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EGDD Bandara
Department of Sports Sciences and Physical Education, Faculty of Applied Sciences/ Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka

HPPGS Pathirana
Department of Sports Sciences and Physical Education, Faculty of Applied Sciences/ Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka

CA Edirisinghe
Institute of Sports Medicine, Colombo, Sri Lanka

Corresponding Author:
EGDD Bandara
Department of Sports Sciences and Physical Education, Faculty of Applied Sciences/ Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka

The major aspects determining the most prevalent injuries in baseball: A review

EGDD Bandara, HPPGS Pathirana and CA Edirisinghe

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Abstract
The major intention of this study is to identify the major injuries that related to the baseball players. Twenty-seven articles related with common baseball injuries in game situation, player position, training period were used for this study. The most common upper body injuries are happened shoulder, head, hand, and lower body injuries are occurred in the knee, ankle, and upper leg. The pitchers are common with upper body injuries and knee and collision injuries are common with defensive players including catchers. Non-game injuries usually occurs when recurrent of the movement and game injuries occurs when contacting while playing. Most of injuries occur in season of baseball training due to the heavy workload with high intensity and high volume of training sessions. This study provides knowledge about the nature of injuries, injury identification, and treatments in order to avoid injuries for performance development.

Keywords: Overuse, pitching, throwing, player position

1. Introduction
Baseball is a bat-and-ball sport where two teams of nine players alternate between batting and fielding while potentially inflicting intentional or unintentional damage on one another. It has become a well-known team sport in the United States (US), Japan, South Korea and Taiwan and has also caught on in Cuba, the Philippines, and Indonesia.
For the sake of convenience, baseball injuries may be split into numerous distinct types. Therefore, can be divided as player position, game vs. non-game injuries, overuse vs. non-overuse injuries, injury location and training season [1, 2, 3]. Pitcher and catcher are the most specific and injurious fielding player positions except other fielding positions [2]. Body parts that are most commonly injured as face, Shoulder, finger, ankle, and upper leg. Furthermore, the most common injuries reported in [4, 2] were strains, sprains, and contusions. The most of injuries has their specific injury risk factor. These injury variables are classified into two types as intrinsic and extrinsic factors. Intrinsic risk variables (age, race, and gender) are often not changeable, making them of limited value when seeking to intervene to avoid harm. The extrinsic risk factors are mostly connected to the game's environment as toughness of the baseball, the rigidity of the bases, and the safety gears utilized when fielding, batting, and base-running [3].
Therefore, this study will identify the most prevalent injuries that occur in game situations vs. practices, overuse vs. non-overuse, and player roles such as pitcher, catcher, infielder, and outfielder. Not only that, this study will identify the in which situation most injuries are happened and rate of injuries happen.
The current study aims to determine the frequency and type of injuries that can happen for Baseball players that do not arise during play. This information is crucial because understanding the prevalence, type, and causation of these injuries can assist reduce their occurrence by informing players, medical personnel, and coaching staff.

2. Materials and Methods
The approach for this systematic review was developed based on previously reported suggestions and results. The all-original data that included in this review, collected from published articles in Research Gate, Google Scholar, Science direct, and PubMed.

The articles found under the, American Journal of Sports Medicine, Encyclopedia of Sports Medicine, Journal of Sports Medicine, Journal Keolahragaan, Orthopaedic Journal of Sports Medicine, Br J Sports Med, JAMA, American Journal of Orthopedic, Journal of Athletic Training, Clinical Journal of Sports Medicine, Current Review in Musculoskeletal Medicine, Pediatrics. The published articles search was done by using the topics of baseball injuries, causes of baseball injuries, sites of injuries in baseball players and common player positions for baseball injuries.

False journals and papers that did not satisfy the standards were eliminated from the collection of articles. After a thorough assessment of the abstract, introduction, results and discussions, the suitable articles were chosen. References were used to identify additional articles in order to obtain more details and results. The baseball injuries were divided into subtopics based on their relevance with player position, movement of players, game situation, and training season.

3. Results & Discussion

To initiate, thirty-two articles were investigated to assess whether or not they reached the data demand. From those collections, twenty-seven articles were chosen. The existing articles did not comply with the requirement. Twelve of the nineteen articles discussed common baseball injuries, ten associated with injuries related to player position, four interacted with game situation and non-game situation injuries in baseball, three presented about training season, and five complied with activity-related baseball injuries. Responses from the seventeen papers covered during the various injuries in baseball of game situation, training period, activities, and player position. This review systematically elaborates these injuries under subtopics.

3.1 The most common injuries in baseball

Baseball players are particularly vulnerable to chronic overuse injuries as well as acute injury [5]. When compared to basketball and hockey, professional baseball and football have a greater number of epidemiological research [1].

The players in Baseball have the highest proportion of athletes in high school who require surgery, with the vast majority of these injuries impacting the elbow and shoulder caused by excessive use from throwing [6]. The injuries in upper extremity are fairly prevalent among baseball pitchers and other athletes. The elbow and shoulder injuries in youth players are predicted to occur at a rate of 26-35 per 100 pitchers each season [7]. In the studies of [8] shows that, the body parts that most frequently injured as head (12.3%), shoulder (17.6%), hand/finger (8.5%), ankle (13.6%), and upper leg (8.2%). As opposed, the most common injuries were characterized as sprains (19%), strains (23%), and contusions (17%) [4, 2]. In contrast to this study, another research has found that sliding injuries are common among baseball players [2].

Moreover, the knee injuries have become 6.5% of all injuries in professional baseball and the most frequent knee injuries reported were contusion (30.5%), patella tendinopathy (10.2%), and meniscal tears (9.2%) [9]. Furthermore, the pitcher's mound had the greatest prevalence of hip and groin injuries on the field [10].

According to the more articles, upper body (especially shoulder) injuries and lower body (especially ankle) injuries are the common injuries due to the over uses of the limb muscles and tendons in baseball.

3.2 Player Position vs. Injuries

The great majority of injuries are caused by noncontact methods across all positions, with pitchers representing for 60.3% of all injuries caused by overuse [6, 11, 8]. Comparably, the Pitchers have been shown to be more vulnerable to injury, particularly upper extremity injuries, than position players [5]. Especially Pitchers are the most likely to sustain elbow injuries that necessitate surgery. Thus medial elbow is the most typically injured site in the upper extremity, with ligament injuries necessitating surgery [12]. In contrast that [4] shows Upper limb injury representing for 58% of all injuries and the shoulder was the most commonly injured body area, with an average of a week of lost engagement time.

Furthermore, [9] investigated that, defensive players were most frequently knee injured (56.5%), with pitchers (17.3%), infielders (14.7%), outfielders (14.7%), and catchers (9.8%). Knee injuries while on offense (43.5%) were most frequent in base runners (24.4%) followed by batters (19.1%). The most common field location for knee injuries to occur was the infield, which was responsible (29.8%) of the total knee injuries. This was followed by home plate (22.7%), other locations outside those specified (18.1%), outfield (14.7%), pitcher's mound (9.7%), and foul territory or the bullpen (4.9%). Two studies of [7, 13] were investigated that personally elbow pain affected more than 25% of pitchers and personally shoulder soreness affected higher than 30% of pitchers. Similar studies of American players in youth and high school revealed a occurrence of elbow discomfort ranging from 18%-29% [14, 15], as well as an incidence of 26% among players in youth and 58% among players in high school [16, 17].

Especially, Catchers and base runners are particularly vulnerable to collision injuries during scoring plays. According to recent research, catchers sustain approximately 2.75 collision injuries per 1000 athletic exposures [18, 5]. Not only that [18] suggested as, the leg injuries were slightly more common in Major League Baseball (MLB) catchers than upper extremity injuries. In contrast that [4] discovered that when all players, regardless of position, were included, injuries in upper extremity were more prevalent than injuries in lower extremity.

The studies of [10] investigated that, hip or groin injury in both minor and major league players, Infielders were injured more frequently than outfielders, hitters, or base runners, and fielding was the most prevalent action at the moment of injury. Figure 1 depicts the injury recurrence rate for all players, pitchers, and fielders by year. According to [19], Young baseball players seldom have lower extremity injuries, while senior baseball players who slide frequently often sustain ankle and knee problems [20].

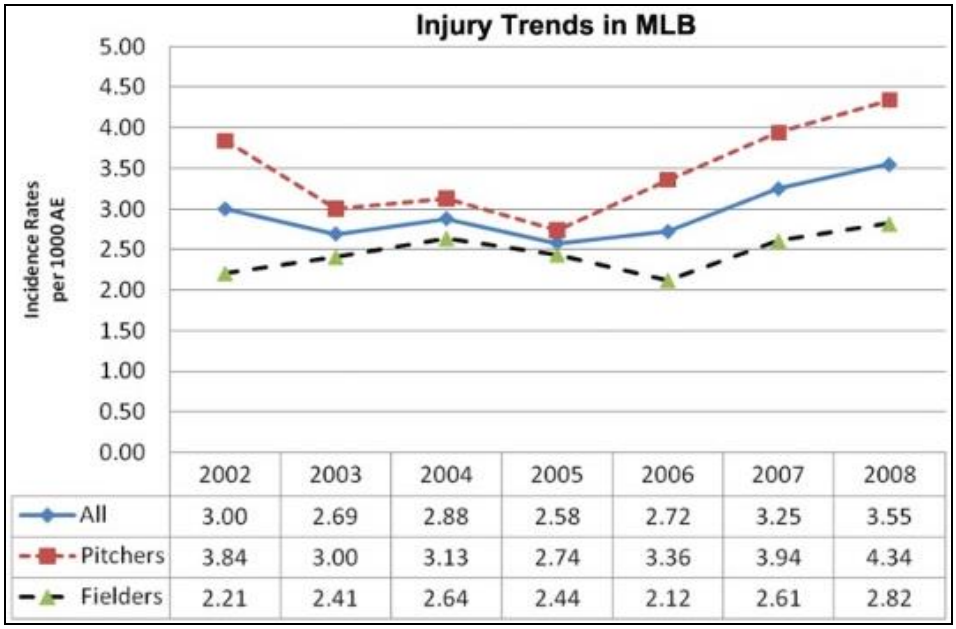

Fig 1: Injury incidence rates for all players, pitchers, and fielders by year [21]

Thus, pitchers, fielders, and other player positions respectively have the risk of upper body injuries and the base runners also has a risk of lower body injuries happen in baseball.

3.3 Game vs. Non-Game Injuries

The majority of game injuries were the result of contact, while 63.9% of practice injuries were non-contact. Base sliding, ball and bat contact, Base running, and player-player contact have all been described as causes of contact injuries in baseball [22, 2].

[1] investigated throwing was the most frequent injury activity recorded as a non-game injury was other (17%), followed by hitting and pitching (15%) and other (27%) and sliding causes knee injury frequently in older people. Similarly, Fielder and batter injuries are often acute traumatic injuries caused by contact with the bat, ball, ground, and another player. On the other hand, pitcher injuries, are typically the consequence of accumulated micro trauma caused by the recurrent throwing action [3], As non-game injuries, Throwing injuries made up the majority of injuries, with fitness and weight training accounting for only 25% of them [1].

Hence, Overuses of the same muscle during the game caused to the injuries of pitchers and throwers. Any situation of the game can be happened injuries with the contact of an object or surface. Less chance to get injuries non-game situations like fitness or weight training.

3.4 Training season vs. injuries

The 80% of professional baseball players' injuries occur throughout the season [1]. April have seen the greatest injuries to MLB players, while September had the least amount of injuries [5]. Furthermore the studies of [1] suggested that, there might be a variety of variables contributing to the high incidence of injuries in spring training, the most likely of which is the rapid rise in work-load. Injury incidence rates for all players by month of season are shown in figure 2. The large percentage (80%) of professional baseball players get injured throughout the season and it has explained a general analysis of whole injuries using the HITS database found that anterior or posterior tears of the superior labrum, elbow sprains, ulnar collateral ligament injuries in the elbow, and shoulder instability were the most common to end the season [23].

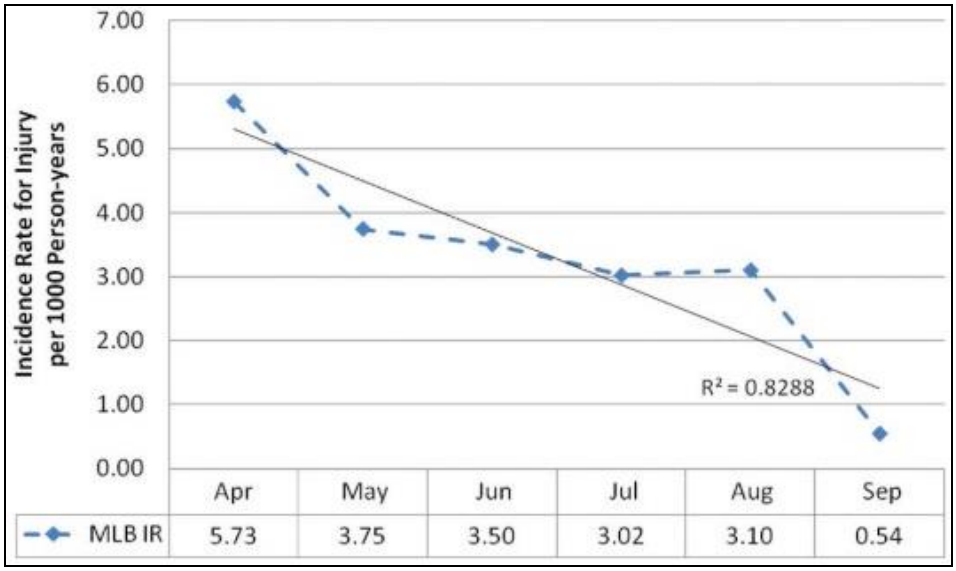

Fig 2: All-player injury rates broken down each season month [21]

Most of injuries occur in season of baseball training due to the heavy workload with high intensity and high volume of training sessions.

3.5 Maneuver vs. injuries

The pitching, hitting, fielding, and base running all had significantly greater percentages of game-related injuries than non-game-related injuries: 23.4% vs. 11.7%, 24.0% vs. 12.3%, 22.6% vs. 10.1%, and 21.6% vs. 4.3%, respectively. Contrarily, throwing, training, and other activities had considerably greater proportions of non-game-related injuries than game-related injuries: 29.8% vs. 5.3%, 13.8% vs. 0.2%, and 18.0% vs. 2.9%, respectively [1].

Base running and sliding are the main reasons why baseball and softball players get serious injuries. Quick deceleration during sliding into a base may cause sprains, fractures or ligamentous injuries in the hands and feet [24, 20]. During a single youth season fewer athletes had a face injury while batting. No information on the type and extent of the injuries was made public [3] Figure 3 compares the diagnoses of injuries that baseball players have received from batted balls to other baseball-related injuries. There are no previous studies on fielding injuries to evaluate. The most prevalent way that fielding injuries occur is believed to be by contact with the ground, the ball, another fielder, and fence [25]. A previous study of [26] conducted a research on the rate of batting injuries, however they only looked at face injuries. In this study, young players who covered their faces when hitting were compared to young players who did not. Its findings show that 5.3 out of every 100 players suffered a face injury while batting in a single youth season.

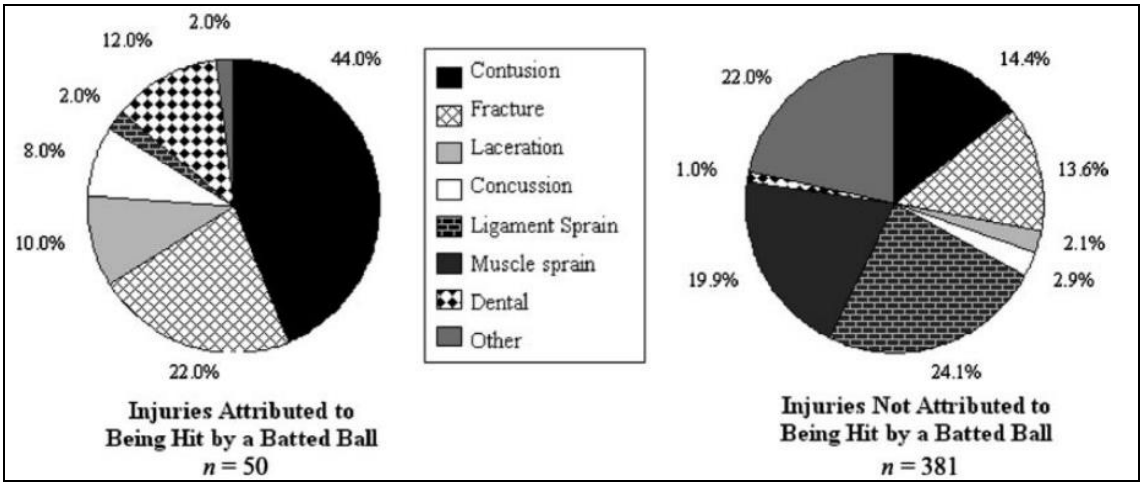

Fig 3: Diagnoses of injuries sustained when players were hit by a batted ball, compared with other baseball-related injuries [8]

Base running caused for the knee injuries and the upper arm movements (pitching and throwing) effect to the shoulder injuries. In addition, blood injuries can be happened due to the contact with equipment or surface while any situation of the game or practices.

Table 2: Summarized findings of articles

Author	Article name	Findings
[14]	Little League survey: the Houston study	The proportion of males exhibiting symptoms does not change considerably with the number of years thrown. Major injuries were observed at all levels of expertise ranging from one to five years.
[15]	Little League survey: the Eugene study	Pitchers' elbows were shown to exhibit flexion contractures, symptoms, and roentgenographic alterations associated to traction strains on a medial side of their elbow through a clinical and radiological assessment. more severe radial head or capitellum lateral compression evidence
[16]	Clinical study of baseball pitchers: correlation of injury to the throwing arm with method of delivery	The findings of this study show that the incidence of injury may be reduced if the underlying mechanisms were better understood so that alternate training and possible rule modifications could be implemented.
[25]	Protective Equipment for Baseball	The most prevalent way that fielding injuries occur is believed to be by contact with the ball, the ground, another fielder, or a fence. The injuries may be drastically minimized if players were encouraged to utilize adequate equipment.
[17]	Pitcher's elbow in adolescents	Throwing even slightly harder will result in micro trauma to muscle tissues, cartilage and ligaments. The overuse results are therefore clearly bigger than the hypertrophy anticipated following the same amount of vigorous exercise.
[20]	Softball Sliding Injuries	On the stationary-base diamonds, 45 sliding injuries (7%) occurred. On the breakaway-base fields, only two sliding injuries (1%) were reported.
[24]	Use of the Hollywood Impact Base and Standard Stationary Base to Reduce Sliding and Base-Running Injuries in Baseball and Softball	In comparison to the Hollywood Effect Base accident rate of 0.08% each game, the indicated breakaway base accident rate of 0.08% per game is favorable. The study's conclusions show that the Hollywood Impacts Base is equally successful in reducing the possibility of injuries associated to bases.
[4]	Epidemiology of collegiate baseball injuries	It has been proposed that shoulder and upper extremity injuries result in increased mobility among baseball players, particularly pitchers and infielders.
[26]	Acceptability of baseball face guards and reduction of oculofacial injury in receptive youth league players	The player position most prone to face injuries is the batter due to closeness to the pitched and batted balls.
[19]	Sports-specific concerns in the young athlete: Baseball	When it comes to musculoskeletal injuries, the emergency department doctor may see young baseball players who identify as having both acute and long-lasting elbow issues. The majority of

		these injuries are unique to the pediatric player.
[7]	Longitudinal study of elbow and shoulder pain in youth baseball pitchers	The elbow and shoulder pain examined in this study are both prevalent ailments among youth baseball pitchers. The causes of shoulder and elbow pain differ, any recommendations should be made only if avoiding discomfort in one location does not increase the chance of suffering in the other.
[13]	Effect of Pitch Type, Pitch Count, and Pitching Mechanics on Risk of Elbow and Shoulder Pain in Youth Baseball Pitchers	There is a higher risk of elbow and shoulder injuries in pitchers between the ages of 9 to 14, they should refrain from using breaking pitches (curveballs and sliders).
[22]	Impact Injuries in Baseball: Prevalence, Aetiology and the Role of Equipment Performance	It is unknown what effect altering a baseball's material properties would have on batted-ball velocity. Baseball bats have been found to decrease head injuries, though the application of protective gear to lessen the frequency and seriousness of cardiothoracic damage seems to be inappropriate.
[27]	Descriptive Epidemiology of Collegiate Men's Baseball Injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 Through 2003–2004	Despite the fact that 25% of injuries in college baseball are severe, it has a lesser rate of injury than other NCAA sports. Injury rates during games were three times greater than during workouts. Injury rates during preseason practices were considerable as those during regular season play. 10% of all injuries during a game were caused by contact with a hit ball, for a 0.56 injury rate overall. 13% of game injuries were caused by sliding.
[8]	Epidemiological features of high school baseball injuries in the United States, 2005-2007	The most often injured body parts were the shoulder (17.6%), ankle (13.6%), head (12.3%), hand (8.5%), baseball, injury, high school, and upper leg (8.2%). The most frequent injury diagnoses were fractures (14.2%), contusions (16.1%), and ligament sprains of the muscle (20.1%).
[21]	Epidemiology of major league baseball injuries	There was a 51.4% of all injuries included the upper extremities, while 30.6% involved the lower extremities. 11.7% of all handicapped list entries were due to injuries to the spine and core muscles, whereas 6.3% were due to other ailments and injuries. Pitchers suffered from upper extremity injuries at a substantially higher rate (67.0%) than did fielders (32.1%). Conversely, fielders (47.5%) had a larger percentage of lower extremity injuries than pitchers (16.9%).
[11]	Incidence of Injuries in High School Softball and Baseball Players	Softball players were more prone than baseball players to get injured during a game. The upper extremity sustained the greatest number of injuries. Pitchers were injured at a rate of 37.3%, while position players were injured at a rate of 15.3%.
[3]	Baseball Injuries	Injury severity, injury features, and injury risk factor were all considered while evaluating injuries.
[18]	Epidemiology of Injuries in Major League Baseball Catchers	Non-collision injuries were the most prevalent kind of injury to catchers. Compared to previously published rates for other player positions, catchers experience less injuries.
[10]	The Epidemiology of Hip and Groin Injuries in Professional Baseball Players	The most common action generating injury was a non-contact mechanism during defensive fielding (74%), while infielders had the most groin and hip injuries (34%). The most extra-articular injuries (96.2%) were managed non-operatively, concluding in an average of 12 days away from work.
[9]	Epidemiology and Impact of Knee Injuries in Major and Minor League Baseball Players.	Non-contact knee injuries were the most common (44%), while Injury rates were higher for base runners than for any other position (24%). The most prevalent locations for injuries were the infield (30%) and home plate (23%).
[5]	Predicting and Preventing Injury in Major League Baseball	Recent years have seen a significant increase in injuries to MLB pitchers and position players in general. Injury risk factors have been found, including shoulder ROM loss and pitch velocity.
[12]	Elbow Injuries in Professional Baseball	Pitchers had the highest rate of elbow injury (40.0%). The majority of individuals who needed surgery (34.2%) were pitchers. The medial elbow is the most commonly injured area, with ligament damage necessitating surgery.
[2]	Injury Prevention in Baseball: from Youth to the Pros	Baseball injuries primarily affect pitchers, but fielders and catchers are also at danger. Stretching and strengthening exercises are critical in reducing non-contact injuries in the lower and upper extremities.
[23]	Summative Report on Time Out of Play for Major and Minor League Baseball	The most often injured players were pitchers, but less than 40% of all injuries involved the upper extremities.
[1]	Analysis of Non-Game Injuries in Major League Baseball	In professional baseball, a significant majority of injuries happen off the field. Pitchers, in particular, are particularly vulnerable to these ailments.
[6]	A Review of Workload-Monitoring Considerations for Baseball Pitchers	Baseball demands a delicate balance between workload to boost performance and prevent injuries, recovery to prevent injury and overtraining, and both.

4. Conclusions

Many researchers executed scientific studies on baseball to learn more about the science of baseball injuries and the correlation between injuries and player position, though there are still significant limitations and common problems in applying injury predictions to baseball game situations. During pitching, batting, throwing, and base running, players' body muscles are constantly overloaded and overused. Different training approaches and strengthening are ways to prepare players' overusing muscles for game situations Therefore, injury prevention is also important to improve performance through the approaches.

Due to a lack of strength and overuse of the shoulder muscle groups are the most common site and muscles associated with most baseball injuries. This injury is most common among pitchers, outfield throwers, and infield throwers. Baseball game circumstances could lead to blood injury knee and ankle injuries, as well as other strain, and sprain, for base runners.

A single baseball player injury that has a significant impact on overall performance and results in a game. A sport bio-mechanist, sport doctors, and physiotherapist specifically examine identification, treatment, and prevention of injuries. Furthermore, coaches and players must be knowledgeable about background of injuries, injury identification, first aid, and treatment. Furthermore, they must be knowledgeable about strength and conditioning to avoid the injuries. The coaches should then be aware of these specific injuries in order to improve talent identification and player performance development.

5. Past Studies Finding

The following table will show the summarized view of the

above-mentioned literatures followed by the researchers used to gather the relevant theoretical knowledge. The reviewed articles are summarized according to the year of publication.

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