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THE PREVALENCE OF SHOULDER PAIN IN PROFESSIONAL MALE WHEELCHAIR BASKETBALL PLAYERS IN GAUTENG, SOUTH AFRICA

Compiled by Claudia Lepera

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Physiotherapy

Johannesburg 2010

Declaration

I, Claudia Lepera, declare that this research report is my own work. It is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

_____

Claudia Lepera

__15th_ day of ___September___ 2010

Dedicated to my family,

mom, dad and Tun for your unending support and encouragement.

Thanks to God for reminding me over and over again that nothing is impossible with His hand to guide me.

ABSTRACT

Introduction

Disabled sport has become very popular over the last decade with a variety of sports now available for persons with disabilities to compete in. Wheelchair basketball is a fast growing sport in South Africa. However, it is also considered a high-risk sport with most reported injuries coming from participating in the game along with tennis, road racing, rugby and soccer (Nunome et al, 2002, Ferrara and Peterson, 2000 and Curtis, 1997). The sport is characterised by high intensity propulsion and manoeuvring as well as reaching overhead for shooting, passing and rebounding (Goosey-Tolfrey et al, 2002 and Curtis et al, 1999). The athletes are thus at risk of developing in particular shoulder injuries.

This study aimed to establish the prevalence of shoulder pain in South African; Gauteng based professional male wheelchair basketball players. It aimed to highlight predisposing factors contributing to the prevalence of shoulder pain as well as establish whether there is a difference in shoulder pain between the wheelchair bound athletes vs. the otherwise ambulatory athletes. By quantifying the magnitude of the problem it was hoped that awareness would lead to measures taken to rectify any problems highlighted by the research.

Methods

Twenty-nine professional South African: Gauteng male wheelchair basketball players took part in a cross sectional descriptive survey based study. The researcher, following signed informed consent, administered a piloted valid and reliable questionnaire to gain information regarding demographics, medical history and lifestyle habits. Results were expressed in the form of tables and graphs with frequencies, percentages and averages used to describe findings.

Results

Prevalence of shoulder pain was found to be 72.4% with 21 of 29 participants having experienced shoulder pain since using a wheelchair and 11 of the 29 (37.9%) having current shoulder pain. The number of years using a wheelchair significantly influenced the prevalence

of shoulder pain (p = 0.03). One hundred percent (nine out of nine) of participants who had been using a wheelchair for longer than 10 years had experienced the problem, while of those who had been using a wheelchair for less than 10 years, 57.14% (four out of seven) had experienced shoulder pain. Time spent at work was found to be significantly associated with the presence of shoulder pain. Of the 12 people who worked more than 30 hours per week, 12 (100%) had experienced shoulder pain (p = 0.05). In the comparison of the ambulatory vs non ambulatory athletes, the wheelchair bound participants tended to be more likely to experience shoulder pain with 12 out of 15 having shoulder problems and 7 of the 12 ambulatory participants having experienced shoulder pain. This was however not a significant finding (p = 0.22).

Conclusion

It was found that the prevalence of shoulder pain in professional wheelchair basketball athletes in Gauteng was 72.4%. This was significantly associated with hours spent at work as well as years spent using a wheelchair. There were no significant findings regarding shoulder pain prevalence in the otherwise ambulatory vs wheelchair bound wheelchair basketball athletes. Shoulder pain is an important problem in the wheelchair basketball athlete. More education is needed regarding prevention of shoulder problems in our athletes with an emphasis on posture and ergonomic handling.

ACKNOWLEDGEMENTS

The following people or institutions provided assistance in preparing the research report:

- Miss Siphe Mtshali (supervisor)
- Dr Nonceba Mbambo - Kekana (co – supervisor)
- Prof Aimee Stewart (physiotherapy post graduate co ordinator)
- Prof Steve Olorunju (statistician)
- Lindsay Harris, Siphe Mtshali, and Steve Olorunju for general advice and assistance including content validation of the questionnaire.
- The Kwa Zulu Natal Visa wings basketball team and management for involvement in the reliability of the questionnaire.
- Management wheelchair basketball South Africa and coaches, players and management staff of Gauteng based professional teams

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CHAPTER 1

1.0 BACKGROUND AND NEED

1.1 Introduction

Wheelchair basketball is an exciting, fast paced, growing sport in South Africa with these athletes having excelled over the last 3 years to become competitive in the world arena of wheelchair basketball (Scott, 2007). South Africa earned the All Africa Title in 2007, which qualified them to compete at the Paralympic games in 2008. The men's national team won South Africa's first European competition in Belgium in 2008 beating France, Belgium and Switzerland for the quadrangular title. With newly acquired, much needed sponsorship monies, this group of athletes are becoming better equipped to compete internationally. Sasol has become a sponsor of the game making international experience a reality for the athletes due to their monetary contributions. This support helped make it possible for the Paralympic South African men's wheelchair basketball team to finish 9th in the world rankings in 2008 (Scott, 2008).

Despite these successes many of the athletes are plagued by injury keeping them from performing at their best. The majority of injuries appearing to keep players on the sidelines appeared to be that of shoulder injuries (Hughes, 2009), but with no actual research done on the subject of shoulder pain in the local wheelchair basketball athlete one cannot quantify the problem. This can lead to an inability to address the problem conclusively (Curtis, 1997). There is a fair amount of research done into shoulder pain in wheelchair users abroad (van Drongelen et al, 2006; Sinnot et al, 2000; Nawoczenski et al, 2006; Gianini, 2006; Curtis et al, 1999 and Burnham et al, 1993) with one study specifically focused on shoulder pain in wheelchair basketball players only (Curtis and Black, 1999). However there is little to be found on such research into our local players.

Disabled sport has become very popular over the last decade with a variety of sports now available for persons with disabilities to compete in. As has been mentioned, wheelchair

basketball is a fast growing sport in South Africa. The increased participation possibly stemming from the recent success of our athletes abroad, as well as new sponsorship monies made available for the development of the sport. The introduction of local games being televised weekly has also added to the improved profile of the sport. In South Africa the Supersport Challenge has recently been introduced. It is a league where professional clubs from the country's provinces come together to compete at the highest local level available.

The game

The game of wheelchair basketball is recognised as one of the highest profile disability sports (Goosey-Tolfrey et al, 2002). It is also considered a high-risk sport due to most reported injuries coming from those participating in wheelchair basketball, followed by tennis, road racing, rugby and soccer. (Curtis, 1997 Ferrara and Peterson, 2000 and Nunome et al 2002). Teams consist of 12 players with 5 on the court at a time. Games can last up to an hour and a half. Players are required to perform at a high intensity with little time for recovery. Substitutions are available which allow for rest periods, but for the starting 5 players these rests can be few if the game is a close one.

The athletes competing on the court will have varying disabilities and are rated accordingly into eight classification levels from 1.0 to 4.5. Players are assigned points based on their functional classification with 1.0 being a high level of disability and hence less trunk stability during shooting (e.g. T2 lesion) and 4.0 being a low level of disability (e.g. A player with a below knee amputation). The team is allowed a total of 14 points on the court at a time. Thus a well-structured team should consist of players with a range of disabilities but a high level of skill (Goosey-Tolfrey et al, 2002).

Biomechanics and injuries associated with wheelchair basketball

The nature of the sport is characterised by high intensity propulsion and manoeuvring as well as reaching overhead for shooting, passing and rebounding (Curtis et al, 1999, Goosey-Tolfrey et al, 2002). The powerful overhead throwing/shooting action is performed from a position of a mechanical disadvantage with the athlete being in a wheelchair (Thiboutot, 1999). These actions

alongside the positioning of the athlete in the chair put the shoulder complex at risk for developing overuse injuries such as rotator cuff tearing as well as impingement of the subacromial structures between the head of the humerus and the acromion (Dec et al, 2000, and Ardic et al, 2006). According to Malloy and Robertson (2007) the athlete with reduced hip extension, decreased thoracic extension or rotation or gluteal drive during the throwing action will generate higher forces through the shoulder joint increasing the likelihood of injury. This in essence would be the case in a wheelchair bound athlete who cannot employ gluteal drive and hip extension, and in some cases does not have thoracic control. In addition to shoulder injury, the constant pressure on the palmar surface of the hand as well as the gripping action during propulsion of the wheelchair may result in carpal tunnel syndrome symptoms and elbow injuries (Dec et al, 2000)

Muscle imbalance in particular has been implicated in the development of shoulder pain in athletes who use wheelchairs. The shoulder is a particularly mobile joint. This mobility is however at the expense of stability of the joint, which makes it particularly vulnerable to the development of dysfunctions/imbalances and injury. Overuse injuries are thus common, due to the shoulder's complex functional anatomy and relatively limited muscle mass. Muscle imbalance at the shoulder joint complex will as a result contribute to the development of shoulder pain. Poor scapulohumeral and trunk control coupled with forward and upward shifting of the humeral head can result in impingement of the rotator cuff tendons and subacromial bursa. The consequences include pain and rotator cuff disruption, which, in wheelchair users can end in severe limitation of one's independence, due to the inability to sufficiently use one's upper limbs in independent wheelchair activities. (Curtis, 1997, Brukner and Khan, 2001 and Sauers, 2006)

The pectoral muscles tend to become very strong with wheelchair propulsion creating a strength imbalance of the posterior and anterior musculature (Curtis, 1997). Since wheelchair propelling primarily strengthens the chest and anterior shoulder muscles, attention needs to be paid to strengthening the posterior rotator cuff and musculature. This attention to correcting muscle imbalances would prevent or rehabilitate many chronic soft tissue injuries in wheelchair athletes (Curtis, 1997, Boninger et al, 2001 and McClure et al, 2006). Shoulder weakness and forces of

gravity often lead to increased thoracic kyphosis while sitting in and propelling the wheelchair. This sitting posture, which encourages scapular protraction and internal rotation of the humerus will further compromise shoulder kinematics leading to possible injury (Curtis et al, 1999).

Over training and intense competition schedules can also be implicated in increased incidence of injuries in the wheelchair athlete. Sports competitions for disabled athletes are a relatively new phenomenon with the first Paralympic games starting as recently as 1960 (Ferrara and Peterson, 2000). More opportunities to compete in national and international competitions continue to arise for South Africa's athletes, as the country's sportsmen are welcomed back into the international sports arena. This can lead to over training and possible increased incidence of over use injuries as these athletes try to lift the level of their game to that of the rest of the world.

Rotator cuff impingement syndrome is a commonly experienced injury for the wheelchair athlete. The role of muscle imbalances around the shoulder joint is considered a key factor in the development of this condition in wheelchair and non wheelchair bound athletes, as has been discussed (Brukner and Khan, 2001, Nyland et al, 1997 and Burnham et al, 1993). Nyland et al (1997) found that players dependant on wheelchairs for their primary mode of mobility, especially those classified in the 1.0 category, were at greater risk of developing muscle imbalances than those classed as 2.0 or 3.0. This was found to be due to the fact that they are more reliant on their wheelchairs for mobility and have less trunk control. They were also found to have poor external rotator torque symmetry with specific weakness of the nondominant shoulder external rotators. Although this was a small study investigating the isokinetic peak shoulder rotator torque and torque ratios of just 33 subjects, the results were significant ($p = 0.034$) in indicating a relationship between wheelchair dependence and the development of shoulder muscle imbalance.

The most common cause of shoulder injury or pain in the wheelchair athlete is said to be subacromial impingement. Contributing factors to the development of this injury in the wheelchair athlete population are believed to be overuse, lack of proper warm up, glenohumeral and scapulothoracic dyskinesia, lack of dynamic lumbo- pelvic control, poor shoulder flexibility,

repetitive overhead arm positioning, and fatigue (Gianini et al, 2006, Lee and McMahon, 2002, Nyland et al, 1997 and Burnham et al, 1993).

In a review done by Groah and Lanig in 2000 on neuromusculoskeletal syndromes in wheelchair athletes it was found that the shoulder is a high-risk joint for the development of overuse injuries. They went on to state that shoulder pain ranges in prevalence from 30 – 51% and is attributed mostly to soft tissue injury. They drew their information from articles ranging from the 70's to the late 90's. They also highlighted the limitations of the literature available stating that prevalence of sport injuries in wheelchair athletes ranged from 26 – 97% depending on the definition and method of ascertaining such injury.

Thus it can be said that research is still very much needed in the area of the wheelchair basketball athlete.

1.2 Problem Statement

Shoulder pain is a common occurrence in wheelchair athletes and has a marked influence on a wheelchair athlete's independence as well as ability to perform in competition. The current injury status of South African wheelchair basketball athletes is unknown. With the increased participation in the sport, an awareness of the extent of the injuries in this group of athletes is of importance.

1.3 Research Question

What is the prevalence of shoulder pain in South African Gauteng male professional wheelchair basketball players?

1.4 Aim of the study

To establish the prevalence of shoulder pain in South African Gauteng male professional wheelchair basketball players.

1.4.1 Objectives of the study

- Establish the prevalence of shoulder pain in South African Gauteng male professional wheelchair basketball players.
- Establish predisposing factors associated with shoulder pain prevalence in South African Gauteng male professional wheelchair basketball players.
- Determine whether there is a difference in the prevalence of shoulder pain between players who are otherwise ambulatory i.e. amputees with prosthetic limbs, and those confined to a wheelchair.

The definition of shoulder pain

For the purposes of this study the presence of any pain or discomfort in the shoulder girdle is an indication of a positive in terms of shoulder pain. The cause thereof, whether it originates in the cervical spine of a neural nature or directly from the shoulder joint itself is not a relevant fact. Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (Merskey, 1986).

Definition of "Professional"

For the purposes of this study "professional" indicates that the athlete receives financial remuneration for playing wheelchair basketball.

1.5 Significance of the study

Sports competitions for disabled athletes are a relatively new development with the first Paralympic games starting as recently as 1960. Involvement in sports activities continues to grow in popularity among people with disabilities and is thus an area requiring more focused attention in the way of research. (Ferrara and Peterson, 2000).

The South African national wheelchair basketball team won the all Africa games in 2007 and qualified for the Paralympic games for the first time since returning to the international arena. At the Paralympics in 2008 the South African team went on to win their first games at a paralympics ever, but were plagued by repetitive strain type injuries further impacting performance at the games. Further research to determine the injury status of South African wheelchair basketball athletes could benefit the future of the sport as well as highlight problem areas in training or lifestyle that could be improved.

In general it is important for therapists working with a sports team to be aware of potential risks for injury or common injuries experienced by those participating in any given sport (Curtis, 1997). This seems to be an area lacking research in local sports teams.

By quantifying the level to which this injury site is affected, it is more likely that further work to correct or prevent shoulder injuries will be conducted. This study will aim to identify causative factors in the incidence of shoulder pain thus highlighting areas needing to be addressed in terms of training, lifestyle and mobility devices. Despite the apparent successes experienced by the South African wheelchair basketball athletes, articles studying this group of athletes have yet to be published, thus indicating a need for further research in this growing area of sport in South Africa.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Introduction

The sources used to find articles and research appropriate to this study included the University of Witwatersrand library, Medline, Pubmed and Pedro web sites. From here research databases were accessed. The data bases used were Science direct and EBSCO host. Google and Google scholar search engines were also used.

The keywords used in searching included *shoulder, pain, injuries, wheelchair, basketball*

The literature review outlined in this chapter is of current research on shoulder pain in the wheelchair user, athlete and more specifically the wheelchair basketball athlete. The review covers the aspects of epidemiology, predisposing factors, biomechanics of shoulder injury, and effects of exercise on shoulder pain as well as a review of the methodologies.
The review will include the discussion of well and poorly conducted research in the hope to highlight gaps in the literature as well as draw on the strengths, but also understand the weaknesses in the manner in which research has been conducted thus far.

2.2 Epidemiology

According to shoulder pain prevalence studies, it has been concluded that manual wheelchair propulsion and wheelchair related activities of daily living result in considerable loading of the upper extremities. This results in individuals with paraplegia being at high risk for shoulder pain and injury with many studies having reported on prevalence of shoulder pain in wheelchair users (Nawoczenski et al, 2006, Van Drongelen et al, 2006, Fullerton et al, 2003, Boninger et al, 2001, Groah and Lanig, 2000 and Curtis and Black, 1999). Studies have shown that up to 78% of spinal

cord injury patients will report shoulder pain with approximately one third of paraplegics and slightly higher in number in quadriplegics (Fullerton et al, 2003, Curtis et al, 1999 and Curtis and Black, 1999)

Groah and Lanig (2000) reported in their review of the literature pertaining to neuromusculoskeletal syndromes in wheelchair athletes that shoulder pain prevalence in wheelchair athletes tends to range from 30 – 51%.

Curtis and Black (1999) found that in the population of wheelchair basketball players they studied 72% had experienced shoulder pain since using a wheelchair with 52% reporting pain at the time of the study. Fullerton et al (2003) found that 70% of the wheelchair athletes they investigated had had shoulder pain since using a wheelchair with 39% reporting pain at the time of the study.

Boninger et al (2001) reported on shoulder pain and shoulder imaging abnormalities in wheelchair users in general. They found that 32% of the participants had shoulder pain at the time of the study with 69% having abnormal radiographs.

These results are all in close keeping with each other. Curtis and Black (1999) and Fullerton et al (2003) reported findings in an athletic population with Boninger et al (2001) reporting on individuals with paraplegia in general. The mean age of the participants in all three studies was the mid thirties. This would have an influence on the results. Boninger et al (2001) compared their radiographic findings to that of a study done on a population with a mean age of 57 and found that the current pain prevalence was higher in the study on older subjects. They found that while only 4% of their subjects had rotator cuff tears, in the older group studied by Escobedo et al (1997) 57% of subjects had confirmed rotator cuff tears. This was put down to age exposing the shoulder to more years of degeneration.

While the methodology used in the studies above varied slightly, the findings are all in keeping with each other. Curtis and Black (1999) used a self report survey study with validated and reliable questionnaires to establish shoulder pain prevalence at a wheelchair basketball tournament. The tool for obtaining data was thus a good one but there were however weaknesses in their study. Selection of subjects was reliant on that of convenience and

depended on players handing the questionnaires back to the researchers. The respondent rate was calculated to be 48% with 46 of 94 athletes completing the questionnaire. No follow up of participants was described or attempt made to improve the respondent rate. The respondent rate indicates that the results of the study were indicative of less than 50% of the population being researched. This is a poor response rate. According to the guidelines offered by the University of Texas, Austin (2008), an adequate response rate would be more than 50%, which puts this rate below “adequate” thus making it difficult for this study to accurately describe prevalence in this group of athletes. No mentions of follow up or reasons for the response rate were given further limiting their findings. A randomised study with face-to-face interviews could have made the survey more accurate in describing prevalence here.

Fullerton et al (2003) had similar findings to Curtis and Black (1999) in the group of athletes they studied. There were also however weaknesses worth highlighting in their study. They also used a questionnaire based survey but no mention of a validation process is made, nor whether the questionnaire was tested for reliability. They mailed the questionnaire to 500 individuals but did not get an adequate response rate thus published the questionnaire in a newsletter distributed at disabled sports events. They gained a randomised total of 257 subjects for their study of which 172 were athletes. The response rate is a little higher than Curtis and Black (1999) thus being adequate but is still only representative of 52% of the original intended sample. The reasons for a poor response rate were not outlined nor the follow up process described. The authors did outline inclusion criteria and defined the criteria for participants to be termed an athlete. These criteria being outlined for the study makes the process reproducible, which is good. Curtis and Black (1999) had a much smaller group of athletes (46) and a poor response rate but did only investigate wheelchair basketball players, which would make their study more relevant and specific thus bringing the number of possible participants down. Fullerton et al (2003) identified basketball as the most played sport (57% of respondents) but did not show associations of shoulder pain prevalence and type of sport played, rather just that the participant played sport. They also did not indicate whether gender played a role in pain prevalence. Curtis and Black (1999) studied females only and found prevalence to be similar to that of the general wheelchair athlete studied by Fullerton et al (2003). There seems to be no male gender specific research

available in wheelchair basketball players. Interestingly while there were weaknesses and differences in the studies results were similar.

Prevalence has been an often-researched topic in the area of shoulder pain in wheelchair users (Gianini, 2006), but there seems to be limited research specifically pertaining to male wheelchair basketball athletes in this regard. The research found has methodological flaws in terms of instrumentation and sample size and selection, which could be improved on in future research. Research regarding the prevalence of shoulder pain in South African wheelchair basketball athletes is very limited and very much a needed area of research if we are to establish the extent of the problem. Only after establishing the extent of the problem and possible contributing factors can we aim to address injury prevention in the wheelchair athlete population (Curtis, 1997).

2.3 Predisposing factors to the development of shoulder pain

2.3.1 Age and years of wheelchair use

Research has been published regarding age and years of wheelchair use having an influence on the development of shoulder pain (Nyland et al, 2007, Fullerton et al, 2003, Boninger et al, 2001, Groah and Lanig, 2000 and Curtis and Black, 1999).

Most studies have found that advancing age increases the presence of shoulder pain in wheelchair users (Nyland et al, 2007, Fullerton et al, 2003, Boninger et al, 2001, Groah and Lanig, 2000). Curtis and Black (1999) however reported in their study that it was the extremes of age and not the older participants in their study on wheelchair basketball athletes that reported more shoulder pain. Fullerton et al (2003) studied 257 participants comprising of 172 athletes and 85 non athletes. They found that the older the wheelchair user the more likely they were to have shoulder pain.

The average age of the participants in Curtis and Black's (1999) study was 33. The average age of the participants in Fullerton et al's (2003) study with shoulder pain was 41 years old with the average age of those without shoulder pain being 34. If Curtis and Black (1999) had had older

participants in there study they may have reported the same as that of Fullerton et al (2003). Curtis and Black (1999) recruited their sample of participants at a wheelchair basketball tournament and relied on a self reporting survey. This resulted in a less than 50% respondent rate of 42 participants. It is possible that this resulted in a misrepresentation of the population studied. Fullerton et al (2003) recruited 257 (51.4%) participants out of a possible 500, which would make their result a slightly better representation of the population studied. Fullerton et al (2003) reported that the older group of participants tended to be the non athletes which may have also contributed to the increased incidence of shoulder pain in this group as they were not exercising. It has been found that exercise does prevent shoulder pain in wheelchair users (Nawoczenski et al, 2006)

Nyland et al (2007) conducted a review article describing the risk factors associated with upper extremity deterioration in spinal cord injury patients. In this review (Nyland et al, 2007) it was stated that advancing age is associated with decreased independence in activities of daily living in the wheelchair bound individual. They however did not indicate whether the populations studied were athletic or not and are thus difficult to compare directly to that of Curtis and Black (1999). The review is in agreement with Fullerton et al (2003) and Nawacenski et al (2006) as well as Boninger et al (2001) who found that the older non athletic wheelchair user displays a greater extent of degeneration and pain in the shoulder joint than the athletic one.

The review article by Nyland et al (2007) drew on information from a vast number of studies published over the last fifteen years thus giving a good indication of what the research is saying on this subject. They did not however include any information on the inclusion/exclusion criteria for articles used. They also did not indicate the search strategy or methodology associated with choosing the articles for the review. They did comment on the general poor quality of research available in the area of wheelchair users however. The problem of relying on subjective interpretation of information too often dependant on retrospective data rather than objective clinical data was highlighted. There were no relevant systematic reviews of a higher standard available indicating a gap in the research in this area.

It has been found that along with age, the longer the participant has been using a wheelchair the more likely they are to have shoulder pain. Studies generally seem to agree with this finding (Nyland et al, 2007, Boninger et al, 2001, Groah and Lanig, 2000 and Curtis and Black, 1999). Fullerton et al (2003) however found this not to be the case in their participants. The group studied by Curtis and Black (1999) was young (averaging 33 years old) with the average years of wheelchair use being 12.5 years. The group studied by Fullerton et al (2003) averaged 15 years in a wheelchair. It is interesting to note that despite using their wheelchairs for two and a half years longer than the group studied by Curtis and Black (1999), those in Fullerton et al's (2003) study did not have significantly associated shoulder pain.

This may be due to the methodology or statistical analysis employed. The majority of the research cited above did tend to link the factor with shoulder pain. In saying that, it has however been discussed in this literature review that the studies by both Fullerton et al (2003) and Curtis and Black (1999) were not of a very high standard. Nyland et al (2007) reported in their review that many studies associated shoulder pain in wheelchair users with longer years of wheelchair use but that there were differing opinions and studies to say otherwise as well. They (Nyland et al, 2007) also commented on the lack of conclusive sound methodological research in wheelchair user.

Thus according to much of the literature, it can be said that age and years of wheelchair use tends to influence the onset of shoulder pain in wheelchair bound individuals in much of the research, with years of wheelchair use being the more often reported associated factor. The influence exercise has on shoulder pain however also seems to play a role with the athlete reporting pain later than the non athlete (Fullerton et al, 2003).

2.3.2 Level of disability and wheelchair dependence

Wheelchair athletes frequently report upper extremity soft tissue injuries with basketball being one of the higher risk sports in terms of shoulder injury in particular (Van Drongelen et al, 2006, Curtis and Black, 1999 and Curtis, 1997). The extent to which the individual is disabled and more specifically the lesion level in spinal cord injuries, has been found to have an effect on shoulder

pain and rotator cuff disorders. This is due to the compromised trunk postural control and abnormal muscle strength ratios that develop around the shoulder following spinal cord injury and with wheelchair use (Van Drongelen et al, 2006 and Sinnot et al, 2000).

Some athletes who compete in wheelchair basketball will use a wheelchair only for sport and are ambulatory for daily activities with or without an alternative assistive device. These athletes include those with amputations, polio or other neuromuscular disorders. Curtis and Black (1999), in their research on shoulder pain in female wheelchair basketball players, found that athletes with such disorders who are not accustomed to using a wheelchair daily had higher incidences of shoulder pain than those fully dependant on their wheelchairs for general mobility. They related this to the possibility that these categories of athlete are not accustomed to this type of upper limb exercise and are thus prone to the development of early shoulder pain. No other studies pertaining to this subject on wheelchair basketball players specifically could be found, but in the review by Nyland et al (2007) on wheelchair bound individuals, it was stated that the more dependent one is on ones wheelchair the more likely one is to develop shoulder pain and shoulder imbalances, which lead to injury. The difference in results here could be related to the role the less disabled athlete plays on the basketball court. This factor would not have been taken into account in the review by Nyland et al (2007) as they did not involve wheelchair basketball athletes as such. Other than the comments made by Curtis and Black (1999) on the relationship of shoulder pain and extent of disability (ambulatory vs non ambulatory) in their study on female wheelchair basketball players above, no other good studies for comparison could be found. Nevertheless, the study by Curtis and Black (1999) was not of a very high standard due the poor response rate (>50%) with no indication of follow up attempts made to improve on this. Studies regarding the impact lesion level has on shoulder pain and muscle imbalance have been conducted on non athletic and general athletic paraplegics and tetraplegics and found to be associated, but again no good research on basketball players specifically (Kulig et al, 2001, Sinnot et al, 2000 and Burnham et al, 1993).

One study by Nyland et al (1997) investigated wheelchair dependence differences of wheelchair basketball players comparing it to shoulder rotator torque. They did not however report on the

impact wheelchair dependence has specifically on shoulder pain. Conclusions could be drawn from the results however. The lower classified players did not develop the acquired symmetry between non dominant and dominant shoulders in terms of external rotator torque as was the case in the higher classified (less disabled) players. From this result one might conclude that the lower classified players were more prone to muscular imbalances developing around their shoulders making them prone to shoulder pain or dysfunction. This would not be in keeping with the results of Curtis and Black's (1999) finding that ambulatory players (higher class) tended to have more shoulder pain than the non ambulatory.

Curtis and Black (1999) accounted for this finding by suggesting that those less dependant on a wheelchair were not as well conditioned for the propulsion activity, as were those lower classified participants who were in their chairs all the time. So while Nyland et al (1997), found that the lower classified participants in their study had a greater risk for developing shoulder pathology, Curtis and Black (1999) found that more of the higher classified wheelchair basketball athletes actually reported shoulder pain. Thus one could look at the role of the lower classified basketball player vs that of the higher classified player on the court. The intensity and speed of the position played on court as well as game time could all contribute to the development of shoulder pain. Thus it is possibly not only the presence of shoulder imbalances secondary to the athletes disability that causes shoulder pathology. The role he is able to play on the court, which is very often determined by his/her disability may also contribute to the development of shoulder pain.

The study by Nyland et al (1997), like that of Curtis and Black (1999) had a poor response rate (49%) with no indication of follow up or attempts to improve on this made. Their sample was also one of convenience at a basketball tournament. No mention of questionnaire validity and reliability processes was made calling into question the quality of the data collection tool. The data collection was however all co-ordinated by the researcher, including the isokinetic testing, indicating no inter rater bias would have influenced results, which is good. Therefore, due to the standard of both studies, conclusions are difficult to make.

This highlights a gap in the literature suggesting a higher standard of research is needed in terms of the effect of being otherwise ambulatory on the prevalence of shoulder pain in the wheelchair basketball player.

Sinnot et al (2000) investigated the relationship between the level of thoracic spinal cord injury and rotator cuff disorders. Forty-two subjects with high and low level paraplegia were investigated. This descriptive cross sectional study highlighted the difference in prevalence of clinically diagnosed rotator cuff disorder in 22 high level (T2-T7) and 20 low level (T8-T12) persons with long term paraplegia. It was found that clinically diagnosed rotator cuff disorder was significantly more prevalent in the high level (T2-T7) group ($p = 0.01$), which was associated with incorrect habitual sitting postures. Kullig et al (2001) also found that the higher the lesion level the weaker the thoracohumeral depressers were resulting in subacromial crowding and greater susceptibility to symptoms of impingement. Both these studies agree with the findings of Nyland et al (1997) in terms of higher lesion participants being more prone to shoulder muscular imbalances. Burnham et al (1993) investigated general wheelchair athletes. They also found that the higher level lesion athletes in their study on shoulder pain in wheelchair athletes had weaker shoulder adductors and internal and external rotators making them prone to shoulder impingement symptoms.

These studies are all in keeping with each other despite only Burnham et al (1993) and Nyland et al (1997) using athletes. Again, very few studies regarding this matter focus on the wheelchair basketball athlete specifically. The study by Sinnot et al (2000) was generally well conducted. The population was identified in terms of disability and gender with the use of clinical records. Shoulder tests used were documented as those used in the previous study by Burnham et al (1993). They included painful arc abduction (Neers sign), resisted shoulder abduction internal rotation and elevation (Jobe's sign) and the impingement position (Hawkins). These tests have been found to be highly reproducible and thus reliable in identifying sub acromial pain with impingement but considered limited as structural discriminators (Johansson and Ivarson, 2008). Thus the tests used by Sinnot et al (2000) would not conclusively identify rotator cuff disorders specifically as has been indicated. This is a weakness in the study. The tests do indicate shoulder pathology, however, thus making the study useful in identifying the relationship between shoulder pain and lesion level albeit not rotator cuff disorders specifically. The respondent rate was 86% with documented attempts to contact the other 14% of the participants not available for

the study. The researchers (Sinnot et al, 2000) clearly outlined blinding, in so much that the tests were carried out by one assessor and then repeated by a blinded research assistant. This serves to make the study reliable in its findings keeping any bias out of the assessment procedures. The ethics were well described and a valid reliable questionnaire was used to establish the presence or absence of shoulder pain. Further more, a pilot study was conducted to analyse intra rater and inter rater reliability, specificity and face validity on 10 subjects prior to commencing the study.

The results of this study by Sinnot et al (2000) serve to highlight the importance of monitoring shoulder integrity in the higher lesion wheelchair user especially. Their inability to maintain a correct posture due to poor pelvic and trunk control puts them at risk for developing shoulder problems. Remaining active has been shown to prolong shoulder integrity (Boninger et al 2001, Fullerton et al, 2003), but the game of wheelchair basketball would quite possibly put an already compromised shoulder at further risk for developing a dysfunction, due to the overhead activity of the sport in a biomechanically unfavourable position.

It can be concluded from this review that wheelchair bound athletes will invariably develop muscle imbalances around the shoulder complex. These are due to the demands placed on the joint complex during propulsion and overhead activity as well as the posture the athletes assume when in their chairs. The lesion level and classification of the wheelchair basketball athlete has been found to affect the formation of muscle imbalances. Those participants more dependent on their wheelchairs have a greater likelihood of developing shoulder muscle imbalances. It must however be noted that not all wheelchair bound athletes that have these imbalances in their musculature develop pain as indicated by the results of the above studies. In fact, it was found that the wheelchair basketball athlete that was otherwise ambulatory or less dependant on their wheelchair had a higher prevalence of shoulder pain (Curtis and Black, 1999). The training habits and role on the court, activities of daily living and shoulder care regime that each athlete undertakes must thus play a role in the prevalence of shoulder pain.

2.3.3 Biomechanics

The biomechanics of wheelchair sports and wheelchair basketball in particular have been researched to a certain degree, with emphasis on strength testing and the role of muscle imbalance in the development of shoulder pain. There are many aspects to consider in wheelchair basketball when investigating the causes of shoulder pain directly related to the game. These include the load placed on the upper extremities caused by throwing, shooting and high speed propulsion.

High and frequent accelerations during the game-related manoeuvres, such as starting, turning and braking serve to load the upper extremities to a large extent. The propulsion technique is thus an important aspect to consider (Vanlandwijck et al, 2001 and Veeger et al, 2002). One should also however consider the surface on which the players take part. Wheelchairs are modified for manoeuvrability and speed, made light and easy to turn, but all this is hindered when the athlete is called to play on a less than desirable court surface. No research was found investigating this however and would be a topic to be considered for future research.

The need to throw the ball and shoot from a mechanically disadvantaged position has been discussed but also little research into the implications of such actions on the shoulder joint in the wheelchair basketball athlete specifically. There has been a fair amount of research done regarding the overhead able-bodied athlete (Burkhart et al, 2003, Malloy and Robertson, 2007, Brukner and Kahn, 2001, Hackey, 1996, Allen and Warner, 1995) which can to a certain extent be applied to the disabled athlete.

In order to fully understand the implications of playing basketball from a seated position the biomechanics of the throwing action is described below with reference to the effect sitting has on these biomechanics and the subsequent predisposition to shoulder injury.

The normal biomechanics associated with throwing a ball places emphasis on the fact that the whole body should be involved in the activity. Ideally the activity starts with drive from the leg muscles and rotation through the hips and progresses through segmental rotation of the trunk and shoulder girdle. It continues with the whip like transfer of momentum through elbow

extension and through the small muscles of the forearm and hand transferring forces to the ball (Brukner and Khan, 2001).

The wheelchair basketball athlete is put at a mechanical disadvantage due to the fact that the role the legs and hips would normally play in the throwing action is removed thus placing extra strain on the shoulder girdle to complete the powerful baseball type pass with the 600-685g ball (Curtis, 1997).

There are four phases involved with the throwing action. They are

1 - preparation/wind up,

2 – cocking

3 – acceleration

4 – deceleration/follow through

1 - Wind up

During wind up the trunk rotates and the shoulder is at 90° to the target. The major forces would normally arise from the lower half of the body. In wheelchair basketball however, the athlete must rely on the trunk muscles if he has innervation to these or purely on the shoulder girdle if he has a higher lesion injury. Very often the athlete with the higher lesion will use the chest pass rather than the baseball pass to avoid setting himself off balance (Goosey-Tolfrey, 2000, Brukner and Khan, 2001 and Stefano et al, 2006).

2 – Cocking

Here the shoulder moves into abduction through full horizontal extension and then into maximal external rotation. When the scapula is maximally retracted, the acromion starts to elevate. With maximal external rotation, the shoulder is loaded, with the anterior capsule coiled tightly and thus storing elastic energy. The internal rotators are stretched. It is in this stage that the anterior inferior glenohumeral ligament and anterior inferior capsule are under greatest strain and the forces through these structures are at their highest. The repetitive nature of this action in the game of wheelchair basketball contributes to the development of subtle instabilities through the cuff and capsule (Goosey-Tolfrey, 2000, Brukner and Khan, 2001 and Stefano et al, 2006).

The trunk and pelvis will continue to rotate clockwise to complete the cocking phase and place the arm in an externally rotated position behind the body. This rotation of the trunk contributes to arm abduction. The force couple between the upper trapezius and serratus initiates acromial elevation and the lower trapezius maintains elevation at abduction angles greater than 65°.The wind up and cocking phase constitute 80% of the throwing action (Brukner and Khan, 2001, Burkhart et al, 2003 and Stefano et al, 2006).

3 – Acceleration

This is the most explosive phase of the throwing action. It involves the sudden release of the stored elastic forces created during the wind up and cocking phase as well as the action of internal rotation from the internal rotators (subscapularis, pectoralis major, latissimus dorsi and teres major). The rotator cuff muscles remain highly active during this time to maintain the stability of the humeral head in the glenoid (Burkhart et al, 2003 and Brukner and Khan, 2001).

This is the shortest phase of the throwing action accounting for 2% of the time. It is during acceleration and late cocking phase that muscle fatigue can lead to poorly co-ordinated cuff action resulting in stretching of the static anterior constraints which can lead to shoulder instability. This phase also includes the release of the ball. The movements involved also place massive amounts of valgus strain on the elbow, which lags behind the internally rotating shoulder (Burkhart et al, 2003, Malloy and Robertson, 2007, Brukner and Kahn, 2001, Hackey, 1996, Allen and Warner, 1995).

4 – Deceleration/follow through

The momentum stored and then released through the past 3 phases is carried mostly though the ball. However, part of these powerful forces will also act on the glenohumeral joint pulling it forwards and thus placing large stresses on the posterior shoulder structures. It is during this time that intrinsic and extrinsic shoulder muscles fire to slow the arm down. The force acting at the humerus to pull it out of the socket can develop in excess of 500N (135kg). It is here that the rotator cuff external rotators must act eccentrically to decelerate the explosive internal rotator action of the acceleration phase. Here to, the scapular stabilizers and posterior deltoid fibres must work eccentrically to maintain the position of the humeral head in the glenoid. Normally at this time the trunk would rotate forward to help dissipate the kinetic energy in the acceleration phase. This would decrease the burden on serratus anterior and the stabilizers of the shoulder.

(Burkhart et al, 2003, Malloy and Robertson, 2007, Brukner and Kahn, 2001, Hackey, 1996, Allen and Warner, 1995) In the wheelchair athlete who does not have trunk control this part of the deceleration phase would be limited thus placing greater stress on the posterior cuff and available musculature (Goosey-Tolfrey, 2000, Stefano et al, 2006 and Burnham et al, 1993).

The aetiology of shoulder injuries in wheelchair athletes is reviewed by Groah and Lanig (2000) as well as Lee and McMahon (2002). In the review article by Lee and McMahon (2002) regarding shoulder biomechanics and the implications in spinal cord injury, the contribution the changes in shoulder muscle biomechanics have on the development of shoulder pain are brought to the fore. Groah and Lanig (2000) reviewed the literature regarding neuromusculoskeletal syndromes in wheelchair athletes. Both articles highlight the influence biomechanics of wheelchair use have on shoulder pain in the wheelchair user with Groah and Lanig (2002) focusing specifically on the athlete. The research generally concluded that the changes in shoulder musculature after spinal cord injury alter the biomechanics of the glenohumeral joint, which can lead to disorders in the glenohumeral complex. The ratios of the muscles responsible for adduction and abduction and internal and external rotation will shift toward dominance of adduction and internal rotation. This is due to the position (thoracic kyphosis with protracted shoulders) the body is forced into during propulsion and sitting posture in the wheelchair. Studies reported that normal scapulothoracic rhythm is altered in spinal cord injury patients resulting in increased scapulothoracic protraction (Groah and Lanig, 2000 and Lee and McMahon, 2002). This results in the glenoid and attached capsuloligamentous structures angling forward leading to the static stabilisers (mainly the anterior band of the inferior glenohumeral ligament - IGHL) being put under unusual tension. The consequent anterior translation due to the stretched IGHL, of the humeral head contributes to the instability of the joint – a common finding in shoulder impingement syndrome (Lee and McMahon, 2002 and Allen and Warner, 1995). Lee and McMahon (2002) go on to discuss the dynamic constraints and the importance thereof in very little detail, other than the general effect over-active pectoralis muscles have on the ease of anterior dislocation and Bankart type lesions studied in vivo. Again reference to the prevalence of shoulder impingement as defined by Neer (1983) is commented on as a common problem in spinal cord injury patients, with very often early progression to cuff tears being evident. The indication here is that impingement syndrome is very

often secondary to instability. Treatment should thus be aimed at correcting underlying causes including anterior glenohumeral joint instability and dynamic muscle fatigue. Focus on the rotator cuff musculature and scapular muscles is suggested as well as posterior capsular stretching.

Both review articles were in agreement with each other regarding the impact biomechanics has on shoulder pain in wheelchair users. Both sets of authors included clinically relevant recent studies in their reviews. The standard of the articles were however quite different. Lee and McMahon (2002) did not clearly outline the criteria used to located sound research articles nor did they comment on the standard of the research in terms of methodology and limitations. Groah and Lanig (2000) on the other hand did comment on the limitations of the available literature. They commented on the fact that most researchers used retrospective type questionnaire studies lending the results to recall bias and very often over reporting of injuries. Both articles did not have criteria for selection of trials and articles. This highlights a problem in the literature suggesting there is a lack of sound systematic reviews regarding the research pertaining to wheelchair athletes. No other related review articles could be found indicating a gap in the research.

There is much research conducted around shoulder pathology and its links to wheelchair propulsion (Mercer et al, 2006, Veeger et al, 2002, Kulig et al 2001, Vanlandwijck et al, 2001, McNitt-Gray et al, 1998 and Nyland et al, 1997). It has been found that with faster propulsion a greater demand is placed on the shoulder and wrist than the elbow, but with slowed propulsion the forces were greater at the elbow (Veeger et al, 2002, Vanlandewijck et al, 2001, Kulig et al, 2001, McNitt-Gray et al, 1998 and Nyland et al, 1997). The wheelchair-user - interface is also an important aspect to consider in the development of shoulder repetitive strain injuries. The surface on which the sport is played needs to be a hard wooden court to minimise friction and resistance to propulsive forces (Vanlandewijck et al, 2001). During propulsion there are increased forces placed through the shoulder, elbow and wrist. This contributes to the occurrence of overuse type injuries at these joints (more especially the shoulder) due to the muscle imbalances that develop as a product of this increase in forces around the joint. The muscular imbalances around the shoulder include weak shoulder depressors (infraspinatus, teres minor, subscapularis, long head

of biceps), which, coupled with the increased weight bearing, can result in crowding of the subacromial space resulting in impingement syndrome. The action of propulsion will result in increased strengthening as well as shortening of the internal rotators of the shoulder (pectoralis major, teres major, latissimus dorsi, subscapularis) as well as the scapular protractor (serratus anterior), thus creating a muscular imbalance. Propulsion coupled with poor sitting posture (be it from bad habits or lack of trunk control due to neurological deficits) will result in changes in the alignment of the humeral head in the glenoid fossa leading eventually to degeneration in the joint (Mercer et al, 2006, Veeger et al, 2002, Kulig et al 2001, Vanlandwijck et al, 2001, McNitt-Gray et al, 1998 and Nyland et al, 1997).

Kulig et al (2001) and Veeger et al (2002) conducted experimental type studies on wheelchair users in a laboratory setting to investigate the load placed on the shoulder during wheelchair propulsion. Both studies concluded that the load placed through the subacromial structures was greatest during high speed propulsion making the shoulder vulnerable to impingement syndromes.

Veeger et al's (2002) study only comprised three subjects making the power of the finding quite low, with Kulig et al (2001) having 69 male participants. Both studies explained inclusion criteria and demographics of the participants making the data clinically relevant to certain population groups. Unfortunately neither study were on wheelchair basketball athletes specifically. No specific study done on wheelchair basketball athletes in this regard could be found. Both studies explained the instrumentation and procedure comprehensively but neither study reported on the validity and reliability of the instrumentation used, which is a concern. Neither study mentioned who was responsible for the data collection or processing. This is a concern as one would like to know whether the collection process was susceptible to bias. The data should all be collected and testing done by one person to avoid any discrepancies in the way in which data was collected or processes explained to the participants.

Despite the weaknesses highlighted here, it appears researchers are in agreement regarding the impact propulsion has on shoulder pain. Better research is however still needed to make credible conclusions.

It can be seen that a primary cause of shoulder pain in wheelchair athletes is shoulder muscular imbalance, which leads to, more often than not, impingement. Factors contributing to the development of shoulder impingement include overuse, inadequate warm – up, glenohumeral and scapulo- thoracic dyskinesia, lack of dynamic lumbo pelvic postural control, poor shoulder flexibility, repetitive overhead arm activity, high speed propulsion in the wheelchair athlete and fatigue (Malloy and Robertson, 2007, Ardic et al, 2006, Brukner and Khan, 2001, McNitt-Gray, 1998, Nyland et al, 1997, Hackey, 1996 and Burnham et al, 1993)

2.3.4 Exercise

Training programs after spinal cord injury are important for the wheelchair user in order to prevent cardiovascular disease and osteoporosis as well as to increase maximal upper-extremity muscle strength (Devillard et al 2007). Devillard et al (2007) compiled a review of the literature regarding effects of training programs for spinal cord injury patients. The inclusion criteria and sources were well outlined with publications selected mainly from the previous 10 years. They drew mostly on clinical trials. They did not indicate a scoring scale for the standard of these trials however exposing a weakness in the review. The search strategy was well outlined under methodology making the review of an adequate standard. The researchers (Devillard et al, 2007) discussed the effects of training programs in spinal cord injury with regards to respiratory function; central and metabolic adaptations; muscle, bone and biomechanical adaptations; functional independence and quality of life modifications. No specific reference was made to athletes in the article but the importance of exercise in the wheelchair bound individual was re enforced. A training program adapted to the individual and the level of the lesion is important to increase fitness as well as improve quality of life and psychological well-being.

Radiographic studies have shown that both active and inactive persons with paraplegia exhibit degenerative changes in the shoulder joint (Ardic et al, 2006 and Boninger et al, 2001). Boninger et al (2001) concluded however that the more inactive a person, the more likely the presence of degeneration in long-term wheelchair users. This study also commented on the influence of poor

conditioning, work activity, transfer technique and wheelchair propulsion technique stating that they may contribute to injury. No actual research was done into these influences how ever.

In the study by Fullerton et al (2003) comparing the prevalence of shoulder pain in wheelchair athletes vs. nonathletic wheelchair users, it was found that the athletes were less likely to have shoulder pain than the nonathletic counterparts. In this survey questionnaire study of 257 subjects it was found that nonathletic wheelchair users were twice as likely to experience shoulder pain compared to the athletic population (Fullerton et al, 2003). In many other studies however, wheelchair athletes are repeatedly reported as having shoulder injuries from the repetitive strain type activity of their sport (Ferarra and Peterson, 2000, Dec et al 2000, Groah and Lanig, 2000 and Curtis, 1997,). The forces generated around the shoulder during high speed propulsion (a skill employed for most wheelchair sport) has been found to increase the incidence of shoulder injury in wheelchair users (Mercer et al, 2006, Veeger et al, 2002, Kulig et al, 2001 Vanlandwijck, 2001 and McNitt-Gray, 1998) This indicates, but does not conclude that athletes would be more susceptible to shoulder pain due to at least the high speed nature of the sport. Fullerton et al (2003) seem to have been the only researchers to compare the athlete to the non athlete however. The other studies investigated the athlete or the general wheelchair user only, which would account for their assumption that wheelchair sports are a high risk activity for shoulder injury. It seems that both groups are susceptible to shoulder injury but that the athletic wheelchair user will start having shoulder pain later in life than the non athletic wheelchair user. As to whether playing basketball specifically would change this conclusion has yet to be established. One would need to compare the wheelchair basketball player specifically with the non athletic wheelchair user.

The results from this study by Fullerton et al (2003) highlighted that non-athletes developed shoulder problems 4 years earlier than the athletic population ($p = 0.01$). However the study did not mention the type of sport played by the athletes. Besides the majority of the athletes being basketball players, the other sports involved here were tennis, rugby, racing, skiing, and hand cycling as well as other sports not named. This is a gap in the study as the type of sport one plays would influence the presence of shoulder pain in terms of the biomechanical stressors

placed on the shoulder being vastly different in say, rugby and hand cycling versus basketball. The throwing or “overhead” athlete is at greater risk of developing shoulder pathology than those athletes of the non-throwing population (Hackey, 1996).

Nawoczenski et al (2006) investigated the effects a specific shoulder exercise regime had on shoulder pain and it was found to be very effective over an eight week trial period. They did not however use athletes to test the regime on. They (Nawoczenski et al, 2006) proved that exercise is helpful in preventing or helping in shoulder pain in the wheelchair user. The exercise does however need to be specific to help prevent or combat shoulder pain according to Nawoczenski et al (2006) who compared their study to that of Curtis et al’s (1999) non significant results. The reasons for the difference in results could be attributed the fact that Curtis et al (1999) used an exercise protocol to specifically target muscles believed to be contributory to abnormal scapular movement patterns identified in able bodied subjects. Nawoczenski et al (2006) designed an exercise regime specific to correct muscular imbalance in wheelchair users. The study by Curtis et al (1999) was flawed in terms of the fact that they did not indicate compliance to the program or follow up during the trial. Nawoczenski et al (2006) had their subjects fill out daily adherence logs and were called weekly to review and clarify any questions about the techniques. Subjects were also progressed as needed after the four week mark to higher resistances. The study by Nawoczenski et al (2006) was a clinical trial proving specific shoulder exercise is helpful wheelchair users with symptomatic shoulder pain. They had clear inclusion and exclusion criteria for an asymptomatic control group and an intervention group. The outcome measures were valid and reliable questionnaire type tools thus no chance of assessor bias. Follow up processes as well as criteria for non compliance and loss of subjects as a result of non-compliance were all clearly noted.

Literature surrounding exercise for shoulder pain in the wheelchair basketball athlete specifically seems to be limited. Groah and Lanig (2000) conducted a literature review on neuromusculoskeletal syndromes in wheelchair athletes generally from which trends can however be drawn. This review by Groah and Lanig (2000) reviewed literature on the incidence, prevalence, evaluation and rehabilitative management of clinical syndromes in this population

group. It was a well compiled review clearly outlining sources where articles were found, the limitations of the available literature as well as selection criteria. The review (Groah and Lanig, 2000) further confirmed that wheelchair users are at risk of impingement secondary to activities of daily living (ADL). This is also further exacerbated in the wheelchair athlete (Groah and Lanig, 2000). Most wheelchair sport has a focus on high speed propulsion and some with acceleration, deceleration and change of direction. Wheelchair athletes tend to focus on strengthening the deltoids, biceps and triceps in the hope of improving propulsion strength (Lanig and Groah, 2000). This is however counter productive with regards to shoulder joint preservation. Instead, a program of adductor strengthening below shoulder level as well as rotator cuff strengthening would be more beneficial to counterbalance the upward pull of the humeral head by the deltoid.

Posture training is also very important in the prevention of shoulder pain in the wheelchair athlete. Wheelchair users often sit with a kyphotic head-forward posture. Exercise aimed at improving postural muscle strength is thus very important. Exercise should aim at increasing scapular retraction and preventing protraction by strengthening serratus anterior, latissimus dorsi; and middle and lower trapezii thus serving to prevent and rehabilitate shoulder impingement in the wheelchair athlete (Nyland et al, 2007, Ferrara et al, 2000, Groah and Lanig, 2000, Curtis, 1997 and Nyland et al, 1997).

Thus, when considering shoulder pain prevalence and contributing factors in the arena of wheelchair basketball, one can see there are many avenues to explore. Exercise has been proven beneficial for wheelchair users on the whole, but we have found that this exercise needs to be specific to prevent shoulder problems from developing (Nawoczenski et al, 2006). This concept should very likely be applied to wheelchair basketball players as well to prevent and treat shoulder imbalances and injury.

Investigating the lifestyle and support structure of these athletes could be one of those avenues needing such insight. How much time is spent training on the basketball court as well as in the gym could very well impact the development of shoulder pain. The support structure in terms of help with daily activities could also impact the wheelchair users shoulder. It is important to find out how this group of athletes spend their time regarding of training and recreation in terms of the

impact this has on the prevalence of shoulder pain in this population. Herein lies a gap in local research that needs filling.

2.3.5 Training habits (length and duration)

There does not seem to be a vast amount of current research in the area of optimal training habits in wheelchair basketball athletes. The research found in this area seems to be outdated and not of a very high standard. It has however been proven that shoulder pain in spinal cord injury individuals responds favourably to specific shoulder exercise regimes (Nawoczenski et al, 2006).

Curtis and Black (1999), Curtis and Dillon (1985) and Burnham et al (1994) reported findings regarding training and injury patterns in wheelchair basketball players specifically. Curtis and Black (1999) found that the hours of exposure to basketball games/training as well as to other sports had no impact on the prevalence of shoulder pain in their population group. This was not in keeping with previous studies mentioned in their research by Curtis and Dillon (1985) and Gellman et al (1988), and was put down to the fact that the average age of the respondents here was younger than those in previous studies. Curtis and Dillon (1985) reported that there is an optimum amount of exercise beyond which injury is more likely to occur and below which an individual may not reap physiological benefit.

Burnham et al (1994) studied training and injury patterns in wheelchair basketball players from nine tournaments throughout Canada in 1990. They found that injuries (unspecified) were associated with more training hours per week. They recommended that training more than three times per week was not advisable. They also found that those athletes involved in other sports during the basketball season were nine times more likely to report injury.

The study by Burnham et al (1994) gained 116 voluntary participants from the circulated questionnaires. There was no mention as to whether the questionnaire was valid or reliable indicating the standard of the data collection tool being poor. No attempt to improve the respondent rate was made and they could only estimate the actual rate gained at 65%. The

results of this study are outdated and the standard poor. The implication here is that better more recent research in this area of study is needed.

The hours spent training and exposure to the sport specifically has not been researched in the South African wheelchair basketball athlete. This is an area worth researching in order to gain insight into optimal training methods. this could result in less injury and better performance in competition.

2.3.6 Activities of daily living

Shoulder pain or upper limb deterioration has a significantly detrimental effect on the independence of the wheelchair bound individual (Nyland et al, 2007, van der Woude et al, 2006, Samuelsson et al, 2004, Lee and McMahon, 2002, Curtis and Black, 1999 and Curtis, 1997)
Much of the research surrounding the impact ADL's have on shoulder pain in the wheelchair user is on the wheelchair bound individual rather than the wheelchair basketball player as such. It is a widely researched and accepted fact that wheelchair users experience shoulder pain very often during transfers and with propulsion in daily living. This incidence is less in the athletic wheelchair user however (Fullerton et al, 2003).

Common activities required for wheelchair bound individuals put them at risk for developing shoulder pain. The highest intra articular forces are generated mid point through the lateral transfer (Groah and Lanig, 2000) thus transfers being the most reported pain provoking activity in wheelchair users. The action of propulsion is of course an integral part of ADL in the wheelchair user and, as has been discussed, a predisposing factor in the development of shoulder problems.

Curtis and Black (1999) found that in female wheelchair basketball athletes, activities of daily living (ADL's) that had an impact on the prevalence of shoulder pain were hours spent driving per week and the number of wheelchair transfers per day. The link to the hours spent driving was put down to the likely posture during the activity of shoulder protraction with arm elevation. Hours spent at work had a weak insignificant association with shoulder pain. Further questioning as to

the type of work activity would have been beneficial here however. The posture in front of computer for example could, as in driving, influence the prevalence of shoulder pain. Sameulsson et al (2004) found that most participants in their study reported more shoulder pain with loading their wheelchair and propulsion up ramps/inclines. They however reported that they could not find any significant associations between shoulder pain and any particular ADL. This is not in keeping with the results of Curtis and Black (1999). They put this down to the idea that most spinal cord injured paraplegics have to do their personal self care activities regardless of shoulder pain.

The variation in results here could be due to the fact that Sameulsson et al (2004) only had data from 13 participants with shoulder pain making their sample size very small. This could impact the power of the findings. Curtis and Black (1999) had a much larger group at 42 participants. The study by Sameulsson et al (2004) like that of Curtis and Black (1999) relied on self reporting survey to start with but then followed up the individuals with reported shoulder pain with an examination and interview. This would make the latter study more reliable than that by Curtis and Black (1999) who relied purely on self reporting. Both studies did use valid and reliable data collection tools, which is good but reported on a follow up process regarding those participants who did not reply to the survey nor did they comment on possible reasons for response rates being so low. Samuelsson et al (2004) had a 62% response rate and Curtis and Black (1999) reported a 48% response rate. Thus both studies had weaknesses. The problem of all round sound research is again highlighted here. The problem of very few studies regarding the wheelchair basketball athlete specifically is again a problem worth highlighting.

Nyland et al (2007) discussed the preservation of upper extremities following spinal cord injury. On the topic of strains of daily life in the wheelchair bound individual comment was made regarding the relationship of fitness level and functional capability. The fitter and better trained/ rehabilitated the individual in terms of muscular strength and peak oxygen intake as well as wheelchair use, the more functionally capable. It was also found that those participants that were employed had a lower body mass index and greater aerobic power than the unemployed participants. The employed participants also had greater upper extremity isokinetic endurance. These results could imply that employed and physically active spinal cord injury participants

should better preserve their upper extremities than those leading an inactive lifestyle. Further research (Nyland et al 2007) however was commented on in terms of the development of upper extremity stresses. During episodes of high physical strain participants with spinal cord injury are more likely to adopt postures that increase the mechanical stresses at the shoulder joint. Thus during a long day at work or difficult transfers or at the end of a hard basketball game one could expect a wheelchair bound individual to adopt a posture that compromises the shoulder joint complex thus making them prone to shoulder joint pathology.

Van der Woude et al (2006) published a basic literature review in the Science Direct data base that was largely in keeping with that reviewed in the literature by Nyland et al (2007). Van der Woude et al (2006), like Nyland et al (2007), commented on the importance of avoiding a sedentary lifestyle in the wheelchair bound individual. According to Van der Woude et al (2006) a poorly rehabilitated and trained wheelchair user is at greater risk of developing shoulder injury than those who work to maintain upper extremity strength and good kinetic handling including posture and propulsion technique.

Unfortunately, like the review by Nyland et al (2007), Van der Woude et al (2006) did not discuss the methodology associated with gathering or standards for selection of studies used in their review. Trials were not critiqued or questioned in terms of the methodology used or the standard of current research. The articles used in both reviews were pertinent to the population being studied and the information clinically relevant and useful, which is good. This does however once again highlight the importance of more well conducted systematic reviews in this area of research.

The activities of daily living impact the prevalence of shoulder pain in the wheelchair user. It can be concluded that it is not advisable to lead a sedentary life but nor is an over active one helpful in the preservation of the shoulder. Maintaining a strong, lean, supple body is important for the wheelchair user in prevention of injury during daily activity due to the stress the ADL's place on the wheelchair bound individual (Nyland et al, 2007 and Van der Woude et al, 2006 and Fullerton et al, 2003)

2.4 Review of the Methodology

Thus far it can be seen that the majority of the research discussed in this review employed the use of a questionnaire as a tool to collect data either as an adjunct to or as the primary tool.
Groah and Lanig (2000) reported in their review article that the use of retrospective design questionnaires tended to be the most used research tool in studies pertaining to wheelchair sports related injuries. It can be seen by the review of the literature above that this is indeed a common tool used to investigate this population. Groah and Lanig (2000) went on to say however, that the main problem in the use of such tools tends to be that of recall bias, which can lead to over reporting of injuries. Survey questionnaires can also be difficult to interpret as they differ in definition of injury and type of injury as well as the time frame during which athletes must recall an injury (Groah and Lanig, 2000). Such concerns contribute to inconsistencies in the current literature.

With this in mind, a study should aim to create a tool that addresses these issues so as not to contribute to such inconsistencies. A questionnaire seems to be the most used method to collect information regarding prevalence of shoulder pain in wheelchair basketball players. To achieve this, special attention needs to be paid to the validity and reliability of the questionnaire. This seems to be a weak area in many of the documented studies.

In an article by Justham (2008) the author highlights the importance of developing an effective data collection tool. The researcher (Justham, 2008) notes that piloting the tool to determine the reliability and validity thereof is important. This refers to the consistency of the tool as well as the degree to which the tool measures that which it has been designed to measure. Lawshe (1975) describes the method for determining content validity. The author (Lawshe, 1975) suggests a method that gauges agreement among raters or judges that are experts in the field to be researched. This agreement (Content validity ratio) notes how essential, useful or unnecessary each item in the survey tool is. Face validity is determined by a group of people who are not necessarily experts in the field but are like the participants who are likely to take the survey. This

group of people will comment on whether the test looks like it measures what it is indended to measure (Runtusanatham, 1998 and Lawshe, 1975).

With regard to administering a survey, according to Chau (1998), researcher administered questionnaires are more affective at gaining a higher respondent rate and areconsidered more effective than mail survey/self administration.

2.5 Conclusion

Thus one can see there is an extensive amount of research pertaining to the wheelchair user and in some cases the athlete.

The literature review has established that specific exercise for shoulder pain in chronic spinal injury patients is helpful (Nawoczenski et al, 2006). Research has also shown that the more active in a sport a wheelchair bound individual the later the onset of shoulder pathology (Fullerton et al, 2003). Research has found that lesion level contributes to the formation of shoulder pain in the wheelchair bound individual (Sinnot et al, 2000). With regards to the wheelchair bound vs ambulatory wheelchair basketball athlete, little insight is had regarding shoulder pain. Conflicting results have been found in the research regarding whether the wheelchair bound individual is more prone to shoulder pain than the otherwise ambulatory one indicating further insight is required. Establishing other contributing factors in terms of the impact a training and game playing schedule has on the prevalence of shoulder pain is yet to be established. Other contributing factors including activities of daily living have been shown to impact the prevalence of shoulder pain (Devillard, 2007, van der Woude, 2006, Sameulsson et al, 2004 and Curtis and Black, 1999), but are yet to be investigated in South Africa's wheelchair basketball population. Thus the gaps in research remain to be filled in South African athletes indicating a need for such further research to be conducted.

Basketball tends to be the one of the most commonly played sports in the wheelchair bound population. The biomechanics of the shoulder joint in the wheelchair user is a well researched and documented predisposing factor to shoulder pain. Contributing factors include time spent in a

wheelchair, age, activity level and posture as well as lesion level. Many of the results found in such studies however tend not to correlate with other similar research.

This research seems to be published to a greater extent outside of South Africa in the US and the Netherlands in particular, indicating very little attention being paid to the local athletes. No research has been found conducted on South African wheelchair basketball athletes regarding the prevalence of shoulder pain. The South African wheelchair basketball team has recently performed well in the international arena. The sport is also gaining support financially in terms of sponsorship monies. It is thus important to gain an understanding of the obstacles and possible areas of concern in which South Africa's athletes need support, in order to continue to participate safely and without undue injury.

CHAPTER 3

3.0 METHODOLOGY

3.1 Study Design

Cross sectional descriptive study. This was the method deemed best to use in a study of prevalence (Chau, 1999). The study was to be that of a survey of data collected at a point in time in a specific population. By employing this method of research, data can be described in terms of averages and trends as well as correlation of data to highlight associations found.

3.2 The study population

Gauteng has 3 teams of professional male wheelchair basketball athletes competing in the provincial Supersport Challenge. Each team consists of 12 athletes, which gives a total of 36 participants.

3.2.1 Sample size

All 36 athletes involved in professional wheelchair basketball in Gauteng were invited to participate.

3.3 Data collection tool

A questionnaire was formulated and piloted by the researcher. The questions used in the tool were drawn partly from those used by Curtis and Black (1999) in a study done on female wheelchair basketball players. Curtis and Black (1999) used the wheelchair user's shoulder pain index (Appendix V), a medical history questionnaire (Appendix VI) and an activity level question series (Appendix VII). The questionnaire (Appendix I) drew from the three aforementioned resources, but included more information on the social support structure for each player in terms

of help at home to perform daily activities, as well as more in depth information on how they spent their time socially and with regards to basketball training and games. Information regarding the basketball activity that caused shoulder pain to worsen was also included.

The questionnaire (appendix I) comprised the following sections:

- Demographics
- Support structure
- Activity level
- Medical History
- Activities that bring about shoulder pain
- Methods used to relieve shoulder pain

3.3.1 Pilot study

3.3.1.1 Aim

To create a valid and reliable questionnaire to use in the main study on shoulder pain prevalence in professional male wheelchair basketball players in Gauteng, South Africa.

3.3.1.2 Objectives of the pilot study were to

- Determine content validity of the questionnaire
- Determine test retest reliability in terms of repeatability of the questionnaire
- Determine whether the participants would agree that the questions were in their non expert opinion clear and unambiguous as well as applicable (face validity)
- Determine how long the questionnaire would take to complete

3.3.1.3 Methodology of the pilot study

Subjects

Five experts with experience in sports physiotherapy, research and statistics were asked to help determine content validity. The first expert was practicing in the area of sports physiotherapy and had completed a Masters degree in Sports Physiotherapy. The second expert was a physiotherapy lecturer and had also completed a Masters Degree in Sports Physiotherapy. The third expert was a Biomedical Statistician. The fourth and fifth experts were physiotherapy lecturers and had both completed a PhD in the area of physiotherapy with one still practicing as a physiotherapist to elite teams of athletes.

All 12 team members of the professional wheelchair basketball team from Kwa Zulu Natal were asked to help determine test re- test reliability, time taken to complete the questionnaire as well as face validity of the questionnaire.

Ethical considerations

The Human Research Ethics Committee of the University of The Witwatersrand approved the pilot study as part of the main study. The coach of the Wings team gave verbal consent to allow the players to complete the questionnaire. Each player was verbally informed of the reasons for completing the pilot questionnaire and asked to help the researcher determine the reliability and face validity of the tool. No one was forced or coerced into completing the questionnaire. Tacit consent was assumed by their completing the questionnaire.

Procedure

Content validity

Content validity was to be determined prior to face validity and reliability. The panel of five experts were each emailed and asked to comment on the content of the questionnaire as well as suggest any changes they deemed necessary or helpful in determining the objectives of the study. They were each contacted telephonically prior to receiving the email to request their participation and introduce the researcher to them. The email sent consisted of a covering letter requesting their participation in the validity process as well as the research proposal and questionnaire to be validated. They were given two weeks to complete this process. They were followed up on email after two weeks and those who did not respond thereafter were phoned four days following the email. The suggestions made by each expert were considered and used to adjust the questionnaire accordingly.

Reliability, face validity and time taken to complete questionnaire

The Kwa-Zulu Natal wheelchair basketball team completed the questionnaire that had been passed by the panel of experts and changed according to their recommendations. They completed it on two separate occasions, two weeks apart following their scheduled practice sessions in Durban. The researcher was present at both occasions to explain the procedure and to answer any questions or address problems with regards to completing the questionnaire. The objectives of the study were outlined for the participants by the researcher prior to them completing the questionnaire. The players were asked to make a note at any question they found difficult to understand on the questionnaire. They were also specifically asked whether, in their opinion, the questionnaire accomplished the objectives of the study. In this way the face validity was determined. The time taken to complete the questionnaire was noted on both occasions in order to determine the time it would take to complete the questionnaire in the main study.

Data analysis

The panel of experts emailed their comments and suggestions from the validity process back to the researcher. All comments were taken into account by the researcher.

Answers from both survey sessions conducted with the Kwa-Zulu Natal wheelchair basketball team were correlated by a biomedical statistician to determine the test retest reliability. This result is expressed as the scale of reliability coefficient**.**

3.3.1.4 Results of the pilot study

Content validity

Of the five experts approached to establish content validity three completed the task. The biomedical statistician, the Masters qualified physiotherapist working in the field of sports and the masters qualified physiotherapist working as a lecturer. The two who did not complete the task cited work commitments as the reason when phoned at the two week follow up time.

It was suggested by all three of the experts to add more detailed questioning regarding the demographics/support structure. One expert suggested the source and intensity of pain (visual analogue scale) experienced should be included. It was suggested by one expert to add details on when pain was experienced during play i.e. with dribbling, shooting, passing or propelling the chair.

The detail regarding pain provoking activities during play was added to the questionnaire prior to giving it to the Kwa Zulu Natal basketball team to answer. It was decided not to add the visual analogue scale to the questionnaire as the study did not aim to determine intensity but rather the presence of pain in the shoulder area. The question as to the source of the pain as well as the intensity did not serve to meet any of the proposed objectives. Questions regarding support and aid in the home were added in order to determine whether help with activities of daily living was a predisposing factor in the prevalence of shoulder pain. This was also added prior to the reliability and face validity part of the pilot study being completed.

Test retest reliability and face validity

Of the 12 team members of the Kwa Zulu Natal wheelchair basketball team nine were available at both sessions to complete the questionnaire. Twelve completed it the first time and nine the second time. Two of the three that were unavailable were away on holiday at the second training session and one was in hospital and thus not at the training session. As a result, twelve participants were involved in the face validity process and nine in the test retest reliability process.

Test – retest reliability

Nine questionnaires were correlated using Spearmen's correlation in order to determine how often participants gave the same answers to the questions posed on the separate occasions. The results regarding repeatability showed a high level of reliability. The scale reliability coefficient was measured at 0.88. The implication of this was that the majority of the questions used were reliable for use in the main study in terms of the fact participants were likely to answer the same on any given day.

Questions that performed poorly regarding repeatability were revisited and a review of answers was made. Minor adjustments to the questionnaire were done. Problems were experienced in the area of hours spent completing an activity. The time limits indicating hours spent doing an activity were adjusted and made to represent a smaller time frame to help players identify time spent more accurately.

Face validity

The participants reported no problems regarding the understanding of questions and had no suggestions regarding the questionnaire. They felt it achieved the objectives of the study in their opinion. In this way face validity was achieved. No adjustments were made to the questionnaire following the face validity process.

Time taken

The average time taken to complete the questionnaire was approximately six - eight minutes.

3.4. Main study

Permission to conduct the study was obtained from the chairman of Wheelchair Basketball South Africa (WBSA) (Appendix III and IV).

Following this consent, the contact details of the coaches of the Gauteng based wheelchair basketball teams were obtained from The South African wheelchair basketball (WBSA) headquarters. The coaches were then asked telephonically for permission for their players to take part in the study as well as to arrange times convenient for all parties concerned to complete the questionnaires. It was determined that practice sessions were the best, most convenient time for all participants. The researcher attended the practice sessions of each of the teams to complete the process.

Each player who consented to taking part was required to fill out the questionnaire outlined under instrumentation (appendix I).

The questionnaire was administered during practice sessions. The time taken to complete the questionnaire was determined by the pilot study outlined above at six to eight minutes; however it took approximately eight to ten minutes in the main study to complete. This was more than likely due to the addition of the informed consent form as well as the minor alterations made to the questionnaire following the content validity process.

The researcher was present during the completion of the questionnaire to answer questions or queries from the participants.

3.4.1 Ethical considerations

The Human Research Ethics Committee of the University of the Witwatersrand approved the study (Appendix VIII). The chairman of Wheelchair basketball South Africa was contacted in order to gain permission for the Gauteng coaches and players to take part in the study (Appendix III and IV). All participants were required to sign a consent form prior to participating in the study. (appendix II). Data from the study will be available to the clubs but only as a group and no club

names or individual results will be made available to the selectors and/or coaches at WBSA in order to protect the study subjects from any bias in team selection in the future.

3.4.2 Data analysis

Demographic data, activity levels and medical history data was analysed using descriptive statistics. Results were expressed in the form of tables and graphs with frequencies, percentages and averages calculated to further describe findings. These results can be found in the results section in chapter 4.

Analyses using the Kruskall Wallis test was employed to determine the associations between shoulder pain and various factors identified in the questionnaire. The results of these tests can be found in the results section (chapter 4) of this report. This serves to highlight trends and describe the degree of association of variables identified in the raw data. The Kruskal-Wallis Test statistics show the chi-square value, the degree of freedom and the associated significance value. By using this significance value one could determine whether shoulder pain prevalence was associated with specific predisposing factors thus meeting the objectives of the study. The Kruskall Wallis Test is useful in comparing three or more groups of data thus meeting the criteria for this study.

3.5 Conclusion

Here ends the chapter on the methodology employed in this study on professional male wheelchair basketball players in Gauteng, South Africa. The following chapter shows the results of the survey highlighting findings of interest. This section is found in chapter 4.0 to follow.

CHAPTER 4

4.0 RESULTS

4.1 Introduction

Section 4.2 describes the demographic data for the participants in the survey. The sections following this describe the results of the questionnaire referring to the objectives of the study. Prevalence, the primary objective of the study, is reported on in section 4.3. Section 4.4 reports the findings regarding predisposing factors relating to the prevalence of shoulder pain. This aims to satisfy the second objective of the study. Section 4.5 reports the data regarding mobility devices and the associations regarding shoulder pain in the ambulatory vs. wheelchair dependant individual, thus focusing on the third objective of the study. Results are described in terms of significance ($p =/< 0.05$). In section 4.6 the findings regarding shoulder pain aggravating factors are reported on.

4.2 Demographic data

Out of 36, 29 participants consented to taking part in the survey based questionnaire study. The average age of the participants was 30.8 (±8.82) years old ranging from 18 to 52.

The survey was conducted at the preseason phase and as a result the teams were not all fully recruited or present for the upcoming season. One team had lost two of their members the previous season to retirement with the other two teams still needing to recruit one and two members respectively due to their players leaving to go play for teams in other parts of the country (not in Gauteng). Two of the regular team members who were due to start the season were still in Italy playing out the European season and were thus not available. All available consenting participants completed the questionnaire within two weeks of each other at practice sessions in Pretoria and Bruma (Johannesburg, Gauteng). The response rate was an acceptable 81%.

The demographics including disability type, occupation and support structure are presented in table 4.1 below.

Table 4.1 Demographics of participants (*n*= 29)

	N	*%*
Occupation		
Employed	19	65.5
Student	4	13.8
Pensioner	1	4.4
Unemployed	5	17.2
Disability group		
Spinal cord injury	13	44.8
Lower extremity musculoskeletal and neuromuscular disabilities	3	10.3
Polio	7	24.1
Spina bifida	1	3.4
Lower limb amputation (bilateral/unilateral; above/ below knee)	5	17.2
Support structure		
Lives alone	11	37.9
Does not live alone	18	62.1
Has help with activities of daily living	4	13.8

Forty – four percent of participants were disabled due to spinal cord injury thus accounting for majority of the group's disabilities. Sixty – five percent of the group were employed outside of basketball despite being paid to play the game. Most of the participants did not live alone (62.1%) with just 13.8% having help with their daily activities.

4.3 Shoulder pain

The primary objective of the study was to establish the prevalence of shoulder pain in male professional wheelchair basketball players. These results are illustrated in Table 4.2 below.

Table 4.2 Shoulder pain prevalence (n = 29)

Question	No. of Participants responding "yes" (n=29)	Percentage of participants responding "yes" (%)
Has experienced shoulder pain since using a wheelchair	21	72.4
Currently experiences shoulder pain (point prevalence)	11	37.9
Experienced shoulder pain prior to using a wheelchair	6	20.7

Seventy – two percent (21 of 29) of participants reported having experienced shoulder pain since using a wheelchair. The "point" prevalence was found to be 37% (11 of the 29) indicating those participants reporting shoulder pain at the time of the survey. Six (20.7%) participants reported having experienced shoulder pain prior to using a wheelchair be it in daily life and on the basketball court or just on the basketball court when they started playing wheelchair basketball. Some participants only used a wheelchair to play basketball in as they were not dependant on a wheelchair for mobility off the basketball court due to the varying nature of their disabilities. The results pertaining to this are presented later in this chapter.

The medical history pertaining to participants shoulder pain and injury experiences is illustrated in table 4.3 below. This table also illustrates the methods participant used to relieve or treat their symptoms.

Table 4.3 Medical history and treatment options (n = 29)

Question	Participants responding "yes" *n=29*	%
- Have you sought medical attention for the shoulder pain?	11	52.4
- Has the shoulder pain limited you from performing your normal daily activities during the past week?	5	23.8
- Have you ever had shoulder surgery?	1	3.5
- Have you ever been given a diagnosis for your shoulder pain?	8	27.6
- Have you used any of the following to relieve shoulder pain:		
Ice	11	37.9
Heat	6	20.7
Exercise	15	51.7
Medication	5	17.2
Rest	13	44.8
Physiotherapy	14	48.3

Shoulder pain interfered with completing daily activities of 24% (five of the 21) of participants. Eight (28%) participants of the 21 who reported having pain could recall a diagnosis. These included rotator cuff tendonitis and shoulder impingement with one subject having had shoulder surgery for a labral tear. Participants were asked how they eased their shoulder pain. The

participants were allowed to select more than one option in this section of the questionnaire. Of the 21 participants reporting shoulder pain, 72% used exercise to ease their pain. Sixty-seven percent had tried Physiotherapy; 62% used rest; 52% used ice; 24 % used medication and 21% used heat. Many of these modalities were used in conjunction with one another. The most common combination tended to be exercise and physiotherapy.

4.4 Predisposing Factors

The second objective of the study was to establish predisposing factors associated with shoulder pain prevalence in the selected population group. The results pertaining to this objective are reported below. They are found under the sub headings of age, years of wheelchair use, occupation, disability type, support structure, activity level and device used for mobility.

4.4.1 Age

The age groups were distributed into 3 categories, which resulted in an even distribution of participants. The categories were; below 25 years of age, 26 – 35 years of age and over 35 years of age as described in fig. 4.1 below.

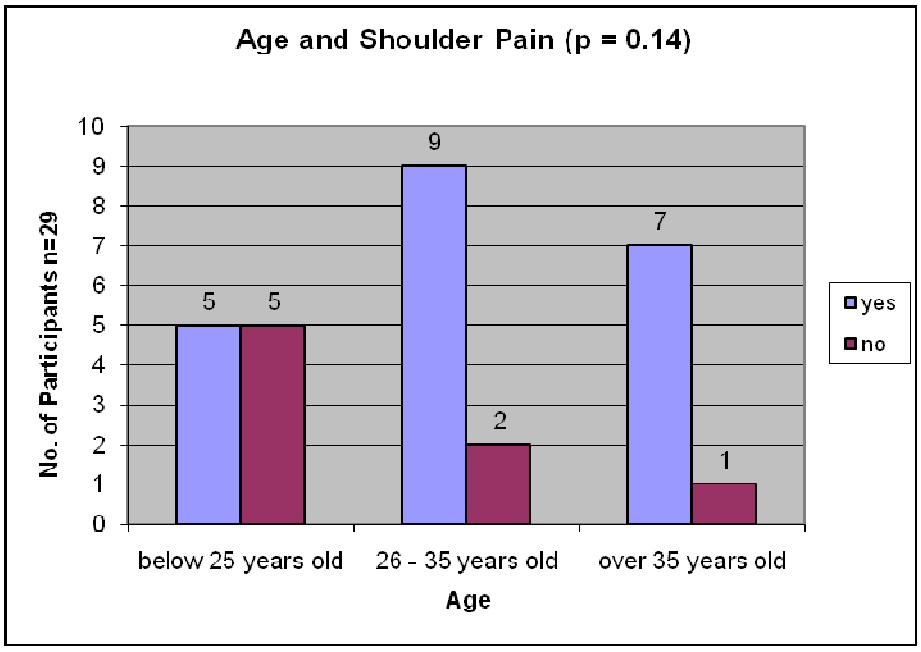

Fig. 4.1 Age and Shoulder Pain (n=29)

Participants were asked if they had ever experienced shoulder pain. The table indicates “yes” for those who had had shoulder pain and “no” for those who had never experienced the problem. In the age group under 25, 50% (five out of ten) of participants reported having experienced shoulder pain while the older group aged 26 – 35 reported nine out of eleven (82%) having had the problem. In the over 35 year old group 88% (seven out of eight) reported having experienced shoulder pain (p = 0.14). While the percentage of participants reporting having experienced pain tended to increase with age, this was not found to be a significant result and thus could not be statistically associated with shoulder pain prevalence.

4.4.2 Disability type

The participants’ disability type and whether they had experienced shoulder pain is illustrated in table 4.4 below. This shows the association of shoulder pain prevalence with disability type.

Table 4.4 Disability type and shoulder pain (n = 29)

Disability type	Has had Shoulder pain	Never experienced shoulder pain
Spinal cord injury	9 (69.2%)	4 (30.8%)
Lower extremity musculoskeletal and neuromuscular disabilities	3 (100%)	0
Polio	4 (57.1%)	3 (42.9%)
Spina bifida	1 (100%)	0
Lower limb Amputation	4 (80%)	1 (20%)

There was no association found between disability type and the prevalence of shoulder pain (p = 0.32). These results indicated that the type of disability the participant had did not predispose them to developing shoulder pain.

4.4.3 Occupation

Table 4.5 below illustrates a list of occupations and employment status of participants.

Table 4.5 – Occupations (n = 29)

Job Description	Number of people	Presumed Job Type
Accountant	2	Desk
Draughtsman	1	Desk
Engineer	1	Desk/site
Financial Administrator	1	Desk
HR Manager	3	Desk
Medical Rep	1	Driving/desk
Network Engineer	1	Desk
Office Manager	1	Desk
Nursery Owner	1	Active
Pensioner	1	Active
Psychometrist	1	Desk
SAPS Official	1	Desk/active
Self Employed	2	Active
Systems Manger	1	Desk
Sports Admin Officer	1	Desk/active
TV manger	1	Desk
Unemployed	9	Active
Total	29	

The occupation was not described in terms of activity involved and was thus difficult to associate with the presence of shoulder pain due to the vast number of different jobs listed. Shoulder pain prevalence was thus explored in terms of employed vs unemployed. Seventeen out of 20 (85%) of those employed participants experienced shoulder pain, while four out nine (44%) unemployed had experienced shoulder pain.

Shoulder pain was further investigated in terms of how much time participants spent at work per week. The results are illustrated in figure 4.2 below.

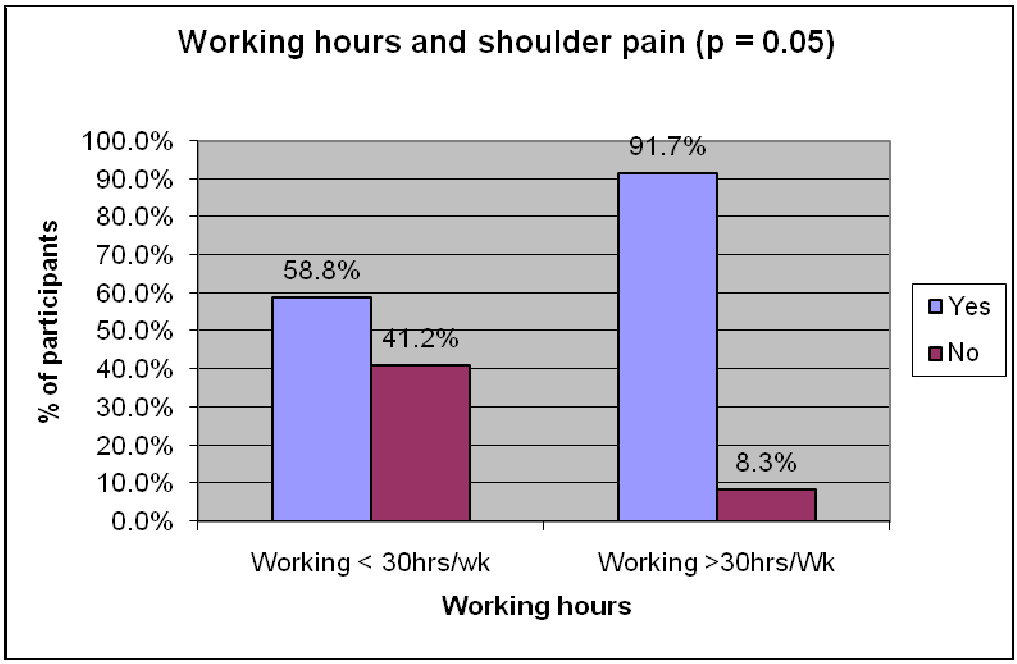

Fig. 4.2 Working hours and shoulder pain (n = 21)

A total of 17 participants of the 21 reporting shoulder pain worked less than 30 hours per week. Of those 21, ten (59%) had experienced shoulder pain. Of the 12 participants who worked more than 30 hours per week 12 (100%) had experienced shoulder pain (p = 0.05). The results indicated that shoulder pain is associated with time spent at work. Those participants spending more than 30 hours per week at work are more likely to experience shoulder pain than those working less than 30 hours per week.

Participants were also asked how much time they spent behind a computer as an indication of possibly how sedentary their job was. There were six participants who spent more than 30 hours at a computer per week with the next most frequently answered time being four to six hours (five participants). Four out five participants who used a computer between four to six hours per week reported having experienced shoulder pain while six out of six of those using a computer longer than 30 hours per week reported shoulder pain (p= 0.39). These results showed no association between shoulder pain and time spent working at a computer.

4.4.4 Support structure

The details of the distribution of the support structure for the participants are illustrated in table 4.6 below. The association of these details with shoulder pain prevalence are then illustrated in table 4.6.1 below this.

Table 4.6 – Support structure (n = 29)

	Yes	%	No	%
Lives alone	11	37.9	18	62.1
Has help with daily activities	4	13.8	25	86.2

Table 4.6.1 – Shoulder pain and support structure (n = 29)

	Lives alone	Does not live alone	Has help with daily activities	No help with daily activities
Shoulder pain	8 (72.7%)	13 (72.2%)	3 (75%)	17 (68%)
No shoulder pain	3 (27.3%)	5 (27.8)	1 (25%)	8 (32%)

Thirty – eight percent of participants lived alone with 14% (four of 29) of participants having help with their daily activities. Of those who lived alone (11), eight (72.7%) reported having experienced shoulder pain. Thirteen of the 18 (72.2%) participants living with someone else reported having had shoulder pain ($p = 0.98$). Shoulder pain was not associated with whether or not the participant lived alone. Four participants of the 29 had help with their daily activities. Of this group three reported experiencing shoulder pain (75%). These results were not compared with those participants who did not have daily help due to the small number of participants who did have help compared to those who did not. Of those who did not have help daily 17 (68%) had experienced shoulder pain. Living arrangements and help with daily activities was not associated with shoulder pain in this group of participants.

4.4.5 Activity level

4.4.5.1 Time spent playing wheelchair basketball games and at practice

Shoulder pain prevalence was investigated in terms of how much time participants spent playing basketball games. The results are illustrated in figure 4.3 below.

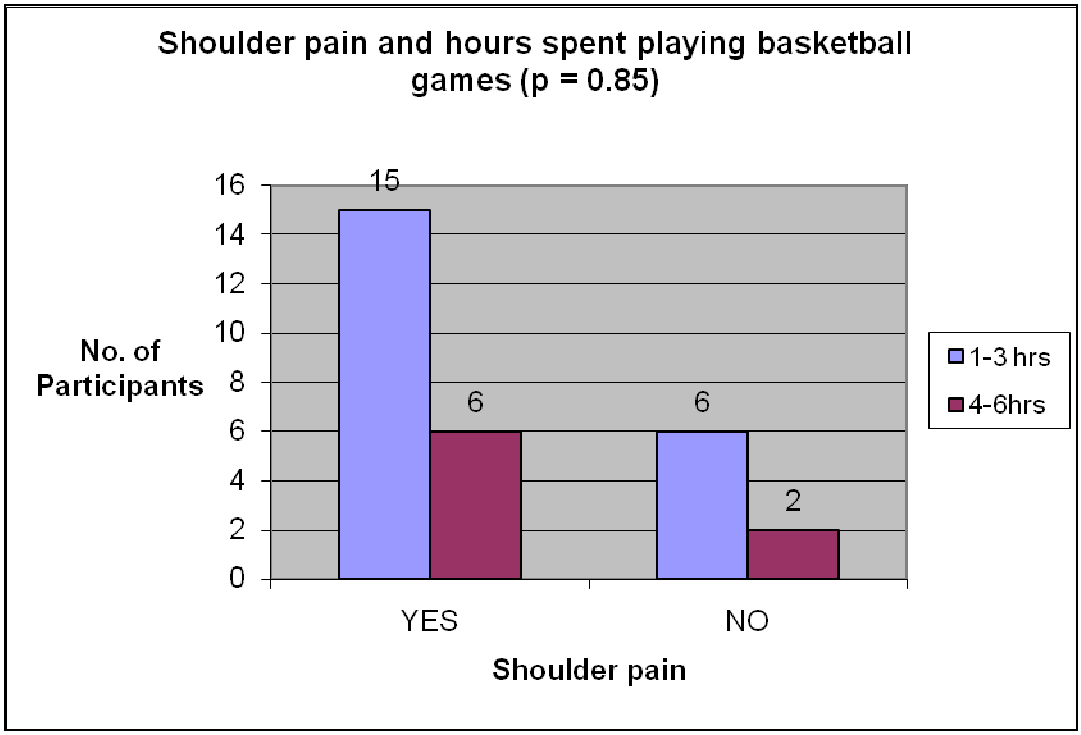

Fig. 4.3 Shoulder pain and hours spent playing wheelchair basketball (n = 21)

The most frequently answered time for number of hours spent playing wheelchair basketball games was one to three hours per week. Of the 21 that reported playing one to three hours of basketball games per week, 15 (72%) reported having experienced shoulder pain while of the eight that played four to six hours per week, six (75%) reported having experienced shoulder pain (p = 0.85). The number of hours spent playing wheelchair basketball games was not associated with shoulder pain prevalence.

Shoulder pain prevalence was investigated in terms of the time spent practicing wheelchair basketball. The results are illustrated in table 4.7 below.

Table 4.7 Shoulder pain and hours spent at wheelchair basketball practice (n = 21)

No of Hours	Has experienced Shoulder Pain	Has never experienced Shoulder pain
1-3	4	3
4-6	6	3
7-9	8	1
10-12	2	0
16-20	1	0
20-30	0	1

Most participants spent between one to nine hours practicing per week (25 out of 29 – 86%). One person reported playing 20 – 30 hours per week but also reported having never experienced shoulder pain. Of the nine who played seven to nine hours per week, eight (89%) reported having shoulder pain. Of the nine who played four to six hours per week, six (67%) reported having shoulder pain and of the seven who played one to three hours per week, four (57%) reported having shoulder pain. Thus while the prevalence of shoulder pain seemed to increase with the increased time spent practicing, this was not a significant finding ($p = 0.31$) indicating time spent practicing was not associated with shoulder pain.

4.4.5.2 Time spent training in the gym

Participants were asked how much time they spent training in the gym per week. Eleven of the 29 (38%) did not attend gym at all. Of this group nine (82%) reported having experienced shoulder pain. Seven (24%) of the 29 participants spent one to three hours in the gym per week. Of this number, five (71%) reported having experienced shoulder pain. Seven of the 29 spent four to six hours per week at the gym and of this group five (71%) also reported having experienced shoulder pain. One person spent seven to nine hours in the gym per week and they reported

never having experienced shoulder pain while of the two who spent 10-12hours per week in the gym one (50%) reported having pain with the one person in the gym 13-15hours per week also having experienced shoulder pain. No association was found between the amount of time spent in the gym per week and the prevalence of shoulder pain (p = 0.55).

4.4.5.3 Time spent watching TV

Shoulder pain prevalence was investigated in terms of time spent watching television. These results are displayed in table 4.8 below.

Table 4.8 Hours spent watching TV and shoulder pain (n = 21)

Hours spent watching TV	Shoulder pain	No shoulder pain
0	4	5
1-3	7	1
4-6	3	2
7-9	2	1
10-12	6	2
16-20	1	1

A possible indication of a sedentary lifestyle could be the hours spent watching television (TV) per week. Participants were asked how long they spent watching TV per week. The majority of participants spent ten – twelve and one to three hours per week watching TV (eight subjects in each category). This accounts to approximately one and a half hours per day. No significant association was found when these results were related to shoulder pain prevalence (p=0.39) indicating shoulder pain was not influenced by the amount of time spent watching TV.

4.5 Device used for mobility

Figure 4.4 below illustrates the distribution of the devices used by the participants for mobility.

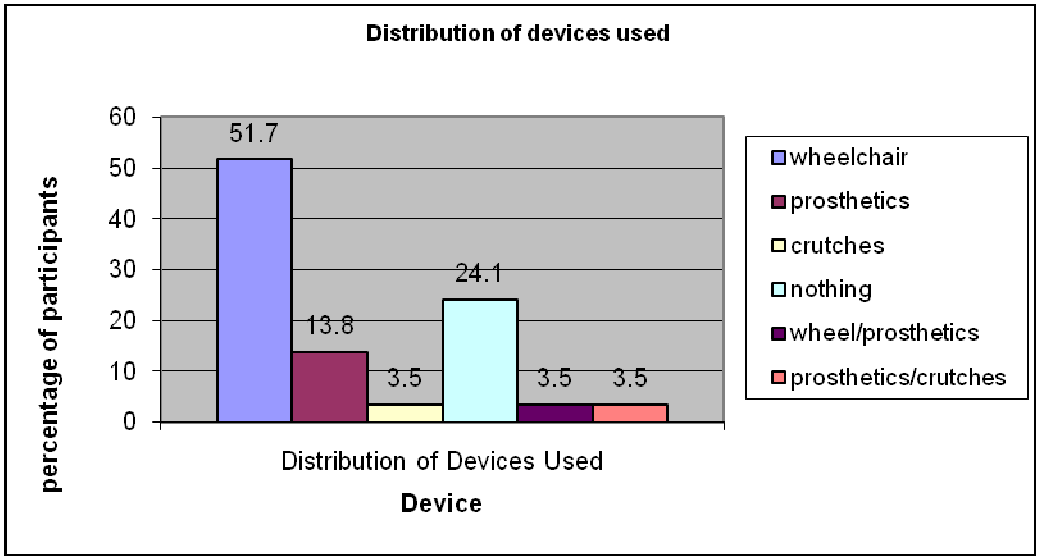

Fig. 4.4 Distribution of devices used (n = 29)

The majority of participants used a wheelchair for general mobility (51.7%) with 24.1% of participants not requiring an assistive device off the basketball court. Those participants who did not require assistive devices were those who had mild lower limb symptoms of cerebral palsy or polio as well as neuromusculoskeletal conditions rendering them minimally disabled and thus eligible to play wheelchair basketball but not reliant on an assistive mobility device off the basketball court.

Figure 4.5 below illustrates the distribution of devices that were used by the participants for mobility and the association with shoulder pain prevalence.

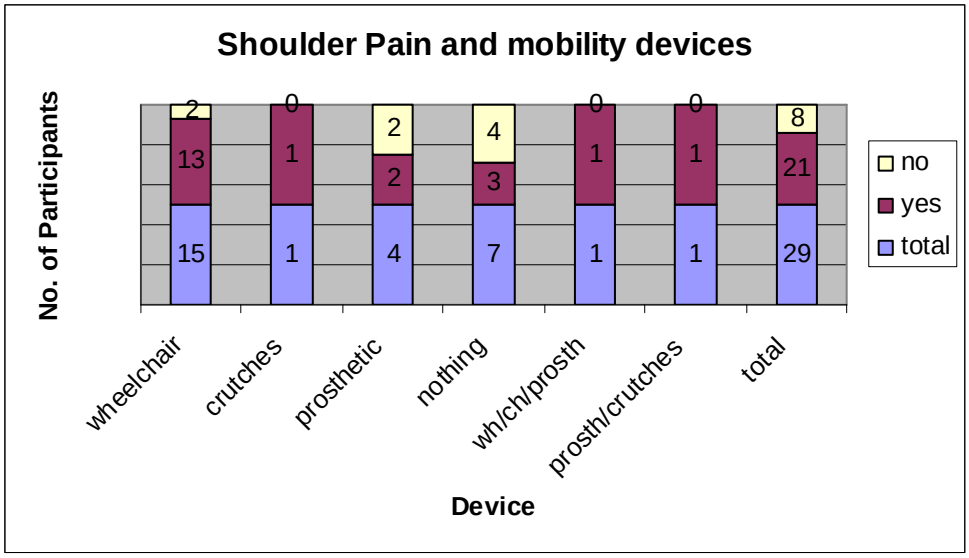

Fig. 4.5 Shoulder pain and mobility devices

Thirteen of the fifteen participants using wheelchairs reported having experienced shoulder pain. Two of the four participants using prosthetics reported having experienced shoulder pain. Three of the seven participants who did not use a mobility device reported having had shoulder pain. There was no association found between the type of device used and the prevalence of shoulder pain ($p = 0.43$).

4.5.1 Ambulatory vs. non-ambulatory

The third objective of the study was to find whether there was a difference in shoulder pain prevalence between the otherwise ambulatory athlete and the wheelchair bound athlete. These results are illustrated in figure 4.6 below.

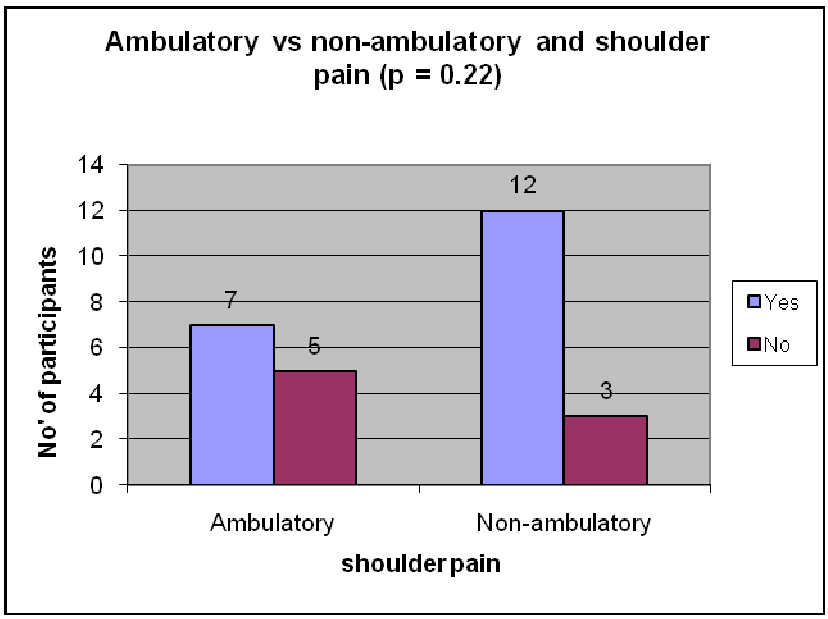

Fig. 4.6 Ambulatory vs. non-ambulatory and shoulder pain (n=27)

Of the 29 participants in the study, 15 (51.7%) were completely dependant on their wheelchair for mobility on and off the basketball court. Twelve (41.4%) of the 29 participants were otherwise ambulatory using prosthetic limbs, crutches or nothing at all. Those not using a device for mobility included mild cerebral palsy or polio diagnosis. Two participants varied between prosthetics and wheelchair as well as crutches (The distribution of devices used for mobility is found in figure 4.5 above). The two participants who were partly dependant on their wheelchairs off the court were not included in this calculation, as they did not fit either category completely. Hence, the total number of participants analysed here were 27, of whom 15 (55.6%) used wheelchairs all the time and 12 (44.4%) used a wheelchair only when playing basketball. Twelve (80%) of the 15 wheelchair bound participants reported having experienced shoulder pain while seven (58%) of the 12 in the ambulatory group reported experiencing shoulder pain ($p = 0.22$). It was found that

shoulder pain was not associated with whether or not the participant was ambulatory or non – ambulatory when not playing basketball.

4.5.2 Years of wheelchair use

A total of 16 participants used wheelchairs as a mobility device off the basketball court. This group were divided according to how long they had used a wheelchair for. Two groups were formed: those using wheelchairs for longer than ten years vs. those using wheelchairs for less than 10 years. There were seven in the latter and nine in the former group. The results are found in Figure 4.7 below.

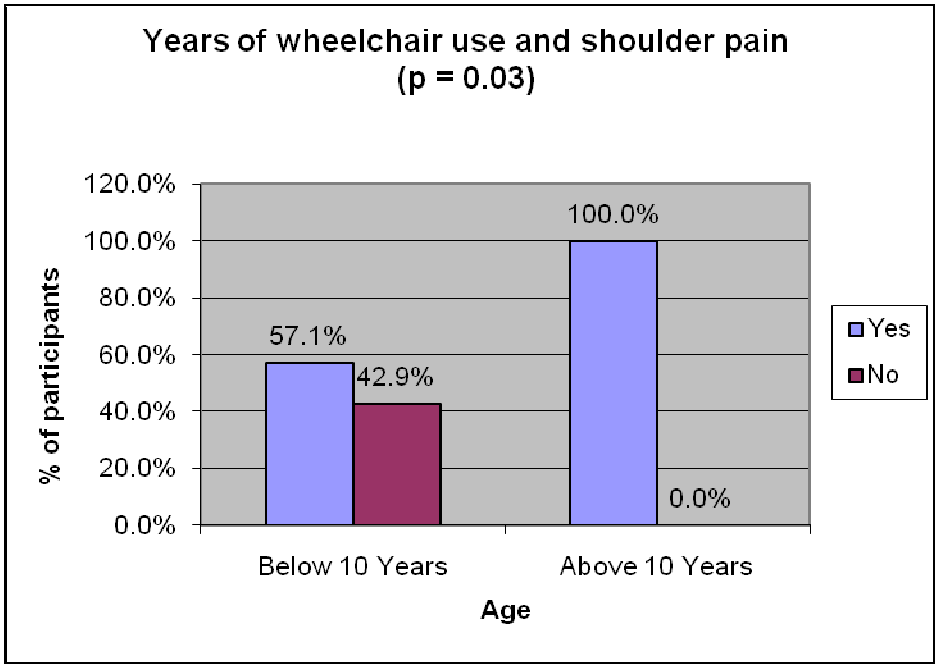

Fig. 4.7 Years of wheelchair use and shoulder pain (n = 21)

One hundred percent of participants (nine out of nine) who had been using a wheelchair for longer than ten years had experience shoulder pain, while of those who had been using a wheelchair for less than ten years, 57.1% (four out of seven) had experienced shoulder pain. The number of years spent using a wheelchair was found to be significantly associated with shoulder pain prevalence ($p = 0.03$). The longer one used a wheelchair the more likely they were to have had shoulder pain.

4.6 Shoulder Pain – aggravating factors

Participants reported on basketball related activities that provoked their shoulder pain. The results are illustrated in figure 4.8 below.

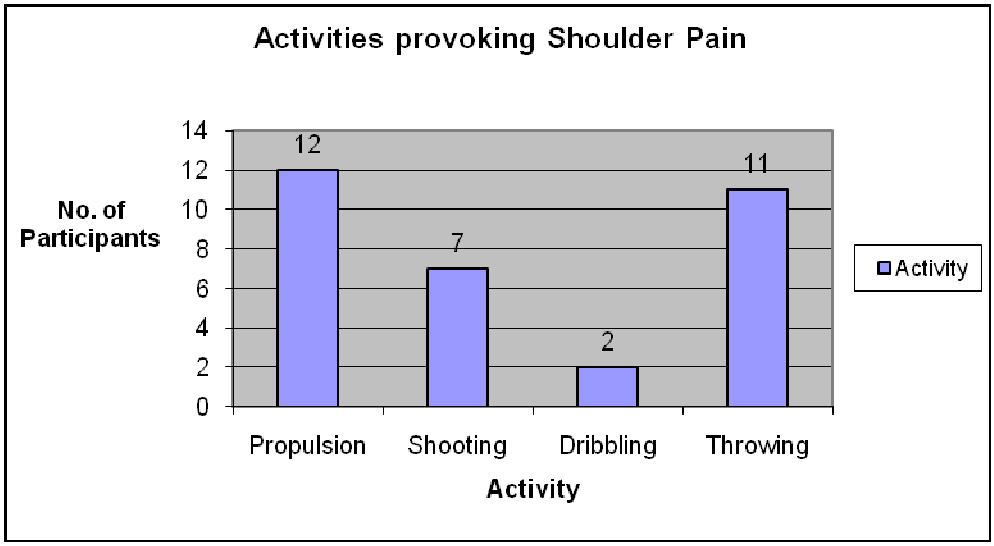

Fig. 4.8 Activities provoking shoulder pain (n=21)

Participants could report on more than one shoulder pain provoking activity. Of the 21 participants who had experienced shoulder pain since using a wheelchair, 12 (57%) reported pain during propulsion of their chair. This was the most reported pain provoking activity with the throwing action coming a close second at 11 (52%) participants.

4.7 Conclusion

The results of the study showed the prevalence of shoulder pain since using a wheelchair in this group of participants to be 72.4%. The point prevalence of shoulder pain at the time of the study was 37.9%. Shoulder pain was found to be associated with two main predisposing factors: time spent at work ($p = 0.05$) and the years of wheelchair use ($p = 0.03$). Those participants spending more than 30 hours per week at work reported shoulder pain more than those spending less than 30 hours per week at work. Those using a wheelchair longer than ten years reported having had shoulder pain more than those using a wheelchair less than ten years. Shoulder pain prevalence

was found to have no association with the ambulatory status of the participants off the basketball court ($p = 0.22$). These results will be discussed further in section 5.0.

CHAPTER 5

5.0 DISCUSSION

5.1 Introduction

This chapter is a discussion of the results of the study presented in chapter 4. The primary objective of the study was to determine prevalence of shoulder pain in male professional wheelchair basketball players; this is discussed in section 5.2. The predisposing factors in the causation of shoulder pain were the second objective and are discussed in section 5.3. The final objective was to establish whether there was a difference in the prevalence of shoulder pain between players who were otherwise ambulatory and those confined to a wheelchair. The results are discussed in section 5.4. The findings pertaining to pain provoking activities are discussed in section 5.5 with limitations of the study in section 5.6

5.2 Prevalence of Shoulder pain

The prevalence of shoulder pain in professional Gauteng male wheelchair basketball players since using a wheelchair was found to be 72.4%. This prevalence indicates the number of participants that have experienced shoulder pain since using a wheelchair. This is a majority number indicating the problem of shoulder dysfunction to be an important one in this group of athletes. Six (21%) participants reported having had shoulder pain prior to using a wheelchair. Thus it would seem that the introduction of the use of a wheelchair into daily life, be it on the basketball court only or due to a spinal cord injury, played a role in causing shoulder pain.

The point prevalence of the group was 37.9%. The study was conducted just prior to the wheelchair basketball season beginning, which could partially account for the 34.5% difference in the results. During this time of the season, players have not returned to full intensity practices and are not playing games. It is during games where the highest intensity of play occurs and players are pushed to their limits often resulting in injury. It is possible that the point prevalence could increase in the middle of the season or during periods of high intensity play.

Other studies have shown that up to 78% of spinal cord injury patients report shoulder pain (Mercer et al, 2006, Fullerton et al, 2003, Vanlandwijck et al, 2001, Curtis and Black, 1999 and Curtis 1997). The results of this study (prevalence = 72.4%) are in close keeping with these studies on both athletes and non athletes. There is only a slight discrepancy in the results in terms of prevalence between studies on athletes and non athletes. One can compare that of Mercer et al (2006) and Fullerton et al (2003) regarding the non athletic wheelchair user, to those studies on wheelchair athletes by Vanlandwijck et al (2001), Groah et al (2000), Curtis and Black (1999) and Curtis (1997, 1985). No significant differences in prevalence were found. It has however been found that the wheelchair bound athlete tends to develop pain later in life than the non athlete (Boninger et al, 2001).

In a study by Curtis and Black (1999) on female wheelchair basketball players, 46 players completed a similar prevalence survey study questionnaire to that used in this study. Their results (Curtis and Black, 1999) showed that 14% of players had experienced shoulder pain prior to wheelchair use while 72% reported having had shoulder pain since using a wheelchair. The results of this study by Curtis and Black (1999) are of particular interest due to their participants also being only wheelchair basketball players. The results of this study on male wheelchair basketball players in Gauteng, South Africa are in keeping with those found by Curtis and Black (1999) on female wheelchair basketball players in the US despite there population being female. This in itself is an interesting finding indicating that gender possibly has no role to play in the prevalence of shoulder pain in the elite/professional wheelchair basketball athlete.

5.3 Predisposing factors in the causation of shoulder pain

5.3.1 Occupation/ work hours

Shoulder pain prevalence was found to be associated with the amount of time participants spent at work ($p = 0.05$). All those participants (12) who spent more than 30hrs a week at work reported having experienced shoulder pain since using a wheelchair. Of those who worked less than 30

hours a week (17), 41% reported having had shoulder pain. This indicates a 59% difference in prevalence, which is quite substantial. This could be related to the fact that most of the participants have sedentary desk type jobs, which would encourage poor postural habits and repetitive strain type injuries. The poor postural habits would result in protracted shoulders and increased thoracic kyphosis with a forward poking chin posture. This posture would result in a compromised shoulder joint resulting in possible secondary subacromial impingement leading to subsequent pain.

It could also be proposed that if participants spend more time at work, they will be more likely to be fatigued by the end of the day. This could further result in poor ergonomic handling especially during transfers and general activities of daily living as well as while propelling their wheelchair. These activities of daily living require a fair bit of upper body strength and effort. Thus doing such activities following long hours at work will likely result in poor execution due to muscular fatigue leading to eventual injury.

No research was found that concurred with this finding of hours spent at work being associated with shoulder pain directly. Curtis and Black (1999) reported that hours spent driving was associated with shoulder pain prevalence but no other research could be found to confirm this finding either. Most studies seem not to be able to agree on what particular activity causes shoulder pain, only that propulsion related activities tend to be the most reported related wheelchair activity.

Nyland et al, (2007) reported in their study on upper extremity preservation in spinal cord injury that during episodes of high physical stress, participants tend to adopt a posture that compromises the shoulder joint complex, making them more prone to shoulder joint pathology. Nyland et al (2007) went on to describe the poor postural position as that which includes increased thoracic kyphosis and shoulder protraction with elevation, which puts the joint at risk of developing an impingement and resultant shoulder pain (Nyland et al, 2007, Mercer et al, 2006, McClure et al, 2006 and Brukner and Khan, 2001). Living an active balanced life style however contributes to maintaining a healthy shoulder (Nyland et al, 2007, Van der Woude et al, 2006 and Fullerton et al, 2003). It is finding the balance between too much and too little that appears to be the problem here in terms of an active lifestyle in the wheelchair user.

Shoulder pain was not significantly associated with the time spent at a computer ($p = 0.39$). Those reporting shoulder pain did not necessarily spend long hours behind the computer. From this result, while we can say that shoulder pain is related to spending more time at work, we cannot say that the time spent behind a computer specifically is the causative factor. The job type may thus not be the causative factor here, but rather the longer hours spent doing a job. The stress and physical fatigue associated with spending longer hours at work would as has been said, more likely impact shoulder pain prevalence than merely sitting at a computer.

Nyland et al (2007) found that the employed wheelchair user reported shoulder pain less than the unemployed. They also however reported that physical stress tended to lead to increased shoulder pain. In Nyland et al's study the participant's involvement in sport or exercise is not however mentioned. The participants in this study were all paid to play wheelchair basketball and were thus considered to be professional athletes. Unfortunately the majority were not paid enough to maintain their lifestyle hence needing to work as well. There are no studies that discuss such a population group. Athletes are compared to non athletes (Fullerton et al, 2003) where it was found that the non athlete develops pain earlier than the athlete; wheelchair users are investigated and it is established that the unemployed tend to experience shoulder pain more often than the employed (Nyland et al, 2007); and finally, the elite wheelchair basketball player has been investigated and found to commonly experience shoulder pain due to the nature of the sport (Ferrara and Peterson, 2000 and Curtis and Black, 1999). It appears that it is not conventional for a professional athlete to have to work outside of their sporting career in general. It is thus difficult to compare the findings in this study to those of other studies conclusively.

5.3.2 Time spent at the gym and training

The results of this study showed no significant association between the hours spent training ($p = 0.31$), time spent in the gym ($p = 0.55$) and time spent playing basketball games ($p = 0.85$) and the prevalence of shoulder pain. Thus the time participants spent training and conditioning did not seem to impact shoulder pain negatively or positively.

This finding is not in keeping with the study conducted by Burnham et al (1994). This may be due to difference in sample sizes. Burnham et al (1994) had a randomised sample of 117 participants from nine tournaments in Canada. This study was indicative of 29 participants. Another reason may be due to differing training methods. The participants in this study tended not to train very much outside of Basketball games and attended at most biweekly training sessions. One could say that the prevalence of shoulder pain might have been generally lower if the participants were in the habit of conditioning themselves for their sport. The optimal time spent conditioning and training was found by Burnham et al (1994) to be three times per week and it was also found that one should not compete in another sporting code while in the wheelchair basketball season. Incidentally, the results regarding time spent in the gym and training did highlight an area of concern in terms of the attention these local athletes pay to conditioning.

The importance of conditioning training in the prevention of shoulder pain is a well documented factor in the prevention of injury in sport. One must maintain a balance of power, strength, stability and suppleness to compete injury free (Malloy and Robertson, 2007, Brukner and Khan, 2001 and Curtis and Dillon, 1985). It has been proven that the wheelchair user needs to maintain upper extremity strength and stability as well as endurance in order to maintain good quality of life (Devillard et al, 2007). This cannot be accomplished by only playing basketball due to the nature of the sport being a high impact one. It also includes massive overloading of the static and dynamic stabilisers of the shoulder complex during the throwing, propelling and shooting actions one must employ to play the game (Malloy and Robertson, 2007, Curtis and Black,1999 and Curtis and Dillon, 1985). Specific shoulder exercise is needed to prevent and treat shoulder pain in wheelchair users (Nawoczenski et al (2006).

It has been said that the demands of wheelchair sports could accelerate the overuse process thereby increasing incidence of shoulder pain (Burnham et al, 1993 and Curtis, 1997). Fullerton et al (2003) found in their study that athletic activity does however have a protective effect on the wheelchair user's shoulder. Perhaps then it is the training technique and attention to biomechanics once again that needs to be focused on rather than the actual hours of training when it comes to predicting shoulder pain. Nawoczenski et al (2006) found that a selective

shoulder exercise regime was helpful in treating shoulder pain more so than general shoulder exercises as implemented in other studies they compared theirs to. This emphasises the need for focused exercise routines aimed at correcting specific imbalances in wheelchair users rather than general training.

One factor worth considering here again is that many of these players have never or do not attempt to protect or strengthen their shoulders biomechanically by doing regular rotator cuff strengthening, scapular stability training and general stretching exercises. This may also play a role in the development of shoulder pain in wheelchair athletes (Lee and McMahon, 2002, Curtis, 1997 and Burnham et al, 1993). The results of this study showed no association between time spent in the gym; at training sessions; and playing basketball and shoulder pain. Very few of the players in this study spent time exercising off the basketball court paying little attention to cross training and strength programs. It has been shown that biomechanics and shoulder exercise plays an important role in preventing and treating shoulder pain in spinal injury and wheelchair athletes (Burnham et al, 1993, Lee and McMahon, 2002 and Nawoczenski et al, 2006), this is thus an area of concern.

It would be interesting to see if the older wheelchair basketball athlete who attends regular gym sessions has a better outcome in terms of shoulder pain than the athlete that does not attend gym to maintain shoulder range and strength. Perhaps those few who are going to gym don't currently have a better outcome due to poor execution of exercises. If the participant does not have a training program focused on good shoulder strength and mobility and stability, as used in the studies where the efficacy of such a program was investigated (Nawoczenski et al, 2006), the desired result may also not be achieved. This study did not highlight whether one should or shouldn't train in the gym to prevent shoulder pain, but the majority of the participants did not gym train at all thus making groups for comparison difficult to make.

5.3.3 Age

This study found that age was not associated with shoulder pain prevalence. The average age of participants was 30 years old. Of those subjects over the age of 35, seven (88%) reported having experienced shoulder pain while five (50%) of those under 25 reported having experienced shoulder pain. These results were not significant in their findings ($p = 0.14$), indicating that age did not impact shoulder pain prevalence in this group of wheelchair basketball players.

Curtis and Black (1999) also reported that there was no significant ($p > 0.05$) association between age and shoulder pain in their population group of wheelchair basketball athletes (ave. age 33). This is in keeping with the results of this study. It has however been found in other studies that shoulder pain prevalence increases with age and years of wheelchair use (Fullerton et al, 2003 and Nyland et al, 2007) which is not in keeping with this study but may be attributed to the fact that the subjects in these studies were not professional athletes.

Curtis et al (1999) found in their research on shoulder pain in tetraplegia and paraplegia that it was the extremes of age (young and old) that most influenced the presence of shoulder pain rather than the older age. Boninger et al (2001) reported that it was body mass index rather than age that influenced shoulder pain. Boninger et al (2001) also investigated a range of wheelchair users (athletic involvement not mentioned) with an average age of 35, which is similar to that in this and that of Curtis and Black's (1999) study. In general it seems that the research thus far is unclear as to the association of age with shoulder pain prevalence.

The wheelchair user's lifestyle as well as exercise habits would very likely affect the outcome in later years however. It appears that it is more likely that being overweight or lazy in terms of exercise during ones life will affect the outcome in later years. This could further confirm that the athletic wheelchair user develops shoulder pain later in life than the non athletic wheelchair user (Fullerton, 2003). But we must also consider what the best athletic activity is in terms of shoulder pain prevention.

5.3.4 Years of wheelchair use

This study found that the number of years one has used a wheelchair is associated with the prevalence of shoulder pain ($p = 0.03$). The longer the participant had used a wheelchair the more likely they were to have shoulder pain.

The shoulder is the primary weight bearing joint in the wheelchair user. The shoulder however, is not a joint made for weight bearing as in the case of the hip. The shoulder is a very mobile joint gaining much of it's stability from its dynamic stabilisers as opposed to the hip, which has a deep socket and vast ligament stability complex relying much less on the dynamic structures that surround it. As a result the shoulder joint is subject to degeneration due to overuse in the presence of inadequate stability for the tasks it is subject to in the wheelchair user. The longer one is in a wheelchair the more likely one is to develop biomechanical changes and imbalances in the force couples around the shoulder joint. This makes the shoulder more susceptible to arthritic changes and rotator cuff tearing due to secondary impingement.

The results of a study by Fullerton et al (2003) are in keeping with those of this study in so much that the longer the subject had been using a wheelchair the more likely they were to have shoulder pain. Fullerton et al (2003) also reported on the fact that shoulder pain in wheelchair users is primarily due to overuse thus expecting the athletic wheelchair user to have accelerated overuse syndromes due to the demands of the wheelchair sports. This interestingly was not the case with athletes, who tended to report the problem four years later than non athletes on average (Fullerton et al, 2003).

The wheelchair user uses his/her upper limbs as a primary weight bearing joint. This alone results in overuse and eventual joint degeneration with prolonged years of wheelchair use, as has been described in radiological studies in the wheelchair user (Ardic et al, 2006 and Boninger et al, 2001). Further more, due to the sustained sitting, and very often poor sitting posture, which may be due to neurological fallout and/or poor biomechanics due to neuromuscular dysfunction, overuse syndromes develop in the shoulder (Nyland et al, 2007 and Curtis et al, 1999). The result is the development of shoulder impingement syndrome, which is due to the change in

biomechanical stressors, which develop around the shoulder joint. The head of the humerus is allowed to move forward and upward in the glenoid, due to the weaknesses of the humeral head depressors and retractors and overused, shortened pectoral muscles. This results in crowding of the subacromial space and subsequent bursa inflammation and possible eventual rotator cuff tearing (Malloy and Robertson, 2007, Brukner and Khan, 2001 and Hackey, 1996).

These factors refer to the use of a wheelchair in all people, not only the athlete. Research has confirmed that wheelchair users who engage in athletic activity tend to slow the development of shoulder dysfunction (Fullerton et al, 2003). There is, however, research to confirm that overhead activity especially the throwing action (Malloy and Robertson, 2007, Brukner and Khan, 2001 and Hackey, 1996), as in wheelchair basketball, as well as high speed propulsion (Lee and McMahon, 2002) will contribute to the development of shoulder injury. Thus the longer the participant uses a wheelchair be it on or off the court or both, the more likely the development of shoulder pain. The more exposure to stresses placed on the glenohumeral (GH) complex the more likely the development of shoulder pain. Should parameters be in place to correct or manage the stresses placed on the joint, this development of shoulder pain would however be delayed or prevented (Malloy and Robertson, 2007, Nawocenski et al, 2006 and Brukner and Khan, 2001).

5.4 The ambulatory vs. non-ambulatory athlete

The results of this study indicated no difference in the prevalence of shoulder pain between participants who are otherwise ambulatory i.e. amputees with prosthetic limbs or individuals mobile on crutches or without, and those confined to a wheelchair ($p = 0.22$). Of the 29 participants, 15 were wheelchair bound of which 13 (87%) had experienced shoulder pain. Twelve were not reliant on a wheelchair off the court. Of this otherwise ambulatory group, eight (67%) had experienced shoulder pain. The lack of association could be due the fact that both groups of participants are exposed to high risk activities regarding shoulder pain. Those who are otherwise ambulatory tend to have to propel their chairs faster, more often shoot from further away as well as work with the ball above their heads far more than the players who are restricted

to their chairs off the court as well as on the court. This is due to their balance and core strength being generally better than those players fully dependant on their wheelchairs. Those fully dependant on their chairs tend not to shoot from as far or throw the ball as far, tending to use the chest pass rather than the baseball pass (shooting and the base ball pass are high risk basketball related activities – Lee and McMahon, 2002, Burkhart et al, 2003, Hackey, 1996, Allen and Warner, 1995 and Burnham et al, 1993). Their role is to position their chair in a blocking position to set the stronger, better balanced players up to put the ball in the basket. Thus while those dependant on their wheelchairs on a daily basis are likely to develop degenerative conditions due to continued overuse, the otherwise ambulatory players are also likely to develop shoulder pain due to overuse during high intensity play rather than continuous use on and off the court.

During tournaments one might find that the otherwise ambulatory players are more likely to have shoulder pain than the wheelchair bound players due to the higher intensity of play as found by Curtis and Black (1999). Curtis and Black (1999) also referred to the player's position in the team having a role to play in causing shoulder pain. They agreed that those with better trunk control were more likely to be exposed to higher intensity of shoulder stresses as has been discussed here. Both groups are thus likely to develop shoulder problems due to slightly different reasons. It is the point prevalence during times of competition that could however be affected and warrants investigation.

Curtis and Black (1999) found that those who were otherwise ambulatory were more likely to have shoulder pain than those who were always in wheelchairs, possibly due to their lack of conditioning in terms of ability and endurance in propelling a wheelchair. Their study was conducted during a tournament which may have accounted for the difference in results here.

Research would suggest that the non ambulatory wheelchair bound athlete would be more at risk of developing chronic shoulder pain when one considers the lack of opportunity to rest even the apparently insignificant shoulder injuries sustained on or off the court. An athlete that must rely fully on their chair at all times does not get a chance to rest an injured shoulder joint due to it's primary weight bearing function (Fullerton et al, 2003, Lee and McMahon, 2002, Ferrara and

Peterson, 2000 and Curtis, 1997). It would thus make the wheelchair bound athlete far more likely to sustain chronic shoulder injuries than the ambulatory athlete. Lee and McMahon reported that the wheelchair bound individual would take six months to resume normal activities of daily living following an impingement injury, while those not confined to a wheelchair resume normal activities following just three months of treatment. This would indicate that the non ambulatory participant would take longer to heal but is not necessarily more likely to sustain such an injury. This is in keeping with the results of this study. Using a wheelchair makes the participant susceptible to shoulder injury whether they are ambulatory or non ambulatory. The chronic nature of the injury would be more likely to be the affected variable between these two groups of participants. This should thus be considered in future studies.

5.5 Pain provoking activity

Of the 21 players that reported having experienced shoulder pain 12 (57%) said it was aggravated during propulsion. During propulsion the shoulders are protracted and elevated with the thoracic spine in flexion. This would place the shoulder in a position to develop massive imbalances very often leading to shoulder impingement. The pectoralis muscles are shortened and the humeral head is placed in an anterior superior position. This would lead to crowding of the sub acromial space resulting in the supraspinatus tendon and sub acromial bursa becoming irritated and thus inflamed as in secondary shoulder impingement.

It has been found that wheelchair propulsion, especially at high speed, will cause shoulder pain in active wheelchair users very often due to impingement (Samuelsson et al, 2004, Lee and McMahon, 2002, Veeger et al, 2001, Kulig et al, 2001, Ferrara and Peterson, 2000 and Burnham et al, 1993). This is due to the increased forces placed through the shoulder joint during propulsion, especially at increased speeds. The intense load placed through the upper extremity during propulsion will result in eventual degeneration in the shoulder joint leading to pain and discomfort very often resulting in reduced independence in daily activities. Samuelsson et al (2004) reported that of 451 individuals studied, 72.4% reported shoulder pain with 54% reporting pain during propulsion. This result is very similar to that of this study despite the difference in

sample size. Further more, if the surface on which the game is being played is not a hard wooden court with minimal friction, participants are also at further risk of developing shoulder pain due to the raised propulsive forces required (Vanlandewijck et al, 2001).

Eleven (52%) participants reported that throwing aggravated their shoulder pain. The shoulder requires a vast amount of stability from its local stabilisers i.e. rotator cuff muscles during the throwing action. If these muscles are not functioning optimally, the humeral head will not sit in the glenoid perfectly resulting in excessive strain of the capsule and ligaments of the joint. With the repetition of the throwing action injury will eventually occur resulting in possible labral tears, rotator cuff tendonopathy, subacromial bursitis and/or an unstable shoulder joint.

There is a vast amount of research regarding the unstable athlete's shoulder and the throwing shoulder. During overhead throwing the shoulder is placed under high intensity loading at the rotator cuff as well as static stabilises of the joint (Stefano et al, 2006, Goosey-Tolfrey et al, 2002 and Brukner and Kahn, 2001). With the further complication of a mechanically disadvantaged position from which they must throw the ball, wheelchair athletes are at greater risk of developing shoulder impingement and rotator cuff disorders than able bodied athletes.

Seven (33%) participants said shooting aggravated their pain. This is an extension of the throwing action to a varying degree, thus the likelihood of shoulder pain developing from this overhead action from a mechanically disadvantaged position being quite high.

Two (nine percent) participants reported dribbling also aggravated their pain. This is more than likely related to the need for propulsion during the dribbling action.

5.6 Limitations of the study

A questionnaire was the measuring tool used to gather information in the study. This is a subjective tool in terms of the fact that it relies purely on the answers of the individual. Despite the validity and reliability processes it is thus not objective in nature and is subject to human error. Participants are required to remember their experiences, which is subject to recall bias.

Further more while an attempt to make the tool reliable and valid was made the process was not executed as well as it could have been. Two out of the five experts approached to determine content validity were unable to complete the process resulting in only three expert opinions on the content of the questionnaire. As a result questions that should have been addressed were not. One such question that would have been useful is how long participants used their wheelchair on a daily basis. This would have been helpful in determining a predisposing factor in shoulder pain as years of wheelchair use was found to be significantly associated factor. This should be addressed in future research in this group of athletes.

This study was conducted at the pre season phase of the wheelchair basketball calendar. Due to this, the teams did not all have full player lists resulting in a lower number of participants in the study than there should have been. When teams are finalised for the season they must have 12 players registered in each. The follow up process could however have been better executed. The two participants in Italy could have been emailed the questionnaire and the players that had retired could also have been tracked to their homes. The remaining three spaces that were filled by players that had opted to play for other teams in the country would not have filled the criteria for this study now being part of teams outside of Gauteng. It would have been easier to gain a full group of participants had the study been conducted during the middle of the season when all teams were fully formed and registered.

The findings in this study are limited to the preseason point prevalence. It would be interesting to follow up with the participants at the middle and end of the season in order to establish whether the prevalence did increase at the middle and end of the season. This could better indicate whether it is using a wheelchair or playing the wheelchair basketball that influences shoulder pain prevalence.

5.7 Conclusion

Here ends the discussion of the results of this study on shoulder pain in wheelchair basketball players. The following chapter will discuss the conclusions and recommendations.

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

It can be said that in the population studied, shoulder pain appears to be a considerably prevalent problem. The study determined the prevalence of shoulder pain since using a wheelchair to be 72.4% in male professional wheelchair basketball players in Gauteng, South Africa. The point prevalence at the time of the study was 37.9%. Predisposing factors in the development of shoulder pain were found to be the years spent using a wheelchair ($p = 0.03$) and the time spent at work per week ($p = 0.05$). There were no significant findings in terms of the ambulatory vs non ambulatory wheelchair basketball athlete and shoulder pain prevalence.

There was also no association found between shoulder pain prevalence and the following factors studied

- hours spent playing basketball games per week
- hours spent at basketball practice per week
- hours spent at the gym per week
- hours spent watching television per week
- hours spent playing other sport per week
- hours spent at a computer per week
- age
- mobility device used
- support structure (living arrangements)

6.2 Recommendations

6.2.1 Clinical recommendations

Shoulder pain is a cause for concern in the area of wheelchair basketball in general. This study however has brought to light the degree to which the condition affects local athletes. It is recommended that further education regarding posture and the importance of maintaining specifically sound biomechanics around the shoulder girdle be made available to athletes. With the hours of work being a predisposing factor, emphasis should be placed on correcting sitting posture and education regarding work place, rest and exercise to prevent repetitive strain type injuries from occurring.

In the professional sports arena it is important that the athlete maintains peak mental and physical fitness. It appears from the lack of conditioning training, that this is not the case in these athletes. Gym programs focusing on shoulder girdle strengthening to prevent shoulder impingement should be an area of focus for this.

Each team should have available to them a conditioning coach or physiotherapist to guide training methods and treat injuries as they arise. By making available the support needed to maintain healthy athletes and training methods one could hope to decrease the number of wheelchair basketball athletes complaining of shoulder pain in this population group.

6.2.2 Recommendations for further research

This study was conducted at the very early stages of the wheelchair basketball season. It would be interesting to find the point prevalence at intervals throughout the season in order to establish whether increased intensity and frequency of play has a bearing on shoulder pain prevalence.

The implementation and assessment of the effect of a shoulder strength and mobility program would be a recommended area of research. This could be aimed at improving shoulder integrity in wheelchair basketball athletes complaining of shoulder pain. By researching the effects of a

specific regime of exercise, one could help to find the best practice for improving the longevity of the wheelchair basketball player's shoulder.

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8.0 APPENDICES

APPENDIX I - QUESTIONAIRRE

Q1.) Occupation:_____

Q2.) Age_____

Q3.) Are you dependant on any devices for mobility? Yes No

q3-1) If yes, what devices do you use for mobility?

1 – wheelchair

2 – prosthetics

3 – crutches

4 – nothing

5 - other (please state)

q3-2) If dependant on a wheelchair, please state the number of years using a wheelchair

_____

q3 –3 What is your medical diagnosis (disability)_____

Q4.) Support structure (tick appropriate answer)

q4-1) Do you live alone? Yes No

q4-2) Do you have help with your daily activities? Yes No

q4-2-1) if yes, state the number of hours per day_____

Q5.) Activity level (tick the appropriate answer)

Number of hours per week you spend doing the following activities

Question	Activity	0	1-3	4-6	7-9	10-12	13-15	16-20	20-30	30<
5-1	Playing basketball games									
5-2	Basketball practice									
5-3	At gym									

5-4	Watching TV									
5-5	At work									
5-6	Playing other sport									
5-7	At a computer									

q5-8) List any other sports you take part in and the level at which you participate:

_____

Q6.) Medical History (tick the appropriate answer)

Question	Statement	Yes	No	Unsure
6-1	Did you ever experience shoulder pain prior using a wheelchair?			
6-2	Have you experienced shoulder pain since you started using a wheelchair?			
6-3	Do you currently have shoulder pain?			
6-4	Have you sought medical attention for the shoulder pain?			
6-5	Has the shoulder pain limited you from performing your usual activities during the past week?			
6-6	Have you had any shoulder surgery?			
6-7	Have you ever been given a diagnosis for your shoulder injury?			

6-8.) If you can remember, what was the shoulder diagnosis?

_____

If you have answered yes to any of the above questions (Q6) then proceed to 7 and 8

Q7.) What activities bring about the shoulder pain? (tick as appropriate)

q7-1.) When propelling the chair

q7-2.) When shooting the ball

q7-3.) when dribbling the ball

q7-4.) When throwing the ball

Q8.) What have you used to relieve your shoulder pain? (tick those applicable)

8-1) Ice

8-2) Heat

8-3) Exercise

8-4) Rest

8-5) Medication

- what do you take and how often?_____

8-6) Physiotherapy

8-7) Other: specify - _____

8-8) List any other ways you have managed your shoulder pain

_____

_____

APPENDIX II – INFORMATION DOCUMENT

Information Document

Hello, My name is Claudia Lepera. I am currently completing a Masters degree in Physiotherapy at the University of Witwatersrand in Johannesburg.
I am doing research on shoulder pain in wheelchair basketball players. I am trying to find out how many players in Gauteng have shoulder pain. I am also trying to see if there are any common factors connecting those who suffer from shoulder pain. In doing this I am hoping to find out how big a problem shoulder pain is amongst the wheelchair basketball players in Gauteng.
I would like to invite you take part in this research study.

What is involved

This study is a descriptive one.
You will be required to complete one questionnaire. It should take no longer than 5 minutes to finish.
The questionnaire asks about any medical history regarding your shoulder as well as some demographic data i.e. age, marital status.
There will be a total of 36 people taking part in this study. They are all from Gauteng and play in the wheelchair basketball teams in Pretoria and Johannesburg. They also all compete in the supersport challenge.

There are no risks involved with taking part in the study. Following the completion of the questionnaires you will not be required to do anything else.

Your participation is completely voluntary.
All the information you give will be kept confidential and no names are required to be entered on the questionnaire

Should you wish to contact me for any further information regarding the study:
Claudia Lepera ph: 0825106832
Email: leperac@yahoo.com

Consent:

I _____ hereby consent to taking part in the abovementioned study.

Signed_____ Date _____

APPENDIX III – REQUEST FOR PERMISSION LETTER TO CHAIRMAN OF WHEELCHAIR BASKETBALL SOUTH AFRICA

Dear Mr Saunders

My name is Claudia Lepera. I am currently completing a masters degree in Physiotherapy at the university of the Witwatersrand.
The title of the study that I am undertaking is “The prevalence of shoulder pain in professional male wheelchair basketball players in Gauteng”.

In order for me to commence the study I would like to ask your consent to my approaching the coaches and their teams to help me by answering a once off questionnaire regarding shoulder pain. This questionnaire hopes to highlight any predisposing factors regarding shoulder pain as well as just how big a problem it might be in the Gauteng teams. I am attaching a copy of the questionnaire for your perusal.

For any further information regarding the study or questions you may have prior to granting consent in this matter please don’t hesitate to contact me. Otherwise I look forward to hearing from you soon.

Regards

Claudia Lepera

APPENDIX IV - LETTER FROM CHAIRMAN OF WHEELCHAIR BASKETBALL SOUTH AFRICA

WBSA

WHEELCHAIR BASKETBALL SOUTH AFRICA

Reg: 2004/012463/08

Mandeville Indoor Centre
Cnr. 10th Street & 7th Avenue
Bezuidenhout Valley, 2094
PO Box 59193, Kengray, 2100
Tel: 27 11 616 7576
Fax: 27 11 616 9236
Email: wbsa@basketball.co.za

21 April 2008

Dear Claudia

RE: MEDICAL RESERCH QUESTIONAIRE

This notice is to give written authorisation from Wheelchair Basketball SA for you to continue with your research project with the 3 wheelchair basketball teams in JHB/Pretoria region.

As discussed the Management of the Clubs concerned are in agreement with you attending their respective practice session once off to get the athletes to fill out a 5 minute questionnaire on shoulder pain.

Again your continual assistance in research into our sport is always welcomed and appreciated. It would truly benefit WBSA if you would make your findings available to us.

Should there be any further queries, please contact the undersigned.

Regards,

Charles Saunders
Director Operations
Mobile: +27 82 474 9058

Directors:
Operations: C. Saunders, Human Resource: M Koning, High Performance: W Riedlert, International Relations: S Moorgas, Development: H Mansana
Affiliated: IWBF World, IWBF Africa Basketball SA, NASPO
www.basketball.co.za

APPENDIX V - WHEELCHAIR USERS SHOULDER PAIN INDEX (CURTIS AND BLACK, 1999)

Based on your experience in the past week, how much shoulder pain do you experience when:

1. Transferring from a bed to chair?
2. Transferring from a wheelchair to car?
3. Transferring from a wheelchair to the tub or shower?
4. Loading your wheelchair into the car?
5. Pushing your chair for 10 minutes or more??
6. Pushing up ramps or inclines outdoors?
7. Lifting objects down from a overhead shelf?
8. Putting on pants?
9. Putting on a t-shirt or pullover?
10. Putting on a button down shirt?
11. Washing you back?
12. Usual activities at work or school driving?
13. Performing household chores?
14. Sleeping?

Each item is followed by a 10cm visual analogue scale, anchored at “no pain and worst pain ever experienced.”

APPENDIX VI - MEDICAL HISTORY QUESTIONNAIRE (CURTIS AND BLACK, 1999)

Did you ever have shoulder pain prior to wheelchair use?
Have you had shoulder pain during time you have used a wheelchair?
Have you had shoulder surgery?
Do you currently have shoulder pain?
Have you sought medical attention for a shoulder problem?
Have you used the following to relieve shoulder pain:
Ice
Heat
Exercise
Medication
Rest
Has shoulder pain limited you from performing your usual activities during the past week?
Have you experienced hand or elbow pain or injuries during the time you have used a wheelchair?

APPENDIX VII - ACTIVITY LEVEL AND EXPOSURE CHARACTERISTICS OF SUBJECTS (CURTIS AND BLACK, 1999)

Age

Years of wheelchair use

Activity level:

- Number of wheelchair transfers per day
- Hours per week of work and school
- Hours per week of sports and leisure
- Hours per week of driving

APPENDIX VIII – ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Lepera

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M080522**
PROJECT	The Prevalence of shoulder pain in Professional male wheelchair basketball players in the Gauteng area
INVESTIGATORS	Ms C Lepera
DEPARTMENT	Physiotherapy
DATE CONSIDERED	08.05.30
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 08.06.11 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Ms N Mbambo

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES