Impact of COVID-19 on arthritis with generative AI

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ABSTRACT

Objective: The study aims to examine the effects of the COVID-19 pandemic on the prevalence of arthritis in the US using a specific generative AI tool.
Methods: The AI tool with Bing.com/copilot, designed to generate Python code, uses data from the Centers for Disease Control and Prevention (CDC) to visualize trends and uncover insights in four key areas: (1) The prevalence of arthritis in adults aged 18 years and older who have diabetes, (2) The prevalence of fair or poor health in adults aged 18 years and older who have arthritis, (3) The prevalence of activity limitations due to arthritis in adults aged 18 years and older with doctor-diagnosed arthritis, (4) The prevalence of arthritis in adults aged 18 years and older who are obese. This research did not require approval from an institutional review board or an ethics committee.
Results: The findings reveal a significant decline in the prevalence of arthritis among adults with conditions such as diabetes and obesity during the COVID-19 pandemic. There was also an observed improvement in activity limitations among patients with doctor-diagnosed arthritis.
Conclusion: The study highlights the potential impact of the pandemic on chronic disease management, particularly arthritis. It underscores the importance of continued monitoring and care for patients with arthritis, especially during a global health crisis like the COVID-19 pandemic. The use of AI tools in generating insights from health data proves to be valuable in this context.

1. Introduction

This research utilizes a specialized AI tool capable of generating Python code to examine the impact of the COVID-19 pandemic on the incidence of arthritis in the US. The AI tool leverages data[1] from the Centers for Disease Control and Prevention (CDC) to visualize trends and discover new insights in four primary areas: (1) the incidence of arthritis in adults aged 18 years and older with diabetes, (2) the incidence of fair or poor health in adults aged 18 years and older with arthritis, (3) the incidence of activity limitations due to arthritis in adults aged 18 years and older diagnosed with arthritis by a doctor, and (4) the incidence of arthritis in adults aged 18 years and older who are obese. Precise queries to the AI tool are essential for generating accurate codes and retrieving the desired data. The recent findings indicate a notable decrease in the incidence of arthritis among adults with conditions like diabetes and obesity during the COVID-19 pandemic. Interestingly, there was an enhancement in activity limitations among patients diagnosed with arthritis by a doctor. These findings emphasize the potential influence of the pandemic on the management of chronic diseases and stress the need for ongoing monitoring and care.

The Division of Population Health at the CDC offers a comprehensive set of 124 indicators, agreed upon by consensus [1]. These indicators enable states, territories, and large metropolitan areas to consistently define, gather, and report data on chronic diseases, which are crucial to public health practice. In other words, the dataset named "U.S._Chronic_Disease_Indicators_Arthritis: Chronic-Disease-Indicators" was designed to improve practices in public health. The dataset categorizes data based on gender groups, including male and female, as well as race groups, which encompass White, Black, Hispanic, Multiracial, and an Overall category. This paper examines the Overall category of four key areas.

The CDC dataset encompasses the entire US population spanning from 2011 to 2021. This study delves into the influence of COVID-19 on arthritis patients, particularly focusing on how the pandemic affected activity limitations among individuals with diabetes and obesity. This research without any hypnosis could potentially uncover the effects of the COVID-19 pandemic on patients with arthritis.

By visualizing the time-series data, users can discern notable changes between the pre-COVID-19 period and the period during COVID-19. This visualization of the dataset facilitates the identification of notable

reductions. A concise literature review was conducted to substantiate the results of dataset experiments.

Scott et al. reported that annual incidence of rheumatoid arthritis diagnoses in the UK fell by 40·1% between 2019 and 2020, likely reflecting the COVID-19 pandemic's impact on their diagnosis [2]. Horton et al. presented that during the initial year of the pandemic, there was a 10 % to 12 % decrease in visits for Juvenile Idiopathic Arthritis among children with commercial insurance in the US [3]. The use of telemedicine services partially offset this decline. This paper shows general arthritis disease trends in the US from 2011 to 2021 with generative AI.

2. Methods

The Python codes were generated using an AI tool available at Bing. com/copilot. This research did not require approval from an institutional review board or an ethics committee. According to the National Center for Biotechnology Information (NCBI), which advances science and health by providing access to biomedical and genomic information, there are 3170 documents on the impact of COVID-19 and arthritis on their site (ncbi.nlm.nih.gov) from January 1, 2023 to December 31, 2023. You can retrieve this information by executing a Google search engine with the command: "impact of COVID-19" "arthritis" site:ncbi.nl m.nih.gov, and setting a custom date range from January 1, 2023, to December 31, 2023.

However, there is no visualization of COVID-19 impact on arthritis with the CDC dataset released on July 27, 2023 [4].

The dataset consists of 33 columns and 78,300 rows, representing one of the largest survey results with 78,300 instances [4]. There are ten questions on arthritis from 2011 to 2021.

This paper challenges and demonstrates generative AI to generate the Python code to analyze and visualize the impact of COVID-19 [5]. This paper investigated the US on arthritis from 2011 to 2021 over ten questions. 'Crude Prevalence' is chosen for data value type. Overall is selected in 'StratificationCategory1' and 'Stratification1' columns respectively. This demonstration is useful for practitioners and researchers in general.

Queries play a key role in generating correct codes with the CDC dataset for novice and non-programmers. Generative AI will be able to assist and support researchers on arthritis in the future.

Code generated for critical analysis can sometimes be unreliable, necessitating expert review. In this study, a professional programmer meticulously examined the generated code, with a particular emphasis on calculations within the dataset. The accurate application of determinants was found to be vital for precise computation. Novices or non-programmers can become accustomed to and verify generated code through repeated practice.

There are three generative AI systems such as ChatGPT-3.5, Gemini and Bing.com with ChatGPT-4 for public use free of charge. This paper used the Bing.com with ChatGPT-4: https://bing.com/chat. You must choose 'More Precise' in a conversation style. The current generative AI has a reproducibility problem due to the use of pseudorandom numbers. In other words, even in 'More Precise', the same query may not produce the same result. The current generative AI has a reproducibility problem. The following query was fed to the AI for generating the Python code and the code was executed on Python installed system.

Query: With rows.csv, show a full code in Python to calculate how many data are available with 'Locationabbr'=='US' and 'Data-ValueType=='Crude Prevalence' and 'StratificationCategory1'=='Overall' and 'Stratification1'=='Overall'.

How many unique questions are in 'Question' column with the filtered condition?

Show the unique questions. Instead of enter the detailed question, user is allowed to pick one of questions, and instead of lines plot dots for values of 'DataValue' with 'YearStart' column values as x-axis. Rotate tick labels with 90-degree in x-axis.

The following are the 10 questions from the code. Running the code in the APPENDIX showed that questions 4, 5, 9, and 10 revealed a significant impact of COVID-19 on arthritis in the US. The generated code has the capability to produce answers to ten questions. However, the author, due to his personal experience and interest with diabetes, selectively chose to address four questions.

1: Adults aged $\geq$ 18 years with arthritis who have taken a class to learn how to manage arthritis symptoms.

2: Arthritis among adults aged $\geq$ 18 years.

3: Arthritis among adults aged $\geq$ 18 years who have heart disease.

4: Arthritis among adults aged $\geq$ 18 years who have diabetes.

5: Fair or poor health among adults aged $\geq$ 18 years with arthritis.

6: Work limitation due to arthritis among adults aged 18–64 years who have doctor-diagnosed arthritis.

7: Severe joint pain due to arthritis among adults aged $\geq$ 18 years who have doctor-diagnosed arthritis.

8: Physical inactivity among adults aged $\geq$ 18 years with arthritis.

9: Activity limitation due to arthritis among adults aged $\geq$ 18 years who have doctor-diagnosed arthritis.

10: Arthritis among adults aged $\geq$ 18 years who are obese.

3. Results

Figs. 1-1 to 1-4 show that arthritis in the US improved from 2019 to 2021, compared to the years 2011 to 2018. The data indicates a notable decrease in the prevalence of arthritis in adults with conditions like diabetes and obesity during the COVID-19 pandemic, compared to the period before the pandemic. Additionally, there was a substantial enhancement in the activity limitations experienced by patients diagnosed with arthritis by a doctor.

4. Discussion and conclusion

This study underscores the decline in prevalence across four domains, comparing the periods before and during the COVID-19 pandemic: the occurrence of arthritis in diabetic adults aged 18 and above, the rate of fair or poor health among adults aged 18 and above suffering from arthritis, the incidence of activity restrictions due to arthritis in adults aged 18 and above who have been diagnosed with arthritis by a doctor, and the frequency of arthritis in obese adults aged 18 and above. A literature review was conducted on the decline in access to clinical care during the COVID-19 pandemic. The literature review results can substantiate the results of the proposed visualization.

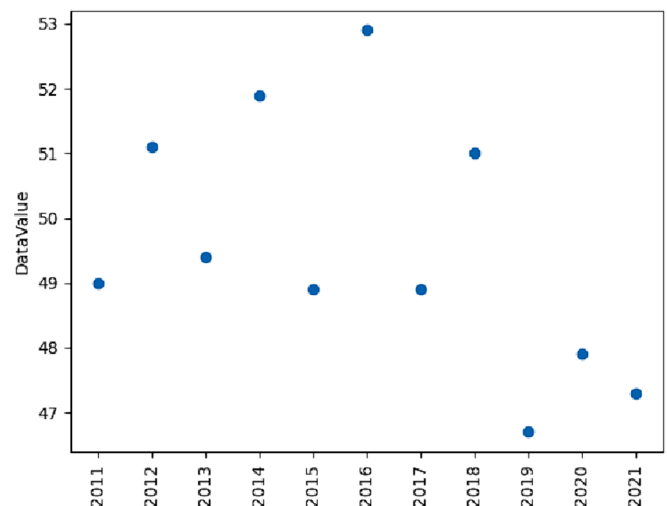Horton et al. reported that the decline in access to clinical care was

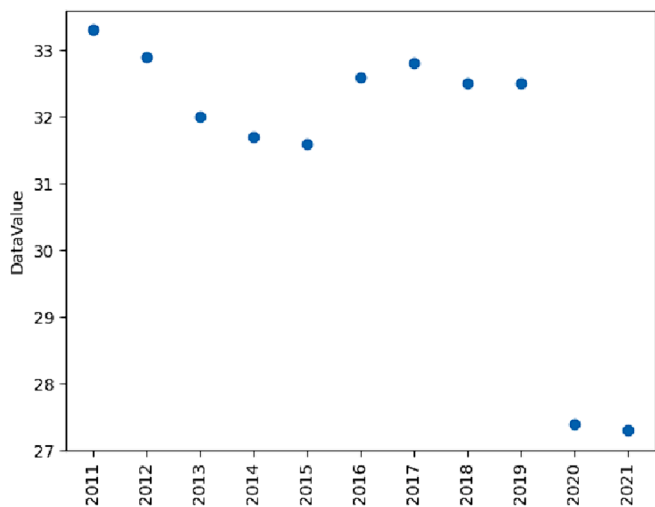**Fig. 1-1.** Arthritis among adults aged $\geq$ 18 years who have diabetes.

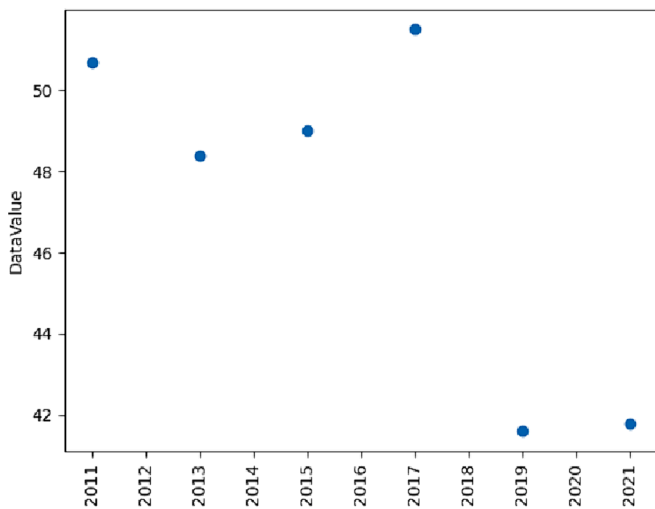**Fig. 1-2.** Fair or poor health among adults aged $>=$ 18 years with arthritis.

Fig. 1-3. Activity limitation due to arthritis among adults aged $>=$ 18 years who have doctor-diagnosed arthritis.
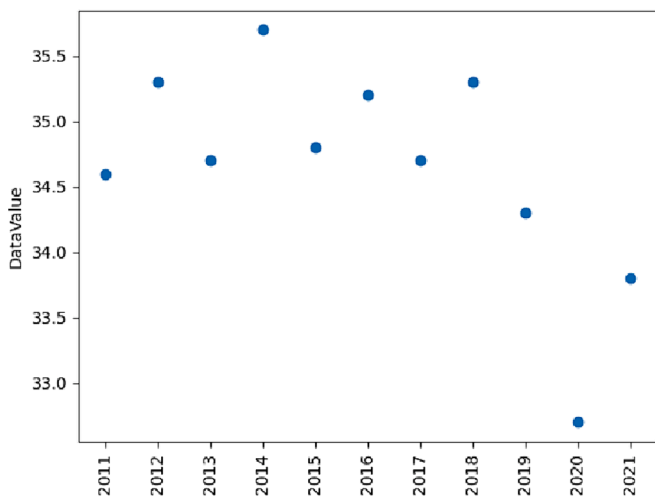

Fig. 1-4. Arthritis among adults aged $>=$ 18 years who are obese.

partially mitigated by the use of telemedicine services [3]. Both Andraska's team [6] and Magesh's team [7] emphasized the disparities in healthcare during the COVID-19 pandemic. They found that in Hispanic and Black populations, there was a positive correlation between decreased access to clinical care and increased COVID-19 positivity rates, compared to their White counterparts. It was generally observed that access to clinical care was reduced for all races during the pandemic [8,9].

A literature review was conducted on the impact of COVID-19 toward arthroplasty procedures. Piple et al. reported that the COVID-19 pandemic led to significant changes in primary elective total joint arthroplasty procedures: there was a notable increase in same-day discharges, a decrease in the average length of stay, fewer discharges to skilled nursing facilities, and a noticeable trend towards younger patients [10].

Chen et al. stated that the COVID-19 pandemic has underscored the recent shift in arthroplasty towards risk stratification and outpatient procedures, potentially leading to enhanced clinical results and substantial cost reductions [11]. Moreover, the potential of virtual technologies to rectify existing inefficiencies in educational and clinical settings is an exciting prospect for future exploration.

CRediT authorship contribution statement

Yoshiyasu Takefuji: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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