Reducing the risk of Lumbar Spine related injuries in fast bowlers with a mixed bowling action

Abstract

This scientific investigation determines how mixed action bowlers are able to reduce the risk of lumbar spine related injuries in fast bowlers. In the history of cricket, fast bowlers have been prone to lumbar spine injuries which mostly stem from having a poor bowling technique or a non-sustainable bowling action. The concept of a 'mixed' bowling action is the amalgamation of both front-on and side-on orthodox bowling actions. By bowling with both the orthodox bowling action and the mixed bowling action, the degree of flexion was measured at the point of release. The data collected proved that there was no difference between the two bowling actions although variables such as the alignment of hips and rotational force of the actions on the lumbar spine which were not able to be measured. These variables would be factors which affect the risk of lumbar spine injuries in fast bowlers with a mixed bowling action.

Contents

Literature review

Overview

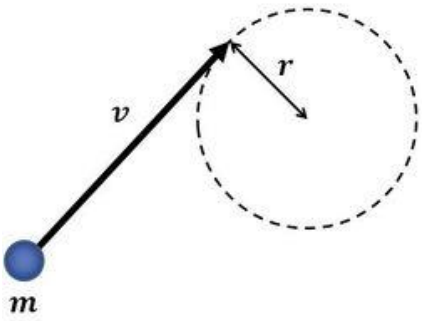
In the sport of cricket, there are two main categories of fast bowlers, being side-on and front-on. The concept of 'mixed' bowling technique was introduced when the bowler would use a combination of front-on and side-on techniques. As a result, it significantly increases the risk of misalignment of hip and shoulder, therefore twisting of the spine and causing hyperextension (Firdaus Tabassum et al, 2020).

The Biomechanics of a bowling action

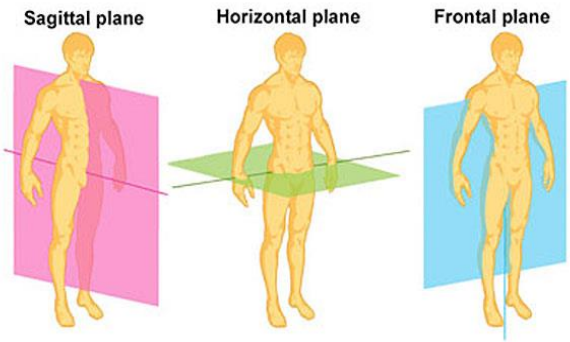
In order to bowl a delivery, a bowler must undergo several stages to build up momentum before releasing the ball [*refer to Fig. 3*]. The run-up and back foot contact (BFC) are utilised to generate and maintain the linear momentum whereas the front foot contact (FFC) is used to convert linear momentum to angular momentum (Felton, 2020). The run-up and BFC are referred to as the pre-delivery stage and the FFC is referred to as the delivery phase.

In order to bowl fast, one must:

- Generate as much linear momentum in the sagittal plane as possible (run-up) (*view Fig. 3*)
- Attempt to convert most of that linear momentum into angular momentum in the sagittal plane.
  (*View Fig. 2 and Fig. 3*)
- Transfer momentum from the ground up using technique (Felton, 2020)



[Fig. 1, HVY Science 2023]



[Fig. 2, Walden, 2023]

[*Fig. 3, Sirajudeen, 2011*]

Stressors of the lumbar spine in fast bowling

The bowling technique of mixed action bowlers correlates with a higher incidence of injuries (McGrath & Finch, 1996). The shoulder counter-rotation has been thought to constitute a high risk for injury in bowlers, therefore reduction of counter-rotation has been highly recommended (Bayne et al, 2011). The seriousness of the mixed action bowling also varies from bowler to bowler, as mixed action bowlers can use elements of both front-on and side-on bowling action to create an unorthodox bowling action.

Misalignment of hips and shoulders

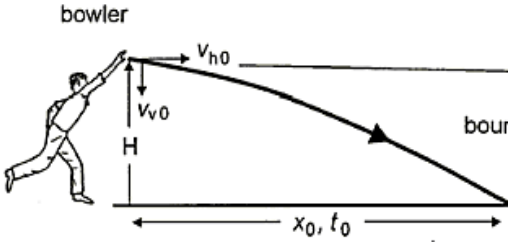
The misalignment of hips and shoulders is a factor which can influence the risk of a fast bowler (especially mixed action bowler) developing lumbar spine related injuries. Foster et al. (1989) found that the alignment of the hips and shoulders can result in greater counter rotation, which is associated with an increased risk in lumbar spine related injuries in fast bowlers (here). Mixed action bowlers often consist of having misalignment in their bowling actions. This a major contributor to lumber spine related injuries in the category of mixed action fast bowlers.

Length of delivery

There are various lengths that a bowler can bowl at, these change in points of release can affect the degree of flexion and pressure the spine undergoes during the delivery stage. (View *Fig. 4* at the bottom of the page)

Consequences of a Mixed Bowling Action

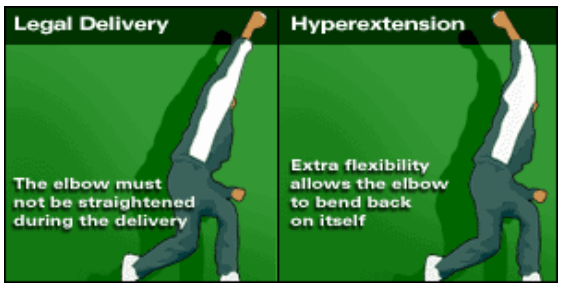
The technique of the mixed bowling action acts as a crucial protection from common injuries relating to abdominal side strains and lower back, more specifically the lumbar spine (Alway et al., 2021), as they are more exposed due to the greater amount of trunk flexion (Arora, M. et al, 2014). The lower back injury is one of the most common injuries which affects young fast bowlers, where the repetitive loading risks damaging the bone, furthermore, exposing fast bowlers to stress fractures (Cricket Australia, 2019).
Due to the misalignment of hips and shoulders in the mixed bowling action, the bone mass density (BMD) in the lumbar spine is contralateral to the bowling arm likely as a response to this asymmetric technique. Consequently, increasing risk of lumbar spine fractures (Alway et al, 2022).



[*Fig. 4, Mcleod & Land, 2000*]

Hyperextension of the elbow in Fast Bowling

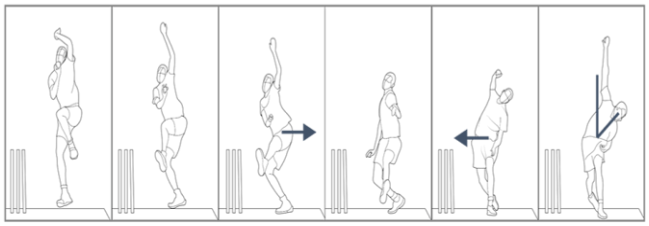
The term hyperextension refers to the player's joint, in this case the elbow, extending beyond the it's normal range of motion (Felton & King, 2019). Through this biological advantage, fast bowlers are able to gain 5% greater bowling speed if they have an elbow hyperextension of 20º as there is a longer delay in the bowling arm's circumduction (Felton et al., 2020) (Worthington et al., 2013) [view *Fig. 5* below].



[*Fig. 5*, Gough, 2001]

Counter-rotation in Fast Bowling

As a result of the misalignment of hips and shoulders due to the mixed action bowling technique, the counter-rotation refers to the rotation of the upper body from front on to side on which contributes to the risk of lumbar spine related injuries (Bayne, 2023). As displayed below [View *Fig. 6*], the third and the last image in the figure highlight how the elements of side-on bowling and front-on bowling produces counter-rotation, introducing extra stress to the lumbar spine of mixed action bowlers.



[*Fig. 6*, Bayne, 2023]

Scientific Research Question

Is there a way to reduce the risk of lumbar spine related injuries in fast bowlers with a mixed action through replacing it with an orthodox, side-on bowling action; is there a statistically significant difference in the degrees of flexion?

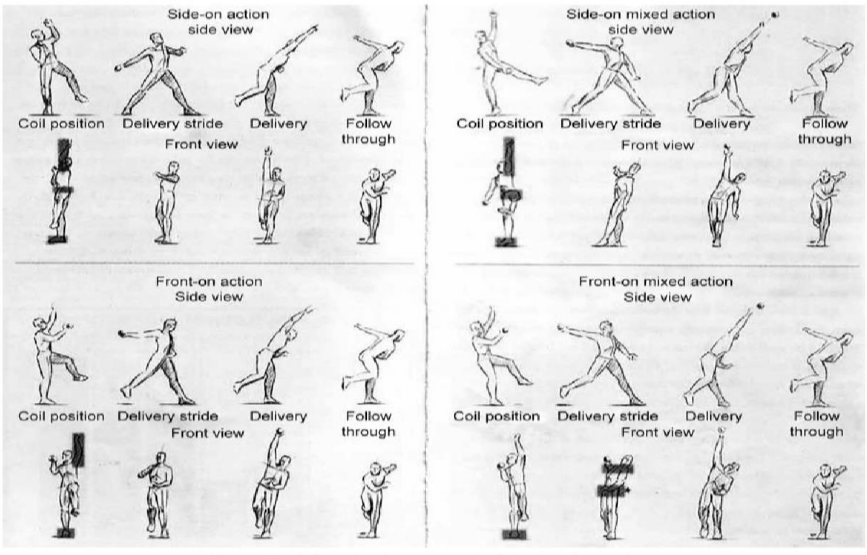
Scientific Hypothesis

It is hypothesised that by utilising the orthodox side-on bowling action that the chance of lumbar spine related injuries in fast bowlers with a mixed bowling action can be reduced. This would be due to the lower stress that is placed on the lumbar spine as the lateral flexion and rotation is less significant in side-on bowling. Consequently, in the orthodox action, the stability of the BFC assists in alignment of hips and shoulders [displayed in *Fig. 7*, where the shaded region of the front view in side-on action is displayed] and creating balance which in turn produces a safer bowling action. The P-value derived from the f-test will indicate that the degree in flexion is greater for the mixed bowling action, indicating that the orthodox action is safer, reducing the risk of lumbar spine related injuries in fast bowlers by replacing the action with the orthodox.

Null Hypothesis: There is not a statistically significant difference in the degrees of flexion regarding the actions or the degree of flexion in the orthodox, side-on action is greater than the mixed bowling action.

Aim of the study

The purpose of this study is to provide ways to improve the mixed bowling action of the subject by replacing it with a correct side-on bowling action; attempting to reduce stress on the lumbar spine. Through the findings of this investigation, coaches could assist players improve, increasing the longevity of fast bowlers and preventing lumbar spine related injuries of fast bowlers with a mixed action (Felton, 2020).



[*Fig. 7, Thiagarajan, K. et al.,2015*]

Methodology

Preparation

The experiment was conducted in a driveway which is a relatively flat surface and replicates the standard length of a pitch (20.12m) with appropriate room for the run-up. It will be a self-study on a 17-year-old male, 185cm tall and is a mixed action bowler.

Equipment	Why is it used in this investigation?
Phone	The phone allows for capturing of images and videos, the angle of flexion and rotation can be measured as well as providing information regarding alignment of hips and shoulders.
Tripod	Provides a consistent height and view of the bowling action, increasing accuracy of measurements. Consistency in measurements.
Digital Protractor	Displays up to two decimal places of the degrees of flexion; allowing the data to be as close as possible to the true value.

Method of Data Collection:

The phone is placed on the tripod and place it next to the crease to capture a side on view of the bowling. Recording begins and subject bowls using the mixed bowling action for one over (6 balls) Then stops recording and labels the recording as ‘trial 1 - mixed action’. This same process is completed for the orthodox bowling action and the recording is labelled ‘trial 1 – orthodox action’. Repeat steps 1-5 four times a day as recommended by Cricket Australia Junior Bowling Guidelines to prevent injuries (Cricket Australia, 2019). The point of release is captured and measured using a digital protractor. Each delivery will attempt to bowl at the consistent length which mitigates the chance of varying degrees of flexion (~17m). Risks such as overtraining and inducing stress on lower back will be considered, and experimentation will resume after absence of pain, at least 3 day of rest until bowling again, if pain continues coaches and other professionals will be referred to.

Methodology for Analysing Data

The footage from the phone is then reviewed, finding a frame which shows the release point of the ball. This is done for each ball bowled in each trial, the data is then compiled and organised into the two categories of mixed and orthodox bowling actions. Using a digital protractor, measurements of lateral flexion (from side-on recording) with highlighting tools. An F-test will then be used to determine the variance between the angles of flexion and rotation in the two bowling actions.

Results

The degree of flexion in the back was retrieved using a digital protractor, the point of release was screenshotted (of both the mixed and orthodox bowling action) and measured using the digital protractor. (*View Fig. 8 below*)

[*Fig. 8*]

The red line displays how the measurements in the data table were derived in Fig. *8* with the help of a digital protractor. The degree of flexion was measured from the lumbar spine to the hand during point of release.

The average degree of flexion for the mixed bowling action was 180.6975 and orthodox bowling action was 179.9925, to further investigate I used the F-test. The p-value derived from the F-test was 0.277083322, therefore rejecting the alternative hypothesis and accepting the null (as the p-value exceeded 0.05).

Mixed Bowling Action	
Trial	**Flexion (º)**
1	179.25
2	178.60
3	182.15
4	180.80
5	176.90
6	181.40
7	175.70
8	183.50
9	179.95
10	177.30
11	184.20
12	176.15
13	182.75
14	177.85
15	181.10
16	189.50
17	183.90
18	180.30
19	178.05
20	184.60

[*Fig. 9, raw data of mixed bowling action*]

Orthodox Bowling Action	
Trial	**Flexion (º)**
1	178.75
2	176.40
3	181.70
4	179.15
5	183.25
6	182.90
7	177.55
8	175.20
9	184.35
10	180.60
11	176.70
12	182.45
13	178.30
14	184.85
15	179.80
16	177.00
17	183.75
18	175.90
19	181.20
20	180.05

[*Fig. 10, raw data of orthodox bowling action*]

Mixed Bowling Action			*Orthodox Bowling Action*	
Mean	180.6975		Mean	179.9925
Standard Error	0.767818809		Standard Error	0.669035785
Median	180.55		Median	179.925
Mode	#N/A		Mode	#N/A
Standard Devi	3.433790103		Standard Deviat	2.992018989
Sample Varian	11.79091447		Sample Varianc	8.952177632
Kurtosis	0.6733351		Kurtosis	-1.225395777
Skewness	0.699387077		Skewness	0.047897912
Range	13.8		Range	9.65
Minimum	175.7		Minimum	175.2
Maximum	189.5		Maximum	184.85
Sum	3613.95		Sum	3599.85
Count	20		Count	20
	1			1

[*Fig. 11, descriptive statistics on both actions*]

F-Test Two-Sample for Variances

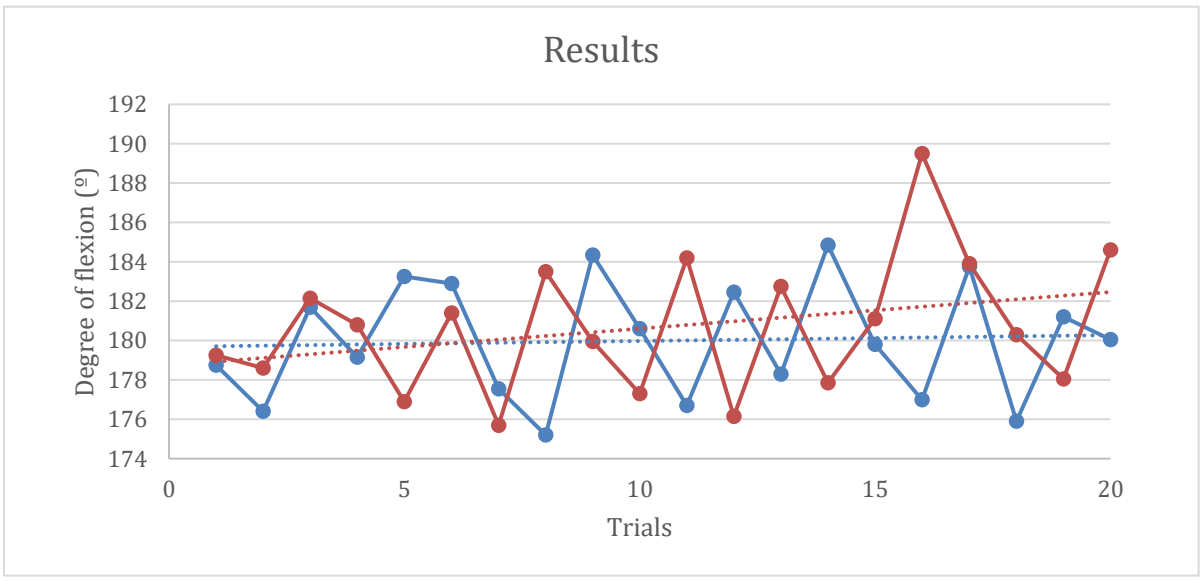
	Variable 1	*Variable 2*
Mean	180.6975	179.993
Variance	11.79091447	8.95218
Observations	20	20
df	19	19
F	1.317100147	
P(F<=f) one-ta	0.277083322	
F Critical one-t	2.168251601	

[*Fig. 12, f-test for variance*]

t-Test: Two-Sample Assuming Equal Variances

	179.25	*178.75*
Mean	180.7737	180.0579
Variance	12.32344	9.35924
Observatic	19	19
Pooled Va	10.84134	
Hypothesi	0	
df	36	
t Stat	0.670048	
P(T<=t) on	0.253552	
t Critical o	1.688298	
P(T<=t) tw	0.507103	
t Critical tv	2.028094	

[*Fig. 13, t-test assuming equal variance*]



Red = Mixed Bowling Action Blue = Orthodox Bowling Action

[*Fig. 14, graphed data using scatterplot including trendline]*

Discussion

The study explored how to reduce the risk of lumbar spine related injuries in mixed action fast bowlers, this would be done by attempting to replace the bowling action with a safer orthodox action. The F-test was used to test the variance and compare the statistical difference between the quantitative variables (mixed and orthodox bowling action). The confidence level of 0.05 was exceeded by the P-value of ~0.28 which proved that the statistical difference was not significant, furthermore a t-test (assuming equal variance) was conducted to further assure that there was no significant statistical difference (P-value = ~0.25) resulting in accepting the null hypothesis and rejecting the alternative hypothesis [View *Fig. 12* and *Fig. 13*].

The data collected on the degrees of flexion in the mixed bowling action had a higher gradient as shown in the scatterplot in the results section. This would suggest that there is a difference present between the degrees of flexion when comparing the two bowling actions. However, the data in the mixed bowling action contained an outlier (189.50º) which has created the potential difference between the two actions [View *Fig. 14*].

Limitations of the Study

Incorrect measurements may skew the data due to the blur of the image, making the point of release hard to find. The hyperextension of the arm (Firdaus Tabassum et al, 2020) is common in fast bowlers, but due to the measurements being taken from the lumbar spine to the hand during point of release, the results may differ, the blue line displayed in *Fig. 8* shows the hyperextension in the arm. In further investigations, the degree of flexion should be measured from the lumbar spine to the bicep [Indicated by the green line in *Fig. 8*].

When undertaking the mixed bowling action, pain was experienced following the over of bowling, the strong counter-rotation and force that was exerted on the lumbar spine is shown in *Fig. 8* by the yellow line. The misalignment of the hips and shoulders (Foster et al., 1989) which were not considered in the beginning of the report would be a contributor to lumbar spine related injuries along with the counter-rotation.

The average of the results along with the p-value from the f-test and t-test (~0.28 and ~0.25), show that there is no distinct correlation of how the mixed bowling action may be responsible for the lumbar spine related injuries in fast bowlers. However, some variables which contribute to lumbar

related spine injuries in fast bowlers were not consistent or measured which would have influenced the results of the data. These variables which were not considered would be affecting the risk of lumbar spine related injuries in fast bowlers even though the degree of flexion may be similar in the two bowling actions.

Further investigation

In further investigations, the misalignment of hips and shoulders in the two bowling actions could be tracked using a front-on camera, screenshotting the FFC, BFC, and follow-through, highlighting the hips and shoulders to provide a visual indication of the difference between the bowling actions. A motion capture system using multiple cameras to track the movement of reflective markers on the bowler's body, using the data and biomechanical models to view the force and torque the spine undergoes during these actions. A larger sample size with bowlers of various ages would make the investigation more valid and more appropriate for the fast-bowling population as it would include various mixed bowling actions.

Conclusion

The main objective of this study was to discover if there is a way to reduce the risk of lumbar spine related injuries in mixed action fast bowlers, by replacing the action (with an orthodox action). The findings of the study determined that there was not significant variance between the degrees of flexion in both bowling actions (P value = ~0.28 in the f-test and ~0.25 in the t-test) therefore leading to the conclusion that there may not be a difference if the mixed bowling action was replaced. Some difference in degrees of flexion was present in the mixed action bowling dataset, however, problems regarding the blurriness of the image (capturing the point of release) and hyperextension of the arm made it difficult to judge the definite measurements.

Although, the limitations of not completely controlling the consistent length the delivery was bowled, not recording the front on angle (which would display the alignment of hips and shoulders) and not having a way of measuring the difference in rotational force regarding the lumbar spine in the two bowling actions, restrict the study from properly finding a way to reduce the risk of lumbar spine related injuries in mixed action fast bowlers. Addressed in the discussion, for future investigations, these contributing factors must be controlled and measured in order to make a more valid study as well as involving more samples (as the results are indicative of one person's mixed bowling action).

In summary, the findings of the study indicate that the two bowling actions do not offer statistically significant degrees of flexion, although, the limitations (of uncontrolled variables) restrict the study from discovering how replacing the mixed bowling action with an orthodox side-on bowling action would reduce the risk of lumbar spine related injuries in fast bowlers.

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