Original Article

Public Online Interest in Injuries Sustained by National Football League Quarterbacks

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Purpose: To use Google search data to determine the public's interest in learning about athletic injuries sustained by NFL quarterbacks and to investigate how long this interest persists after the injuries. **Methods:** We identified starting NFL quarterbacks during the 2019−2020 season online and used the official NFL injury report to determine whether an injury had occurred to a quarterback. We used the Google Trends tool to analyze search trends around a quarterback's injuries from July 22, 2019, to October 22, 2019. Google trends data was extracted as relative search volume over time. We then compared the results to the expected search forecast derived from an autoregressive integrated moving algorithm (ARIMA) model. **Results:** All 6 injured quarterbacks were associated with increases (64% to 100%) in relative search volumes for terms related to their injury. Furthermore, the data showed a consistent increase in search engine activity around the injuries associated with NFL quarterbacks in the first 3 days, marking a particularly influential time frame for public engagement. **Conclusion:** Our data show an increase in Google traffic surrounding the injuries of prominent NFL quarterbacks within the first 3 days following their injuries. **Clinical Relevance:** Social media can provide a platform for patient education through increasing patient awareness and knowledge regarding athletic injuries.

American football (hereafter simply "football") has been one of the most popular team sports in the United States since the early 1900s, with the National Football League's "Super Bowl" being one of the most watched events in American television.[1] In addition, football is also one of the most played sports in America, with >5 million participants age >6 years playing tackle football in 2018.[2] Despite football's sustained popularity, concerns of injuries occurring during the playing of football, including neurologic and musculoskeletal injuries, have led to recent publications in which the authors encourage orthopaedic surgeons to ask whether "supporting American football at all is consistent with our best professional norms."[3] Because of this

concern among the academic community, numerous studies have been conducted regarding the understanding, prevention, and rehabilitation of concussions and head injuries in football.[4-7] Similarly, numerous studies regarding the prevention and rehabilitation of musculoskeletal injuries in football have also been undertaken.[8-10] Interest in injuries sustained during the play of football is not concerning only to the academic community; indeed, football and the dangers that the game presents have become a prevalent concern among players, parents, and spectators alike.

Because of this concern, participation in youth and high school football has dropped dramatically. Since 2006, participation in tackle football has dropped from 8.4 million participants age of >6 to 5.2 million in 2018.[2] This decrease in participation demonstrates that the public at large is 1) aware of the injuries sustained in football and 2) willing to use the information gained regarding football's risks and alter their perception of football. Because of the scrutiny the game of football is facing, and because the public is willing and able to obtain information regarding football injuries, it is essential that the information that they gain is evidence based and of sound quality.

The purpose of this study is to use Google search data to determine the public's interest in learning about athletic injuries sustained by NFL quarterbacks and to

investigate how long this interest persists after the injuries. Our hypothesis is that the general public is interested in injuries sustained by NFL quarterbacks and that the interest is sustained for a considerable time following the injury.

Methods

Google Trends

Google Trends (https://trends.google.com/trends/) is a tool readily accessible by the public used to analyze search engine trends. Google Trends data are displayed relative to the highest search volume for the given time period. For example, when analyzing 1 month of data and the highest raw search volume for a specific query occurs on the 15th of that month, then every other day for the given month will be displayed as a percentage of the maximum value found on the 15th. Google Trends excludes duplicate searches made from the same user within a short period of time to improve the data validity. Google Trends also excludes all special characters from search strings to remove confusion and increase accuracy of results when searching for specific trends. Additionally, some terms can be searched as a topic. A topic includes searches that are different words, but have the same meaning. For example, when searching for "gamekeeper's thumb," searches for "skier's thumb" would also be included.

To determine public awareness for specific orthopaedic injuries, procedures, and recovery after injuries to NFL quarterbacks, the authors first identified all the starting quarterbacks in the NFL using depth charts published on ESPN.com. Only quarterbacks who were scheduled to be the starting quarterback for their respective team during the 2019–2020 NFL season, or would have been the starter if they were healthy during week 1, were included. Thus, back-up or second-string quarterbacks were not included in our study. Throughout the NFL season, the authors used the official NFL injury report to determine when an injury had occurred to an included quarterback. For an injury to be included, the quarterback had to miss ≥ 1 full game. The authors then extracted data from Google Trends on November 1, 2019 (roughly halfway through the season). Specific inquiries (listed below) from July 22, 2019, to October 22, 2019, related to each quarterback injury that occurred up to that point in the season were searched. The authors followed the same procedure to include the remaining injuries that occurred in the second half of the season. Patrick Mahomes's injury was the only one that met criteria during the second half of the season. For Mahomes's injury, the authors extracted Google Trends data on December 28, 2019, from September 1, 2019, to December 1, 2019. As the NFL is predominantly played in the United States, each search was conducted looking for trends within the United States only.

Drew Brees

Drew Brees of the New Orleans Saints tore the ulnar collateral ligament of his thumb on September 15, 2019, during week 2 of the NFL season. We chose to evaluate the search terms "what happened to drew brees," "drew brees recovery," "ulnar collateral ligament reconstruction," and "gamekeeper's thumb."

Patrick Mahomes

Patrick Mahomes of the Kansas City Chiefs suffered a dislocated patella on October 17, 2019, during week 7 of the NFL season. We chose to evaluate the search terms "what happened to Patrick Mahomes," "dislocated knee," "knee injury," "patella dislocation," and "knee injury recovery."

Nick Foles

Nick Foles of the Jacksonville Jaguars broke his clavicle on September 8, 2019, during week 1 of the NFL season. We chose to evaluate the search terms: "what happened to Nick Foles," "broken collarbone," and "clavicle fracture."

Cam Newton

Cam Newton of the Carolina Panthers disclosed he was suffering from a Lisfranc injury on September 24, 2019. We chose to evaluate the search terms: "what happened to Cam Newton," "lisfranc injury," and "lisfranc injury recovery."

Ben Roethlisberger

Ben Roethlisberger of the Pittsburgh Steelers sustained an undisclosed elbow injury, which resulted in surgery, on September 15, 2019, during week 2 of the NFL season. We chose to evaluate the search terms: "what happened to ben roethlisberger," "elbow injury," and "elbow surgery."

Sam Darnold

Sam Darnold of the New York Jets was diagnosed with mononucleosis on September 12, 2019. We chose to evaluate the search terms: "what happened to Sam Darnold," "infectious mononucleosis," "mono," and "mono recovery"

Statistical Analysis

To determine the greater-than-expected percentage, the time period before each injury was used to forecast an expected relative search volume for after the injury occurred. Then, the observed relative search volume was compared with the expected search volume. To do this, an autoregressive integrated moving algorithm (ARIMA) model was used to forecast the expected search volume. R Studio (R Foundation, Vienna,

Table 1. Orthopedic search interest after NFL quarterback injuries

Quarterback	Search Term	Greater than Expected Search Volume (%)	95% Confidence Interval
Patrick Mahomes	Knee injury	87.2	82 to 92
	Knee injury recovery	82.1	57 to 100
	Dislocated knee	98.5	97 to 100
	What happened to Patrick Mahomes	99.6	97 to 100
	Patella dislocation	99.1	98 to 100
Drew Brees	What happened to Drew Brees	99.9	99 to 100*
	UCL reconstruction[†]	81.4	66 to 97
	Drew Brees recovery	100	88 to 100
	Gamekeepers thumb[†]	86.7	69 to 100
Nick Foles	What happened to Nick Foles	98.4	92 to 100
	Broken collarbone	86.9	79 to 95
	Clavicle fracture[†]	91.6	88 to 95
Cam Newton	What happened to Cam Newton[‡]		
	Lisfranc injury[†]	94.7	89 to 100*
	Lisfranc injury recovery	71	50 to 92*
Ben Roethlisberger	What happened to Ben Roethlisberger	100	99 to 100*
	Elbow surgery	63.9	42 to 85
	Elbow injury	79.3	66 to 92
Sam Darnold	What happened to Sam Darnold[‡]		
	Infectious mononucleosis[†]	83.9	81 to 87*
	Mono	74.3	71 to 78*
	Mono recovery	95.4	80 to 100*

The greater than percentages were based on a relative search volume taken from Google Trends (0 to 100 scale); therefore the maximum greater than expected percentage is 100.

*Greater than expected percentage for the day of the injury.

[†]Searches that were conducted as topics (including diseases and injuries)

[‡]A peak in search interest occurred 2 days before Cam Newton disclosed his lisfranc injury and 3 days before Sam Darnold's Mono diagnosis was released, as media outlets projected a disclosure was coming soon.

Austria) was used for the ARIMA model and Stata 15.1 (STATA Corp., College Station, TX) for all other analyses.

Results

Six NFL starting quarterbacks were included in this study: Patrick Mahomes, Drew Brees, Cam Newton, Ben Roethlisberger, Sam Darnold, and Nick Foles. All 6 quarterbacks were associated with significant increases in relative search volumes for terms related to their injury (Table 1; Fig 1A to 1F). Search terms related to Ben Roethlisberger's injury ("what happened to Ben Roethlisberger") and Drew Brees's injury ("Drew Brees recovery) were associated with the highest increase, at 100% above the expected volume. A search term related to Ben Roethlisberger's injury ("elbow surgery") was associated with the lowest increase, at 64% above the expected volume (Table 1).

Patrick Mahomes

Searches related to Patrick Mahomes's injury all increased >80% above the expected volume the day after the injury. The range for these associated search terms was increases of 82.1% to 99.6% (Table 1). Because of the relative nature of Google Trends, searches related to Patrick Mahomes's injury were elevated to such an extent at the time of the injury that,

in comparison, searches in the following week were negligible (Fig 1E).

Drew Brees

Searches related to Drew Brees's injury all increased >80% above the expected volume the day after the injury. The range for these associated search terms was increases of 81.4% to 99.9% (Table 1). Searches related to Drew Brees's injury ("Drew Brees recovery" and "gamekeeper's thumb") remained increased by a range of 22% to 44% over the following week (Fig 1C).

Nick Foles

Searches related to Nick Foles's injury all increased >85% above the expected volume the day after the injury. The range for these associated search terms was increases of 86.9% to 98.4% (Table 1). Nick Foles's injury also displayed greater than expected searches ("clavicle fracture" and "broken collarbone") continuing into the following week by a range of 22% to 23% (Fig 1D).

Cam Newton

Searches related to Cam Newton's injury all increased >70% above the expected volume the day after the injury. The range for these associated search terms was increases of 71.0% to 94.7% (Table 1).
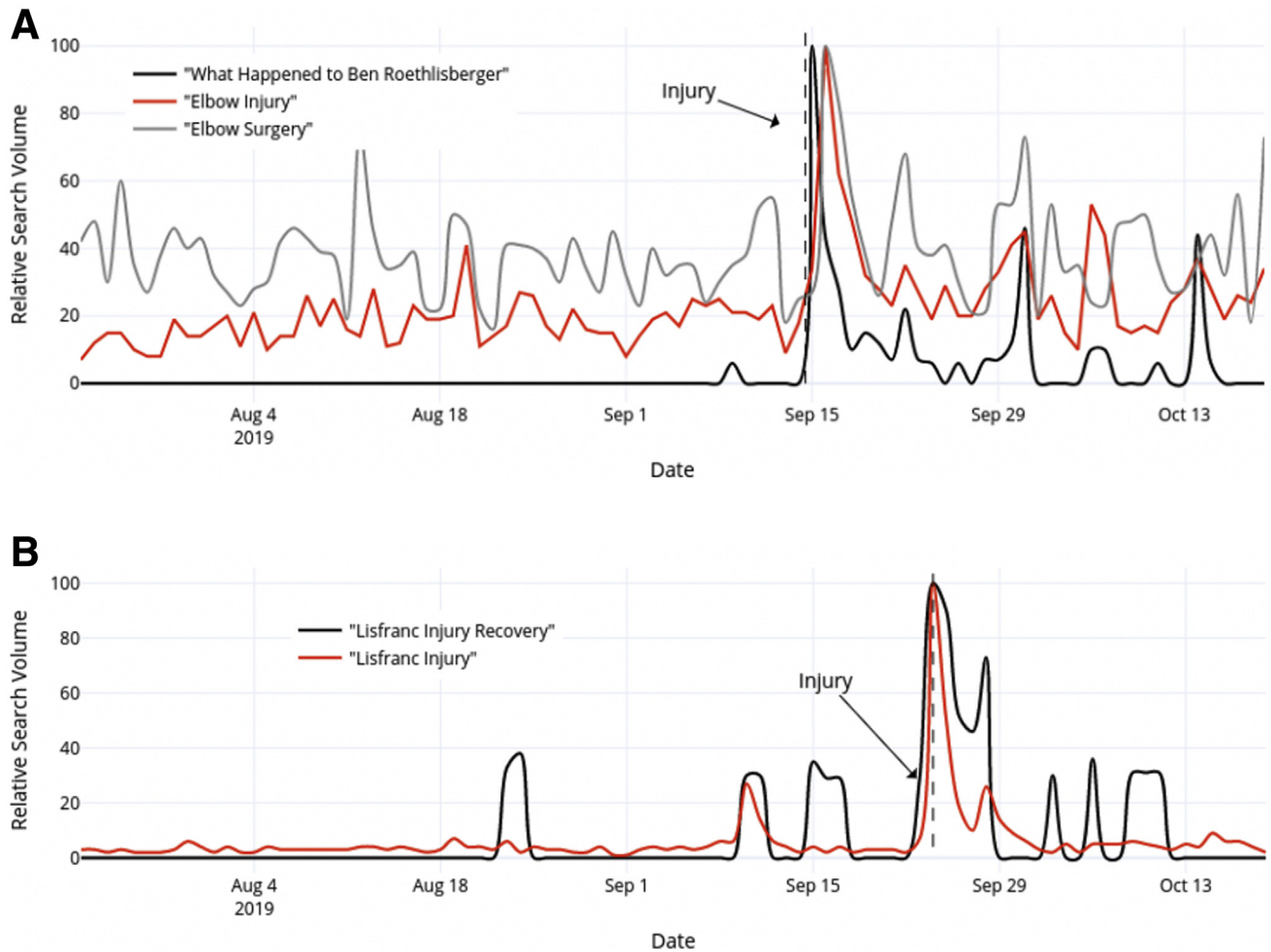
Fig 1. Public awareness for NFL Quarterback injuries. (A) Ben Roethlisberger. (B) Cam Newton. (C) Drew Brees. (D) Nick Foles. (E) Patrick Mahomes. (F) Sam Darnold.

"Lisfranc injury recovery" and "lisfranc injury" displayed a mean greater than expected by 43% (95% confidence interval [CI] 14 to 72) and 32% (95% CI −3.4 to 68), respectively. Searches for "lisfranc injury recovery" and "lisfranc injury" were associated with continued elevations in search interest during the week after Cam Newton's injury announcement (Fig 1B).

Ben Roethlisberger

Searches related to Ben Roethlisberger's injury all increased >60% above the expected volume the day after the injury. The range for these associated search terms was increases of 63.9% to 100% (Table 1). All 3 terms related to Ben Roethlisberger's injury were associated with continued increases in greater than expected search interest. "What happened to Ben Roethlisberger," "elbow injury," and "elbow surgery"

increased by a range of 19.6% to 26.2% above the expected search volumes the following week (Fig 1A).

Sam Darnold

Searches related to Sam Darnold's injury all increased >70% above the expected volume the day after the injury. The range for these associated search terms was increases of 74.3% to 95.4% (Table 1). Additionally, "mono" and "infectious mononucleosis" were also associated with a mean greater than expected increase over the following week. "Mono" displayed a 27% increase (95% CI 4 to 50) and "infectious mononucleosis a 33% increase (95% CI 7 to 60) (Fig 1F).

Cam Newton and Sam Darnold were not injured during a game, but their injury and illness resulted in the highest number of searches on the day of the announcement instead of the day after (Fig 1B and 1F).
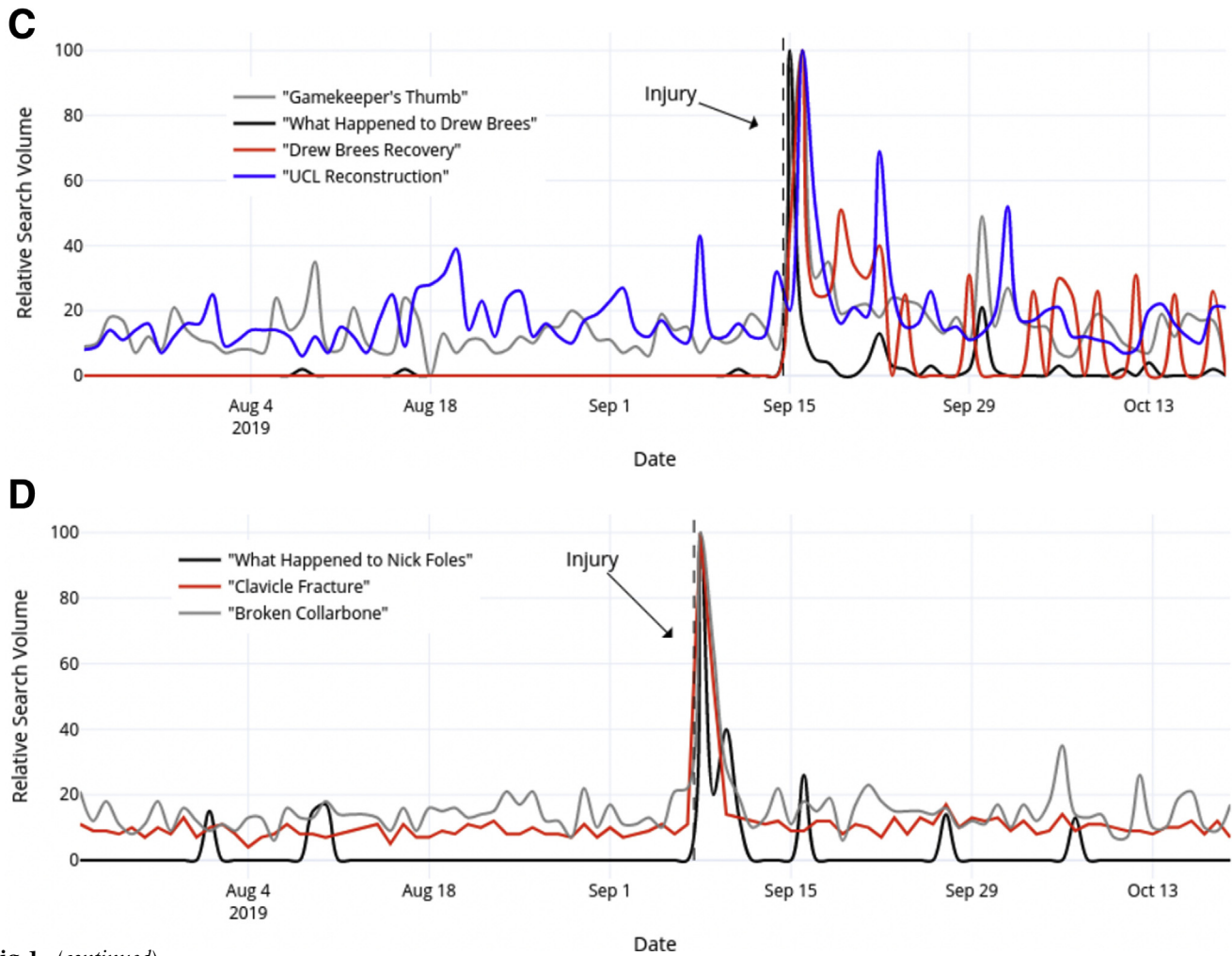
Fig 1. (continued).

Discussion

Our data demonstrate an increase in Google traffic surrounding the injuries of prominent NFL quarterbacks during the NFL season. Furthermore, these data show a consistent increase in search engine activity around the injuries associated with NFL quarterbacks, marking a particularly influential time frame for public engagement.

The utility of Google Trends and social media analyses can be demonstrated by previous publications on this subject in other fields. In an evaluation of skin cancer prevention and selfies, Noar et al.[11] concluded that social media posts (even those from nonclinicians) led to a significant increase in public engagement on the topic. Furthermore, Torgerson et al.[12] found that public knowledge of the national sexual assault hotline increased after the airing of the number in an episode of the television show "Grey's Anatomy." This study has been praised by numerous high-profile news and media outlets for its societal impact. Knowledge of these studies should be intriguing to orthopaedic surgeons, and with the results in mind, orthopaedic surgeons should welcome the use of social media to engage and potentially elevate public education and awareness of orthopaedic conditions.

Based on our data, the conclusion can be made that orthopaedic patients, NFL fans, and the public at large are interested in injuries to NFL quarterbacks (Table 1; Fig 1). The authors believe this information to be beneficial for the orthopaedic community with respect to patient relationships, marketing, and patient education regarding athletic injuries. However, our data are also important for the game of football and the NFL. Concerning injury awareness, patient education and knowledge are essential for the progression of football at all levels, including the NFL, owing to the demonstrated concern and criticism[3] placed on the game lately because of the risk for athletic injuries.
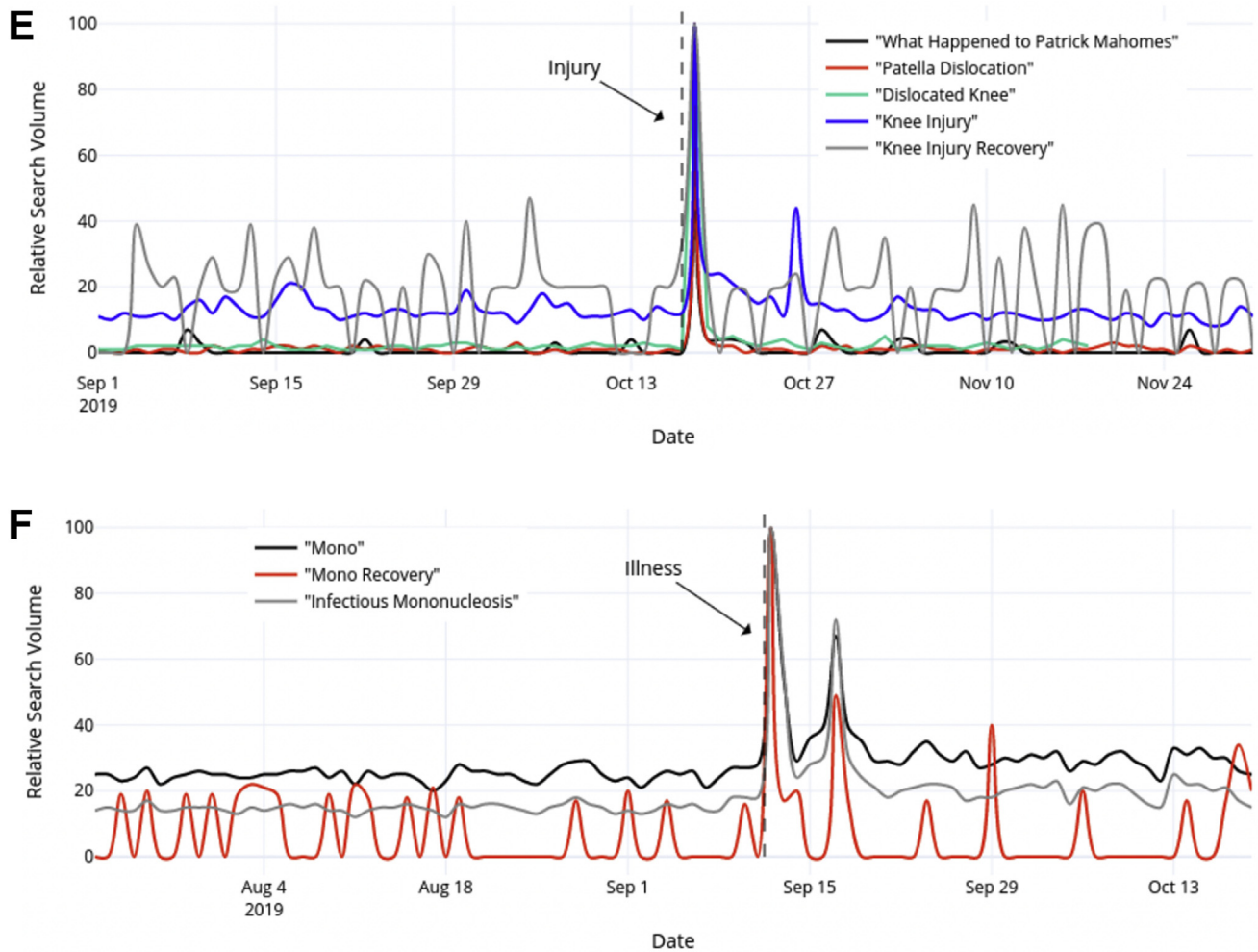
Fig 1. (*continued*).

For individual physicians, this knowledge should help build an educational platform mitigating the outcomes of injury through earlier diagnosis, injury recovery data, and return-to-play data. Doing so would not only increase individual patient awareness of athletic injuries (resulting in better informed decision making of whether football is a game they want to play), but would also increase public engagement with orthopaedic surgeons. In addition, and perhaps most importantly, readily available information regarding athletic injuries and recovery can help set appropriate expectations and possibly give hope to a young athlete suffering from a similar injury and recovery cycle.

In this light, the authors believe the information presented could help local orthopaedic surgeons and sports medicine specialists through marketing, advertisement, and streamlining care. Our data show a minimum of a 64% increase in search traffic from an NFL quarterback injury, with a maximum of 99.1% increase (100% maximum). If these physicians (through their advertising marketing partment) use social media to comment or discuss current sports medicine injuries involving NFL quarterbacks (or other athletes), it will likely increase their own social medial traffic and exposure. Furthermore, increasing their exposure during times of peak interest may then improve their overall reach for injury prevention and rehabilitation in their community. Additionally, these sports medicine specialists could use targeted local internet advertising and marketing search terms. When patients use specific search terms regarding professional athletic injuries, those terms could be redirected to informational or professional websites created by the sports medicine specialist. Here, they could present their professional opinions and outcomes regarding athletic injury and recovery. However, based on our data, the ideal time for physicians to use nationally

televised sports medicine injuries as a means of raising patient awareness and education is within 3 days of the injury. Because of the relatively quick spike in public interest, we recommend local orthopaedic surgeons initially turn to social media sites so that their opinions and thoughts regarding the injury can be quickly released and reach the greatest audience. Thus, knowledge of the data we present should allow the local orthopaedic surgeons and sports medicine specialists who take the time to engage with patients through these means to have an obvious advantage in regard to patient referrals in an increasingly competitive market.

Our data should also be of interest to societies such as the American Academy of Orthopaedic Surgeons, the Arthroscopic Association of North America, and the American Orthopaedic Society of Sports Medicine (among others), because Google Trends data regarding NFL quarterback injury data and sports medicine is only a small portion of the social influence these injuries have. In addition to patients and fans, gamblers and book makers, sports agents, teams, therapists, physicians, and many others have a vested interest in the injuries these athletes sustain and the associated recovery time. Thus, ensuring the information disseminated regarding these injuries is accurate and evidenced based is of the utmost importance to a very large audience. The vast audience relying on this information provides an immense opportunity for socially engaged orthopaedic surgery and sports medicine societies to increase the reach, societal influence, and public perception of sports medicine at large.

Furthermore, orthopaedic and sports medicine journals can use our data for the use of well-timed editorials and educational productions regarding athletic or other injuries. In light of our data, journals should be proactive in monitoring professional sporting events (or other high-profile injuries) and inviting commentary/perspectives for the injuries occurred, as well as having editorials ready for common orthopaedic injuries for release when the public interest is high. Doing so would likely result in a multitude of positive outcomes for the journal. The increased traffic from high public demand and interest would undoubtedly increase traffic to the journal, but the proposed editorials and educational materials would also likely be posted on social media by socially engaged physicians after high-profile injuries. Both of these occurrences would increase the impact and societal reach of the journals electing to produce timely and high-quality educational materials. Additionally, and more importantly, the quality of disseminated information regarding orthopaedic and athletic injuries would greatly increase, in our opinion, from journals undertaking these recommendations.

Limitations

Our study is not without limitations. Only the information available through Google, which does not include the multitude of social media platforms also discussing the injuries, were evaluated. This means the potential reach and educational impact of these injuries is far greater than the data included in our study. Furthermore, because our study evaluates only Google searches, we cannot quantify the degree of interest of those searching on the topic (those looking for education versus those just trying to see what happened). Furthermore, the injuries analyzed here only capture NFL quarterback injuries, which inherently may result in more interest and attention than players in other positions or other sports. Thus, our results may be biased towards greater interest than other athletic injuries.

Conclusions

Our data show an increase in Google traffic surrounding the injuries of prominent NFL quarterbacks within the first 3 days after their injuries.

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