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Original research

Public Interest in Hyaluronic Acid Injections for Knee Osteoarthritis in the United States and Europe: An International Google Trends Analysis

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ABSTRACT

Background: Hyaluronic acid injections remain a common nonsurgical alternative for the treatment of knee osteoarthritis despite limited clinical evidence and varying global recommendations regarding its use. We used the Google Trends tool to provide a quantitative analysis of public interest in hyaluronic acid injections for knee osteoarthritis in the United States and Europe.

Methods: We customized Google Trends parameters to obtain search data from January 2009 to December 2019 in both the United States and Europe. Combinations of "arthritis", "osteoarthritis", "hyaluronic acid", "knee arthritis", "knee osteoarthritis", and "knee injection" were entered into the Google Trends tool, and trend analyses were performed.

Results: The models generated to describe public interest in hyaluronic acid for knee injections in both the United States and Europe showed increased Google queries as time progressed ($P < .001$). The United States growth model displayed linear growth ($r^2 = 0.90$) while the European growth model displayed exponential growth ($r^2 = 0.90$).

Conclusions: Our results indicate a significant increase in Google queries related to hyaluronic acid injections for knee osteoarthritis since 2009 in both the United States and Europe. Our models suggest that despite mixed evidence supporting its use, orthopedic surgeons should expect continued public interest in hyaluronic acid for knee osteoarthritis. The results of our study may help to prepare surgeons for patient inquiries, inform the creation of evidence-based shared decision-making tools, and direct future research.

Introduction

Knee osteoarthritis is a top contributor to global disability, with significant economic burden stemming from both direct treatment costs and indirect costs due to a loss of productivity [1,2]. The incidence of knee osteoarthritis is projected to rise in the future given obesity and aging trends in the United States and abroad [3]. There is currently no cure for osteoarthritis, so the development of safe, effective treatments for knee osteoarthritis has the potential to significantly impact disease progression for millions of people worldwide.

One alternative to surgical treatment for knee osteoarthritis that has received increased attention in recent years is viscosupplementation with intra-articular hyaluronic acid (HA). HA is a naturally occurring nonsulfated glycosaminoglycan nonprotein compound with repeating β-1,4-D-glucuronic acid and β-1,3-N-acetylglucosamine units [4]. HA has been used as part of the treatment plan for various dermatological, ophthalmological, and musculoskeletal conditions [5]. Evidence regarding the effectiveness of HA injections for knee arthritis is mixed, with varying recommendations in the United States and Europe. In the United States, the American Academy of Orthopaedic Surgery (AAOS)

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released an evidenced-based clinical practice guideline on the treatment of knee osteoarthritis in 2013 which strongly recommended against the routine use of HA for knee osteoarthritis, and this recommendation was downgraded to a moderate recommendation in the 2021 update [6]. The European National Institute for Health and Care Excellence (NICE) released a similar evidenced-based recommendation against the use of HA for treatment of knee arthritis in 2014 [7]. Despite these evidence-based guidelines, the 7 European countries that comprise the EUROpean VIScosupplementation Consensus group (EUROVISCO) have stood by their 2015 recommendation supporting its use [8]. While the AAOS and NICE Clinical Practice Guideline Process does not allow committee members with financial conflicts of interest to participate in the voting process for guideline recommendations and follows rigorous standards for guideline development, EUROVISCO allows recommendations to be developed with multiple committee members having industry conflicts directly related to HA viscosupplementation [9,10].

The increased use of HA injections for knee osteoarthritis despite varying recommendations and inconclusive clinical evidence may stem from a combination of the industry and direct-to-consumer marketing creating the public's request for HA injections, as well as the lucrative market available for physicians who provide HA treatments [6–8,11]. HA injections are not covered by many insurance providers, leading to steep out-of-pocket costs for those willing to pay [11]. Increased numbers of publications describing the effectiveness of HA for knee osteoarthritis in recent years suggest increasing popularity of HA injections for knee osteoarthritis [12]; however, public interest in using HA to mitigate knee osteoarthritis pain has not been previously quantified.

Internet search traffic data are one mechanism that can be used to quantify public interest in a novel treatment such as HA for knee osteoarthritis symptoms. Google Trends is an open-source tool that is used to track the frequency with which search terms are entered into the Google search engine. Previous research indicates that Google Trends data describing public interest in various surgical procedures have correlated with actual health-care utilization [13–18]. Furthermore, the Google Trends tool has recently been used to track public interest in 2 other nonoperative treatments for knee osteoarthritis—stem cell injections and platelet-rich plasma therapy [19,20]. Trends regarding public interest in HA for knee osteoarthritis may help to guide patient counseling, inform the creation of evidence-based decision aids, and direct future research.

The purpose of our study was to utilize the Google Trends tool to quantify public interest in information related to HA injections for knee osteoarthritis in the United States and Europe. We assessed whether public interest in HA therapy for knee osteoarthritis showed temporal, seasonal, income-related, or geographic trends.

Material and methods

The methodology was derived from the study by Cohen et al. describing public interest in platelet-rich plasma therapy for knee and hip osteoarthritis [20].

Google Trends

The Google Trends tool can provide customizable analysis regarding public interest in a given search term over a specified time period in a specified geographical location. After the search term of interest is entered into the Google Trends database and the time period and location are selected, the Google Trends tool provides visuals and outputs depicting the relative popularity of the search term over the specified time period. The data are provided as relative search volume (RSV) values, which are reported on a scale of 0-100. An RSV of 100 indicates the highest percentage of searches for the topic of interest relative to all Google queries, whereas an RSV of 0 indicates that the relative interest in the search term was less than 1% of its maximum RSV [21].

Search terms

Potential search terms were identified after a literature review of previous studies evaluating the use of HA for knee osteoarthritis [8,12,22]. Additionally, popular search engine inputs related to HA injections for knee osteoarthritis were discovered using the "related queries" feature of the Google Trends tool. Ultimately, the combination of search terms incorporated into linear, quadratic, and exponential models describing public interest in HA for knee osteoarthritis included the following keywords: "arthritis", "osteoarthritis", "hyaluronic acid", "knee arthritis", "knee osteoarthritis", and "knee injection". Of note, all combinations of search terms included "hyaluronic acid" in the query.

Temporal trends

To study temporal trends in public interest in HA for knee osteoarthritis, we entered combinations and permutations of the search terms selected into the Google Trends tool. We used the data provided by the Google Trends tool to generate a database describing public interest per search term from January 2009 to December 2019 within the United States and Europe. To identify potential geographic differences in public interest in HA for knee osteoarthritis within the United States and Europe, geographic parameters specified in the Google Trends tool were "United States of America" to describe American public interest and the 7 European countries which constitute EUROVISCO (Belgium, France, Germany, Italy, Spain, Turkey, and the United Kingdom) to represent European public interest. We created linear, quadratic, and exponential growth models describing changing public interest in HA for knee osteoarthritis over time for the search terms included in our study. We determined model strength using standard measures of accuracy—mean absolute percentage error, mean absolute deviation, and mean squared deviation. We used regression analysis to determine whether public interest in HA for knee osteoarthritis significantly increased from January 2009 to December 2019.

Seasonal trends

To evaluate seasonal variations in public interest in HA treatment for knee osteoarthritis, we grouped Google Trends values from January 2009 to December 2019 for the search terms used to generate the HA growth model ("arthritis", "osteoarthritis", "hyaluronic acid", "knee arthritis", "knee osteoarthritis", and "knee injection") by month and season (winter: December-February, spring: March-May, summer: June-August, fall: September-November) in both the United States and Europe.

Income-related trends

To describe potential income-related differences in the public interest in HA for knee osteoarthritis treatment, public interest in HA for knee osteoarthritis was recorded in the 5 highest median-income states (Maryland, New Jersey, Hawaii, Massachusetts, and Connecticut) and the 5 lowest median-income states in the United States (Mississippi, West Virginia, Arkansas, New Mexico, and Louisiana) [23]. We subsequently averaged Google Trends data from the 5 highest-income states and 5 lowest-income states and created a "high-income growth model" and "low-income growth model" for public interest in HA for knee osteoarthritis.

Geographic trends

To describe potential geographic differences in public interest in HA for knee osteoarthritis in the United States, we generated models describing public interest in HA for knee osteoarthritis in the 5 most populous cities in the United States (New York, NY; Los Angeles, CA; Chicago, IL; Houston, TX; and Phoenix, AZ), each of which is located in a different geographic region of the country. We created linear, quadratic, and exponential growth models describing changing public interest over time for each city.

Results

Temporal trends

The models generated to describe public interest in HA for knee injections in both the United States and Europe demonstrated a consistent increase in search volume from January 2009 to December 2019 ($P < .0001$) (Fig. 1) with no noticeable decline or slowdown following the publication of the AAOS and NICE recommendations against its use. For the United States growth model, the linear model had the strongest measures of accuracy, with a mean absolute percent error of 7.3% and an $r^2 = 0.90$. For the European growth model, the exponential model had the strongest measures of accuracy, with a mean absolute percent error of 17.9% and an $r^2 = 0.90$ (Fig. 1). The linear and exponential lines of best fit used to describe growth in public interest in the United States and Europe, respectively, reflect varying growth rates of public interest over the study period.

Seasonal trends

In both the United States and Europe, public interest in HA for knee osteoarthritis was greatest in the month of October and least in the month of December (Table 1). Seasonal Google Trends analyses showed similar public interest in HA for knee osteoarthritis in the spring, summer, and fall seasons, with decreased public interest in the winter season in both the United States and Europe (Table 2).

Table 1
Monthly Google Trends search volumes for hyaluronic acid and knee osteoarthritis, 2009-2019.

Month	Mean Google Trends search volumes (% relative to peak)	
	United States	Europe
January	61.7	43.1
February	62.3	44.1
March	62.9	43.3
April	66.5	45.2
May	62.9	45.3
June	65.0	43.7
July	63.7	42.4
August	62.8	43.2
September	63.4	43.4
October	66.6	48.2
November	65.1	45.1
December	58.5	40.9

Income-related trends

The growth model generated to describe public interest in HA for knee osteoarthritis in the 5 highest-income states demonstrated faster growth than the model generated to describe public interest in HA for knee osteoarthritis in the 5 lowest-income states (Fig. 2).

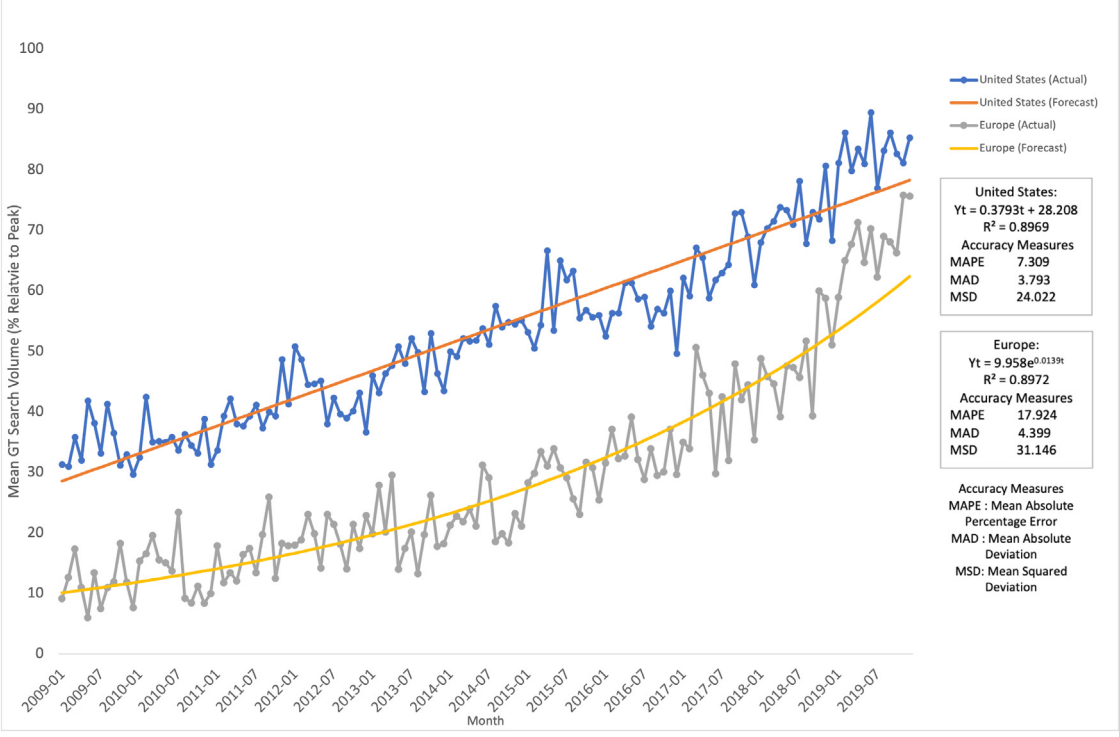

Figure 1. Growth models to describe public interest in hyaluronic acid injections for knee osteoarthritis in the United States and Europe, January 2009 to December 2019. GT, Google Trends.

Table 2
Seasonal Google Trends search volumes for hyaluronic acid and knee osteoarthritis, 2009-2019.

Season	Mean Google Trends search volumes (% relative to peak)	
	United States	Europe
Winter	60.8	42.7
Spring	64.1	44.6
Summer	63.8	43.1
Fall	65.0	45.4

Geographic trends

New York City and Los Angeles showed the most consistent growth in public interest in HA for knee osteoarthritis followed by Chicago, Phoenix, and Houston (Fig. 3).

Discussion

Our results reveal that in both the United States and Europe, there has been a significant increase in Google searches related to HA for knee osteoarthritis from 2009 to 2019. Our models predict continued growth in public interest in HA for knee osteoarthritis in both the United States and Europe despite conflicting clinical recommendation guidelines in both locations. In Europe, where the use of HA for knee osteoarthritis was recommended by EUROVISCO in 2015, there was exponential growth in public interest in HA injections for knee osteoarthritis in the years included in our study [8]. In the United States, despite recommendations from the AAOS against the use of HA for knee osteoarthritis in 2013, a linear increase in public interest in HA for knee arthritis was still observed throughout the study period [24]. While quantifying the incidence of HA use for knee osteoarthritis in the United States is difficult due to dynamic clinical recommendation guidelines, varying insurance coverage, and a lack of centralized data collection, the results of our study align with previously published literature that demonstrates increased insurance claims for HA use for knee osteoarthritis over the years that were included in our study. This suggests that the Google Trends tool may serve as an effective barometer to gauge public interest in HA for knee osteoarthritis in the future [25].

We identified seasonal, income, and geographic variations in public interest in HA for knee osteoarthritis. In both the United States and Europe, public interest was greatest in the fall season and least in winter season. Additionally, in the United States, public interest in HA for knee arthritis was greater in the 5 highest-income states than in the 5 lowest-income states. Income-related trends in public interest align with the results of a recent study that examined public interest in platelet-rich plasma therapy for knee osteoarthritis, another nonsurgical alternative for knee osteoarthritis patients seeking pain relief [20]. Income-related trends may be related to the inconsistency with which HA injections are covered by insurance companies. While Medicare often covers HA injections for knee osteoarthritis, 17 major insurance carriers that cover more than 64 million Americans (approximately 30% of all privately insured Americans) will not cover the cost of HA for knee osteoarthritis [11]. For patients whose insurance will not cover the cost of treatment, a sequence of 3 injections of HA for knee osteoarthritis may cost more than $2000, compared to an average of $320 for those with insurance that can be applied to the treatment [11]. Furthermore, in many clinics, surgeons are not the only providers administering HA injections. Nonoperative medical personnel who are incentivized to fill their clinic with procedures could be more likely to suggest a series of HA injections vs a single steroid injection, for example, when counseling patients in order to increase revenue. The extraordinary costs associated with HA treatment of osteoarthritis may partially explain the increased public interest in the 5 highest-income states when compared with the 5 lowest-income states. However, it is important to note that other factors including health education and social determinants of health likely also influenced the trends observed in this study.

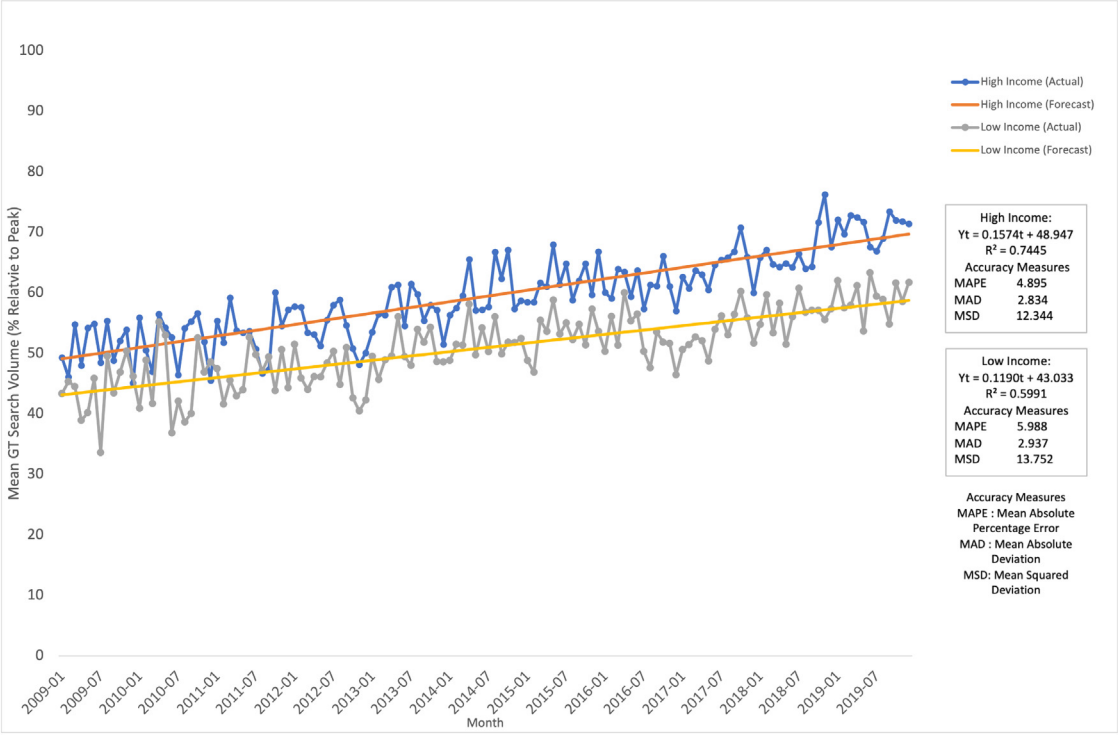

Figure 2. Linear trend model for public interest in hyaluronic acid for knee osteoarthritis in the highest- and lowest-income states in the United States. GT, Google Trends.

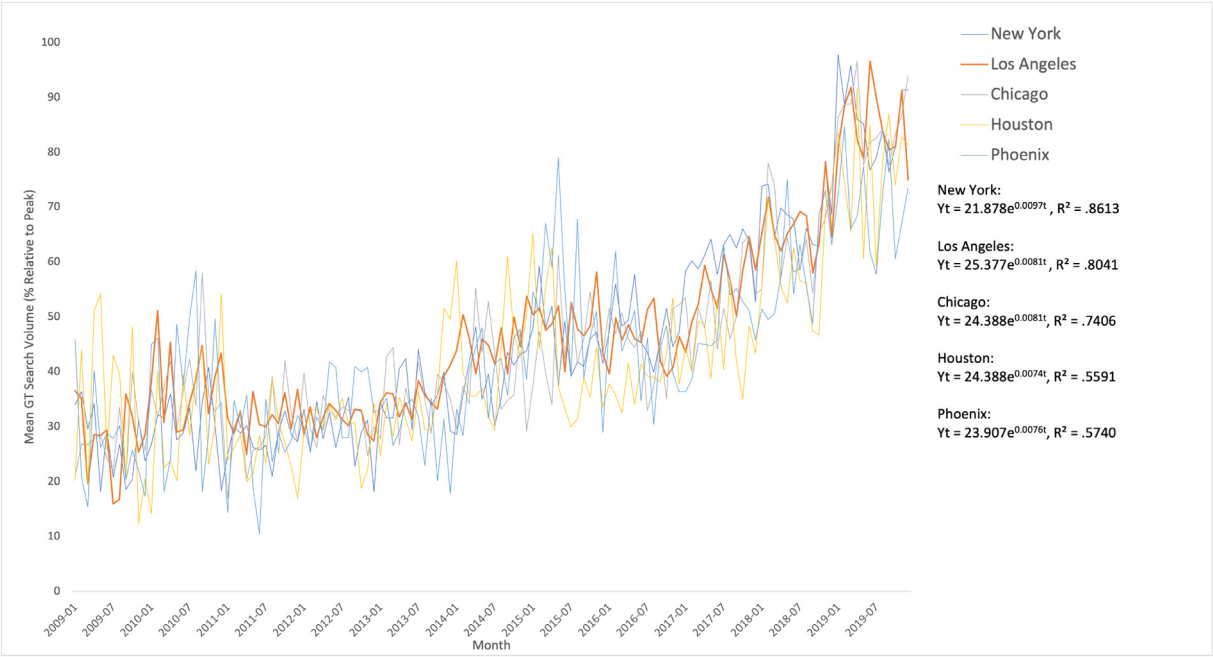

Figure 3. Exponential trend model describing public interest in hyaluronic acid for knee osteoarthritis in the 5 most populous cities in the United States. GT, Google Trends.

Recently, the AAOS released updated guidance regarding the use of HA for knee osteoarthritis for the first time since 2013. In 2013, the AAOS gave a strong recommendation against using HA for symptomatic osteoarthritis of the knee, a shift from 2008 when the AAOS was "unable to make a recommendation for or against the use of intra-articular HA for patients with mild to moderate symptomatic knee osteoarthritis. [26]. In August 2021, the AAOS declared that "hyaluronic acid intra-articular injection is not recommended for routine use in the treatment of symptomatic osteoarthritis of the knee. [6]. Ideally, guidelines recommending against the use of HA treatment for knee osteoarthritis would reduce the frequency with which patients receive such injections. However, Bedard et al. revealed that despite temporary changes in the frequency of HA injections for knee osteoarthritis after revised guidelines were released by the AAOS in 2013, the practice remains in common use, which aligns with the increased public interest observed in our study in the years following the 2013 AAOS announcement [25]. Bedard et al. concluded that "further interventions beyond publishing clinical practice guidelines are needed to change practice patterns" [25].

One reason why simply providing new clinical guidelines may not be effective in changing practice patterns is because requests for HA injections may come from patients themselves, often after hearing about the benefits of the therapy from media sources (not AAOS guidelines) that rarely discuss the lack of evidence supporting its use. This "implicit hype" associated with media coverage of unproven medical therapies has been observed for another nonsurgical alternative for knee osteoarthritis, platelet-rich plasma [27]. It is likely that the same phenomenon is affecting how patients consume information about the efficacy of HA injections for knee osteoarthritis, as the information patients encounter online regrading osteoarthritis is often not credible and difficult to understand for the average reader [28].

Our findings that patients are increasingly curious about HA for knee osteoarthritis (as evidenced by temporal trends in Google searches) in conjunction with the fact that the information patients encounter online is often subject to "implicit hype" regarding its effectiveness means that orthopedic surgeons must be prepared to properly counsel patients regarding the efficacy of HA injections. Proper counseling may come in the form of the creation of decision aids that discuss the risks and benefits of HA injections for knee osteoarthritis and outline which subset of patients may benefit from its use. Orthopedic surgeons who anticipate public inquiries regarding popular treatment options with debatable clinical benefits such as HA can also prepare patient education materials that convey the evidence-based recommendations that are often missing from online searches. For example, patients may not know that 63% of studies on the therapeutic effects of HA injections for treatment of knee osteoarthritis were industry-funded and that none of the studies with at least 1 company employee as an author reported negative conclusions about the efficacy of HA for knee osteoarthritis [10]. Discussing with patients the potential conflicts of interest that often introduce bias into the information they are finding online may help to influence their opinions on the subject.

Our findings demonstrating increased public interest in HA for knee osteoarthritis over the last 10 years—despite limited, placebo-controlled studies demonstrating its efficacy—illustrate the need for further research on the topic. The AAOS provided its updated recommendations regarding the use of HA intra-articular injections for symptomatic osteoarthritis of the knee after reviewing 28 studies comparing the effectiveness of HA injections to controls [6]. However, while some studies demonstrated a statistically significant benefit with the use of HA, these studies could not reach the significance for a minimally clinical meaningful difference. Furthermore, there are concerns about conflicts of interest with the sponsors and authors of some of the studies that were in favor of viscosupplementation. While developing clinical practice guidelines, the AAOS ensures that experts who may have relevant conflicts of interest (viscosupplementation) may not actively participate in the guideline recommendation voting process, while the EUROVISCO 2015 guideline did not have the same restrictions. Future research regarding the effectiveness of HA for knee osteoarthritis should include subgroup analyses and osteoarthritis severity stratification, elements often missing from prior studies [6].

There are several limitations to our study. First, while Google Trends data can evaluate online interest in HA for knee osteoarthritis, we cannot directly connect increased public interest observed online to increased volumes of HA injections to treat knee osteoarthritis symptoms. However, trends in public interest observed in this study do align with the limited information available on the frequency of HA injections in the United States throughout the study period [25]. Second, although Google accounts for more than 90% of internet search traffic, the Google Trends tool cannot evaluate public interest in HA for knee osteoarthritis on other search engines [29]. Additionally, there is limited demographic information provided by Google about the users whose searches are reflected in our study results. However, prior research from both the United States and Europe indicates that the internet is a frequent health information source for older patients in the age range of the typical osteoarthritis patient, so it is likely the demographics of those seeking information related to osteoarthritis on Google are representative of the patient population as a whole [30–32].

Conclusions

Our findings demonstrate increased online public interest in HA injections for knee osteoarthritis from 2009 to 2019 in both the United States and Europe despite mixed clinical evidence regarding its efficacy and inconsistent recommendations regarding its use from governing bodies in both locations. Our models suggest that public interest in HA for knee osteoarthritis is expected to continue to increase in upcoming years. Inconsistencies in recommendations regarding its effectiveness illustrate the potential benefit of more high-level placebo-controlled studies evaluating its effectiveness in order to prepare orthopedic surgeons to counsel an increasingly curious public. Additionally, measures must be implemented to encourage the adoption of responsible and evidence-based marketing such that direct-to-consumer marketing and science align to improve the quality and value of effective treatments in health care, thereby reducing the utilization of expensive and ineffective treatments. Further discussions and awareness of financial conflicts of interest and how these impact recommendations would be valuable for both the general public and medical professionals.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2022.09.003.

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