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Visual analysis of foreign ice hockey research based on knowledge graphs

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Abstract: *This paper takes the ice hockey literature included in the Web of science database from 1980-2022 as the data source, and uses Citespace5.8R3 visual software analysis tool, using literature, knowledge mapping, comparative analysis and other methods, to analyse the research on the development of ice hockey in foreign countries, aiming at presenting the status quo, hotspots and fronts of the research of ice hockey in foreign countries, and so on, and to provide for the development of ice hockey projects, research selection to provide reference. Findings: (1) The number of foreign ice hockey research publications is generally rising in waves, which can be divided into two phases: the slow growth phase (1983-2022) and the sharp growth phase (2013-2021) (2) The research is more in the countries with high competitive level of ice hockey programme, such as Canada, the United States, Sweden, etc. (3) The research reflects the cross integration of multiple disciplines and is distributed in the fields of engineering, sports science, neurology, psychology, sociology, social sciences, psychology, and so on. (4) The research hotspots are diffused from the initial sports injury and protection; athlete's age to the sports performance and hockey physical fitness.*

Keywords: *ice hockey; visual analysis; sports injuries; sports performance*

1. Introduction

In recent years, documents such as the Opinions on Vigorously Developing Ice and Snow Sports with the 2022 Beijing Winter Olympics as an Opportunity and the Action Plan for the Development of Ice and Snow Tourism (2021-2023) have been released successively, reflecting the state's emphasis on ice and snow sports, increasing the participation of the masses in ice and snow programmes, and promoting the development of ice and snow programmes in China.

Ice hockey is a combination of skating skills and hockey and a very ornamental sport, introduced to China in the early 20th century. The development time is relatively short, experienced the "initial emergence", "twists and turns", "recovery and improvement", "gold", "decline", sustainable development "several stages"[1] The level of ice hockey can represent the overall level of a country's winter Olympics[2], so ice hockey has become one of the main contents of the study of winter sports in various countries. At present, the domestic research on ice hockey mainly focuses on carrying out the status quo, development countermeasures, etc., and the research mainly adopts the qualitative analysis method; it lacks the bibliometrics perspective to quantitatively, objectively, and dynamically observe the status quo, hotspots, and trends of the research on ice hockey in foreign countries. This study uses knowledge mapping to visualise and analyse the literature related to ice hockey in foreign countries to provide information reference for the development of ice hockey projects in China.

2. Data sources and research methodology

2.1. Data sources

Data from Web of sscience database, with the search formula TS="ice hockey", the document type "Article", the language "English", and the time span from 1983-2022. The time span is 1983-2022. A total of 1,918 articles were retrieved, and 622 articles were screened by the inclusion and exclusion criteria.

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2.2. Literature method

In this paper, we queried the Web of science database for hockey-related papers, screened the abstracts, selected representative papers, and summarised and classified them.

2.3. Knowledge mapping method

In this paper, Citespace 6.1R6 software was used to process, statistically as well as visually analyse the screened literature in terms of annual publications, national publications, institutional publications, disciplinary distribution, keywords, keyword emergence, and so on.

3. Results and analyses

3.1. Characterisation of the spatial and temporal distribution of ice hockey

3.1.1. Time distribution

Statistics on the number of publications of the ice hockey programme over the years were obtained in Figure 1.The number of publications of ice hockey from 1983 to 2020 was generally in a growth phase.The number of publications during 1983-2013 went up and down, with an average of 53 publications per year, which was a slow development phase.The number of publications during 2013-2015 and 2019-2020 periods saw a sharp increase in the number of publications. The number of publications is closely related to the major events of the project or the policies of the country, and the reason for the two sharp increases in the number of publications may be related to the hosting of the Sochi Winter Olympic Games in 2014 and the success of Beijing's bid for the Olympic Games in 2022, whih has promoted people's research on ice hockey.

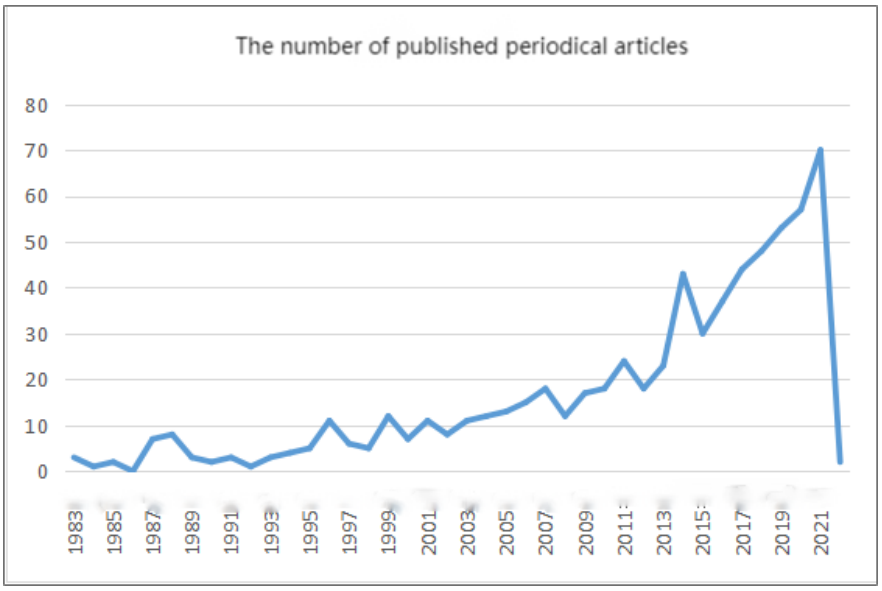

Figure 1: Temporal distribution of the amount of hockey literature

3.1.2. Distribution of national issuances

Import the downloaded data into Cite Space software and select "Country" as the node type to generate a country co-occurrence map for analysis. Adjustment and statistics. From Table 1, it can be seen that among the top 10 countries, Canada (282 articles) and the United States (247 articles) have far more articles than other countries and are in a dominant position. The centrality of articles in the United States and Canada is equally far ahead of other countries. Canada and the United States are both countries in the North American region; most of the remaining countries in the top 10 in terms of volume of articles are countries with high levels of competitive ice hockey, and most are located in Europe. From the number and centrality of articles by country, it can be seen that the research power of the ice hockey programme is mainly distributed in the North American and European regions.

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Table 1: Statistics on the number of articles issued by foreign ice hockey programmes

serial number	nations	volume of publications	per cent	centrality
1	Canadian	260	40.43 per cent	0.40
2	America	234	36.4 per cent	0.48
3	Sweden	43	6.69 per cent	0.06
4	Finland	33	5.13 per cent	0.09
5	England	32	4.98 per cent	0.2
6	Switzerland	20	3.11 per cent	0.05
7	Czech Republic	18	2.8 per cent	0.01
8	Germany	17	2.64 per cent	0.09
9	Ireland	17	2.64 per cent	0.01
10	Australia	16	2.49 per cent	0.01

3.2. Hockey Keyword Analysis

By using Cite space to map the keywords, the frequency of the keywords was counted to get Table 2.From the table, it can be seen that the frequency of the keywords Sport, Injury and Player is obviously higher than the frequency of other keywords, which is the hotspot of the researchers. The research hotspots mainly include injury (Injury), athlete (Player), concussion (Concussion), and sports performance (Performance).

Table 2: Hockey high frequency keywords (top 10)

serial number	byword	frequency	centrality
1	Sport	94	0.42
2	Injury	82	0.21
3	Player	76	0.19
4	Concussion.	56	0.19
5	Performance	55	0.17
6	Head	37	0.15
7	Traumatic brain injury	35	0.14
8	Risk	32	0.06
9	Epidemmiology (epidemiology)	30	0.06
10	Power (physical)	26	0.06

3.3. Keyword clustering analysis

The keywords were clustered to show the top ten subject terms formed by the keyword clustering to obtain Figure 2. The top ten subject terms were "concussion", "impact biomechanics ""knee"" "sport"" "bone mass"" "safety" "femoroacetabular impingement" "children "relative age effect" "adolescence".

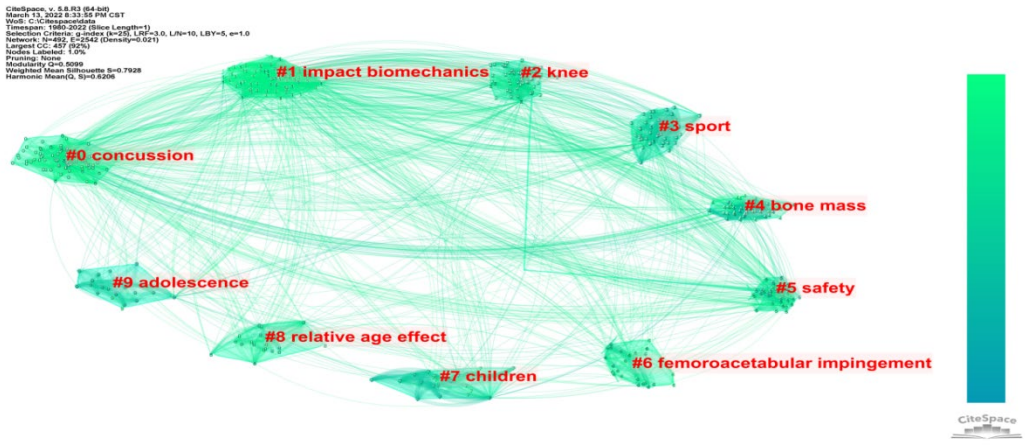

Figure 2: Hockey keyword clustering

The first 10 subject terms were generalised to obtain Table 3. By generalising the first 10 subject words, two knowledge clusters can be obtained. They are C1 Ice hockey injuries and protection and C2

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Age of ice hockey players .

Table 3: Hockey clustering knowledge groups and highly cited literature

knowledge base	subject line	Highly cited literature
C1	#Concussion #Safety #femoroacetabular impingement #Impact biomechanics #Knee #Bone mass	Blood Biomarkers for Brain Injury in Concussed Professional Ice Hockey Players Fair-play rules and injury reduction in ice hockey Prevalence of Increased Alpha Angles as a Measure of Cam-Type Femoroacetabular Impingement in Youth Ice Hockey Players Does Cervical Muscle Strength in Youth Ice Hockey Players Affect Head Impact Biomechanics? Three-dimensional kinematics of the knee and ankle joints for three consecutive push-offs during ice hockey skating starts Rapid loss of bone mineral density of the femoral neck after cessation of ice hockey training: a 6-year longitudinal study in males
C2	#Children #Relative age effect #adolescence	Childrens ice hockey injuries Injuries in Canadian youth ice hockey: The influence of relative age Collision Type and Player Anticipation Affect Head Impact Severity Among Youth Ice Hockey Players

3.3.1. C1 Ice Hockey Injuries and Protection

Ice hockey is a sport that has a higher injury rate compared to other sports due to the specificity of the sport. So there are studies on ice hockey injuries. For example, Flik collected injury data from 8 teams for one season and there were 113 injuries out of 23,096 players. Most of the injuries occurred during the game, and concussion was the most common injury, followed by medial collateral ligament sprains of the knee, acromioclavicular joint injuries, and ankle sprains[3]. Literature search revealed that more studies have been done on concussion, femoral acetabular injuries and spinal injuries while less studies have been done on medial collateral ligament sprains of the knee, shoulder lock joint injuries and ankle sprains. Therefore the focus is on concussion, femoral acetabular injuries, and spinal injuries.

Research on concussions has focused on the following areas. Firstly, for the incidence of concussions; e.g. Echlin's statistics on the rate of concussion injuries and recurrent concussions for two teams in a season in Canada found that the concussions all occurred during the game[4]. Secondly, factors influencing the occurrence of concussions; e.g. Schneider explored the risk of concussions in adolescent male ballplayers with pre-season reports of neck pain, headache and dizziness by studying 3832 adolescent athletes in Canada and showed that pre-season reports of neck pain and headache were risk factors for concussions, and that dizziness was a risk factor for concussions[5].Emery's study of the Canadian Alberta and Quebec teams were analysed in a two-year study to explore whether there was a correlation between the risk of concussion and win-loss record or penalty minutes, and the results were a significant correlation between team wins and losses and risk of injury, with 22% fewer injuries among teams that won 50% or more of their games during the season[6]. Third, the effects of concussion on the body. Shahim investigated 35 athletes in Sweden's top professional ice hockey league who had suffered concussions and underwent repeated blood sampling at 1, 12, 36, and 144 hours post-trauma; there was no significant increase in the level of Tau-A in the post-concussion samples, and serum levels of Tau-C were significantly higher in the post-concussion samples, as compared to the pre-concussion samples. In addition, Tau-A levels correlated with the duration of post-concussion symptoms. Serum Tau-A is a newly identified biomarker that can be used to predict when it is safe to return to play after a sports-related concussion[7].

Studies of spinal injuries have focused on examining injury rates. For example, Tator studied the causes and incidence of major spinal injuries suffered by ice hockey players. 271 major spinal injuries were reported by Canadian ice hockey players between 1943 and 1999, 49.0% of which occurred in players aged 16-20 years[8]. 117 spinal injuries entered between January 1966 and March 1987 were investigated by Jones, with the majority of injuries occurring in adolescents and players under 30 years of age who participated in supervised games. The majority of the injuries occurred in adolescents and players under 30 years of age participating in supervised play[9].

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Research on femoral acetabular injuries has focused on. Firstly, the influencing factors of femoral acetabular injury. For example, Philippon examined the clinical hip angle of ice hockey players and skiers, and from the results, the hip angle of ice hockey players was significantly higher than that of skiers, and it was concluded that the prevalence of hip impingement syndrome in ice hockey players was also higher than that of skiers[10]; Stull studied the kinematic characteristics of the hip joints of 12 adolescents during sprinting as a way of exploring whether the position of the hips during sprinting. The results of this study were that hip position during sprinting in youth hockey players may lead to femoral neck impingement of the acetabulum and may result in glenoid labral tears and/or articular cartilage damage[11]. Secondly, the efficacy of treatment of the femoral acetabulum; Bizzini studied the effectiveness of a common treatment after femoral acetabular injury in five athletes with femoral acetabular injuries. The results were that hip rotational range of motion was restored on average after 3 weeks. Core and hip strength values reached preoperative levels in an average of 7.8 months. After an average of 6.7 months, the athletes were able to return to unlimited practice with their hockey team, and after an average of 9.6 months, the athletes were able to participate in their first competitive game [12]. Finally, the effect of femoral acetabular injuries on athletic performance; Brunner explored whether femoral acetabular injuries could have an effect on hip muscle strength, range of motion, and aspects of athletic performance in junior hockey players. By studying 74 athletes, the results showed that 50 of the 74 players had bony deformities associated with femoral acetabular injuries, 16 of which were symptomatic. There were no significant differences in hip muscle strength, hip mobility, and on-ice athletic performance between players without femoral acetabular injuries and those who were asymptomatic or symptomatic[13].

Sports injury prevention and protection focuses on the following areas. First sports equipment protection against sports injuries, Clark's ability to protect ice hockey goalie helmets against three concussive impact events was tested by modelling falls, puck impacts and shoulder collisions in ice hockey, and the results showed that the tested ice hockey goalie helmets were well-designed to control falls and puck impacts but did not provide sustained protection against shoulder collisions, and that there may be improvements in helmets to protect the goalie from shoulder collisions opportunities[14]. Second training for sports injury prevention; e.g. Tyler studied whether hip muscle strength and flexibility play a role in the incidence of adductor and hip flexor strains in players on National Hockey League hockey teams, measuring 47 athletes, with the result that - if a player's adductor strength is less than 80 per cent of his abductor strength, he is 17 times more likely to suffer an adductor strain[15].

In summary, research on concussion and spinal injuries mainly focuses on concussion injury rates and influencing factors, while research on injury mechanisms and the effectiveness of treatment methods is relatively small; on femoral acetabular injuries, on the contrary, research mainly focuses on the treatment of femoral acetabular injuries and influencing factors, with relatively little research on injury rates and on sports performance. Sports injury protection mainly focuses on research on equipment and physical training.

3.3.2. C2 Relationship between age and performance of ice hockey players

Research on athlete age has focused on the following areas. Firstly, research on athletes' age and sports performance; for example, Hancock analysed the relative age effects of 147,991 male ice hockey players aged 5 to 17 years old, comparing the relative age effects of male athletes participating in competitive and non-competitive ice hockey, and the results showed that players had strong relative age effects when they were selected by coaches through a tryout system for competitive teams, and that in the case of non-competitive teams where there were no coach selections teams, there was a strong relative age effect for players between the ages of 5 and 8, but not for players between the ages of 9 and 17[16]. Secondly, there are studies on athletes' place of birth as well as date of birth, for example, Bruner surveyed 566 in four countries, the United States, Sweden, Finland, and Canada, and used a number of regression models to explore the consistency of the relationship between the place of birth and the date of birth of adolescent athletes. The results showed that the four countries were consistent and that most of the youth athletes were not from urban areas. There was no evidence of an interaction between date of birth and place of birth[17]. As well as studies on age and physical fitness of athletes; for example, Vigh-Larsen investigated the relationship between age and body composition and athletic performance in ice hockey players, and the results of the study showed that there was no overall correlation between age and performance, and that there was only a small to moderate association between age and body composition. However, the oldest players had consistently lower high-intensity exercise performance, the youngest players had lower body weights, and aerobic capacity was similar. This suggests that abilities related to size, strength and power are the most critical differentiating parameters between younger and older hockey players[18].

From the above, it can be learnt that the research on the age of ice hockey players has been relatively

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more comprehensive. And there are many problems that need to be explored in our research on the age of ice hockey players.

4. Trends in Ice Hockey Research

The keyword emergence feature in Cite space can be used to detect large changes in citations over a certain period of time. This can be used to detect the decline or rise of a particular keyword. A graph of the historical stages of hockey keyword emergence from 1983-2022 is obtained through Cite space (Figure 3). The red area represents the stage where the frequency of the keyword is higher, for example face mask emerged in the time period 1997-2006.

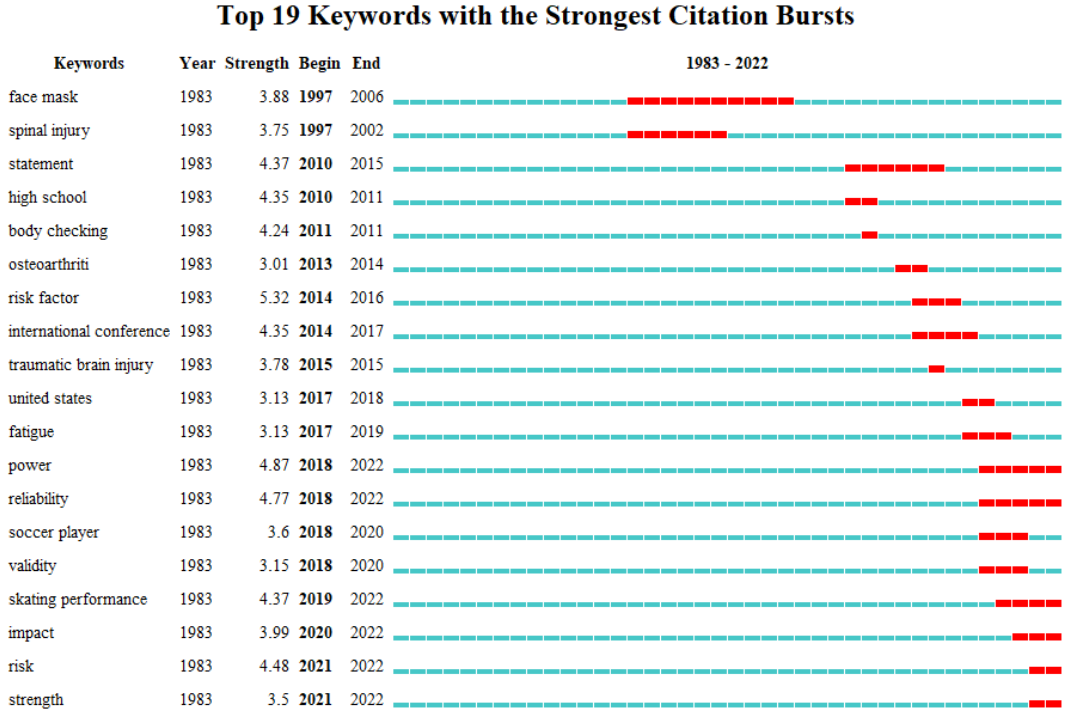

Figure 3: Hockey keyword emergence map

From the figure, we know that the keywords with high emergence rate so far are "power", "reliability", "skating performance", "impact", "risk" and "strength", which are at the forefront of foreign hockey research. The key words "power", "reliability", "skating performance", "impact", "risk" and "strength" are at the forefront of foreign ice hockey research, and the changes of these key words may continue to be studied in the coming time. changes are likely to continue to be studied in the coming period, and these keywords are mainly associated with sports performance. The hotspots of ice hockey research initially focus on sports injuries and influencing factors. Therefore, it can be concluded that the hotspots of ice hockey research have shifted from sports injury to sports performance over time.

5. Conclusions

By combing and analysing the volume of foreign publications on ice hockey projects, countries, institutions, disciplines, keywords, and keyword emergence, the following conclusions were drawn:

The hockey programme gradually caught fire and the volume of publications gradually rose. 1983-2013 saw waves of ups and downs, and after 2013 the volume of literature began to increase dramatically, especially in the 2013-2015 and 2019-2021 timeframes.

Research efforts are mainly concentrated in Europe and North America, such as Canada, the United States, Sweden and other countries, and the research institutions are mainly comprehensive universities in these countries.

Hockey research involves several disciplines. The main focus is on sports science, orthopaedics, engineering, recreational sports and tourism, physiology, psychology, etc., with a major trend towards

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multidisciplinary cross-research.

The research hotspots initially focused on sports injuries and protection; athletes' age and other aspects. Sports injury mainly focuses on concussion, spine, femoral acetabular injury, and sports protection mainly focuses on sports equipment for sports injury protection and physical training for sports injury prevention.

As the research evolved, the hotspots began to evolve from sports injuries and the like to the beginning of sports performance and hockey fitness training.

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