The prevalence of injuries in women's cricket and its relationship to training practices and physical conditioning

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Signature:

Date: 29/11/2006

SUMMARY

The purpose of this study was to determine the injury rate amongst international women cricketers, as well as anatomical areas which are more susceptible to injuries. A secondary aim was to evaluate how women cricketers prepare themselves for high level competition.

Four teams participated in the study and each team comprised of 14 players. The players were required to complete two different questionnaires relating to the injuries they sustained in a nine month period (eight months prior to the 2005 World Cup and one month during the World Cup) and how they prepare themselves physically for competition.

The injured players (mean age: 25.1 ± 1.10 years, height: 1.6 ± 0.02m, and weight: 61.9 ± 1.99 kg) yielded an injury rate of 0.48 injuries per player over the nine month period. The majority of injuries were sustained during the World Cup (58%), with most of these injuries occurring in the second week of competition (12 out of 16 injuries). Muscle injuries accounted for most (43%) of the injuries. A large proportion of the injuries occurred in the lower limb, namely 59%. Upper limb and spinal injuries accounted for 26% and 15%, respectively.

The top ranked teams seemed to participate more in a periodized training schedule and most teams had more than 12 weeks of pre-season training. Endurance training was focused on the most through both pre-season and in-season (39%-47%) during a week of training, while most teams did not spend much time on anaerobic training (15%-25%) during the week. Most countries were on a par with each other when participating in skills training. The Sri Lankans did the most pre-season bowling training, namely more than 2.5 hours a week. Australia spent more than 3.5 hours on batting during the in-season. Stretching, swimming and low intensity cardiovascular training (27%, 20% and 19%) were the major forms of recovery, respectively. Pearson's correlation revealed that periodization had an effect on the number of injuries

teams sustained. There was a strong correlation between the amount of anaerobic training which teams perform during the pre-season and there world ranking at the World Cup (r=-0.93; p=0.03).

Similar injury prevalence rates were found in this study (48%) and the study by Kelly *et al.* (2003) on Australian women's cricket (47%). It also seems a universal finding that the lower limb is more susceptible to injuries. These findings are also mirrored by those in men's cricket. Women do not seem to suffer from many spine-related injuries, which is more prevalent among men.

The results of this study suggest that players and teams need to review how international players condition themselves to play international cricket. Players need to train more specifically to the needs of cricket. Women cricketers need to pay special attention to there lower limbs and in particular to strengthening their knees. Core strength is a factor that seemed to be neglected during training, but from this study it is suggested that superior core strength may prevent players from sustaining injuries.

OPSOMMING

Die doel van hierdie studie was om die aantal beserings in internasionale dames krieketspelers te bepaal, sowel as om die anatomiese areas te identifiseer wat meer vatbaar vir beserings is. 'n Sekondêre doel was om die voorbereiding van dames krieketspelers te evalueer voor 'n hoë vlak kompetisie.

Vier spanne het aan die studie deelgeneem en elke span het uit 14 spelers bestaan. Die spelers moes twee verskillende vraelyste invul wat gehandel het oor die beserings wat voorgekom het tydens 'n nege maande periode (agt maande voor die 2005 Wêreldbeker en een maand gedurende die Wêreldbeker), asook hoe hulle hulself fisieke voorberei het vir die kompetisie.

Die beseringskoers in hierdie studie was 0.48 beserings per speler oor die nege maande periode. Die beseerde spelers se gemiddelde ouderdom was 25.1 ± 1.10 jaar, lengte 1.6 ± 0.02m, en gewig 61.9 ± 1.99 kg. The meerderheid van die beserings het tydens die Wêreldbeker voorgekom (58%), en die meeste beserings het ook tydens die tweede week van die kompetisie voorgekom (12 uit 16 beserings). 43% van die beserings was spierbeserings en 'n groot proporsie beserings was beperk tot die onderste ledemate (59%). Die voorkoms van boonste ledemaat en werwelkolom beserings was onderskeidelik 26% en 15%.

Spanne met die hoogste rangordes het meer gebruik gemaak van periodisering en die meeste spanne het minstens 12 weke voor-seisoen oefening gehad. Gedurende beide die voor- en binne-seisoen is meestal uithouvermoë tipe inoefening gedoen (39%-47% van die weeklikse inoefening). Meeste spanne het nie veel tyd aan anaërobiese inoefening spandeer nie 15%-25% van die weeklikse inoefening. Sri Lanka het die meeste tyd tydens die voor-seisoen aan boulinoefening spandeer, naamlik meer as 2.5 ure per week. Australia het meer as 3.5 uur per week aan kolfwerk spandeer tydens die binne-seisoen. Strek, swem en lae intensiteit

kardiovaskulêre oefening (27%, 20% en 19%) is hoofsaaklik vir herstel gebruik. Volgens die Pearson korrelasie koëffisiënt was daar 'n sterk verband tussen periodisering en die aantal beserings in 'n span. Daar was ook 'n sterk korrelasie tussen die hoeveelheid anaërobiese inoefening en die span se rangorde by die Wêreldbeker ($r=-0.93$; $p=0.03$).

'n Soortgelyke prevalensie van beserings is in hierdie studie gevind (48%) as in die studie deur Kelly *et al.* (2003) in Australiese dames krieketspelers (47%). Dit blyk ook 'n universele bevinding te wees dat meer beserings in die onderste ledemate voorkom. Hierdie resultate is ook dieselfde in mans. Dit wil voorkom asof dames nie soveel rugbeserings as mans opdoen nie.

Die resultate van hierdie studie suggereer dat spelers en spanne moet nadink oor hoe internasionale spelers voorberei word vir kompetisie. Spelers sal hulle kondisionering meer krieket-spesifiek moet maak. Dames krieketspelers sal spesifiek moet aandag gee aan die inoefening van die onderste ledemate, en veral die versterking van hulle knieë. Dit blyk ook dat die inoefening van die kernspiere ("core strength") agterweë gelaat word, maar hierdie studie wys dat sterk kernspiere die risiko vir beserings mag verlaag.

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LIST OF ABBREVIATIONS

h	:	hour(s)
cm	:	centimetre(s)
kg	:	kilogram(s)
m	:	metre(s)
min	:	minute(s)
mm	:	millimetre(s)
r	:	correlation coefficient
p	:	probability value
s	:	second(s)

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HISTORY

A. HISTORY OF WOMEN'S CRICKET

Evidence depicting the women's game was found in the form of pictures as far back as the 1300s. However, the first women's club was only founded in 1887 and it was known as the White Heather Club. Matches were played between villages or teams that comprised of single and married women. These games caused plenty of excitement as betting was very popular among the spectators. Within four years membership grew from eight to 50 members. The first recorded match was played between Bramley and Hambleton in 1745 and it was reported that there was a crowd of more than 2 000 supporters. In 1811 the first county game was played between Surrey and Hampshire in Middlesex. This game was sponsored by two noblemen, to the amount of 1 000 guineas. The participants were reported to range from the age of 14 to 60 (Harris, 2005).

Overarm bowling was invented by Christeine Willes. She got tired of getting into tangles with the large skirts that they used to play in. Although she invented this new technique, her brother took all the credit. He then spent most of his time trying to get this action recognized. But his playing career abruptly ended when he was no-balled while playing at Lords against the Melborne Cricket Club. He was so distraught, that he got onto his horse and rode away. He never played another cricket game (Harris, 2005).

Cricket as a sport played by both men and women, experienced a decline in numbers and the game almost became extinct until the late 19th century. Just after the rebirth of the men's game in the late 19th century, two professional women's teams evolved. They were known as the Original English Lady Cricketers and they played exhibition matches all over the country. They played their first game in Liverpool and this drew an astounding crowd of 15 000 spectators. This is a crowd that some international men's players could not even imagine playing in front of (Harris, 2005). These ladies were very successful on the field and this contributed to the establishment of women's cricket. Unfortunately, after a successful two years, the manager fled with the profits and this brought women's cricket once again to a halt (Harris, 2005).

In 1926 a group of cricket enthusiasts formed the Women's Cricket Association (WCA) in England. A total of 49 matches were played in their first season throughout England and this also led to the founding of the Colwall cricket festival. This festival is still held today and is a symbol of the success of the Women's Cricket Association. In 1927 there were ten women's cricket clubs. By 1934 there were 80 clubs and only four years after that 123 clubs were registered. The WCA at one stage boasted a total of 208 affiliated clubs and 94 school teams (Harris, 2005).

B. INTERNATIONAL WOMEN'S CRICKET

The first international game played by the English was against The Rest of the World at Leicester in 1933. In 1934 the first international tour by England took place when they toured Australia and New Zealand. The total cost of the tour was £80 (Harris, 2005).

Originally a test match was played over three days, but in 1985 it was extended to four days. Presently, women play test matches over four days and one day games which last 50 overs per side. Compared to men's cricket, women play the shorter form of the game more regularly (Harris, 2005).

C. HISTORY OF SOUTH AFRICAN WOMEN'S CRICKET

Western Province was the first province in South Africa to play women's cricket. According to the record books it seems that they played the game as early as the 20^{th} century (Markman, 2003). One of South Africa's pioneer women cricketers is Mrs Winifred Kingswell. She was the first president of the Peninsula Girls' School Games Union which was formed in 1920/21. This organization was not only affiliated with school girls' cricket but also a number of other sports which young girls played at the time. In 1932 the Peninsula Ladies' Cricket Club was formed and in 1934 it became affiliated to the Women's Cricket Association (Markman, 2003).

Up until the Second World War women's cricket was played regularly in South Africa. In 1949 the South African and Rhodesian Women's Cricket Association was formed. They represented women's cricket in both regions. This association organized what we know today as interprovincial tournaments. Western Province proved to be too strong and won the first three of these competitions. At this time there were seven associations or provinces namely, Border, Eastern Province, Natal, Northern Rhodesia, Northern Transvaal, Southern Transvaal and Western Province (Markman, 2003).

D. HISTORY OF THE WOMEN'S WORLD CUP OF CRICKET

Sir Jack Hayward funded two England tours to the West Indies in 1970 and 1971. Then he was approached by the England captain at the time, Rachael Heyhoe-Flint, for a sponsorship. This sponsorship was used to fund the teams on tour and it was also used to fund the inaugural Women's World Cup in 1973 (Harris, 2005).

The first Women's World Cup in 1973 was held two years before the first men's World Cup (Thompson, 2005). Sir Roger Bannister, chairman of the Sports Council of Engand, opened the event in June 1973 (Harris, 2005). The tournament was contested between Australia, New Zealand, Jamaica, Trinidad and Tobago, England, Young England and an International XI, (which included players from other competing countries). Matches were played over 60 overs and the cup was awarded to the team that had the greatest number of points after the round robin (Thompson, 2005).

Sir Jack Hayward paid £40 000 of the costs out of his own pocket. When he was asked somewhat scathingly why he would want to pour so much money into what was seen as a commercially unattractive game he replied: "It's quite simple, I love women, and I love cricket - and what could be better than to have the two rolled together?" Despite a successful first World Cup, women's cricket continued to struggle until 1997, when the England Cricket Board merged with the Women's Cricket Association (Thompson, 2005).

Although Sir Hayward took care of the finances, there was turmoil on the political front. South Africa had five players lined up to play in the International XI, but the Caribbean countries threatened to withdraw if any South Africans took part. The Caribbean's got their way and no South Africans were permitted to play. Even with all this controversy the International XI came a valiant third, with three wins from six matches.

The competition was interrupted by rain, especially in the initial rounds. This was very similar to the latest World Cup held in South Africa 2005, where 25% of the matches in the round robin stages were rained out. The final was contested between the two top teams, namely England and Australia, at Edgbaston. Both teams comprised on average of housewives, teachers and secretaries. Enid Bakewell scored a prolific 118, as England scored 273 for 3. The one sided final was won by England who finally beat Australia by 92 runs. Heyhoe-Flint took the honour of bowling the last over and as she recalls: "I paced out my run, turned to bowl and found that everyone of my English team mates had placed themselves at least 70 yards out on the boundary edge- including the wicket keeper Shirley

Hodges!" (www.cricinfo.co.za, 2005). The final was given a royal stamp of approval and the trophy was awarded by Princess Anne (Thompson, 2005). After this tournament women's cricket was on the international map and Heyhoe-Flint went on to become a household name (Harris, 2005).

1. Second World Cup (India 1978)

The second world cup was contested in a 50 over format and was only contested between four teams participated, namely India, England, Australia and New Zealand. After, the West Indies and Holland had to withdraw because of financial reasons (Thompson, 2005).

This tournament nearly did not go ahead, because of financial constraints. However, India stepped in as they were the only country that would draw large crowds that would make it financially viable. The build up to the tournament was marred by controversy, because the "English captain Rachael Heyhoe-Flint was dropped amid rumours of jealousy of her popularity, with the older Mary Pilling replacing her in the leading role." (Thompson, 2005). The excuse was that they were going for a young squad and that was the reason she did not make the team. However, there were seven other players in the squad that were older than 30. Hayward was so disgusted at the way Flint had been treated, that he withdrew from the WCA and sponsoring the tournament. This is the main reason why the tournament was held in India. With no sponsorship and support India could at least draw large crowds which could help the WCA financially. Despite all the conflict, England made the final, and played against Australia. England scored a meager 96 for 8. Australia made the score easily with 18 overs to spare and won by 8 wickets (Thompson, 2005).

2. Third World Cup (New Zealand 1982)

The same teams as in 1978 competed against each other with the addition of an International XI. For the third women's World Cup the format reverted back to the 60 overs format. Australia again defeated the English, however, the game was better poised when Australia hit the winning runs in the penultimate over. The highlight of the World Cup was that there were 3 000 spectators at the final and the final was televised from the Christchurch ground (Thompson, 2005).

3. Fourth World Cup (Australia 1988-89)

The final of the fourth World Cup was a replica of the previous two World Cups with Australia again coming away with the trophy and making it three in a row. It was again a 60 over format and England scored a slow 127. Australia also batted slowly but they were deliberate in their approach and only lost two wickets in reaching the total with still 15 overs to spare. Ireland did exceptionally well and made history when they reached the third place play-offs (Thompson, 2005).

4. Fifth World Cup (England 1993)

The 1993 World Cup saw the likes of Denmark and Holland enter the competition. However, they were not very successful and only won one game each. This World Cup saw a new strength in women's cricket. New Zealand made it through to the finals by winning all seven of their qualifying matches and conceding only 1.6 runs an over. England beat the reigning champions causing them not to qualify for the final. England's effort was spear headed by Carole Hodges' match winning century. England beat New Zealand in the final at Lords which saw a 4 500 strong crowd support the ladies at the home of cricket (Thompson, 2005).

5. Sixth World Cup (India 1997)

With the 1997 World Cup came the standardisation of the 50 over format. Australia won their fourth trophy when they beat New Zealand in the final. It was an exciting game which saw the Aussies win with three overs to spare and their captain Belinda Clark score 52 as the opener. Even though the host nation did not play in the final, the crowds at Eden Gardens were enormous and support was spirited for both teams (Thompson, 2005).

6. Seventh World Cup (New Zealand 2000)

In the 2000 World Cup the unexpected happened. New Zealand beat the Australians by four runs in a close contest in Auckland. New Zealand only scored 184 and all sense said that was far too little. However, off spinner Clare Nicholson bowled Belinda Clark for 91. Australia, on 150 for 7, lost two more wickets. Off the final over Australia needed five runs but Charmaine Mason was out on the first ball of the over. New Zealand was the new champions (Thompson, 2005).

7. Eighth World Cup (South Africa 2005)

It was the first time South Africa hosted the Women's World Cup. The competition was based in Pretoria with the teams playing their games in the surrounding areas. It seemed like there was going to be a repeat of the World Cup before. Australia beat England in the semi-finals to advance. The Indians then pulled off a well deserved victory against New Zealand. The Australians, still upset after losing the trophy previously to New Zealand, were certainly not going to give the trophy away. They successfully beat the Indians in a one-sided final.

CHAPTER TWO

CHARACTERISTICS OF THE GAME

A. PLAYING CONDITIONS

The women's game is played under very similar circumstances as the men's game. In South Africa provincial games are played over 50 overs a side. Normally the games are played during the day. The ball is red and weighs 142g (men's ball weighs 156g). During the World Cups they played with a white ball weighing 142g, even during the day matches.

The boundary should be a minimum of 60 meters and a maximum of 65 meters. The distance is measured from the middle stump of the pitch at each end forming two semi circles which then should be joined by a straight line to form the complete boundary. All other rules relating to the men's game, is the same for the women's game.

B. PHYSIOLOGICAL REQUIREMENTS FOR CRICKET

Men's International cricket is experiencing a phase of substantial growth. International audiences are growing and both spectators and sponsors demand more coverage and exposure. As a result the players are exposed to greater physical and physiological demands (Noakes and Durandt, 2000).

Women's cricket has experienced similar growth, but for slightly different reasons. Women's cricket has experienced growth due to an increase in player numbers. More and more women and young girls are finding the game enjoyable and are beginning to play the game on either a social or competitive level. This results in women being exposed to more playing time.

The most important difference between the men's and women's game is that in most male international teams, the players are professional. In women's cricket only a small percentage of international teams are paid professionals. There is no reliable statistics; however, out of eight teams at the 2005 World Cup only two teams had a small number of players in their teams being paid to play. This presents even greater demands, as women still need to work in order to bring in an income and many of them have families to care for. Therefore, women cricketers have a great deal to overcome, especially when time to train is limited with all these commitments.

Cricket is a game consisting of multiple components. It involves inordinate physical skills and mental aptitude. This includes having to be able to concentrate for very long periods of time, and for which physical fitness can not fully compensate (Noakes and Durandt, 2000). Noakes and Durandt (2000:921) said that:

> "We are of the opinion that modern cricketers will benefit from superior physical fitness, regardless of their skill. Thus we agree that, for cricketers of equal skill, physiological factors determining their fitness will ultimately predict their success and longevity in the sport."

There are various models to predict the factors which limit exercise performance. The models being: the classic cardiovascular–anaerobic model, the energy supply-energy depletion model, the muscle power-muscle recruitment model, and lastly, the biomechanical model. The first three of these models have shortcomings when it comes to explaining energy needed when playing cricket. So the last model, namely the biomechanical model of exercise performance, seems to have most influence on cricket (Noakes and Durandt, 2000).

The classic cardiovascular-anaerobic model is a theory which closely relates to the duration and intensity of the activity. Different energy systems dominate energy supply at different times throughout the activity. Using this concept energy metabolism during exercise can be classified as either anaerobic (oxygen-independent) or aerobic (oxygen–dependent). The limiting factor is considered to be the rate of energy supply by the active muscles, rather than being limited by other physiological or metabolic factors. Therefore, if one knows the duration and intensity of the activity an individual can train specifically for the demands of the sport. This model has little relevance to cricket as even the most vigorous activities in cricket would not induce phosphagen depletion in the active muscles (Noakes and Durandt, 2000). The reason cricket does not totally deplete phosphagen levels is that most cricket activities last at most ten seconds and these activities are seldom of a maximal nature. There is often a rest period between these intense bouts of exercise. During these short rest periods there is restoration of the phosphagen stores. Therefore, it can be said that cricket does not fully deplete phosphagen levels within the muscles (McArdle *et al.*, 2001:227).

The energy supply-energy depletion model relates to the idea that whole-body energy depletion could occur during a cricket match. This model is popular in prolonged endurance events such as marathons and ultra marathons where competitors are active for at least 2 hours and is based on the fact that the body can deplete its carbohydrate stores within 2-2.5 hours of very vigorous exercise. However, cricket is not vigorous enough to deplete the carbohydrate reserves. The only way this may happen is if the player deliberately chooses to do so (Noakes and Durandt, 2000).

The muscle power-muscle recruitment model is often used to explain reduced performance and activity at altitude or in hyperthermic conditions. The cerebral motor cortex progressively reduces skeletal muscle recruitment. This means that the cerebral cortex governs the skeletal muscle. It reduces the skeletal muscle recruitment to prevent the body from essentially damaging itself (Noakes and Durandt, 2000). In cricket, it is only in rare circumstances when this model may be applied to explain a decrement in performance: for instance, in extreme heat when a player gets dehydrated.

None of the above theories, therefore, completely explain why cricketers fatigue. There is no doubt that cricketers fatigue, especially fast bowlers near the end of a spell or a batsman scoring 100 runs. All cricketers participating in the various skills of cricket experience some kind of fatigue. Cricket can be described as a sport which induces fatigue through short bouts of high-intensity exercise which are interspersed with prolonged periods at a much lower exercise intensity. Cricketers rarely increase their heart rate above 128 beats per minute (Noakes and Durandt, 2000). The only exception is bowlers who may reach 180-190 beats per minute during their overs of bowling. In a one day game bowlers on average bowl about 64 deliveries in 40 minutes. In this time they run about 1.9 km in 5.3 minutes, this means an average speed of 21.6 $km.h^{-1}$. During the delivery action the body experiences about 64 seconds of upper body action and 64 episodes of lower body deceleration. On the activity of batting, two batsmen each scoring 100 can run up to 3.2 km. This is equal to running 3.2 km continuously in approximately 8 minutes. This means the running speed is 24 $km.h^{-1}$ and the number of decelerations, when turning at the crease or stopping would be at least 110. These activities clearly may induce fatigue in players (Noakes and Durandt, 2000).

So far there have been no clear explanations to the fatigue that cricketers experience. There is one model, the biomechanical model of exercise performance that may shed more light on this issue. Nicol *et al.* (1991) showed that repeated eccentric muscle contractions during running produce intense fatigue which requires a long period of recovery time. The theory behind this model is that the repeated eccentric muscle contractions produce an altered skeletal muscle function, especially a loss of the elastic energy production. The result is increased work during the push-off phase of the running stride. This causes muscle damage and muscle which are damaged in this way require a substantial amount of time to recover (Nicol *et al.*, 1991).

It has become popular to use the presence of muscle proteins in the blood as indicators of muscle damage. The proteins that are often measured are creatine kinase (CK) and aspartate aminotransferase (AST). Creatine kinase is a reliable marker of muscle damage after various forms of activity. High peak forces are a characteristic of eccentric activity, which seems to produce greater soreness and muscle damage compared to concentric contractions. A study done on subjects who had to participate in a 90 minute shuttle run test showed increased levels of serum activity of both CK and AST after exercise. In a shuttle test there is a series of accelerations and decelerations and all these activities produce eccentric work. The elevation in enzymes within the blood lasted for 48 hours and peaked at 24 hours. These increased levels of enzyme activity are closely linked to severe soreness (referred to as DOMS, delayed onset of muscle soreness) and muscle damage. This muscle damage has also been identified with a magnetic resonance imaging test. It was shown that eccentric muscle contractions, which are common in acceleration and deceleration activities, cause microscopic muscle fibre damage (Thompson *et al.,* 1999).

Another study where the aim was to compare the effects of concentric and eccentric muscle actions on indirect indices of muscle damage and collagen breakdown in untrained human subjects, produced similar results (Brown *et al.*, 1999). In this study subjects performed two bouts of isokinetic leg exercise (knee flexion-extension) on a dynamometer. They used the extensor-flexor mechanism for the study. Subjects reported significant DOMS ratings after the eccentric exercise and no DOMS after the concentric exercise. There were no changes in creatine kinase, LDH-1 or alkaline phosphatase after the concentric activity. However, after the eccentric exercise bout there were significant increases in creatine kinase and LDH-1 on days 3 and 7 post exercise. There was also an increase in collagen concentration. This may be speculative, but it may suggest that the breakdown of collagen could put subjects at an increased risk of connective tissue injury. It is concluded that eccentric contractions may result in temporary muscle damage and significantly more muscle soreness compared to concentric contractions (Brown *et al.*, 1999; Thompson *et al.*, 1999). To this end, Morgan and Allen (1999) suggested that the real stress of cricket results from the damage caused by these repeated eccentric muscle contractions which you experience through all the skills in cricket. It is important to realize that it is not only the eccentric acceleration but also the deceleration phase that causes damage to the muscles. In cricket examples are; running between the wickets, a fast bowler gathering momentum delivering the ball and then having to stop and control the direction of the follow through. Even a fielder having to start chasing a ball for 30m from a stationary position, having to stop, collect the ball and throw it in the opposite direction experience this eccentric muscle contractions (Thompson *et al.*, 1999). To be able to cope with these repeated eccentric muscle contractions may require substantial muscle strength to reduce the extent of muscle damage (Noakes and Durandt, 2000).

CHAPTER THREE

INJURIES IN CRICKET

A. INJURIES IN MEN'S CRICKET

Cricket in the old days was described as a sport of "moderate injury risk". There is no physical contact between opponents and the game of cricket was always referred to as "The Gentleman's Game." In the modern era cricketers play many more games and most professional cricketers play year round competitively. It is therefore not surprising that today's cricketers are affected by many injuries which vary in nature and cause.

In past studies done abroad and in South Africa, the incidences of injuries varied from 2.6 to 333/10 000 cricket playing hours. These studies suggest that 28.4%-71.6% of cricketers sustain between 1.61 and 1.91 injuries per season (Stretch, 2003). The latest research done by Stretch and Venter (2005) over a six year period on the provincial and national team in South Africa yielded comprehensive results. Stretch recorded 1 606 injuries sustained by 783 cricketers (2.1 injuries per player per season). This is an increase from the previous studies done by Stretch over a four year period which yielded 1.9 injuries per player (Stretch and Venter, 2005). One can therefore conclude that in South African men's cricket, there is an average of at least two injuries per player per season. Considering that minor injuries can keep players out of play for at least two weeks and serious injuries result in a minimum lay off of two months, it is evident that injuries can severely impair a player's performance and development.

There have been a number of studies done throughout the world on injuries sustained by cricketers. These studies have been done at an international, provincial / county and club level.

Injuries to players' lower limbs range from 22.8% to 50.0% (Stretch, 2003). Upper limb injuries accounted for 19.8% - 34.1% of total injuries, with the fingers having the majority of these injuries. Trunk and back injuries represented 33.3% and 18% respectively. The head, neck and face region accounted for between 5.4% and 25%. The majority of these head, neck and face injuries were contusions, lacerations and concussions (Stretch, 2003). There has been a retrospective study done in English county cricket which yielded the following findings: the regional distribution of injuries was noted and lower limb injuries accounted for 45%, upper limb, 29%, trunk, 20%, and head and neck, 6% (Leary and White, 2000).

The largest study done in South Africa on all 11 provincial teams and the national team over a period of six seasons yielded some very comprehensive results. The study was done from the 1998-1999 season up to and including the 2003-2004 season. The latest article which was published with this data was published in 2005 and covered all six seasons. There was a previous article published on the same study which only incorporated the first three seasons. The statistics referred to below are founded from the above study, unless otherwise stated (Stretch and Venter, 2005).

In South Africa the regional distribution of injuries has been thoroughly documented. Lower limb injuries accounted for 49% with the breakdown within the lower limb injuries as follows: knee (13%), hamstring (18%), ankle (12%), quadriceps (11%) and the groin (7%). The major causes of these injuries were bowling, fielding, overuse and training. Upper limb injuries represented 23% of total injuries in South African national and provincial players. These upper limb injuries included injuries predominately to the phalanges and metacarpals (33%), gleno-humeral joint (23%) and the elbow joint (13%). Injuries were mostly caused by impact from the ball during fielding and batting and resulted in fractures (Stretch and Venter, 2005).

Looking at other sports such as baseball, young players often suffer from shoulder and elbow pain. In a study done on young players (9-12 years) shoulder pain was the most frequently reported at 32% and elbow pain at 26%. The most common factor which was identified was the onset of arm fatigue and overuse of the pitching arm. It was recommended that players be removed from the game if arm fatigue was reported or pitching frequency was increased dramatically (Lynman *et al.*, 2001).

In the above mentioned study done by Stretch and Venter (2005) it was reported that back and trunk injuries accounted for 23% of total injuries in men's cricket. The lumbar area was the worse affected, as 46% of all back and trunk injuries were in this area. These were mainly joint and muscle injuries with a smaller amount being fractures. The injuries were caused by overuse, bowling, fielding and batting for long periods of time.

According to Stretch and Venter (2005), when investigating the mechanism of injuries, the fast bowler's delivery and follow through at 25% was the major contributing factor to all injuries recorded in this study. Running, catching, diving and throwing the ball during fielding activities was also a large contributor to injuries, namely 23% and overuse injuries accounted for 17% of total injuries during the study. The various batting situations, such as running between wickets (4%); batting for a long innings (4%); direct impact from the ball (7%); training (4%) and participation in other sports (3%) were all additional causes to sustaining injuries during the six seasons. The most common diagnosis of injuries were muscle strains (31%) sustained by players during matches and practices (Stretch and Venter, 2005).

Injuries can keep players out of practices as well as matches. Injuries which kept players out of the game for seven days accounted for 47.8% of all the injuries during the above mentioned study. Many injuries (28.4%) resulted in players being out for 8-21 days, while 23.8% of players were out of the game for more than 21 days with serious injuries (Stretch and Venter, 2005).

B. BOWLING

Fast bowlers experience a series of collisions with the ground in the run up phase. The run up phase leads to two large collisions with the landing of the back foot and then the front foot, during the delivery stride. The forces that are generated can be three to nine times the weight of the bowler's body. These forces are distributed through various tissues in the body. At the same time the trunk is stretching sideways while bending and twisting to achieve maximum velocity (Hassan *et al.*, 2003:37).

The study of ground reaction forces during the bowling action have yielded some major insights into the physical demand and impact placed on fast bowlers. The back foot experiences the first impact or contact with the ground in the delivery stride. Hurrion *et al.* (2000) found that peak vertical ground reaction force on the back foot is 1.95±0.08 kN or 2.4 times the bowler's body weight. The breaking force on the back foot was 0.77±0.12 kN or one time the bowler's body weight. The front foot is the pivot mechanism and the full momentum and load of the body is transferred onto the front foot during the delivery stride. The peak vertical ground reaction force on the front foot was 4.80±0.92 kN (5.75 times the bowler's body weight). The breaking force on the front foot was 2.93±0.56 kN (3.54 times the bowler's body weight). This clearly shows that the body is experiencing almost six times its body weight during the bowling action. If a bowler's body is not strong enough to handle these forces, or there are malalignment or biomechanical problems, these errors may lead to injuries (Bartlett, 2003).

In the late seventies it was suggested that the fifth lumbar vertebrae, especially at the neural arch, was the most susceptible to a stress fracture (Cryon and Hutton, 1978). In particular, the pars interarticularis, is more vulnerable to damage because of the repetitive flexion, rotation and hyperextension during bowling. Conditions called spondylolisthesis and spondylolysis are common injuries in bowlers who repetitively produce these movements in the bowling action. This load is felt in the lower lumbar area because of the spine and the pelvis moving in different directions. Elliot (2000) has also found that most of these injuries occur on the side contra lateral to the bowling arm. The possible reason for this could be the change in direction in the counter-rotation of the trunk. This change in direction is combined with the lateral flexion and hyperextension on this side of the lumbar vertebrae (Elliot, 2000).

In 2005 Stretch and Venter reported that bowling was the major cause of injuries (40%) in South African men's cricket, while fielding and wicket keeping accounted for 33% and batting 17% of all injuries respectively. Of all the bowling injuries, 55% were lower limb injuries and 33% were back and trunk injuries. Of these back and trunk injuries, 79% were stress fractures caused by overuse of the bowling action. Importantly, players younger than 24 years of age suffered 74% of the stress fractures (Stretch and Venter, 2005).

According to Stretch (2003) young fast bowlers are at the greatest risk of sustaining injuries, especially to soft tissue structures of the lower limb. The bowling injuries have a close relationship to overuse and this could be caused by early specialization in order to excel (Stretch, 2003). Bowling, as an individual activity, definitely is a major cause of injuries, with between 38% and 47% of school boy cricketers sustaining back injuries. This first percentage refers to a study done by Foster *et al.* (1989) on 82 high performance young male bowlers between the ages of 15-22 years. The second percentage (47%) refers to a study done by Stretch (1995) on school boy cricketers in South Africa. According to Stretch (2003) in older provincial players this injury figure is in the range of 33.0% to 65.7%.

Injuries to the back have been widely reported in cricket and more specifically in fast bowlers (Foster *et al.*, 1989; Elliot, 2000; Stretch and Venter, 2005). There are a number of factors which could cause back injuries. Movements which are reported to aggravate back injuries are activities which require repetitive flexion, extension and/or rotation of the spine. Examples of sports or activities which show these characteristics are the serve in tennis, gymnastics, high jumping and fast bowling.

A study was done in Australia on eighty-two high performance young male fast bowlers (mean age: 16.8 years). Subjects were tested prior to the competitive season. Tests included kinanthropometric measurements; isokinetic leg, shoulder and torso strength tests; flexibility tests; postural assessment and force data was also collected during bowling deliveries. Subjects were filmed laterally and from above and their front foot ground reaction force was also measured. Players had to complete a bowling log book detailing their training and playing programmes. All cricket related injuries were also assessed by a sports physician. At the end of the season, which lasted approximately six months, players were assessed in terms of injury incidence. Eleven percent of players suffered from stress fractures to the vertebrae in the L4-S1 region. Twenty- seven percent sustained soft tissue injuries to the back. Certain physiological and kinanthropometric characteristics of young fast bowlers, showed to predispose players to injuries (Foster *et al.*, 1989).

A low longitudinal arch seemed to be the common denominator in stress fractures compared to high longitudinal arches. Trunk rotation in order to re-align the shoulders of more than 40° to a more "side-on" position between back foot impact and front foot impact in the delivery stride caused a higher incidence of back injuries. Long periods of bowling are definitely a factor which may lead not only to back injuries, but other overuse injuries as well. The release height, expressed as a percentage of the standing height, was significantly and positively related to back injuries. The greater release height could indicate greater ground reaction forces at the delivery stride (Foster *et al.*, 1989). The high occurrence of back injuries especially, in young bowlers, is not the result of a single etiological factor. It is caused by a combination of predisposing factors, such as poor physical preparation, high demands, biomechanical aspects of the bowling technique and an increase in training frequency and duration (Hassan *et al.*, 2003:37).

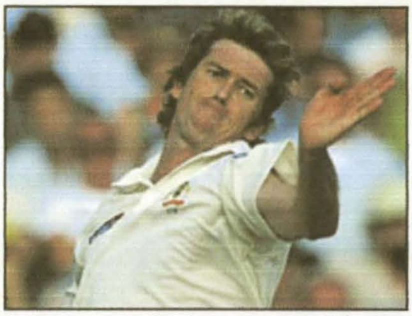
Stretch (2003), after the first three seasons of his study, already concluded that fast bowlers were at an increased risk of injury due to many reasons: 1) the huge demands that fast bowling places on the musculoskeletal system, 2) incorrect technique, 3) poor preparation and training, and 4) overuse. The latter is especially a concerning factor as Stretch found that overuse was the major cause of back injuries in fast bowlers. The majority of these injuries were stress fractures in the lumbar spine due to bowling (Stretch, 2003).

Incorrect bowling technique has been one of the reasons linked to a significant number of bowling injuries. There are three types of bowling actions; 1) side-on, 2) front-on and 3) a mixed action. The different techniques are characterized by the body position which the bowler adopts. The body positions are defined by the alignment of the hips and shoulders with each other at rear foot impact and there is little deviation from this position until the release of the ball. These are defined as follows:

> **Front-on bowling action:** a shoulder alignment of greater than 200° at either back or front foot impacts. The right hand horizontal is connected with a line drawn through the leading shoulder parallel with the pitch. In the front on action the rear foot at impact is pointing down the pitch (perpendicular to the stumps). The hips and shoulders align across the line of the pitch (Elliot, 2000).

Photograph 1: Andrew Flintoff is a modern day examples of the front- on bowling action (http://news.bbc.co.uk/sport1/hi/cricket/skills/4176852).

Side-on action: A shoulder alignment of less than 190° at back or front foot impact (Foster *et al.*, 1998). In the side on action the bowler's rear foot at impact is parallel with the stumps, the hips and shoulders at this moment point towards the batsmen (Elliot, 2000).



Photograph 2: One of the elite cricketers in world cricket with a side-on bowling action, Glen McGrath (http://news.bbc.co.uk/sport1/hi/cricket/skills/4176852).

The mixed action is characterized by the lower body producing a front on alignment and the upper body follows a side on action. It can also operate the other way, with the lower body producing a side on position and the upper body producing a front on action.

This alignment in the upper body is created by counter-rotation away from the batsmen in the transverse plane. This counter-rotation has been shown as a predictor of increased incidence of lumbar spondylolysis, disc abnormality and muscle injuries particularly in fast bowlers (Elliot, 2000). This mixed action also places the trunk in excessive lateral flexion and hyperextension in the lumbar spine at front foot impact compared to the side-on and front-on bowling actions (Elliot, 2000). The increased shoulder counter-rotation (shoulder alignment minus hip alignment) has been consistently related to increased incidence of back injuries (Elliot, 2000). However, it has been shown that shoulder counter-rotation is not a good indicator of lumbar torsional stress, particularly when the trunk is laterally flexed and hyperextended.

In summary, the mixed-action bowler is more hyperextended and laterally flexed. Add to this the greater rotation of the upper body, and one can understand why the lumbar spine is under more stress than with the side-on or front-on actions (Elliot, 2000). It is suggested that to prevent injury from reoccurring a combination of rest, physical rehabilitation, technique modification and workload limitation should be incorporated. Rehabilitation should focus on retraining co-contraction of the deep trunk muscles such as the transverse abdominus and lumbar multifidus muscles (Elliot, 2000).

C. BATTING

In South African cricketers, Stretch and Venter (2005) found that batting injuries were mainly found in the lower limb area (52%). Upper limb injuries (23%) were mainly caused by impact. Overall, batting injuries could be attributed to impact, batting for a long period of play and running between the wickets.

Finger injuries due to impact continue to be a problem area for batsmen. Often key players are kept out of important matches because of the impact of a ball on the finger. Cricket gloves are designed to prevent injuries and are there for protection. Glove designers have made many changes to gloves in order to improve the quality of the protection which they offer. Another critical aspect to consider is the comfort of these gloves as batsmen are required to wear them for the duration of their innings (Bartlett, 2003). In a study of 59 respondents in men's English county cricket over a period, 39% of the group sustained hand or finger fractures while batting. Twenty-five of the 44 breaks were on the bottom hand and 19 on the top hand. On the bottom hand the thumb and first finger and on the top hand the small finger was most frequently fractured.

The helmet is another crucial piece of armor on a batsman's body. The helmet needs to be able to withstand a ball impacting at $160km.h^{-1}$ when facing a fast bowler. It is recommended that batsmen wear helmets in order to protect them from sustaining serious injuries that could be fatal (Stretch *et al.*, 2000).

Cricketers will often stand in the field for a day and a half and then will be expected to go out and bat for hours and with relatively little time to rest, especially for the opening batsmen. As mentioned before in the discussion on the physiological requirements of cricket, batsmen, because of the stop-start nature of the activity, are required to perform repeated eccentric muscle contractions. Substantial muscle strength is needed to reduce muscle damage and possible injury due to fatigue. Batsmen therefore need to have endurance fitness to be able to concentrate while batting for long periods of time, their muscles need to be strong and powerful to perform sprints and sustain the continuous eccentric muscle contractions. Physiologically they need to be able to efficiently draw energy from their anaerobic energy systems in order to supply energy to withstand the continuous running between wickets (Bartlett, 2003).

Batsmen have to be highly skilled and perceptive when it comes to facing fast bowlers (Bartlett, 2003). When facing a bowler delivering a ball at $40.2m.s^{-1}$ ($144km.h^{-1}$) it takes 439ms to reach the batsmen, it is then assumed that movement time takes 250ms, therefore this leaves just 189ms to make a decision and initiate a reaction to the oncoming ball (Stretch *et al.*, 2000). This information says that a ball is traveling at high speeds towards a batsman.

How often do we hear a coach or commentator say, "Keep your eye on the ball"? It has been shown that it is impossible to do this. Batsmen do not keep their eye on the ball. The eyes focus on the point of delivery. They maintain this gaze for the first part of flight. A saccade then brings the fovea below the ball where the ball would bounce. The direction of the gaze is maintained for a period before and after the ball bounces. After this action the head and eyes move down quickly to track the last path of the ball flight. In reality, batsmen have a very short time to decide what to do and to initiate the movement. If this is not done in a short space of time, this could lead to impact of the ball against the batsmen and result in serious injury (Land and McLeod, 2000).

D. FIELDING

In 2005, Stretch and Venter reported that fielding injuries, which included injuries to the wicket keepers, were predominately to the upper (43%) and lower (40%) limbs, irrespective of the age of the players. Thirty-one dislocations were reported and fielding caused 20 of these injuries (65%).

Fielders have to concentrate for long periods of time. They need to focus on every single ball that is delivered to the batsmen. There is always a chance that the ball will come to any fielder. Fielders are expected to stand in a non-ergonomically correct position. Their job is to catch, stop all balls near to them and move quickly to the wicket during each delivery. They are also required to back up when another fielder is throwing at the wickets as well as performing support with chases to the boundary. The other danger is the new "sliding stop" which effectively saves time in returning the ball to the wickets. It does have risks of sustaining injuries that previously have not yet been well documented. There has been a case of a seventeen year old sustaining a bucket handle tear of the medial meniscus in the left knee while performing the sliding stop (Bartlett, 2003).

Generally, for a sport that requires a great deal of throwing, there are relatively fewer shoulder injuries than would be expected. The reason for most shoulder injuries is largely due to fielders throwing accurately for distance. Rotator cuff lesions, especially in the mid-supraspinatus to the mid-infraspinatus injuries, are commonly caused by eccentric loading in the later phases of the throwing action. Shoulder injuries are less common in bowling because of the strict rules stipulating on technique. Overuse rotator cuff injuries are still present in bowling, however, are not that common if bowling load is well managed. Myers and O'Brien (2001), however, did not link these injuries to training. It is suggested that specific rotator cuff exercises should form part of an elite cricketers training regime. However, Bartlett (2003) documented that it is unlikely to form part of a sub-elite players training regime.

E. BIOMECHANICAL DIFFERENCES BETWEEN MEN AND WOMEN'S BODIES

Genetically women have a wider pelvis than men. The wider pelvis creates a more acute angle between the femur and the anterior iliac spines. This creates a greater prominence of the hips laterally. The ischial tuberosities and the acetabula are wider apart. Women also have a greater lumbar curve and the pelvis is anteriorly tilted (anteversion). This greater hip width influences the position of the femurs, which are more angled than in men. This produces the common "X"shape which is often referred to in women. The wider pelvis is also associated with an increased quadriceps angle (Q angle). The wider pelvis and the significant angle of the femurs provoke a genu valgum at the knee joint. This can be aggravated by more hyperlaxity which women tend to have. This genu valgum provides excessive stress to the knee joint. The medial collateral ligament is overstretched, the lateral meniscus and the lateral tuberosity of the tibia are subject to large loads, which can lead to premature wear and tear (Delavier, 2002).

The body is a perfectly developed kinetic chain. So problems which may develop higher up in the upper body, may filter down to the lower extremities creating more injuries and pain lower down in the legs. With the excessive femoral anteversion, there is a compensatory increase in the external tibial torsion; this creates a pronation of the ankle in order to maintain a suitable plantar grade position. With the genu valgum comes a medial collapse at the ankle joint, and a disappearance of the plantar arch. This is often referred to as a flat foot which is accompanied with pronation. This stretches certain muscles in the foot (*peroneus longus muscle*) and places even more strain on the already overstretched medial collateral ligament (Delavier, 2002).

This entire triad is termed the 'miserable malalignment' and features include: valgus knee, weak or underdeveloped *vastus medialis obliques* and a hyper mobile patella. With normal walking and running there is an exaggerated patella motion which leads to overriding and excessive wear and tear within the knee joint and in particular on the patella and the femoral groove. This causes anterior knee pain, problems with the Iliotibial band, lumbar pain and a lack of efficiency when performing activities (Fulkerson, 1999).

There are muscular strength differences that could also evident between men and women. There are differences in the *vastus medialis obliquus* orientation in women. This muscle tends to be weaker and this causes instability within the knee and in the patella. The patella does not have substantial medial dynamic stabilization during movement. This obviously causes the abnormal movement of the patella and the wearing on structures such as the patella, femoral and tibial surfaces and in the femoral groove (Bennett *et al.*, 1993). There are factors that increase female lumbar lordosis this also increases the compression load and tensile forces on the discs (d'Hemecourt *et al.*, 2002)

The strength differences between men and women have been well-documented. An adult women on average only has 56% of the static strength in there upper-bodies as compared to their male counterparts. Trunk strength is slightly better (64%), but a women's strongest area in comparison to men is their lower-body strength where women have about 72% of the strength of men (Lauback, 1976). The reason for these differences is the pubertal hormonal changes that adolescents encounter. Men have higher levels of testosterone which is involved in muscle growth. The other possible reason for this difference is cultural expectations as women age. It is not traditionally thought that women should be active and as a result they experience a type of detraining (Plowman and Smith, 2002).

A last contributing factor may be social and habitual factors. Women tend to sit in a hip adducted position. This adduction produces an increased valgus stress on the knee. Together with the fact that women have a wider pelvis which creates a valgus tension at the knee this sitting position only adds to the stress. Wearing high heels moves the centre of gravity forward, this creates a 'sitting back' posture or a more accentuated anterior pelvic tilt which females already have. Keep in mind that these problems do not affect all women but in general women are more predisposed to obtaining these particular problems. Which could in tern lead to certain injuries (Fulkerson, 1999).

More and more women want to have a career, as well as the fact that it is often a necessity to have an additional income. Women are also the caregivers in a family and they have vast family responsibilities towards children and spouses. This results in limited time for training and skill development.

It cannot be safely assumed that injuries that are common in the male game will mirror in the female game. Research studies done in New Zealand on women rugby players clearly show evidence that injuries differ between male and female rugby players (Levy *et al.*, 1997).

F. INJURIES IN WOMEN'S CRICKET

There is a serious lack of information in connection with injuries in women's cricket. Although there may be many reasons for this, the main reasons are probably related to the relatively low profile of high level women's cricket and a lack of funding for research projects. At the other end of the scale there is an abundance of research on the men's game. International and provincial women's teams often do not have the support team that the men have and therefore, there is a lack of staff to help with the collection of data related to training and injuries.

In the past few years, as some of the women's teams have turned professional, the medical back up has also improved. The unfortunate problem is that there are only two or three international teams that have this medical support. At grass routes level there are not the structures to give the players the support they need and this negatively impacts on the international teams. This causes a huge rift between the international teams and the feeder teams. In order for the women's game to grow, more focus needs to be put into the feeder teams so as to further develop the international standard of the women's game. We are unable to infer the data obtained from men's cricket. The reason we cannot is because of different somatotyping, difference in demands and physique and the biomechanical differences between men and women (Kelly *et al.*, 2003).

There are currently only two research articles on Women's Cricket. The first of these papers was done in Australia on Australian women state and national cricketers. This study was done over a one season period. The two main aims were to 1) investigate injuries sustained during the season and 2) determine the duration players were unable to participate in order to better understand recovery rates. In this study a cricket season was defined as the period from when the player began pre-season training until the final tour or game (Kelly *et al.*, 2003). They referred to an injury as:

> "...an impairment that affected the player's availability for selection, limited their performance during a major match, required surgery or treatment and was reported to a state or national team physiotherapist." (Kelly *et al.*, 2003:5).

In this study there were a total of 96 players of whom 45 sustained injuries. This yielded an injury prevalence of 46.9% during the season.

In this study injuries to the hip/pelvic region were most common (13.6%). Injuries in this area included sacroiliac joint, gluteal area, adductor and groin muscle strains or ligament sprains. The ankle/foot area and shoulder each had an incidence rate of 11.4%. The shoulder injuries were mostly muscular by nature. Most of the shoulder injuries were sustained during either throwing or bowling activities. Lower leg injuries comprised 10.7% of total injuries and these injuries were mostly calf muscle strains or tears and shin splints. The lumbar spine represented 10.7% of the injuries and these where all mainly recurrent/chronic problems (Kelly *et al.*, 2003).

There were only two serious injuries linked to cricket and these were a concussion suffered by a direct impact to the head while batting and a thumb dislocation while wicket keeping. A further two serious injuries occurred outside of the cricket game and training sessions.

It was evident that most of the injuries occurred while fielding (27.1%), compared to batting (15.7%), throwing (12.9%) and bowling (10%). The majority of injuries kept players out for less than one training session. Only ten players missed between 1 to 4 training sessions. A similar trend was seen in the number of matches missed. 40% of the players missed only one match as a result of injury and only 18.6% of the players missed between one and four matches.

The vast majority of injuries occurred during the competitive in-season (78.7%), in comparison with specific pre-season (8.6%) or during the pre-season phase (7.2%). During specific pre-season players concentrate more on cricket specific skills training, while during pre-season they do more base fitness training. Chronic injuries resulted in 4.3% of total injuries. However, Kelly *et al.* (2003) stated that this rate may in fact be higher but players may not report them with regard to their nature and chronicity. They may also not perceive them as being serious enough to report (Kelly *et al.*, 2003).

The second study on injuries in women's cricket was done in England on the Hampshire Ladies County Cricket squad. There were a total of 14 players that took part in the five week period of the study, which took place during the season. Fielding accounted for the majority of the injuries (38%) and batting for 8% of the injuries. Injuries which occurred during pre-match warm ups represented 38% of the injuries and there were two injuries (15%) that occurred during training sessions. The majority of the injuries were first-time injuries (62%), while four injuries (31%) were recurrent from a previous season and one injury (8%) was a recurrent injury from the present season. Most of the injuries (77%) lead to no time being lost in training or matches, 15% lead to one to three days been lost and 8% of the injuries caused the players to be out for more than 21 days (Salter, 2003).

Lower limb injuries represented 62% of the injuries and the upper limbs accounted for 38%. There were no back, trunk or head, neck or face injuries. Haematomas were the most common injury (38%) and muscle strains accounted for 31% of injuries. Ligament sprains, fractures, shin splints and tendonitis all shared one injury each. It was interesting to note that there were no injuries suffered to the back. However, it must be kept in mind that this study had a small sample size and only represented one English county squad and it was over a short study period (Salter, 2003).

INJURIES IN OTHER WOMEN'S SPORTS

In a field hockey survey in London in which 158 players took part, 74.4% of these players reported injuries (Murtaugh, 2001). Players were chosen by a cross-sectional design in order to get a diverse sample of hockey players from a variety of competitive levels. Players were required to fill out a questionnaire based on the level of competition, position, experience, hours of training and injuries sustained in a one year period. The average age of injured players was 20.4±3.2yrs. The uninjured players were younger and less experienced. The majority of injuries were to the lower limb (51%), head and face (34%), upper limb (14%) and back/torso (1%). The most common type of injuries was ligament sprains and these were predominately in the ankle. Other prevalent injuries were contusions and fractures (17.1% and 16.4% respectively). Most contusions were to the head/face region, whereas most fractures occurred to the hands, wrist and fingers. The head and face injuries were caused predominately by contact with the ball, stick or another player. Goalkeepers seemed to have the highest injury rate over all playing positions. A back pain questionnaire was also completed. Although back pain is not always an acute injury it was a common complaint amongst most players. The pain was often serious enough that 12% of players reported missing practice, game time or school. The lower back was the most common complaint followed by the upper back, neck and tail bone (Murtaugh, 2001).

A study done in the United States of America on women collegiate rugby players focused solely on knee injuries which occurred during a four season period. There were 810 collegiate rugby players and there were a total of 76 knee injuries. They were divided as the following: meniscal tears (25), medial collateral ligament tears (23), anterior cruciate ligament tears (21), patella dislocations (5) and posterior cruciate ligament tears (2) (Levy *et al.*, 1997).

Early studies comparing injuries among male and female athletes show females have a higher injury rate in general (Levy *et al.*, 1997). However, the latest evidence shows that this sexual difference in injury rates seems to be sport-specific. This seems to be truer for sports that experience a great deal of jumping and pivoting. Female athletes experience ACL injuries four times more than males and in soccer the incidence is doubled (Levy *et al.*, 1997). In basketball there is also a four times greater incidence of knee injuries in women than in men (Arendt and Dick, 1995).

A study done by Giza *et al.* (2005) on the first two seasons of the Women's United Soccer Association (WUSA) showed an injury rate of 55%. The most common diagnoses were strains (30.7%), sprains (19.1%), contusions (16.2) and fractures (11.6%). The most frequently injured body site was the knee (31.8%), head (10.4%), ankle (9.3%) and foot (9.3%). Sixty percent of these injuries occurred in the lower limb area (Giza *et al.*, 2005).

Table 1: A summary of the different studies related to injuries in different women's sports.

Site	**Hockey** (Murtaugh, 2001)	**Soccer** (Giza *et al,* 2004)	**Cricket** (Salter, 2003)	**Cricket** (Kelly *et al*, 2003)
Upper limb	14%	N/A	38%	11.4%
Back and torso	1%	N/A	0%	10.7%
Head, face and neck	34%	11%	0%	N/A
Lower limb	51%	60%	62%	34.7%

There is considerable literature supporting the notion that women suffer from higher knee injury rates than men. There are a number of proposed contributing factors and these can be divided into extrinsic and intrinsic factors. Extrinsic factors are: body movement in sport, muscular strength, coordination, shoe-surface interface, level of skill and physical conditioning. Intrinsic factors are joint laxity, limb alignment, notch dimensions and ligament size (Arendt and Dick, 1995).

Most anterior cruciate ligaments injuries are non-contact in nature and are caused by sudden deceleration, landing from a jump, or while cutting. The hamstrings need to have considerable eccentric strength to keep the knee in a safer, slightly flexed position. Quadriceps also need to have strength and endurance both eccentrically and concentrically. This is interesting as it has been found that hamstring-to-quadriceps strength ratio is less in women than in men. This does make women more susceptible to knee injuries. As seen in the previous paragraphs women clearly show to have a greater incidence of lower limb and knee injuries (Arendt and Dick, 1995).

In conclusion there is a lack of research in the field of women's cricket. There are injuries in all sports and it would only be beneficial to the game of women's cricket if research can be added. As we have seen in the previous chapter men playing cricket are exposed to a large number of injuries. There are some serious injuries that can have a detrimental affect on a players career as well as on their quality of life as they mature. Valuable information gained from research can be used to prevent injuries by truly preparing women cricketers in the most efficient way possible. The research could be used to educate players, coaches and trainers. The level of competition will be increased and hopefully potential sponsors will also see women's cricket as a potential avenue to gain exposure.

CHAPTER FOUR

PROBLEM STATEMENT

Women's cricket has been played for many years, however, in the last twenty years the game has expanded and grown to reach a variety of nations. In terms of competitive competition at an international level women's cricket is a relatively young game. It is therefore not surprising that there are only a limited number of previous studies on women's cricket in the literature.

Women cricketers are at an increased risk of injuries because of many controllable and uncontrollable factors. Firstly, women's cricket is a new game for most women in South Africa and as a result they are inexperienced. This inexperience may mean their skill and technique aren't as finely tuned as they should be. Coaches and players are new to the game and incorrect training practices, which do not necessarily benefit the players, can cause more harm than good. For instance, incorrect training practices can result in imbalances between agonist, synergist and antagonist muscles and this could cause injuries. These imbalances may be as a result of a limited amount of knowledge when it comes to correct training prescription. Women have a totally different body shape to men because of their wider pelvis. Women also tend to carry their weight differently on their bodies. These differences could lead to injuries which are not necessarily prevalent in men's cricket.

When studying injury rates and patterns, one also needs to look at training practices. Not enough training will not only cause weaknesses in certain areas, but an underconditioned player will also fatigue quickly. Fatigue usually increases a player's susceptibility for injury and can easily prevent a player from performing at optimal levels. In many instances, players are expected to train and condition themselves despite the fact that they do not possess the knowledge to train themselves adequately and correctly.

Scientific knowledge surrounding women's cricket is very limited. Much of our knowledge about cricket-related injury patterns are derived from studies on men's cricket. In the light of the problem mentioned above, it is likely that a different picture may arise in the women's game. Furthermore, the worldwide increase in the popularity of women's cricket warrants more and comprehensive research in this field. Therefore, the aims of this study were to: 1) quantify the prevalence of injuries, and 2) describe the training practices of international women's cricket teams.

A. MOTIVATION AND BENEFITS

Women's cricket is a popular sport and its growth is visible in many countries world wide. Mostly research is taken from the men's game and is then applied to the women's game. This cannot give a fair or true reflection as men and women differ in their physical make-up, and training requirements may therefore differ. Therefore it is imperative that research is done on women cricketers. Quality research involving the women's game could be used to educate coaches, trainers and players. This may contribute towards healthier and fitter players and could lead to an improvement in the quality of competitions. This, in turn, could lead to more support from spectators and interested parties, which in turn could draw more sponsors to the women's game.

The women's World Cup, which was held in South Africa in 2005, is the pinnacle competition of the sport. It is where the best of the best compete for top recognition. The World Cup also affords researchers the opportunity to gather information on injury patterns and a clear insight into the way they train and prepare their bodies physically. The World Cup is played by the best players currently in the sport and it is an opportunity to gain insight into the state of the particular sport.

B. SPECIFIC QUESTIONS TO BE ADDRESSED IN THIS STUDY

1) What are the injury rate in women's cricket during a major competition and is there a correlation between injury susceptibility and the rankings of the individual teams?
2) How do women cricketers train during pre-season and in-season to prepare themselves for a major competition?
3) Is there a correlation between their training, the injuries they sustain and their ranking during the World Cup?

CHAPTER FIVE

METHODOLOGY

A. STUDY DESIGN

This descriptive research project was conducted during the Women's World Cup of Cricket held in Pretoria during March and April 2005.

There were eight international teams with fourteen players in each squad, resulting in a total of 112 players. There were three individuals critical to the study, namely 1) the coach and 2) the biokineticist, physiotherapist or fitness specialist and 3) the players. These individuals were required to give detailed information on various aspects related to their preparation for the World Cup and during the tournament.

The data were collected by using subjective open-ended questionnaires, which the players and management completed. The questionnaire was originally developed by Dr. Richard Stretch (Nelson Mandela Metropolitan University) and is used by the United Cricket Board of South Africa in obtaining medical data from male cricketers (Appendix C). Dr. Stretch gave permission for the questionnaire to be used in the current study. The questionnaire was slightly revised, in order to modify the layout. A further two questionnaires were developed in order to be able to answer all the study questions, namely the Injury Report (Appendix A) and the Training Regime Questionnaire (Appendix B). The questionnaires were used to collect data relating to injuries and training practices during the World Cup, as well as during the 8 months prior to the tournament, from August 2004 to March 2005.

B. QUESTIONNAIRES

1. Injury Report (Appendix A)

1) The coaches or biokineticists of the individual teams completed the injury report. This related only to the injuries that have occurred prior to the tournament from August 2004 to March 2005.

2) When there were injuries that occured during the tournament it was the responsibility of the person treating the player (biokineticist or physiotherapist) to fill out the form.

3) One questionnaire was filled out per player per respective injury. If a second injury occurred to the same player another questionnaire was completed for that specific injury.

1.1 Definitions related to injuries.

An injury was defined as a pain which prevented a player from completing a match, a practice or a training session, or caused them to seek medical attention. An acute injury was defined as an injury that showed rapid onset with immediate pain, and which had not been treated previously. A chronic injury was an injury which had been treated before and had a prolonged onset. The chronic injury could either have been from a previous season or the present season.

2. Training Regime Questionnaire (Appendix B)

1) This was a separate questionnaire directed towards the coaches, trainers or biokineticist. There was only one questionnaire filled out per team. This questionnaire included questions on training procedures to evaluate how the individual teams train.

2) A similar questionnaire evaluating the training procedures was completed by a random sample of players from each team in order to evaluate their individual training methods. A sample size of 50% of each team was used.

C. ETHICAL CONSIDERATIONS

Consent for the study was granted by the United Cricket Board, the Women's International Cricket Council and the team managers of each team. All parties were assured that information gathered from the questionnaires will be handled strictly confidential and will only be used for the purposes of the research project.

D. DATA ANALYSIS

Descriptive statistics were used to calculate mean scores and compare it to existing findings in the men's and women's game. Descriptive analysis was done to determine which injuries and in what anatomical areas they were most prevalent. Through the questionnaires the amount of training of the different teams was quantified for both pre-season and in-season. The questionnaire was used to identify a number of trends and possible causative factors for the reported injuries. Pearson correlation analysis was used to determine any relationships between the various outcome variables, such as the correlation between injuries and the amount and type of training done. $P < 0.10$ was considered statistically significant.

CHAPTER SIX

RESULTS

A. INTRODUCTION

In this chapter, the results of two different questionnaires are presented. The first of these questionnaires is the Injury Report Questionnaire. This questionnaire was designed to collect information from the players and their medical team regarding injuries sustained by the players. The questionnaire covered injuries that occurred eight months prior to the World Cup, as well as injuries during the World Cup tournament. The second questionnaire was designed to collect information from the players about their training practices. Questions were directed at the various types of training players engaged in, as well as the amount of time they spent training.

In the 2005 World Cup, which was held in Pretoria, South Africa, there were a total of eight teams participating. All the teams were approached to participate in the study. Four teams responded positively to the request. All their completed questionnaires were received after the World Cup.

B. INURY REPORT QUESTIONNAIRE

This part of the study stretched over a nine month period. This included the eight months prior to the World Cup and the four weeks during which the Women's World Cup Tournament took place. All the countries who took part in this study had fourteen players each in their squad. There were a total of 27 injuries out of 56 players (48.21%) over the study period. This yielded a frequency of 0.48 injuries per player over the nine month period that injuries were recorded.

1. Characteristics of injured players

Table 2: Characteristics of the players (n = 26) who sustained injuries during the nine month study period.

Country	Age (years)	Height (m)	Weight (kg)	BMI (kg/m^2)
South Africa	22.6 ± 2.17	1.7 ± 0.03	71.1 ± 3.39 **	24.7 ± 2.81
Australia	31.2 ± 1.58 *	1.6 ± 0.03	59.1 ± 2.51	21.8 ± 2.33
New Zealand	23.5 ± 2.25	1.6 ± 0.04	66.0 ± 2.74 ***	23.5 ± 0.83
Sri Lanka	24.1 ± 1.30	1.6 ± 0.07	52.8 ± 1.94	20.2 ± 2.24
Total	25.2 ± 1.10	1.6 ± 0.02	61.9 ± 1.99	22.6 ± 2.05

(* p=0.008)

(** and *** p=0.012)

The players' mean age varied from 22.6 to 31.2 years. Overall, South Africa had the youngest players at 22.6 ± 2.17 years. The Australian team had a statistically significantly older group of players at 31.2 ± 1.58 years (p=0.008), compared to the other three teams. The mean age of all the injured players was 25.2 ± 1.10 years.

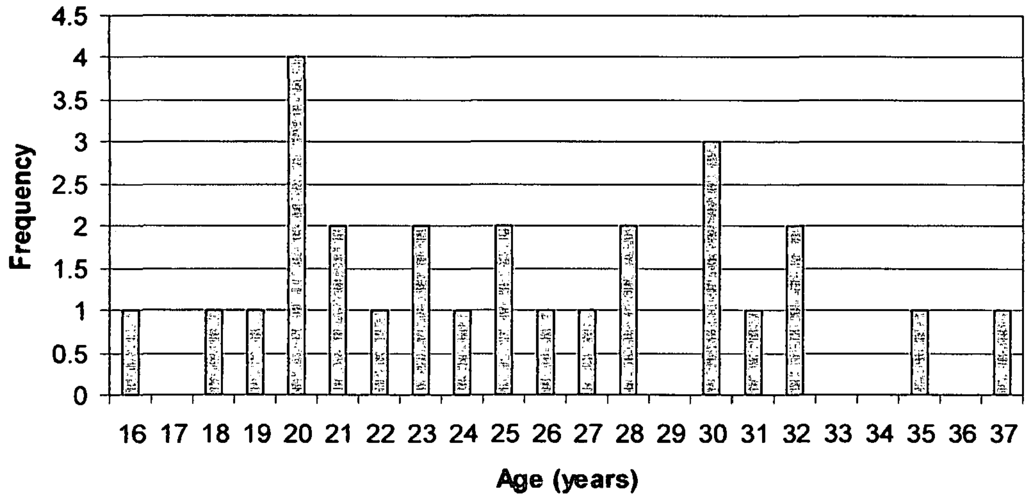


Figure 1: The age distribution of the injured players.

Figure 1 shows that the age distribution of the injured players follow a bimodal distribution, with a higher concentration of injuries around the 20 years and 30 years. Furthermore, there were 11 injuries in the younger third (16-22 years) of players and eight injuries in the older third (30-37 years) players.

South Africa had the tallest players at an average height of 1.69 ± 0.03m. The country with the shortest players was the Sri Lankan team who had an average height of 1.61 ± 0.07m. There was no statistically significant difference between the four countries with respect to height (p>0.05).

The players varied largely with respect to body mass (52.8-71.1kg). South Africa had the heaviest women with a mean value of 71.1± 3.39kg. The Sri Lankan team, in accordance to their height distribution, was also the lightest team. The players of South Africa and New Zealand were statistically significantly heavier than the Australian and Sri Lankan players (p=0.012). When having a look at the BMI of the injured players South Africa had the highest value of 24.7 ± 2.81.

Figure 2: The handedness of the injured players.

An interesting finding was that the New Zealand and Sri Lankan teams had equal numbers of left and right handed players amongst the injured players. The majority of injured players in the South African and Australian teams were right handed.

2. Dispersion of Injuries

In the eight months prior to the World Cup, there were a total of 11 injuries out of 56 players. During the one month of the World Cup there were 16 injuries among 56 players. There was only one individual who recorded two injuries and both of these injuries were chronic injuries. One of the injuries fell in the eight months prior to the World Cup and the other injury, unrelated to the first injury, occurred during the World Cup.

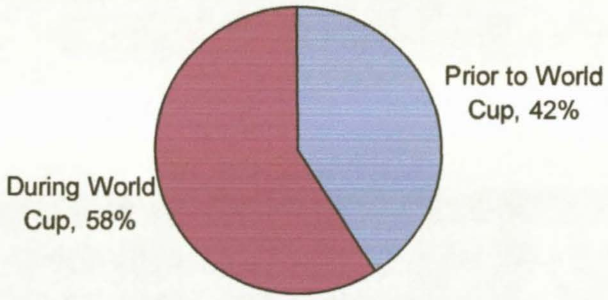


Figure 3: The distribution of injuries prior to (eight months) and during (one month) the World Cup.

Figure 4: The dispersion of injuries over the nine months study period.

Figure 4 shows that South Africa and Sri Lanka suffered the most injuries during the World Cup (five each) and the South African team also had the most injuries prior to the World Cup (a total of four). The New Zealanders had to deal with the fewest injuries prior to (two) and during (two) the World Cup.

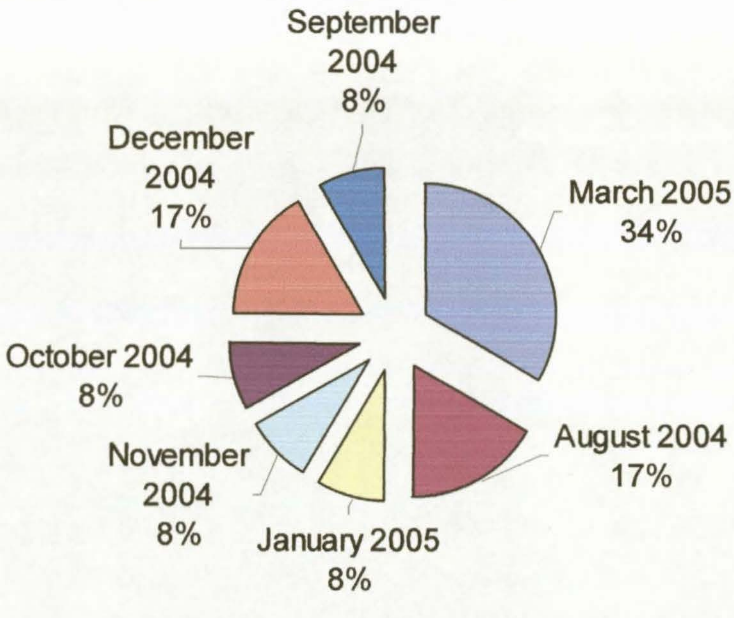


Figure 5: A breakdown of injuries per month, within the eight months prior to the World Cup.

Injuries prior to the World Cup were recorded from August 2004 to March 2005 (the month before the World Cup). A significant amount of injuries occurred in the first and fifth months (August and December 2004, 17%). The majority of injuries, however, occurred in the month leading up to the World Cup, namely 34% in March 2005 (Figure 5).

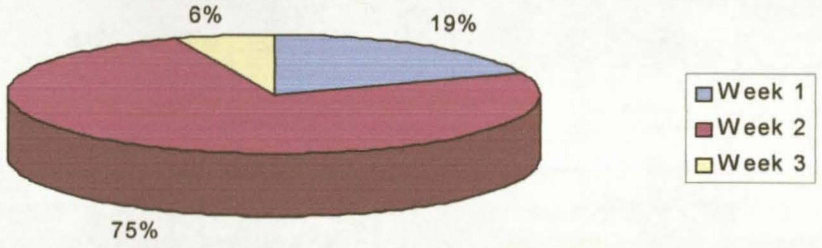


Figure 6: The prevalence of injuries during the World Cup.

Of the total number of injuries during the World Cup (n=16), least injuries (6%) were reported in week three (the last week). Most of the injuries occurred in the second week of the World Cup (75%).

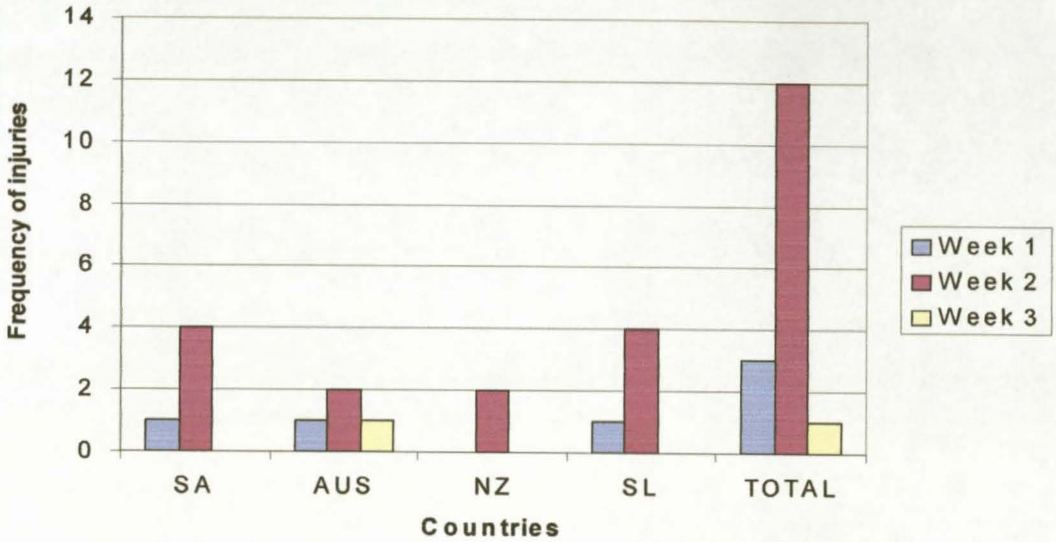


Figure 7: The distribution of injuries per country during the World Cup.

South Africa and Sri Lanka each had four injuries in week two, while the Australians were the only team to sustain injuries in the third week of the World Cup. The New Zealand players only suffered two injuries during the World Cup and both these injuries happened in week two.

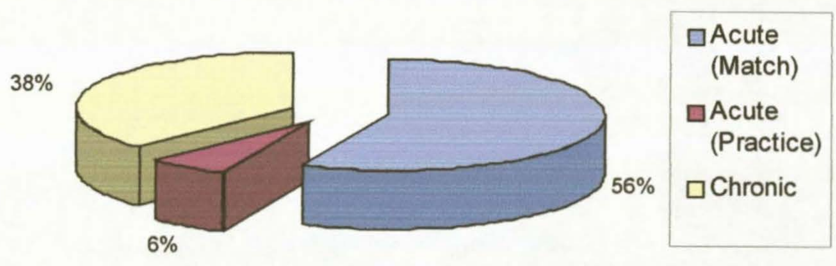


Figure 8: The incidence of acute and chronic injuries during the World Cup.

A large number of injuries occurred while the players were playing matches (56%), while only 6% of injuries sustained while training. There were also a significant percentage of injuries that were chronic (38%), meaning that players suffered from them on a continuous basis.

3. Activities associated with injuries over the nine month period (prior to and during the World Cup).

Fielding and batting caused the most injuries, namely 25% and 22%, respectively. Catching a ball was not included in the fielding category. Catching on its own caused 15% of all injuries during the study period. Throwing related activities seemed to cause the least number of injuries (8%). The "other" injury that was referred to, was a non cricket related injury sustained by one of the South African players.

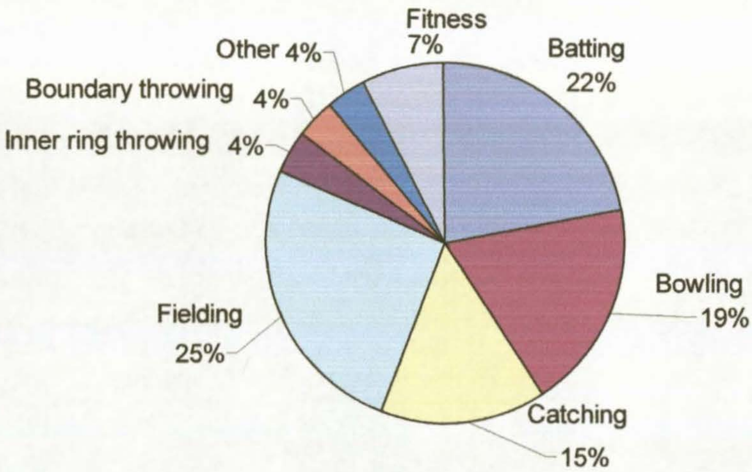


Figure 9: The percentage of injuries sustained during different cricket-related activities.

4. Mechanism and description of injury

Table 3: The mechanism and brief description of the injuries sustained per country.

	South Africa	Australia	New Zealand	Sri Lanka
Injury 1	Caught the ball in the incorrect position. Fractured phalanges.	Thoracic facet joint sprain. Secondary to structural scoliosis.	Grade 2 hamstring strain on left side.	Chasing the ball to boundary. Grade 1 gastrocnemius tear.
Injury 2	Shin splints. A chronic condition.	Initial injury during fielding, then aggravated during batting. Forearm pronators spasm and strain secondary to cervical spine & shoulder neural irritation at myotomes.	Grade 1 lateral ligament complex sprain of the ankle.	Used a sliding stop to retrieve a ball. Aggravated a chronic hip bursitis. However was Grade 1 tear in external rotator/ hip abductor.
Injury 3	Patella tendinosis. Chronic and overuse.	Left medial calf strain (sudden onset). Developed into Achilles tendonosis. Neural tightness	Lower Back Pain: L6 intervertebral disc degeneration	Diving for a catch. Damage to tendons in phalanges.
Injury 4	Side strain of internal and external intercostals muscles.	Bursitis at hamstring origin at ischial tuberosity Caused by tight hamstring.	Dived to take a catch. Landed awkwardly. Ulnar-carpal ligament strain.	Fitness training, doing a sprinting exercise. Grade 2 hamstring tear.
Injury 5	Side step during match. Tore Anterior Cruciate Ligament. Rugby game. Surgery was needed.	Chronic shoulder hypermobility. Repeated training. Tight posterior capsule, weak eccentric rotator cuff strength.		While batting performed a cut shot. Aggravated a lateral epicondylitis tendon injury.
Injury 6	Change of direction and run towards ball-Quadricep strain in rectus femoris	Patella Femoral Pain Syndrome-maltraking of patella & tendonosis on patella tendon.		Caught ball incorrectly. Possible fracture of phalanges.
Injury 7	Taking a run strained			Slipped while fielding. Strain

	gastrocnemius. Grade 1.			of Medial Collateral Ligaments Grade 1.
Injury 8	Keeping -Side shuffle stood badly. Achilles tendon sprain.			Sliding to stop a ball. Tensor Fascia Latae + gluteus medius strain.
Injury 9	Spina bifida- chronic, overuse and genetic			

5. Nature of injury in nine month period (prior to and during the World Cup).

Muscle injuries accounted for 43% of all injuries. Other injuries and fractures had the lowest percentages of injuries, with 3% and 7%, respectively.

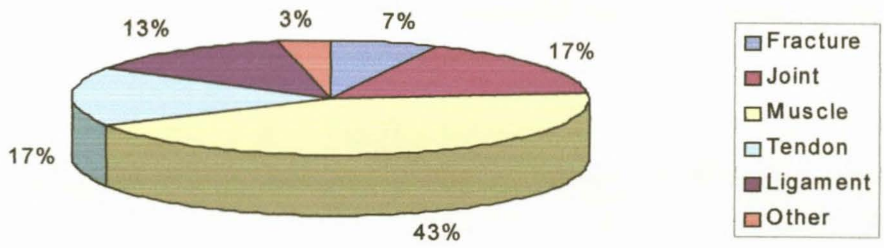


Figure 10: The specific anatomical structures in which the most injuries were sustained (all countries).

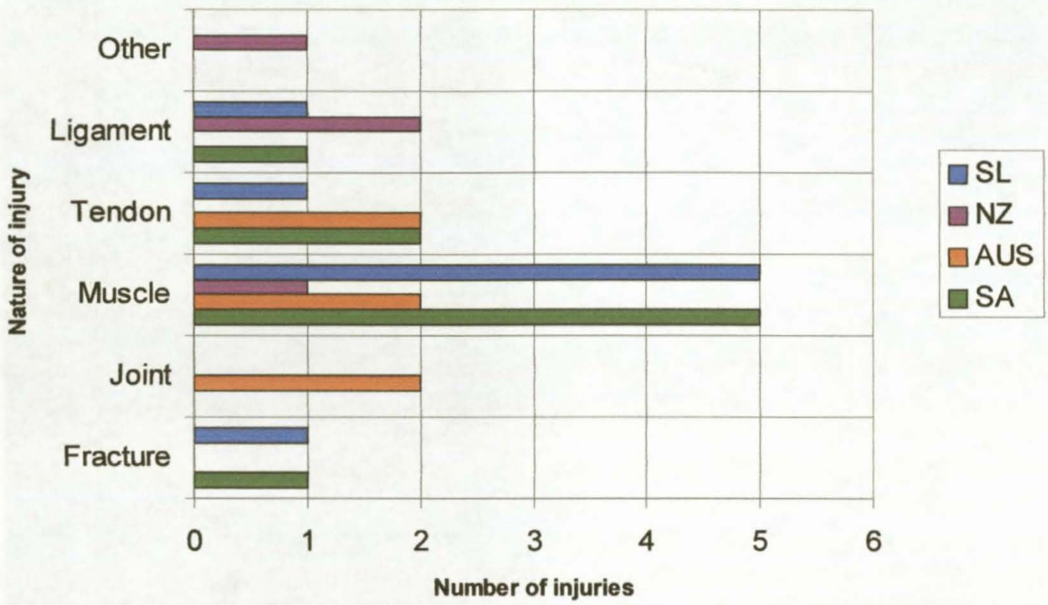


Figure 11: Distribution of injuries per anatomical site for each country.

Fractures and injuries to "other" structures accounted for the least number of injuries in all teams. South Africa and Sri Lanka had one fracture each. Both fractures occurred in the phalanges of their wicket keepers. Injuries to muscles were the most notable injuries, with a combined total of 13. Injury patterns for all other anatomical structures were similar between the different teams.

6. The type of injuries which occurred during the nine months (prior to and during the World Cup).

The percentages in figure 12 were calculated from the total number of injuries that occurred during the study period. The majority of women cricketers (64%) suffered first time injuries during the study period. The remaining injuries (36%) were of a chronic nature. These were either sustained in the previous competition season, or during the season prior to the World Cup.

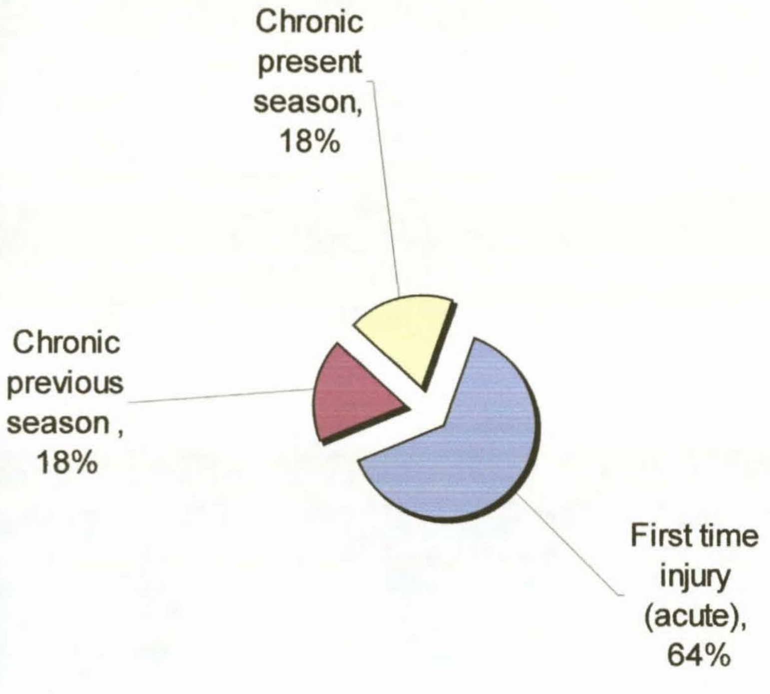


Figure 12: A division of the type of injury (acute and chronic).

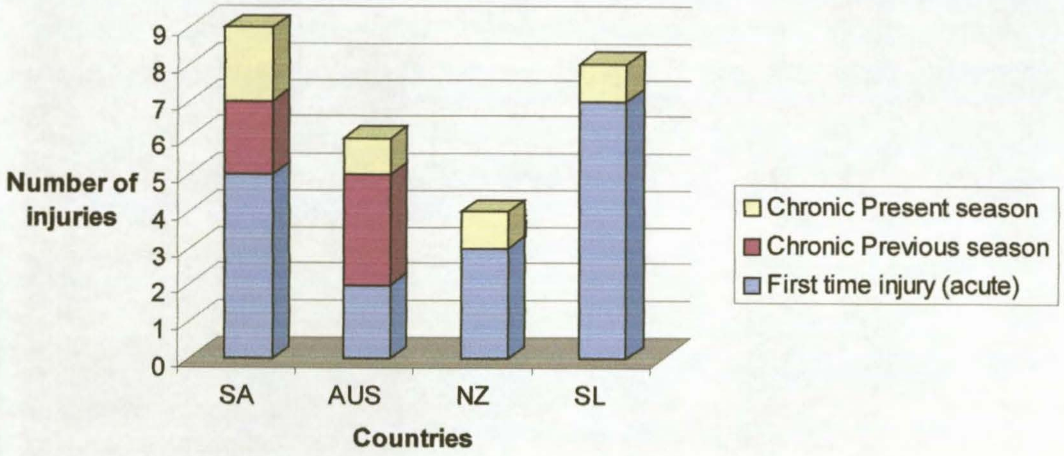


Figure 13: A breakdown of the prevalence of injuries, per country.

Players from New Zealand and Sri Lanka did not suffer from any chronic, previous season injuries (figure 13). The majority of their injuries were acute injuries. Australia and South Africa both had injuries from the previous season (chronic). Australia reported the most chronic, previous season injuries (n=3).

7. Time out of practice sessions during the nine months (prior to and during the World Cup).

Most injuries caused players to miss practice sessions for between 1-3 days (34%) and 4-7 days (35%). These two categories accounted for 69% of practice days lost. There were no players who did not participate in practice sessions for 15-21 days. There were a total of 3 injuries causing players to miss practice for more than 22 days.

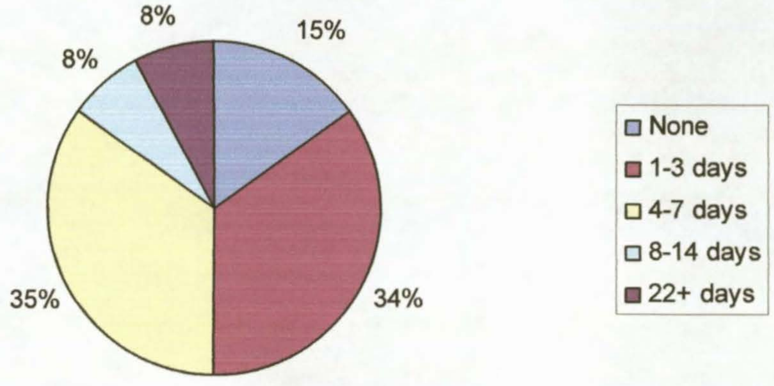


Figure 14: The number of missed practice sessions due to injury.

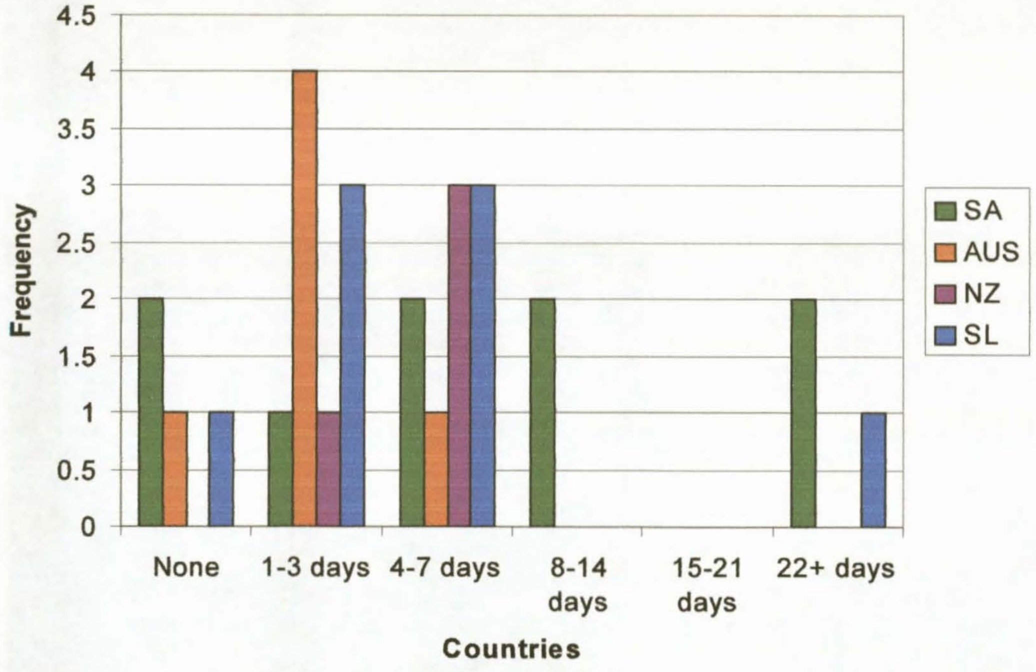


Figure 15: The number of missed practice sessions due to injury per country over the nine month study period.

The majority of injured Australian players missed less than 3 days in practice sessions. South Africa had two players and Sri Lanka had one player who did not play for more than 22 days.

8. Location of injuries

The injuries in figure 16 were classified according to the total number of injuries over the nine month study period. A large proportion of the injuries occurred in the lower limb, namely 59%. Upper limb and spinal injuries accounted for 26% and 15%, respectively.

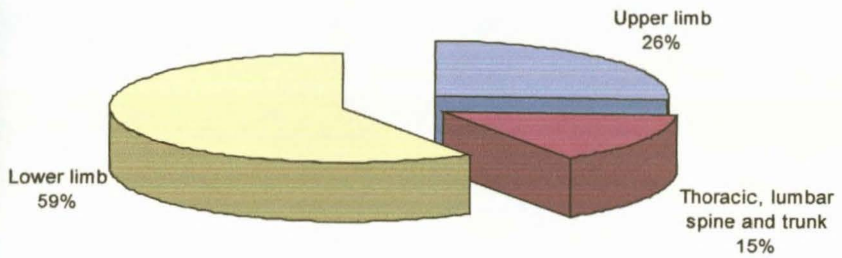


Figure 16: The distribution of injuries in the various body segments.

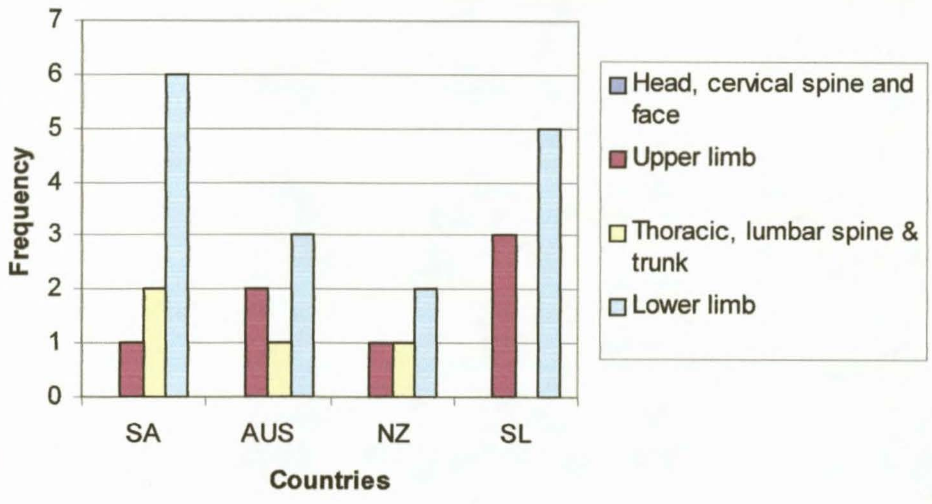


Figure 17: The specific location of injuries for each team.

All the countries suffered from a greater number of lower limb injuries than any other type of injuries. South African players suffered from more spinal injuries than upper limb injuries. New Zealand presented with an equal number of upper limb injuries and spinal injuries. There were no head, cervical spine and face injuries reported in any team.

C. TRAINING REGIME QUESTIONNAIRE

1. Introduction

This questionnaire was given to 50% of the players within each team. Players were randomly selected from the squad and the questionnaires were completed during the World Cup tournament. A total of 29 players completed the training questionnaire.

2. Periodization

Questions in the Training Questionnaires were directed at the pre-season and in-season training periods, prior to the World Cup. For the purpose of this study, the following definitions were used:

> **Pre-season** was defined as the time spent preparing for the competitive season, or for the World Cup. No competitive matches were played during this period.
>
> **In-season** was defined as the part of the year where players were taking part in competitive matches and/ or tournaments.
>
> **Periodization** was defined as the process of structuring training into phases (Bompa, 1999).

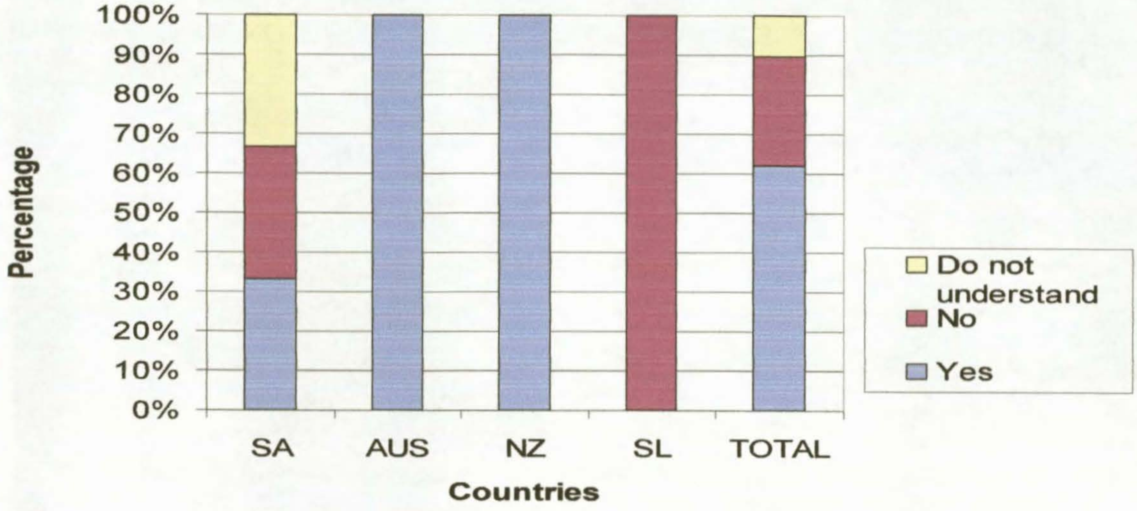


Figure 18: Periodization of training among individual countries.

Sixty-two percent of the players periodized their training, while 28% of the players did not periodize their training and 10% indicated that they did not understand the question. All of the Australians and New Zealanders periodized their training. The South Africans had a three way split between the various options. None of the Sri Lankans periodized their training.

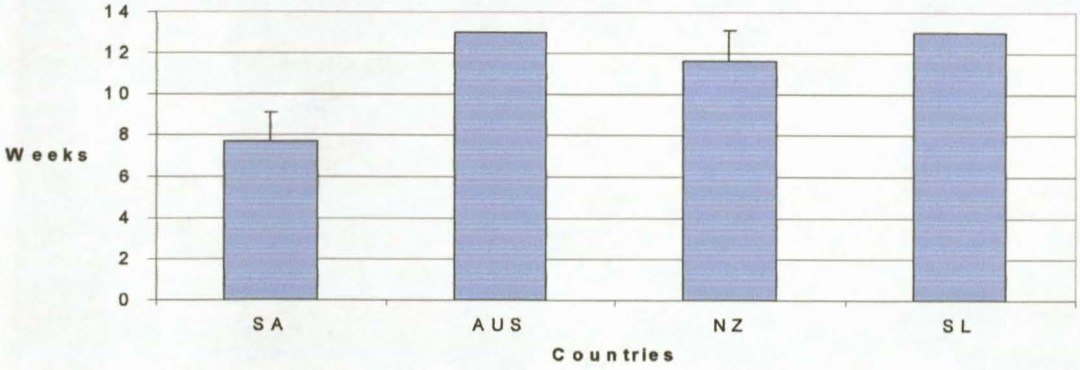


Figure 19. The average number of weeks of pre-season training for the individual countries.

Australia and Sri Lanka did the most pre-season training, namely thirteen weeks. Each player in these teams completed at least twelve weeks of training. New Zealand averaged just less than twelve weeks, while South Africa did the least amount of pre-season training, namely less than eight weeks.

3. Pre-season and in-season

3.1 Description of players who completed the questionnaire

All the players who completed the training questionnaire were required to state what their role in the team was. These players are considered a representative sample of all the players of the four teams who participated in this study.

Table 4: The players' roles within their respective teams.
All players were asked to state what their role was within the team. Most players specified what type of bowler they were as well as where they battered in the batting line up. That is the reason for the total not equaling the amount of players who filled out the questionnaire.

	SA	AUS	NZ	SL	TOTAL
Fast Bowler	2	0	1	0	3
Medium pace	4	1	3	0	8
Off spin	0	0	1	0	1
Leg spin	1	1	0	2	4
Bat-Top order	6	1	3	1	11
Bat-Middle	1	2	2	1	6
Bat- low order	2	3	3	2	10
Wicket keeper	0	1	1	2	4
All rounder	2	2	2	3	9

3.2 Training variables

During the pre-season, most of the training was focused on endurance training (47%), while less training time was spent on strength (38%) and anaerobic (15%) training. However, anaerobic training time increased from 15% during pre-season to 25% during in-season. During the in-season both the amount of strength and endurance training were decreased. However, most of the time was still spent on endurance training.

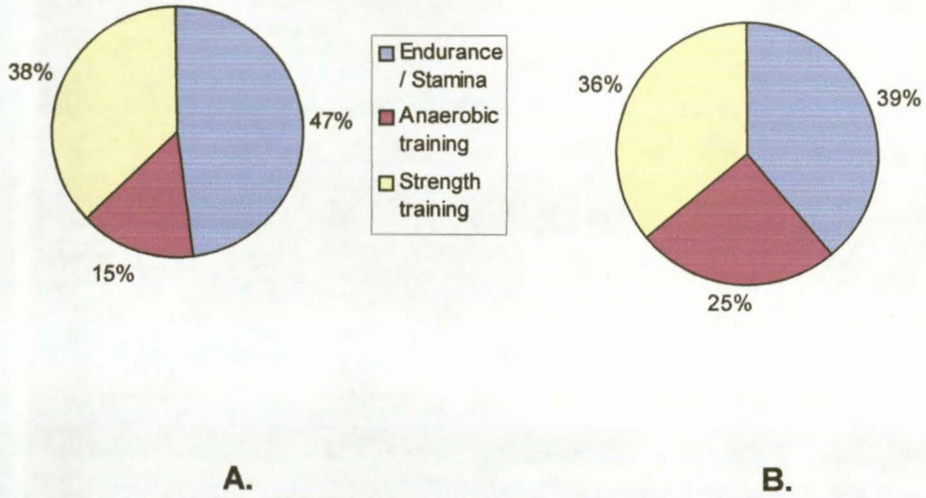


Figure 20: The type of training the players participated in during (A) the pre-season and (B) the in-season.

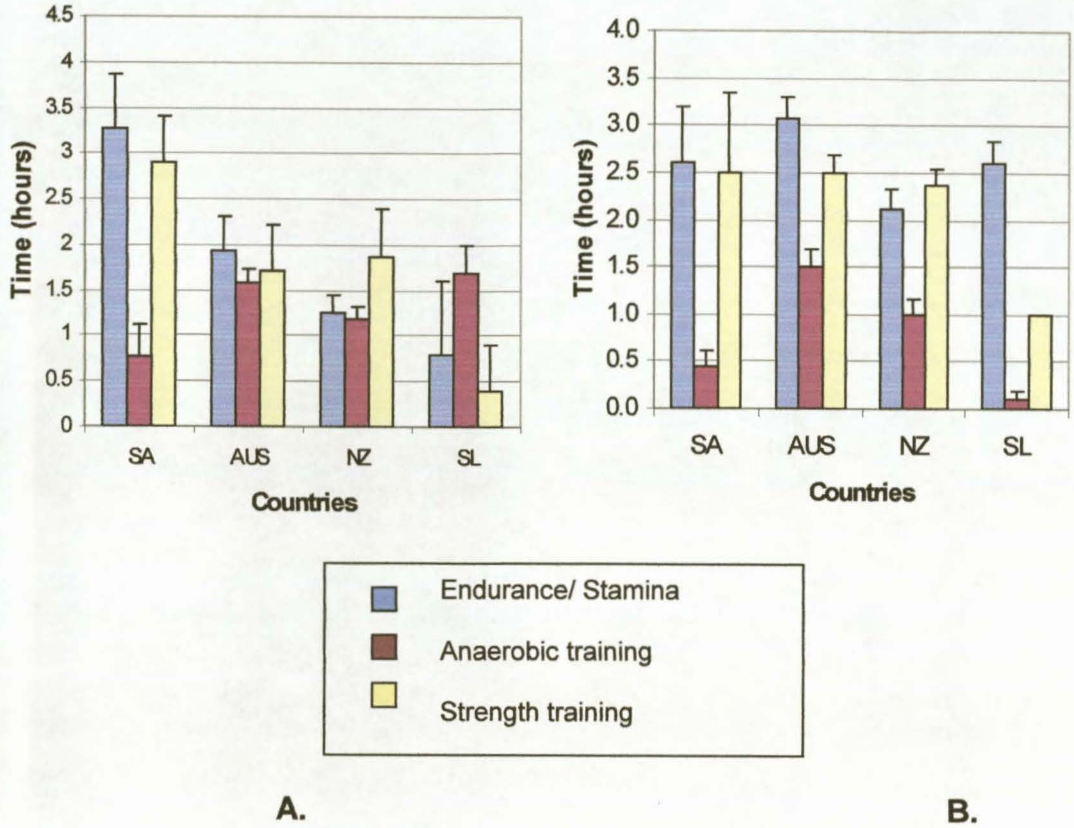


Figure 21: Distribution of type of training per country during the (A) pre-season and (B) in-season.

The results in figure 21 are based on the number of hours of the particular type of training per week. All the countries spent nearly the same amount of time on strength training during the pre-season, with the exception of Sri Lanka who did no strength training during the in-season. While South Africa and Sri Lanka only did a small amount of anaerobic training per week, Australia and New Zealand spent 90 minutes and 60 minutes, respectively, on anaerobic training per week. During the in-season, all countries increased their anaerobic training, while most countries decreased their endurance training (with the exception of South Africa).

3.3 Training Modalities

In the above figure the kilometers is an indication of kilometers covered within one week. Most countries did endurance training in the form of running and cycling, and to a lesser extent, swimming. While Sri Lanka only performed running as their endurance activity, the other three countries seemed to emphasize cycling above running, both during the pre-season and in-season.

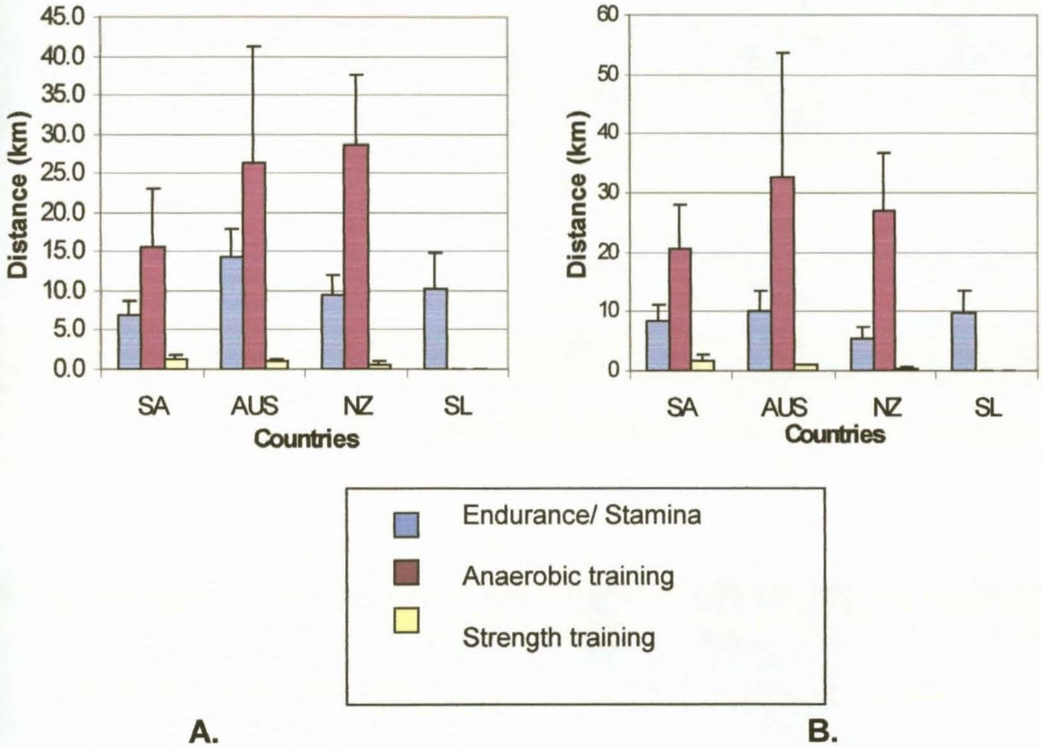


Figure 22: Amount and type of endurance training per country during the (A) pre-season and (B) in-season.

3.4 Strength Training

Seventy nine percent of players performed pre-season strength training, while only 76% of players participated in strength training during the in-season.

A. B.

Figure 23: The main areas of the body where strength training was done during the (A) pre-season and (B) in-season.

In the questionnaire there were six categories of strength training specified, which were representative of various muscle groups. Strength training of the shoulder region represented the main focus (22%) for most players. Back, leg and arm areas all shared 21%. The area which the players tend to neglect is the core and chest area (11% and 4%, respectively). During the in-season, shoulders were trained the most and the chest area was still the least trained of all the body areas.

Table 5: The specific focus of strength training per country during the pre-season and in-season.

Areas	South Africa		Australia		New Zealand		Sri Lanka	
Season	Pre	In	Pre	In	Pre	In	Pre	In
Shoulder	66%	77%	100%	100%	100%	100%	40%	0%
Legs	66%	77%	86%	86%	100%	100%	40%	0%
Arms	66%	77%	86%	86%	100%	100%	40%	0%
Core	33%	56%	100%	100%	100%	100%	40%	0%
Back	66%	56%	86%	86%	100%	86%	40%	0%
Chest	11%	22%	86%	86%	88%	86%	40%	0%

Pre: Pre-season
In: In-season

The New Zealand team concentrated on overall body strengthening, thus training all the body areas equally. Australia had an overall focus on all body areas with a few players leaving out some areas. South Africa, however, had reduced focus on the core and chest area. New Zealand and Australia continued to do a large amount of strength training during the in-season. Sri Lanka did no strength training during the in-season.

3.5 Flexibility Training

A total of 62% of the players reported that they regularly performed a stretching regime during pre-season. However, during the in-season more players participate in regular stretching regimes (76%). When players stretched they tended to focus on the legs (22%) during both pre-season and in-season. The core and chest area were the least of the players' focus during both pre-season and in-season.

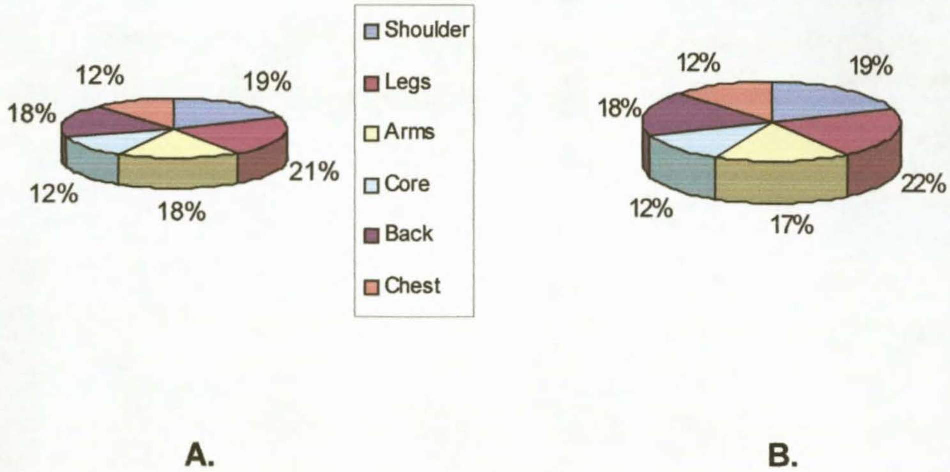


Figure 24: Flexibility training per body area during (A) pre-season and (B) in-season.

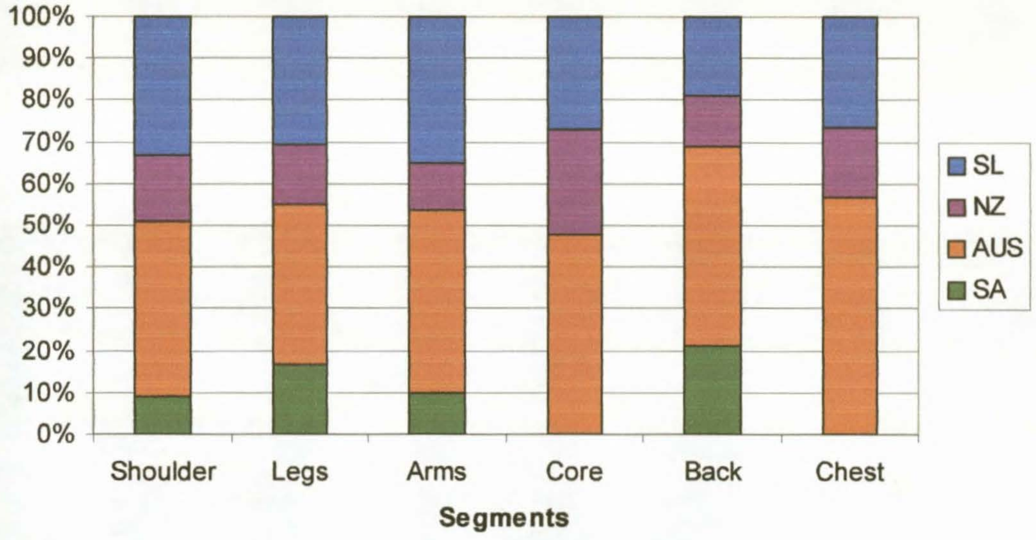


Figure 25: The focus of flexibility training per country during pre-season training.

The percentage on the Y-axis is calculated from the total number of players per country that participated in a stretching routine. The majority of Australian players followed a stretching program which targeted all areas of the body. Sri Lanka had a high focus on stretching especially in the shoulder, legs and arm segments. South Africa did not do any stretching in the core and chest area.

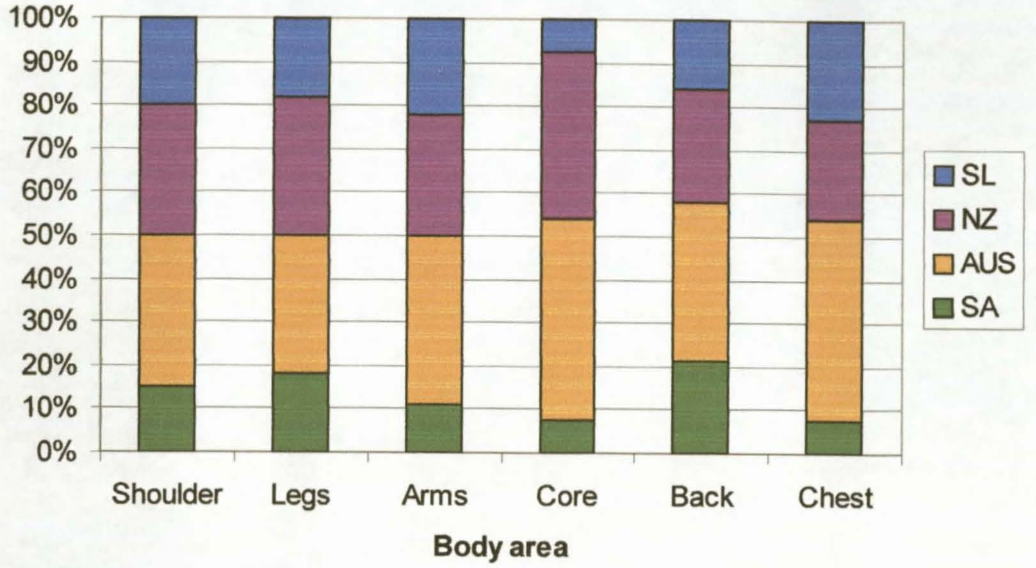


Figure 26: The focus of flexibility training per country during in-season training.

The percentage on the Y-axis is calculated from the total number of players per country that participated in a stretching routine during the in-season. Australia and New Zealand did the most flexibility training during the in-season, while South Africa and Sri Lanka placed less focus on this part of their preparation.

3.6 Skills Training

Batting was the most practiced skill for Australia, South Africa and New Zealand. Sri Lanka did the least batting practice. However, they spent the most hours on bowling and fielding during the pre-season.

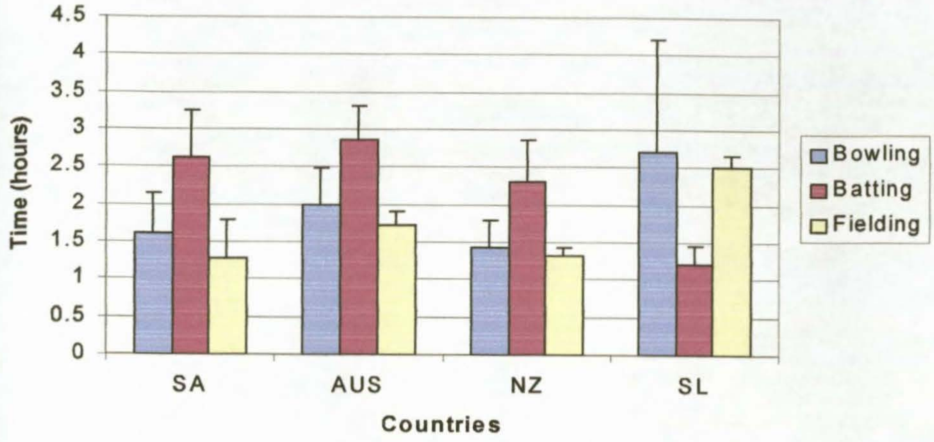


Figure 27: The hours spent training various cricket skills during pre-season training (hours/week).

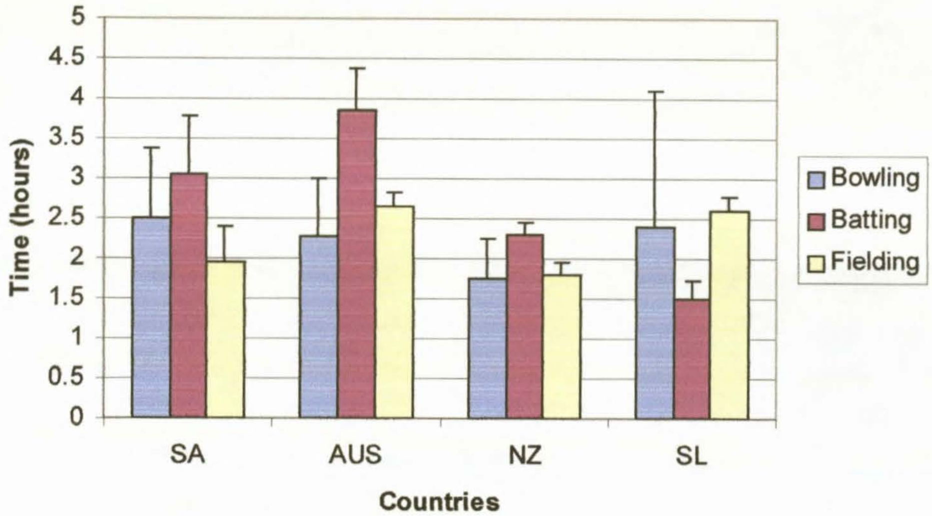


Figure 28: The hours spent training various cricket skills during the in-season (hours/week).

Following a similar trend as during the pre-season, Australia spent a significant amount of time on batting. The Australians increased their amount of batting time during the in-season, as did all the other teams. All the teams increased their hours training the various skill components during the in-season. The exception was Sri

Lanka who slightly decreased their bowling time from the pre-season to the in-season.

3.7 Hours of practice per session

Sri Lanka had the longest training sessions of the four teams prior to the World Cup (2.9 ± 0.1hrs). New Zealand spent the least time practicing, with a session lasting only two hours (2 ± 0.09hrs).

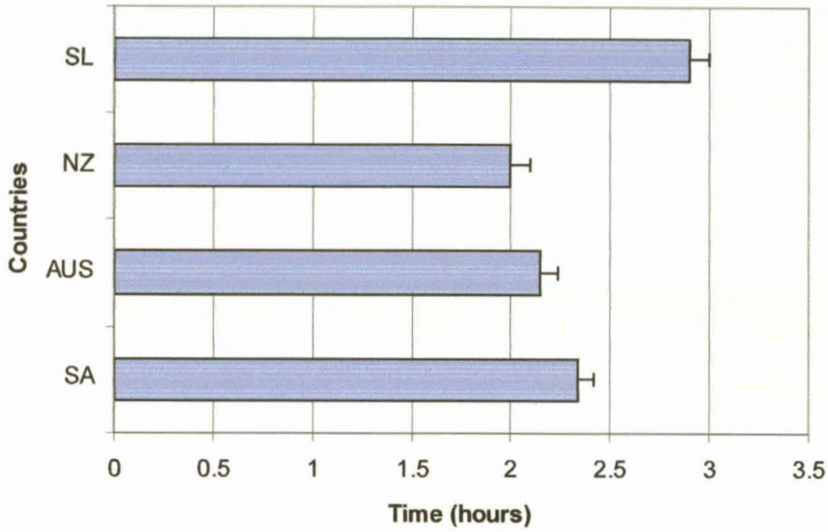


Figure 29: Hours of practice per session prior to the World Cup.

3.8 Number of matches and training practices per week

Sri Lanka trained most regularly during a week, attending four sessions per week. All the other teams trained around three sessions per week. Matches were distributed between 0.5 and 2 matches per weekend prior to the World Cup.

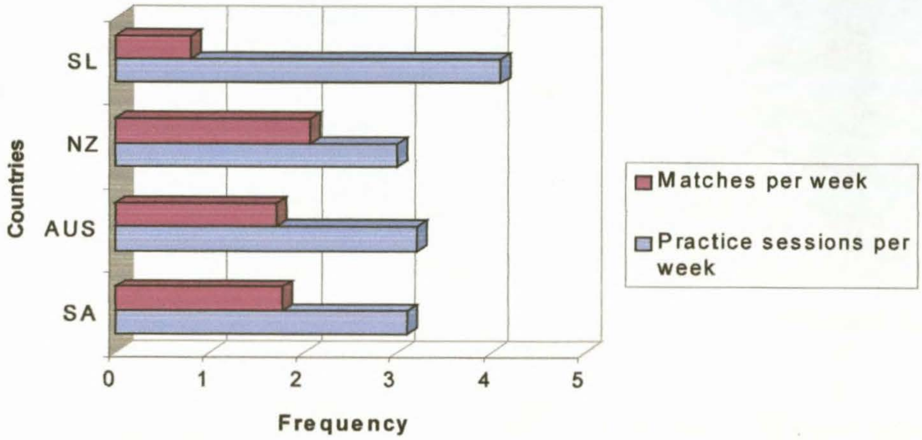


Figure 30: The frequency of matches and training practices per week prior to World Cup.

3.9 Recovery

Stretching, swimming and low intensity cardiovascular training (27%, 20% and 19%) was the major forms of recovery, respectively. These recovery modalities were mostly used after matches. However, stretching and low intensity cardiovascular activity was mostly used after practice sessions.

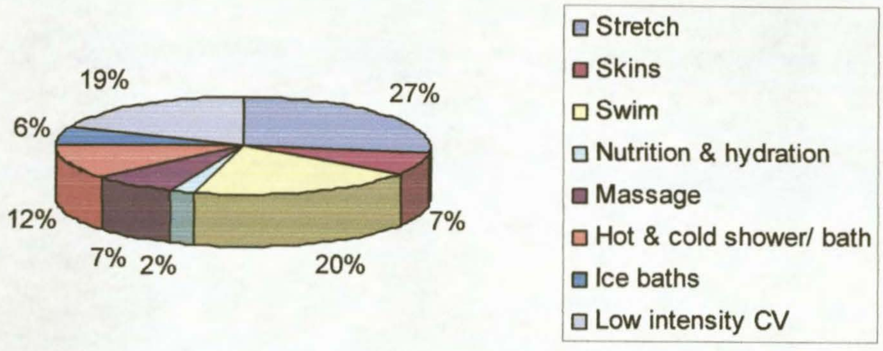


Figure 31: The various forms of recovery which teams use after practice and matches.

Stretching, swimming and low intensity cardiovascular training (27%, 20% and 19%) was the major forms of recovery, respectively. These recovery modalities were mostly used after matches. However, stretching and low intensity cardiovascular activity was mostly used after practice sessions.

3.10 Alternative Training Modalities

Australia took plyometric training very seriously. They spent an hour each week training power development using plyometrics. New Zealand also used this training modality, however, slightly less than the Australians did. South Africa and Sri Lanka did no plyometric training. Sri Lanka and Australia participated in pilates training on a weekly basis. Australia spent just over half an hour and the Sri Lankan team spent 0.8 hours doing pilates. South Africa and New Zealand spent minimal time and no time respectively performing pilates.

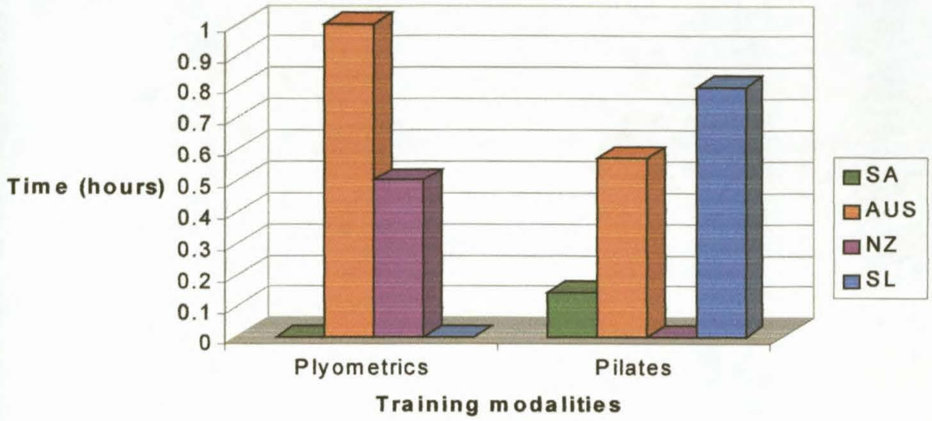


Figure 32: The distribution of other training modalities per country.

Australia took plyometric training very seriously. They spent an hour each week training power development using plyometrics. New Zealand also used this training modality, however, slightly less than the Australians did. South Africa and Sri Lanka did no plyometric training. Sri Lanka and Australia participated in pilates training on a weekly basis. Australia spent just over half an hour and the Sri Lankan team spent 0.8 hours doing pilates. South Africa and New Zealand spent minimal time and no time respectively performing pilates.

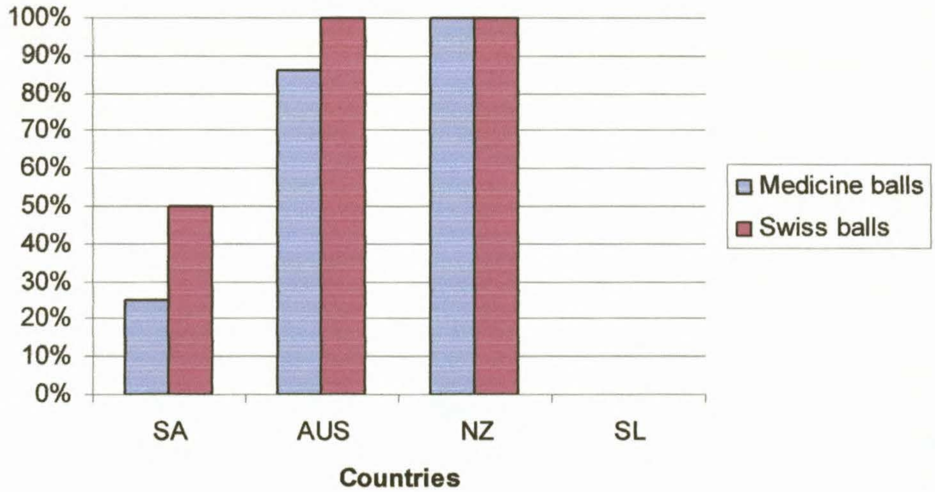


Figure 33: The percentage of players per team using medicine balls and swiss balls to train.

Most of the players in the New Zealand and Australia teams used medicine balls to train with (86% and 100%, respectively). One hundred percent of Australian and New Zealand players used swiss balls during training. Sri Lanka did not use swiss balls at all for training. South Africa used these various training modalities only minimally.

D. RELATIONSHIP BETWEEN THE WORLD RANKING, NUMBER OF INJURIES AND VARIOUS PHYSICAL AND TRAINING PARAMETERS

Table 6: Pearson correlation coefficients

	Rank during World Cup	Total number of injuries
Acute injuries	0.8 (p=0.2)	
Total injuries	0.8 (p=0.2)	
Body weight	0.2 (p=0.8)	0.5 (p=0.6)
Body Mass Index	0.1 (p=0.9)	-0.01 (p=0.99)
Age	0.8 (p=0.2)	0.3 (p=0.7)
Periodisation	-0.8 (p=0.2)	-0.8 (p=0.2)
Endurance training	0.16 (p=0.8)	0.8 (p=0.2)
Anaerobic training	-0.97 (p=0.03) *	-0.8 (p=0.2)
Strength training	-0.2 (p=0.8)	0.2 (p=0.8)
Core training	-0.6 (p=0.4)	-0.8 (p=0.2)
Ave. hours skill training	-0.5 (p=0.6)	0.1 (p=0.9)
Hours of practice	0.6 (p=0.4)	0.7 (p=0.3)
Pilates	0.2 (p=0.8)	0.3 (p=0.7)
Plyometrics	-0.99 (p=0.01) *	0.7 (p=0.3)
Swiss ball training	0.7 (p=0.3)	-0.8 (p=0.2)

There was an inverse relationship between the number of injuries per team, and whether the team used the principles of periodization in their training (r= -0.8; p=0.2). The results indicate that those teams who were less likely to periodize their training, suffered more injuries (South Africa = nine injuries and Sri Lanka = eight injuries). There was a strong, but non-significant correlation between players who periodized their training and the teams' ranking at the World Cup (r=-0.8; p=0.2). Similarly there was a strong, but non-significant correlation between the rank of the team and the prevalence of injuries within the team (r=0.8; p=0.2).

There was a strong correlation between the amount of endurance training players engaged in and the frequency of injuries that players sustain (r= 0.8; p=0.2), but there was no correlation, between the amount of endurance training and the teams' ranking at the World Cup (r=0.2; p>0.8). There were also strong correlations between the amount of anaerobic training individual players did and the likelihood that they are to be injured (r=0.8; p=0.2), as well as their world ranking at the World Cup (r=-0.9; p=0.03). There was no correlation between the amount of strength training players did and the frequency of injuries which players sustained (r=0.2; p=0.8). There was a strong negative correlation between core training and the frequency of injuries (r=-0.8; p=0.2).

There was no statistical correlation between the rankings of the teams and the prevalence of injuries within the teams (r=0.8; p=0.2). There was also no statistical correlation between the amount of acute injuries within the team and the ranking of the individual teams (r=0.8; p=0.2). Both the prevalence of total injuries and the prevalence of acute injuries seem to have an influence on the teams ranking during the World Cup. It is not a statistical correlation, however, total and acute injuries does show to have an influence on the teams World Cup rankings (r=0.8; p=0.2).

There was a statistically significant correlation between the rank of the teams and the amounts of plyometric training they participated. It is very clear that plyometrics had positive effect on the teams' performance

E. SUMMARY

The overall incidence of injuries within this study was 0.48 injuries over the study period. During the World Cup the second week definitely saw the majority of the injuries occur (75% of all injuries). Most of the injuries that occurred were caused by fielding (25%), batting (22%), bowling (19%) and catching (15%) during the study period. Injuries to muscles were the most notable structure within the body that got injured. First time injuries accounted for 64% of injuries and chronic injuries represented 36% of all injuries. Injuries to the lower limb were the most frequent (59%).

From the training questionnaire it was evident that most teams emphasized endurance training through both the pre-season and in-season. Strength training was conducted to a lesser extent and anaerobic training was the most neglected form of physical conditioning. The Australians and New Zealanders made use of many of the alternate forms of training such as pilates, plyometrics, swiss ball training and medicine ball training.

A statistically significant correlation was found between anaerobic training and the teams rank during the World Cup (r=-0.97, p=0.03). It can therefore be suggested that teams need to pay special attention to anaerobic training.

CHAPTER SEVEN

DISCUSSION

A. INJURY QUESTIONNAIRE

1. Physical characteristics of women cricketers

The descriptive statistics included measurements such as age, weight and height. New Zealand and South Africa had statistically significantly heavier players (Table 2). However, there was no correlation (r=0.5; p=0.6) between body weight and the number of injuries the individual countries sustained. Although it is possible that there truly isn't a relationship between the variables, it is also unlikely to detect a significant relationship with a small sample size.

In general, there are many injuries to the legs and feet in sports which involve running and being on your feet for long periods of time, which may be aggravated by excess body weight. The reason for this is that the impact of running on the lower extremities is approximately 2.5 times the body weight of the individual (Powers and Dodd, 1999). A greater body weight would therefore create more force on the joints, within the lower legs. This force is then transmitted from the feet all the way up the body. Performing lateral movements or having to change direction and having to decelerate and accelerate quickly, as cricketers need to, also place more strain on the legs. It is known that there is more torsion and shearing forces on a joint with a change in direction, opposed to a strict linear movement (Kreighbaum and Barthels, 1996). If muscles, tendons and ligaments are not sufficiently strong enough, this could result in devastating injuries (Kreighbaum and Barthels, 1996).

Arendt and Dick (1995) suggested that there are intrinsic and extrinsic factors that could predispose a player to knee injuries. Most of the time there is little that can be done about the intrinsic factors, as these are often related to genetics. However, increasing a player's muscular strength, their ease of movement, co-ordination and increasing their level of skill and physical conditioning (extrinsic factors) could help reduce injuries, and in particular knee injuries.

2. Types of injuries: acute and chronic

There was no correlation between the age of injured players and the injuries they sustained ($r=0.3$; $p=0.7$). However, team Australia had the oldest players by a significant margin (31.1 years) and they also suffered most from chronic injuries recurring from previous seasons. This could be expected as an older group of women could have potentially played many more hours in their careers, and as a result many of these injuries could be from years of wear and tear, combined with busy competitive schedules. The older an athlete the more he or she is prone to suffer from chronic injuries, especially in the lower back region (Ross, 1999). Chronic injuries most often progress slowly over a long period of time and can be caused by repeated acute injuries over years of competition (Porth, 1994). The constant movement and irritation in a specific area caused by over-training or poor performance techniques all can result in a chronic condition (Prentice, 2003).

The South African team suffered the majority of chronic, present season injuries. They had a very young squad which you could expect to be very eager to please the coaching staff and represent their country. It could be speculated that they either hid the seriousness of their injuries from management, or that they played even though management was aware that they were injured. Possibly they never believed how serious the injuries were and therefore once they could play for the national team in the World Cup, never fully rehabilitated the weak and affected areas. These types of chronic injuries often arise from an acute injury that was never correctly managed or when the player returned to activity before the healing was complete (Prentice, 2003).

In this study on female cricketers, total chronic injuries accounted for 38% of all injuries. This is considerably higher than what Kelly *et al.* (2003) found in her study on Australian women cricketers (4.3%). Salter (2003), in a study on English women county cricketers, reported similar results as in the current study. They had a total of 31% of injuries coming from chronic injuries during the previous season and 8% coming from the present season (grand total 39%). In this study, both chronic injuries from the previous season and the present season accounted for 18% each of all injuries. Stretch and Venter (2005) reported that recurrent injuries from the previous season in the men's game made up 22% of injuries and recurring injuries from the same season accounted for 12%.

Sixty-five percent of all injuries among men cricketers were first time injuries, which is very similar to the results of the current study (64% acute injuries) (Stretch and Venter, 2005). It does seem that acute injuries are common in most studies on cricket injuries.

Sri Lanka recorded a large number of acute injuries (88%), which can be detrimental to their overall performance as players are constantly suffering from new injuries. South Africa suffered from the most injuries (chronic and acute) during the study period (n=9). South Africa had four chronic injuries which players were playing with during the World Cup. They also suffered from five acute injuries. According to Stretch and Venter (2005), 49% out of 65% acute injuries were sustained by players younger than 24 years old (Stretch and Venter, 2005). This could also be the reason why South Africa suffered from the most injuries, since they had the youngest players in the study. Salter (2003) found that 71% of the injuries in the study came from players between the ages of 18-25 years, and only 29% of injured players were between the ages of 25-35 years (Salter, 2003). From this study it would also seem that younger players are more likely to suffer from injuries.

In Stretch and Venter's (2005) study injuries in club and schoolboy cricket accounted for 14% of injuries, provincial A 30%, provincial B 41% and the international team 9%. In South Africa 24% of injuries were as a result of previous injuries to the same area and 23% of all new injuries were past injuries from the same season (Stretch, 1995). Smith (1992) found that 20% of injuries sustained while on tour were re-aggravated from a previous injury (Smith, 1992). A concerning statistic is that 30% of all injuries to schoolboy cricketers are recurrent injuries, while 37% of newly acquired injuries were from the current season (Stretch, 1995). This could lead us to believe that there is a lack of adequate rehabilitation which could result in future problems during the career of a cricketer (Finch *et al.*, 1999).

3. The prevalence of injuries during the World Cup

In week one of the World Cup, each country played four matches. Therefore, there were sixteen matches played and three injuries were sustained. There were then twelve matches played in week two, during which time twelve injuries were reported. In the last week there were only three games played and only one injury occurred (figure. 6).

The majority of injuries thus occurred in week two of the World Cup (75%). The seriousness with which teams approached the qualifying stages and the fact that crucial games had to be won in week two in order to qualify for the latter knock out rounds, could have contributed to the higher prevalence of injuries in this week. Additionally, players could have been injured in week one already, but have chosen to dismiss the injury in order to be part of the games in the next week. The added stress and extra playing time during week two may thus have aggravated the injury to the point where it was reported.

Australia was the only team to suffer any injuries in week three (n = 1). This is not a surprising finding, since Australia won the World Cup and thus played the most games of all the teams who participated in this study. New Zealand was the only other team in this study who reached the semi finals, but they reported no injuries in the last week.

4. Injury rate in women's cricket

In this study, the injury rate over the nine month study period was 0.48 injuries per player. Two previous studies have been done to quantify the injury rates among women cricketers. Kelly *et al.* (2003) had 96 players in her study and she reported 45 injuries (46.9%). Therefore, each player can be said to have suffered 0.47 injuries during the season, which was very similar to the results of the current study. Salter (2003) only studied one county team in England and the study period was limited to five weeks. Among the fourteen players, thirteen injuries (92.8%) were reported, yielding 0.93 injuries per player over the study period. This injury rate is much higher than that of the other two studies, however, the authors did not state during which time of the season the study took place. This injury rate could be higher because they are county cricketers and it would be expected that they do not have the same level of conditioning as international women cricketers. These county players could also not be as experienced as the international cricketers are.

Compared to women cricketers, it seems that the injury rates in men's cricket are somewhat higher. A study done by Stretch and Venter (2005), which extended over six seasons comprising of South African national and provincial men's teams, yielded an injury rate of 2.1 injuries per player per season. Furthermore, this figure is higher than in the previous study in 2003 when 1.9 injuries per player per season over a four season period (Stretch, 2003). Perhaps there was an increase from

2003 to 2005 because there was an increase in game time. Players' competitive schedules have increased. There has also been the introduction of the 20 over a side game. Although the game is played over a shorter space of time it is still played at the same intensity. Most of these matches in South Africa are played at the end of the season. This would result in players' competitive season being longer. The reason men's injury incidence is higher than in women's could be because men play far more games and they are on tour more, both provincially and internationally.

5. Activity-related injuries

There were four major cricket related activities which caused injuries, namely fielding (25%), batting (22%), bowling (19%) and catching (15%). Fielding injuries did not include catching or throwing a cricket ball, but were limited to injuries related to chasing the ball, retrieving the ball, sliding to stop the ball and diving (to stop the ball).

In the current study, all of the fielding injuries were first time injuries. Of the four catching injuries, two were serious injuries to the phalanges of the wicket keepers and both these injuries happened during the World Cup. In both cases the prognosis was a long rest period and possible surgery. In cricket, wicket keeping is not only a vital fielding position, but also a position where players are likely to sustain injuries often and most times also of a serious nature. Therefore special attention must be paid to the training and catching technique of wicket keepers, as well as their mobility and physical conditioning.

Salter (2003), in their study on English women cricketers, reported 38% (n = 5) fielding injuries, but only 8% batting injuries. According to Kelly *et al.* (2003), fielding yielded 27% injuries, batting 16%, throwing 13% and bowling caused the fewest injuries, namely 10%. In the above studies catching injuries were included in the fielding category. It seems that among women cricketers, fielding is the main cause of injury.

Batting also seems to be a more dominant cause of injuries than bowling. This is very different from men's cricket where Stretch and Venter (2005) recorded 40% of all injuries being caused by bowling and batting accounted for 17%. It is possible that because women are lighter and do not bowl at such pace as men, they are not as susceptible to bowling injuries. There is a common problem that fielding causes so many injuries.

In 2005, Stretch and Venter reported that fielding caused 33% of all injuries in men's cricket. However, this cannot be directly compared to the current study, as Stretch and Venter's study included catching injuries within the fielding category, where the current study separates these injuries. If we combine all the fielding injuries in the current study we find that 48% of all injuries were caused by fielding.

Of the men's fielding injuries, 43% were upper limb and 40% were lower limbs injuries. Furthermore, 68% of these fielding injuries were first time injuries (Stretch and Venter, 2005). In the current study 57% of the fielding injuries were sustained to the lower limb and 43% to the upper limb. However, out of the six upper limb injuries, two of the injuries kept players out for more than 22 days. In Stretch and Venter's (2005) study, only 5% of all injuries were sustained by the wicket-keepers (Stretch and Venter, 2005). This is a much smaller percentage compared to the 50% in the current study. It is true that a larger sample size would give a truer reflection of the number of injuries among the various roles of players within a cricket team. Therefore, the high rate of injuries among wicket-keepers in the present study may be skewed due to the small sample size. However, it may also be suggested that male wicket-keepers have superior technical skills than women, which may be an aspect that needs to be addressed by the women's coaches.

It is apparent from the current study, as well as for the reported results on men's cricket, that fielding is a major cause for injury. This problem may be addressed, to an extent, in the training programmes of cricketers. Coaches and trainers should therefore pay special attention to diving techniques during fielding, while players should make sure they are conditioned, specifically being stable and strong when being off balance and having to change direction.

6. Location of injuries

The primary injury location was the lower limb (59%), and most injuries to this area was in the South African (n = 6) and Sri Lankan (n = 7) teams. These lower limb injuries comprised of calf strains (n=4), joint related injuries to the knee (n=4) and hamstring strains (n=3). In the Australian study on women cricketers, 36% of their injuries were sustained in the lower limb area (Kelly *et al*, 2003). Similar tendencies were recorded in three different studies on sportsmen, namely 49% (Stretch and Venter, 2005), 54% (Chomiak *et al.*, 2000) and 45% (Brukner, 2001) lower limb injuries. However, the current study suggests that women suffer from more lower limb injuries than men.

Hamstring injuries are common in sports that involve sprinting and explosive movements, therefore one would expect a high prevalence of hamstring injuries in cricket. It is important to identify risk factors that could lead to these injuries. The hamstring is also more likely to get injured during the late forward swing phase (deceleration phase) in the gait cycle. This is possibly because the hamstring has to use eccentric strength and the muscle may not have sufficient eccentric strength. In cricket this injury may happen when the player made an extra long stride during running between the wickets, or while reaching for the ball when batting. If the player does not have enough eccentric strength, or is not accustomed to this type of movement, he/she may over-stretch and injure the muscle (Hassan *et al.*, 2003:60).

Management of hamstring injuries is critical in preventing recurrent hamstring injuries. This management is a long process and it begins at the acute stage and continues till the player has full functional mobility and fitness (Hassan *et al.*, 2003:60). It is important that the quadriceps and hamstring muscles are working synergistically. An imbalance in this relationship can result in injuries (Hassan *et al.*, 2003:61). It is imperative that in order to prevent hamstring injuries players participate in a consistent strengthening and stretching program.

In chapter one it was pointed out that women tend to have weaknesses in the medial knee area (specifically the *vastus medialis obliquus).* Because of a women's wider pelvis, the knee area is susceptible to injuries. There is an increased quadriceps angle, causing a genu valgum appearance in the knee area. This genu valgum places more strain on the knee joint (see page 24-26 for more detail). This idea can be confirmed in the current study, where 4 knee injuries were reported. Out of these knee injuries there where two chronic problems, one injury was related to fielding and the fourth was initially sustained in a rugby game which the player participated in. Women cricketers therefore need to develop strength around the knee area and in particular to the medial musculature to aid stability of the knee.

Bowlers tend to suffer from infrapatella tendinopathy because of the forces generated during bowling. These forces may exceed the tensile strength of the patella tendon. The fact that infrapatella tendinopathy is as a result of excessive knee hyperextension it can be aggravated by the aggressive bracing of the front knee during front foot landing in the delivery stride. It is very important that this injury is diagnosed correctly and rehabilitated effectively as it can easily progress and become a chronic problem. Patellofemoral syndrome is a common complaint, in bowlers and in sportswomen (Hassan *et al.*, 2003:69). It is an overuse injury of the infrapatella cartilage. Biomechanical factors often predispose players to this kind of injury. Progressive concentric and eccentric strengthening of the quadriceps, hamstring, adductor and abductor muscles must be done. Players' flexibility and proprioception should also be well trained (Hassan *et al.*, 2003:70).

A possible reason for so many calf injuries (n=4) would be neural tightness or the fact that players are requiring a powerful push off-phase and the calf musculature is being placed under too much stress. Players possibly do not have the necessary explosive strength and the gastrocnemius-soleus complex is stressed beyond loads it can handle.

Fielding was the major cause of lower limb injuries (44%) in this study. Batting and bowling only accounted for 13% and 6%, respectively, of the lower limb injuries. There were also a large number of chronic lower limb injuries (25%), however, no chronic upper body injuries were recorded.

Particular focus needs to be directed towards the large amount of lower limb injuries caused by fielding and which are chronic in nature. It would seem sensible to suggest that players are perhaps not fit enough. They are getting injured in the field and as we are aware players can stand in the field for long hours and often after they have batted for a long period of time. Women cricketers need to condition themselves effectively in order to be able to respond quickly to a ball which needs to be intercepted. Muscles could be in a fatigued state due to repeated eccentric muscle contractions. These muscles are then not able to cope with the demands of a sudden reaction which needs to be efficiently executed. Players should also keep themselves warm and mobile when standing in the field. It could happen that players are not exposed to any play for a period of time while on the field, but they are suddenly required to field a ball. The muscle may then be in a relaxed state and probably also cold and as a result muscle tears may be experienced. Players, while on the field, should constantly move around and perform dynamic stretching activities to keep their bodies in a "ready state" (Hassan *et al.*, 2003:55). Players must be sure that when waiting to go to bat they are warm and optimally stretched. They may perform some sprinting and agility work before they go to bat so when on the field, and quick singles are needed to be taken, they can respond immediately and are at lesser risk of tearing or straining muscles.

Upper limb injuries represented 26% of all injuries among women cricketers. Fifty-seven percent of these injuries were caused by catching a ball, while bowling, fielding and throwing accounted for 14% each of the upper limb injuries. The catching injuries were predominately seen in the phalanges. As mentioned before there were two serious injuries sustained by the wicket-keepers of two teams. In Kelly *et al.* (2003) study they only refer to shoulder injuries, which represented 11.4% of all injuries. Salter (2003) recorded an incidence of 38% for the upper limb area.

Similar statistics are found for male cricketers. Twenty-three percent of their injuries are in the upper limb area and these are predominately in the phalanges and metacarpals (33%). These injuries were mainly the result of direct impact from the ball while fielding and batting (Stretch and Venter, 2005). In the current study on women cricketers, there were no injuries from a direct impact to the hand while batting. This may possibly be because women cricketers are not exposed to fast bowling to the same extent as male cricketers are. Therefore, the impact may not be sufficient enough to cause damage. The gloves that the women play with are the same as for the men; therefore fewer injuries are probably related to less impact. Batting injuries are mostly lower limb injuries (50%), and occurred mostly in the hamstrings and calf muscles.

It seems that a major problem site in men's cricket is the back area and that specifically fast bowlers suffer from stress fractures and other serious back conditions. Stretch and Venter (2005) reported an incidence of 23% of lower back problems in men's cricket. In the present study, 15% of injuries located in the thoracic, lumbar and trunk areas. According to Kelly *et al.* (2003) only 11% of injuries in their study were from the back area and these were mainly chronic problems. Salter (2003) reported no back or trunk injuries in their study.

It seems therefore that back injuries are less prevalent in women compared to male cricketers, and that the prevalence in this study is comparable to what has been reported earlier in other studies on women's cricketers. A possible reason could be that the women fast and medium pace bowlers do not bowl as fast as their male counterparts. This would mean that there is less power and momentum being transferred through the back. Women, in general, also weigh less than men and as a result there would be a reduced load placed on the body structures, during the delivery stride.

In the current study South Africa had the most back injuries (n=2). The reason could be that the young players were not conditioned well enough and perhaps they have not accumulated the necessary knowledge on how to stretch and train properly. Three out of the four back injuries were seen in the bowlers. Only one batting injury affected the back and this injury was a chronic condition.

The unfortunate problem is, that these back injuries are mainly chronic and of a muscular nature. This may mean that women players could be playing with constant pain and may thus not be able to bowl optimally. Women cricketers, especially bowlers, need to be very aware of their flexibility in the lower limb, back and hip area. Core and back strength training, as well as pelvic and abdominal stability, should be a large focus point in the players training regime, as this will help to protect their backs (Hassan *et al.*, 2003:77). Furthermore, players should be aware of their technique as women's cricket is still a young sport and it is possible that players have not always received correct coaching in terms of bowling actions. Particularly with mixed bowling actions the upper body and lower body do not exhibit the same orientation. This means that the upper body is either in a front-on or side-on approach and the lower body is exhibiting the opposite orientation (Hassan *et al.*, 2003:42-45). This place counter-rotational forces on the lumbar back and can cause severe damage if this bowling style is not identified and corrected. Injuries to bowlers have been largely associated to incorrect bowling technique and overload (Elliot, 2000). It is imperative that bowlers stick to a periodized progressive loading schedule so structures in the body can adapt to increasing bowling demands (Elliot, 2000).

7. The nature of injuries

In the present study, muscle injuries accounted for 43% of the total injuries among women cricketers. Players in the South African and Sri Lankan teams sustained five of these muscle injuries within each team. The New Zealand and Australian teams only suffered one and two muscle injuries, respectively. In Salter's study (2003) 31% of all injuries were muscular in nature. In men, muscle injuries constitute 47% of injuries, tendon injuries, 9%, joints and fractures, 6% each and ligament injuries, 5% (Stretch and Venter, 2005). These statistics not only show similar trends for men and women, but also emphasizes the fact that cricket places great demands on the muscular systems of the players.

The question is could lack of physical strength lead to a higher incidence of injuries? Muscle strength in a cricketer is vital, since the body has to overcome gravitational forces and at the same time, it must be manipulated through space by levers. Bones, which represent these bony levers, need to overcome resistance in the form of inertia and muscle viscosity. More often these bony levers have to work at unfavourable angles of pull. With all these factors working against the body, most movement is executed at an efficiency level of less than 25%. A high level of strength and muscle control is therefore needed to aid the athlete in more efficient movement (Prentice, 2003).

Training certain muscles may lead to muscle hypertrophy and this causes connective tissue cellular make-up to increase. This strengthens the muscles' connective tissue, which improves the structural and functional integrity of tendons and ligaments. These changes and adaptations protect muscle and joints from injury. Therefore, resistance training can be used as a preventative aid and as rehabilitation tool (Vailas and Vailas, 1996). According to Hassan *et al.* (2003) inadequate eccentric muscular strength can be one of the reasons why injuries could occur (Hassan *et al.*, 2003:47). Croisier (2004) also suggest that muscle tightness and/or weakness could be a cause of injuries and in particular hamstring injuries (Croisier, 2004).

There was, however, no correlation between the amount of strength training and the number of injuries the players sustained ($r = 0.2$; $p=0.8$). Once again, one could argue that the small sample size is responsible for this weak correlation. On the other hand, the relationship was calculated as the correlation between the number of injuries and the average number of hours the teams spent strength training during a week. A more important variable than the quantity of strength training is the quality of the strength training. The crucial factors in strength training programmes, such as correct training technique, training the correct muscles, how cricket-related and functional the training was, training muscles over the full range of movement and at cricket-related velocities, was not evaluated in this study. To what extent the quality of a strength training programme determines or predicts future muscle injuries is therefore a relevant topic for future research.

8. Time out of training practices

Missing time out of training and practice can be severely detrimental to a player's development, as well as to the development of the team. When injured, players are unable to train physically and they miss out on time to improve their technique. If players are continually having to miss practice and training because of injury there cannot be a healthy flow of improvement in their performance.

It was found in this study that 69% of players missed out on between one and seven days of practice because of injury. More serious injuries led to between eight to fourteen days (8%) and more than 22 days (8%) out of practice. These results indicate that if a player is injured, there is an 85% chance that she will be out of practice for at least one full week.

These findings, however, do not show the same tendencies that were observed in the previous study on women cricketers. Salter (2003) found that most injuries (77%) lead to no time being lost, while 15% of injuries kept players out of training for one to three days. However, they also found that 8% of injuries had players out for more than 21 days. According to Kelly *et al.* (2003) most players missed less than one training session because of an injury, while 22% of players were forced to miss training for one to four days.

The vast majority of injuries kept players out for only a short space of time. This probably shows that most of these injuries are acute and minor in nature. Therefore they do not need a lengthy healing process. However, it is vital that these injuries are still managed well. Players need effective rehabilitation strategies to ensure that players heal properly and quickly, so these injuries do not become a bigger problem or become chronic in nature.

B. TRAINING REGIME QUESTIONNAIRE

1. Composition of training programmes

1.1 Endurance training

An analysis on cricket activities will show that cricket places a demand primarily on the aerobic energy system, because of the long hours that cricketers are expected to play. Players also need to stay mentally focussed and may be required to concentrate for hours on end (i.e. multi-day games). If the physical body begins to tire, the mind will not be as sharp to react and make critical decisions. This continuous need for aerobic energy is, however, interrupted intermittently with demands from the anaerobic energy system. Cricket players therefore also need to develop their anaerobic capacity to fulfill the intermittent high speed and power requirements of the game.

Suggestions to improve aerobic fitness would be either running, cycling or swimming for 30-40 min, four times a week (Pollock *et al.*, 1998). The player's heart rate should be between 65%-85% of the maximum heart rate (Hassan *et al.*, 2003:12). Swimming and cycling are good forms of exercise, however, if we consider the impact that bowlers have to withstand, running may help condition a bowler's body better for the constant impact on the lower body. On the other hand, it is also important to consider the age and history of injuries of the cricketer as running may aggravate past injuries. It would be useful to combine running with cycling and swimming as a cross training activity. This cross training would decrease boredom, reduce the risk of overuse in specific areas and it would decrease the risk of suffering from running related injuries (Powers and Dodd, 1999).

In this study, the main focus through both pre-season and in-season was definitely endurance training. Although the volume of endurance training decreased from pre-season to in-season, it still represented the majority of the players' training. Australia did the most endurance training compared to the other countries and they spread their endurance training between running and cycling. Both Australia and New Zealand included a large amount of cycling in the pre- and in-season. All the countries, except South Africa, decreased the volume of endurance training during the in-season. It would be thought that during the in-season fitness levels need to be maintained, while incorporating more cricket specific training and recovery sessions into the players schedules (Hassan *et al.*, 2003:10). Three out of the four countries adhered to this principle.

1.2 Anaerobic training

In cricket, players have to perform many quick and short sprints over ten to forty metres. The sprint may last from two to ten seconds and these may be repeated in quick succession after each other. Batsmen have to run between the wickets over a distance of 22m. It may only be one run, or it may be three (Noakes and Durandt, 2000). At the crease you have to decelerate, stop and turn for the next run. These are the reasons why anaerobic training should also be included in the preparation of cricketers.

The anaerobic energy system can be conditioned by using explosive high intensity activities. The anaerobic energy system is made up of two systems, namely the immediate energy system (ATP-PCr) and the short term energy system (anaerobic glycolysis). When movement starts, the high-energy phosphate, adenosine triphosphate (ATP) and phosphocreatine (PCr) provide the immediate energy. After a few seconds (±10 seconds) the glycolytic pathway provides more and more energy, up to activities that last approximately two minutes (McArdle *et al.*, 2001:459).

Anaerobic training was definitely the most neglected aspect of the cricketers' training. Both endurance and strength training received a considerable amount of time. The Australian team did the most anaerobic training with one and a half hours a week. This is a reasonable amount, however, it could be increased to fully prepare the players for a demanding sport such as cricket. South Africa and Sri Lanka did very little anaerobic training. South Africa only accumulated 30min of anaerobic training a week. That is a small amount of anaerobic training within a week. All this was done during the pre-season. During the conditioning and pre-season phase anaerobic training should be one of the main focuses, in order to prepare the players for the high intensity phases of the game (Hassan *et al.*, 2003:10).

During the in-season, all teams increased the amount of anaerobic training that they did. Sri Lanka went from doing the least amount of anaerobic training during the pre-season to doing the most anaerobic training during the in-season. This is not the incorrect way to progress training, however, it must be remembered that during the in-season it is important to pay attention to sport-specific skills and to maintain fitness. During the in-season players should decrease the amount of training volume which they do and increase the intensity of the exercise. This means that they are well conditioned, but are not overtrained (Ozolin, 1971). It can also be suggested that the strong correlation between anaerobic training and injuries ($r=0.8$, $p=0.2$) could encourage teams to alter their focus. This would mean more time spent on anaerobic training.

1.3 Strength training

Strength training received the second most amount of time in all the teams' training programmes. Three of the four countries spent around 2.5 hours per week on strength training during the pre-season. Thereafter the volume was decreased during the in-season and more focus was placed on anaerobic training. Most emphasis was placed on training of the shoulders, arms and legs. There was no correlation between the amount of strength training and the number of injuries sustained in each team. For strength training to truly improve specific physical performance and protect the body during sport-specific movements, an athlete must train those muscles during activities that mimics the movement in which that power and strength is needed (McArdle *et al.*, 2001:500-505). Since cricket players need to be able to perform actions from a still position, they need to generate power through both the upper body and lower body. It seems therefore that cricketers in this study at least targeted the correct muscles during strength training; however, it was beyond the scope of this study to evaluate the quality of the strength training programmes.

Strength is also critical when players are required to decelerate and change direction. These decelerations require eccentric contractions of the leg muscles. It is known that eccentric muscle contraction causes more muscle soreness and more microscopic muscle fibre damage than concentric contractions (Strauber, 1989). Eccentric muscle contractions thus often lead to muscle injuries. Therefore, strength is needed in order to protect muscles, ligaments, tendons and joints from injury. Muscles with superior strength will not only be less prone to muscle damage, but will also be more fatigue resistant (Fleck and Falkel, 1986). One of the factors that can influence specifically muscle injuries is tightness and/ or weakness of muscles (Croisier, 2004).

Strength training to the core and chest area seems to be the most neglected. Although not yet scientifically shown, many individuals in the coaching and sport science field have a common belief that core strength is a critical aspect to producing a superiorly strong and powerful athlete who is injury free (Marlow, 2001). It is suggested that core stability improves an athlete's balance and body control. This means skills are executed in a more efficient way and energy and movements are not wasted (Marlow, 2001).

In this study, there was a statistically significant negative correlation between the presence of core strength and stability training in a team's training regime and the number of injuries that was sustained by the team ($r= -0.8$; $p=0.20$). It therefore seems that the inclusion of core training reduced the likelihood of sustaining injuries.

1.4. Flexibility training

Flexibility is the ability of a joint to move through a range of motion. Moving through a full range of motion is often critical in the success of executing a specific skill effectively and efficiently. Although it is widely believed that stretching reduces injuries, there is little evidence to support these beliefs (Gleim and McHugh, 1997). Flexibility does, however, help maintain a good posture (Plowman, 1992). By performing sport-specific activities as well as everyday activities with a good posture an athlete can help protect their backs (Powers and Dodd, 1999).

Flexibility, in general, seemed to be well managed in all the teams studied and all areas of the body received attention. Australia spent more time than the other three teams on stretching regimes. It is an allocated training activity and not an activity that is just left to the players to do before and/or after a game or training session. In the current study there was no correlation between players that participated in flexibility training and the incidence of injuries within the teams ($r=0.04$; $p=0.9$).

2. The relationship between injuries sustained and periodization of training

In this study, a large percentage of players got injured during March 2005 (34%), which was the month leading up to the World Cup. Serious injuries so close to a major competition would not have enough time to heal and these players would therefore likely enter the competition with underlying injuries. It is concerning to think that this happened, as the month before a competition is the time when players should start to peak for the upcoming competition. At this time, teams should be fine tuning their team strategies and possibly participate in a few warm up matches.

One way of preventing untimely injuries from occurring prior to a major competition, is to carefully periodize the players' training program and preparation. Through periodization, a peaking strategy is developed so that athletes reach their best performance in time for the specific competition (Foran, 2001). When designing a peaking strategy the following should be considered, namely the individual's physical characteristics, the individual's strength and weaknesses, training conditions and the individual's motivation. The periodized program must lead to ultimate performance when it is most important. Peaking is a superior state, where the body is in a specialized biological state of perfect health, optimal physiological state, which is displayed through quick adaptability to training stimuli, and a speedy recovery rate following training or competition (Bompa, 1999). Bompa (1999:295) describes the end result of periodization (peaking) perfectly:

> "The athlete's body reflects a high state of functional synergism (acting together), in which organs and systems channel towards achieving optimum efficiency and the highest possible performance."

As part of the training questionnaire in this study, players were specifically asked if they periodize their training. Both Australia and New Zealand periodized their training, while only some players in the South African team used periodisation. Sri Lanka did no periodization. A number of players in the South African team actually reported that they did not know what was meant by the phrase.

Even though players in national teams do not plan their own training schedules, it would be preferable if they play an active role in the development of their training regimes, understand the thinking behind the composition of training programmes and why and how periodization is implemented. When players have confidence and belief in what they do, it results in a more dedicated approach. If athletes believe in what they are doing, their compliance towards training and specific training programmes is better. Furthermore, periodization can be used in any conditioning program, with the added advantage that it will provide variation in exercise stimulation, along with adequate rest and recovery (Foran, 2001).

South Africa, who made somewhat use of periodization, and Sri Lanka, who didn't employ periodization at all, reported nine and eight injuries, respectively. They were also the lower ranked teams (Sri Lanka=6 and South Africa=7) among the four teams that participated in this study. There were a total of eight teams participating in the Women's World Cup. It was thus evident from the results of this study that there is a strong correlation between periodization of training and the number of injuries sustained ($r = -0.8$; $p=0.2$), as well as the ranking of the team ($r = -0.8$; $p=0.2$). Although both these correlations were not statistically significant, this can be solely attributed to the small sample size.

3. Skills Training

There was no statistically significant difference among the four countries with regard to the time spent on training the different cricket skill components. Most teams seem to practice between two hours and just under three hours in one practice session. In general, all teams increased the amount of time spent on the different skill components from the pre-season to the in-season. This would be expected as teams are working to maximize their performance (Hassan *et al.*, 2003:11).

Sri Lanka spent a great deal of their time on bowling, especially during the pre-season. This could have been influenced by the presence of two leg spinners in the sample of players who completed the questionnaire. Leg spinners usually spend large amounts of time on their bowling action, because it is a highly complicated skill to master and time is needed to develop variations and rhythm. Leg spinners also have a slight advantage they do not bowl at pace and as a result they have reduced forces transmitted through their bodies, unlike the fast and medium paced bowlers. This may protect them from typical fast bowling injuries such as lumbar and thoracic injuries, lower limb injuries and posterior talar impingement syndrome (Stretch and Venter, 2005).

4. Recovery

The most popular recovery technique amongst the women cricketers were stretching, swimming and low intensity cardiovascular activities. All these activities are executed to help players recover as quickly as possible for the next match or practice session. A further aim of the various recovery strategies is to minimize the risk of delayed onset of muscle soreness (DOMS), which is in particular brought on by eccentric muscle actions (McArdle *et al.*, 2001:540).

5. Alternative training modalities

The four training alternatives that were discussed are plyometrics, pilates, medicine balls and swiss balls. These alternatives where chosen because they are popular trends in the fitness industry and many professional athletes are using these modalities to condition themselves.

Australia and New Zealand spent one hour and half an hour, respectively, on plyometric training during a week. South Africa and Sri Lanka did no such training.

The base movements in *plyometrics* in the lower body are jumping, hopping and bounding movements. In the upper body actions are swinging, push-offs, catching and throwing weighted instruments. Plyometrics is critical in developing strength and power in muscles, particularly in sprinting activities and power development through the torso towards the arms as in a throwing action. Plyometric training is therefore designed to improve the relationship between strength and explosive power. This is important as it improves speed, vertical jump height, increase muscle strength development and improves co-ordination between the arms and legs. (Hassan *et al.*, 2003:16)

Plyometric training involves loading a muscle during isometric contraction (eccentric) which provides a rapid stretch and then immediately afterwards it produces a shortening (concentric) action. The lengthening of the muscle in the stretch-shortening cycle produces a more powerful movement. This occurs because there is a larger recruitment of motor units before the concentric phase, while the stretch which is induced produces reflexes that increase muscle activation.

The majority of players from Australia and New Zealand use medicine and swiss balls within their training regime. Only a few players in the South African team used these alternative training methods. Swiss balls were used by 50% of their players and medicine balls by only 25%. Sri Lanka did not use any of these pieces of equipment. Medicine balls are excellent tools in developing strength and power in a functional manner. Exercises can be developed to improve strength through mimicking the actual skill. This creates a more efficient flow from training to skill repetition in a competitive environment.

There was a moderately strong correlation between the use of swiss ball training and the prevalence of injuries, although this correlation was not statistically significant due to the small sample size ($r=-0.8$; $p=0.2$). Future studies should investigate this relationship further.

Time spent doing pilates did not seem to influence the amount of injuries teams sustained nor did it influence the teams rank at the World Cup. However plyometric training had a strong correlation between the amount of time spent doing plyometric training and the rank at the World Cup ($r=-0.99$, $p= 0.01$). Plyometric training also seemed to reduce the amount of injuries teams sustained ($r=-0.7$, $p=0.3$)

CHAPTER EIGHT

CONCLUSIONS

A. MAIN FINDINGS

From this study it would seem that the incidence of acute (first time) injuries are similar in women (62%) and men (65%) cricketers. However, men have an injury rate of 2.1 injuries per player per season, whereas the women in this study suffered from 0.48 injuries per player over the nine month study period. One likely explanation for this is that men suffer from more injuries because of a greater exposure to playing time. Women do not play as much international cricket as the men do. Therefore, women do not need to contend with the immense physical demands placed on the body by such busy touring schedules.

There are a reasonable amount of chronic injuries and this hinders the development of a player's overall ability. If players are constantly having to rest they cannot train optimally and performance may be hindered by constant pain. It is vitally important that players follow strict rehabilitation strategies to prevent injuries from becoming chronic in nature.

Comparing types of injuries it is evident that bowling is a large contributor to injuries in the men's game (40%). Women do not suffer from as many bowling injuries (19%). This could be because women tend to weigh less and bowl at slower speeds, which results in less load on the body's structure.

Lower limb injuries in men (49%) (Stretch and Venter, 2005) and women (59%) (current study) cricketers seem to be the main problem area where injuries occur. However, in comparison women suffer from more leg injuries. This could be attributed to their wider pelvis and increased quadriceps angle which ultimately places more wear and tear on the knee and lower limb areas. It is well documented that women have a higher risk of sustaining anterior cruciate ligament injuries, as well as other knee related injuries (Yu *et al.*, 2002).

The training questionnaire yielded some vital information on the players' training habits. Endurance training was given the most attention, followed by strength training and lastly anaerobic training. These trends flowed from pre-season training into the in-season training. There was a strong correlation between the time teams spend on anaerobic training and their rank at the end of the World Cup ($r=-0.97$; $p=0.03$).

There was a strong correlation between time spent on core stability training and injuries sustained within the teams. It is therefore paramount that players pay special attention to developing core strength. It can be suggested that a strong core would decrease the likelihood of sustaining injuries.

If players do not adequately prepare themselves physically this could lead to a greater number of injuries. It was evident from this study that the two higher ranked teams had a more balanced and comprehensive approach to their training, which was not only manifested in the smaller number of injuries reported in these teams, but also in their success in the World Cup tournament

B. Limitations of the study

Firstly, there was a small sample size, with only four countries participating out of eight. A larger sample size would clarify, for instance, the relationships between specific types of training and the incidence of injuries. Secondly, the questionnaires relied on the players' understanding of the specific questions, as well as their memory of their training practices and injuries sustained over a nine month period. Thirdly, the study only stretched over a nine month period. Longer investigations would not only give a more accurate estimate of the prevalence and injury risk in women's cricket, but will also help to identify specific trends in the type of injuries associated with women's cricket.

C. SUGGESTIONS

1) Players need to spend a substantial amount of time on anaerobic training. From this study it would seem that superior anaerobic fitness can result in improved performance and less injuries.
2) Core strength must be taken seriously and players should train this particular area diligently to prevent injuries.
3) Lower limb injuries definitely seem to be a problem area in women sport, including cricket. Players should seek advice on correcting biomechanical malalignments as well as dedicating sufficient time to conditioning the lower limbs.
4) Coaches and trainer should be aware that fielders and wicketkeepers are both in peak physical fitness and that they have mastered the correct techniques of catching and retrieving a cricket ball.
5) A database should be set up in order to constantly monitor international women's cricket injuries. The knowledge obtained from the database will help medical teams and sport scientist to better serve women cricketers and therefore help develop the game.

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APPENDIX A

INJURY REPORT FORM 2004/2005 SEASON -WOMEN'S CRICKET

INSTRUCTIONS

1) To be completed by the biokinetist, physiotherapist or doctor in charge of the team in connection with the relevant player.
2) Complete on one questionnaire for each injured player.
3) A questionnaire should be filled out for each injury a player sustains pertaining to injuries occurring prior to and during the World Cup.

Medical Practitioner: .... **(Doctor, Physiotherapist)**

Country...

Name of player..

ID number ....

Contact number or email ....

Age...

Height..

Weight...

Questions 1 and 2 are compulsory to all players and injuries.

1) Player Profile (tick relevant box, more than one box can be ticked)

Right-handed batswomen	☐	Left-handed batswomen	☐
Right-handed bowler	☐	Left-handed bowler	☐

2) Role in team (tick relevant box, more than one box can be ticked)

Fast Bowler	☐	Batswomen-Top order	☐	Wicketkeeper	☐
Medium pace	☐	Batswomen- Middle order	☐	All Rounder	☐
Off spin	☐	Batswomen- Lower order	☐		
Leg Spin	☐				

Questions 3 to 6 to be filled out if injury occurred prior to the World Cup.

3) Month of injury: (not during World Cup) If needed, tick more than one box.

Aug '04 ☐ Sept '04 ☐ Oct '04 ☐ Nov '04 ☐

Dec '04 ☐ Jan '05 ☐ Feb '05 ☐ March '05 ☐

4) Team represented when injured:

School ☐ Club ☐ Province ☐ International ☐

Other (Specify...)

5) Occurrence:

a) One-day Match ☐ 2/3/4 Day Match ☐ Practice ☐

b) Gradual onset of symptoms ☐ Chronic problem ☐

c) Other (Specify)..)

6) At the time of injury, did the player take any medication on a regular basis?

Yes ☐ No ☐

If yes, please specify: (e.g. Asthma, supplements, birth control or hormone replacement therapy.)

....

....

....

....

....

<u>Questions 7 and 9 to be filled out if injury occurred within the World Cup.</u>

<u>7) During World Cup:</u>

<u>Week 1:</u> 16 March '05- 24 March '05 ☐

<u>Week 2:</u> 25 March '05- 01 March '05 ☐

<u>Week 3:</u> 02 April '05- 09 April '05 ☐

<u>8) Occurrence:</u>

a) Match ☐ Practice ☐

b) Gradual onset of symptoms ☐ Chronic problem ☐

c)Other (Specify)..)

9) At the time of injury, did the player take any medication on a regular basis?

Yes ☐ No ☐

If yes, please specify: (e.g. Asthma, supplements, birth control or hormone replacement therapy.)

....
....
....
....
....

<u>Questions 10 to 15 relate to the injury mechanism and diagnosis. Must be filled out for all players and their injuries</u>

<u>10) Activity: (how did injury occur)</u>

Batting ☐ Bowling ☐

Catching ☐ Fielding ☐

Throwing:
Inner ring ☐ Boundary ☐

Other sports ☐

Fitness training ☐

Other (Specify...)

If the injury occurred while bowling, what type of boot was being worn ....
....

If the injury occurred while bowling, specify any specific delivery ....
....

If the injury occurred while batting, specify if it occurred during playing a particular shot...
....

or were you in the process of taking a run. Yes ☐ No ☐

11) Mechanism of injury
....
....
....

12) Diagnosis:
....
....
....

13) Nature of Injury:

Fracture ☐ Stress Fracture ☐

Joint ☐ Dislocation ☐

Muscle ☐ Tendon ☐

Ligament ☐ Fascia ☐

Cartilage ☐ Nerve ☐

Open Wound ☐

Other (Specify...)

14) Type of injury

a) First time injury ☐ Recurrent: Previous season ☐

Recurrent: Present season ☐

b) Acute ☐ Chronic ☐

15) Time out of game:

Practices:

None ☐ 1-3 days ☐ 4-7 days ☐

8-14 days ☐ 15 -21 days ☐ 22+ days ☐

Matches:

None ☐ 1-3 days ☐ 4-7 days ☐

8-14 days ☐ 15 -21 days ☐ 22 + days ☐

Questions 16 to 19 relate to the location of the injury on the body, only the necessary regions need to be marked. Where there is space please specify name of muscle, tendon or ligament which has been injured.

16) HEAD, CERVICAL SPINE & FACE

a) Anatomical Site

Cranium	☐	Temple	☐	Ear	☐
Eye	☐	Eye brow	☐	Cheek	☐
Nose	☐	Lips	☐	Mouth	☐
Chin	☐	Cervical vertebrae	☐		

Other (Specify)
....)

b) Diagnosis:

Fracture	☐	`Unconsciousnes	☐	Laceration	☐

Eye Injury (..)

Other (Specify..)

Was surgery required? Yes ☐ (Specify. ....)

Was surgery required? No ☐

17) UPPER LIMB ***(shoulder and forearm)***

a) Anatomical Site

Sterno-Clavicular Joint	☐	Clavicle	☐	Humerus	☐
Acromio-Clavicular Joint	☐	Gleno-Humeral Joint	☐	Elbow Joint	☐
Radius	☐	Ulnar	☐	Wrist Joint	☐
Metacarpal	☐	Phalanges	☐		

Soft-tissue (Specify ....) ☐

Other (Specify..) ☐

b) Diagnosis:

Fracture	☐	Dislocations	☐	Sublaxation	☐
Bursitis	☐	Lateral Epicondylitis	☐	Medial Epicondylitis	☐
Impingement	☐				

Nerve (......................................) ☐ Tendon (..................................) ☐

Muscle Strain/Tear (..) ☐

Rotator Cuff Syndrome (..) ☐
Ligament (..) ☐

Other (Specify...) ☐

Was surgery required? Yes ☐ (Specify..)

Was surgery required? No ☐

18) THORACIC AND LUMBAR SPINE & TRUNK

a) Anatomical Site

Cervical Spine ☐ Thoracic Spine ☐ Lumbar Spine ☐

Sacro-iliac Joint ☐ Ribs ☐ Sternum ☐

Abdominal muscles ☐

Soft-tissue (Specify..)

Other (Specify...)

b) Diagnosis

Spondylosis ☐ Spondylolysis ☐ Spondylolisthesis ☐

Disc lesion ☐ Stress fracture ☐ Pedicle sclerosis ☐

Facet Joint ☐ Nerve (...)

Tendon (...) ☐

Muscle Strain/Tear (.......................................) ☐

Ligament (...) ☐

Other (Specify...) ☐

Was surgery required? Yes ☐ (Specify.......................................)

Was surgery required? No ☐

19) LOWER LIMB

a) Anatomical Site

Hip Joint	☐	Groin	☐	Femur	☐
Hamstring	☐	Quadriceps	☐	Hip Adductors	☐
Hip Abductors	☐	Knee	☐	Patella	☐
Tibia/Shin	☐	Fibula	☐	Achilles Tendon	☐
Calf	☐	Ankle	☐	Heel	☐
Talus	☐	Metatarsals	☐	Tarsal	☐
Phalanges	☐				

Soft-tissue (Specify ....) ☐

Other (Specify ....) ☐

b) Diagnosis

Nerve (....................................)	☐	Tendon (...............................)	☐
Muscle Strain/Tear (....................)	☐	Stress fracture (........................)	☐
Ligament (................................)	☐	Meniscus (...............................)	☐

Other (Specify..) ☐

Was surgery required? Yes ☐ (Specify. ....)
Was surgery required? No ☐

APPENDIX B

Training Regime to be filled out by individual player

INSTRUCTIONS

1) To be completed by the individual player in connection with their training procedures.

1) Country ....

2) Role in team

Fast Bowler	☐	Batswomen-Top order	☐	Wicketkeeper	☐
Medium pace	☐	Batswomen- Middle order	☐	All Rounder	☐
Off spin	☐	Batswomen- Lower order	☐		
Leg Spin	☐				

3) GENERAL

a) Do you periodize your training. Yes ☐ No ☐ Don't understand ☐

(Periodize refers to dividing your training year into cycles and meeting specific training objectives within these cycles)

Questions 4 to 10 pertain to PRE-SEASON training. (Pre-season is weeks leading up to your most competitive part of the season. It does not necessarily refer to preparation prior to the World Cup.)

4) How many weeks of pre-season training did you have?

0 weeks	☐	2 weeks	☐	4 weeks	☐
6 weeks	☐	8 weeks	☐	10 weeks	☐
12 weeks	☐	12+ weeks	☐		

5) How many hours per week do you dedicate to fitness during pre-season training?

1) Endurance/ stamina ......hrs .... min

2) Anaerobic work ....hrs............ min

3) Strength ....hrs .... min

6) ENDURANCE TRAINING (Long-slow distance training)

a) How many kilometres did you run in a week? .... km

b) How many kilometres did you cycle in a week? .... km

c) How many kilometres did you swim in a week? ....km

7) ANAEROBIC TRAINING (Short interval training with reduced amount of recovery between sets)

a) How many hours in a week did you dedicate to anaerobic training? ....hrs ....min

8) STRENGTH TRAINING (Weight training)

a) Did you participated in a strength training program in a gym?
Yes ☐ No ☐

b) Specify:

Shoulders	☐	Arms	☐	Back	☐
Legs	☐	Core	☐	Chest	☐

9) FLEXIBILITY

a) Did you participate in a rigid stretching regime? Yes ☐ No ☐

b) Specify:

Shoulders	☐	Arms	☐	Back	☐
Legs	☐	Core	☐	Chest	☐

10) SKILLS TRAINING

a) How many hours a week do you train skills (ie. bowling, batting and fielding) during the pre-season?

1) Bowling ....hrs .... min
2) Batting ....hrs .... min
3) Fielding ....hrs .... Min

<u>Questions 11 to 17 pertain to IN-SEASON training. (In-season is the weeks and months in which you play the most competitions and matches. It does not necessarily refer to just the World Cup.)</u>

11) How many hours do you dedicate to fitness in a week during in-season training?

1) Endurance/ stamina .... hrs .... min

2) Anaerobic work .... hrs .... min

3) Strength .... hrs .... min

12) ENDURANCE TRAINING (Long-slow distance training)

a) How many kilometres do you run in a week? .... km

b) How many kilometres do you cycle in a week? .... km

c) How many kilometres do you swim in a week ? ....km

13) ANAEROBIC TRAINING (Short interval training with reduced amount of recovery between sets)

a) How many hours in a week do you dedicate to anaerobic training? ....hrs .... min

14) STRENGTH TRAINING (Weight training)

a) Do you participate in a strength training program in a gym?
Yes ☐ No ☐

b) Specify:

Shoulders	☐	Arms	☐	Back	☐
Legs	☐	Core	☐	Chest	☐

15) FLEXIBILITY ☐

a) Do you participate in a rigid stretching regime? Yes ☐ No ☐

b) Specify:

Shoulders	☐	Arms	☐	Back	☐
Legs	☐	Core	☐	Chest	☐

16) SKILLS TRAINING

a) How many hours a week do you train skills (ie. bowling, batting and fielding) during the in-season?

1) Bowling ....hrs .... min

2) Batting ....hrs .... min

3) Fielding ....hrs .... min

17) TRAINING SESSIONS

a) On average how long do you practice in one practice session?......hrs ...... min

b) How many sessions do you have per week? ....

c) How many days in a week do you play matches (average)? ....

18) RECOVERY

a) How do you recover after a match or a hard training session?

....

....

....

b) Do you often suffer from Delayed Onset of Muscle Soreness?

1) After a game?	Yes	☐	No	☐
if yes, how often	Always	☐	Sometimes	☐
2) After gym work	Yes	☐	No	☐
if yes, how often	Always	☐	Sometimes	☐
3) After practice	Yes	☐	No	☐
if yes, how often	Always	☐	Sometimes	☐

19) OTHER TRAINING MODALITIES

a) Do you participate in any plyometrics? Yes ☐ No ☐

If yes, how often: One hour a week ☐

Two hours a week ☐

Three hours a week ☐

Other specify...................... hrs

Why do you use this training modality?

....

....

....

b) Do you participate in any pilates training? Yes ☐ No ☐

If yes, how often: One hour a week ☐

Two hours a week ☐

Three hours a week ☐

Other specify...................... hrs

Why do you use this training modality?

....

....

....

c) Have you used medicine balls as a training modality? Yes ☐ No ☐

If yes, did you find them beneficial? Yes ☐ No ☐

Why do you use this training modality?

....

....

d) Have you used swiss balls as a training modality?	Yes	☐	No	☐
If yes, did you find them beneficial?	Yes	☐	No	☐

Why do you use this training modality?

....

....

....

Are there any other training practices that you participate in which have not been covered in the above questionnaire?

....

....

....

....

....

....

Thank you very much for your time and co-operation. Good luck for the tournament ahead.

APPENDIX C

UCBSA INJURY REPORT FORM FOR THE 2002-2003 SEASON

Medical Practitioner: .... (Doctor, Physiotherapist)
Province:
Boland [] Border [] EP [] Easterns [] FS []
Gauteng [] GW [] Natal [] Northerns [] North West []
WP [] SA [] National Academy []

Injured Player: ....

Age:
Role in team: All Rounder [] Batsman [] Wicketkeeper []
Fast Bowler [] Spin Bowler []

Month of injury:
Jan [] Febr [] March [] April [] May [] June []
July [] Aug [] Sept [] Oct [] Nov [] Dec []

Team represented when injured:
School [] Club [] Province 'B' [] Province [] International []
Provincial Academy [] National Academy [] Other
(Specify...)

Occurrence:
One-day Match [] 3/4/5 Day Match [] Practice
[]
Gradual onset of symptoms [] Other
(Specify...)

Activity:
Batting [] Bowling [] Catching [] Fielding
[]
Throwing [] Other sports [] Fitness [] Other
(Specify......................)
If the injury occurred while bowling, what type of boot was being worn
....

Nature of Injury:
Fracture [] Stress Fracture [] Joint [] Dislocation []
Muscle [] Tendon [] Ligament [] Fascia [] Cartilage
[] Nerve [] Open Wound [] Other
(Specify...)

* First time injury [] Recurrent: Previous season [] Recurrent:
Present season []

* Acute [] Chronic [] Acute on chronic[]

Time out of game:
Practices: 1-3 days []4-7 days [] 8-14 days [] 15 -21 days [] 21 + days[]
Matches: 1-3 days [] 4-7 days [] 8-14 days [] 15 -21 days [] 21 + days[]

Mechanism of injury:
....
....

Diagnosis:
....
....

If not an injury please provide reason for consultation and diagnosis
....

HEAD, CERVICAL SPINE & FACE
Anatomical Site
Cranium [] Temple [] Ear [] Eye [] Eye brow [] Cheek []
Nose [] Lips [] Mouth [] Chin [] Cervical vertebrae [] Other (Specify)...)
Diagnosis:
Fracture [] Unconsciousness [] Laceration [] Eye Injury (..................) []
Other (Specify ....)
Was surgery required? Yes [] (Specify ....) No []

UPPER LIMB
Anatomical Site
Sterno-Clavicular Joint [] Clavicle [] Acromio-Clavicular Joint []
Gleno-Humeral Joint [] Elbow Joint [] Humerus []
Radius [] Ulnar [] Wrist Joint []
Metacarpal [] Phalanges []
Soft-tissue (Specify ....) [] Other (Specify..)
Diagnosis:
Fracture [] Dislocations [] Sublaxation []

Bursitis []
Lateral Epicondylitis [] Medial Epicondylitis [] Impingement ……………………)[]
Nerve (………………) [] Tendon (………………) [] Muscle Strain/Tear (…………..) []
Rotator Cuff Syndrome (………………………………) [] Ligament (……………………) []
Other (Specify ……………………………………………………………………………………)
Was surgery required? Yes [] (Specify ……………………………) No []

THORACIC AND LUMBAR SPINE & TRUNK

Anatomical Site

Thoracic Spine [] Lumbar Spine [] Sacro-iliac Joint []
Ribs [] Sternum [] Abdominal muscles []
Soft-tissue (Specify ………………………………) []
Other(Specify………………………………………)

Diagnosis

Spondylosis [] Spondylolysis [] Spondylolisthesis [] Disc lesion []
Stress fracture [] Pedicle sclerosis [] Facet Joint []
Nerve (……….) []
Tendon (…………………………………) [] Muscle Strain/Tear (……………………………) []
Ligament (……………………………) [] Other (Specify……………………………………)
Was surgery required? Yes [] (Specify ……………………………) No []

LOWER LIMB

Anatomical Site

Hip joint [] Groin [] Femur [] Hamstring [] Quadriceps []
Hip Adductors [] Hip Abductors [] Knee [] Patella [] Tibia/Shin []
Fibula [] Achilles Tendon [] Calf [] Ankle [] Heel []
Talus [] Metatarsals [] Tarsal [] Phalanges []
Soft-tissue (Specify ………………………) [] Other (Specify ……………………………………….)

Diagnosis

Nerve (…………………) [] Tendon (………………) [] Muscle Strain/Tear (…………) []
Ligament (……………) [] Meniscus (…………….) [] Other (Specify………………………)
Was surgery required? Yes [] (Specify ……………………………) No []

Please return completed forms to: Dr Richard Stretch, University of Port Elizabeth,
PO Box 1600, Port Elizabeth, 6000