International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

ISSN:2347-6567

IJAMSCR |Volume 4 | Issue 2 | April – June - 2016
www.ijamscr.com

Review article *Medical research*

Low back injuries in fast bowlers: A literature review

Akhil Mathew,[1*] Subash chandra Rai[2] and Dr. Dhanesh Kumar K U[3]

[1] *Musculoskeletal and Sports Physiotherapy (PG), Nitte University/Nitte Institute of Physiotherapy/ Mangalore, Karnataka/India*

[2]*Associate prof. Musculoskeletal and Sports Physiotherapy, Nitte University/Nitte Institute of Physiotherapy/Mangalore, Karnataka/India*

[3]*Prof. Musculoskeletal and Sports Physiotherapy, Nitte University/Nitte Institute of Physiotherapy/Mangalore, Karnataka/India*

[*]**Corresponding author: Akhil Mathew**

Email: unitedkerala14@gmail.com

ABSTRACT

Background

Professional fast bowlers have been found to be at higher risk of developing low back injuries than other form of cricket players. The most common injuries related to bowling are overuse injuries to the back.

Objective

The aim of this report is to review the sources that describe biomechanical perspective of low back injuries and various preventive or countermeasures in fast bowling.

Method

A thorough literature review was done to complete the report from following sources: Pubmed, Pedro, Cochrane, Science direct and Cinahl

Conclusion

From the review it is evident that there is a need to continue with injury surveillance, identifying preventive strategies as well as a need for future research to be done to evaluate the efficacy of intervention strategies in order to reduce the risk of back injuries in fast bowlers.

Keywords: Low Back Injuries, Fast Bowlers, Cricket Injuries, and Bowling Injuries.

INTRODUCTION

Low back injuries are injuries occurring over lumbosacral area due to various pathologies. Fast bowlers are at high risk for developing back injuries; it develops as an acute onset and can gradually progress into a chronic pathologic condition which compromises the stability of the low back spine, resulting in pain, fatigue and muscle spasm along with tingling, numbness and finally resulting in chronic instability of the spine[1].

Around 40% of injuries in cricket results from fast bowling, with 55% of these being lower limb injuries and 33% back and trunk injuries. Professional bowlers were found to have sustained back injuries; out of it 50% of fast bowlers were diagnosed with a stress fracture of lumbar vertebra. Fast bowlers missed about 16% of potential playing time because of injury, while other players missed

less than 5%[2]. The primary activity associated with injury was the delivery and follow-through of the fast bowler[2]. Among cricket players low back injuries are common in fast bowlers involving repetitive flexion-extension, rotation of the trunk and absorption of large ground reaction forces over a short period of time. Studies have found that there is no single cause, but rather a combination of factors that may predispose a bowler to injury[3].

Biomechanics of bowling includes the various aspects of bowling techniques with regards to the normal anatomical alignment, mechanical aspects and energy distribution throughout the phase of bowling [4]. Fast bowling regardless of technique has an inherent risk of injury. Biomechanical studies of fast bowling techniques have reported bony and soft tissue lower back injuries as being more common with a mixed bowling technique than with a front-on or side-on technique, this will cause the spine to counter rotate un naturally resulting in stress fracture. Comparing with spin or slow bowlers, fast bowlers are especially prone to injuries as they perform their bowling technique at a very high intensity. The speed of bowling is usually above 140km/hrs[3, 5]. The technical requirement of bowling is momentum, alignment, stability and force absorption. These four principles are mainly required to develop and maintain all body movements in the direction of the batsman to ensure hip and shoulder face in the same direction at back foot landing to maintain balance and support throughout the delivery stride to reduce and release the stresses produced during run-up and delivery.

Four phases of bowling includes run up, tight gather, lock up and follow through.

Running Technique

Arms, feet and knees move down target line, hips and head still and tall, Elbows locked at 90 degrees and pull straight back, drives same side leg through

Tight gather

All levers in tight to body and in the direction of the batsmen, Ensure hips and shoulders face in the same direction at back foot landing.

Lock up

Lock off front leg on impact, Lock off front arm into front hip. All levers aligned towards the target.

Follow through

Back leg driving through towards the target, bowling arm across the body, Timing of hip drive to release point.[6] Injuries result from a number of factors such as poor bowling technique, counter rotation, lateral flexion and hyper extension. Over bowling or over use, increased work load, poor physical preparation, reduced strength of core muscles, genetic predispositions such as low foot arch, postural defects, biomechanical aspects of bowling technique, escalation of training technique and duration of bowling spells in matches[1,4]. Out of this over use injury has been reported to be a major contributing factor to injuries sustained by fast bowlers[4,5]. The bowler has been reported to experience a range of abnormal radiological features such as bony abnormalities e.g. spondylolytic incidences, spondylolisthesis, spondylolysis, pedicle sclerosis and pars defect, disk degeneration, muscle and other tissue tears and pain. There were significant differences in the size of the muscles on each side of the lumbar spine particularly in the quadratus lumborum. However, the effect of muscle asymmetries on forces and torques about the lumbar spine remains unclear[6]. The Australian Cricket Board (ACB) states that bowlers concentrating on bowling too fast for extended periods during practice and match play will be predisposed to lower back injury. As a result, the ACB limits bowlers of medium pace and above to a maximum of 8 consecutive over in 1 spell, and to a maximum of 20 over in any one day[3].

Run up **Tight gather** **Lock up** **Follow through**

MATERIALS AND METHODS

A structured literature search was done using various electronic data base.

Source of data

PubMed, APTA, PeDRO, Science Direct, Cinhal, Embase. Study design: Literature review. Inclusion criteria: only English articles, Exclusion criteria: Articles of other languages. Procedure: Key words used: Fast Bowling, Low back injuries, Cricket injuries, Bowling injuries. To identify relevant studies database like Pub med, Medline & APTA were searched, MeSH database was used, Only English articles were considered for the study. This study was done to review the available literature on low back injuries in fast bowlers, which is among the most common and serious injuries in cricket.

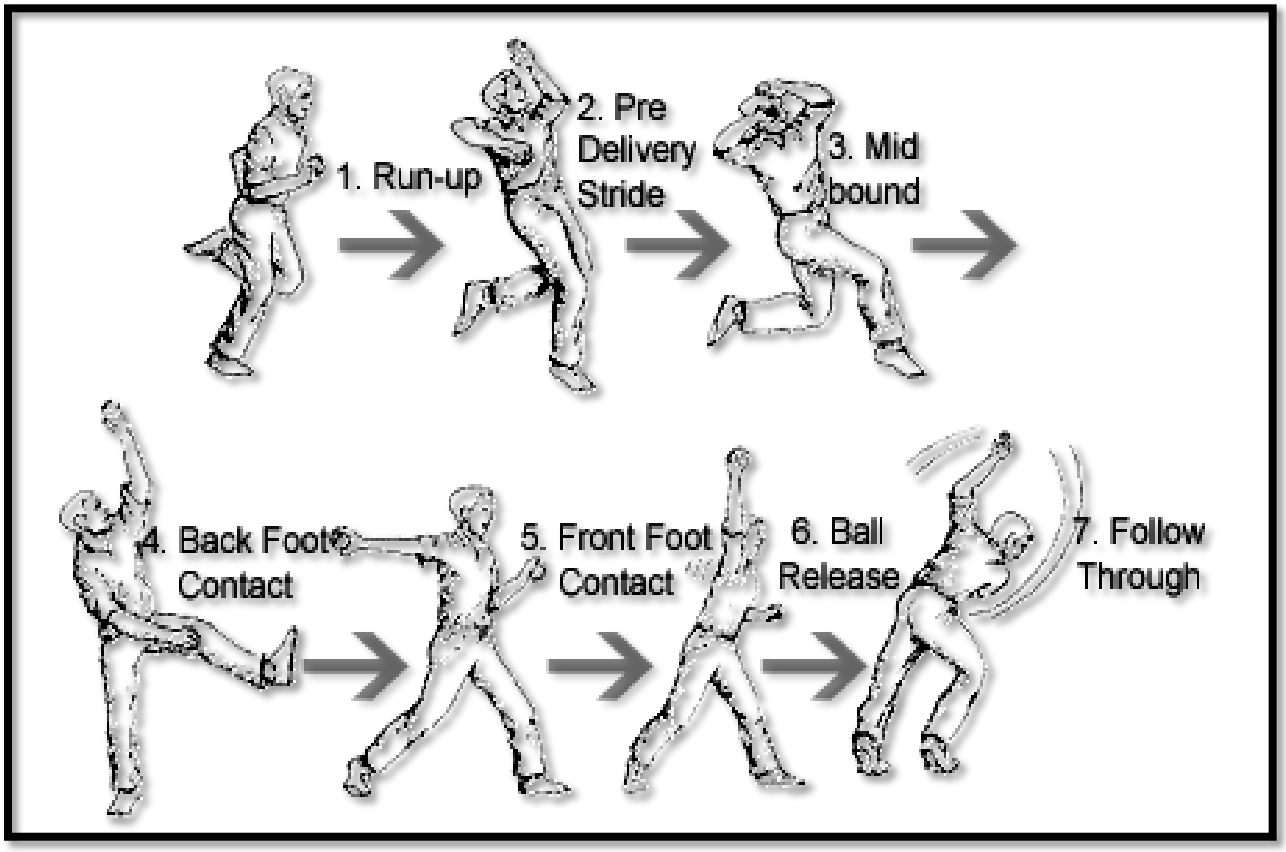
Literature Review

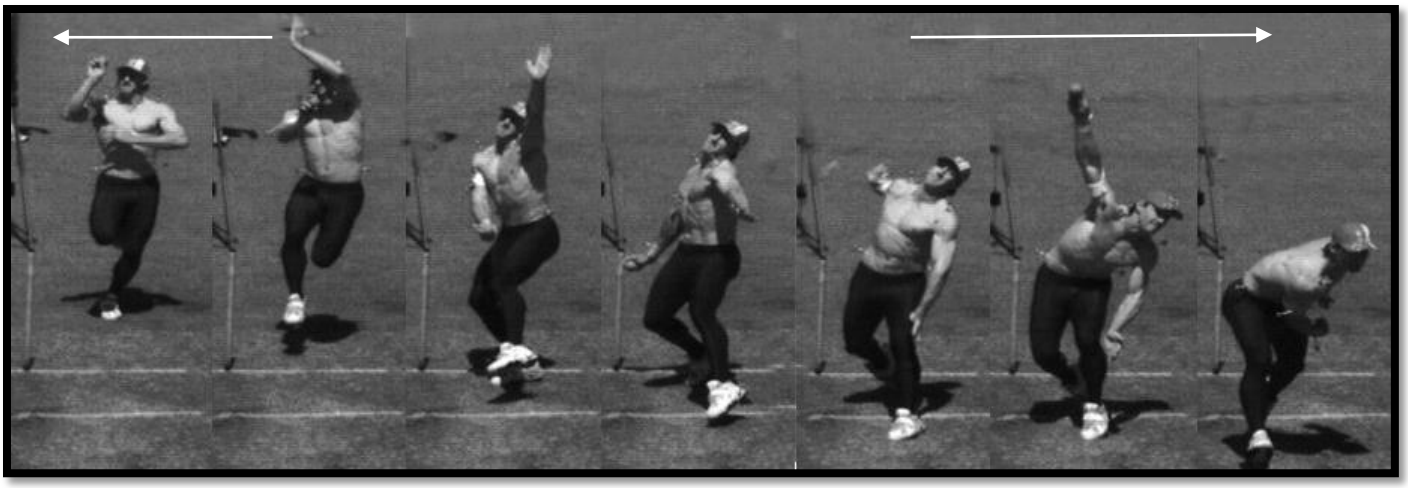
A study conducted in 2005 to review the injury in Australian cricket player states that fast bowlers face most of the injuries in cricket.

Keepers 1% Spinners 4% Batsmen 4% Bowlers 16%

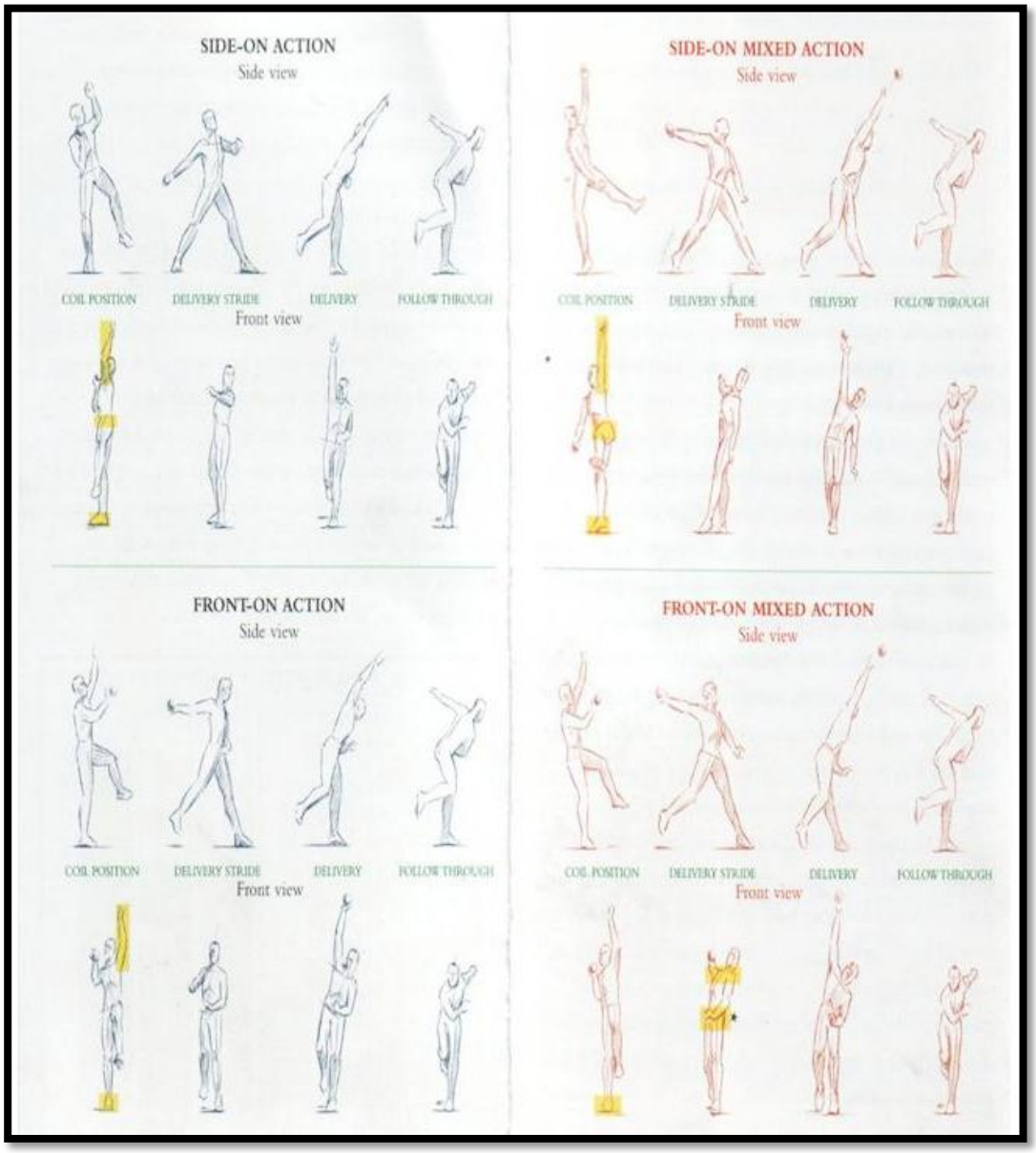
This clearly establishes fast bowlers are the priority group for continued injury risk factor research. (Orchard et al., 2005, sports health)[7] Fast Bowling involves repetitive twisting, extension and rotation of the trunk in a short period, while body tissues and footwear must absorb the large ground reaction forces (GRF). It is the speed of the delivery, and thus the force of the action, that make the fast bowler prone to a higher incidence of injury.[5] the bowling action itself can be di-videdinto3stages: The run-up to back foot impact (BFI), the delivery stride the release and follow through.

The run up to the BFI is the movement of the bowler from stance (i.e. a standing position) to the landing of the back foot. The delivery stride is the period between the BFI and ball release. The release phase occurs when the ball actually leaves the hand and has been delivered to the receiving batter.



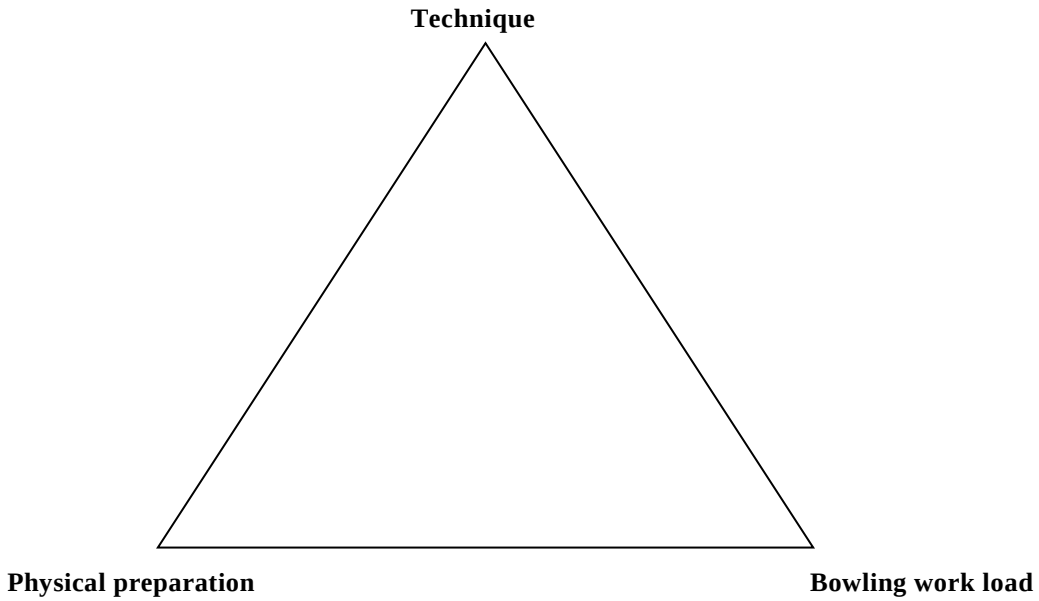


These stages of the bowling action determine a bowler's technique, and there is evidence to suggest that particular bowling techniques can put a bowler at an increased risk of injury The fast bowler uses one of two bowling techniques side- or front-on or a combination of these, known as the mixed bowling technique.[8]



RISK FACTORS

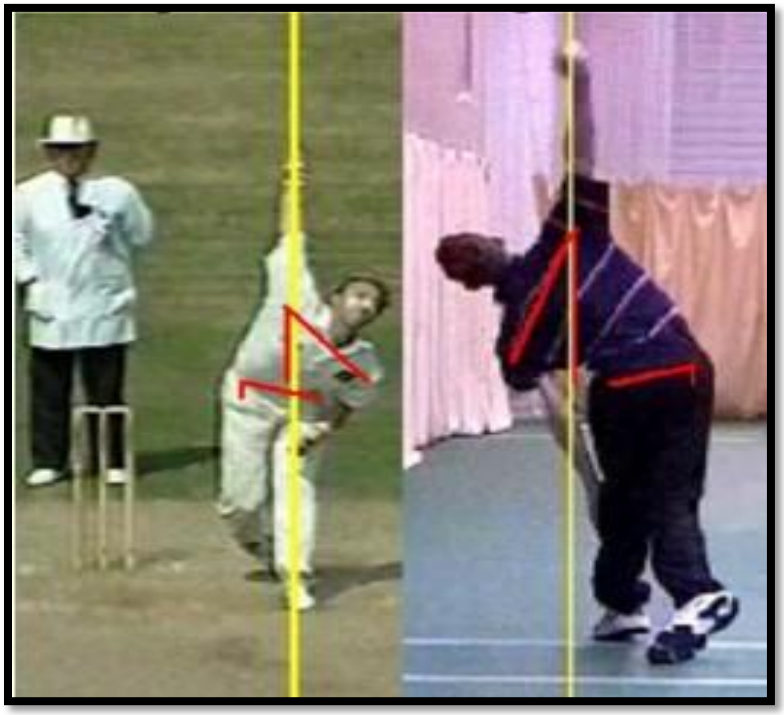
An understanding of the risk factors contributing to injury is the cornerstone of prevention. Bony and soft tissue injuries to the lower back are the key area of concern for fast bowlers. Injuries to the lower back occurred more frequently amongst bowlers who adopted a mixed bowling technique, as compared with those using a front-on or side-on technique. It has been proposed that injury to fast bowlers can be attributed to a combination of poor technique, poor physical preparation and overuse.



Injuries result from a number of factors such as poor bowling technique, counter rotation, lateral flexion and hyper extension, over bowling or over use, increased work load, poor physical preparation, reduced strength of core muscles, genetic predispositions such as low foot arch, postural defects, biomechanical aspects of bowling technique, escalation of training technique and duration of bowling spells in matches. Out of this over use injury has been reported to be a major contributing factor to injuries sustained by fast bowlers. The side-on and front-on bowling techniques are associated with the lowest incidence of injury as they reduce the degree of extension and lateral flexion of the lower back. The mixed action results in excessive twisting of the spine that leads to the adoption of a hyper extended and laterally flexed position of the spine during the delivery stride.

This places considerable stress on the lumbar spine, making it prone to injury. Regardless of how physically fit a cricketer is, if the bowling technique used involves hyperextension and/or excessive twisting of the spine (i.e. the mechanical characteristics of the mixed bowling technique) then there is a significant risk of developing a back injury. Such injuries can include the development of abnormal radiological features in the lumbar spine, which result from a combination of factors such as genetic disposition, incorrect bowling technique, poor preparation and/or overuse. While abnormal radiological features of the spine of fast bowlers have not been significantly associated with impact forces involved in the bowling stride, there is little doubt that the large GRF, in conjunction with the mixed action, will lead to injury[5,6].

The bowler experiences a series of impacts with the grass in the run-up, followed by 2 large impacts resulting from landing on the back and then front foot, on very hard turf or concrete. During delivery, these forces are transmitted through the bones, cartilage, tendons, ligaments and muscles of the foot, leg, thigh and pelvis to the discs in the spine and the facet joints of the vertebrae. Peak vertical GRFs of 4.1 to 9 times the bowler's body-weight have been recorded when the front foot is planted on the ground.[6]



The fast bowler has been reported to experience a range of abnormal radiological features such as bony abnormalities (e.g. spondylolytic incidences, spondylolesthesis, spondylolysis, pedicle sclerosis and pars defect), disk degeneration, muscle and other tissue tears, and pain. There were significant differences in the size of the muscles on each side of the lumbar spine (particularly in the quadratus lumborum). However, the effect of muscle asymmetries on forces and torques about the lumbar spine remains unclear.[4, 9]

Table1: Use of Field Based Test to identify Risk Factors:[10]

Screen test	Purpose of test	Procedure
Knee extension	To assess hamstring muscle length in a position of hip flexion	Range of assisted active knee extension measured in a supine position with the hip of the testing leg held in 90^0 flexion.
Modified Thomas test (hip extension)	To assess flexibility of the hip flexors	In a supine position, the contra lateral hip is held in maximal flexion with testing leg lowered towards the floor. Femur angle measured relative to the horizontal
Combined elevation	To assess combined thoracic extension (strength and range of motion), shoulder girdle flexion and scapula retraction.	Prone position, arms outstretched, with feet, hips, chest and chin in contact with floor. Both arms raised off floor as high as possible without flexing elbows. Measured perpendicular distance (cm) from the base of the metacarpal of the thumb to the floor.
Ankle dorsi flexion lunge	To assess range of dorsiflexion at the ankle joint and mobility in the midfoot	Tape measure fixed along floor. Foot positioned beside tape so that heel line and big toe aligned. Heel held to prevent it from lifting off the floor and subtalar joint manually locked. Lunge forward until knee touches wall. Maximum distance (cm) from great toe to the wall recorded

Calf heel raises	To assess endurance of the ankle plantar flexor muscles in a weight bearing task	Stand on one foot, rise onto ball of that foot as high as possible, then slowly lower heel while maintaining knee extension. Number of raise/lower cycles recorded.
Stride length	Length of bowling delivery stride	Using side-on footage, distance (cm) measured from back of heel of back foot at BFI to back of heel of front foot at FFI. This stride length was also normalized, being expressed as a percentage of the standing height of the bowler
Front knee angle	Angle of front knee during delivery stride	Using side-on footage, angle of front knee at FFI measured using the line formed by the medial malleolus marker, medial femoral epicondyle marker and up the middle of the thigh. Angle also recorded when front knee was most flexed after FFI and prior to ball release
Height of ball release	Height of ball release	Using side-on footage, distance (cm) measured from the ground directly under the front foot to the centre of the ball in the frame of ball release. This height was also normalized, being expressed as a percentage of the standing height of the bowler
Ball speed	Ball speed at ball release	Using side-on footage, ball speed (km/h) calculated from the frame at ball release (the first frame the ball is not in contact with the hand) to one frame after ball release
Shoulder angle at BFI	Shoulder alignment at BFI	Using overhead footage, a line was drawn through the primary alignment of the acromion process at BFI. This line was continued down the pitch, parallel to the alignment of the pitch, and the angle of the shoulders relative to the pitch alignment in the direction of bowling was measured
Minimum shoulder angle	Alignment of shoulders in most side-on position	Using overhead footage, the frame in which the shoulders obtained the most side-on position between BFI and ball release (usually just before FFI) was identified. The angle of the shoulders relative to the pitch alignment in the direction of bowling was measured.
Shoulder counter-rotation	Rotation of shoulders to a more side-on position after BFI	This was automatically determined by subtracting the minimum shoulder angle from the shoulder angle at BFI

The injury prevention measures adopted by the Commonwealth Bank Cricket Academy as part of their ongoing program for elite cricketers are (Done, 1996):[3] at the start of each year, players are given a thorough medical, physiotherapy, biomechanical (fast bowlers) and podiatry assessment with recommendations to be followed up. Fast bowlers who have any previous record of back injury are also screened using other appropriate methods to assess the current status of the problem. Each player follows an appropriate (for training age, age and player type) strength training program including special shoulder and abdominal programs. Special strength assessments are also made at the AIS in Canberra early in the program to enable more specific strength training programs to be set. Each player follows a stretching routine. All physical training sessions and matches include appropriate warm-up and warm-down. A number of recovery methods are also made use of on a regular basis including massage, swimming, stretching and spa pools.

AIS medical and physiotherapy staff review weekly ongoing problems to ensure any rehabilitation or set programs are progressing according to plan. Fast bowlers should undergo physical training before each season to prepare them for the rigorous of their sport. Preventative fast bowling: The Commonwealth Bank Cricket Academy (a program of the Australian Institute of

Sport (AIS)) regards injury prevention as one of its key roles in the implementation of a program aimed at the development of elite cricketers entitled "SPOT". S -screen bowlers at a early age for all risk factors including posture, P -good physical preparation is essential, O –over bowling and overuse should be avoided, T -correct technique is also important. Their coaching booklet, 'Prevention of Lower Back Injuries in Fast Bowlers', states that bowlers concentrating on bowling too fast, for extended periods during practice and match play predispose themselves to lower back injury . As a result, the following restrictions are on bowlers of medium pace and above: Bowlers are limited to a maximum of eight consecutive over in one spell; Bowlers are limited to a maximum of twenty over in any one day. This review brings together the current literature on low back injuries in fast bowlers and various preventive measures, suggestions and also highlights the areas of future research could be done.

RESULT

Total 16 articles were reviewed which consist of 11 cohort studies, one case study, 2 survey, one cross sectional study and a quasi-experimental study.

DISCUSSION

The finding of the review is that the fast bowlers are at high risk for developing back injuries. It has been stated that the incidence rate is higher as the year pass by. Fast bowling, in particular, is reported as being the phase of play with the highest injury incidence amongst cricketers.3Various factors pertaining to fast bowling, such as incorrect technique, volume and intensity as well as conditioning can lead to an increased risk of injury. In the current study done by RA Stretch stated that bowling injuries comprised 50.7% of the total number of injuries reported. Significantly more fast bowlers (26.4%) than spin bowlers (8.7%) were injured in the current study. Schoolboy fast bowlers, however, were found to present with more back and trunk injuries[5,6].

Young fast bowlers are more prone to overuse injury than their older counterparts. Overuse injuries occur as a result of repetitive micro trauma where a number of forces combine to produce a fatigue effect. Developing muscles, bones and musculotendinous attachments are areas of potential injury. Fast bowlers who repeatedly hyperextend their lumbar spines in the delivery stride often experience lower back pain as rapid growth of the vertebral bodies is not matched by that of the dorsal soft tissues. The increased elasticity of the intervertebral disc, incomplete ossification of the posterior vertebral elements and the incomplete formation of the iliolumbar ligament (until the third decade of life) can increase the propensity of young cricketers to injury. It is the elastic intervertebral discs that transmit forces more readily to the facet joints, placing undue stress on the pars intra articularis, which can lead to serious overuse injuries as they can limit participation for long periods of time. Excessive bowling throughout the growth period when the spine is relatively immature will increase the cricketer's vulnerability to injury, as the forces associated with bowling are unable to be absorbed.[5, 11,13,18,23]

Lumbar soft tissue injuries were reported more common among pace bowlers. Bowlers who had bowled more than 20 matches over in the week leading up to a match had an increased risk of sustaining a bowling injury. A further risk for bowling injury is bowling second in a match that is, batting first. Bowlers with a low longitudinal foot arch were more likely to develop a stress fracture than those with a high arch. Shoulder depression and horizontal flexion strength for the preferred limb and quadriceps power in the non-preferred limb were also significantly related to back injuries.[24] Bowlers who rotated the trunk to realign the shoulders by more than 400 to a more side-on position between back foot impact and front foot impact in the delivery stride were more likely to sustain back in-juries. Lumbar vertebral stress injuries in fast bowlers noted that the prevalence of lumbar vertebral stress injuries in fast bowlers is high, with figures up to 67% reported. Potential risk factors identified include bowling action, overuse, age, lumbar muscle asymmetry and physical characteristics.[20] while prospective studies provide evidence that bowling action and over use are risk factors for developing lumbar vertebral stress injury. Extreme lumbo pelvic lateral flexion and large moments during the delivery stride may contribute significantly to the loading of the pars

interarticularis and therefore the high incidence of spondylolysis in fast bowlers.[4,21,24]

Bowling actions such as the mixed action appear to be strongly associated with an increased risk of developing stress lesions in the lumbar spine, especially in adolescent populations. Current evidence suggests that for adult bowlers, excessive contra lateral lumbar side-flexion, rather than shoulder counter-rotation, is the key variable in the mixed action that increases the risk of lumbar spine injury. These data indicate that the technique of fast bowlers who use a mixed action should be assessed and retraining provided to reduce the risk of lumbar spine injury.[4,21,25] A prospective cohort study of fast bowlers conducted over one summer cricket season measured a broad range of musculoskeletal, fitness, anthropometric and technique variables through a pre-participation screening. Of the 35 measures, only two were identified as independent predictors of injury. Reduced hip internal rotation on the back foot impact leg was associated with a significantly decreased risk of injury, and reduced ankle dorsiflexion on the front foot impact leg was associated with a significantly increased risk of injury. A lack of ankle dorsiflexion on the front foot impact leg could relate to injury to fast bowlers in a number of ways. Tight calf musculature with a lack of ankle dorsiflexion may contribute to higher ground reaction forces at front foot impact as there is less displacement available to attenuate the impact. Compromised function of the calf muscle could increase load on the knee and patellar tendon via the closed kinetic chain. Alternatively, it may be possible that decreased ankle dorsiflexion results in changes in both tibial and femoral alignment, which have been speculated to cause changes in optimal pelvis and lumbar spine alignment in weight bearing.[26]

The fundamental approach to injury prevention must be through education of coaches, participants and parents, along with appropriate legislation. This includes early screening programs for those at highest risk of injury, by sports professionals as well as limiting the number of bowling over[5]**.** It is important that cricket coaches develop an awareness of the condition of spondylolysis and its incidence in the fast bowling population. They should be familiar with the roles of poor preparation, incorrect technique, and overuse in its etiology. Continuous cricket, commercial pressures, the one-day game, and contractual arrangements can make it difficult for coaches to prepare their fast bowlers adequately. All the coaches interviewed agreed that fast bowlers used to bowl more in the nets. It is clear that a fast bowler, unprepared for the sudden increase in bowling intensity that accompanies the beginning of the season proper, or a return from injury, is at risk of back injury. Coaches must encourage correct technique from an early age and supervise some form of bowling prescription. It is assumed that the timeous conditioning and monitoring of physical fitness throughout the season will assist in adequately preparing fast bowlers and thus assist in reducing injury.[25]

Guidelines for safety in children's sport cricket recommendations include that fast bowlers aged 11 to 13 should undergo a minimum physical preparation which consists of upper body strength (30 push-ups in 1 minute), aerobic fitness (3000m in a 15 minute run), sit and reach flexibility (+5cm) and abdominal strength (30 sit-ups in 1 minute). Physical demand recommendations are also made. These include the fast bowler practicing 2x30 minute bowling sessions per week (under 13 year olds) and 2 spells of 4 over each (under 13 year olds). Limiting matches to once a week and limiting practice time for those playing with more than one team were also recommended.[11] A back injury screening program should be aimed at high performance of fast bowlers. This Fast Bowling Unit should provide expert medical, physiotherapist, biomechanical and fitness training consultations. This will create leading athlete management program for players in its highest injury risk category.[10] Specifically, the program should look at screening for postural factors, radiological evaluations (if required), fitness testing, biomechanical assessment, technique training and practice organization. These screenings should conduct three times a year: pre-season, mid-season, and post season. It should be the aim that the information developed through the program will enable the Fast Bowling Unit to become available to the wider cricket community.[10]

CONCLUSION

Fast bowling, is reported as being the phase of play with the highest injury incidence amongst cricketers. Various factors pertaining to fast bowling, such as incorrect technique, volume and

intensity as well as conditioning can lead to an increased risk of injury. It is clear that a fast bowler, unprepared for the sudden increase in bowling intensity that accompanies the beginning of the season proper, or a return from injury, is at risk of back injury. Coaches must encourage correct technique from an early age and supervise some form of bowling prescription. It is assumed that the timeous conditioning and monitoring of physical fitness throughout the season will assist in adequately preparing fast bowlers and thus assist in reducing injury.

From the review it is evident that there is a need to continue with injury surveillance, as well as a need to continue with and increase the number of studies that evaluate the efficacy of intervention strategies in order to reduce the risk of injury to cricketers.

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How to cite this article: Akhil Mathew, Subash chandra Rai and Dr. Dhanesh Kumar K U3, Low Back Injuries in Fast Bowlers: A Literature Review Int J of Allied Med Sci and Clin Res 2016; 4(2): 184-195.
Source of Support: Nil. **Conflict of Interest:** None declared.