

# Visualizing Sports Injuries in Athletes

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**Abstract**—This paper uses the information visualization platforms of Web of Science, CiteSpace, and Many Eyes, to visually assess and analyze the primary injuries that are sustained by competitive athletes in college. Data compiled includes but is not limited to: sports injuries in youth athletes, high school athletes, and collegiate athletes. The research ranges from 1972 to present day.

**Index Terms**—Athletic injuries, sports injuries, epidemiology, gender differences, information visualization, Web of Science, CiteSpace, ManyEyes, College sports

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## I. INTRODUCTION

Sports injuries can transpire as a result of exercise, accident, incorrect training, poor conditioning, overdoing activities, lack of warm-up and stretching or poor equipment. Most sports injuries involve the musculoskeletal system including the muscles, bones and its associated tissues, ligaments, and tendons.

The majority of sports injuries that occur because of sports and exercise can be treated and can be broken into two main categories: acute and chronic. Acute sports injuries are results from a specific traumatic incident such as an injury, or illness that occurs in one specific area of the body, such as a muscle, bone, or joint. Acute pain can be isolated, with immediate pain, but normally has a limited duration. Chronic injuries result from repetitive or overuse which results in stress and trauma to the body's muscles, tendons, bones and joints when there hasn't been enough time to recover from an injury. Chronic pain indicates subtle symptoms that start slowly and grow to more persistent if not treated or recognized early can lead to an incapacitating injury.

With the increased number of individuals participating in sports there are known risks and vulnerabilities to certain groups of athletes. Those groups are older athletes, youth athletes (children and adolescents), and women athletes. Older athletes at least over the age of 45 have a change in their body and tissue composition in their joints and cartilage for knees and back. Injuries take longer to heal and require an exercise regiment focusing stretching and strengthening.

Children and adolescents athletes can be at risk because their muscles, bones, and joints are still growing and more susceptible to injuries. Because of the immaturity of their growth plates trauma from an injury can be more potentially serious for younger athletes.

In 1972, Title IX was introduced as federal law that banned gender discrimination in public education. The number of girls and women participating in organized sports increased dramatically. Gender difference between men and women athletes are part of extensive studies however, based on the size of this particular subject, this paper is going to be limited to comparison with collegiate athletes.

The purpose of this paper is to determine the main sports injuries that occur to collegiate athletes and provide visual graphics identifying these injuries.

## II. VISUALIZATION TOOLS

The three visualization tools used to define the main sports injuries within the three groups of athletes were: Web of Science, CiteSpace, and ManyEyes. After obtaining the primary data for a query search on sport injuries through Web of Science from 1980 to present, the data was then processed through CiteSpace for the major keywords cited from reference results from Web of Science. Finally, ManyEyes was selected as the final visualization tool to display the results of the sports injuries query.

Section 2, 3 and 4 will provide a brief summary of each application and its methodologies.

### 2.0 Web of Science

#### 2.1 Overview Web of Science

Creators: Thomson Reuters

Functionality: Web of Science is an online academic citation index database covering 1900 to current/present (Drexel University Libraries start at 1980 to current/present). Web of Science provides access to multiple databases which allows cross discipline research and in-depth details within the academic and scientific fields. This covers the following type of literature formats: peer review, full text articles, editorials, chronologies, abstracts, proceedings journals and book based, and technical papers.

Features: Web of Science features six databases Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Conference Proceedings Citation Index, Index Chemicus, and Current Chemical Reactions. Web of Science citation index will lead to any other literature (book, academic journal, proceedings, etc.) current or past showing current trends and patterns in more than one discipline.

Data Handling: Web of Science uses bibliometric measures through a search engine interface and provides references to citation indexing, author, topic, title, subject keywords, abstract, periodical title, author's address, and publication year.

Graphics and Features: The Citation Report used a bar chart graphic which is graphical visual provided by Web of Science application. The data is clearly labeled showing published items in each year and citations in each year.

User Experience: The user experience for the Web of Science graphic user interface is designed for a novice with very little technical experience. The search engine is easy to manipulate, allowing the user to refine the search results, allows the user to save the results in several formats (email, plain text, EndNote, HTML, Tab delimited, BibTex).

## 2.2 Web of Science methodology

### Methods

1. Retrieved bibliographic records from the Web of Science both from the time frame of 1980-2012. Since Web of Science only goes back to 1980, the statistical information from 1972 and introduction of Title IX and expanding to 1979 are missing.



Fig.1. Web of Science screen capture for Sports Injuries

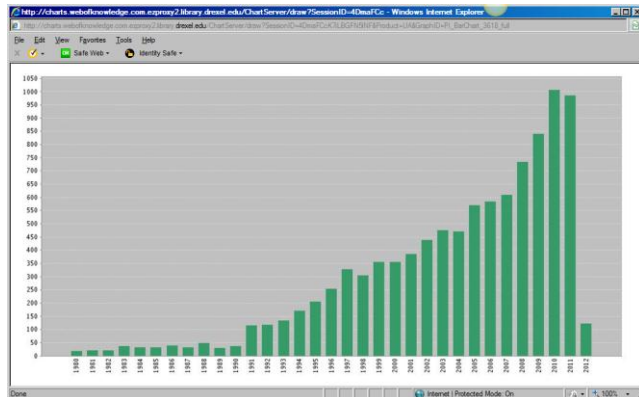


Fig.2. Web of Science for Sports Injuries Published items in each year (all years)

Note from 1980 to 1991, published items regarding sports injuries were less than 50. From 1991 to present, the amount of items published jump with the largest increase being in 2010 with over 1,000 items.

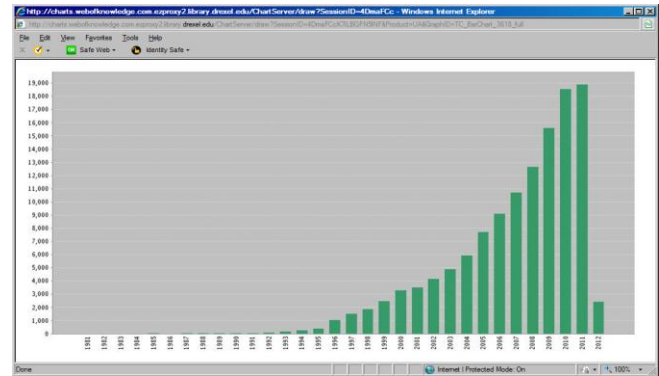


Fig.3. Web of Science for Sports Injuries Citations in each year (all years)

Sports Injuries Citations were almost non existence from 1,980 to about 1996 when it reached 1000 and the highest year was 19,000 citations.

## RESULTS

There were 9,953 results found but only the first 2000 records were downloaded as a sample to get an idea of what key areas of sports injuries to focus on. The data was then saving into a text format to populate CiteSpace II.

### 3.0 CiteSpace II

#### 3.1 Overview of CiteSpace II

Creators: Chaomei Chen version 3.0.R5.

Functionality: Produces visualizations based on nodes and links between articles and shows trends and patterns through clusters. CiteSpace II uses full records and references from Web of Science database.

Features: CiteSpace II through its Java application allows easy access upload of datasets and produces network patterns for co-citations, co-occurrences and directed citing links.

Data Handling: The operator uses a Graphic User Interface (GUI) upload the data that was downloaded in plain text from Web of Science website. The dataset is converted either into Author co-citation analysis (ACA) or Document co-citation analysis (DCA) and both topics were set to DCA for this project.

Graphics and Features: CiteSpace II has several different various graphics that can be displayed. The application can show graphics in a citation burst with the color map on or off, a cluster view, a timeline view, and clusters with or without labels, clusters with convex hull and color or without color. Font sizes and cluster sizes can be altered and link walkthrough for each year time segment.

User Experience: The application is much more complex to operate as a novice but after working the application a few time, CiteSpace II is pretty easy to manipulate.

#### 3.2 CiteSpace II methodology

The main CiteSpace II query page– Project Home was in the Project II directory and data directory was download\_sports injuries into five data sets. The time slicing was set from 1980-2012, Cited Reference and select top 50 most sited or occurred items from each slice, cite reference was set for document co-citation analysis (DCA). The rest of the radio buttons were left on the default settings.

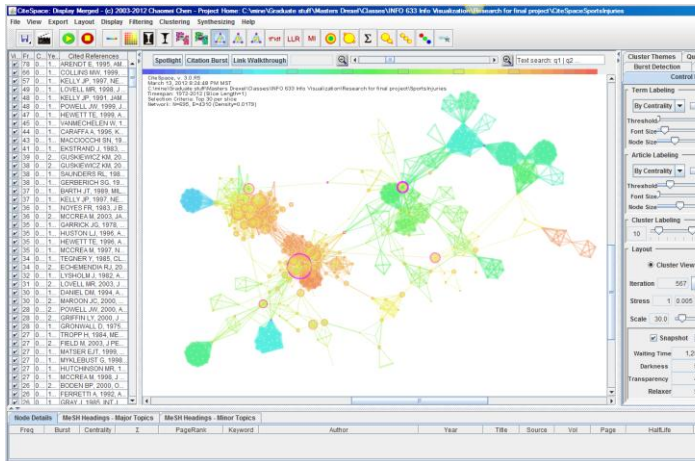


Fig. 4. CiteSpace II initial results

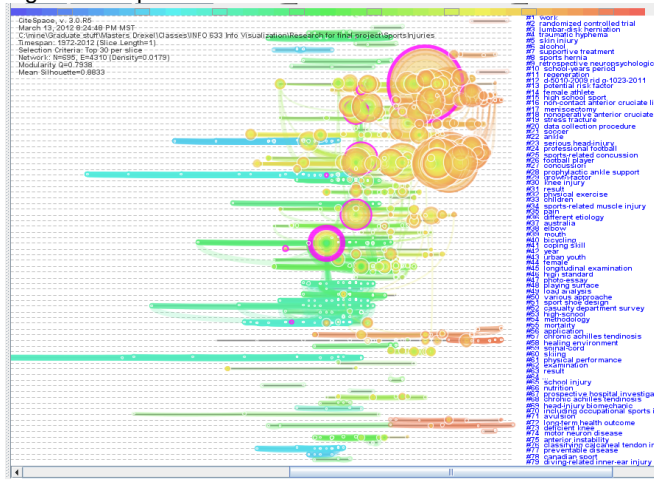


Fig. 5 CiteSpace II Time line with label

Summary of Clusters base on terms of Sports Injuries came up with over 351 results which were the primary source for the research

Cluster ID	Size	Silhouette	Mean (Q)	Label (TFIDF)	Label (LIR)	Label (X)
24	14	0.619	1993	(16.99) concussion, (15.74) caucasian football league season, (15.49) football player, (15.12) neuropsychological testing, (15.12) cerebral concussion	concentration (29410.11, 1.0E-4), player (13571.26, 1.0E-4), symptom (10935.87, 1.0E-4)	concentration
55	32	0.8	1979	(12.19) musculoskeletal, (11.85) musculoskeletal, (12.41) recreation, (9.99) incidence rate, (*) sports-related eye injury	injury (11964.41, 1.0E-4), sports (11524.84, 1.0E-4), anterior cruciate ligament (9718.15, 1.0E-4)	injuries
29	31	0.995	1973	(21.97) growth-factor, (21.97) children's sport, (17.37) overuse injury, (13.08) use, (9.25) factor	sports (10228.77, 1.0E-4), anterior cruciate ligament (9905.59, 1.0E-4), injury (8209.81, 1.0E-4)	injuries
58	29	0.276	1991	(16.53) leading environment, (13.07) platelet-rich plasma, (13.07) sports medicine, (10.22) use, (*) shoulder	injuries (5275.97, 1.0E-4), prep (4743.11, 1.0E-4), patient (3996.92, 1.0E-4)	injuries
30	23	0.971	1982	(12.94) knee injury, (9.45) knee, (8.23) gonarthritis, (8.23) long term incidence, (6.43) anterior cruciate ligament reconstruction	injury (3893.15, 1.0E-4), of-the-ligament (1149.31, 1.0E-4), low-back-pain (1107.59, 1.0E-4)	injuries
45	23	0.771	1987	(13.74) longitudinal examination, (13.74) cognitive response, (12.81) after-athlete, (12.81) abuse, (12.17) sport injury rehabilitation	injury (3905.91, 1.0E-4), injured (2870.05, 1.0E-4)	injuries
25	21	0.671	2003	(15.74) sports-related concussion, (15.62) concussion, (14.4) recovery, (14.91) collegiate football player, (14.30) non-concussion study	concussion (11138.96, 1.0E-4), athlete (8265.13, 1.0E-4), day (6221.36, 1.0E-4)	injuries
51	21	0.832	1980	(19.14) sport shoe design, (16.63) design, (11.63) shoe, (9.09) jumping technique, (9.09) health-peak-leg complex	injuries (7651.84, 1.0E-4), shoe (4348.31, 1.0E-4), exercise (3727.38, 1.0E-4)	injuries
48	19	0.85	1983	(13.91) playing surface, (13.91) biomechanical aspect, (13.91) load analysis, (9.15) knee, (8.38) knee injury	injury (4932.4, 1.0E-4), players (4732.11, 1.0E-4), knee (4318.15, 1.0E-4)	injuries
13	18	0.634	1990	(14.06) potential risk factor, (13.19) female athlete, (13.02) stiffness, (12.24) women, (12.17) healthy men	women (11675.1, 1.0E-4), injury (8632.71, 1.0E-4), men (7559.42, 1.0E-4)	injuries
16	17	0.831	2001	(14.99) non-contact anterior cruciate ligament injury, (11.27) prevention program, (11.27) leading risk factor, (9.83) soccer player, (9.53) anterior cruciate ligament injury	non-contact acj injury (3608.57, 1.0E-4), injury (2823.84, 1.0E-4), injury (2771.29, 1.0E-4)	injuries
23	17	0.982	1971	(15.82) tennis hand injury, (10.27) hand, (9.09) horseback, (8) concussion, (7.9) horse	players (2552.42, 1.0E-4), injury (4347, 1.0E-4), knee (2217.39, 1.0E-4)	injuries
15	15	0.765	2002	(13.17) high school sport, (11.27) girl, (9.23) high school, (9.09) subsequent injury patterns, (8.91) leading	injury (4337.45, 1.0E-4), rate (4492.36, 1.0E-4), boy (2545.83, 1.0E-4)	injuries
41	15	0.695	1981	(17.17) coping skill, (17.17) adolescent sport injury, (17.17) conjunctive moderator variable, (17.17) social supports, (17.17) multidisciplinary research	injuries (1347.81, 1.0E-4), sports (2830.42, 1.0E-4), anterior cruciate ligament (2754, 1.0E-4)	injuries
61	15	1.066	1993	(19.93) physical performance, (19.93) warming-up, (13.02) performance, (10.52) sports-related injury, (9.79) man	(10.0E-4), hamstring (1494.1, 1.0E-4)	injuries
52	13	0.942	1979	(14.74) causality-dependent survey, (11.86) eye injury, (11.24) survey, (11.24) musculoskeletal sports injury, (8.20) use	adolescents (1423.36, 1.0E-4), injury (1226.6, 1.0E-4), mild head-injury (1305, 1.0E-4)	injuries
75	10	0.134	1997	(13.72) conventional, (13.72) sports eye injury, (13.72) eye injury, (11.60) sport	injury (1450.07, 1.0E-4), athletes (1037.88, 1.0E-4), sports (115, 100E-4)	injuries

Fig. 6 CiteSpace II Cluster Summary result from Sports Injuries

## RESULTS

The results from CiteSpace II were converted into a Microsoft Excel spreadsheet for easier sorting and results. The primary hits were for the word Injury (20) or Injuries (80), followed by Sports (15) and Sports related injuries (14). The top of the list for injuries were anterior cruciate ligament/ACL (13), concussion (12), and epidemiology (5).

Epidemiology is the science concerned with the study of the factors determining and influencing the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population for the purpose of establishing programs to prevent and control their development and spread. Also, the sum of knowledge gained in such a study.

## 4.0 ManyEyes

The final section of this paper is the visualization of Sports Injuries keywords discovered through CiteSpace II through the use ManyEyes application. This particular visualization application software was selected because of its ease of use as well as the variety of graphics that can be produced from either a text or spreadsheet format.

## 4.1 Overview of ManyEyes

Creators: IBM Research and the IBM Cognos software group. Functionality: Produces visualizations based on user-defined data sets, with data types ranging from statistics tables to free text values.

Features: ManyEyes provided various methods to convert data into the largest amount of visual options and offers variety of visualization types such as traditional charts, tree maps, world maps, block, bubble, network diagrams and the visualizations are interactive.

Data Handling: The operator can either use data sets contributed by other end user or they can upload their own data. The application can handle data tables, Free Text entries with specific headers, and spreadsheet formats (Excel, delimited text and XML). Data limitation is 5MB and everything is visible to anyone on the Internet.

Graphics and Features:

- Text analysis – tag clouds, word trees, phrase net, word cloud generators
- Set of values: bar charts, block histograms, and bubble charts
- Data relationship: scatter plots, matrix charts, and network diagrams
- Parts of the whole: pie charts, tree map and tree maps for comparison
- Maps: country maps and world map
- Changes of data over time: line graphs, stack graphs and stack graphs for categories.

User Experience: The more extensive in allowing the user different types of visual options for displaying their data.

## 4.2 ManyEyes methodology

ManyEyes is only application that can produce a full text analysis graphics and map graphics. Though this application creates extremely versatile visuals, the graphics are still very generic and scientific looking. There are some hidden functionalities that takes some effort to learn but there is documentation on the site that can walk a first time user through the process.

The CiteSpace II Cluster Summary was converted into a spreadsheet and all duplicate files were removed. The results were converted into three columns – keyword, type and number of instances. The file was then converted in ManyEyes to produce a Word Cloud graphic, cluster keyword graphic, a treemap graphic, a pie chart and a customizing matrix chart to demonstrate the versatility of graphics in ManyEyes.





## CONCLUSION

Research shows the main sports injuries that were identified as knee injuries particularly the ACL, which is greater in women and adolescents than men. The reasons stated were youth athletes are still growing and going through puberty and their muscles are not strong enough for certain movements that of the knee joint stable.

The anatomy of women particularly the quadriceps and ligaments surrounding the knee in women aren't as strong in men to stabilize the joint for cutting, jumping, bending and pivoting motions. The hormones released during the menstrual cycles in woman can also contribute to differences in the composition strength of the ACL.

Men's Soccer		Women's Soccer		Men's Basketball		Women's Basketball	
Injured Structure	Num. Rate	Injured Structure	Num. Rate	Injured Structure	Num. Rate	Injured Structure	Num. Rate
Collateral ligament	316 0.51	Collateral ligament	192 0.62	Collateral ligament	158 0.21	Collateral ligament	181 0.28
Cartilage meniscus	19 0.19	Cartilage meniscus	105 0.34	Cartilage meniscus	100 0.13	Cartilage meniscus	189 0.29
Patella or patellar tendon	130 0.21	Patella or patellar tendon	92 0.3	Patella or patellar tendon	196 0.26	Patella or patellar tendon	158 0.24
ACL	81 0.13	ACL	97 0.31	ACL	49 0.07	ACL	189 0.29
Posterior cruciate ligament	22 0.04	Posterior cruciate ligament	12 0.04	Posterior cruciate ligament	5 0.01	Posterior cruciate ligament	9 0.01

## ACL INJURY STRUCTURE FOR SOCCER AND BASKETBALL

### ACKNOWLEDGMENTS

The author wish to thank Professor Chen for introducing the vast world of information visualization.

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ManyEyes website [http://www-](http://www-958.ibm.com/software/data/cognos/manyeyes/visualizations/)

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