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PHYT875

Adv. Ortho. Assessment and Treatment

**Little League Elbow: Diagnosis, Prevention & Treatment**

Baseball, frequently described as “America’s favorite past time”, is a sport loved by many. The career of a baseball athlete often begins at a young age competing on little league teams across the nation. In fact, 5.7 million children in eighth grade or lower in the United States participate in the organized sport of baseball1. The demands of this sport include repetitive, high-velocity overhead throwing placing many youth at risk for injury. While the incidence of known overuse injuries in baseball of all ages is only 2-8% per year, overuse injuries occurs in approximately 20%-40% of pitchers ages 9-12 years old1,2. These numbers represent the risk young athletes are facing that can lead to a lifetime of disability and dysfunction. Over the years, Little League Elbow has been a hot conversation topic in the world of sports. Due to sports specific demands and competitiveness of the game, young athletes are placed at risk for developing injuries affecting their ability to participate in this sport long term, in addition to the onset of functional disabilities. The purpose of this paper is to define this condition in terms of anatomical dysfunction and diagnosis, identify preventive measures that can be taken in the clinic, on the field, or through education, conservative treatment options, as well as a brief list of differential diagnoses that may present similarly to this condition.

Little league elbow (LLE) is an injury to the medial epicondylar apophysis caused by repetitive valgus stress to the medial elbow3. This injury is most common in pitchers, but can also occur in catchers, infielders, and outfielders. Repetitive microtrauma leads to a delayed or accelerated growth of the medial epicondyle, traction apophysitis and medial epicondylitis2. The significance of these conditions in regards to younger athletes is the involvement of the growth plate. LLE is one of the most severe injuries seen in young throwing athletes and can lead to chronic pain and growth deformities negatively affecting an athlete’s sporting future1.

This condition occurs in children and teenagers involved in sports that require repetitive throwing motions. It is more common in younger athletes due to “weaker physeal cartilage at growth centers, muscle tightness associated with rapid long bone growth, increased laxity of soft tissues structures, and decreased development of neuromuscular movement patterns”4, pg 631

**Anatomy**

To better understand this injury, it is important to understand the anatomy and biomechanics of the elbow joint. The elbow is a complex hinge joint composed of three separate articulations: the ulnohumeral joint, radiohumeral joint, and radioulnar joint12. Flexion and extension occurs at the ulnohumeral joint with motion ranging from approximately -15-0 degrees of extension to 150 degrees of flexion3. 85 degrees of supination and 75 degrees of pronation occurs at the radioulnar joint2. Additionally, slight laxity of 3-4 degrees of varus-valgus movement is considered normal2.

The elbow joint is unique in that there are many static and dynamic stabilizers that provide support to this joint. The static stabilizers include bony articulations, joint capsule, and ligaments. The medial ligamentous structure supports the elbow joint during valgus stress and includes the ulnar collateral ligament complex including the anterior oblique bundle, posterior oblique bundle, and transverse ligament2. The lateral ligamentous structure supports the elbow joint during varus stress and consist of the lateral collateral, lateral ulnar collateral, and accessory lateral collateral ligaments2. The muscles that cross the elbow joint include the triceps, biceps, and brachioradialis2. The wrist flexors and pronators provide additional support against valgus stress and the wrist extensor and supinators provide support against varus stress2.

In the adolescent elbow, numerous ossification centers and cartilaginous physes are present that ossify at various points of growth3. The mnemonic CRITOE (capitellum, radius, internal epicondyle, trochlea, olecranon, external epicondyle) is frequently used in literature to assist health care providers in remembering the order of appearance and ossification of growth centers2 (See APPENDIX 1). The medial epicondyle is one of the last growth plate structures of the elbow to close which occurs around age 15 and on that is most impacted by LLE 2,5. These growth plates are made up of cartilage3. With repetitive motion and not enough rest, the cartilage weakens and injury to the growth plate occurs leading to disruption of bone growth potentially causing a shorten limb if the entire growth plate is affected or asymmetry with in a joint if only a portion of the growth plate is affected leading to abnormal stresses and further injury within the joint3. . Once full skeletal maturity is achieved during the late-teens, ligaments becoming the weaker link in the structure and ligamentous injuries such as ulnar collateral ligament sprains are more common2.

**Mechanism of Injury**

The LLE injury is common in young baseball pitcher because of the anatomy of the ossifying elbow, but more importantly because of the mechanism of stress that is applied the elbow during a pitch. There are six phases of a baseball pitch including the windup, stride, arm cocking, arm acceleration, arm deceleration phase, and follow-through6 (See APPENDIX 2). Overuse injuries, such as little leagues elbow, is caused by repetitive microtrauma caused by the large forces and torques exerted at the elbow during a pitch6. During the late cocking and early acceleration phase, a valgus strain is highest at the elbow with approximately 87 degrees of flexion with a maximum valgus torque of 18-28nm (compared to 90-120nm in adult pitchers)7. Because of this, risk of injury to the medial elbow is higher during this phase of throwing.

A valgus stress occurs during the throwing motion of a pitch resulting in a tensile stress of the medial structures including the epicondyle, epicondylar apophysis, and collateral ligaments2. The valgus overload is accompanied by a high magnitude of angular acceleration and moment of inertia causing compression of lateral structures including the capitulum and radial head8 (See APPENDIX 3). Repeated stress without appropriate rest time causes tissue breakdown to exceed tissue repair leading to injuries such as LLE causing instability, abnormal pressures, inflammation, and pain.

**Diagnosis**

Early recognition is key to successful outcomes and prevents the onset of functional disabilities2. A comprehensive evaluation should include, but not limit the onset of pain, period of skeletal maturity, volume and velocity of pitching, and other sports participation. The repetitive microtruama that leads to the onset of LLE is associated with a host of symptoms. Observation of ecchymosis, muscle atrophy, and presence of increase carrying angle will assist in identifying a pathology7. While a carrying angle of 5-10 degrees on the dominant throwing arm in common in older experienced pitchers, a contracture at a younger age may be indicative of a chronic injury. Key identifiers that can assist in early diagnosis also include the onset of medial elbow pain, commonly during the acceleration phase of throwing due to the increase of medial force, and decrease in throwing velocity, form, and distance5. Progressive tenderness over medial epicondyles is typically one of the first signs of injury onset in addition to pain with resisted wrist flexion due to the attachment site of this musculature5.

Anterior-posterior and lateral radiographs are effective in identifying medial elbow joint injury. Because this injury effects the growth plate, comparing radiographs to the contralateral side will assist in identifying a physeal line abnormality on the affected side5. Radiographic imaging can also identify possible avulsion fractures, bone spurs, and osteochondritis7. A detailed diagnositic algorithm has been developed by Gregory et al to assist in clinical management decision making7 (See APPENDIX 4).

**Prevention**

Education and protection are two concepts critical to injury prevention9. Injuries such as LLE can prematurely end a baseball career and it is the responsibility of athletes, parents, coaches, and health care providers to implement protocols to avoid the onset of this condition1.

Identification of modifiable and non-modifiable risk factors may assist in the initiation of preventative measures, including technique training and pre-rehabilitation, to decrease the risk of future injury. Anatomical risk factors such as athlete height, bodyweight, a decrease in available glenohumeral abduction and internal rotation range of motion and an increase in available external rotation and horizontal flexion have been correlated with increase valgus torque in youth pitchers7. While evaluation and critique of throwing mechanism can assist in decreasing the valgus load applied to the elbow, additional preventative methods have been identified to decrease an athlete’s risk of injury.

Research has found an increase in shoulder and elbow injuries with higher volumes of pitching9. USA Baseball Medical and Safety Advisory Committee guidelines developed game-time pitch count recommendations to decrease the risk of overuse injuries and protect children who play the sport10 (See APPENDIX 5)**.** These recommendations were developed in 2006, modeled after similar guideline developed by Japan in 19951. Pitch count recommendations for athletes age 9-10 include 50 per game, 75 per week, 1000 per season, and 2000 per year. For youth ages 11-12, recommendations include 75 per game, 100 per week, 1000 per season, and 3000 per year. Finally, 13-14 year olds should pitch no more than 75 per game, 125 per week, 1000 per season, and 3000 per year9, 10. Recommended pitch limitations only apply to games and do not include pitches during practice or warm-up to allow for appropriate training time and proper development of technique which is critical for injury prevention. Unfortunately, a recent survey by conducted by Ahmad et al indicated that 28% of players, 25% of patents and 31% of coaches reported that they do not believe that the number of pitches thrown is related to injury11. Compliance to limiting the number of pitches in youth is not adhered to by players, coaches, and parents due to numerous factors including lack of resources to track and manage data1. The results from this survey indicate that further education is required for athletes, parents, and coaches on the importance of limiting the number of pitches and on the risk and long term negative outcomes of not following these recommendations can have on these young athletes. Future research should identify realistic methods to assist in managing pitch count numbers throughout a season.

Additionally, this committee has developed further guidelines to protect youth pitcher by recommending competing no more than 9 months in a year to allow for rest and recovery, discouraging specialty pitches which includes curveballs and sliders, developing and maintaining good mechanics and ball control, participating in only 1 performance as a pitcher per day, avoiding showcase participation, and limiting participation to 1 team per season10.

Pitching velocity has also been heavily correlated to increase in elbow injuries in youth athletes. Based off a study of 750 youth baseball players, Axe et al presented average speed and distance of pitches for athletes ages 8-149(See APPENDIX 6)**.** For athletes who have the skill to throw above the average value of their age group, they are at an increased risk for developing an injury. According to the chart developed by Axe et al, athletes who are 3-5 standard deviations above their age group average for speed and distance of a throw, these athletes should be protected by abiding by pitch count guidelines 2 years younger than their age9.

Another preventive measure that can be taken to avoid LLE is the avoidance of early sports specialization and year-round training. Longer competitive seasons and higher intensities lead to an increase risk of injury in pediatric athletes due to the immature musculoskeletal system2. Allowing for periods of rest and/or cross-training with a sport that does not include overhead activities will allow tissues to rest and recovery of micro-injuries. Sports such as javelin throwing, football quarterback, softball, competitive swimming etc. should be avoided in the off-season because these sports still requires use of overhead activity10.

Additionally, a proper conditioning and training program can ensure correct throwing technique and decrease the risk of injury2. Axe et al has developed an interval throwing program from athlete’s ages 8-12 years old to assist in the transition from the clinic to the field and from off-season to pre-season9. This protocol gradually re-introduces sport specific demands athletes may experience in competition to ensure readiness to return to play9 (See APPENDIX 7a and 7b).This program consist of 4 phases: return to throwing, return to pitching, intensified pitching, and a simulated game to gradually progress toward return to play. Advancement through the program is determined by the “soreness rules” (See APPENDIX 8**)** which details appropriate progression and rest time based on the onset and duration of soreness9

Education for players, coaches, and parents on recommending pitching limitations and appropriate conditioning, training, and resting protocols can decrease the risk of youth athletes developing injuries such as LLE.

**Treatment**

Initiation of conservative treatment early in the rehabilitation phase has been proven to lead to positive outcomes. A rehabilitation program should consist of regaining full range of motion, strength, muscular endurance, dynamic stabilization, neuromuscular control, and a return to play protocol such as a progressive throwing program (Refer to PREVENTION Section)9. Crowther et al recommends 4-6 weeks of rest with no throwing in conjunction with ice and NSAIDs to decrease inflammation in the area. Elbow and shoulder strengthening followed by a gradual return to throw program once strength and range of motion have returned5.

Shanely et al provides a detailed four phase rehabilitation program for upper extremity injuries to return athletes to play. The initial phase of treatment should include relative rest with no throwing to avoid additional harmful stresses to the elbow joint. During this phase, reduction in inflammation, restoration of range of motion and flexibility via joint mobilizations and gentle range of motion, in addition to continuation of core and lower extremity conditioning to maintain flexibility and sports specific neuromuscular control4. Shanley et al recommends progression to the next phase of rehabilitation once range of motion without pain at rest, pain no greater than 3/10 with activity, and at least 90% of elbow range of motion is achieved4.

The second phase of treatment continues to focus on regaining full range of motion and the initiation of strength and muscular endurance activities4. Techniques such contract-relax and rhythmic stabilization can be utilized during this phase to promote quality neuromuscular control. Indication of readiness to progress to the next phase of rehabilitation includes pain free motion with all activities, symmetrical joint motion when compared bilaterally, improved strength to at least 70% of the uninjured extremity (measured via hand held dynamometer, and results indicating less than 15% impairment on a functional outcome measure such as the Quick Dash4.

The third phase of treatment is focused on preparing for return to play. During this phase, strengthening, endurance, and neuromuscular control activities are intensified to mimic sports specific demands, yet in a protective environment4. Activities such as plyometrics, advanced core strengthening and lower extremity balance tasks will challenge athletes control and prepare for the initiation of return to sport4.

The fourth and final phase of treatment includes sports specific drills and the initiation of an interval throwing program as described in the prevention section of this paper4. A gradual return to sport will ensure full recovery and readiness to accept game related demands. An example of this rehabilitation program can be found in Appendix 9.

**Differential Diagnosis**

LLE is not the only potential cause of pain on the medial aspect of the elbow. Health care providers must rule out other common elbow injuries including avulsion fractures of the medial epicondyle and sprains or complete tears of the ulnar collateral ligament2. These injuries typically result in acute onset of pain with a known mechanism of injury. A medial epicondyle fracture can be identified with point tenderness and swelling directly over the medial epicondyle with a elbow flexion contracture of more than 15 degrees2. UCL injuries present similarly to LLE, however, these injuries occur more frequently in skeletally mature teenagers2. Ulnar neuritis, which is compression at the ulnar nerve, and C8-T1 radiculopathy can also lead to medial elbow pain and should be ruled out via neurological testing and an upper quarter screening evaluation. Additionally, proper identification of pain source could lead to injuries of the posterior or lateral elbow including osteochondritis dissecans (OCD) of the capitellum and Panner disease. OCD occurs from repetitive lateral compression with a report of dull lateral elbow pain with associated clicking or popping sound. Panner’s disease usually occurs in children age 7-12. This condition is defined as osteochondrosis of the capitellum and presents as dull, achy pain that occurs with movement. This disease is self-limiting and complete rest typically leads to successful recovery2. In all, undiagnosed pain of the elbow should result in removal from play with protected rest until clinical or diagnostic imaging proves modified return to play is safe.

A complex group of injuries, commonly referred to as Little League Elbow affects numerous youth and adolescent baseball athletes worldwide. This condition cause pain and altered mechanics that can lead to permanent joint structure abnormalities due to the involvement of the growth plate if not treat properly. Organizations such as USA Baseball have recognized the impact and prevalence of this condition and has develop recommended guideline to protect athletes of the sport. A progressive rehabilitative program, including a period of no pitching has been proven to be effective in returning injured athletes to play. Health care providers, coaches, parents, and athletes all play an important role at maintaining the health and integrity of competitive sports by protecting our players from injury.

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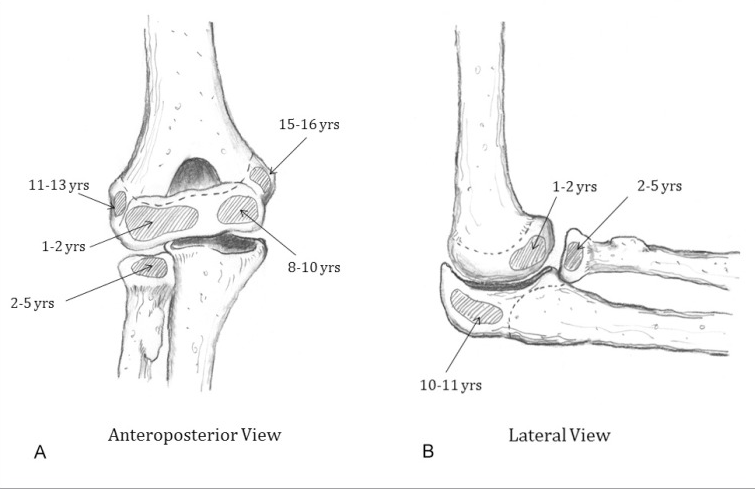
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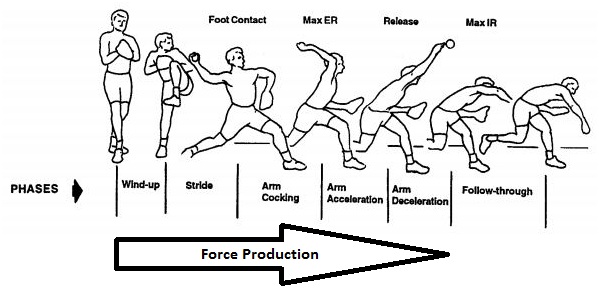
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Appendix 1



*Areas of ossification centers of the elbow and typical age at which they close7*

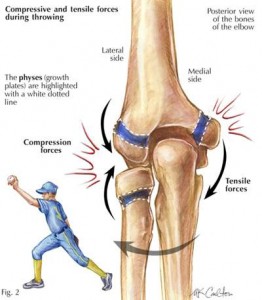
Appendix *2*



*Phase of a baseball pitch*

*Image retrieved from Biomechanics101.wordpress.com via Google image search*

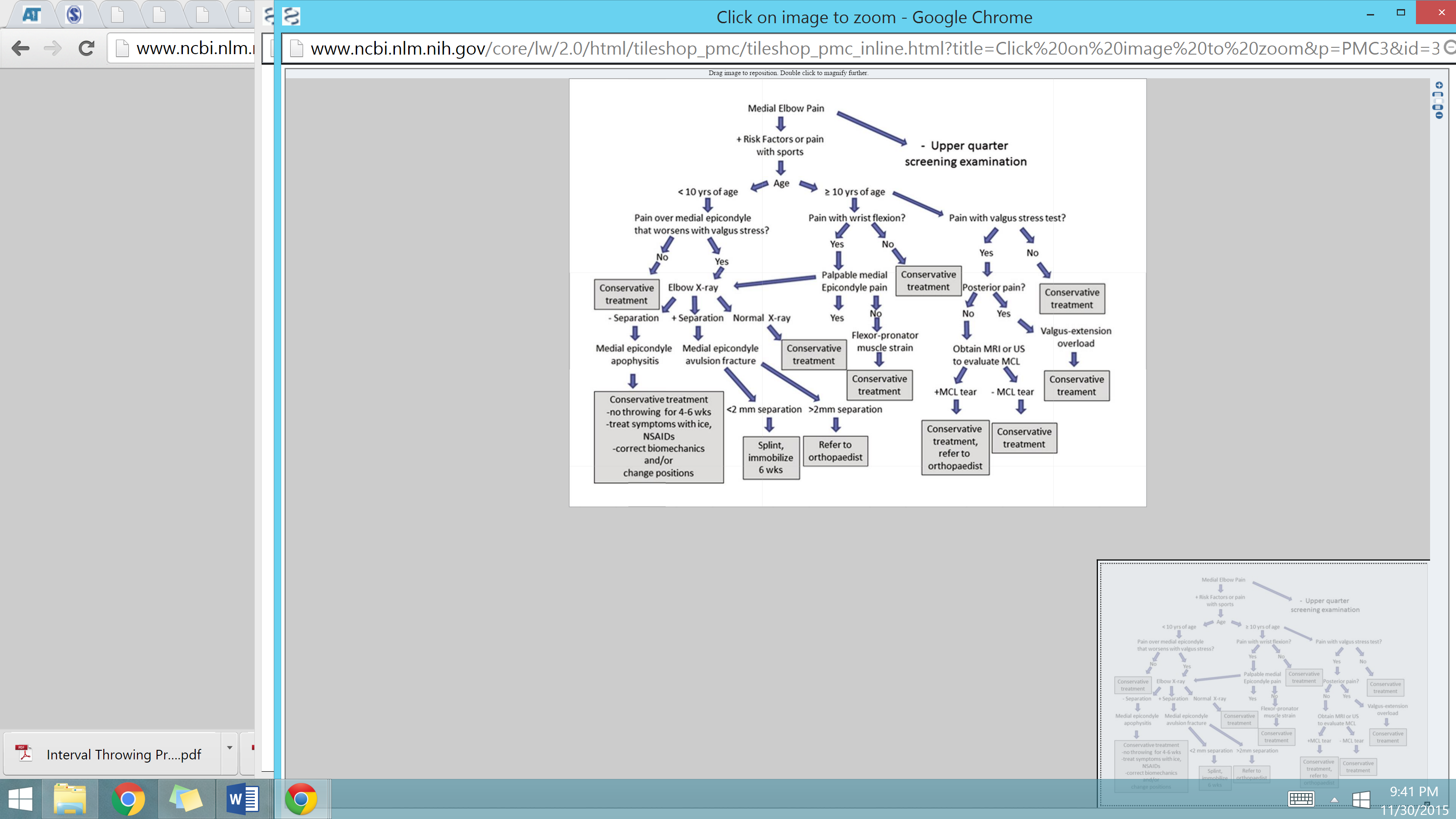
Appendix 3



*Forces in the elbow during a baseball pitch*

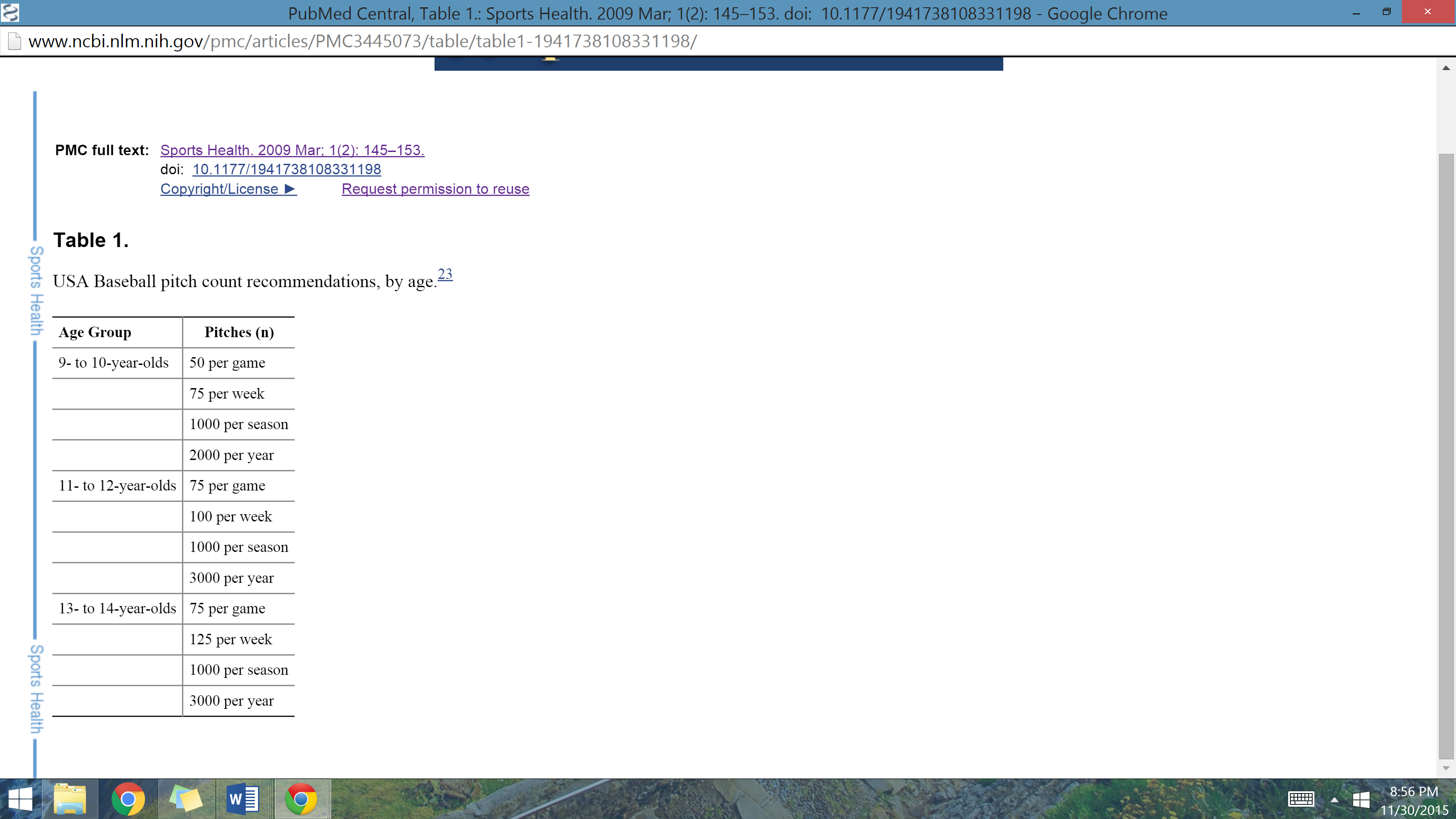
*Image retrieved from ericcressey.com via Google image search*

Appendix 4



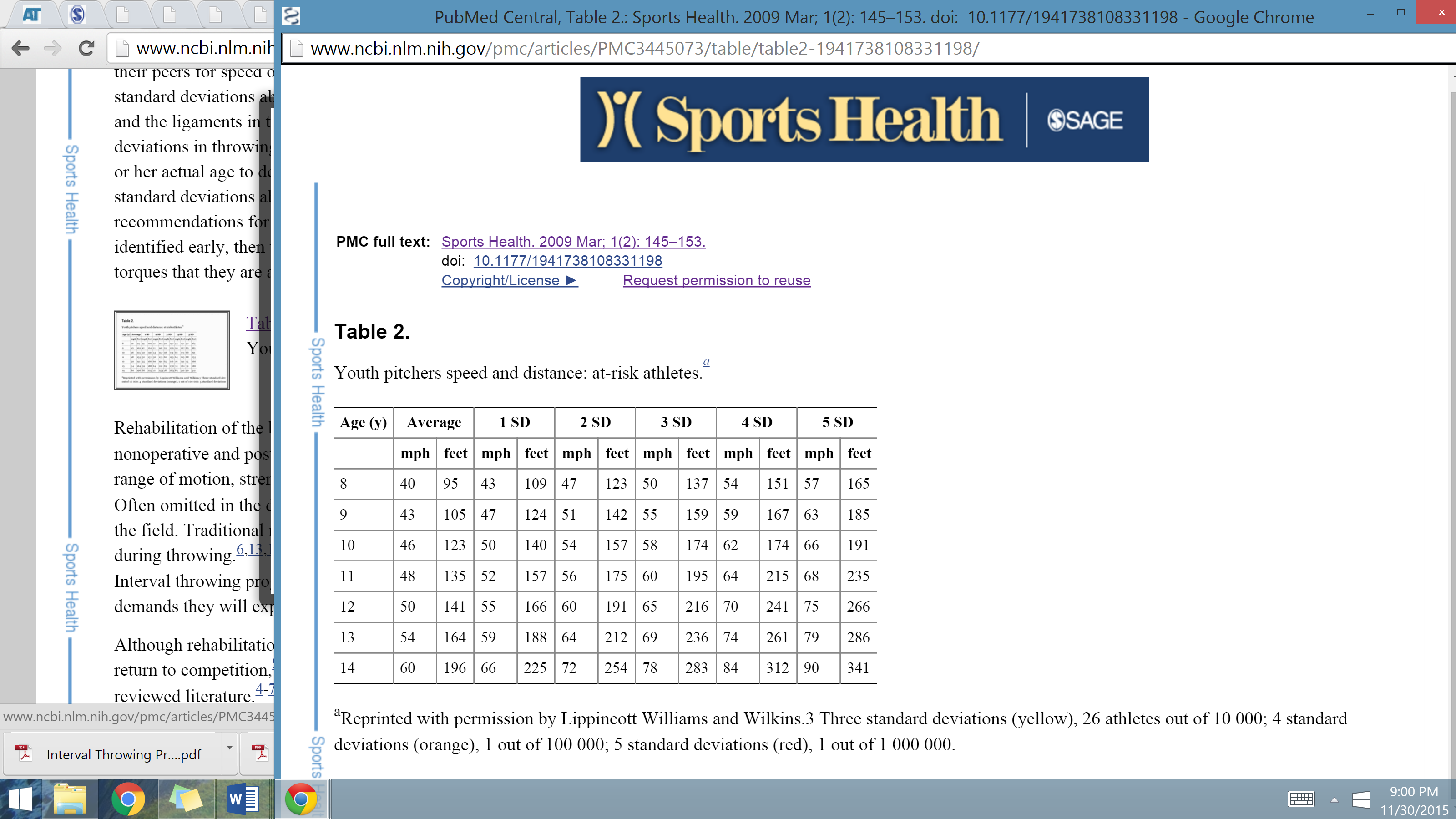
*Clinical Decision Making Algorithm for treatment7*

Appendix 5



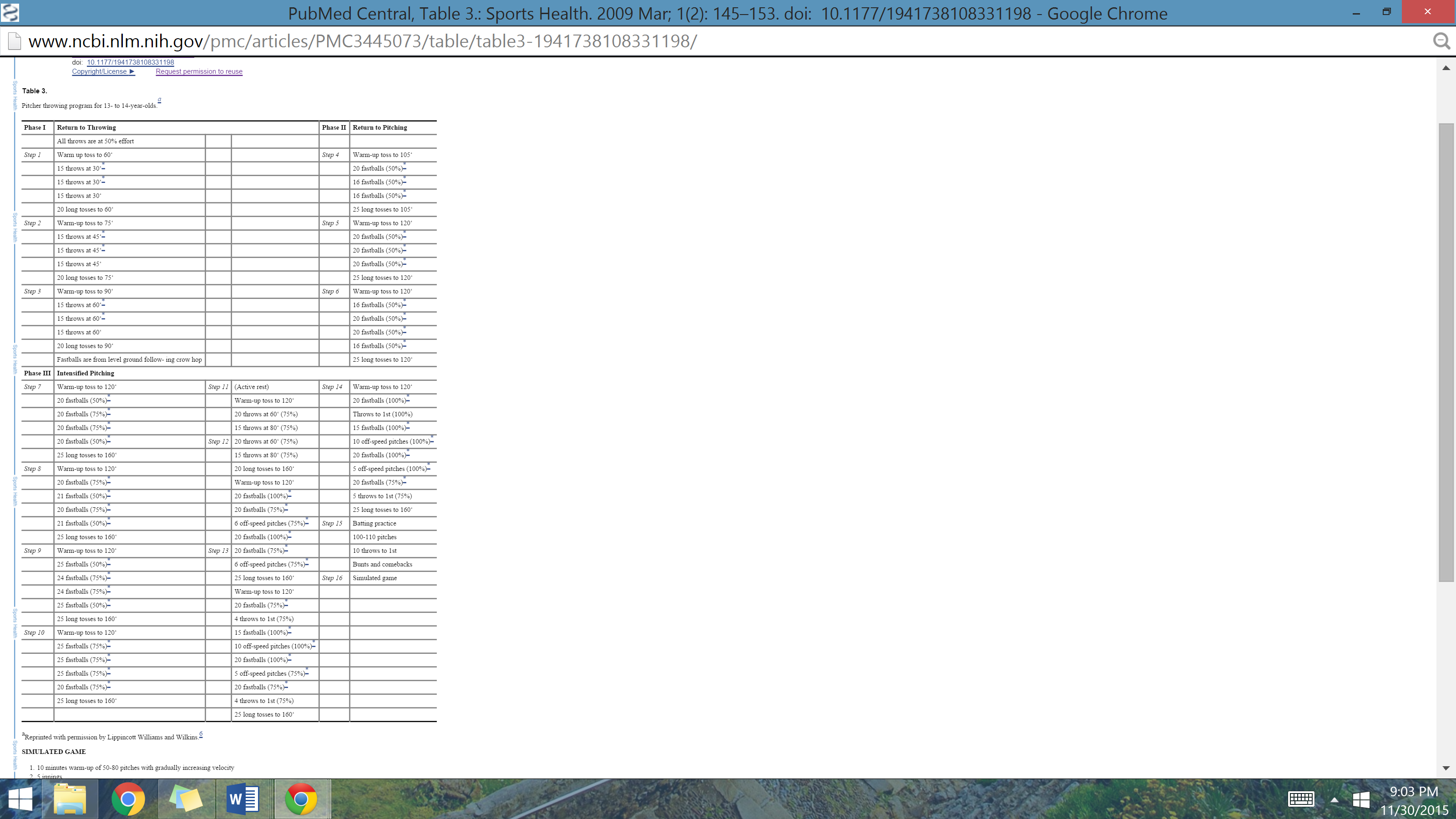
*USA Baseball pitch count recommendations9*

Appendix *6*



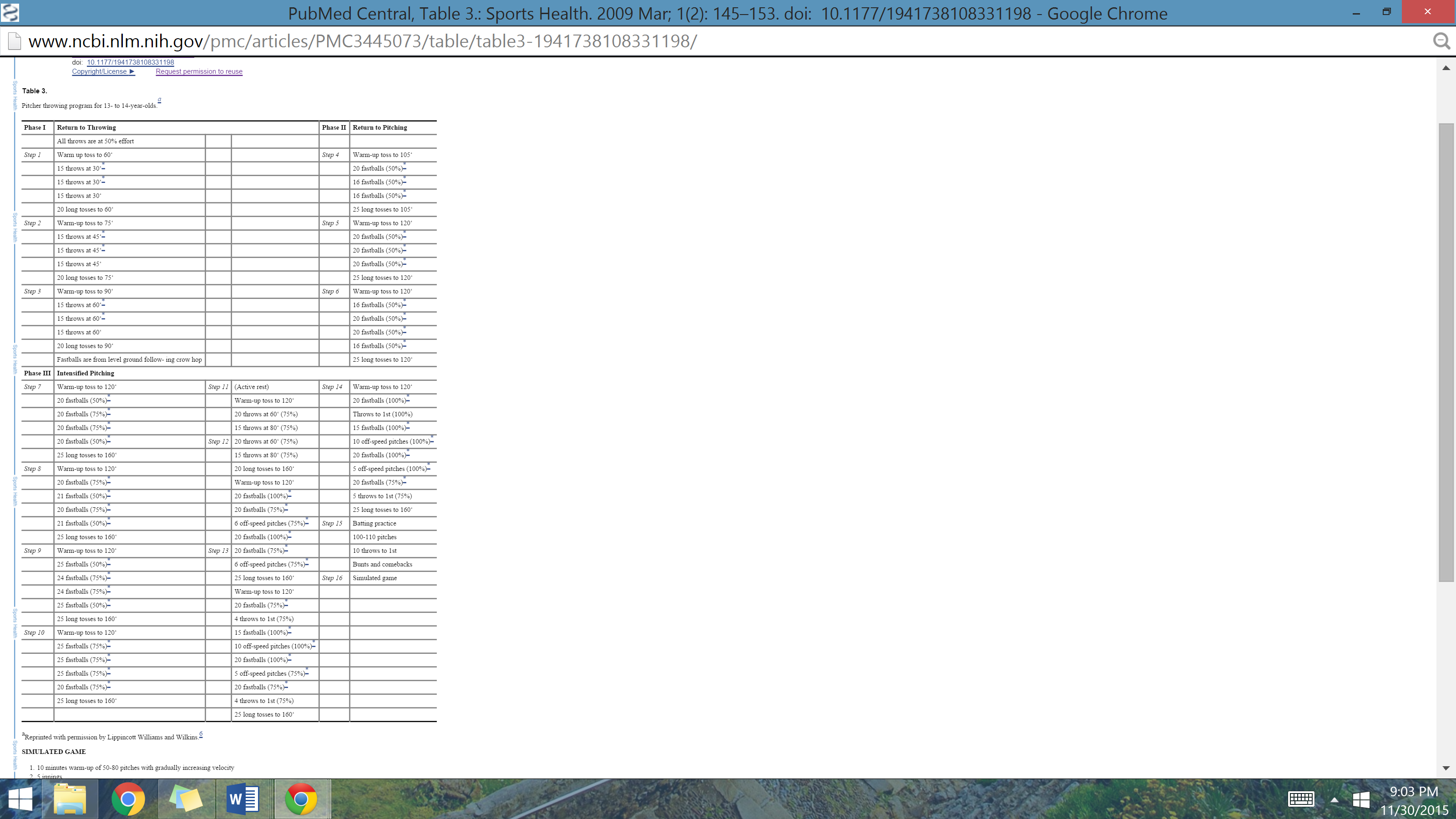
*Average speed and distance of youth pitcher, by age. The faster/further an athlete can throw above the average, the higher risk they are for obtaining an injury9*

Appendix 7a



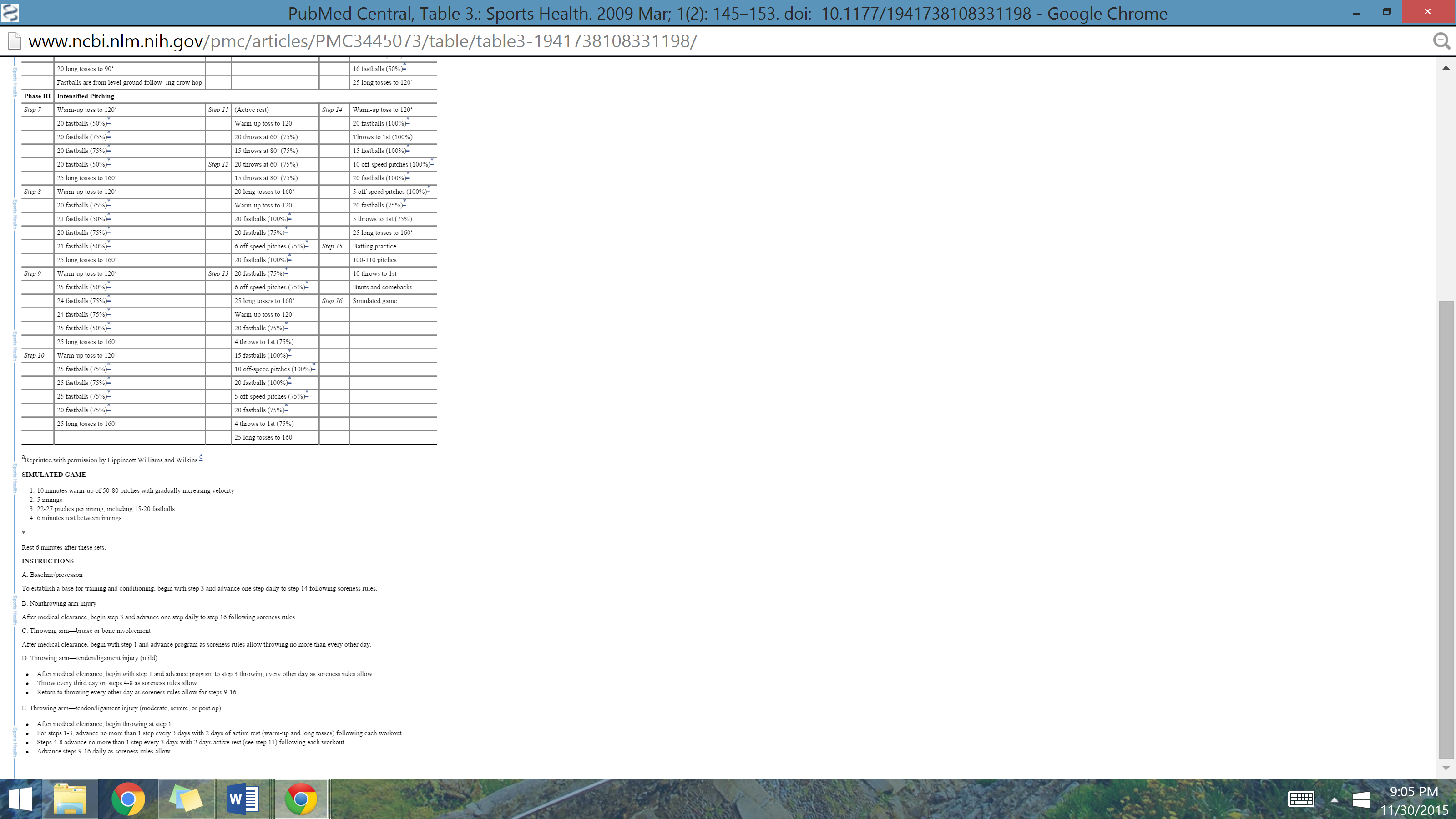
*Progressive throwing program from pitchers age 13-149*

Appendix 7a (cont)

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*Progressive throwing program from pitchers age 13-14 (cont.)9*

Appendix 7b



*Progressive throwing program from pitchers age 13-14 (cont.)9*

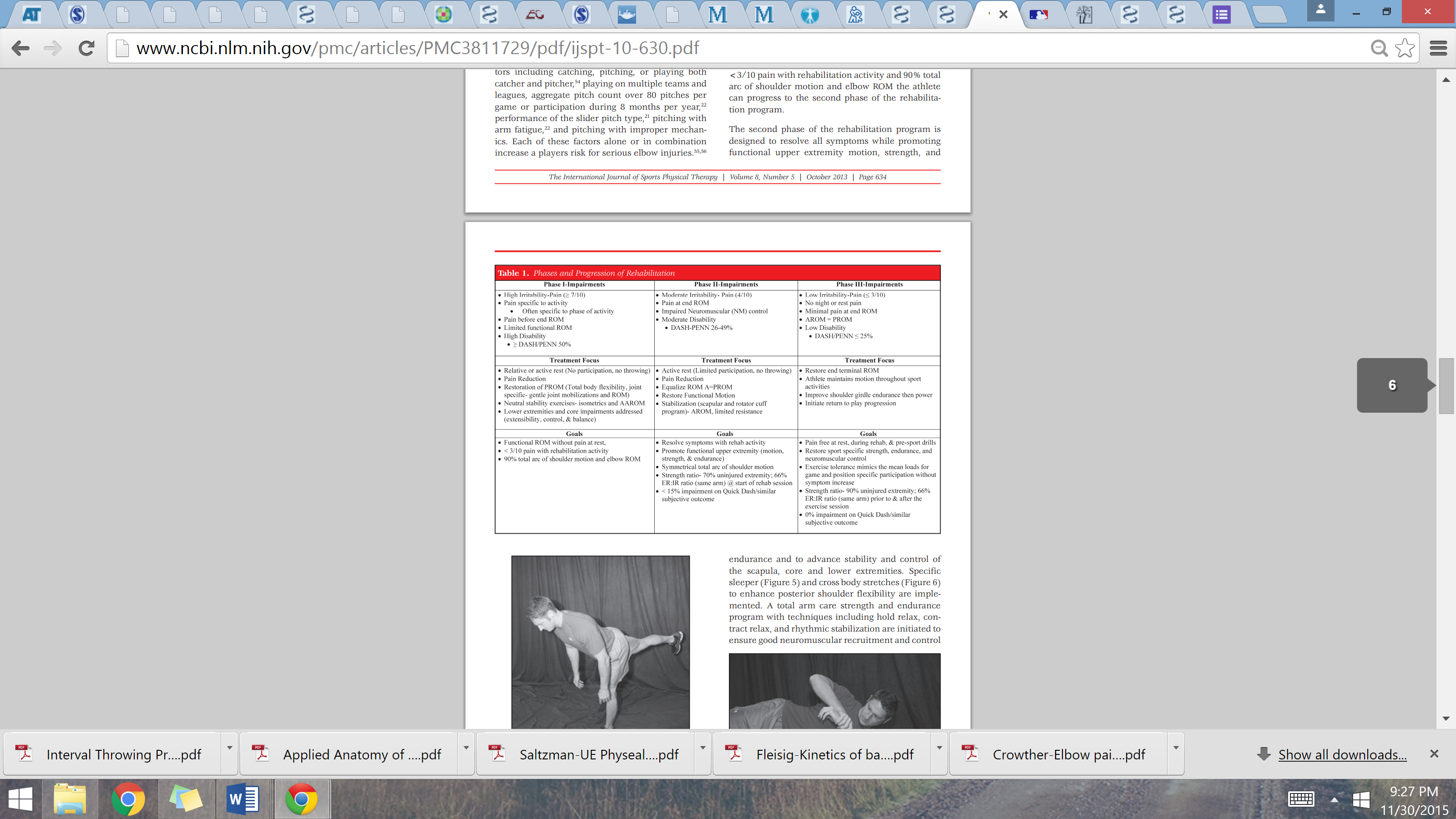
Appendix 8

**Soreness rules, all players**

* If no soreness, advance one step every throwing day
* If sore during warm-up but soreness is gone within the first 15 throws, repeat the previous work out. If shoulder becomes sore during this workout, stop and take 2 days off. Upon return to throwing, drop down one step
* If sore more than 1 hour after throwing, or the next day, take 1 day of fand repeat the most recent throwing program workout
* If sore during warm-up and soreness continues through the first 15 throws, stop throwing and take 2 days off. Upon return return to throwing, drop down on step

*Sorness rules for progression through progressive throwing program9*

Appendix 9



*Progressive Rehabilitation Program Recommendation4*