Cricket: Nature and incidence of fast-bowling injuries at an elite, junior level and associated risk factors

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Abstract

Objective. To compile an injury profile of 46 fast bowlers aged 11 - 18 years, and to identify the associated risk factors for injury during one academy cricket season.

Methods. The fast bowlers selected were tested and observed for one academy cricket season (March - November). Subjects were grouped into injury classifications (uninjured=S1; injured but able to play=S2; injured and unable to play=S3). Anthropometrical and postural data for the subjects were collected pre-season (T1). Physical fitness screenings were conducted and the relationship between fitness and occurrence of injuries was assessed. Additional factors such as bowling techniques and bowling workload were assessed. A regression analysis was conducted to analyse the relationship between bowling workload and weeks incapacitated.

Results. Fifteen per cent of the subjects remained injury free for the duration of the season. The incidence of serious injury (S3) showed a statistical and moderate, practical significant increase (V=0.23, df≥2) throughout the data collection period (4% at T1 - 30% at T3 (post-season)). The most common injuries were to the knee (41%) and lower back (37%), occurring from mid-season (T2) to T3. The nature of the injuries was predominantly strains (39%) and 'other' (39%), with the highest reported incidence during the period T1 - T3. Sprains followed, with an overall incidence of 14%. Subjects were incapacitated approximately 1 out of every 7 weeks of play. The S1 and S2 bowlers performed consistently better than the S3 bowlers in all the fitness variables tested. Bowling workload presented a statistically significant ($p<0.0005$) increased risk of injury. A strong, significant positive relationship ($R^2=0.62$, $p<0.0005$) was found between the number of weeks incapacitated and bowling workload.

Conclusion. The results indicated that inadequate fitness, high bowling workload and bowling technique all have a multifactorial role in predisposing a bowler to increased risk of injury. These variables did not act alone, but have all contributed to recurring injuries.

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Introduction

In the past cricket in most Commonwealth countries was played solely during the summer months, but its popularity has increased so much that it has lost its 'season' and is now being played throughout the year. Because of the longer season, cricket players are exposed to more demanding schedules, with more time spent training and practising.[7] This increase in workload may be a contributing factor to the increased incidence of injuries noted. Researchers agree that the physical demands of the fast-bowling action can have a damaging effect on the bowlers concerned. Studies done in South Africa have shown bowling to account for 41% of injuries incurred.[7,8] In a more recent study by the Australian Cricket Board it was reported that fast bowlers at first-class level significantly increased their risk of injury when their bowling workload exceeded more than 20 - 30 overs a week.[5] On average 1 in 6 elite Australian fast bowlers was unable to play owing to injury at any given time.[1]

An injury database has been established by the United Cricket Board of South Africa to help to reduce the incidence of injury by identifying and predicting future injury, thereby utilising the information as guidelines for injury prevention.[7] This database is applicable to players at a provincial and national level. The statistics on schoolboy injuries indicate that more schoolboys are acquiring an 'adult-like' injury profile, favouring injuries to the back and trunk (33%), with the highest incidence of these injuries (47%) occurring among the young fast bowlers.[7]

Various factors, including the type of bowling action, have been associated with a risk of injury, with a 'mixed' bowling action associated with the highest number of lumbar spine injuries. These injuries, specifically stress fractures, can be caused by too much bowling or by a bowling technique fault that causes the spine to counter-rotate unnaturally, resulting in a stress fracture of the bone.[6] Fast bowlers are especially prone to injury as they perform their bowling technique at a very high intensity. To ensure the next generation of elite fast bowlers remain injury free for as long as possible it is important to monitor schoolboy injuries with a view of identifying risk factors that could lead to appropriate intervention strategies and ultimately to prolonged cricket careers and a reduced incidence of injury. The aim of this study was to compile an injury profile of fast bowlers aged 11 - 18 years, and to identify the associated risk factors for injury during a normal academy cricket season.

Method

Forty-six junior fast bowlers aged 11 - 18 years underwent an initial screening in which anthropometrical and postural data were collected. A baseline overall fitness score, based on summated T-scores for each of the physical fitness components (flexibility, muscle strength and endurance, agility and aerobic capacity), was established before the start of the cricket academy training year (T1) (it is beyond the scope of this article to provide details of the fitness scores – these can be obtained from the author). The group was tested and observed throughout the data collection period (March - November). At this stage each bowler received a bowling logbook in which he recorded and monitored bowling workload for the season. Further information regarding fitness was collected on two other occasions, during T2 and T3. Information obtained assisted in acquiring a fitness profile of the fast-bowling subjects during the study period. In addition to the fitness testing and screening the bowlers were required to complete two questionnaires implemented in this study. Questionnaire 1 was completed by all participants while Questionnaire 2 was completed only by those who had reported having sustained a particular injury. The questionnaires were handed out at the initial T1 contact session and returned at the T2 contact session.

The nature of the questions asked allowed for the collection of data regarding the type of bowling technique used by each bowler, the number of injuries incurred, the specific body parts injured, the type of injury and the possible risk factors for injury. These questionnaires were based on those previously used in other cricket fast-bowling studies and modified for the purpose of this study.

The Statistica 7.1 statistics programme was used to analyse the raw data. Changes in injury status throughout the season were analysed using a Pearson chi-square test and a two-way cross tabulation. The significant difference in physical fitness performances was determined utilising an analysis of variance (ANOVA) and the Scheffé *post-hoc* procedure to determine which groups were significantly different. Where statistical significant differences were detected either Cohen's d test or Cramer's V test was used to determine the practical significance of such comparisons. A multiple regression test was used to investigate the relationship between injury and bowling workload as a risk factor for injury. Statistical significance is indicated by *p*-values <0.05 ($p<0.05$), while practical significance is indicated by either Cohen's d values of 0.2 or better (d>0.2) for tests based on sample means, or Cramer's V for tests based on sample frequencies. The significant value depends on the applicable degrees of freedom (indicated by df >0.2 in the text), but at least a minimum value of 0.10. All fitness scores as well as bowling workload figures were converted to standard T-scores and these in turn were summated to derive overall fitness and workload T-scores. It is important to note that TT indicates the overall average score for the entire season. Changes in performances, bowling workload and injury status were analysed using various ANOVA techniques, and analysis of covariance (ANCOVA). A regression analysis was conducted to analyse the relationship between bowling workload and weeks. The relationship between injury and risk factors (bowling workload, bowling technique, fitness, past injury and recurrent injury) was analysed using ANCOVA. ANCOVA was also utilised to accommodate continuous variables in the analysis. These factors were relative to the number of weeks each bowler was incapacitated during the course of the study.

During the data collection period the groups were re-classified into the following player status classifications:

Status 1 (S1) (uninjured). Subjects who remained injury free for the entire data collection period, with injury being defined as any condition preventing or limiting player participation in a match or practice for an extended period of time (2 or more weeks).

Status 2 (S2) (not severely injured). Subjects injured at the beginning of the data collection period, but who were able to continue with normal cricket activities during the data collection period.

Status 3 (S3) (severely injured). Subjects who were unable to return to normal cricket activities during the data collection period owing to a debilitating injury sustained during the data collection period.

Results

The average mean age of the participants in the study was 14.6 ± 2.0 years, with the oldest being 18 years of age. Their average mean height was 170.0 ± 17.7 cm and weight 64.2 ± 16.8 kg. The overall physical fitness score, calculated as summated T-scores for the components of physical fitness, showed significant changes ($p<0.05$) between T1 (48.13) and T2 (51.34) and T1 and T3 (51.37).

Hyperextension of the knees was found to have the highest incidence (43%). Lordosis and winged scapula were found among 39% of the subjects, closely followed by flat feet and pronating feet, with an incidence of 37% each (Table I).

TABLE I. Postural deviations of the total sample (*N*=46)

Physical characteristics	*N*	%
Hyperextended knees	20	43
Lordosis	18	39
Winged scapula	18	39
Flat feet	17	37
Pronating feet	17	37
Kyphosis	12	26
Supernating feet	9	20
Knocked knees	8	17
Scoliosis	2	4
Bow legs	1	2

The S1 and S2 bowlers generally performed better than the S3 bowlers, especially when considering the overall fitness scores for all the relevant variables. None of these differences however was significant ($p>0.05$), except in the case of hamstring flexibility (straight-leg raise test) during T1 and T2 as well as overall at TT ($p<0.05$, d>0.2) (Table II).

During the course of the season 42% of the 46 subjects utilised at least one of the mixed bowling techniques. This was assessed using the bowler's questionnaire and coach classifications according to video-analysis results. Video data were collected by filming the bowlers in action from the front and side views. With the exception of 2 bowlers during T2, who utilised a combination of side-on and side-on mixed techniques (the lower body is at a side-on position and the

TABLE II. Straight leg-raise score differences between the S1/S2 and S3 bowlers rather present the data at (mean ± SD)

Test: Straight leg raise (degrees)

T	S1 & S2		S3		Significance	
	M	SD	M	SD	p	d
T1	83.17	8.36	74.53	8.90	0.003	1.01
T2	85.77	6.66	78.36	12.85	0.015	0.82
T3	84.03	8.23	86.33	9.05	0.542	NA
TT	84.32	6.39	77.64	9.12	0.006	0.90

TABLE III. Incidence of injury from T1 to T3				
Injury status	**T1 (%)**	**T2 (%)**	**T3 (%)**	**TT (%)**
S1	28	30	24	15
S2	67	61	46	50
S3	4	9	30	35
Total	100	100	100	100

S1 – uninjured; S2 – injured but able to play; S3 – injured but unable to play.

shoulders are in a front-on position), all subjects continued to utilise their original techniques from T1 to T3.

ANOVA indicated statistically significant changes in bowling workload over the study period ($p<0.05$). A *post-hoc* analysis revealed statistically significant changes between all test periods ($p<0.05$). Cohen's d tests confirmed that the practical significance of these changes can be described as small ($0.2<d<0.5$) for T2 and T3, and large ($d>0.8$) for T1 and T2 as well as for T1 and T3. At T1 28% of the participants reported being injury free for the past two cricket seasons, with 72% reporting an injury at one or more stage during the preceding two seasons and reporting at least 58 separate injuries. The S3 group increased significantly from 4% at T1 to 30% at T3. The overall results showed that only 15% of the players remained injury free during the course of the season, with 35% at some stage injured to such an extent that they were unable to play (Table III).

The most common injuries were to the knee (41%) and lower back (37%), followed by 'other' (16%) and shoulder injuries (16%). The 'other' injury group included injuries to areas such as the groin, face, heel, toes, stomach and wrist. Knee, shoulder and upper back injuries increased from T2 and T3, while lower back injury incidences remained the same throughout the season. Ankle and finger injuries occurred predominantly at T1, reducing as the season progressed (Fig. 1).

Strains and 'other' accounted for 39% of the injuries incurred (TT) and had the highest reported incidence during T1 - T3. The category 'other' represented injuries such as abrasions, herniations, subluxations, unexplained pain syndromes and concussions. Sprains accounted for 14% of the injuries. Less frequently reported injuries were tears, fractures, bruises, breaks and dislocations. However, of the 15 lower-back injuries reported (Fig. 1), 3 (20%) were stress fractures that occurred between T1 and T2. The categories of injuries that occurred more prevalently during T1 than T2 were sprains, tears and bruises, while those more prevalent during T2 than T1 or T3 were strains, fractures and 'others' (Fig. 2).

Fifty-nine per cent of the participants reported having been injured in the two cricket seasons preceding testing at T1. Over the three testing sessions many of these injuries were reported as recurring at T1 (41%) and T2 (41%) and increasing in incidence to 48% at T3. Overall recurrent injuries accounted for 43% of reported injuries. Bowling (41%) accounted for more injuries than those caused by other sports (28%) at TT.

Bowlers were incapacitated approximately 1 week out of every 7 weeks of play. The 'not severely injured' bowlers generally performed better than those who were 'severely injured', especially when considering the overall fitness scores for all the relevant variables. However, only hamstring flexibility (straight leg-raise test) during T1, T2 and overall at TT showed significant differences ($p<0.05$, $d>0.2$). The 'severely injured' bowlers (S3) showed higher bowling workloads than the 'not severely injured' bowlers (S2). Of the risk factors analysed only bowling presented a statistically significant ($p<0.05$) increased risk of injury.

A strong significant relationship ($R^2=0.62$, $p<0.0005$) was found between weeks incapacitated and bowling workload, supporting the finding that increased bowling workloads show a linear relationship with the increase in number of weeks incapacitated from normal play. Where the regression formula, i.e. weeks incapacitated =-3.7842 + 0.0527 (balls bowled per week), is used for prediction purposes, it should be restricted to instances where a young fast bowler bowls between 60 and 300 balls per the approximate range of bowling workload used to derive the regression formula.

Discussion

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. With regard to bowling fitness, each player should be able to identify his own weakness/es with regard to physical performance and to counteract these weaknesses. This could promote the assertiveness of each bowler to take care of his individual fitness needs with a view to reducing the risk of injury. The overall physical fitness of each subject involved in the current study improved marginally as the season progressed. Physical fitness at T1 is more important than T2 fitness, as it has a significant relationship ($p<0.05$) to risk of injury throughout the rest of the year. This is supported by the findings that poor seasonal fitness

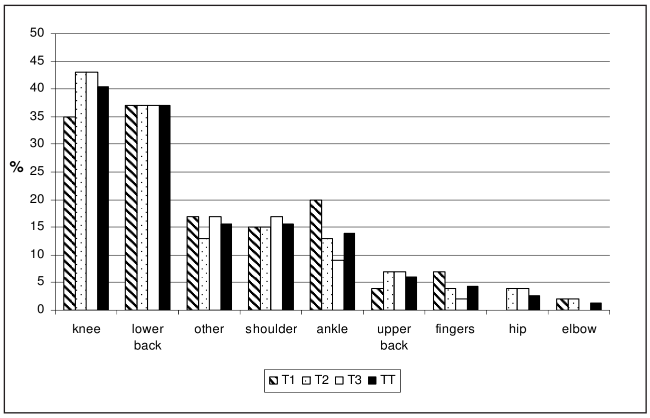

Fig. 1. Seasonal injury incidence per anatomical area.

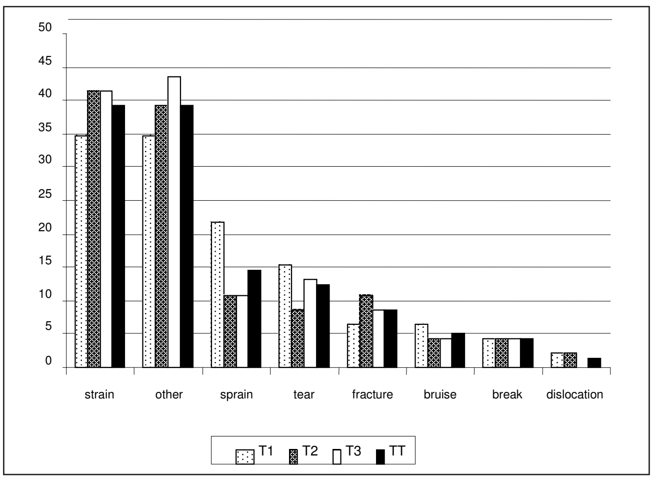

Fig. 2. The nature of injuries to fast bowlers.

conditioning may increase the risk of injury among fast bowlers.[3,7] Fitness at T1 and T2 should be adequate to allow the bowlers to withstand the demands of the fast-bowling action. A high incidence of injury, however, was noted in the current study throughout the season, suggesting that the unconditioned bowler is at a greater risk of fatigue-related injury compared with his fitter, better-prepared counterparts. Unfortunately, research did not yield any national or international data on the fitness requirements and specific profiles of fast bowlers for any age and/or level of play. The latter complicates matters with regard to identifying relevant weaknesses timeously and designing improvement programmes.

An incorrect bowling technique can increase a bowler's risk of serious injury, particularly to the lower back.[7] Regular technique analysis is therefore essential to ensure that the bowler is bowling correctly at all times. Bowling technique only does not seem to predispose a fast bowler to injury. A repeatedly faulty technique is more likely to play a role in injury incidence when coupled with an increased workload and poor physical preparation. In the current study it was found that there was a significant increase in bowling workloads between T1 and T2 (d>0.8). It was also observed that the most serious injuries occurred in bowlers with the highest bowling workloads. These bowlers compounded matters by continuing to bowl while injured, thus causing further injury. These findings are similar to those of Dennis *et al*.[2] Both studies identified excessive bowling workloads as a possible risk factor for injury. Dennis *et al*. also found a significant relationship between low, infrequent bowling workloads and injury, concluding that workloads that are too high or too low have an equal risk of injury in a fast bowler. A possible 'required workload' exists that prevents injury by adequately conditioning the fast bowler to withstand the pressures of continued sessions of fast bowling.

Furthermore, a strong relationship was found between workload and weeks incapacitated (R^2=0.62, p<0.0005), indicating that excessive bowling workloads influenced the severity of injury to such a degree that there was a linear relationship between bowling workload and weeks a bowler was unable to bowl.

The greatest reported risk factor to injury was past injury (74%), closely followed by recurrent injuries (61%). The data collected from the injury questionnaires indicated that the neglect of minor injuries such as cramp, fatigue, nodules and tendonitis predisposed the fast bowlers to more severe sprains and tears. Junior bowlers are at greatest risk of sustaining an injury and then becoming re-injured in the same season, as they are still maturing and developing.[9] Past injury has been identified as being a primary risk factor for injury and has shown that fast bowlers are the most susceptible to recurrences of past injuries of the same nature.[4,9] The initial onset of injury therefore should be prolonged for the longest possible time – particularly in a junior bowler. To delay the initial onset of injury, bowlers should be screened before each season and monitored continuously throughout the season. At the onset of injury the bowler should be adequately treated and rehabilitated to ensure full recovery.

The most commonly injured were the knees (52%), followed by the lower back (43%), with most of these injuries occurring during T2 and T3. The primary mechanism of injury in this study was bowling (54%), other sport (41%), and other cricketing activities or random accidents (5%). Bowling as a mechanism of injury showed a slightly higher incidence compared with data in the Stretch and Venter study.[9] In their study bowling accounted for 40% of injuries, followed by fielding at 33%, but overall the data demonstrate similarities with regard to injury mechanisms.

Bowlers exceeding bowling workload guidelines experienced the greatest number of recurring injuries, aggravated by continued bowling while injured. Neglect to follow the recommended rest period between bowling days has been a significant contributing factor towards injury in the current study. The bowlers are continually repeating an explosive action that places great strain on their anatomy. This is compounded as the subjects have shown to be inadequately prepared physically.

Other risk factors that may have contributed in a multifactorial sense were 'past injury' and 'injuries due to other sports'. Mismanagement and neglect of previous injury may have a negative compounding effect on a bowler's chances of incurring recurrent injuries. Many of the bowlers reported that their injuries were due to other sports (41%), but that they had not sought medical intervention as the nature of the injury was not serious enough to require medical intervention. Sportsmen often excel at more than one sport and consequently they become overwhelmed by the training demands of each sport. In the case of the young athlete the physical demands of each activity begin to take their toll on their immature bodies, resulting in overuse-type injuries.

No individual risk factor was identified as playing a principal role in injury incidence. However, workload as a factor did have a higher statistical significance for increased injury risk. The significance of fitness, bowling technique and workload all played a role in injury occurrence. These variables, however, did not act alone but all had a contributing influence to the occurrence or re-occurrence of injuries at some stage. The bowling action alone would not have been so detrimental if the workloads were not so high, and workload would not have been as detrimental to a well-conditioned, uninjured bowler.

In conclusion, the data in this study have highlighted many areas of concern regarding risk factors for fast-bowling injury. These data, coupled with other similar research done in this regard, should be made available and utilised by parents, coaches and cricketers to assist in educating them about the nature, incidence and possible risk factors for injury. In doing so injuries and/or risk of injury can be identified timeously to prevent the early onset of injury in the young, junior, elite fast bowler, thus prolonging their bowling careers.

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