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Cheerleading injuries: A narrative review of the literature

Angela Bagnulo, BA, DC*

Background: *With its increase in participation rate and complex stunts and gymnastic-like maneuvers, cheerleading injuries are on the rise.*

Objective: *A structured narrative review of the literature was performed to discover the status of the literature on a growing yet under recognized sport. Cheerleading injuries are described in terms of distribution, etiology, and prevention.*

Methods: *A literature search was conducted. The articles were then reviewed and included based on broad criteria set out by the author.*

Results: *The search produced 87 articles related to cheerleading injuries or articles with a mention of cheerleading. A total of 26 articles were included in this review based on the inclusion criteria. The most common injury experienced by a cheerleader is an ankle ligament sprain.*

Summary: *The recognition of cheerleading as a sport and a mandatory reporting database are needed along with further research for injury prevention strategies to be implemented.*
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KEY WORDS: injury, cheerleading, ankle sprain

Antécédents : *Les blessures liées aux activités des meneuses de claque (« cheerleading ») sont en hausse en raison du nombre croissant de personnes s'y adonnant, des acrobaties complexes et des manœuvres de gymnastiques pratiquées.*

Objectif : *Une analyse de la littérature structurée et narrative a été effectuée afin de découvrir l'état des écrits portant sur un sport en pleine croissance, mais insuffisamment reconnu. Les blessures liées à la claque sont décrites en fonction de leur distribution, étiologie et prévention.*

Méthodologie : *Une recherche documentaire a été menée. Les articles ont par la suite été examinés et inclus en fonction de larges critères établis par l'auteur.*

Résultats : *La recherche a permis de recenser 87 articles portant sur les blessures liées à la claque ou qui mentionnent ce sport. Un total de 26 articles ont été inclus dans cette revue en raison du critère d'inclusion. La blessure qui survient le plus fréquemment chez les meneuses de claque est l'entorse du ligament de la cheville.*

Résumé : *Il est nécessaire de reconnaître la claque comme un sport, de mettre en place une base de données à déclaration obligatoire, et d'effectuer des recherches supplémentaires pour arriver à mettre en œuvre des stratégies de prévention des blessures.*
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MOTS CLÉS : blessure, meneuse de claque, entorse de la cheville

*private practice
3018 New St. #3
Burlington, On
L7N 1M5
drbagnulo@theproactiveathlete.ca

Introduction

Cheerleading is a rapidly growing sport with participation in the United States (US) increasing by approximately 18% per year and starting in athletes as young as 5 years of age.[1] Injury rates are also increasing due to the increase of gymnastic-like maneuvers used in cheerleading.[2] Reported injury rates are approximately 1-2.8 per 1000 athletic exposures.[2,3] Most of the literature focuses on catastrophic events utilizing data gathered from hospitals in the US.[4-6] Few studies have looked at the more frequent and pervasive musculoskeletal injuries. This may be due in part to the lack of mandatory reporting in the sport.[2] From the available literature on cheerleaders, the most commonly injured area is the ankle, with a prevalence of 44.9%, and the most common type of injury being a sprain.[2] One of the most commonly suggested causes of ankle injury is the practice surface.[7]

The purpose of this narrative review is to identify the injuries that occur due to the high physical demands of a cheerleader and to create awareness for chiropractors and other health care professionals treating the neuromusculoskeletal system, who may encounter a cheer-related injury in practice. This is achieved by identifying injury distribution, etiology, and prevention of cheerleading injuries.

Methods

A literature search was conducted to indentify all articles related to the topic of cheerleading injuries. All articles were considered based on the paucity of literature on this topic. The following databases were searched; Medline, CINAHL, SportDiscuss, ICL, Mantis, PedRo, Rehabilitation Reference Center, Cochrane, and Pubmed. Search terms utilized were 'cheer,' cheerlead*,' and 'injur*.' Controlled vocabulary was used when available and reference tracking was performed for any articles potentially missed throughout the search. The articles were then reviewed and included based on inclusion criteria. The inclusion criteria were any article that was about cheerleading or that gave a significant mention to cheerleading in the body of the paper without a limit on the year of publication. Articles also had to be in written in English and published in a peer-reviewed journal. Case reports, surveys, narrative reviews and clinical trials were included in this study.

Results

The search produced a total of 87 articles related to cheerleading injuries or articles with a mention of cheerleading. Sixty-four of those articles were duplicates and articles that were not peer-reviewed or were irrelevant to the purpose if this paper, and therefore were excluded. A total of 23 articles were included in this review with the word 'cheerleading' or 'cheerleader' in the title or an article regarding sports with a significant mention of cheerleading in the paper. Seven other articles were included in this review on gymnastics, and lower limb biomechanics to help support some issues related to cheerleading which was absent in the literature when searching 'cheerleading' alone.

Discussion

Is cheerleading a sport?:

The National Collegiate Athletic Association (NCAA) was developed in 1906 to protect its athletes but cheerleaders are not included under this realm.[8] Although not recognized as a sport by the NCAA, a study by Thomas et al in 2004, demonstrated that the physical fitness of a cheerleader is similar to that of any other collegiate sport by comparing results on various physical tests (push-ups, V02 max, body composition, etc). Just like any other varsity sport, cheerleading has summer camp, tryouts, regular practice schedules and competition. Comparable to gymnastics, a high level of strength, agility, power, and flexibility are required for the acrobatic-like maneuvers, cheerleading stunts and pyramids.[9] Sports injuries are occurring and it is to be expected that similar injuries can occur in cheerleading.

Distribution, frequency and associated factors of injury:

Epidemiology is where the majority of the research exists on cheerleading and studies are conducted through individual reports or surveys to estimate injury distribution.

In 2004, Jacobson et al conducted two survey studies at universities across six athletic conferences in the United States and at 104 high schools in the Midwestern United States. Injury rates and data presented similar results between high school and collegiate athletes, and between other athletes participating in different sports at the same level. High school cheerleaders experienced an average

of 3.8 injuries throughout their careers comparable to 3.5 at the collegiate level. Cheerleaders experiencing injuries over 12 months represented 41.2% at the high school level and 39.7% in college with at least one missed day by 41.3% and 46.7% of cheerleaders respectively.[2,10]

In 2009, Shields et al conducted two prospective survey studies looking at cheerleading injuries related to type of team and event. Both studies gathered data from the same population; 412 cheer teams across America consisting of 9022 cheerleaders 3-29 years of age. Data was collected online by each team who had a reporter submit weekly injury report data over one year. From this data two papers were written, one paper covering stunt-related injury and the other reporting on fall-related injury. In both studies, 83% of injuries occurred during a practice versus an athletic event or a competition. The most common mechanisms of injury were basing or spotting (24%), failure to complete a maneuver (15%), tumbling (15%), and falls (14%).[4,11] Falls occurred from an average of five feet and were on a foam floor only 38% of the time versus a gymnasium floor or grass, etc. Forty-three percent of falls involved more than one cheerleader during the maneuver. The most common age for a fall to occur was in high school cheerleaders compared to All Star or recreation league, elementary school or collegiate level (51%).[11] The most common injuries experienced by this population of cheerleaders were a strain or sprain of the ankle (15%), neck (7%), lower back (5%), knee (5%), and wrist (4%). When sprains/strains occurred from a fall, the ankle and neck was the most common site affected (18%, 13% respectively). This differed depending on what level of cheerleading was considered. Interestingly, All Star cheerleaders who solely practice and compete, without participating in athletic events, were more likely to injure the upper extremity and to experience a fracture/dislocation. The overall average injury rate calculated per athletic exposure was 13.3 injuries per 100,000 athletic exposures for fall-related injury and 0.57 per 1000 athletic exposures for stunt-related injuries. Majority of injuries are treated at the scene of injury (32%) and about 22% were taken to the hospital for emergency care with injures such as cartilage, ligament, or tendon tears; a dislocation; and a herniated disc.[4] When looking at time lost, 46% of cheerleaders were able to return to the next performance or practice while 50% had an average of 2.5 weeks off, 3% were prohibited from participating the remainder of the season and two athletes indefinitely, the majority being high school cheerleaders.[4,11] Data above come mainly from stunt-related injuries because fall-related injuries are less common but it is important to note that they can be more severe including concussions, fractures, dislocations and death, which was not reported in these two studies.[11]

A smaller study by Schulz et al followed 1675 competitive high school cheerleaders across North Carolina for three years (1996-1999). A total of 1115 cheer-related injuries occurred over the three years with 43.5% keeping a cheerleader out of participation for a week or more, and 28.3% resulting in a visit to an emergency department. Fifty-six percent of injuries occurred during a stunt or pyramid due to a fall from a height and contact with another team member. The most common injury types were a sprain/strain (539) and a fracture/stress fracture (193). Overall, an ankle sprain was the most common injury experienced (231). These results correspond to those of Shields in 2009. A key difference between the findings of these two papers is overall injury rate. The injury rate found by Schulz et al were higher (8.7 per 10,000 athletic exposures) than those of Shields due to the addition of teams in the Shields study with lower levels of cheer experience and decreased difficulty of stunts.[4,11,12]

Across all studies, the most common injury is an ankle sprain. Neck, lower back, knee and wrist sprains are also highly prevalent.

Sprains/strains:

In any sport, and as mentioned above in cheerleading, the most common type of injury is a muscle strain and ligament sprain, specifically to the ankle. This is not surprising based on the high demands on the musculoskeletal system.[3]

The most current paper on sprain/strain injuries in cheerleaders was published in 2010 by Shields and Smith. It looked at athlete exposure and injury data from 412 US cheerleading teams. Results showed that stunts (34%) and tumbling (32%) were the most common mechanisms of sprain/strain injuries followed by tosses, pyramids, jumps, and dancing.[3]

With the gymnastic-like maneuvers performed in cheerleading it is reasonable to assume that joints are under immense loading and require dynamic stability in order to prevent ligament sprain. A pre/post study

by Rowe et al in 1999, looked at the effects of a two-hour cheerleading practice on dynamic postural stability, anterior knee laxity, and hamstring extensibility to investigate the risk of ACL injury in cheerleaders. Measurements were taken with the Biodex tilting platform system, an arthrometer, and a goniometer respectively which the authors have tested and confirmed reliability for their usage. Subjects were 17 male and female cheerleaders between the ages of 18 and 25 who train for two hours, four days per week. Anterior knee laxity increased 20-25% and hamstring extensibility increased by three degrees post training. The increased muscle length and possible fatigue will make it more difficult for the body to stabilize the knee in response to a lax ACL. The investigators also found an increase in medial and lateral postural sway of 2.9 degrees on the Biodex platform providing preliminary data to suggest susceptibility to ACL injury based on lack of control in the subtalar joint and tibial internal rotation. This increase in sway was not found in other planes. A weak positive relationship between increased anterior knee laxity and medial-lateral mean deflection change was found ($r = 0.58$, $p=.016$). Although statistically significant, it may not be clinically significant and further studies are required with a larger pool of subjects to detect a difference. The muscle extensibility should be confirmed with EMG studies and joint motion studies to get a better idea of risk and tailor injury prevention programs accordingly.[13]

Catastrophic Injuries:

Unlike the previously mentioned papers on musculoskeletal cheerleading injuries, data for catastrophic injury are available through hospital data, specifically The National Center for Catastrophic Sports Injury Research (NCCSIR). Although not the most common of injuries, catastrophic injuries are significantly prevalent in this sport.

The NCCSIR database was examined by Boden et al in 2003, for reported injuries that occurred in cheerleaders from 1982-2002. Catastrophic injuries included 17 severe head injuries, resulting in 13 skull fractures and two deaths; eight cervical fractures or major ligament injuries; three spinal cord contusions; and one head injury with a cervical fracture. The most common mechanisms for these injuries were pyramid and basket toss.[7]

The first study to investigate concussion in cheerleading reported a rate of 11.32 per 100,000 athlete exposures.[14] This represents a rate of concussion at a North Carolina high school cheer practice, which was comparable to other sports team's rates during games, for example soccer and wrestling with respective rates of 19.91 and 15.96.[14] Numbers are high considering rates are likely underreported due to the ill-defined definition of concussion. Significant differences exist between cheer practice and competition that may justify the greater occurrence of concussion during practice. Practices are lengthy while competition lasts only minutes yet both qualify as one athletic exposure. Also, competition requires a mandatory amount of spotters being present which is not controlled during practice.[14]

According to the NCCSIR, collegiate cheerleading accounts for 70.5% of all female catastrophic sports injuries and high school cheerleading accounts for 65.2%. This outweighs any other female sport in the amount of catastrophic injuries. From 1980 to 2007 the number of hospital visits for cheer injuries increased from 4954 to 26,786.[7,8,11]

Etiology:

Cheerleading injury is caused by the high demands to the musculoskeletal system with its gymnastic-like maneuvers and potential to fall from a height or collide with team members. There are no studies present specifically investigating the etiology of cheer-related injuries but theories based on authors' suggestions on contributing factors are evident in the literature.

One theory that has been investigated in other sports is the landing technique of female athletes. Landing patterns affect how the body absorbs energy and force. Proper landing requires controlled actions of the muscles of the abdomen, hips, thighs, lower leg, and feet.[15] A flexed position of the hip, knee, and ankle allows the muscles, rather than the joints, to absorb most of the ground reaction force as it is transmitted up the kinetic chain.[15] Despite this benefit of landing in a flexed position, at initial ground contact, female athletes assume a more erect position compared to their male counterparts. It has been suggested that females may attempt to dissipate the forces over a wider range of joint motion and that in an erect position, they have a muscular landing strategy that allows energy absorption from their ankle plantar-flexor muscles.[16] This extended position highlights a potential key risk factor for ankle injury in the female athlete due

to a decreased ability to absorb ground reaction forces during landing. The landing mechanics of female athletes and the repetitive nature of cheerleading, further increase the risk of injury to the ankle when practice stunts are performed on a hard vinyl floor. Muscles provide shock absorption, but when fatigued, the ligaments and bones of the ankle experience significant stress and strain due to the impact of the hard surface.[15,17,18]

Other factors contributing to injury in cheerleaders are their long season, various practice surfaces, weather conditions, and the distraction of loud crowds and music.[19]

There are reports on eating disorders among high school cheerleaders due to the weight limits and the small uniform that exposes the stomach and legs. Malnutrition and significantly low body mass may contribute to injuries in this particular age group. In a survey study on dieting, body dissatisfaction and eating problems in female high school cheerleaders, Thompson found that 46% were trying to lose weight, 44-73.5%, depending on their race, reported body dissatisfaction, and 13.5% had a possible eating problem. Thompson concluded that cheerleaders were not more likely to have eating disorders or distorted body images than other female adolescents and that high school females are at 'high risk' for eating disorders.[20]

Prevention:

The NCAA Injury Surveillance System (ISS) is currently the largest collegiate athletic injury database. An injury database is a resource to base safety and risk management decisions and to further injury prevention research. The ISS provides a foundation for decision-making and policy development at both the institutional and association level.[21] There are no mandatory reporting systems or an injury database for cheerleading injuries and cheerleading is not included in the NCAA ISS therefore the primary goal for injury prevention is recognition of cheerleading as a sport by all educational institutions. Although cheerleading has been around since the 1960's, it has only recently become a sport involving gymnastic and acrobatic maneuvers that have significantly increased the amount and severity of injury. This necessitates control in guiding the rules and regulations especially at the university level where more difficult stunts are being performed and this can only be possible if cheerleading is supported and recognized as all other varsity sports are. Being under regulation of an athletic department will aid in injury prevention including mandating qualified coaches, certified athletic trainers, number of spotters, restricting those who are less experienced from pyramids and basket tosses, and providing safer practice locations and times.[7,8] A 40% decrease in injury has been shown when trained coaches are present.[14] Parents of cheerleaders have founded the National Cheer Safety Foundation to help manage risk in their cheer athletes. They have created a website that allows for cheer injury reporting and support for cheerleaders and parents. This foundation is setting the stage for injury prevention, and hopefully after some time it will have gathered enough data to influence the school systems and cheerleading organizations to offer their support.[8]

Studies are available to demonstrate that an exercise program can prevent sprain and strain injuries.[3] In 2011, Greenstein et al introduced a closed chain, eccentric training program to a professional football cheerleading team to prevent hamstring injury which, to date has been the only trial looking at prevention of injury in cheerleaders. This study found that the specific exercise program prescribed might decrease hamstring injury among professional cheerleaders.[22] Hamstring injuries occur in 31% of professional cheerleaders.[22] Professional cheerleading and high school or collegiate cheerleading all perform gymnastic-like maneuvers during a routine and therefore this study can be applied to all cheerleaders. It is important to identify that hamstring injuries may be more common in professional cheerleaders because they spend all of their time dancing and performing gymnastics and no time on stunts or pyramids. Further studies are required examining the effect of an exercise program on the prevention of injuries commonly in high school and collegiate cheerleaders such as ankle and knee ligament sprains.

As previously mentioned, cheerleading injuries occur most commonly during the months of practice preparing for competition.[7] Practice takes place on a hard gymnasium floor made of vinyl or rubber, and polyurethane, designed for sports such as volleyball or basketball, and activities such as aerobics.[23] Spring flooring was introduced in 1997 at the first National cheerleading competition held in Atlanta. The goal of the spring floor was to decrease the injury rate. It is composed of springs between two layers of wood, covered with a carpet-topped foam. While meant to provide bounce, it has also been suggested that the spring floor may also attenuate peak

vertical and impulse forces.[23] When compared to a vinyl-tiled floor, a spring floor was shown to decrease the risk of head injury due to its shock-absorbing capacity. This was determined using a device (Triax) that could calculate critical heights. The Triax consists of a tripod that suspends and drops a device that can measure the height, time, and impact velocity. Critical height for a wooden gym floor and dry grass were both calculated to be 4.5 feet and 0.5 feet for concrete. More than 11 feet for spring and foam but exact height was not determined due to the limited height of the tripod. The Triax only gathers vertical information and it assumes that the head would hit the ground initially during a fall, so this information should be interpreted with caution or used as a conservative measure to guide height restrictions on particular floors. Since grass has a lower critical height value than expected, more difficult stunts should not be performed on grass and attention should be paid to temperature and weather that can change the absorbing-capacity of the surface.[23]

Surfaces have been suggested to increase the risk of injury in sport along with improper jumping mechanics.[2,7,17,23-25] The introduction of a spring floor and its ability to absorb energy may compensate for the smaller amounts of absorption seen in female athletes when landing in an erect posture and help compensate for mechanical problems related to fatigue. This could translate to a decrease in the risk of ankle, or other lower limb injury.[23]

Other injuries:

Cases found in the literature include splenic rupture in a 16-year-old female from being tossed in the air and caught[26]; coxa saltans/snapping hip syndrome in a 16-year-old high school cheerleader due to overuse from twisting maneuvers of the hip[27]; bilateral ganglion cysts and triangular fibrocartilage tears in a 19-year-old cheerleader that developed gradually over four years from ulnar abutment syndrome[28]; and a 17-year-old cheerleader who sustained bilateral ACL tears on an awkward drop landing[29].

In 2001, Wolford described the diagnosis and surgical treatment for Cheerleader Syndrome; also know as idiopathic condylar resorption. Although common in cheerleaders, this condition is not exclusive to cheerleaders. Idiopathic condylar resorption occurs in females less than 20 years of age participating in sports and experience trauma to the jaw. Resorption of a mandibular condyle occurs due to systemic, degenerative, inflammatory, and traumatic causes, which then causes occlusal and musculoskeletal instability, resulting in TMJ dysfunction and pain and dentofacial deformities.[30]

Limitations:

Studies presented here are not without limitations. All of these studies were performed in the United States and therefore are not representative of the population as a whole. Rules and regulations exist in various cheer organizations but none are enforced worldwide so they change from state to state and country to country. Also, no list of all cheer teams exists to recruit teams to gather data from so, whenever cheer teams are recruited for a study the population is never a true representation.

The epidemiology papers are where most of the data is concentrated. These contain retrospective data from hospitals and coach or trainer reports. Limitations always exist when relying on recall and one can expect that injuries be highly underreported especially when considering concussion and its ill-defined definition. Although hospital data is reliable, most injuries do not require a hospital visit and if they do, the notes are often lacking useful detail pertaining to the event such as location, type of stunt, number of spotters or coaches, etc. Similarly with prospective survey studies relying on trainers or coaches reporting the injuries again may be underreported. This limitation stresses the need for a mandatory reporting system like those of other sports, as a stepping-stone to further research and prevention strategies and for evidence-based safety recommendations.

Summary

As evidenced by this review, the literature on cheerleading is sparse. It is known that lower limb injuries, specifically to the ankle, are common in cheerleading and due to landing mechanics, surface, and difficulty of maneuver. Although very little literature supports that an exercise program may prevent injury, it is worth implementing until further research is conducted on causation that will then lead to appropriate prevention strategies. It is also known that catastrophic injuries are on the rise and suggestions on rule change and updates on regulations regarding stunt and surface restrictions seem reasonable. Unfortunately these recommendations may not be en-

forced until cheerleading is recognized for the sport that it is. Like the National Cheer Safety Foundation, parents, athletes and health care professionals must take the time to be well educated on the sport, the potential for injury and possible preventative methods.

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