

# Trends in Ulnar Collateral Ligament Injuries and Surgery From 2010 to 2019

## An Analysis of a National Medical Claims Database

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**Background:** Ulnar collateral ligament (UCL) injuries have been on the rise for the past 3 decades. Current epidemiological studies on the incidence of UCL injuries have been limited to state or regional data.

**Purpose:** To utilize a large national claims database to determine the rates of UCL injuries and UCL surgical procedures over the past decade (2010-2019) and whether there has been a change in UCL surgical procedure patterns in the United States.

**Study Design:** Descriptive epidemiology study.

**Methods:** The PearlDiver patient claims database was used to identify UCL injuries occurring from 2010 and 2019 that were sustained by male patients between 10 and 34 years of age. The study cohort was divided into 5 age groups (10-14, 15-19, 20-24, 25-29, and 30-34 years). Primary outcomes included the number of patients in each age group who sustained a UCL injury, the number of patients in each age group who underwent surgery, and the mean time from injury to surgery.

**Results:** A total of 19,348 UCL injuries occurred between 2010 and 2019, and 13% required a surgical intervention. Most of the injuries (54%) occurred in the 15- to 19-year group. Patients in the 20- to 24-year group were more likely to undergo surgery versus the 15- to 19-year group. Results demonstrated a trend toward delayed surgical interventions in patients in the 20- to 24-year group in the latter part of the decade.

**Conclusion:** Data suggested that male patients <20 years account for the majority of UCL injuries, while male patients aged between 20 and 24 years are most likely to undergo surgery. Despite a number of targeted injury-prevention strategies and rule changes in sports, the UCL injury rate remained high. Therefore, there is a clear and present need to continue to develop UCL injury-prevention strategies for the younger population.

**Keywords:** UCL; ulnar collateral ligament; PearlDiver; trends; epidemiology

The ulnar collateral ligament (UCL), an important stabilizer for the medial elbow,<sup>3</sup> is prone to injuries as a result of forces commonly encountered during overhead athletics such as baseball pitching or throwing and upper extremity weightbearing activities such as gymnastics and wrestling.<sup>13,23,30</sup> UCL injuries are associated with significant pain and reduced elbow function. Depending on the severity of the UCL injuries, they can be treated nonoperatively with rest and physical therapy or through surgical interventions to repair or reconstruct the ligament.<sup>9</sup>

Over the past 3 decades, there has been an alarming trend in the increased incidence of UCL injuries, resulting in surgical interventions for young, active overhead male athletes.<sup>6-8</sup> This led to a large body of research that has attempted to elucidate a cause for this spike in injury rates. Currently, no study has identified a singular cause for the rising incidence of UCL injuries; rather, it is believed to be a multifactorial problem including overuse, early sports specialization, and poor biomechanical techniques.<sup>1,11,12,21,22,27,29</sup> In 2016, Mahure et al<sup>19</sup> published an analysis of patients undergoing UCL reconstruction in New York state, which revealed a 343% increase in UCL reconstruction between 2003 and 2014, with nearly 88.5% of all UCL reconstruction procedures occurring in

adolescents and young adults aged between 15 and 24 years. Prediction models based on the work of Mahure et al<sup>19</sup> indicated the potential for a continued increase in UCL reconstruction rates for patients aged between 15 and 24 years while suggesting a leveling off or decrease in UCL reconstruction rates for other age groups through the year 2025.

The use of large medical databases has allowed for population-level investigations of UCL injuries and treatment trends. Studies have demonstrated an increased rate of UCL reconstruction and repair among collegiate<sup>26</sup> and professional baseball pitchers<sup>5</sup> as well as in the general population.<sup>4,8,16</sup> Recent studies have shown that the utilization of UCL repair recently surpassed that of UCL reconstruction.<sup>31</sup> More recently, some surgeons have been advocating for the use of bracing and/or biological injections (ie, platelet-rich plasma injections) to treat some UCL injuries.<sup>6,20</sup> Therefore, being aware of both injury rates and operative trends is important to better understand the current state of care for UCL injuries in overhead male athletes. Additionally, access to sports performance centers and injury-prevention programs, either through private facilities or in collaboration with health care networks, has become more available to the general population over the past decade. Access to these programs and facilities may have improved the injury rates beyond what was published using regional trends.

The purpose of this study was to utilize a large national claims database to determine if rates of UCL injuries and UCL surgical procedures have continued to increase as projected and if there has been any change in UCL surgical procedure patterns in the United States. It was hypothesized that there would be an increased rate of UCL reconstruction but a leveling off in the rate of UCL injuries.

## METHODS

This study was performed as a retrospective data analysis using the PearlDiver Mariner patient claims database (PearlDiver Technologies). PearlDiver is a proprietary, web-based research platform accessing adjudicated medical claims data from a national repository of commercial, Medicare, Medicaid, government, and cash payer types. At the time of this study, there were 151 million Health Insurance Portability and Accountability Act (HIPAA)—compliant records within the PearlDiver database spanning from June 2010 through June 2019. Patients were

identified within the database using Current Procedural Terminology (CPT) and International Classification of Diseases—Ninth and Tenth Revisions (ICD-9 and ICD-10, respectively) codes. To ensure that data complied with HIPAA requirements, all data were provided in an aggregated form so that no singular patient record could be identified or accessed; additionally, samples with <11 patients were not provided from the database. Institutional review board approval was waived for this study, as this research did not directly involve human participants.

UCL injuries were identified within PearlDiver's orthopaedic subgroup using ICD-9 (841.1: ulnar collateral ligament sprain) and ICD-10 (S53.441A: ulnar collateral ligament sprain of right elbow, initial encounter; S53.442A: ulnar collateral ligament sprain of left elbow, initial encounter; and S53.429A: ulnar collateral ligament sprain of unspecified elbow, initial encounter) codes. We adhered to exclusion criteria previously used in the literature: female patients, patients <10 years and >34 years at the time of injury, a diagnosis of cancer before the index procedure, a diagnosis of arthritis, and patients with a concurrent elbow dislocation or fracture.<sup>12</sup> Additionally, data were limited to the first instance of a UCL injury to avoid the duplication of patients or potential confounding variables from repeat injuries. Data from 2020 were also excluded because of regional differences in sports participation due to the COVID-19 pandemic. A total of 19,348 UCL injuries meeting the study criteria were identified between 2010 and 2019 (Figure 1).

Patient data pertaining to age and insurance status were obtained for the final study sample. The patient sample was divided into 5 groups based on age at the time of the diagnosis: 10-14, 15-19, 20-24, 25-29, and 30-34 years. The primary outcomes for this study were the number of patients in each age group who sustained a UCL injury as well as the number of patients in each age group who underwent surgical intervention for a UCL injury. For the purposes of this study, "surgical intervention" was defined as either UCL repair or UCL reconstruction within 18 months of the patient's UCL diagnosis. This time frame was intentionally set to be long enough to capture patients who engaged in nonoperative care and pivoted to a surgical intervention but short enough to limit the potential for other injuries to occur. Surgical interventions were identified using CPT codes 24346 (reconstruction medial collateral ligament, elbow, with tendon graft, including graft harvest) and 24345 (repair medial collateral ligament, elbow, with local tissue graft).

All statistical analyses were performed using the PearlDiver application. PearlDiver's native application

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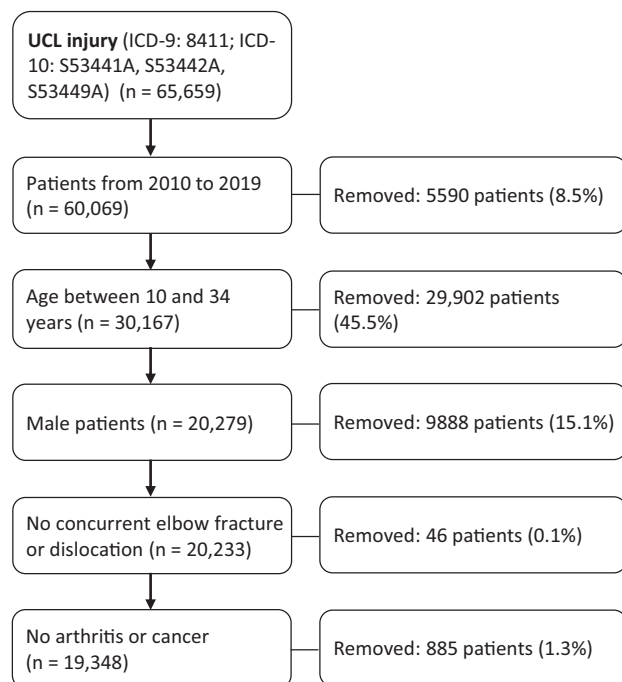
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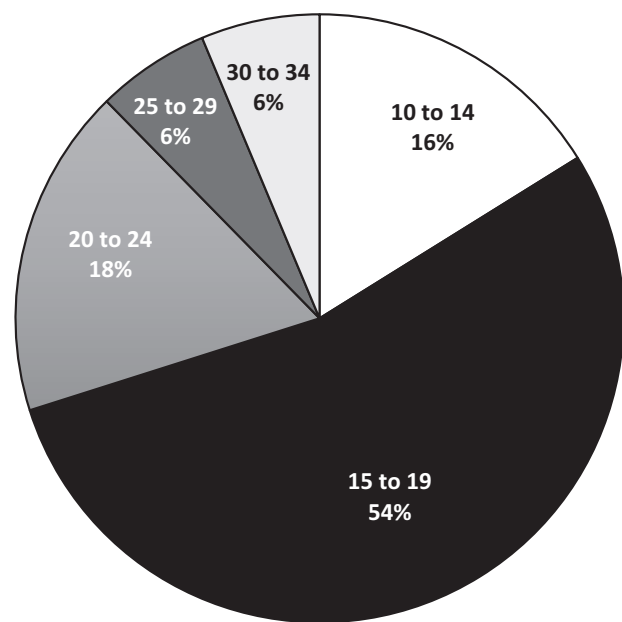
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Ethical approval for this study was waived by Hartford HealthCare (reference No. FWA00021932).



**Figure 1.** Flowchart depicting the study-inclusion process.



**Figure 2.** Ulnar collateral ligament (UCL) injury rates by age group.

uses RStudio (Version 3.6.1; Posit). The distribution of injuries and surgical interventions between age groups was determined using chi-square tests; a  $P$  value  $\leq .05$  was considered to be statistically significant.

## RESULTS

### UCL Injuries

Of the 19,348 UCL injuries identified between 2010 and 2019, more than half (54%) occurred in the 15- to 19-year age group. The number of injuries occurring in the 10- to 14-year and 20- to 24-year groups was nearly identical (16% and 18%, respectively). The lowest injury rate (6%) was noted in the 25- to 29-year and 30- to 34-year age groups (Figure 2).

Yearly UCL injuries by age demonstrated a consistent oscillatory pattern across all age groups. Patients <25 years had the greatest number of injuries occurring in the early part of the past decade, peaking in 2014 and then declining through 2017 before beginning to rise again. Patients in the 25- to 29-year group showed a similar pattern as the younger age groups but demonstrated reduced year-to-year variability. The oldest patients in this cohort, those in the 30- to 34-year group, did not follow the trend of increasing injury rates after 2017 as noted in the younger age groups (Figure 3).

### UCL Surgical Procedures

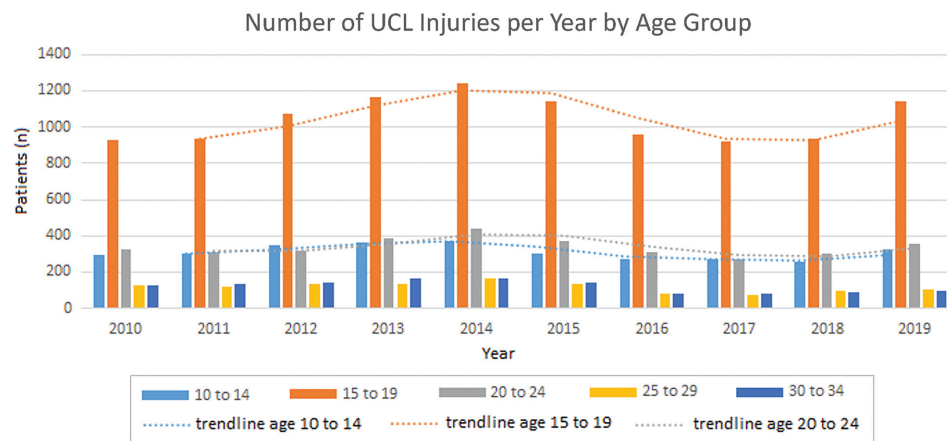
A total of 2496 (13%) patients with UCL injuries underwent either repair or reconstruction of their UCL. Overall, there were considerably more reconstruction procedures than repair procedures over the open period for this study; however, there was a trend indicating that UCL repair was becoming more common from 2017 onward, with repair making up around 19% of all UCL surgical procedures before 2017 and nearly 34% from 2017 to 2019 (Figure 4).

Data analysis for UCL reconstruction was limited to the 15- to 19-year and 20- to 24-year groups because of data limitations from PearlDiver in which the other age groups had <11 patients for the majority of years. Therefore, surgery rates were calculated as the total number of surgical procedures divided by the total number of injuries for that specific year within a specific age bracket. Yearly trends for UCL surgical procedures indicated that patients in the 20- to 24-year group consistently made up the largest percentage of patients undergoing surgical correction in the United States, with the largest number of UCL procedures performed in 2017 (Figure 5).

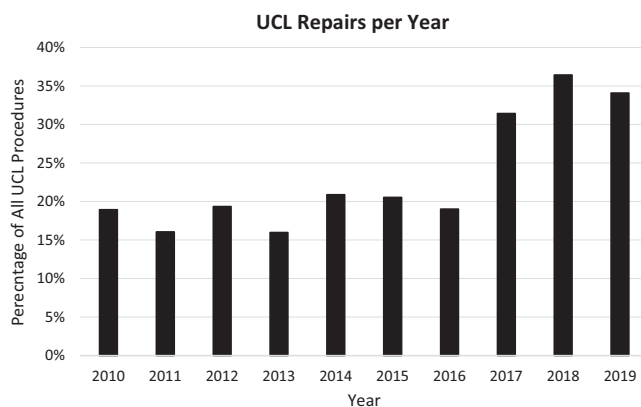
Data indicated that for patients in the 20- to 24-year group, it was becoming more common to delay surgery for at least 3 months during the latter part of the decade compared to the early part of the decade. This trend was not seen in patients in the 15- to 19-year group (Figure 6).

## DISCUSSION

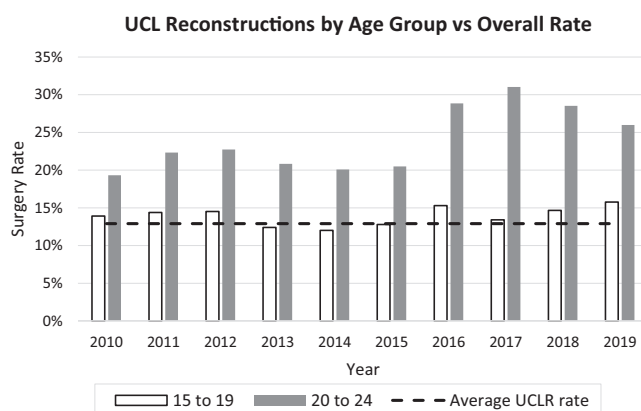
In this study, we sought to build on previous evidence to explore differences in trends for both UCL injuries and surgical interventions for male patients 10 to 34 years of age in the United States from 2010 through 2019. Adolescent male patients (aged 15-19 years) continued to represent



**Figure 3.** Yearly trends in ulnar collateral ligament (UCL) injuries by age group.



**Figure 4.** Percentage of ulnar collateral ligament (UCL) repair procedures conducted per year compared to the total number of yearly UCL surgical procedures.



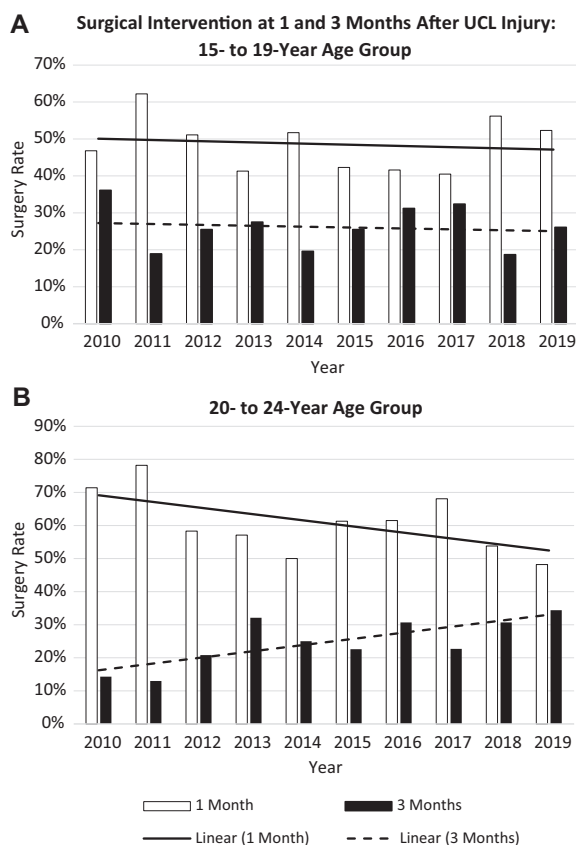
**Figure 5.** Yearly ulnar collateral ligament (UCL) reconstruction (UCLR) trends for the 15- to 19-year and 20- to 24-year age groups compared to the decade mean UCLR rate (dashed line).

the majority of those who sustained a UCL injury; however, young adult male patients (aged 20-24 years) underwent a surgical intervention for their UCL injury at a greater frequency than adolescent male patients. Results also demonstrated that although the timing of the surgical intervention for adolescent male patients remained constant over the past 10 years, with most patients treated operatively within 1 month of their original UCL diagnosis, the proportion of young adult male patients who underwent at least 3 months of nonoperative treatment before a surgical intervention increased.

Recent studies have demonstrated that the rate of UCL surgical procedures has been on the rise for the past 3 decades, and this trend was projected to continue through 2025, especially for adolescents and young adults.<sup>19</sup> However, the majority of these studies were limited by regions using state-level databases or surveys specific to a small region serviced by a single medical center or health network. Additionally, many of these studies were performed before the broader utility of biological treatment methods.<sup>6,20</sup> Concerns about an increased incidence of UCL injuries and surgery in male youth have been a consistent theme in the literature for decades. At a single Florida institution, the incidence of UCL injuries seen at the clinic increased 12-fold from 2000 to 2016, with a mean patient age of 16.7 years.<sup>32</sup> Erickson et al<sup>10</sup> leveraged the PearlDiver database and reported a 4.2% increase in UCL reconstruction for all patients from 2007 through 2011, with a 9.8% increase in patients aged 15 to 19 years.

The results of the current study demonstrated that male patients aged between 15 and 19 years had the greatest proportion of UCL injuries over the past decade (54%). These findings could reflect the idea that male patients in this age group are still maturing physically while participating in sports at a higher level of competition. Additionally, this injury rate could be caused by year-round sports participation, an increase in sports specialization, or poor biomechanics while participating in their sport.

We also found that the rate of UCL injuries for male patients <25 years oscillated over the past decade, but surgery rates, especially for patients aged between 20 and 24



**Figure 6.** Trends in the timing of a surgical intervention after an ulnar collateral ligament (UCL) injury for the (A) 15- to 19-year age group and (B) 20- to 24-year age group. Horizontal lines are trend lines.

years, continued to increase over the same period. Although male patients aged 15 to 19 years had the greatest number of UCL injuries over the past decade, this group accounted for only 14% of the UCL surgical procedures over the same time period, whereas male patients aged 20 to 24 years accounted for around 18% of the UCL injuries but 25% of the UCL reconstruction procedures. Our data indicated that male patients in the 20- to 24-year age group underwent surgery more frequently than those in any other age group, and this pattern was consistent over the past decade. This finding could be because this age group may have been engaged in higher level athletics in which continued participation was needed to retain their scholarship; thus, there was a greater need to return to sports. The lower surgery rate seen in the 15- to 19-year group could indicate that these patients may have opted to drop out of their sport rather than undergo surgery or that they underwent nonoperative treatment for a partial UCL tear.

Damage to the structures of the medial elbow has been documented in patients as young as middle school age.<sup>2,15</sup> When looking at the younger age groups, it was surprising to see the 10- to 14-year group with a similar incidence of UCL injuries as that in the 20- to 24-year

group. Although we were limited in the ability to analyze the surgical interventions for the 10- to 14-year group, it highlights the need for primary prevention in this young vulnerable population. Children should have the right to participate in sports on their own terms rather than those of their parents or coaches.<sup>24</sup> Further, sports programs have an obligation to recognize the rights of children by ensuring safe environments and engagement in developmentally appropriate play that acknowledges that they are children first and athletes second.<sup>24</sup> The implementation of these culture changes within youth sports may lead to less sports specialization, youth burnout, and overuse injuries.<sup>1</sup> Our results indicated that UCL repair was performed more often in the latter portion of the decade, from 2017 to 2019, compared to before 2017. UCL repair comprised approximately 19% of procedures from 2010 through 2016 but increased to nearly 34% from 2017 to 2019. A recent study by Willenbring et al<sup>31</sup> noted that UCL repair was outpacing UCL reconstruction, and while the current study did not show more UCL repair procedures than UCL reconstruction procedures, the data did show that UCL repair was becoming more common.

The trend data presented in this work are somewhat inconsistent with the data presented by Mahure et al,<sup>19</sup> who previously suggested that UCL reconstruction rates for patients aged between 15 and 24 years would increase through 2025. While the data in the current study suggested a continued trend for patients aged between 20 and 24 years, they do not suggest an increased rate in patients aged between 15 and 19 years. The differences between data trends may be caused by regional differences across the United States, as the current work utilized a national database while Mahure et al<sup>19</sup> focused on state-level data. The differences in trends point toward variations in regions across the United States and suggest the need for future work to understand regional differences to better target injury-prevention programs.

Another aspect of this study that was unique to this work compared to previous epidemiological studies was analysis of the timing of surgery after a UCL injury. Overall data demonstrated a trend of undergoing surgery later (3 months after the diagnosis) in the latter portion of the decade, while the early part of the decade was characterized by a surgical intervention occurring within 1 month of the diagnosis. However, this trend seemed to be more common in patients aged 20 to 24 years, while patients aged between 15 and 19 years more consistently underwent surgical interventions within 1 month of the diagnosis over the entirety of the decade. A potential reason for the development of this trend was the use of biological treatment approaches (eg, platelet-rich plasma) as an adjunct intervention for ligamentous injuries. Additionally, several studies published during the same period as analyzed in the current study advocated for 3 months of nonoperative care for athletes with UCL injuries, suggesting 1 to 2 weeks of rest to allow for the initial inflammation stage to pass, followed by 4 weeks of upper extremity strengthening and proprioception training, with the final 6 weeks devoted to a gradual return-to-throwing or return-to-playing program.<sup>18,28,33</sup> The increased awareness of

partial UCL tears may also be a reason for the rise in biological and nonoperative treatment options for UCL injuries shown in this study.<sup>14,17</sup> Patients who experienced recurrent pain or dysfunction after 3 months were considered candidates for a surgical intervention. Although this does not explain direct causation, the consideration of nonoperative treatment before UCL reconstruction has been a recent development.

## Limitations

There are some limitations to this study. This was a secondary data analysis of a large, all-claims database, with limitations inherent to such analyses (eg, inability to provide specific data as to the injury severity, chronicity with regard to the time between the injury and seeking medical treatment, how the pain manifested and level of pain experienced, or patient activity level), which could influence the findings of this study. Another limitation of the PearlDiver database was the lack of clinical information (ie, type and severity of UCL tear, range of motion or strength limitations) or any pertinent data regarding the patient's involvement in sports and his position, which would be essential in developing a treatment plan. Therefore, there is no way to fully understand how these factors may have influenced the treatment path. Additionally, this study was extremely dependent on the accuracy of coding for each patient, and coding errors could have affected the accuracy of the data presented in this study. For example, a skeletally immature patient with medial elbow soreness could be miscoded as a UCL injury. Finally, this study was designed using very stringent definitions for patient inclusion (nearly two-thirds of UCL injuries and all data concerning female patients were excluded to match previous literature looking at baseball-, football-, and wrestling-related injuries<sup>18,25</sup>), and as a result, the generalizability of the study findings is limited to the study population. Furthermore, surgery rates of those populations that were excluded may be lower than those discussed in this work.

## CONCLUSION

The data presented in this analysis demonstrated a shifting UCL injury rate for male patients aged between 15 and 19 years and a trend toward delayed surgical interventions in patients aged between 20 and 24 years. Despite a number of targeted injury-prevention strategies and rule changes in sports, the UCL injury rate remained high and did not demonstrate any indication of declining. Therefore, there is a clear and present need to continue to develop UCL injury prevention strategies for young patients.

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