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Karelys Parada Date

The Association Between the Utilization of Preventative Dental Treatment and the Experience of Arthritis Symptoms and Pain Severity

By

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Master of Public Health

Epidemiology

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Committee Chair

The Association Between the Utilization of Preventative Dental Treatment and the Experience of Arthritis Symptoms and Pain Severity

By

Karelys Parada

B.A., New York University, 2012

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An abstract of
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Abstract

The Association Between the Utilization of Preventative Dental Treatment and the Experience of Arthritis Symptoms and Pain Severity

By Karelys Parada

Objective: Previous studies have shown evidence of an association between periodontal disease and arthritis disease activity. The goal of this analysis was to evaluate the association between preventative dental treatment utilization and arthritis symptoms and pain severity in adults with arthritis in a nationally representative sample.

Methods: Data from 2010-2014 National Health Interview Survey on adults ages ≥18 was used to measure the prevalence of individuals who had seen the dentist ≤1 year ago, along with three measures of arthritis disease activity (joint pain/aching/stiffness in the past 30 days, pain began >3 months ago, level of joint pain severity). Logistic regression models were constructed to measure the association of time since last seeing the dentist with joint pain and time of symptom onset. Secondly, using only 2014 data, a proportional odds logistic regression model examined the effect of time since last seeing the dentist had on 3 levels of pain severity (Mild, Moderate, and Severe).

Results: After weighting the data and controlling for gender, age, race/ethnicity, smoking, BMI, education, marital status, and health insurance coverage, it was found that, for individuals who last saw the dentist ≤1 year ago, the OR for joint symptoms in the past 30 days was 0.83 (95% CI: 0.83-0.83) and the OR for symptoms beginning >3 months ago was 0.93 (95% CI: 0.92-0.93). Additionally, frequent dental visits were associated with reduced pain severity (proportional OR: 0.68; 95% CI: 0.68-0.69).

Conclusion: There is evidence to suggest an association between preventative dental treatments and arthritis symptoms and severity. These findings support the public health efforts to promote dental care for individuals with arthritis.

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INTRODUCTION

Arthritis

Arthritis, meaning joint inflammation, is an overarching term comprised of over 100 different types of rheumatic diseases that affect the joints and the connective tissue surrounding the joints. The most common type of arthritis is osteoarthritis, while other endemic forms that occur include rheumatoid arthritis (RA), lupus, fibromyalgia, and gout. Symptoms are composed of pain, stiffness or inflammation of the joints, while more severe forms of arthritis, such as RA or lupus, can affect multiple organs and display an array of symptoms. It is the most common cause of disability among adults in the U.S. with an estimated 22.7% of adults aged 18 years or older (52.5 million or 1 in 5 adults) with self-reported doctor-diagnosed arthritis, of which 26.0% are women and 19.1% are men in every age group [1, 2]. Although arthritis is most common in individuals 65 years of age or older, it affects members of every age group, including approximately 1 in every 250 children under age 18 [1, 3]. Similarly, it affects members of all ethnic groups, with age-adjusted prevalence rates higher in Non-Hispanic whites, Blacks/ African-Americans, and American Indian/Alaskan Native (22.3%, 21.8%, and 28.6% respectively) versus Hispanics and Asian/Pacific Islanders (15.6%, 10.6%) [3]. Additionally, arthritis is a significant public health issue because along with its high prevalence, high lifetime risk, and being a common cause of disability, it often occurs in conjunction with other chronic conditions, such as heart disease, diabetes and obesity. Furthermore, the medical expenditure associated with arthritis and other rheumatic conditions average $128 billion per year [4] and will continue to be exacerbated over time by an aging population [5].

Osteoarthritis (OA), also known as degenerative joint disease, is the most common type of arthritis and is characterized by the progressive breakdown of cartilage, joint lining, ligaments and underlying bone. The disease onset is gradual, usually beginning after 40 years of age, and is the most common form of arthritis affecting an estimated 33.6% of adults aged 65 or older [6]. The areas of the body that are most commonly affected are the knees, hips, hands and spine and although the cause is unknown, it is thought to be influenced by biological processes, such as muscle weakness or genetic predisposition, in conjunction with mechanical events affecting the joints[7]. It is estimated that among U.S. adults, about 27 million are affected by clinical OA [6]. The incidence of hand, hip and knee OA in adults aged 20 years and older, accounting for age and sex, is 100, 88, and 240 per 100,000 person-years, respectively [8]. Although women have higher rates of incidence compared to men, especially after age 50, the overall incidence rates of OA increase with age, but eventually level off around 80 years of age [9].

Rheumatoid Arthritis (RA) is a chronic autoimmune disease that is most commonly characterized by inflammation and tenderness of multiple peripheral joints, though the course and severity of RA can vary greatly depending on the individual [10]. One study on the progressive course of RA identified five different types of progression that varied from slow onset and moderate progression to fast onset and late decreasing progression, to no progression at all [11]. Another prospective study on the early course of rheumatoid arthritis found that 75% of individuals with RA experienced remission within 5 years of diagnosis [12]. It is estimated that 0.5-1.0% of adults in industrialized countries are affected by RA, with 5-50 per 100,000 new cases annually [13]. The

incidence of RA is two to three times higher in women and highest in adults in their sixties. Currently the cause of RA is unknown, though there is general consensus that the interaction of genetic predisposition and environmental triggers are the ideal conditions for RA incidence [14]. If left untreated, RA can lead to premature mortality, disability due to pain and disfigurement of the hands and feet, compromised quality of life, overall mental distress, and other comorbidities [15]. Therefore, understanding the potential causes and risk factors for clinical RA is paramount in improving the quality of life and reducing the burden of the disease for those affected by RA.

Another chronic autoimmune disease, Systemic Lupus Erythematosus (SLE or lupus), is similar to RA in that the immune system produces antibodies to attack healthy tissue in the body, thus leading to inflammation and tissue damage in the joints, but lupus also affects the skin and internal organs, and it can cause life threatening complications [16]. Lupus is expressed through a variety of manifestations such as rash, photosensitivity, oral ulcers, arthritis, serositis, and kidney disease among other clinical findings [16]. Women are primarily affected by the disease with a female to male ratio of 9:1 and peak onset age of late teens to early forties [17]. Certain ethnic groups, such as African-American and Afro-Caribbean, are predominantly more affected by lupus and are more commonly diagnosed at a younger age as compared to Caucasians [18]. Like RA, lupus diagnosis can be difficult due to the disease's broad symptoms and signs; thus is it is dependent on a rheumatologist's verification [16]. A 2008 study evaluated SLE prevalence by referencing 2005 census data for persons ages 15-64 in San Francisco and estimated that there exist 161,000 cases of definite SLE and 322,000 cases of definite or probable SLE in the US [19]. A more recent study evaluating the prevalence of SLE in a

Medicare population approximated the prevalence of SLE as 3 per 1,000 beneficiaries [20]. Although SLE incidence is difficult to measure because of complexities in diagnosis, estimates range from 1.8 to 7.6 cases per 100,000 person-years. Of the many rheumatic diseases, SLE is one of the more fatal forms because of its association with organ failure, infection, and cardio vascular disease, contributing to 14.5% of all rheumatic disease mortality [21, 22]. A report of the death trends from SLE from 1979 to 1998 revealed that the annual number of deaths increased from 879 to 1,406, with a crude death rate increase from 39 to 52 per 10 million people and an overall 22,861 deaths reported during the study period [21]. As the crude death rate increased with age, 35% of deaths were in the 15 to 44 year age bracket [21]. Additionally, death rates among women were 5 times higher than in men and 3 times higher in African-Americans compared with Caucasians[21]. Overall, African-American women aged 45 to 64 had the highest death rates, which increased the most over time [21]. Nevertheless, survival rates seem to be improving suggesting the presence of more effective disease recognition and better treatment of infection complications [23].

Similar to the previously mentioned arthritis types, Fibromyalgia is a condition of unknown etiology characterized by chronic widespread muscle pain and tenderness. The disorder is commonly accompanied with symptoms, such as extreme fatigue, sleep disturbances, abnormal pain processing, problems with memory, and psychological distress [24]. Given the complexities of this disorder, treatment is often approached in an interdisciplinary manner, with patient self-management being paramount [25]. It was estimated in 2005 that 2% of the population (5 million adults) were affected by fibromyalgia, with women (3.4%) being 7 times more likely to have the disease than men

(0.5%) [6]. In a retrospective cohort study, conducted in order to measure the incidence of fibromyalgia, 2595 incident cases were identified between 1997 and 2002. Women were 1.64 times more likely to have the disease as compared to men (11.28 vs. 6.88 cases per 1000 person-years). Additionally, it was revealed that fibromyalgia is strongly associated (2.14 to 7.05 times) with comorbid conditions such as depression, anxiety, irritable bowel syndrome, chronic fatigue, and other rheumatic conditions, such as SLE and RA [26].

Gout is the most prevalent form of inflammatory arthritis, and it is characterized by hyperuricemia, the excess deposition of uric acid crystals (monosodium urate) in the joints and soft tissue throughout the body [27, 28]. It is manifested as either "acute gouty arthritis" or "chronic gouty arthopathy" [29]. The acute phase of gout, the more classically clinical of the two, is characterized by acute rapid onset, severe pain, and red and swollen joints, with about half of initial attacks affecting the big toe, but also commonly affecting the foot, ankle, knee, wrist, finger, and elbow [27]. Following the abatement of an acute gout flare-up is a period of asympotomatic disease inactivity, called an intercritical period, in which urate crystals continue to deposit into tissue and inconspicuously cause damage to joints, bursae, and tendons [27]. Untreated attacks of acute gouty arthritis, followed by progressing frequent intercritical periods, can naturally develop into chronic gout [27]. Chronic gout is characterized by chronic arthritis, with pain and disability, and progressive joint damage [30]. Clinically important risk factors for gout include obesity, hypertension, poor kidney function, and dietary factors such as excess alcohol consumption, particularly beer, and a diet rich in meat and seafood [30]. Using nationally representative data (NHANES) from 2007-2008, it was found that 8.3

million (3.9%) US adults are affected by gout, with the prevalence among men being about 3 times as high as women (5.9% vs 2.0%, respectively) [31]. This data indicated that the prevalence of gout has increased significantly by 1.2%, after adjusting for body mass index and hypertension, over the past two decades [31]. In a study estimating the incidence of gout in Caucasian and African-American male physicians, it was found that the incidence of gout among the African-American cohort was 3.11 per 1,000 person-years versus 1.82 per 1,000 person-years among Caucasian males. Over a follow-up period of 26 to 34 years, the cumulative incidence was 10.9 % and 5.6% among African-American and Caucasian males, respectively [32]. Similar to the previous mentioned arthritis types, gout treatment is lifelong. However, it can be managed with medications and lifestyle modification, such as weight loss, and a low sugar and low purine diet [30].

Periodontal Disease

Periodontal disease, also known as gum disease, is an inflammatory condition of the supporting structures of the teeth, such as gums and bone, affecting 35 to 50% of the adult population [33]. Preliminary signs of periodontal disease are exhibited through bacteria accumulating under the gums until layers of plaque (film) and tartar (hardened plaque) develop into what is known as gingivitis [34]. Gingivitis is characterized by redness, swelling, and bleeding of the gums, along with changes in gum shape and the loss of their adhesion to the teeth [34]. According to national data, gingivitis is present in early childhood, increases in prevalence and severity in adolescence, then steadies among older age groups [35]. As the accumulation of hardened plaque progresses, it can naturally develop into a more severe form of periodontal disease, known as periodontitis. Although periodontitis is not an unavoidable result of gingivitis, the best way of

preventing periodontitis is to initially prevent gingivitis [34, 35]. Periodontitis is an inflammatory disease characterized by the destruction of the bone, connective tissue, and gum supporting the tooth in short, periodic episodes of tissue damage, followed by some restoration, and then longer periods of disease remission[34]. According to a 2009-2010 CDC report on the prevalence of peritonitis, 47.2% of US adults aged 30 years and older possessed some type of periodontitis with varying degrees of severity, with the majority of periodontitis cases (70.1%) occurring in the 65 years and older age group [36]. After accounting for age, periodontitis was seen more commonly in men compared to females (56.8% vs. 38.8%), the Mexican-American ethnic group (70.4%), persons with less than a high school education (66.7%), persons living below the federal poverty level (67.6%), and current smokers (68.7%) [36].

The Link Between Arthritis and Periodontal Disease

Periodontal disease and its relationship with arthritis are of great importance because of the possible bidirectional relationship between these two conditions. Evidence has revealed a possible relationship between periodontal disease and systemic diseases. Periodontal bacteria has been identified as a potential risk factor for cardiovascular diseases, cerebrovascular diseases and preterm low birth weight infants [37]. Since periodontal disease provokes both local and systemic inflammatory responses, it is also found to be a potential risk for increased morbidity and mortality in conditions such as diabetes, rheumatoid arthritis, osteoporosis, obesity, and complications in pregnancy [38-41]. Furthermore, recent studies have shown that periodontal treatment therapies have a beneficial effect on arthritis conditions and symptoms, regardless of the patient's medication status [42]. On the other hand, arthritis is a disease that commonly occurs

with other chronic conditions and limits physical activity and motor function, thus leading to disability. Periodontal disease could be attributed to the limitations in motor function and joint pain typically suffered by patients with RA. Difficulty in motor function would make activities related to maintaining oral health, such as brushing and flossing, a strenuous feat. Because of the physical disability and immunosuppressant medications that are associated with rheumatic diseases such as RA and OA, it may be that these conditions have a great impact on oral health [43].

This evidence supports the notion that oral health impacts one's general well-being, and it is therefore important for arthritis patients to regularly seek dental visits and receive dental treatment. In fact, the American Dental Association (ADA) recommends regular dental visits once or twice a year [44]. The purposes of this analysis will be to assess the benefits of seeking preventative dental treatment on arthritis symptoms. This study will evaluate if, among those with arthritis, individuals who have seen a dentist within the past year are less likely to report 1) symptoms of joint pain, aching, and stiffness in the past 30 days, 2) joint symptoms beginning more than 3 months ago, and 3) higher severity of joint pain compared to individuals who have not been to the dentist. Because oral hygiene reduces disease activity, I hypothesize that individuals who have seen the dentist will report less joint pain than individuals who have not seen the dentist. The goal of this analysis is to explore the relationship between preventive dental treatment and arthritis symptoms, while subsequently determining if there is an unmet need for dental care among people with arthritis.

METHODS

Study Design and Sample

Data was derived from the National Health Interview Survey (NHIS), an annual, cross-sectional, household interview survey with a complex sampling design that collects information on the civilian noninstitutionalized population residing in the United States. NHIS is one of the major data collection programs of the National Center for Health Statistics (NCHS), which is part of the Centers for Disease Control and Prevention (CDC). Interviews are conducted in-person with an adult resident of each sampled household who answers questions regarding demographic, personal and health status characteristics of each member of the household. NHIS oversamples Blacks/African-Americans, Hispanics, and Asians, with persons of these race/ethnicity groups aged ≥65 years having twice the probability of being selected. Sampling and interviewing are continuous throughout each year. For the purposes of this analysis, NHIS data from 2010 to 2014 were combined in order to increase the number of persons and the precision of estimates [45]. The response rates for the sample adult components (≥18 years) in 2010 through 2014 were, respectively, 60.8%, 66.3%, 61.2%, 61.2%, and 58.9% (n=165,950).

The population was subsequently restricted to adults with a chronic arthritis condition status who have not lost their entire upper and lower natural (permanent) teeth, and who had records in the sample adult core and person files. Respondents self-reported physician-diagnosed arthritis status, defined as answering yes to the question, “Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?” Self-report of

arthritis condition status has been found as a valid method for surveillance purposes [46]. In this population, 125,330 respondents were excluded because they have never been told, or did not report, that they have arthritis.

Because periodontitis is a disease initiated from uncontrolled plaque buildup on teeth, 6,841 respondents were subsequently excluded from the sample for having reported losing all upper & lower natural teeth, as their dental visits would not be for the purposes of combatting gingivitis. A final sample size of 33,750 was used for the analysis

Time Since Last Saw the Dentist Determination and Grouping

Respondents were asked, "About how long has it been since you last saw a dentist? Include all types of dentists, such as orthodontists, oral surgeons, and all other dental specialists, as well as dental hygienists." The respondents reported having last been never 6 months ago or less; 6 months to 1 year ago; 1 year to 2 years ago; 2 to 5 years ago; or more than 5 years ago. However, bearing in mind the ADA recommendations, respondents were grouped by either having seen the dentist 1 year ago or less, or more than 1 year ago or never.

Outcome Variables

Joint Pain Symptoms. Arthritis symptoms, characterized by joint pain, aching, and/or stiffness within the past 30 days, was measure by the question, "The next questions refer to your joints. Please do NOT include the back or neck. DURING THE PAST 30 DAYS, have you had any symptoms of pain, aching, or stiffness in or around a joint?" Respondents were categorized as either having or not having experienced joint pain symptoms.

Timing of Symptoms. Respondents who answered yes to the question, "Did your joint symptoms FIRST begin more than 3 months ago?" were categorized as having their joint symptoms begin more than 3 months ago.

Joint Pain Severity. For 2014 only (the most recent year with all relevant variables), respondents were asked to assess the severity of their joint pain level, during the past 30 days, on a scale from 0 to 10, "where 0 is no pain or aching and 10 is pain or aching as bad as it can be. Scores from 0 to 3, 4 to 6, and 7 to 10 were defined as mild, moderate, and severe joint pain, respectively [47].

Covariates

Based on known risk factors, information on sociodemographic factors (age, sex, body mass index (BMI), race, marital status), socioeconomic status (SES) (education, insurance coverage), and adverse habits (smoking) were obtained from the NHIS 2010-2014 dataset. Age was classified into 3 age groups: 18-39 years, 40-69 years, and ≥70 years. Similarly, BMI was defined as weight in kilograms divided by the square height in meters and classified into the following BMI groups: underweight (≤18.5 kg/m^2), healthy weight (18.5–25.0 kg/m^2), and overweight and obese (≥25.0 kg/m^2). Information on race and ethnicity was collected and respondents were categorized as White only, Black/African-American only, American Indians/Alaska Natives (AI/AN) only, Asian only, and Multiple race respondents. Marital status was defined as "married" if respondents reported being married, regardless of whether or not the spouse was living in the household, and "not married" if the respondent reported being widowed, divorced, separated, never married, or living with their partner. Because educational attainment has been shown to have a medium to strong relationship with SES, highest level of education

was used as an SES indicator [48]. Respondents reported their highest level of school completed or the highest degree received and were categorized into 3 groups: less than 9^{th} grade, 9^{th} to 12^{th} grade, more than 12^{th} grade. Respondents' smoking habit was recorded as smoking everyday, some days, or not at all. Smoking was later divided into two categories: yes (current every day or some day smoker), and no (never smoked or former smoker).

Statistical Analysis

Analyses were implemented to compare the characteristics of the study population between those who have and have not seen the dentist a year ago or less. Because it is hypothesized that frequent dental visits would prevent arthritis symptoms, time since last seeing the dentist was coded in such a way as to make having seen the dentist 1 year ago or less the exposure. Therefore, an odds ratio (OR) of less than 1 would indicate a protective effect and vice-versa. Furthermore, characteristics were compared in those who experienced joint paint in the past 30 days; those who have and have not had their symptoms begin more than 3 months ago; and those among mild, moderate, and severe levels of pain severity. Chi-square tests were applied to categorical variables (e.g., demographic, socio-economic, and life style data).

To assess the influence of the time since last visiting the dentist and arthritis symptoms, two logistic regression (LR) models were constructed. In the models, 'Joint symptoms' and 'Symptoms began more than 3 months ago' were introduced as outcome variables. Moreover, for 2014, the only year collect pain severity ratings, a proportional odds logistic regression (POLR) model examining the relationship between time since last visiting the dentist and the three ordered levels of symptom severity was developed.

Joint pain severity, categorized as 'Mild', 'Moderate', and 'Severe,' was the only outcome variable. The POLR model was checked to ensure that the proportional odds assumption held and, with the use of dummy variables, OR estimates of mild, moderate, and severe pain outcomes were compared in order to verify the fact that the ORs between each next pain level were indeed proportional. For all three models, 'Time since last saw dentist' was considered the independent variable. For all regression models, crude ORs and 95% confidence intervals (CI) were calculated. Furthermore, confounding assessment was conducted by performing backward and stepwise elimination and by dropping each covariate, one at a time, from the models and comparing that OR and CI to that of the gold standard (GS) model. If the OR is within 10% of the GS OR and gains precision, then the covariate in consideration is dropped and considered to be the best model. Following confounding assessment, it was found that, although dropping each variable from the model one at a time showed less than a 10% change in OR, precision was not gained. Therefore, in an effort to control for risk factors as verified by previous literature, all the covariates were included in the models, which produced adjusted odds ratios (OR). Moreover, in order to account for the multistage probability sample and to give each person in the U.S. population a non-zero probability of selection, sample weights were utilized and weighted ORs and 95 % CIs were calculated.

As a last step, collinearity and goodness of fit were assessed with collinearity diagnostics and receiver operating characteristics (ROC) curves, in an effort to assess whether some of the covariates in the models may be associated with one another and whether the models can appropriately classify those with the outcome variable more accurately than those without the outcome variable.

Statistical significance was defined as $P<0.05$. Data analyses were performed using SAS 9.1.2 (SAS Institute, Inc, Cary, North Carolina).

RESULTS

Descriptive data of the sample

In the 2010-2014 NHIS dataset, of the 33,750 respondents included in the study sample, 461 (1.37%) were excluded for not reporting the time since they last saw the dentist. Of those who did relay this information, 21,544 individuals (64.7%) reported having seen the dentist a year ago or less, and 11,745 (35.3%) individuals said they last saw the dentist more than 1 year ago (Table 1). The majority of the respondents' ages ranged from 40 to 69 years old (62.8), with a mean ±standard deviation (SD) of (60.9±14.4) and (57.9±15.2), respectively for less than 1 year and more than 1 year groups. Among the respondents, the majority were women (63.1%), of white race (78.6%), overweight or obese (74.7%), who had completed more than the 12^{th} grade (56.9%), were not married (55.0%), and had health insurance coverage (91.5%). Although over half of the respondents did not report smoking status, 17.2% reported to be smokers. With respect to the data above, the covariates and time since last saw dentist are not independent of one another (<0.0001).

Table 1. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Time Since Last Saw Dentist Based on the 2010-2014 National Health Interview Survey

	Eligible Adults (n=33,750)		1 year ago or less (n=21,544)		More than 1 yr ago (n=11,745)		χ^2 test *P* value
	No.	%	No.	%	No.	%	
Gender							
Male	12,469	37.0	7,644	35.5	4,641	39.5	<.0001
Female	21,281	63.1	13,900	64.5	7,104	60.5	
Age							
18-39	3,404	10.1	1,862	8.6	1,509	12.9	<.0001
40-69	21,208	62.8	13,503	62.7	7,442	63.4	
70+	9,138	27.1	6,179	28.7	2,794	23.8	
Race/ethnicity							
White	26,497	78.6	17,657	82.1	8,517	72.7	<.0001
African American	5,237	15.5	2,681	12.5	2,455	20.9	
American Indian/Alaska Native	306	0.9	170	0.8	130	1.1	
Asian only	1,054	3.1	676	3.1	354	3.0	
Multi-racial	611	1.8	336	1.6	268	2.3	
Smoker							
Yes	5,797	17.2	2,815	13.1	2,919	24.9	<.0001
No	10,454	31.0	7,046	32.7	3,321	28.3	
Missing	17,499	50.9	11,683	54.2	5,505	46.9	
BMI							
Underweight	432	1.3	257	1.2	169	1.4	<.0001
Healthy Weight	8,102	24.0	5,566	25.8	2,491	21.2	
Overweight & Obese	23,935	70.9	15,056	69.9	8,743	74.4	
Missing	1,281	3.8	665	3.1	342	2.9	
Highest level of school completed							
less than 9th grade	1,988	5.9	786	3.7	1,167	10.0	<.0001
9th to 12th grade	12,527	37.2	6,935	32.3	5,395	46.1	
more than 12th grade	19,135	56.9	13,779	64.1	5,138	43.9	
Marital Status							
Married	15,195	45.0	10,694	49.6	4,329	36.9	<.0001
Not Married	18,555	55.0	10,850	50.4	7,416	63.1	
Insurance Coverage Status							
Covered	30,829	91.5	20,593	95.7	9,812	83.7	<.0001
Not Covered	2,855	8.5	917	4.3	1,905	16.3	
Joint pain symptoms							
Yes	24,725	73.3	15,479	71.9	8,911	75.9	<.0001
No	9,008	26.7	6,055	28.1	2,831	24.1	
Missing	17	0.1	10	0.1	3	0.0	
Symptoms began >3 months ago							
Yes	23,144	68.6	14,466	67.2	8,368	71.3	<.0001
No	1,573	4.7	1,010	4.7	539	4.6	
Missing	9,033	26.8	6,068	28.2	2,838	24.2	

[a] Respondents answering "yes" to the question "Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

The 2014 study sample (n=7,673) exhibited comparable results with 1.3% (n=105) of respondents missing information on the time since they last saw the dentist (Table 2). The sample utilized in the analysis included 4,977 (65.8%) individuals who

last saw the dentist a year ago or less, and 2,591 (34.2%) individuals who saw the dentist more than a year ago. The mean ±SD age of the less than 1 year and more than 1 year groups were (61.5±14.4) and (58.6±14.9), respectively, and 62% of the respondents' ages ranged from 40 to 69 years old. Respondents were more commonly women (63.5%), white (80.0%), overweight or obese (74.0%), who had completed more than the 12th grade (57.7%), were not married (55.3%), and were covered by health insurance (93.2%). Again, over half of the respondents did not report smoking status, yet 31.0% reported to be nonsmokers. Just as before, the covariates and time since last saw dentist are related (<0.0001).

Table 2. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Time Since Last Saw Dentist Based on the 2014 National Health Interview Survey

	Eligible Adults (n=7,673)		1 year ago or less (n=4,977)		More than 1 yr ago (n=2,591)		χ^2 test *P* value
	No.	%	No.	%	No.	%	
Gender							
Male	2,798	36.5	1,724	34.6	1,034	39.9	<.0001
Female	4,875	63.5	3,253	65.4	1,557	60.1	
Age							
18-39	741	9.7	427	8.6	304	11.7	<.0001
40-69	4,754	62.0	3,029	60.9	1,665	64.3	
70+	2,178	28.4	1,521	30.6	622	24.0	
Race/ethnicity							
White	6,130	80.0	4,137	83.2	1,918	74.1	<.0001
African American	1,102	14.4	563	11.3	518	20.0	
American Indian/Alaska Native	70	0.9	40	0.8	29	1.1	
Asian only	217	2.8	150	3.0	64	2.5	
Multi-racial	144	1.9	81	1.6	58	2.2	
Smoker							
Yes	1,265	16.5	598	12.0	652	25.2	<.0001
No	2,375	31.0	1,621	32.6	726	28.0	
Missing	4,033	52.6	2,758	55.4	1,213	46.8	
BMI							
Underweight	101	1.3	62	1.3	37	1.4	<.0001
Healthy Weight	1,810	23.6	1,259	25.3	535	20.7	
Overweight & Obese	5,440	70.9	3,474	69.8	1,935	74.7	
Missing	322	4.2	182	3.7	84	3.2	
Highest level of school completed							
less than 9th grade	436	5.7	173	3.5	257	10.0	<.0001
9th to 12th grade	2,805	36.7	1,541	31.0	1,216	47.1	
more than 12th grade	4,412	57.7	3,253	65.5	1,108	42.9	
Marital Status							
Married	3,434	44.8	2,452	49.3	940	36.3	<.0001
Not Married	4,239	55.3	2,525	50.7	1,651	63.7	
Insurance Coverage Status							
Covered	7,143	93.2	4,801	96.6	2,238	86.6	<.0001
Not Covered	518	6.8	170	3.4	347	13.4	
Joint pain severity							
Mild	1,204	15.7	873	17.5	313	12.1	<.0001
Moderate	2,370	30.9	1,554	31.2	789	30.5	
Severe	1,999	26.1	1,106	22.2	862	43.9	
Missing	2,100	27.4	1,444	29.0	627	33.3	

[a] Respondents answering "yes" to the question "Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

Tables 3 and 4 show the study population's demographics stratified by the two LR outcome variables while Table 5 specifically depicts the 2014 sub-sample's characteristics, grouped by three levels of severity. [1]

[1] Please find data in the Tables section, starting on page 29.

Association Between Time Since Last Saw Dentist and Arthritis Symptoms

In effort to closely examine the impact of preventative dental treatment on arthritis symptoms, the independent effect of time since last saw dentist on the three outcome measures were examined. Initially, the univariate association between time since last saw dentist and arthritis symptoms was assessed through crude ORs in two LR models. When comparing individuals who last saw the dentist a year ago or less to those who last saw the dentist more than a year ago, the OR for experiencing joint pain, aching, and/or stiffness in the past 30 days was 0.81 (95% CI: 0.77-0.86) (Table 6). This means that those who wait more than a year to see the dentist have 1.23 times the odds of joint pain in the past 30 days than those who saw the dentist a year ago or less. There was no difference, however, in the odds of joint symptoms beginning more than 3 months ago when comparing the two groups (OR: 0.92; 95% CI: 0.83-1.03). Afterwards, the association between time since last saw dentist and joint pain severity was assessed through a proportional odds ratio (POR). The statistically significant POR observed was 0.58 (95% CI: 0.52, 0.64).

Table 6.Odds Ratios and 95% Confidence Intervals Relating Time Since Last Saw Dentist to Symptoms of Joint Pain/Aching/Stiffness in the Past 30 Days, Joint Symptoms Began More Than 3 Months Ago, and Level of Joint Paint Severity in Adults with Arthritis[a]

	Crude OR (95% CI)	P value	Adjusted[b] OR (95% CI)	P value	Adjusted[b] and Weighted OR (95% CI)	P value
Joint Pain/Aching/Stiffness in past 30 days						
No	1.00 (ref)	<.0001	1.00 (ref)	<.0001	1.00 (ref)	<.0001
Yes	0.812 (0.771, 0.855)		0.813 (0.751, 0.880)		0.829 (0.826, 0.831)	
Joint symptoms begin more than 3 months ago						
No	1.00 (ref)	0.143	1.00 (ref)	0.144	1.00 (ref)	<.0001
Yes	0.923 (0.828, 1.028)		0.883 (0.748, 1.043)		0.926 (0.920, 0.932)	
Severity of joint pain on average, past 30 d[c]						
	1.00 (ref)	<.0001	1.00 (ref)	<.0001	1.00 (ref)	<.0001
Mild, Moderate, or Severe	0.581 (0.524, 0.645)		0.725 (0.619, 0.849)		0.683 (0.681, 0.685)	

[a] Respondents answering “yes” to the question “Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?”

[b]adjusted for sex, age, race/ethnicity, smoking, education, BMI, marital status, coverage

[c]Proportional Odds Ratios

Following the adjustment for all covariates, the findings were slightly altered. The OR of joint pain in the past 30 days for those who last saw the dentist a year ago or less remained 0.81 (95% CI: 0.75-0.88). Although still nonsignificant, the relationship between the time last saw dentist and joint symptoms beginning more than 3 months ago became stronger (OR: 0.88; 95% CI: 0.75-1.04). The POR for joint pain severity remained significant as well, but the relationship weakened (POR: 0.73; 95% CI: 0.62-0.85).

Finally, after weighting the adjusted models, an association between the time since last seeing the dentist and all three outcomes was observed. The odds of joint pain in the past 30 days for those who visited the dentist a year ago or less was 0.83 (95% CI: 0.83-0.83) times that of individuals who last saw the dentist more than a year ago. Unlike previously, the odds of joint symptoms beginning more than 3 months ago was significantly less for individuals who saw the dentist a year ago or less, compared to those who last saw the dentist more than a year ago (OR: 0.93; 95% CI: 0.92-0.93). The relationship between time since last seeing the dentist and joint pain severity became stronger, with a POR of 0.68 (95% CI: 0.68-0.69).

Collinearity diagnostics revealed no indication of collinearity in any of the models, and the two LR models showed poor discrimination with areas under the curve (AUC) of 0.6, while the POLR model had acceptable discrimination with an AUC of 0.7.

DISCUSSION

Given the findings within the existing literature regarding associations between the progression of periodontal disease and arthritis condition and symptoms, data from

2010-2014 NHIS was utilized to investigate the affect frequent dental visits have on arthritis symptoms [40, 41]. The main results for this analysis demonstrated less odds of joint pain, pain beginning more than 3 months ago, and pain severity in individuals who have seen the dentist a year ago or less, compared to those who saw the dentist more than a year ago. I hypothesized that individuals with arthritis who frequently visit the dentist and receive preventative dental services will report less joint pain, rather than individuals who see the dentist infrequently. In this study, the time since last seeing the dentist does appear to have an association with joint pain, time of joint pain initiation, and pain severity. This finding supports my hypothesis that individuals with arthritis who have seen the dentist will report less joint pain than individuals who have not seen the dentist. Thus, the decreased odds in arthritis symptoms and pain severity after seeing the dentist a year ago or less might be attributed to preventative dental treatment.

The demographic frequencies that resulted are in line with the epidemiological characteristics of arthritis. In general, the population consisted mostly of women and was aged between 40-69 years. It was also noticed that most respondents were categorized mostly as “not married.” This was thought to be due to the fact that women naturally live longer than men, so it could be that the not married group is made up of widows. However, after finding no interaction between marital status and gender, the distribution may be attributed to the grouping of the marital status from 10 possible responses to a dichotomous variable, based on the legal status of marriage, not on whether or not the person was in a committed domestic partnership.

Previous findings have revealed differing prevalence rates if arthritis in Non-Hispanic whites, Blacks/African-Americans, and other racial/ethnic minorities [49]. This

analysis demonstrated that Whites with arthritis make up the largest portion of the population sample, followed by Blacks/African-Americans. When associations of time since last seen dentist and the 3 outcome variables were compared among a white and a Black/African-American respondent, the association was stronger and further from the null for the white respondent versus the Black/African-American respondent. This is consistent with earlier studies showing that, when compared with whites, a higher proportion of blacks had arthritis-attributable activity limitations, work limitations, and severe joint pain [49]. Nevertheless, arthritis appears to affect racial/ethnic minorities disproportionately, and additional studies are needed to examine the underlying reasons for these disparities.

In regards to this analysis, we cannot speak towards the distinction of frequent dental visits altering arthritis pain symptoms versus general poor health or lack of access to care. In order to combat the notion that dental visits are an overall proxy these markers of low SES, the covariates of health insurance coverage and highest level of educational attainment were accounted for in the models. Although most of the respondents (95.1%) reported having some type of health care coverage, it was not clarified whether or not the coverage also included dental coverage. Additionally, there is no 1:1 correlation between educational attainment and SES status, so definite inferences about the population cannot be made in this regard, though previous studies have found that low-education and low-income families do not pay enough attention to dental care measures and regular preventive visits to a dental professional [50]. Thus, future studies should assess whether dental visits and treatment truly influence the experience of arthritis symptoms and pain, or if it is rather an indicator of access to care and general poor health.

The strength of this study was the use of the NHIS 2010-2014 database, composed of U.S. men and women, which may have avoided selection bias; thus, it is applicable to the general U.S. population. The large number of persons also presents a higher level of precision of estimates. In addition, access to a wide range of variables of interest allowed adjustment for potential confounders, which was performed in evaluating factors associated with time since last saw dentist. Finally, the self-reported outcome measures of joint pain and pain severity are considered the most valid because of their subjective nature of pain experience [51].

There were certain limitations to this analysis, however. Because of the cross-sectional design of the study, this data cannot be used to infer causation. Additionally, unlike previous studies which have measured the effect of non-surgical periodontal treatment on arthritis symptoms with disease activity score tests (DAS28), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and tumor necrosis factor-alpha (TNF-α) levels, this analysis utilized self-reported measures, which is always subject to recall bias [52]. Moreover, as a result of social desirability, respondents may have over-reported their frequency of dental visits, thus being misclassified as having last seen the dentist ≤1 year ago. This could have potentially weakened the observed association between dental treatment utilization and arthritis symptoms. Finally, the NHIS question that asks about one's time since last seeing a dentist is not specific to preventative dental treatments, such as annual cleanings, but also includes visits to orthodontists, oral surgeons, and other dental specialists. This means a person who had, for example, not had a teeth cleaning in over a year, but had recently seen the dentist for oral reconstructive surgery or any

other non-routine procedures, would be misclassified to the exposure group, and would thus bias the results.

It is vital to increase efforts to promote oral health and to raise awareness of the benefits of dental care and oral hygiene for individuals with arthritis. A previous study assessing an intervention in the form of a patient dental care leaflet, which highlighted the importance of dental care and was distributed to patients with inflammatory arthritis, discovered minimal change in patient behavior [53]. This is troubling since it has been reported that patients with RA are less likely to visit the dentist than are those without arthritis [43]. Overall, oral health providers need to recognize and apply modifications of dental care and protocol based on the medical status of patients with arthritis, as they play an important role in the early recognition of arthritis, as well as the control of the disease [54].

Arthritis significantly alters health-related quality of life and is projected to increase prominently in prevalence as the population ages, even without taking into account the rising prevalence of periodontal disease, a risk factor that overwhelmingly affects the 65-year and older age group [36, 55, 56]. Thus, improving oral hygiene for all persons is an important public health objective. Among those with arthritis, who represent a large and resistant target group, oral hygiene and regular dental treatment can have an even greater impact on health by reducing pain, improving function, decreasing the risk of comorbid diseases, delaying disability, and promoting mental well-being. Future research should focus on identifying barriers to regularly visiting the dentist, which may be the result of a myriad of factors. Also, future research with a longitudinal

design is suggested in order to better infer causality and to evaluate the relationship between the time since last seeing the dentist and arthritis condition and symptoms.

REFERENCES

1. Barbour, K.E., et al., *Prevalence of doctor-diagnosed arthritis and arthritis-attributable activity limitation-United States.* MMWR 2013, 2010-2012. **62**(44): p. 869-873.
2. Centers for Disease, C. and Prevention, *Prevalence and most common causes of disability among adults--United States, 2005.* MMWR Morb Mortal Wkly Rep, 2009. **58**(16): p. 421-6.
3. Sacks, J.J., et al., *Prevalence of and annual ambulatory health care visits for pediatric arthritis and other rheumatologic conditions in the United States in 2001-2004.* Arthritis Rheum, 2007. **57**(8): p. 1439-45.
4. Yelin, E., et al., *Medical care expenditures and earnings losses among persons with arthritis and other rheumatic conditions in 2003, and comparisons with 1997.* Arthritis Rheum, 2007. **56**(5): p. 1397-407.
5. Hootman, J.M. and C.G. Helmick, *Projections of US prevalence of arthritis and associated activity limitations.* Arthritis Rheum, 2006. **54**(1): p. 226-9.
6. Lawrence, R.C., et al., *Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II.* Arthritis Rheum, 2008. **58**(1): p. 26-35.
7. Felson, D.T., *Risk factors for osteoarthritis: understanding joint vulnerability.* Clin Orthop Relat Res, 2004(427 Suppl): p. S16-21.
8. Oliveria, S.A., et al., *Incidence of symptomatic hand, hip, and knee osteoarthritis among patients in a health maintenance organization.* Arthritis Rheum, 1995. **38**(8): p. 1134-41.
9. Buckwalter, J.A., C. Saltzman, and T. Brown, *The impact of osteoarthritis: implications for research.* Clin Orthop Relat Res, 2004(427 Suppl): p. S6-15.
10. Sangha, O., *Epidemiology of rheumatic diseases.* Rheumatology (Oxford), 2000. **39 Suppl 2**: p. 3-12.
11. Graudal, N.A., et al., *Radiographic progression in rheumatoid arthritis: a long-term prospective study of 109 patients.* Arthritis Rheum, 1998. **41**(8): p. 1470-80.
12. Masi, A.T., et al., *Prospective study of the early course of rheumatoid arthritis in young adults: comparison of patients with and without rheumatoid factor positivity at entry and identification of variables correlating with outcome.* Semin Arthritis Rheum, 1976. **4**(4): p. 299-326.
13. Scott, D.L., F. Wolfe, and T.W.J. Huizinga, *Rheumatoid arthritis.* The Lancet. **376**(9746): p. 1094-1108.
14. Gabriel, S.E., *The epidemiology of rheumatoid arthritis.* Rheum Dis Clin North Am, 2001. **27**(2): p. 269-81.
15. Brooks, P.M., *The burden of musculoskeletal disease--a global perspective.* Clin Rheumatol, 2006. **25**(6): p. 778-81.
16. Justiz-Vaillant, A., P.E. Akpaka, and P. Poonking, *Systemic Lupus Erythematosus: some Epidemiological and Clinical Aspects.* American Journal of Public Health Research, 2015. **3**(2): p. 46-50.

17. D'Cruz, D.P., M.A. Khamashta, and G.R. Hughes, *Systemic lupus erythematosus.* Lancet, 2007. **369**(9561): p. 587-96.
18. Petri, M., *Epidemiology of systemic lupus erythematosus.* Best Pract Res Clin Rheumatol, 2002. **16**(5): p. 847-58.
19. Helmick, C.G., et al., *Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part I.* Arthritis Rheum, 2008. **58**(1): p. 15-25.
20. Garris, C., M. Shah, and E. Farrelly, *The prevalence and burden of systemic lupus erythematosus in a medicare population: retrospective analysis of medicare claims.* Cost Eff Resour Alloc, 2015. **13**: p. 9.
21. *Trends in Deaths from Systemic Lupus Erythematosus — United States, 1979–1998.* Morbidity and Mortality Weekly Report, 2002. **51**(17): p. 371-374.
22. Trager, J. and M.M. Ward, *Mortality and causes of death in systemic lupus erythematosus.* Curr Opin Rheumatol, 2001. **13**(5): p. 345-51.
23. Bernatsky, S., et al., *Mortality in systemic lupus erythematosus.* Arthritis Rheum, 2006. **54**(8): p. 2550-7.
24. Smith, H.S., R. Harris, and D. Clauw, *Fibromyalgia: an afferent processing disorder leading to a complex pain generalized syndrome.* Pain Physician, 2011. **14**(2): p. E217-45.
25. Sumpton, J.E. and D.E. Moulin, *Fibromyalgia.* Handb Clin Neurol, 2014. **119**: p. 513-27.
26. Weir, P.T., et al., *The incidence of fibromyalgia and its associated comorbidities: a population-based retrospective cohort study based on International Classification of Diseases, 9th Revision codes.* J Clin Rheumatol, 2006. **12**(3): p. 124-8.
27. Grassi, W. and R. De Angelis, *Clinical features of gout.* Reumatismo, 2011. **63**(4): p. 238-45.
28. Roddy, E. and M. Doherty, *Epidemiology of gout.* Arthritis Res Ther, 2010. **12**(6): p. 223.
29. Zurek, M., *[Pathogenesis, diagnostics and therapy of gout].* Vnitr Lek, 2006. **52**(7-8): p. 736-41.
30. Roddy, E., C.D. Mallen, and M. Doherty, *Gout*. Vol. 347. 2013.
31. Zhu, Y., B.J. Pandya, and H.K. Choi, *Prevalence of gout and hyperuricemia in the US general population: the National Health and Nutrition Examination Survey 2007-2008.* Arthritis Rheum, 2011. **63**(10): p. 3136-41.
32. Hochberg, M.C., et al., *Racial differences in the incidence of gout. The role of hypertension.* Arthritis Rheum, 1995. **38**(5): p. 628-32.
33. Monsarrat, P., et al., *Effect of periodontal treatment on the clinical parameters of patients with rheumatoid arthritis: study protocol of the randomized, controlled ESPERA trial.* Trials, 2013. **14**: p. 253.
34. *The pathogenesis of periodontal diseases.* J Periodontol, 1999. **70**(4): p. 457-70.
35. Burt, B., *Position paper: epidemiology of periodontal diseases.* J Periodontol, 2005. **76**(8): p. 1406-19.
36. Eke, P.I., et al., *Prevalence of periodontitis in adults in the United States: 2009 and 2010.* J Dent Res, 2012. **91**(10): p. 914-20.

37. Moutsopoulos, N.M. and P.N. Madianos, *Low-grade inflammation in chronic infectious diseases: paradigm of periodontal infections.* Ann N Y Acad Sci, 2006. **1088**: p. 251-64.
38. Fowler, E.B., L.G. Breault, and M.F. Cuenin, *Periodontal disease and its association with systemic disease.* Mil Med, 2001. **166**(1): p. 85-9.
39. Arigbede, A.O., B.O. Babatope, and M.K. Bamidele, *Periodontitis and systemic diseases: A literature review.* J Indian Soc Periodontol, 2012. **16**(4): p. 487-91.
40. de Pablo, P., et al., *Periodontitis in systemic rheumatic diseases.* Nat Rev Rheumatol, 2009. **5**(4): p. 218-24.
41. Mercado, F.B., et al., *Relationship between rheumatoid arthritis and periodontitis.* J Periodontol, 2001. **72**(6): p. 779-87.
42. Ortiz, P., et al., *Periodontal Therapy Reduces the Severity of Active Rheumatoid Arthritis in Patients Treated With or Without Tumor Necrosis Factor Inhibitors.* Journal of periodontology, 2009. **80**(4): p. 535-540.
43. Pokrajac-Zirojevic, V., L.M. Slack-Smith, and D. Booth, *Arthritis and use of dental services: a population based study.* Aust Dent J, 2002. **47**(3): p. 208-13.
44. *American Dental Association Statement on Regular Dental Visits*. 2013; Available from: http://www.ada.org/en/press-room/news-releases/2013-archive/june/american-dental-association-statement-on-regular-dental-visits.
45. Statistics, N.C.f.H., *NHIS questionnaires, datasets, and related documentation 1997 to the present [article online], 2015*, N.C.f.H. Statistics, Editor. 2015.
46. Sacks, J.J., et al., *Validation of a surveillance case definition for arthritis.* J Rheumatol, 2005. **32**(2): p. 340-7.
47. Kapstad, H., et al., *Cutpoints for mild, moderate and severe pain in patients with osteoarthritis of the hip or knee ready for joint replacement surgery.* BMC Musculoskelet Disord, 2008. **9**: p. 55.
48. Sirin, S.R., *Socioeconomic status and academic achievement: A meta-analytic review of research.* Review of educational research, 2005. **75**(3): p. 417-453.
49. *Racial/ethnic differences in the prevalence and impact of doctor-diagnosed arthritis--United States, 2002.* MMWR Morb Mortal Wkly Rep, 2005. **54**(5): p. 119-23.
50. Costa, S.M., et al., *A systematic review of socioeconomic indicators and dental caries in adults.* Int J Environ Res Public Health, 2012. **9**(10): p. 3540-74.
51. Katz, J. and R. Melzack, *Measurement of pain.* Surg Clin North Am, 1999. **79**(2): p. 231-52.
52. Erciyas, K., et al., *Effects of periodontal therapy on disease activity and systemic inflammation in rheumatoid arthritis patients.* Oral Dis, 2013. **19**(4): p. 394-400.
53. Cornell, P., *Don't forget to clean your teeth: does informing patients about the link between dental hygiene and rheumatoid arthritis encourage better dental care?* Musculoskeletal Care, 2013. **11**(2): p. 121-4.
54. Treister, N. and M. Glick, *Rheumatoid arthritis: a review and suggested dental care considerations.* J Am Dent Assoc, 1999. **130**(5): p. 689-98.

55. Mili, F., C.G. Helmick, and D.G. Moriarty, *Health related quality of life among adults reporting arthritis: analysis of data from the Behavioral Risk Factor Surveillance System, US, 1996-99.* J Rheumatol, 2003. **30**(1): p. 160-6.
56. *Public health and aging: projected prevalence of self-reported arthritis or chronic joint symptoms among persons aged >65 years--United States, 2005-2030.* MMWR Morb Mortal Wkly Rep, 2003. **52**(21): p. 489-91.

TABLES

Table 1. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Time Since Last Saw Dentist Based on the 2010-2014 National Health Interview Survey

	Eligible Adults (n=33,750)		1 year ago or less (n=21,544)		More than 1 yr ago (n=11,745)		χ^2 test *P* value
	No.	%	No.	%	No.	%	
Gender							
Male	12,469	37.0	7,644	35.5	4,641	39.5	<.0001
Female	21,281	63.1	13,900	64.5	7,104	60.5	
Age							
18-39	3,404	10.1	1,862	8.6	1,509	12.9	<.0001
40-69	21,208	62.8	13,503	62.7	7,442	63.4	
70+	9,138	27.1	6,179	28.7	2,794	23.8	
Race/ethnicity							
White	26,497	78.6	17,657	82.1	8,517	72.7	<.0001
African American	5,237	15.5	2,681	12.5	2,455	20.9	
American Indian/Alaska Native	306	0.9	170	0.8	130	1.1	
Asian only	1,054	3.1	676	3.1	354	3.0	
Multi-racial	611	1.8	336	1.6	268	2.3	
Smoker							
Yes	5,797	17.2	2,815	13.1	2,919	24.9	<.0001
No	10,454	31.0	7,046	32.7	3,321	28.3	
Missing	17,499	50.9	11,683	54.2	5,505	46.9	
BMI							
Underweight	432	1.3	257	1.2	169	1.4	<.0001
Healthy Weight	8,102	24.0	5,566	25.8	2,491	21.2	
Overweight & Obese	23,935	70.9	15,056	69.9	8,743	74.4	
Missing	1,281	3.8	665	3.1	342	2.9	
Highest level of school completed							
less than 9th grade	1,988	5.9	786	3.7	1,167	10.0	<.0001
9th to 12th grade	12,527	37.2	6,935	32.3	5,395	46.1	
more than 12th grade	19,135	56.9	13,779	64.1	5,138	43.9	
Marital Status							
Married	15,195	45.0	10,694	49.6	4,329	36.9	<.0001
Not Married	18,555	55.0	10,850	50.4	7,416	63.1	
Insurance Coverage Status							
Covered	30,829	91.5	20,593	95.7	9,812	83.7	<.0001
Not Covered	2,855	8.5	917	4.3	1,905	16.3	
Joint pain symptoms							
Yes	24,725	73.3	15,479	71.9	8,911	75.9	<.0001
No	9,008	26.7	6,055	28.1	2,831	24.1	
Missing	17	0.1	10	0.1	3	0.0	
Symptoms began >3 months ago							
Yes	23,144	68.6	14,466	67.2	8,368	71.3	<.0001
No	1,573	4.7	1,010	4.7	539	4.6	
Missing	9,033	26.8	6,068	28.2	2,838	24.2	

[a] Respondents answering “yes” to the question “Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?”

Table 2. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Time Since Last Saw Dentist Based on the 2014 National Health Interview Survey

	Eligible Adults (n=7,673)		1 year ago or less (n=4,977)		More than 1 yr ago (n=2,591)		χ^2 test *P* value
	No.	%	No.	%	No.	%	
Gender							
Male	2,798	36.5	1,724	34.6	1,034	39.9	<.0001
Female	4,875	63.5	3,253	65.4	1,557	60.1	
Age							
18-39	741	9.7	427	8.6	304	11.7	<.0001
40-69	4,754	62.0	3,029	60.9	1,665	64.3	
70+	2,178	28.4	1,521	30.6	622	24.0	
Race/ethnicity							
White	6,130	80.0	4,137	83.2	1,918	74.1	<.0001
African American	1,102	14.4	563	11.3	518	20.0	
American Indian/Alaska Native	70	0.9	40	0.8	29	1.1	
Asian only	217	2.8	150	3.0	64	2.5	
Multi-racial	144	1.9	81	1.6	58	2.2	
Smoker							
Yes	1,265	16.5	598	12.0	652	25.2	<.0001
No	2,375	31.0	1,621	32.6	726	28.0	
Missing	4,033	52.6	2,758	55.4	1,213	46.8	
BMI							
Underweight	101	1.3	62	1.3	37	1.4	<.0001
Healthy Weight	1,810	23.6	1,259	25.3	535	20.7	
Overweight & Obese	5,440	70.9	3,474	69.8	1,935	74.7	
Missing	322	4.2	182	3.7	84	3.2	
Highest level of school completed							
less than 9th grade	436	5.7	173	3.5	257	10.0	<.0001
9th to 12th grade	2,805	36.7	1,541	31.0	1,216	47.1	
more than 12th grade	4,412	57.7	3,253	65.5	1,108	42.9	
Marital Status							
Married	3,434	44.8	2,452	49.3	940	36.3	<.0001
Not Married	4,239	55.3	2,525	50.7	1,651	63.7	
Insurance Coverage Status							
Covered	7,143	93.2	4,801	96.6	2,238	86.6	<.0001
Not Covered	518	6.8	170	3.4	347	13.4	
Joint pain severity							
Mild	1,204	15.7	873	17.5	313	12.1	<.0001
Moderate	2,370	30.9	1,554	31.2	789	30.5	
Severe	1,999	26.1	1,106	22.2	862	43.9	
Missing	2,100	27.4	1,444	29.0	627	33.3	

[a] Respondents answering “yes” to the question “Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?”

Table 3. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Symptoms of Joint Pain/Aching/Stiffness in the Past 30 Days Status Based on the 2010-2014 National Health Interview Survey

	Eligible Adults (n=33,750)		Joint Symptoms (n=24,725)		No Joint Symptoms[b] (n=9,008)		χ^2 test *P* value
	No.	%	No.	%	No.	%	
Gender							
Male	12,469	37.0	8,874	35.9	3,589	39.8	<.0001
Female	21,281	63.1	15,851	64.1	5,419	60.2	
Age							
18-39	3,404	10.1	2,293	9.3	1,111	12.3	<.0001
40-69	21,208	62.8	15,900	64.3	5,300	58.8	
70+	9,138	27.1	6,532	26.4	2,597	28.8	
Race/ethnicity							
White	26,497	78.6	19,305	78.2	7,179	79.8	<.0001
African American	5,237	15.5	3,994	16.2	1,242	13.8	
American Indian/Alaska Native	306	0.9	224	0.9	82	0.9	
Asian only	1,054	3.1	696	2.8	335	4.0	
Multi-racial	611	1.8	472	1.9	139	1.5	
Smoker							
Yes	5,797	17.2	4,410	17.8	1,386	15.4	<.0001
No	10,454	31.0	7,758	31.4	2,691	29.9	
Missing	17,499	51.8	12,557	50.8	4,931	54.7	
BMI							
Underweight	432	1.3	319	1.3	112	1.2	<.0001
Healthy Weight	8,102	24.0	5,519	22.3	2,578	28.6	
Overweight & Obese	23,935	70.9	17,928	72.5	6,001	66.6	
Missing	1,281	3.8	959	3.9	317	3.5	
Highest level of school completed							
less than 9th grade	1,988	5.9	1,473	6.0	512	5.7	0.1878
9th to 12th grade	12,527	37.2	9,230	37.5	3,292	36.7	
more than 12th grade	19,135	56.9	13,946	56.6	5,180	57.7	
Marital Status							
Married	15,195	45.0	10,909	44.1	4,277	47.5	<.0001
Not Married	18,555	55.0	13,816	55.9	4,731	52.5	
Insurance Coverage Status							
Covered	30,829	91.5	22,576	91.5	8,236	91.6	0.682
Not Covered	2,855	8.5	2,102	8.5	753	8.4	
Time since last saw dentist							
1 Year or less	21,544	64.72	15,479	63.5	6,055	68.1	<.0001
More than 1 year ago	11,745	35.28	8,911	36.5	2,831	31.9	

[a] Respondents answering "yes" to the question "Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

Table 4. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Joint Symptoms Began More Than 3 Months Ago Status Based on the 2010-2014 National Health Interview Survey

	Eligible Adults (n=33,750)		Joint symptoms began more than 3 months ago (n=23,144)		Joint symptoms did not begin more than 3 months ago (n=1,573)		χ^2 test *P* value
	No.	%	No.	%	No.	%	
Gender							
Male	12,469	37.0	8,292	35.8	578	36.8	0.463
Female	21,281	63.1	14,852	64.2	995	63.3	
Age							
18-39	3,404	10.1	2,126	9.2	167	10.6	0.118
40-69	21,208	62.8	14,914	64.4	983	62.5	
70+	9,138	27.1	6,104	26.4	423	26.9	
Race/ethnicity							
White	26,497	78.6	18,149	78.5	1,151	73.2	<.0001
African American	5,237	15.5	3,671	15.9	322	20.5	
American Indian/Alaska Native	306	0.9	212	0.9	12	0.8	
Asian only	1,054	3.1	633	2.7	61	3.9	
Multi-racial	611	1.8	446	1.9	26	1.7	
Smoker							
Yes	5,797	17.2	4,151	17.9	258	16.4	<.0001
No	10,454	31.0	7,298	31.5	457	29.1	
Missing	17,499	51.8	11,695	50.5	858	54.6	
BMI							
Underweight	432	1.3	300	1.3	19	1.2	<.0001
Healthy Weight	8,102	24.0	5,128	22.2	388	24.6	
Overweight & Obese	23,935	70.9	16,816	72.7	1,109	70.5	
Missing	1,281	3.8	900	3.9	57	3.6	
Highest level of school completed							
less than 9th grade	1,988	5.9	1,362	10.6	111	7.1	0.1425
9th to 12th grade	12,527	37.2	8,657	42.9	571	36.5	
more than 12th grade	19,135	56.9	13,059	46.6	883	56.4	
Marital Status							
Married	15,195	45.0	10,193	44.0	716	45.5	0.2538
Not Married	18,555	55.0	12,951	56.0	857	54.5	
Insurance Coverage Status							
Covered	30,829	91.5	21,131	91.5	1,438	91.5	0.941
Not Covered	2,855	8.5	1,968	8.5	133	8.5	
Time since last saw dentist							
1 yr or less	21,544	64.72	14,466	63.4	1,010	65.2	0.143
More than 1 years ago	11,745	35.28	8,368	36.7	539	34.8	

[a] Respondents answering "yes" to the question "Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

Table 5. Characteristics of a Cohort of U.S. Adults with Arthritis[a] by Severity of Joint Pain on Average in the Past 30 Days Status Based on the 2014 National Health Interview Survey

	Eligible Adults (n=7,673)		MILD (n=1,204)		MODERATE (n=2,370)		SEVERE (n=1,999)		χ^2 test *P* value
	No.	%	No.	%	No.	%	No.	%	
Gender									
Male	2,798	36.5	528	43.9	862	36.4	596	29.8	<.0001
Female	4,875	63.5	676	56.2	1,508	63.6	1,403	70.2	
Age									
18-39	741	9.7	103	8.6	213	9.0	186	9.3	<.0001
40-69	4,754	62.0	732	60.8	1,451	61.2	1337	66.9	
70+	2,178	28.4	369	30.7	706	29.8	476	23.8	
Race/ethnicity									
White	6,130	80.0	1,004	86.7	1,976	83.5	1,419	71.2	<.0001
African American	1,102	14.4	103	8.6	261	11.0	458	23.0	
American Indian/Alaska Native	70	0.9	8	0.7	28	1.2	18	0.9	
Asian only	217	2.8	31	2.6	71	3.0	42	2.1	
Multi-racial	144	1.9	18	1.5	31	1.3	56	2.8	
Smoker									
Yes	1,265	16.5	149	12.4	356	15.0	441	22.1	<.0001
No	2,375	31.0	395	32.8	780	32.9	597	29.9	
Missing	4,033	52.6	660	54.8	1,234	52.1	961	48.0	
BMI									
Underweight	101	1.3	11	1.0	23	1.0	32	1.7	<.0001
Healthy Weight	1,810	23.6	301	26.2	544	24.0	356	18.6	
Overweight & Obese	5,440	70.9	838	72.9	1,703	75.0	1,525	79.7	
Missing	322	4.2	54		100		35		
Highest level of school completed									
less than 9th grade	436	5.7	24	2.0	129	5.5	160	8.0	<.0001
9th to 12th grade	2,805	36.7	313	26.0	848	35.9	872	43.8	
more than 12th grade	4,412	57.7	865	72.0	1,388	58.7	959	48.2	
Marital Status									
Married	3,434	44.8	528	48.3	1,109	46.8	766	38.3	<.0001
Not Married	4,239	55.3	622	51.7	1,261	53.2	1,233	61.7	
Insurance Coverage Status									
Covered	7,143	93.2	1,146	95.5	2,203	93.0	1,840	92.2	0.0014
Not Covered	518	6.8	54	4.5	166	7.0	155	7.8	
Time since last saw dentist									
1 Year or less	4,977	65.8	873	73.6	1,554	66.3	1,106	56.2	<.0001
More than 1 year ago	2,591	34.2	313	26.4	789	33.7	299	43.8	

[a] Respondents answering "yes" to the question "Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

Table 6.Odds Ratios and 95% Confidence Intervals Relating Time Since Last Saw Dentist to Symptoms of Joint Pain/Aching/Stiffness in the Past 30 Days, Joint Symptoms Began More Than 3 Months Ago, and Level of Joint Paint Severity in Adults with Arthritis[a]

	Crude OR (95% CI)	P value	Adjusted[b] OR (95% CI)	P value	Adjusted[b] and Weighted OR (95% CI)	P value
Joint Pain/Aching/Stiffness in past 30 days						
No	1.00 (ref)	<.0001	1.00 (ref)	<.0001	1.00 (ref)	<.0001
Yes	0.812 (0.771, 0.855)		0.813 (0.751, 0.880)		0.829 (0.826, 0.831)	
Joint symptoms begin more than 3 months ago						
No	1.00 (ref)	0.143	1.00 (ref)	0.144	1.00 (ref)	<.0001
Yes	0.923 (0.828, 1.028)		0.883 (0.748, 1.043)		0.926 (0.920, 0.932)	
Severity of joint pain on average, past 30 d[c]						
	1.00 (ref)	<.0001	1.00 (ref)	<.0001	1.00 (ref)	<.0001
Mild, Moderate, or Severe	0.581 (0.524, 0.645)		0.725 (0.619, 0.849)		0.683 (0.681, 0.685)	

[a] Respondents answering “yes” to the question “Have you ever been told by a doctor or other heath professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?”

[b]adjusted for sex, age, race/ethnicity, smoking, education, BMI, marital status, coverage

[c]Proportional Odds Ratios