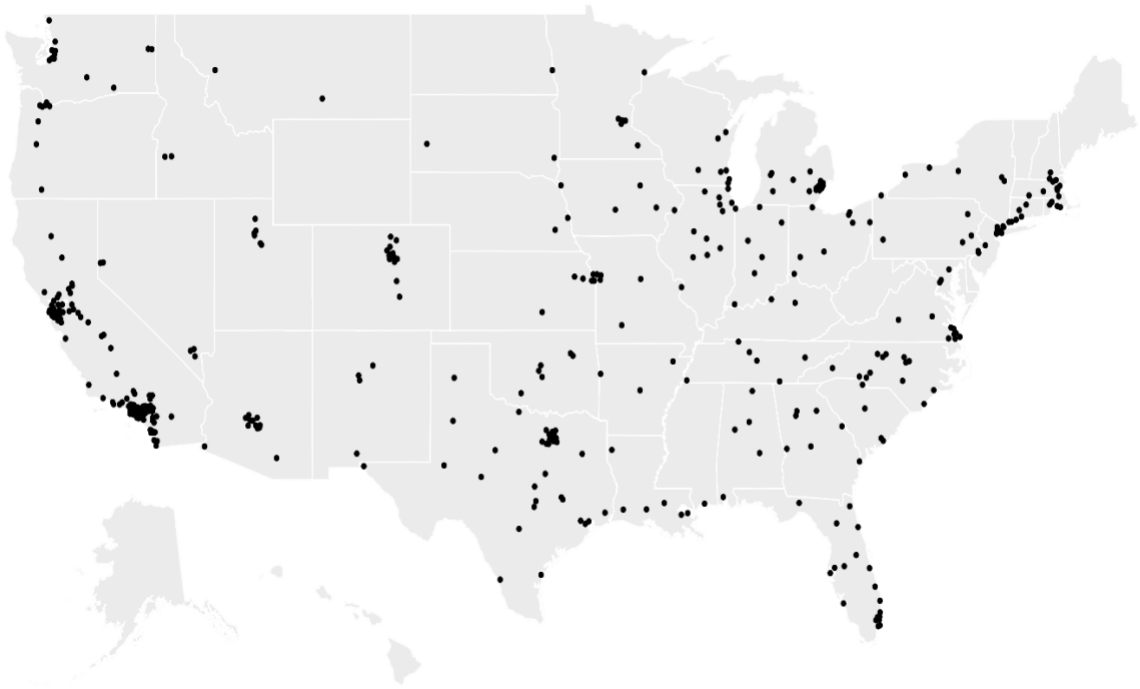
The 500 Cities Project encompasses the 497 most populated U.S. cities as well as a city each from Vermont, West Virginia, and Wyoming to cover all 50 U.S. states. Each state accounted for 1 to 121 cities, with the population of each city ranging from 42,417 (Burlington) to 8,175,133 (New York City). The cities differ in terms of population. We use the percent estimates provided by the 500 Cities Project to perform the analysis to consider for cities with different characteristics. Previous research has used these estimates to perform the analysis for a smaller geographical unit (Fitzpatrick et al. 2018; Liu et al. 2018). The data represent 33.4 percent of the total U.S. population 18 years or older and includes data on 13 health outcomes, 9 preventative methods, and 5 unhealthy behaviors. Our variables of interest are the crude prevalence of arthritis (health outcome), doctors' visits (preventive practice), and the adjusted prevalence of obesity and smoking (unhealthy behavior).

The 500 Cities Project developed estimates using the 2014-2017 BRFSS data, which we used in this research. Our study period is limited to the 2014-2017 range due to the span of the 500 Cities Project, which we use in conjunction with the ACS data. The ACS is an on-going annual nationwide survey with a goal of reflecting the most current characteristics of population and housing factors (ACS 2022). This information is used to construct balanced panel data to support our city level analysis. However, the 2014-2017 ACS data lack observations for some cities that are included in the 500 Cities Project, forcing our study to drop these cities and leaving us with 417 cities. Figure 1 shows the cities used in this study, suggesting most states have been

included in the analysis. Due to using the lagged independent variables, we lose observations for arthritis and doctors' visit from the year 2014 from the 500 Cities Project.

Figure 1. 417 largest U.S. cities, 2014-2017.

- Cities



Source: 500 Cities Project, a collaboration between CDC, the Robert Wood Johnson Foundation, and the CDC Foundation merged with U.S. Census Bureau's American Community Survey

Table 1.a presents the means and standard deviations of certain health variables drawn from the 500 Cities Project for individuals 18 years and older. Arthritis prevalence represents the percentage of residents in cities that have been diagnosed with the condition by a health care professional anytime in their lifetime. The average crude arthritis prevalence rate is 22 percent.

Table 1. Descriptive Statistics for Health and Socio-Economic Variables in the U.S., 2014-2017.

Table 1a. 500 Cities Project		
Health Variables	Mean	Std. Dev
Percent arthritis	21.617	4.198
Percent doctors' visits	67.739	5.177
Percent smoking	17.867	4.257
Percent obesity	29.315	5.710
Table 1b. American Community Survey		
Socio-Economic Variables	Mean	Std. Dev
Percent employment	64.966	5.089
Percent insurance coverage	89.456	5.701
Median income	55,929	18,402
Percent high school completed	24.556	6.778
Average household size	2.724	0.415
Percent male	48.453	1.871
Median age	34.914	3.964
Percent white	64.350	16.931
Percent black	15.316	15.486
Percent hispanic	24.647	19.471
Percent asian	7.918	9.684
N	1,251	

Table 1a: Data come from 500 Cities Project, a collaboration between CDC, the Robert Wood Johnson Foundation, and the CDC Foundation.
Table 1b: Data come from U.S. Census Bureau's American Community Survey.
Note: The employment variable is for individuals 16 years and older. Individuals 25 years and older who have completed high school are used.

The doctors' visits variable represents the percentage of residents in cities who reported visiting a doctor for a routine check-up in the previous year, excluding visits pertaining to specific injuries or illnesses. The average crude prevalence of such doctors' visits is 68 percent. We use smoking and obesity prevalence rates as control variables due to their association with arthritis. Smoking prevalence represents the percentage of residents in cities who reported having smoked more than 100 cigarettes in their lifetime and currently smoke. Obesity prevalence represents the percentage of residents in cities who have a body mass index greater than 30. On average, the smoking prevalence rate is 18 percent and obesity 29 percent.

Table 1.b presents the means and standard deviations of certain socio-economic variables drawn from the ACS. This table shows the overall socio-economic characteristics of cities' populations, which will help us understand how they influence disparity. The employment rate of individuals 16 years or older is 65 percent, with the median income being $56,000. 90 percent of the population has either private or public insurance coverage. 25 percent of individuals 25 years or older has a high school graduation or equivalent. The household size is on average 2.72. The median age is 35, and 49 percent of the population is male. 64 percent of the population is white, with 15 percent black, 25 percent Hispanic, and 8 percent Asian populations comprising ethnic minorities. This information shows the variations of the city's population according to the city's socio-economic characteristics. These differences result in health disparities seen in previous literature (Janssen et al. 2006).

3. Methods

To analyze the relationship between socio-economic factors, doctors' visits, and arthritis, we use the path analysis model. Path analysis model has been used in previous research to find a causal relationship (Greil, McQuillan, Shreffler et al. 2011; Jackson, Denny, Sheridan et al. 2016; Song

2011; Xu, Luke, and Short 2021). Our model is based on a linear statistical model which is similar to regression analysis but additionally evaluates the impact of socio-economic factors directly and indirectly on arthritis prevalence while considering doctors' visits. The path analysis results include these crucial direct and indirect impacts necessary to achieve a more comprehensive understanding of the connections between our factors. They display the importance of the alternative or mediating path of doctors' visits in influencing the outcome variable of arthritis prevalence. We use one year lag independent variables to estimate the direct and indirect effect of socio-economic factors on arthritis prevalence. The use of lag independent variables accounts for the endogeneity problem in the data. We first estimate the impact of one-year lag variables of socio-economic factors on the prevalence of doctors' visits. In order for doctors' visits to have a mediating effect we determine whether there are any significant effects of disparity factors on arthritis prevalence (Baron, and Kenny 1986). After finding the total effect, we introduce the mediating variable and the disparity factors to analyze the direct and indirect effect of the socio-economic factors.

$$Doctor'sVisits_{c,t} = \beta_0 + \beta_1\, Economic_{c,t} + \beta_2\, Social_{c,t} + \beta_3 RiskFactors_{c,t} + \varepsilon_{c,t} \quad (1)$$

$$Arthritis_{c,t} = \beta_0 + \beta_1\, Economic_{c,t-1} + \beta_2\, Social_{c,t-1} + \beta_3\, RiskFactors_{c,t-1} + \varepsilon_{c,t} \quad (2)$$

$$Arthritis_{c,t} = \beta_0 + \beta_1\, Doctor'sVisits_{c,t-1} + \beta_2\, Economic_{c,t-1} + \beta_3\, Social_{c,t-1} + \beta_4\, RiskFactors_{c,t-1} + \varepsilon_{c,t} \quad (3)$$

In Equation 1, $Doctor'sVisits_{c,t}$ represents the crude prevalence of doctors' visits in city *c* at year *t*. $Economic_{c,t}$ and $Social_{c,t}$ includes economic and social variables in city *c* at year *t*. In Equation 2, $Arthritis_{c,t}$ is the crude arthritis prevalence in city *c* at year *t*. Equation 3, includes the mediating variable $Doctor'sVisits_{c,t-1}$ in city *c* at year *t-1*.

$Economic_{c,t-1}$ represents economic factors such as a city's insurance coverage, employment rate, high school education rate and natural log of median income while $Social_{c,t-1}$ represents social factors like the population's gender, race, average household size, and median age in city *c* at year *t-1*. Arthritis risk factors denoted by $RiskFactors_{c,t-1}$ are the adjusted prevalence of obesity and smoking at city *c* at year *t-1*.

4. Results

Table 2 shows the effects of socio-economic factors on the prevalence of doctors' visits at the city level. Economic factors such as a city's insurance coverage, median income, and high school education rate are positively and significantly associated with the prevalence of doctors' visits. Specifically, an increase in median income by 1 percent increases the prevalence of doctors' visits by 3.47 percent (p value 0.000). The results also suggest that an increase in a city's black population by 1 percent is associated with an increase in the prevalence of doctors' visits by 0.24 percent (p value 0.000). Increases in white, Hispanic, and Asian populations are also significantly associated with an increase in the prevalence of doctors' visits, but to a lesser extent. Though existing research on the subject yielded mixed responses, our results suggest an absence of disparity in the prevalence of doctors' visits based on the racial composition of a city (Palmer et al. 2013; Valderrama, Gillespie, and Mercado 2013). Instead, we found disparity in prevalence of doctors' visits according to a city's economic variables, which is in accordance to previous literature (Andersen, Yu, Wyn et al. 2002; Tumin, Menegay, Shrider et al. 2018). Our results validate the requirement of the path analysis model, where the independent variable is significantly related to the mediating variable. The differences in the prevalence of doctors' visits based on different factors will be reflected in a city's arthritis prevalence. These results make our study the first of its kind to quantify disparity in health care access in the largest U.S. cities.

Table 2. Impact of Socio-Economic factors on Doctors' Visits for 417 cities in the U.S., 2014-2017.

Independent variables	Percent doctors' visits
Percent insurance coverage	0.123***
	(0.026)
ln(median income)	3.471***
	(0.850)
Percent employment	-0.015
	(0.580)
Percent high school completed	0.108***
	(0.026)
Percent white	0.047***
	(0.015)
Percent black	0.242***
	(0.018)
Percent hispanic	0.063***
	(0.012)
Percent asian	0.090***
	(0.022)
Percent smoking	0.319***
	(0.057)
Percent obesity	0.012
	(0.037)
Controls	YES
N	1,251

Source: 500 Cities Project, a collaboration between CDC, the Robert Wood Johnson Foundation, and the CDC Foundation merged with U.S. Census Bureau's American Community Survey
Note: Additional controls include gender, median age, and average household size in the cities.
*p < .05. **p <.01. ***p < .001

Table 3, column 1 shows the total effect of one year lagged socio-economic factors on arthritis prevalence at the city level. An increase in employment by 1 percent is associated with a decrease in arthritis prevalence by 0.10 percent (p value 0.000), suggesting the presence of disparity in arthritis prevalence. Insurance coverage and high school completion rate are positively associated with arthritis prevalence. A higher percentage of racial minorities is associated with a decrease in arthritis prevalence. An increase in a city's lack population by 1

Table 3. Relation of Socio-Economic factors, Doctors' Visits, and Arthritis for 417 cities in the U.S., 2014-2017.

Independent variables (t-1)	(1) Percent arthritis(t) (total effect)	(2) Percent arthritis(t) (direct effect)	(3) Percent arthritis(t) (indirect effect)
Percent doctors' visit		-0.027*	
		(0.014)	
Percent insurance coverage	0.060***	0.064***	-0.003*
	(0.012)	(0.013)	(0.002)
ln(median income)	0.280	0.374	-0.095*
	(0.407)	(0.410)	(0.052)
Percent employment	-0.097***	-0.097***	0.000
	(0.013)	(0.013)	(0.000)
Percent high school completed	0.062***	0.065***	-0.003*
	(0.012)	(0.013)	(0.002)
Percent white	0.006	0.008	-0.001*
	(0.008)	(0.008)	(0.000)
Percent black	-0.022**	-0.015	-0.007**
	(0.009)	(0.010)	(0.003)
Percent hispanic	-0.037***	-0.035***	-0.001*
	(0.005)	(0.005)	(0.001)
Percent asian	-0.058***	-0.056***	-0.002
	(0.011)	(0.011)	(0.001)
Percent smoking	0.420***	0.429***	-0.009*
	(0.028)	(0.028)	(0.005)
Percent obesity	0.194***	0.194***	-0.000
	(0.018)	(0.018)	(0.001)
Controls	YES	YES	YES
N	1,251	1,251	1,251

Source: 500 Cities Project, a collaboration between CDC, the Robert Wood Johnson Foundation, and the CDC Foundation merged with U.S. Census Bureau's American Community Survey
Note: Additional controls include gender, median age, and average household size in the cities.
*p < .05. **p <.01. ***p < .001

percent decreases the arthritis prevalence by 0.02 percent (p value 0.05). The results suggest that cities with greater minority populations are more likely to have lower arthritis prevalence. This is similar to the results of existing literature for the U.S. adult population (Barbour et al. 2017; Park, Mendy, and Vieira 2018). Again, our results add to the literature on the health disparity of arthritis prevalence in the largest U.S. cities and first of its kind. The differences in arthritis prevalence should be addressed, and thus we evaluate how does the doctors' visit in the cities

help mitigate this condition. Further, an increase in smoking and obesity rates, arthritis risk factors, is associated with an increase in arthritis prevalence. These results prove the significant role cities' socio-economic characteristics play in influencing arthritis prevalence. It is hoped that policymakers will take our findings into consideration to improve upon location-based intervention regarding arthritis prevalence, for instance, amending policy to increase aid for highly afflicted populations. Our findings may be used to supplement programs such as Healthy People 2020 (HHS), a national health program formed by the U.S. Department of Health and Human Services which focuses on improving the health and quality of the American people with goals of controlling obesity and smoking, two arthritis risk factors.

Table 3, column 2 shows the direct effect results of one year lagged socio-economic factors and one year lagged doctors' visits on crude arthritis prevalence at the city level. The most interesting result from this analysis is the independent effect of one year lagged doctors' visits on arthritis prevalence. An increase in previous year doctors' visits is associated with a decrease in arthritis prevalence by 0.03 percent (p value 0.04). The results suggest that doctors' visits are an important factor in reducing the arthritis prevalence irrespective of a city's socio-economic characteristics, suggesting a causal relationship. An increase in doctors' visits will help to reduce the growing arthritis prevalence and its associated disability. This analysis, compared with column 1's results, indicated an insignificant relation between a city's black population and its arthritis prevalence, suggesting the importance of doctors' visits in decreasing arthritis prevalence. We did not find any other major differences in the total effect and direct results for the rest of the indicators.

Table 3, column 3 shows the indirect effect of one year lagged socio-economic factors on crude arthritis prevalence through the channel of doctors' visits at the city level. Indirect results

suggest that an increase in insurance coverage and high school education decreases arthritis prevalence. An increase in median income by 1 percent decreases the arthritis prevalence by 0.10 percent (p value 0.07), which is explained by higher doctors' visits in such cities. The population of every race examined was negatively associated with arthritis prevalence. The indirect effect results validate the previous results, suggesting a causal impact of higher prevalence of doctors' visits on lower arthritis prevalence. Our results will allow policy makers to focus on promoting doctors' visits as it will lower arthritis prevalence in cities irrespective of its socio-economic characteristics. There is no direct literature to our study. We are the first to analyze this relationship at the largest U.S. cities. Previous research has examined the relationship between income inequality, health outcomes, and primary care, which found a negative association between primary care and health outcome (Shi et al. 1999).

5. Discussion

With socio-economic factors controlled for, the mediating factor doctors' visits has a negative independent effect on a city's arthritis prevalence, implying that regular doctors' visits effectively reduce arthritis regardless of a city's characteristics. These results have great implications due to the severity of arthritis and its continuous spread over its victims and their lives. Cities may focus their policies on the awareness of regular doctors' visits, given their importance, leading to an increase of health care access among the population. Healthy People 2020 has an overarching goal of achieving healthy lives in our society, free of preventable diseases and early death (HHS). Our study attempts to address this goal by explaining the importance of doctors' visits in mitigating arthritis. Socio-economic traits of a city and how they are linked to its health outcomes have been researched in previous studies (Do, Finch, Basurto-Davila et al. 2008; Freedman, Grafova, and Rogowski 2011; Kravitz-Wirtz 2016; Miao, and Wu

2016). We study how some socio-economic factors impact a city's arthritis prevalence and more specifically, how doctors' visits can limit it regardless of these factors. This paper is the first to establish this relation between cities' socio-economic factors, doctors' visits, and arthritis prevalence. Analyses at the city level are important, as according to the 2010 Census, 80 percent of the U.S. population lived in urban areas (USCB 2022), namely cities, which are more likely to be planned accordingly. Intervention can be readily performed at the city level, designing, and rewriting policies that improve the health of residents.

Healthy People 2020's second goal is to achieve health equity and reduce disparities (HHS). Our direct results suggest that disparities pertaining to arthritis can be mitigated by increasing the prevalence of doctors' visits, which is portrayed by the low prevalence of arthritis in cities with higher percentages of black populations. This is contradictory to previous research that have suggested that arthritis disparities exist especially among blacks (Dunlop et al. 2001). The effectiveness of prevalence of doctors' visits in mitigating arthritis is most clearly seen among blacks. We found that cities with higher employment rates saw lower arthritis prevalence, but the prevalence of doctors' visits did not play a big role.

Our indirect results also suggest the importance of the prevalence of doctors' visits in lowering arthritis prevalence. A city's economic factors such as median income, insurance coverage, and high school education rate are all negatively associated with arthritis prevalence. An increase in white, black, Hispanic, and Asian populations in a city are significantly associated with lowering arthritis prevalence. These indirect results additionally confirm the previous results implying that increasing the prevalence of doctors' visits leads to lower arthritis prevalence. Understanding the relationship between socio-economic factors, doctors' visits, and

arthritis prevalence is important to achieve health equality by guiding policy makers with recent and widely applicable information.

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