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Current Physical Conditioning Knowledge of High-School Athletic Coaches in the Johannesburg-North Education District – A Cross Sectional Survey

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DECLARATION

I declare that this mini-dissertation is my own, unaided work. It is being submitted for the Degree of Master of Physiotherapy in the University of Pretoria. It has not been submitted before for any degree or examination in any other University.

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Juan Darryl Eekhout

__________________ Day of ______________________ 2013

ABSTRACT (ENGLISH)

Sports injuries in the adolescent are becoming more frequent as more athletes participate in sporting activity, and sport is the leading cause of injury in the adolescent. Appropriate physical conditioning of the adolescent which includes a warm-up session, endurance training, strengthening exercises and balance training have shown to reduce the rate of injury during pre-season and in-season training. The aim of this study was to establish the current knowledge of athletic coaches in the Johannesburg-North Education District, in the physical conditioning of high-school middle- and long-distance runners. There was no validated questionnaire available to complete this study, so a questionnaire was designed based on the most recent evidence regarding each item. Athletic coaches at each school were selected based on the following inclusion criteria: that they worked at high schools and/or secondary schools whose students participated in middle and long distance running, that they spoke and understood English, that they worked at private and/or public schools, and that they were either gender. There were 33 high schools in the Johannesburg-North Education District that completed the survey out of a possible 42 high schools, a response rate of 78 per cent. Following the statistical analysis of the results, it was found that the questionnaire had an internal consistency (reliability co-efficient) of 0.92. The coaches scored on average 67 per cent for the questionnaire, showing that they had a good knowledge of the physical conditioning concepts. The only significant relationship found was between the coaches' scores for the use of balance and proprioceptive exercises and age. In conclusion it was found that coaches in both public and private schools have correct physical conditioning knowledge with regards to high school middle and long distance runners. Recommendations are made with regards to future policy, and the researcher suggests that future studies should involve testing the coaches' practical application of their knowledge.

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CHAPTER 1 – INTRODUCTION AND BACKGROUND

1.1 Introduction

Sports injuries in adolescents are becoming more frequent as more athletes participate in sports and because of the period of physiological change in the adolescent (Abernethy and Bleakley 2007). Sport is the leading cause of injuries in adolescents and the leading cause of injuries requiring medical attention (Emery, Rose, McAllister and Meeuwisse 2007; Rauh, Koepsell, Rivara, Margherita and Rice 2006; Emery, Cassidy, Klassen, Rosychuk and Rowe 2005;). Appropriate physical conditioning of the adolescent, which includes a warm up, endurance training, strengthening exercises and balance training reduce the rate of injury during pre-season and in-season training (Fradkin, Zazryn and Smoliga 2010, Veigel and Pleacher 2008, Brooks, Schiff, Koepsell, and Rivara 2007, Fradkin Gabbe and Cameron 2006, Emery et al. 2005, Olsen, Myklebust, Engebretsen, Holme and Bahr 2005). However, despite the reported benefit of physical conditioning programmes in adolescent sport, studies show that coaches are not incorporating these aspects of conditioning into their programmes (Brooks et al. 2007, Emery et al. 2007). The coaches beliefs and attitudes may also prevent them from incorporating the most recent scientific evidence into the physical conditioning programme (Shehab, Mirabelli, Gorenflo and Fetters 2006)

From a medical and economic perspective, significant cost is involved in the treatment and management of sports injuries (Fradkin et al. 2006). Other negative effects of injuries are the fact that injury may interfere in the potential benefits of increased self-esteem, community involvement and increased fitness (Veigel and Pleacher 2008). Especially in the adolescent, the benefit of a preventative physical conditioning programme goes beyond just preventing the injury.

Physiotherapists are extensively involved in effective rehabilitation programmes for the treatment of injuries (Veigel and Pleacher 2008). By astutely planning a conditioning programme the coach together with the physiotherapist may reduce some intrinsic risk factors such as a lack of strength, flexibility and fitness levels.

Athletic coaches' knowledge needs to be investigated, to establish whether their education level is of a relevant standard to promote injury prevention (Gianotti, Hume and Tunstall 2010).

1.2 Background

Following a period of treating learners from high-schools in the Johannesburg-North area with overuse injuries, as a private practitioner I noticed there were similar patterns of athletic training. I decided to investigate the possible causes of injuries in this group of middle- and long-distance runners. Although the causes of many overuse injuries are multifactorial, and may consist of intrinsic and extrinsic risk factors, the focus in this study was the use of a physical conditioning programme in injury prevention. A thorough training history revealed that some of the runners' coaches may not be utilising some or all of the components of a physical conditioning programme in their respective training sessions. This engaged my interest in the topic of using physical conditioning as part of an injury prevention strategy and whether the coaches' knowledge thereof had any bearing on injury prevention.

1.3 What is currently known?

Injuries in the adolescent athlete are a growing problem as more youth are encouraged to remain physically active. According to a 2004 Gauteng provincial profile, provided by Statistics South Africa, "athletics is the most predominant sport across all schools in Gauteng" (Lehohla 2004: 58). Due to the increasing number of schools with sports facilities, an increase in the number of participants is expected, with an increased likelihood of injuries. Overuse injuries particularly in middle- and long-distance runners may be prevented. In order to prevent these injuries from occurring, the epidemiology of injuries in the middle- and long-distance athlete needs to be understood.

Rauh et al. (2006) and Rauh, Margherita, Rice, Koepsell and Rivara (2000) found that the incidence of lower extremity injuries in cross-country runners was high. Kennedy, Knowles, Dolan and Bohne (2005, page 34) identified intrinsic and extrinsic risk factors to foot and ankle overuse injuries in the adolescent runner, "as the demands and expectations of a runner increase from coaches, parents and peers alike." Intrinsic risk factors for injury include anatomic alignment, age, and level of fitness, gender, strength, flexibility, previous injury history, body size and psychosocial variables. Extrinsic risk factors include type of conditioning, running surface, protective equipment, coaches' education, running shoes and weather conditions that one runs in. Many of the intrinsic and extrinsic risk factors can be minimised with a coach having an appropriate level physical conditioning knowledge. Risk factors such as level of fitness, strength, flexibility, running surface, type of conditioning as well as coaches' education are all variables which can be controlled by the coach using an appropriate physical conditioning programme (Kennedy et al. 2005).

Studies have shown that a conditioning programme should consist of multiple components to best prevent injury (Hubscher, Zech, Pfeifer, Hansel, Vogt and Banzer 2010, Hadala and Barrios 2009, Veigel and Pleacher 2008, Aaltonen, Karjalainen, Heinonen, Parkkari and Kujala 2007, Abernathy and Bleakley 2007, Brooks, Schiff, Koepsell and Rivara 2007). Several components of conditioning have been explored in the literature such as static stretching, warm-ups, multi-intervention conditioning, strength training, level of fitness, balance and proprioception and cool-downs and these shall now be discussed individually.

A component which is considered controversial is static stretching. However, static stretching is still widely practiced, even though there is considerable evidence to suggest that there is no beneficial effect of static stretching in the prevention of injury (Shehab et al. 2006). Several studies have found that static stretching did not reduce the incidence of delayed onset muscular soreness or injury rates (Small, McNaughton and Matthews 2008, Herbert and De Noronha 2007, Thacker, Gilchrist, Stroup and Kimsey 2004, Pope, Herbert, Kirwan and Graham 2000). In fact, some studies have even shown a negative effect of pre-exercise stretching on peak torque and sprint times in certain athletes (Chaouachi, Chamari, Wong, Castagna, Chaouachi, Moussa-Chamari and Behm 2008; Caine, Caine and Maffulli 2006).

Although stretching may not be an effective injury prevention strategy, considerable amount of evidence exists to suggest that warming up may help prevent injury (Fradkin et al. 2010, Soligard et al. 2008, Fradkin et al. 2006, Olsen et al. 2005). Fradkin et al. (2006) hypothesised that warming up will help reduce the number of sports related injuries. However, the systematic review found insufficient evidence to endorse or discontinue routine warm ups prior to physical activity. This finding prompted Fradkin et al. (2010) to investigate the effects of warming up on physical performance. The results of this meta-analysis showed that warm ups improved performance of athletes in 79 per cent of the criteria, and that there is not a large amount of evidence suggesting that warm ups are detrimental. In their study of comprehensive warm ups in female soccer players, Soligard et al (2008), incorporated a programme consisting of endurance, strength, plyometrics, balance and technique to assess whether it helped to reduce the number of injuries. Although the study by Soligard et al (2008) was performed on soccer players, the study is useful to identify specific components of a warm up that may be beneficial in endurance athletes. Soligard et al (2008) did not find any significant reduction in the number of injuries, but did find a reduction in the risk of severe, overuse and overall injuries. Similarly Olsen et al. (2005) performed a randomised controlled trial to investigate the effectiveness of a structured warm-up programme to reduce the number of injuries in 120 handball teams in Norway. The results of the study by Olsen et al (2005) again were positive in that the number of knee and ankle injuries was reduced by using a programme consisting of running drills, technique, balance, strength and power.

A majority of the studies investigating injury prevention promote multi-intervention programmes as the most beneficial in reducing the incidence of injury (Hubscher et al. 2010, Hadala and Barrios 2009, Veigel and Pleacher 2008, Aaltonen et al. 2007, Abernathy and Bleakley 2007, Brooks et al. 2007). Brooks et al. (2007) investigated the prevalence and predictors of pre-season conditioning among high-school athletes and found that the majority of the athletes in the study met the criteria for either aerobic, stretching or strengthening components. However, there was a small minority of subjects that met the criteria for all three components, which highlighted the need for school or coach education to ensure the athletes participate in all three conditioning components. Aaltonen et al (2007, page 1 585) reviewed the prevention of sports injuries and found that “a decreased risk of sports injuries was associated with the use of insoles, external joint supports, and multi intervention programmes.” This result was similar to that of Abernathy and Bleakley (2007) whereby they investigated the strategies to prevent injury, particularly in adolescents, and they concluded that strategies consisting of pre-season conditioning, functional movements, education, balance and sport-specific skills are effective in reducing the incidence of injury in adolescents. Hadala and Barrios (2009) also found that a multi-intervention physiotherapy programme reduced the risk of injury in a yacht crew during the America’s Cup competition.

The individual components that have been studied to prevent injury or improve performance include core strengthening, weight/resistance training, hip strengthening and plyometrics (Sato and Mokha 2009, Snyder, Earl, O’Connor and Ebersole 2009, Storen, Helgerud, Stoa and Hoff 2008, Niemuth, Johnson, Myers and Thieman 2005, Spurrs, Murphy and Watsford 2003). Sato and Mokha (2009) found that core strengthening improved 5 000 m running performance in recreational and competitive runners, but had no beneficial effect in the prevention of injury. Similarly, Storen et al (2008) found that maximal strength training improved running economy and increased the time to exhaustion among well-trained, long-distance runners. An interesting factor in overuse running injuries was identified by Niemuth et al (2005), who suggested an association between strength imbalance in the hip abductor, adductor and flexor muscle groups, and lower extremity overuse injuries in runners. The association between hip strength imbalance and lower extremity overuse injuries correlated well with Snyder, Earl, O’Connor and Ebersole (2009) who found that resistance training of the hip muscles lead to an improvement in lower extremity biomechanics, which in turn lead to a reduction in injury risk during running. Lastly, Spurrs, Murphy and Watsford (2003) investigated the effect of plyometric training on running performance and found that a six-week plyometric training programme led to improvements in three kilometre running performance.

Another important risk factor in injury prevention is that of fitness level, where endurance training or aerobic exercise plays a vital role. Beneficial effects of endurance training though include increased left ventricular wall thickness in female athletes, improved autonomic system function and improvements in maximal oxygen uptake and two-kilometre and five-kilometre running times (Loprinzi and Brodowicz 2008, Venckunas, Raugaliene, Mazutaitiene and Ramoskeviciute 2008; Raczak, Danilowicz-Syzmanowicz, Kobuszewska-Chwirot, Ratowski, Figura-Chmielewska and Szwoch 2006). Buist, Bredeweg, Van Mechelen, Lemmink, Pepping and Diercks (2008) found that to the contrary, a graded training programme in novice runners did not reduce the incidence of running related injuries when comparing a thirteen-week graded programme to a standard eight-week programme.

Lastly, research has been conducted into the use of balance and proprioceptive exercises in the prevention of sports injuries (Hubscher et al. 2010, Emery et al. 2007, McHugh, Tyler, Mirabella, Mullaney and Nicholas 2007, Emery et al. 2005). Hubscher et al. (2010) found that from seven high quality studies that proprioceptive/neuromuscular retraining exercises are effective in preventing certain types of sports injuries in the adolescent. This finding is in agreement with a trial conducted by Emery et al. (2005) which showed that a home-based balance training programme using a wobble board was effective in improving balance and reducing sports injuries in healthy adolescents. In two studies investigating the effect of a balance-training programme in two high school sports, Emery et al. (2007) and McHugh et al. (2007) found their programmes to be effective in reducing acute injuries in basketball and ankle injuries in football players respectively. Following the review of the relevant evidence active warm-ups, strengthening, balance, aerobic training and technique should all form part of an appropriate conditioning programme to prevent injury in the adolescent.

The majority of the literature on preventative programmes in sports has focused on specific sports such as soccer, American football, and basketball (McGuine 2006). Lack of appropriate physical conditioning knowledge by athletics coaches, is a risk factor which may predispose athletes to injury. Multi-intervention conditioning programmes are effective in preventing in injuries in high-school athletes. Evidence exists to suggest that coaches may not be implementing the practice of implementing physical conditioning knowledge in the school setting (Brooks et al. 2007, Emery et al. 2007 and Shehab et al. 2006). Therefore this survey attempted to establish the knowledge of high school athletic coaches in the physical conditioning of middle and long distance runners.

1.4 Research problem

High-school athletics coaches may lack basic physical conditioning knowledge in the prevention of injuries in middle- and long-distance runners. Coaches who lack appropriate physical conditioning knowledge may be predisposing high-school athletes to injuries. Multi-intervention conditioning programmes are effective in preventing in injuries in high-school athletes. In the South African setting, no known studies have explored whether coaches have the appropriate conditioning knowledge. Currently we do not know what the level of knowledge of this group of coaches has, which would be beneficial for myself (as a physiotherapist working with coaches), as well as the physiotherapy profession to know so that we may help the coaches in the community with injury prevention strategies – should it be required."

1.5 Research question

What is the current knowledge of high school athletics coaches in the Johannesburg-North education district, of the physical conditioning of high school middle and long distance runners?

1.6 Aim and objectives

1.6.1 Aim

To establish the current knowledge of athletic coaches in the Johannesburg-North Education District, about the physical conditioning of high-school middle- and long-distance runners.

1.6.2 Objectives

1.6.2.1 To describe the biographic profile of the coaches (age, gender, highest level of education, number of years coaching, private or public school coach).

1.6.2.2 To assess the coaches' knowledge (success rates) about physical conditioning of high-school middle- and long-distance runners with regards to the following:

- Pre-exercise stretching;
- Warm-up sessions;
- Preseason conditioning;
- Core strengthening;
- Weight/resistance training;
- Plyometric training;
- Endurance training;
- Balance and proprioceptive exercises.
- Static stretching as a cool down regime

1.6.2.3 To establish the association between coaches' physical conditioning knowledge and biographic variables – within and between the following coaches' groups:

- Age
- Gender
- Highest level of education
- Number of years coaching
- Private or public schools

1.7 Significance of the study

The survey set out to determine the level of coaches' physical conditioning knowledge in the Johannesburg-North Education district. The survey also sets a platform for further research into the athletic field in South Africa by attempting to establish the coaches' current knowledge. This knowledge includes the influence of an evidence-based conditioning programme on the incidence of injuries in high school athletes during a season. The survey may also serve to establish a body of research regarding athletes and so may assist in developing practice guidelines and coaching protocols in high-school athletics, thereby setting an evidence-based standard. The survey also reemphasises the role that physiotherapy has in research, the prevention of injuries, as well as the education of other role players in injury prevention.

1.8 Scope of the study

The aim of this study is to establish the current knowledge of athletic coaches in the Johannesburg-North Education District, in the physical conditioning of high-school middle and long distance runners. The researcher acknowledges that there are numerous variables that may contribute to the type of physical conditioning program that occurs at each high-school. Confounding variables such as environmental effects on physical conditioning and contextual variables such as the influence of weather conditions, state of sports facilities and/or the effect of parental involvement in the physical conditioning of high-school runners, shall not be investigated at all in this study. Other contextual variables that were not investigated in this study are the influence of the coaches and runners upbringing, effect of diet on performance and/or history of previous injury to the runners.

The purpose of this survey was not to explore the epidemiology of running-related injuries in high-school runners or to promote any preventative physical conditioning program over any other. This survey does not take into account other aspects of conditioning, such as psychological conditioning.

1.9 Definition of terms

Several terms used throughout the following chapters of this study and are defined here for a clearer understanding.

1.9.1 Balance

Balance is defined as “the ability to maintain the body’s centre of gravity within its base of support and can be categorized by either static or dynamic balance,” (DiStefano, Clark and Padua 2009, p. 2718).

1.9.2 Physical conditioning knowledge

Physical conditioning knowledge is defined as an understanding of “a structured and repetitive physical activity program that produces a higher level of physical fitness and athletic function, optimizing performance and minimizing risk of injury” (Brooks et al. 2007, p. 241).

1.9.3 High-school athletic coach

A high-school athletic coach is defined as the person/s who instructs the runners of ages 14 to 18 years old in skills, strategy and physical training to obtain the highest possible level of success within their individual ability. The coaches were all employed by their respective schools and have been coaching for a minimum of one year. The coaches are all teachers at their respective schools in the Johannesburg-North education district, which comprises both public and private schools.

1.9.4 Levels of knowledge

The coaches' level of knowledge (success rate) was based on the mean score overall for each section of the survey. If the coach's score was below the mean, then the coach's level of knowledge was scored as poor. Similarly if the coach's score was above the mean, then the coach's level of knowledge was scored as good. If the coach's score was equal to the mean score, then the coach's level of knowledge was scored as fair.

1.9.5 Plyometric training

Plyometric training is a type of strength training that involves explosive movements such as jumping, bounding or hopping in different directions or planes of movement, which activates eccentric muscle contraction (Spurrs et al. 2003).

1.9.6 Strength training

Strength training is a term used to describe a variety of dynamic resisted or non-resisted training programmes based on progressive overload and designed to improve muscular strength and endurance (Malina 2006).

1.9.7 Warm up

The term warm up is defined as “a period of preparatory exercise in order to enhance subsequent competition or training performance,” (Fradkin et al. 2006, p. 215; Fradkin et al. 2010, p. 140).

1.10 Outline

In the following chapter, the literature review is discussed in relation to the aims of the study. Relevant literature is analysed for quality and discussed within the context of the current study. Chapter 3 outlines the methods used to complete the study, and the results of the survey are given, analysed and discussed in chapters 4 and 5. Lastly, conclusions are drawn from the findings of the study and recommendations for future research and clinical practice are suggested.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

In this chapter the concepts relating to physical conditioning and how they interact are discussed. The discussion also looks at the existing knowledge about each concept, with in-depth analysis of the methodology, data and empirical findings, and the limitations and conclusions of the research. The concepts that are explored are the epidemiology of sports injuries, risk factors predisposing athletes to injury, the use of warm-up sessions, strengthening, endurance, and balance training within a physical conditioning programme to prevent injury. Figure 2.1 illustrates the relationship between epidemiology, risk factors and physical conditioning and how they interact regarding injury prevention.

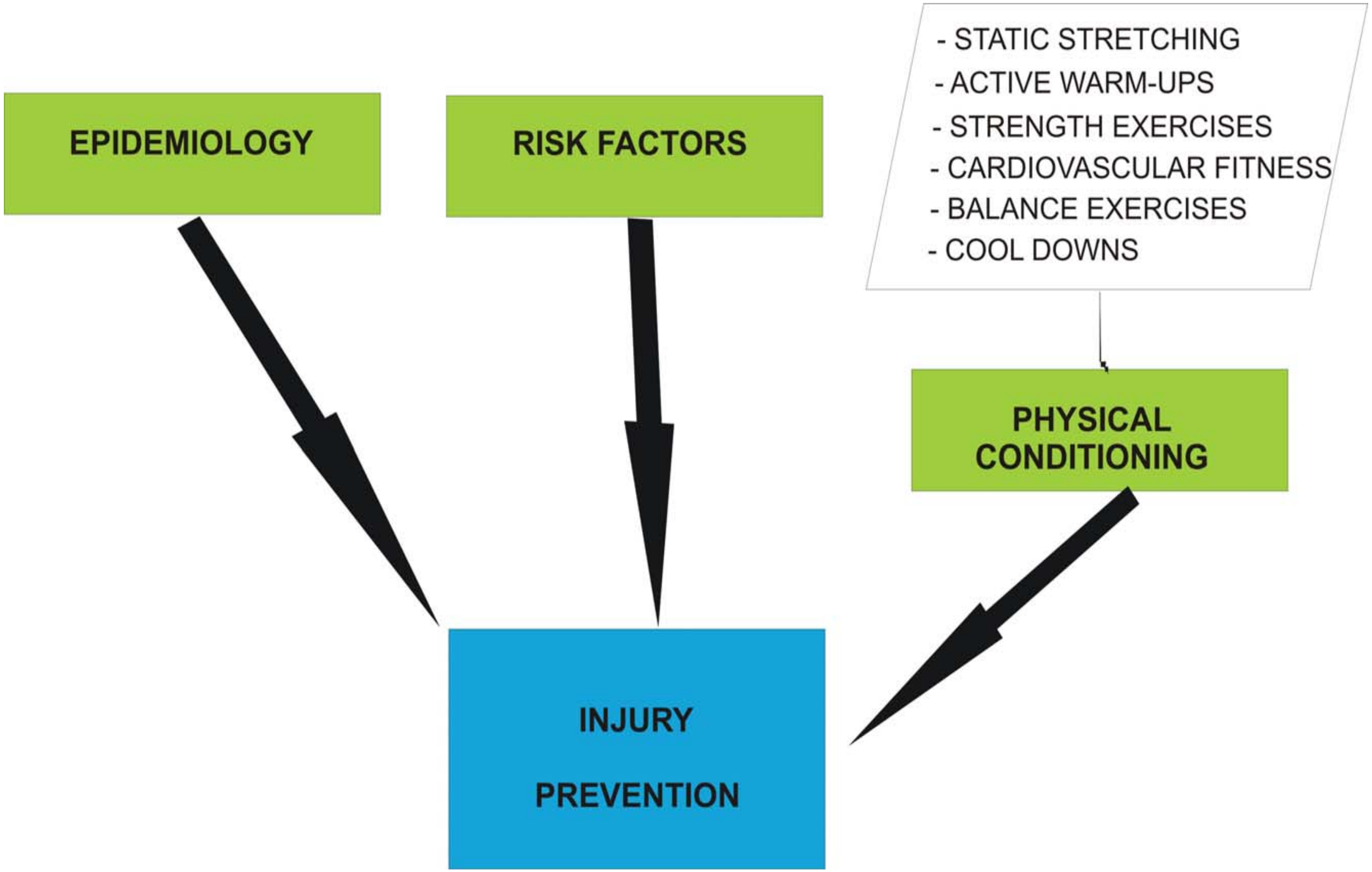

Figure 2.1: Conceptual framework of the study of physical conditioning

2.2 Epidemiology of adolescent sports injuries

The trend towards engaging in physical activity has meant that more and more adolescents are participating in sports or recreational activities. This means that as more adolescents participate in sport, so the number of injuries that occur will increase. The use of epidemiological data has been used to identify the rates of injury and risk factors involved with these injuries. Using these studies, risk factors can be identified that predispose adolescents to injury and may enable the development of injury prevention conditioning programmes and strategies (Caine et al. 2006). The incidence or rate of injury is expressed as the number of injuries per 1 000 hours of athletics exposure, occurring either during training or an athletic event (Caine et al. 2006; Rauh et al. 2006; Rauh et al. 2000).

The majority of current epidemiological research – in adolescent sport - consists of descriptive epidemiology, which quantifies injury occurrence, who is affected, when the injuries occur and what the outcome of these injuries are (Caine et al. 2006). Three epidemiological studies were found regarding adolescent sports injuries.

In their prospective longitudinal study, Rauh et al. (2000) determined the incidence rate of injury among high-school cross-country runners over a fifteen-year period. The participants consisted of 199 boys' and girls' cross-country team-seasons from twenty-three high-schools in western Washington State in the United States of America (USA). The injury and disability data was collected by the coaches and trainers, who obtained training on how to complete the Daily Injury Reports (DIR). The athlete's body part injured and type of injury was also recorded. The injury rate was defined as the number of injuries per 1 000 athletic exposures. Incidence rate ratios and their 95 per cent confidence intervals were estimated to compare injury rate between boys and girls. The overall injury rate for runners between 1979 and 1994 was 13.1 per 1 000 athletic exposures (AEs). Girls had a significantly higher injury rate than boys ($p < 0.0001$) and a significantly higher number of days lost to injury than boys ($p < 0.0001$). Subsequent injuries saw rates of 37.6 per 1 000 AEs for re-injury to the same body part and 3.7 per 1 000 AEs for secondary injuries to a new body part. Overall 72 per cent of the injured athletes sustained injuries which resulted in four days or less of absence from practices and meets. Overall shin injuries were the most common form of new injury.

Similarly, Rauh et al. (2006) prospectively monitored a cohort of 421 runners competing in twenty-three male and female cross-country teams in Seattle, Washington during the 1996 cross-country season. The objectives of the study were to determine the incidence of lower-extremity injury among high-school cross-country runners and to identify risk factors for injury. Data collection was done by the athletic coaches – who had been trained prior to the season beginning – using the Athletic Health Care System Daily Injury Report form. Injuries that did not occur during a training session or athletic meet were excluded. When recording injuries, the coaches recorded the body part injured as well as the type of injury, and the report required five minutes or less to complete. Other anthropometric measurements were done at the beginning of the season by the same experienced physical therapist. All subjects also completed a questionnaire on baseline characteristics such as gender, grade level, height, weight, previous high-school cross-country running experience, preseason running, and prior running-related injuries. Throughout the season the coaches recorded the distance, intensity, surface, and terrain for each run performed.

The injury rate was calculated as the number of injuries divided by the number of athletic exposures. Injury rate ratios with 95 per cent confidence intervals were calculated to compare the incidence of injury in an exposed group with that of a baseline group. Chi-square tests for trend were used to determine whether there was an increased injury risk with increased leg length discrepancy. The authors used Cox proportional hazards regression analysis to examine the association between risk of initial injury and the independent variables, as well as to assess the combined effect of baseline risk factors and training practices. During the 1996 cross-country season girls (19.6/1 000 AEs) had a significantly higher rate of injury than boys (15.0/1 000 AEs), with most injuries occurring during practice rather than meets, but no *p* value was given. The shin was the most common injury site, followed by the knee and ankle. The only statistically significant predictors of injury were a Q-angle of more than twenty degrees and a running injury during the pre-season.

Similarly to their study in 2000, Rauh et al. found significant findings in their 2006 study. The findings showed that girls are at higher risk of injury and that the shin is the most common site if injury in high-school cross-country runners. Additionally Rauh et al. (2006) identified two significant risk factors associated with running injuries.

Caine et al. (2006) performed a review of the literature on the incidence and distribution of paediatric sports-related injuries. The authors searched MEDLINE (1966 to 2006) and SPORTDiscus (1975 to 2006) for relevant articles and additional references were retrieved from the bibliographies of retrieved articles. Articles were selected where incidence rates (reported as rate of injuries per unit athlete time) and distribution of injury in children's and youth sports were reported. A total of 49 studies were eligible for review. Many of the studies were characterised by short-comings in the methodology and study differences that limited the interpretation of the results between studies. The results of the review show that boys have higher incidence rates per 1 000 hours exposure in ice hockey (range, 5 to 34.4), rugby (range, 3.4 to 13.3) and soccer (range, 2.3 to 7.9), and for girls in soccer (range, 2.5 to 10.6), basketball (range, 3.6 to 4.1) and gymnastics (range, 0.5 to 4.1). However when AEs are used boys show a higher injury incidence in cross-country running (range, 10.9 to 15.0), soccer (range, 4.3 to 17.0) and baseball (range, 2.8 to 17.0), and girls a higher incidence in cross-country running (range, 16.7 to 19.6), softball (range, 3.5 to 10.0) and gymnastics (8.5).

Caine et al. (2006) also found a higher injury rate in girls for cross-country running, gymnastics and soccer. This finding supports those findings by Rauh et al. (2006; 2000) where the injury rate in girls was also higher than boys. When looking at the anatomical location of injuries in track and field athletes, the review by Caine et al. (2006) found one article show in that the lower extremity was the most common site of injury – in particular the lower leg and ankle. When the study examined environmental location of injury, it was once again found that the proportion of injuries was higher in practice than competition due to the larger amount of exposure time. Yet the study did find that most incidence rates are actually higher in competition for most sports. The studies by Rauh et al. (2006; 2000) were both cited in this review, and again they emphasise that girls had significantly higher rates of disabling injuries than boys in terms of time lost to injury among cross-country runners.

Caine et al. (2006) also reviewed the economic impact that paediatric sports injuries have on society. The cost of an injury not only includes the cost of the emergency room visits, doctors' bills, physiotherapy, medicine and hospital bills, but also indirect costs to parents livelihood, as well as the psychosocial impact on the child and/or the parents.

The literature review shows that there are very few epidemiological studies that looked at injuries in adolescent cross-country or middle distance runners. To date no epidemiological studies undertaken in the South African high school setting with regards to athletic injuries could be found. In both the studies by Rauh et al (2000; 2006) the data was collected by the athletes' coaches, which may have led to some reporter bias, when looking at the consistency of injury reporting. Reporter bias on the coaches' part would be particularly true in the earlier study in 2000 which was conducted over a fifteen-year period, as schools may have changed athletic coaches during this period or the coaches may have become inconsistent with regular reporting over such a large time period due to waning interest. In their earlier study Rauh et al. (2000) did not screen athletes prior to the data collection for possible risk factors associated with injuries; however they did remedy this by performing screening in their 2006 study. This is an important part of an epidemiological study as they help identify risk factors associated with injury incidence, which may allow researchers, coaches, medical professionals and parents minimise possible risk factors. The second factor that the study by Rauh et al. (2000) did not take into account was the exact injury type – although they do acknowledge this in their discussion. This allows the potential for misdiagnosis of injuries from the coach's perspective. Similarly the Rauh et al. (2000) acknowledge that it is difficult to know whether the results of their study can be generalised, and therefore we cannot know for sure whether the injury rate amongst South African high-school runners will be similar or not.

In the more recent study by Rauh et al. (2006) the study was conducted over a shorter period of time and they investigated risk factors associated with injury. Although the study used the same physiotherapist to perform all anthropometric measurements, no evidence in the paper suggests that the therapist's measurements were reliable and consistent between runners. Secondly the coaches again recorded all the injury and training data, which has the potential for recorder bias. The results of the data collection, reported that the girls had a significantly higher injury rate than the boys, yet no *p* value is given. Rauh et al. (2006) did acknowledge that running injuries are multi-factorial, and that they omitted the factors of warm-ups, level of competition, muscle imbalance, foot positioning, shoe wear and weather conditions as risks for injury. Therefore the study was only able to identify a few risk factors associated with injuries. Lastly the results of this study may not be able to be generalised within a South African context.

The review by Caine et al. (2006) only took into consideration epidemiological studies from two scientific databases, which limits the number of studies that the search could yield. Comparisons of the data between studies were limited due to the fact that injury rates were reported using different methods, namely injuries per 1 000 hours or injuries per 1 000 athletic exposures. The studies that were reviewed also contained minimal athletics injury data, so incidence rates in this regard may be difficult to predict. Lastly the study failed to identify any significant risk factors associated with injury incidence, and so fails in identifying areas in which sports medicine could provide appropriate prevention of athletic injuries.

The use of epidemiological data has been used to identify the rates of injury and the risk factors involved with these injuries. These studies can thereafter also be useful to reduce the rate of injuries by enabling the development of injury prevention conditioning programmes and strategies (Caine et al. 2006).

The studies that examined the epidemiology of injuries generally reported the occurrence of injuries as injuries per 1 000 hours of athletic exposures, either during training or an athletic event (Caine et al. 2006; Rauh et al. 2006; Rauh et al. 2000). These epidemiological studies have shown that participation in physical activity is associated with lower morbidity rates (Emery 2003). However, participation in physical activity also carries a certain amount of risk for injury, particularly in the child or adolescent as significant impact on their participation may impact their future health (Emery 2003). The identification of risk factors for injury and appropriate strategies to minimise these risks remains extremely important in the field of injury prevention.

2.3 Risk factors for injury in adolescent sport

Risk factors in sport are defined by Emery (2003, page 257) as “any factors that may increase the potential for injury.” Generally risk factors for injury are divided into two categories, intrinsic and extrinsic factors. Intrinsic factors include gender, age, experience, previous injury, body size, performance measures, psychosocial aspects, biomechanics, strength and flexibility, proprioception and fitness levels. Extrinsic risk factors include level of activity (competition/practice), playing surface, protective equipment, coaches education and training, type of sport (contact/noncontact), weather conditions, time of season/time of day, running shoes and conditioning programmes (Veigel and Pleacher 2008; McGuine 2006; Emery 2003; Johnston, Taunton, Lloyd-Smith, and McKenzie 2003). Some of these risk factors can be manipulated, such as biomechanics, strength, flexibility, proprioception, fitness levels, level of activity, protective equipment, running shoes and/or conditioning programmes. These are the risk factors where the physiotherapist and coach can play a vital role. Risk factors associated with adolescent sports injuries are multi-faceted, but do not seem to be as comprehensively researched as adult risk factors. Three articles were found relating to adolescent risk factors and one paper investigating risk factors in adult runners.

Duffey, Martin, Cannon, Craven and Messier (2000) studied the etiological factors associated with anterior knee pain in distance runners. The objectives of the study were to examine differences between non-injured runners and runners who had anterior knee pain, to explore the relationships between these measures in both groups, and to develop hypotheses regarding risk factors for anterior knee pain. Subjects were divided into a control group of non-injured runners (*n*=70) and an anterior knee pain injury group (*n*=99). During the research process high-speed videography, a force platform and a Cybex II+ isokinetic dynamometer were used to assess rear foot motion, ground reaction forces, and knee muscular strength and endurance. Each runner also completed a training history questionnaire. Descriptive group statistics were used to compare all variables associated with training, anthropometric measurements, muscular strength and endurance, rear foot movement and kinetics. Linear discriminant function analyses were performed to using a backward elimination variable to select the most important discriminators between injury and control groups for the abovementioned factors. The significance of variables as predictors of injury was set at a *p* value of 0.05. The results of the study by Duffey et al. (2000) showed that pronation through the first ten per cent of stance, arch index, shoe mileage, and extension peak torque were the best overall predictors for anterior knee pain ($p \leq 0.05$). Thus the injured subjects had underutilised their running shoes, had a more cavus foot, pronated less through the first ten per cent of stance, and had weaker quadriceps than the control group.

Although the above study examined risk factors in adult runners, Emery (2003) reviewed the risk factors for injury in child and adolescent sport specifically. The studies objective was to identify risk factors and potential prevention strategies for injury in child and adolescent sport. Several databases were searched using the following subheadings: athletic injuries, sports injury, risk factors, adolescent, and child. The studies were selected for the review following strict inclusion and exclusion criteria, and the internal validity of each article was assessed. A total of 45 studies met all the criteria for the review and the data was extracted under the following headings: study design, study population, exposures, outcomes and results.

The review identified two subgroups of risk factors for injury in child and adolescent sport. Non-modifiable risk factors and potentially modifiable risk factors were explained. The results of the review showed that non-modifiable risk factors such as males, left-handedness, increasing age, amount of exposure and level of competition increase the risk of injury in many sports, with sport-specific rates of injuries varying considerably. There is conflicting evidence regarding measurements of height, weight and age and risk of injury in the adolescent.

In the review, twenty of the 45 studies reviewed examined potentially modifiable risk factors for injury specifically to child and adolescent sport. The majority of the studies reviewed showed no association between biomechanical alignment, flexibility, or strength with injury in child and adolescent sport. However, there were a few sport-specific studies done in relation to gymnastics, figure skating, wrestling, baseball, hockey and football, which showed exception to the above finding. Four intervention studies targeted risk factors such as limitations in flexibility, strength, endurance, and proprioception. One study showed no effect of a half-time warm-up and stretching programme in high-school football, whilst another study demonstrated a significant protective effect of specific education, conditioning, and rehabilitation programme in adolescent soccer players.

Emery (2003) also reviewed two randomised controlled trials which both showed a significant reduction of injury and protective effect using a multi-faceted training programme and a seven-week pre-season training programme in female handball and female soccer players respectively. The review also identified that there may be some psychosocial risk factors which may be modifiable in reducing injury risk. These studies showed correlations between low socioeconomic status and higher injury risk, as well as a high correlation between stressful life events and higher injury risk.

The review by Emery (2003) also reviewed the risk factors for injury in adult sport due to the few epidemiological studies addressing risk factors in child and adolescent sport. Some risk factors for injury that have been identified in adult sport include decreased strength, poor endurance and decreased off-season sports-specific training. However, the most significant predictor of injury in most studies appears to be previous injury. There is some evidence to show that multi-faceted training programmes significantly reduce the incidence of ankle sprain injuries and anterior cruciate ligament injuries in some sports.

Similarly to Emery (2003), McGuine (2006) identified the available research regarding risk factors and prevention of injuries in high-school athletes. Studies were reviewed following a search on several databases. Key concepts and medical subheadings included: high-school, adolescents, sports injury, athletic injury, prospective, cohort, epidemiology, incidence, risk factors, prevention, baseball, basketball, cheerleading, cross country, field hockey, football, gymnastics, hockey, lacrosse, rugby, soccer, softball, swimming, tennis, track and field, volleyball, and wrestling. Studies also had to meet certain inclusion and exclusion criteria, and once included were identified as either being injury risk factor studies or injury prevention studies. The data was extracted under the following headings: sport(s) or injuries studies, year of publication, lead author, and description of the subjects, sample size, variables studied, whether multi-variate analyses were used, data reported and results.

The results of the review by McGuine (2006) identified extrinsic and intrinsic risk factors for injury as well as injury prevention strategies used to prevent injury. Studies that examined extrinsic risk factors suggest that athletes were at greater risk for injury during competition than practice and with coaches who had less experience. There was conflicting evidence regarding the use of protective equipment. The studies that examined intrinsic risk factors suggest that there is conflicting evidence for injury risk between male and female athletes. However, athletes who were older, had more experience, and who were in a higher grade were at higher risk of injury, possibly due to higher exposure times. Additionally players who have sustained previous injury were at higher risk for re-injury in several studies and players who were overweight were more susceptible to injury. Two studies looked at the effect of psychosocial variables on injury risk, and showed that players with higher levels of pre-season negative life changes and players with low vigour and high fatigue were at higher risk for injury during the season.

Six studies for injury prevention met the inclusion criteria. All six of the studies examined the use of a lower-extremity exercise programme to address intrinsic risk factors. The injury reduction research focussed on reducing injuries in soccer, basketball, team handball, and volleyball players. Two studies in McGuine's (2006) review showed a reduction in the number of ACL injuries in athletes who performed jumping and landing techniques, strength exercises, and structured warm ups compared to those athletes in the control groups who did not perform the intervention. Similarly a further two studies examined the effect of balance training exercises on the incidence of ankle sprains in basketball, soccer and handball players. Both studies showed a lower incidence of ankle sprains in the group of athletes who participated in the balance exercise programmes compared to those who did not participate. A handful of studies also looked at multi-intervention strategies to prevent injury in adolescent athletes. The interventions consisted of a combination of player education, structured warm-up/cool-down, and injury rehabilitation. The studies showed a decrease incidence in injury incidence of twenty-one per cent, particularly for lower extremity injuries and acute knee injuries.

Veigel and Pleacher (2008) review outlines the efficacy of current injury prevention strategies in youth sport. Similarly to McGuine (2006) they discuss the effect of conditioning programmes and educational programmes in the prevention of injuries, but the study also touches on the effect of rule changes and safety equipment in sports injury prevention. Although there have been educational programmes and rule changes implemented in ice hockey and baseball in the USA and Canada, to date there is no research to show that these programmes have significantly reduced the incidence of injury. The review also shows that there seems to be no significant evidence to suggest a decreased injury incidence when using safety equipment such as braces, eye protection, face guards and/or headgear. Veigel and Pleacher (2008) also discuss the use of conditioning programmes as an injury prevention strategy in youth sport. Much of the evidence regarding routine stretching before or after exercise to prevent injury is inconclusive, yet a large number of coaches continue to advocate its use. Many recent injury intervention studies have shown that neuromuscular interventions, proprioceptive training and sport-specific skills are effective in reducing the number of ACL injuries, and other sports related injuries in female soccer players, female handball athletes, a basketball team, healthy adolescents, and Australian football players. Veigel and Pleacher (2008) suggest that traditional warm-ups and cool-downs should be replaced with structured warm-up programmes.

As can be seen from the overview of existing knowledge there is a limited number of studies on risk factors for injury in adolescent sport. The majority of research into risk factors for injury has been conducted in adult samples, as can be seen in Duffey et al. (2000) article for factors associated with anterior knee pain in runners.

Although Duffey et al. (2000) investigated risk factors in a sample of runners, it is not appropriate to generalise the results of the study amongst adolescent runners, as the demand on the adolescent's ever changing body may create a different biomechanical response than that in an adult. It is unclear from the data collection and analysis in this study as to who collected the data, and if there was more than one data collector, whether there was good inter-tester reliability.

However, the review by Emery (2003) was of a high quality, with strict data synthesis. The one shortcoming of this review – as was acknowledged by the author

– was that due to differing research designs, measurements, injury definitions and methods of injury data collection, it was difficult to compare the results from each study with one another. Many of the studies in this review also contained a bias in the "lack of measurement and control for confounding variables" (Emery 2003, page 266). The studies included in this review also contained varied samples of athletes, such as team and individual sports, which made it difficult for comparisons. Similarly most of the sports that were studied in this review were baseball, basketball, hockey, soccer and gymnastics, so the results of the review may be difficult to compare to risk factors that may be identified in adolescent runners.

McGuine (2006) also found that the majority of research into risk factors for sports injury in adolescents has looked into the more popular sports such as American football, soccer and basketball. The author also acknowledges the lack of research into risk factors for injury in sports that emphasise upper limb activity. Similarly to Emery (2003) it is difficult to compare data between studies due varying study designs, data collection, injury definitions, and use of appropriate medical professionals for data collection.

Finally, the review by Veigel and Pleacher (2008) was not a sound literature review. The article discusses certain prevention strategies for injury, but there is no discussion about how the data was extracted, who collected the data, and what the selection criteria included. The article touches on similar aspects of injury prevention to that of McGuine (2006), but is not comparable in terms of scientific basis for the argument of injury prevention. The article is written as though it is a professional opinion, more than as a literature review, and due to the poor method and discussion should be interpreted with caution in terms of its impact on sports medicine.

From the literature review of risk factors in adolescent sport, clearly more investigation in the scope of adolescent sport is needed. Secondly, the need to investigate risk factors associated with injury in adolescent runners is clear, as well as the need for sound methodology and injury definitions across the board in investigating risk factors. However, it is apparent that the pattern of using multi-intervention programmes may have some benefit in reducing the incidence of injury in adolescent athletes. The evidence supporting multi-intervention strategies, as well as the benefits of each individual component will now be discussed.

2.4 Injury prevention strategies

2.4.1 Static stretching

Stretching is routinely used to improve flexibility in athletes, and several methods of stretching including passive, static, isometric, ballistic, and proprioceptive neuromuscular facilitation exist. Flexibility is the "intrinsic property of the body tissues that determines the range of motion achievable without injury at a joint or group of joints" (Thacker et al. 2004, page 371).

Stretching is often recommended by coaches, sports teachers or physiotherapists, either prior to or after exercise (Shehab et al. 2006). Static stretches are often used as part of a warm up to prevent muscle soreness, reduce number of injuries or improve flexibility (Small et al. 2008; Herbert and De Noronha 2007; Thacker et al. 2004). The evidence though shows the contrary to this practice of injury prevention. The current body of evidence suggests that routine stretching prior to an athletic event may predispose the athlete to injury or negatively affect their performance, yet the use of stretching in the school athletic setting is continually prescribed (Small et al. 2008; Shehab et al. 2006; Cramer, Housh, Johnson, Miller, Coburn and Beck 2004; Thacker et al. 2004; Pope et al. 2000).

Pope et al. (2000) performed a randomised trial to assess the prevention of lower-limb injury following pre-exercise stretching. They assessed 1 538 army recruits who were divided into a control and experimental group. Each group underwent a twelve-week training programme which was either preceded by active warm up exercises or active warm up exercise and a twenty-second static stretch of each major muscle group of the lower limb at each session. Uni-variate and Cox regression models were used to examine the effects of stretching while controlling for BMI, weight, height, age and twenty-metre progressive shuttle run test (20mSRT). The study found 175 injuries in the control group and 158 injuries in the stretch group. They found no significant effect of the pre-exercise stretching on reduction of injury risk (p value > 0.05), and concluded that stretching as part of a warm up does not significantly reduce the risk of injury and that fitness may play an important part in injury prevention. Fitness of the army recruits was assessed using the twenty mSRT, which following the data analysis was shown to be a strong predictor of injury risk. However, although the study found a strong and reliable association between the twenty mSRT score and lower limb injury, no causal relationship has been shown.

Thacker et al. (2004) also performed a systematic review of the literature on the impact of stretching on sports injury risk. They searched electronic databases from 1966 to 2002 from MEDLINE, Current Contents, Biomedical Collection, Cochrane library and SPORTSDiscus. Each study was weighted by total study size and a 95 per cent confidence interval was calculated using the Mantel-Haenzel procedure. There was no formal test for publication bias due to no significant differences between studies being found. There were six articles which met all inclusion and exclusion criteria for the study. Results from the review showed that a passive stretch for fifteen to thirty seconds is more effective than a dynamic stretch to improve flexibility and that the duration of flexibility after stretching is from six to ninety minutes. The study found that stretching did not significantly reduce the number of injuries, and has been associated with decreased strength benefits, increased arterial blood pressure, decreased jump performance, decreased plantar flexion, and decreased running economy and performance.

Similarly Thacker et al. (2004) found that warm-ups that include stretching have not been shown to reduce muscle soreness. However, programmes that combine warm ups, strength and balance training have demonstrated effectiveness in the prevention of knee and ankle injuries. In summary, the authors concluded that there was not enough evidence to support or discourage the regular use of stretching before or after exercise.

Further negative effects of static stretching were found by Cramer et al. (2004) in their experimental study in a group of women who were recreationally active. The study examined the effects of static stretching on concentric, isokinetic leg extension peak torque in stretched and un-stretched limbs using a test-retest design. Fourteen participants volunteered to take part in the study and performed a five-minute warm up prior to the testing. The peak torque of the dominant and non-dominant leg was measured by a calibrated Cybex 6000 dynamometer, prior to stretches and then after stretching. The data was analysed by two separate three-way repeated measures Analysis of Variance (ANOVA). A *p* value of less than 0.05 was considered statistically significant. The statistical analysis showed the peak torque of both the dominant and non-dominant legs decreased following the static stretches. The researchers suggested that this decrease may be due to changes in the mechanical properties of the muscle or via the central nervous system inhibitory mechanism. The changes in the mechanical properties of the muscle affect the muscle's length-tension relationship due to increased muscle compliance. The changes in the muscle compliance may increase sarcomere shortening distance and velocity, and decrease the force production in the muscle due to the force-velocity relationship (Cramer et al. 2004). This study showed a similar stretch-induced decrease in force in both the stretched and un-stretched limbs, which suggests a central nervous system mechanism may be responsible for the decreases in force production (Cramer et al. 2004). Overall the study indicated that static stretching impairs maximal force production.

With current evidence in mind one needs to understand why static stretching is still common practice as part of a warm up. Shehab et al. (2006) give some insight as to the possible reasons for coaches still practicing this potentially harmful habit. The study performed a cross-sectional survey of seventy-one high-school athletic coaches in public schools in Southeast Michigan County. The survey examined the knowledge, attitudes and practice of the coaches with regards to pre-exercise stretching and sports injuries. The investigators developed a survey based on a review of the literature and discussion with team physicians and coaches not involved in the study, as there was no similar survey instrument found in the literature. The survey was pilot tested and the ease of readability was 10.8 based on the Flesch-Kincaid grade level scale. A response rate of forty-six per cent yielded data that most of the coaches were male and had graduate degrees. The average age of the coach was thirty-nine years with eleven years' experience. Frequency and summary statistics were calculated for all variables and comparisons were made between gender of the coaches, coaching experience, and setting of the school. Data analysis was done using *t* tests and chi-square tests. The survey found that there was a distinct gap between the coaches' current practice and recent evidence regarding pre-exercise stretching. The results showed that ninety-five per cent of coaches agree that pre-exercise stretching is beneficial, and ninety-three per cent believe it may prevent injury. Approximately eighty per cent of the coaches felt that pre-exercise stretching is important for athletic conditioning and sixty-three to eighty-five per cent believe that the possibility of injury or fatigue was not an important drawback for pre-exercise stretching. Another important finding was that the coaches stated they would be influenced by personal experience (95%) and scientific research (93%) as factors that could change their recommendations. Therefore showing that coaches valued their personal experience just as much as scientific evidence in determining their practice, but an obvious disconnect between recent evidence and current practice exists among high school athletic coaches.

Reinforcing the findings in the Thacker et al. (2004) review, Herbert and De Noronha (2007) reviewed ten randomised trials looking at the effect of stretching before or after exercise on muscle soreness. The authors searched the several databases between 1966 and May 2006 and screened for articles that were eligible for the study. The methodological quality of the studies was assessed using the Cochrane Bone, Joint and Muscle Trauma Group quality assessment tool. No heterogeneity of effect was found, therefore a fixed-effect model was used to pool findings across the studies. Pooling of the data was done by converting the 100 mm analogue and ten-point pain scales into a common 100-point scale. None of the studies that were included examined the effects of stretching on muscle soreness in children. The finding from their review of the articles consistently suggest that stretching before or after exercise does not reduce muscle soreness in young healthy adults.

Small et al. (2008) performed a systematic review with respect to using static stretching during a warm up to prevent injury. The literature review examined articles from after 1990 to before January 2008 from MEDLINE, SPORTDiscus, PubMed, and ScienceDirect databases to assess the efficacy of stretching as part of a warm-up with respect to injury prevention. Seven studies met the inclusion and exclusion criteria, of which four were randomised controlled trials and three were clinically controlled trials. The included trials were assessed for methodological quality using a criteria list by Tulder et al. (2003), with the scores ranging from twenty-six to seventy-nine points out of 100. The heterogeneity of the studies did not allow for meta-analysis and studies were considered to be positive if the results concluded that a static stretching protocol resulted in significant reduction in total injury risk (p value < 0.05). From their review, it was found that six of the seven included studies showed a negative effect for static stretching (p value > 0.05), and conclusions were based on the effect of stretching on total injury risk and not the original authors conclusions. The four RCTs scored over fifty points for methodological quality, and the CCTs scored below fifty points, showing that there is moderate to strong evidence that routine static stretching does not prevent injuries.

However, some studies reviewed showed that static, pre-exercise stretching may prevent the incidence of musculotendinous and ligamentous injuries, due to the improved flexibility in the ligaments and musculotendinous units. The improvement in the flexibility may be due to elongation of the connective tissue, which may improve muscle relaxation and thus improve joint range of motion (Small et al. 2008).

A randomised trial by Chaouachi et al. (2008) also found a negative effect of static stretching on sprint performance in a group of thirteen to fifteen-year old youths. The study examined the effects of stretch and sprint training on the acute effects of static stretching in forty-eight healthy school students. Subjects were randomly divided into two experimental groups participating in six weeks of sprint training during the physical education classes. The sprint only group did not implement static stretching into the pre-training warm-up, whilst the static stretch and sprint training group performed static stretches at the beginning and middle of speed training. The two groups performed low back and hamstring flexibility tests using a standard sit and reach device, and each participant performed the test three times with the best of three scores being used in the statistical analysis. Sprint times were also assessed using maximal sprint tests over thirty metres before and after training. Statistical analysis was done by using a three-way repeated measure Analysis of Variance (ANOVA). The results from the study showed that prior static stretching impairs sprint times at ten ($p = 0.01$) and thirty metres ($p = 0.0005$). Both groups showed overall improvement in times over ten and thirty metres sprint distance after training, and the stretch and sprint group were more resistant to stretch-induced sprint deficits than the sprint only group at five ($p < 0.0001$), ten ($p = 0.0002$) and thirty metres ($p < 0.0001$).

Similarly to research into risk factors for injury, the research into static stretching has been mostly conducted in adult populations. For instance the study by Pope et al. (2000) whose studies in adult army recruits found no significant reduction in lower limb injury following a static stretch programme. Another problem with this study was that there was no mention of blinding of the injury assessors in the study as to which group the individual recruits were assigned or to the nature of the study. This could have led to some reporter or an effect bias when recording results on behalf of the injury assessor, if they had pre-perceived ideas regarding the effect of stretching on injury prevention. Cramer et al. (2004) also performed their study using an adult female population, however their sample size was very small, and no power calculation was noted to assess for effect of the intervention.

However, in the study by Shehab et al. (2006) had several limitations as discussed in the article. Firstly the results were only collected from high schools in a certain area, and so may not be generalised to other coaches, other schools or other levels of competition. Secondly the data collected in two of the sections was self-reported and this could lead to some recall bias. The number of coaches that could participate in the study as also limited due to the lack of direct contact with the coaches, and this may have unfairly eliminated the coaches from several sports. Lastly the study examined the knowledge, attitudes and practices of several different coaches in different sports, and this makes it difficult to apply the results implicitly to athletics, as a general consensus is given for all sports.

The implication of Herbert and De Noronha's (2008) review also requires some critical analysis because although the study was methodologically sound, the study did not review articles relating to the effects of stretching on muscle soreness in children. The results should thus be interpreted with caution when applying within a school setting.

The study conducted by Chaouachi et al. (2008) did investigate the effect of stretching in the adolescent athlete and found impairment in sprint times after stretching. Although the study was conducted soundly there were a few factors which affect the methodological quality. Firstly the sample was one of convenience due to the relationship between the laboratory centre and the physical trainer at the school. Secondly there is no mention as to who recorded the baseline and subsequent measurements during the study, which may have resulted in recorder bias.

The current evidence on the effects of static stretching on injury prevention suggests a divided opinion as to whether there is a beneficial or detrimental effect. The practice of using static stretching though remains popular with high school coaches in many sports. The continued practice of static stretching may be due to the lack of evidence for its discontinued use, particularly in adolescent and youth sport. The majority of the research into static stretching has been conducted in adult sample populations, as a result making it difficult to generalise within a youth setting. Recently research looking at using active warm-up sessions to help prevent injury rather than static stretching has been conducted, and many of the studies have been conducted in adolescent athletes. The use of active warm-up sessions will now be explored.

2.4.2 Warm-up sessions

As discussed in the previous chapter, there are many components to a structured warm-up session – one of which is static stretching. In this chapter a second component - that of active exercises during a warm-up session - will be discussed. The term “warm-up” is defined as “a period of preparatory exercise in order to enhance subsequent competition or training performance” (Fradkin et al. 2010, page 140). Although this aspect of the warm up session is not routinely done, the use of active exercises to prepare the athlete for training or competition is an important aspect of injury prevention. Active exercises that can be used in a warm-up programme include strength, proprioception, technique, neuromuscular control and dynamic movements (Fradkin et al. 2010; Soligard et al. 2008; Abernethy and Bleakley 2007; Fradkin et al. 2006; Olsen et al. 2005). Moderate evidence exists that these methods prevent injury in adolescents, but there is a trend towards using these methods of warming up in conditioning programmes.

Several studies evaluated the effects of a structured warm up on physical performance and injury prevention (Fradkin et al. 2010; Soligard et al. 2008; Fradkin et al. 2006; Olsen et al. 2005). In a cluster randomised controlled trial by Olsen et al. (2005), 120 team handball clubs from central and eastern Norway were investigated with regards to the effect of exercises to prevent lower limb injuries. The study looked particularly at the effect of a structured warm up to reduce the incidence of knee and ankle injuries. The clubs were matched by region, playing level, gender, and number of players to reduce potential confounding variables. The clubs were block randomised into a control group of 879 players, and an intervention group of 958 players. The clubs that were part of the intervention group received a structured warm-up programme at the beginning of the handball season, with follow up through the season from instructors. The intervention programme consisted of arm-up exercises, technique, balance and strength. The control group was instructed to carry on training as per usual. The primary outcome of the study was an acute injury to the knee or ankle. The sample size was determined following a pilot study to determine the incidence of injury the previous season. The power calculation was set at ninety per cent, as 915 players to have a fifty per cent reduction in injuries. The study used relative risk of the number of injured players according to the intention to treat principle to compare the risk of an injury in the two groups. Cox regression was the analysis tool used for the primary and secondary outcomes, and two-tailed *p* values of less than 0.05 were considered significant. During the season 129 acute knee and ankle injuries occurred, of which eighty-one occurred in the control group and forty-eight injuries in the intervention group. Significantly fewer injured players were in the intervention group than the control group for injuries overall, lower limb injuries, acute knee or ankle injuries, and acute knee and upper limb injuries.

The study therefore concluded that a structured warm-up programme to improve proprioception and control of knees and ankles during landing and pivoting movements reduces injuries to the lower limb in youth handball teams.

Fradkin et al. (2006) performed a systematic review to examine whether warming-up prevented injury in sport. Relevant studies from MEDLINE, SPORTDiscus and PubMed from 1966 to April 2005 were searched for human subjects, and if they utilised other activities than just stretching. The reference lists used in the included studies were also searched for relevant articles. The methodological quality of the studies was assessed using the PEDRo scale. The review found five studies that met the study criteria regarding warming up on injury risk, with PEDRO scale scores ranging from seven to nine out of eleven. Due to the paucity, heterogeneity and limitations of the five studies, definitive conclusions could not be drawn as to the role of warm-ups for reducing the risk of exercise-related injury. Three of the studies found that warming up prior to sports participation significantly reduced injury risk, whilst the other two studies suggested no significant reduction of sports injury following a warm up programme. The authors concluded that insufficient evidence perhaps supports that warming-up is harmful to sports participants.

Further studies into structured warm up programmes were performed, but majority of these studies investigated injury prevention in footballers, American football or basketball. Soligard et al. (2008) performed a cluster randomised controlled trial amongst 125 female youth football clubs in Norway that were followed for eight months. Participants were 1892 female players aged thirteen to seventeen years, which were randomly allocated to an intervention group (n = 1055) and a control group (n = 837). The intervention group received a programme of warm-up exercises designed to reduce the risk of injury and enhance performance, whilst the control group were instructed to warm up as usual. The main outcome measure was any injury to the lower extremity and injury reports were completed subjectively by the coaches. The risk of injury between the two groups was compared by the rate ratio of risk of injury according to the intention to treat principle. A Cox regression was used to assess for the primary and secondary outcomes and *p* values of less than 0.05 were considered significant. The internal validity found no differences between the groups in their training or match exposure during the study. Injury recorders were blinded to the subjects group, and interviewed the players using a standardised questionnaire. During the season 121 players in the intervention group and 143 in the control group sustained relevant injuries, with an overall incidence of injury of 3.9 per 1 000 player hours. The intervention group showed a significantly lower risk of injuries overall, overuse injuries and severe injuries. The intervention group also had significantly fewer players that had two or more injuries; however, the primary outcome did not reach significance. The study by Soligard et al. (2008) showed that a structured warm-up programme in young female footballers showed that the risk of injury can be reduced by one third and severe injuries by one half.

Finally, Fradkin et al. (2010) performed a meta-analysis on the effects of warming up on physical performance. Relevant studies were identified online via MEDLINE, SPORTDiscus and PubMed from 1966 to April 2008 with regards to the effects of warming-up on performance improvement. Performance improvement was defined as “the concept of measuring the output of a particular process or procedure, then modifying this to increase the effectiveness of the initial process or procedure” (Fradkin et al. 2010, page 140). Studies were included only if the subjects were human, and only of the warm-up included activities other than stretching. Methodological quality was assessed using the PEDRo scale, with a higher score being of better quality evidence. All studies that scored a six or less out of ten were excluded. Thirty-two studies were included in the review with scores ranging from 6.5 to nine out of ten. The studies showed a majority improvement in performance after warm-up (79%) following assessment on nine different combinations of warm up. The study showed that completing a warm up before participating in many different sports has been shown to improve the subsequent performance. Fradkin et al. (2010) also suggest from their review that there is very little evidence to suggest that warm up has a negative impact on performance.

The general consensus is that active warm ups have a beneficial effect in injury prevention, but only a handful of articles have examined the effect of warm-ups on injury prevention. More high quality studies in active warm-ups need to be performed to assess whether their overall impact is beneficial to injury prevention. Secondly, only two of the studies reviewed regarding active warm-ups investigated the effect of active warm-ups in an adolescent population. It would be beneficial to perform more research into active warm-ups in adolescents to improve the volume of evidence in this regard.

In the randomised controlled trial by Olsen et al. (2005), the methodological quality of the study was high; however, the generalizability of their results amongst adolescent athletes who compete in sports other than handball is questionable. The techniques and endurance required in handball differ to the technique and possibly the endurance required by adolescent middle and long distance runners. Similarly in the systematic review by Fradkin et al. (2006) no significant conclusions could be made from the results due to the heterogeneity and limitations of the included studies. The review only produced five good quality studies based on the PEDRo scale, which again shows the lack of a significant body of evidence regarding the use of active warm-ups in injury prevention.

In the randomised controlled trial by Soligard et al. (2008) a comprehensive, multi-intervention warm-up programme was used to assess its effectiveness in reducing injuries in young female footballers. The study had a very large sample size and showed a beneficial effect of a comprehensive warm-up in injury prevention; however there are several limitations in the study. Firstly the authors relied on the football coaches to teach the exercise programme to the students without follow-up instructions and the coaches were responsible for the injury reports. Subjective reporting of this nature gives the study a biased slant when interpreting the positive results found. Secondly there were a large number of teams excluded from the study due to the fact that they did not deliver any data on injury exposure, and because there was no blinding of the subjects to group allocation, many coaches were not willing to participate as part of the control group. Another factor that affects the quality of this study is that the inflation factor for cluster effects was higher than the power calculation, indicating that the authors underestimated the number of players needed to establish the intervention effects. The power calculation also estimated a lower drop-out rate (15%) than actually occurred (25.6%) which could mean that if there was a larger sample that completed the study, there may have been a larger beneficial effect on injury prevention.

Several weaknesses exist in the review by Fradkin et al. (2010) as well, although the weaknesses in the review have been acknowledged by the authors. One of the limitations of Fradkin et al. (2010) review is that the sample size in many of the included studies was relatively low in number. Many studies were also excluded due to the studies examining the effect of warm-ups on physiological characteristics, instead of the effect on injury prevention. The exclusion of these results may have limited the number of studies showing a beneficial or detrimental effect of using active warm-ups.

The studies that have examined the effect of active warm-ups on injury prevention seem to favour a beneficial outcome. However, due to the limited number of studies and the heterogeneity of studies it is difficult to make definitive conclusions regarding the effect of active warm-ups, Similarly better methodological quality studies need to be performed. The lack of definite effect may be due to the fact that these warm-ups consist of multi-factorial components, which may themselves have merit in injury prevention. The next section will discuss the effect of strengthening exercises in injury prevention.

2.4.3 Strength training

"Strength training" is a term used to describe a variety of dynamic resisted or non-resisted "training programmes based on progressive overload and designed to improve muscular strength and endurance" (Malina 2006, page 478). Strength training is another integral component of an injury prevention conditioning programme in athletes, as Niemuth et al. (2005) showed an association between injury risk and muscle weakness. Due to the repetitive nature of running, the majority of injuries tend to be overuse injuries, which may be as a result of muscle imbalances (Niemuth et al. 2005). The studies that have investigated the effects of strengthening programmes on injury prevention have looked at various aspects of strengthening including resistance training (Snyder et al. 2009; Malina 2006), plyometrics (Spurrs et al. 2003), core strengthening (Sato and Mokha 2009) and maximal strength training (Storen et al. 2008).

The review of the current literature regarding strength training yielded six articles of relevance. In a randomised trial by Spurrs et al. (2003) the study assessed the effect of a plyometric training programme on distance running performance. Running performance was correlated with running economy which was defined as “the steady-state oxygen requirement for a given submaximal running velocity” (Spurrs et al. 2003, page 1). A total of seventeen male distance runners were randomly assigned to an experimental group (n = 8) and a control group (n = 9). The experimental group performed six weeks of plyometric training, whilst the control group just performed their usual running. Subjects in both groups continued their average weekly running of sixty to eighty kilometres. Pre- and post-test measurements were taken of musculotendinous stiffness, maximum isometric force, rate of force development, five-bound distance test, counter movement jump height, running economy, maximum oxygen consumption, lactate threshold and three kilometre time. The mean (SD) was calculated for all test variables using standard methods and a one-way Analysis of Variance (ANOVA) was used to determine whether any differences existed between the experimental and control groups. Pearson’s correlation was used to analyse the relationship between changes in musculotendinous stiffness and running economy. The statistical significance was set at p less than 0.05. The results of the study showed a significant improvement in three kilometre running time ($p < 0.02$) in the experimental group who underwent the plyometric training. Similarly running economy was significantly improved at twelve kilometres per hour ($p < 0.004$), fourteen kilometres per hour ($p < 0.002$) and sixteen kilometres per hour ($p < 0.009$).

In the descriptive analysis study by Niemuth et al. (2005), the study looked at hip muscle weakness and overuse injuries in recreational runners. The sample for the study consisted of thirty-two injured and forty-eight non-injured runners who met the inclusion and exclusion criteria. The injured runners in the experimental group had been referred to one of three physiotherapy clinics by a physician. Initial visits consisted of a completed health and running history, and a complete biomechanical assessment. Each leg was tested for muscle strength during an isometric contraction in six muscle groups by a blinded recorder who used a hand-held dynamometer. A Chi-square analysis was used to determine if the age, weight or leg dominance affected injury status in the injured runners. Pearson's correlation was calculated for the internal reliability of the muscle measurements by the hand-held dynamometer between trials one and two. For each muscle group by leg combination, the Anderson-Darling Normality Test was applied to check for normality of muscle strength scores in the shape of each distribution. Independent group *t* tests were used to compare muscle strength differences between first-time and recurrent injury runners. A two-way mixed Analysis of Variance (ANOVA) was conducted for the factors of injury status and leg, and for duration of symptoms and leg. The level of significance was set at *p* less than 0.05. Compared to the non-injured runners, the injured group showed significant side-to-side differences in muscles strength in hip flexors ($p < 0.026$), hip abductors ($p < 0.000$) and hip adductors ($p < 0.010$). The injured side hip flexors and hip abductors were significantly weaker and their hip adductors were significantly stronger than their uninjured side muscles. Non-injured runners did not show any side-to-side differences in hip strength. The results of the study suggest that a relationship exists between hip muscle imbalance and injury patterns in runners suffering from overuse injuries that do not exist in uninjured runners.

A majority of the research into strength training examined the effect of such training in adult populations. Malina (2006) performed an evidence review to assess the effects of weight training programmes in pre- and post-pubertal youths. The study was a review that looked at twenty-two reports dealing with experimental resistance training programmes in context of subjective characteristics, training protocol, responses, and occurrence of injury. Studies that were based on young athletes and isometric protocols were not included. The study did not have clear methodology in terms of article searches or objective measures of article quality. The author subjectively analysed the data. The study found that resistance training two or three times a week resulted in significant improvements in muscular strength. Although it was concluded that weight training was relatively safe among adolescents, only ten studies monitored injuries. The estimated injury rates during the respective programmes were 0.173, 0.053 and 0.055 per 100 hours of participation, but it is unclear from the review whether these injury rates were significant or not. The studies did however fail to monitor whether the weight training is beneficial in reducing the injury incidence. The resistance training did not influence height and weight of the adolescents. The literature suggests that training protocols that involve weight training should be supervised and has a low instructor-to-participant ratio to maintain the safety of these programmes.

Similarly Storen et al. (2008), found no negative effects of maximal strength training programme in distance runners. Storen et al. (2008) assessed the effect of maximal strength training in runners on running economy and time to exhaustion in seventeen well trained runners. The runners were randomly assigned to an intervention ($n = 8$) or a control group ($n = 9$), with the intervention group supplementing their normal endurance training with an eight week squatting programme. The two groups were matched for age and five-kilometre running performance, and none of the participants had undergone any resistance training in the previous six months. Pre- and post-tests were performed measuring heart rate, blood lactate concentration and maximal oxygen uptake during five-minute runs. The second day of testing consisted of tests for time, heart rate, blood lactate concentration and maximal oxygen uptake during a run to exhaustion at maximal aerobic capacity. After a period of thirty minutes subjects were then tested for a one repetition maximum in a half-squat with free weights. Descriptive statistical analysis was done to display means and standard deviations. To compare means, paired t-tests and independent sample t-tests were used. Correlations were calculated using Pearson's correlation test and significance was set at p less than 0.05. After the eight-week training programme significant improvements were seen in one repetition maximum ($p < 0.01$), rate of force distribution half-squat ($p < 0.01$), running economy at seventy per cent maximal oxygen uptake ($p < 0.05$), time to exhaustion at maximal aerobic capacity ($p < 0.05$), heart rate at lactate threshold ($p < 0.01$) and heart rate at seventy per cent maximal oxygen uptake ($p < 0.01$) in the intervention group. Significant correlations were found between five-kilometre running time and lactate threshold velocity ($p < 0.01$), between five-kilometre running time and maximal aerobic speed ($p < 0.01$) and between five-kilometre running time and maximal oxygen uptake ($p < 0.01$). The study concluded that heavy resistance training for eight weeks increased running economy and time to exhaustion at maximal aerobic speed among well-trained, long distance runners.

Sato and Mokha (2009) showed a similar improvement in running performance in their study. The study used a test-retest design to evaluate whether core strength training (CST) influences running kinetics, lower extremity stability and 5 000-metre performances in runners. The study examined twenty-eight recreational and competitive rear-foot-strike runners who qualified and volunteered for the study. Subjects were randomly allocated to a control (n = 14) and a core stability training group (n = 14), but only twenty participants completed the post-training tests. Screening for core stability was scored according to the Sahrmann core stability test. Measures of ground reaction force, lower extremity stability and running performance were assessed between the two groups. Lower extremity stability was assessed using the Star Excursion Balance Test, and running performance was determined by 5 000-metre run time measured on outdoor tracks. A mixed design Analysis of Variance (ANOVA) was used to determine the influence of CST on each dependant variable and the significance was set at p less than 0.05. The results of the study show that the CST group showed significantly faster times in the 5 000-metre run ($p < 0.05$) after six weeks. However the CST did not influence ground reaction force variable and lower extremity stability.

An alteration in lower limb biomechanics following a strengthening programme was examined by Snyder et al. (2009) which showed some beneficial changes in biomechanics with regards to injury prevention. The study assessed the effect of a hip abductor and hip external rotator muscle strengthening programme over a period of six weeks in fifteen female participants, using a within subjects repeated measure design. The participants were fifteen healthy female volunteers who met the inclusion and exclusion criteria, and their biomechanical data was collected during running by a high speed motion capture system. The intervention consisted of six weeks of closed chain hip rotation exercises and measurements of strength were done using a hand held dynamometer before, at three weeks and after the six weeks of strengthening. Joint range of motion, eversion velocity, eversion angle at heel strike, and peak joint movements were analysed using repeated measure ANOVA, with a significance value set at *p* less than 0.05. A separate analysis of variance was conducted with the dependant variables of peak hip abduction and external rotation strength. The results show that the hip abductors and hip external rotators strength increased by thirteen per cent ($p = 0.009$) and twenty-three per cent ($p < 0.0005$) respectively. Eversion range of motion decreased ($p = 0.05$), hip adduction range of motion increased ($p = 0.05$), whilst rear foot inversion moment decreased by fifty-seven per cent ($p = 0.02$) and knee abduction moment decreased by ten per cent ($p = 0.05$). Snyder et al (2009) found that strengthening of the hip external rotators and abductors led to alteration of lower limb joint loading which improved biomechanics and may lead to reduced injury risk.

The evidence reviewed with regards to strength training yielded only one study examining the effects of strength training in youths and potential risk of injury (Malina 2006), while only two studies showed any potential benefit of strength training in reducing the incidence of injury (Niemuth et al. 2005; Snyder et al. 2009). The other three articles reviewed examined the effects of strength training on running performance (Sato and Mokha 2009; Storen et al. 2008; Spurrs et al. 2003) and not on injury prevention.

In Spurrs et al. (2003) randomised trial the effect of plyometric training only examined the effect on running performance and not injury prevention. The study's sample size was very low (n = 17) and therefore the potential overall effect in a larger population is unknown as no power calculation was performed. Secondly it is unclear from the study as to who performed the data collection and whether there was any blinding of the data collectors to the subjects' group allocation. Another limitation to the study, as acknowledged by

Spurrs et al. (2003, page 6) is that there was a “trend towards differences between the two groups on certain aspects of the pre-test data.”

A positive association was however found between hip muscle strength imbalance and overuse injuries in runners in a later study (Niemuth et al. 2005). The well-conducted study though had a few limitations, which were acknowledged by the authors. Firstly the study made use of a handheld dynamometer for muscle testing and the reliability of this device would depend on the strength of the tester. Secondly, some of the information collected for analysis was self-reported by the study subjects, which may have led to some recall bias on their part, and so may have affected the accuracy of the information. More female than male participants were included due to the fact that participants were selected if they met inclusion criteria as they presented at the clinics. Lastly, runners were excluded if they had lower limb overuse injuries concurrently with injuries to their hip, sacroiliac joints, and low back.

Malina (2006) also found that strength training using weights and resistance machines does not necessarily predispose the athlete to injury. Although the study examined twenty-two experimental studies on the subject of weight training in youth populations, the methodological analysis of the studies was very subjective as no scale was used to assess the quality of the studies. Overall the reported methodology in the study was poor. It is also unclear whether there was heterogeneity of the studies’ data, so comparisons between the studies may have been difficult to perform.

Storen et al. (2008) study also examined strength training on running performance and not on injury prevention. The sample size used in the study was also relatively small (n = 17), and so it may be possible that a similar effect may not exhibit the same results in a larger population. No power calculation was performed to determine the correct number of subjects required. Secondly no clear indication is given as to who collected the data pre- and post-test, or whether there was any blinding of the assessors to the subjects’ group allocation. Purely subjective evaluations performed by the test leader as to whether subjects could perform the strength training and run on a treadmill without supervision. Lastly the subjects had to self-report their weekly amount of time spent in different training intensity zones, all of which could have affected the accuracy of the information used in the study.

Sato and Mokha (2009) also examined the effects of strength exercises on running performance and not on injury prevention. The study was also limited by the amount of collector and recall bias, as there was no clear indication as to who performed the data collection, whether the data collectors were blinded to subjects' group allocation, and the subjects self-reported on training logs. Another limitation to the study was the explanation of the warm-up session performed prior to each 5 000-metre run, which makes the study less reliable.

One of the only studies to examine the relationship between muscle strength and injury was the experimental study by Snyder et al. (2009). Although the study found a relationship between hip muscle strengthening and improved lower limb biomechanics, the sample size used in the study was relatively low (n = 15). Secondly, all the subjects in the study had a normal foot type which limits the interpretation of the results within populations who present with excessive pronation or supination. Lastly there is a need for studies to examine the changes of lower extremity biomechanics during other tasks following hip muscle fatigue or in a group of patients with hip muscle weakness.

Strength training is one of many components that can be used in a conditioning programme to prevent sports injuries. However, when reviewing the current evidence, only a couple of studies showed a potential positive effect of strength training on injury prevention (Snyder et al. 2009; Niemuth et al. 2005). The other evidence reviewed shows that strength training may only improve running performance (Sato and Mokha 2009; Storen et al. 2008; Spurrs et al. 2003) and did not take into consideration the effect on injury prevention. A concerning point is that once again the majority of strength training literature involved adult sample populations, and the application of strength training principles amongst youth runners may not yield similar results. However, Malina (2006) did show that several experimental studies have shown weight and resistance training to be safe in youth participants, as well as not predispose them to injury. More methodologically sound studies need to be conducted in youth athletes to assess whether strength training has a beneficial effect on injury prevention. The next section will examine the effects of endurance training as part of a conditioning programme to prevent injury in youth athletes.

2.4.4 Cardiovascular endurance training

Endurance training is "training performed to increase aerobic capacity or fitness. The aerobic capacity of an individual is the ability to utilise the body's glycogen stores via the aerobic metabolic pathway," (Brukner and Khan 2001, page 98). An athlete's fitness is measured by maximal oxygen uptake or (maximal oxygen consumption (VO_{2MAX}). Heart rate tends to correlate well with oxygen consumption, so if an athlete has a reduced resting heart rate, then it correlates with a higher fitness level (Brukner and Khan 2001). Endurance training forms the basis of any athletes training, and in runners can be a cause of running-related injury if done in excess (Buist et al. 2007). The aim of this section of the literature review is to establish if there is any evidence that endurance training as part of a conditioning programme has any effect on injury prevention.

The literature review yielded only one article that examined the effect of a graded training programme on running-related injuries. Buist et al. (2007) performed a randomised controlled trial of 532 novice runners who were divided into a control (n = 268) and an experimental group (n = 264). The control group followed an eight-week standardised training programme and the experimental group followed a modified thirteen-week training programme leading up to a recreational four-mile run. The thirteen-week graded programme was based on the ten per cent training rule, whereby the training load was increased by ten per cent in volume on a weekly basis. Stratified randomisation occurred to ensure that both the training groups were equal in terms of priori injury risk. A baseline questionnaire covered the demographic variables, current sports participation, running experience and site of previous musculoskeletal complaints. The primary outcome measure was running related injury per 100 participants. A power calculation was carried out for a main outcome variable of running-related injury using a logistic rank survival power analysis. The power calculation indicated that 512 participants were required to show a twenty per cent reduction in injury. Two-tailed t-tests were used for comparing normally distributed continuous variables, and Chi-square tests were used for discrete variables to evaluate the effect of a graded training programme. Differences were considered significant at *p* less than 0.05. The results of the study showed that a graded training programme alone was not preventative for sustaining running related injuries (p = 0.90). The control group had an injury rate of 20.3 per cent compared to 20.8 per cent in the graded training group, with the log-rank test showing no significant differences between the two groups (p = 0.18).

Several limitations exist in the research reviewed regarding the use of endurance training in injury prevention. Firstly, only one study was found regarding the use of endurance training and injury prevention, which means very minimal research in to the topic has been explored. Secondly, the article by Buist et al. (2007) explored the use of a graded training programme in an adult population, and therefore the use of endurance training as part of an injury prevention programme in adolescents has not been researched.

The actual study by Buist et al. (2007) has several limitations itself. Firstly collection of the data from the subjects is not mentioned, or whether the data collector was blinded to the subjects' group allocation. Secondly the subjects had to complete their own training logs during the study which may have resulted in recall or reporter bias resulting in inaccurate information. Lastly the study did not compare the graded endurance group to that of subjects who did not participate in an endurance programme at all as a control. This could be a suggestion for future studies in endurance training, to explore whether a risk for injury may exist between the two groups.

Due to the lack of quality and quantity of research into endurance training as part of an injury prevention programme, no definitive conclusions can be made. There is a serious need for research into this aspect of conditioning in high-school middle and long distance athletes. Future studies should also be of better methodological quality. The use of balance exercises as part of an injury prevention programme will now be discussed.

2.4.5 Balance training

Balance can be defined as “the ability to maintain the body’s centre of gravity within its base of support” (DiStefano et al. 2009, page 2718).Balance can be further divided into static and dynamic balance. Static balance is the “ability to sustain the body within its base of support” and dynamic balance is “the ability to maintain equilibrium during a transition from a dynamic to a static state” (DiStefano et al. 2009, page 2718). Balance training requires the input of a number of biological systems and sensory organs including the visual, vestibular and proprioceptive systems. Over the past few years there has been increasing interest in the use of balance training as part of a conditioning programme to prevent injury in the adolescent athlete. Proprioceptive balance exercises have been used in rehabilitation programmes following an injury to aid in the recovery process. These exercises are now also being incorporated into conditioning programmes as an important prevention strategy in adolescent athletes (DiStefano et al. 2009; Emery et al. 2007; McHugh et al. 2007; Emery et al. 2005).

There were four studies found during the literature review regarding the use of balance exercises as part of an injury prevention programme. In their earlier study Emery et al. (2005) assessed the effectiveness of a sport-specific balance training programme to prevent injury incidence in high school basketball. The randomised controlled trial evaluated 920 basketball players between the age of twelve and eighteen years. The subjects were randomly allocated to a control (n = 426) or intervention group (n = 494) where they both received a standardised warm-up programme. The intervention group also received an additional warm-up component and a balance training programme on a wobble board. A baseline questionnaire was completed at the initial assessment which was conducted by the team therapist, who was blinded as to the subjects’ group allocation. The main outcome measure was any injury occurring during the basketball season that required medical attention and/or caused a player to be removed from that current session and/or miss the subsequent session. Baseline variables were compared across the study groups using a ninety-five per cent confidence interval, and injury rates and confidence intervals were calculated using a Poisson regression model. A multivariate Poisson regression analysis was done to estimate the relative risk of injury in the training group compared to the control group. Significance of results was set as p less than 0.05. The results of the study showed that the basketball specific training programme was effective in reducing acute-onset injuries in high school basketball ($p = 0.047$). The protective effect found with regards to all injury ($p = 0.18$), lower extremity injury ($p = 0.3$), and ankle sprain ($p = 0.15$) did not reach significance. There was however poor self-reported compliance to the home-based balance training programme.

Similarly Emery et al. (2007) studied the effectiveness of a home-based balance training programme in reducing sports injuries among healthy adolescents. The study consisted of a randomised controlled trial of ten Canadian high schools, where 127 students were recruited from physical education classes for grade ten to twelve, and randomly allocated to a control (n = 61) or experimental group (n = 66). Each subject completed a baseline questionnaire and a physiotherapist assessed height, weight and balance prior to the study intervention. Students in the experimental group participated in a daily six-week and then a weekly six-month home-based balance programme. The control group received testing only. The primary outcome measures were timed static and dynamic balance, twenty-metre shuttle run and vertical jump. Baseline variables were compared between the groups using descriptive statistic. Multivariate mixed-effect regression analysis was done to further examine the effects of the training programme in improving both the static and dynamic balance test results. Stratified analysis based on previous injury was also examined using Fisher's exact methods. After six weeks the intervention group showed improvements in static ($p < 0.0005$) and dynamic balance ($p = 0.007$) times compared to the control group. There was also evidence of a protective effect of the balance exercises over six months as there was less reported injuries in the intervention group than the control group after six months. The training programme was also more effective among subjects who had reported an injury in the previous year than those who reported no previous injury.

McHugh et al. (2007) also looked at the effect of a balance training programme in reducing non-contact ankle sprains in a cohort of high-school football players. Two high-school football teams consisting of 175 players were monitored during three seasons each from 2003 to 2005. Before each session players were categorised into minimal risk, low risk, moderate risk or high risk categories according to height, body mass, previous injury and current ankle brace/tape. Players in the low-, moderate- or high risk groups were placed into a balance training programme using a foam stability pad for four weeks pre-season and twice a week during in-season. Post-intervention injury incidence was compared to pre-intervention incidence for players with increased risk. The significance of the results was set at a value of p less than 0.05. The prevalence of non-contact ankle inversion sprains was significantly reduced ($p < 0.01$) for the players identified as being at risk for injury and who were on the intervention. Previous ankle sprains ($p = 0.48$) and body mass index classification ($p = 0.31$) were not significant post-intervention risk factors. The injury incidence for the players on the intervention was significantly lower ($p < 0.01$) than the combined injury incidence for the low-, moderate-, and high-risk players before the intervention, representing a seventy-seven per cent reduction in injury incidence.

Lastly, DiStefano et al. (2009) conducted a systematic review to examine the evidence supporting the use of balance training in healthy individuals. As balance is considered a risk factor to sports injury, and thus an integral component of many conditioning programmes, one needs to understand the effects of balance training in healthy individuals. The electronic search featured three databases; PubMed, CINAHL and SPORTDiscus for articles between 1988 and January 2008. A total of 16 articles were included in the review, which were all rated according to the PEDRo scale for methodological quality, with scores ranging from one to seven out of eleven. The authors also calculated effect size from means and standard deviations before or after balance training programmes where possible. Effect sizes greater than 0.7 were considered strong, between 0.41 and 0.7 were moderate and weak effect sizes were less than 0.4. Only two out of the sixteen articles reviewed showed no significant effect ($p > 0.05$) of improvements in balance following a balance training programme. The majority of the articles (n = 14) showed a significant improvement in balance ($p < 0.05$) with balance training in healthy individuals, and none of the studies indicated a negative effect of balance training in healthy individuals. The review suggests that there is strong evidence that balance training can improve static and dynamic balance in healthy individuals. It is suggested that balance training should be practiced for a minimum of ten minutes per day, three days per week for at least four weeks to improve balance ability.

The review of the current literature provides moderate to strong evidence that balance training may be an effective part of an injury prevention programme, but there are some limitations to the research that has been reviewed. Firstly in Emery et al. (2005) study, the authors discuss the use of a warm-up programme prior to the basketball players participating in activity, but no detailed description of the exact warm-up is given. The study also examined the effect of balance exercises in a population of basketball players, and thus further research would need to examine the effect of sport-specific balance exercises in injury prevention. Emery et al. (2005) study only found significantly positive effects of injury prevention for acute injuries, and not all injuries in high-school basketball players. The compliance of the students to the home exercise programme was also a limitation to the results of this study, and methods to improve subject compliance should be considered when assessing the use of a home exercise programme.

In their follow-up study, Emery et al. (2007) performed a cluster randomised controlled trial to assess the effectiveness of a home-based balance-training programme in reducing sports-related injuries among healthy adolescents. The study fails to mention at what level of significance the p value is set at prior to their discussion of their results. Secondly, the compliance in collecting prospective sports participation reports was poor. Thirdly, the moderate reliability and small inter-subject variability associated with the dynamic balance test could lead to an increased similarity between the study groups for this study variable. Lastly, the plateau or ceiling effect of the static balance test led to the inability to examine changes in subjects who reached the maximum time allowed for this test.

In the cohort study by McHugh et al. (2007) no clarity exists as to who collected the demographic and anthropometric data prior to the study, as well as whether there was adequate blinding of these data collectors to which category each subject was allocated. A major flaw to this study was the lack of randomised allocation of the participants into treatment and control groups. Thirdly, there was no control or documented control for confounding variables in the study, particularly the lack of control over ankle brace and tape use. Lastly there were twelve subjects who should have been on the intervention but chose not to participate and were excluded for analysis of effect of the intervention. The exclusion of these twelve subjects could have been included on an intention-to-treat basis.

The review by DiStefano et al. (2009), had few limitations due to the high methodological quality of the systematic review. However the authors acknowledged that several limitations were observed in a few studies. Only a few of the studies included measures to monitor compliance and supervise the training programmes. Secondly, that the issue of a pure randomised control group is important when evaluating the effectiveness of an intervention programme. Lastly DiStefano et al. (2009) suggest that the evaluators measuring subjective data should be blinded as to which group subjects have been allocated in future studies.

The use of balance exercises as part of an injury prevention programme have shown positive outcomes for previously injured and healthy adolescents (DiStefano et al. 2009; Emery et al. 2007; McHugh et al. 2007; Emery et al. 2005). Strong evidence appears in several studies with good methodological quality, showing the benefit of using balance exercises as part of an injury prevention programme in adolescents as well as adults (DiStefano et al. 2009; Emery et al. 2007; McHugh et al. 2007; Emery et al. 2005). Although improvements in compliance to these programmes is required, as well as more blinding of assessors in future studies, the beneficial trend of using balance exercises in an injury prevention programme is indicated. The next section will discuss the use of multi-intervention injury prevention programmes.

2.4.6 Multi-intervention training

Multi-intervention training is defined as a multi-faceted conditioning or exercise programme that involves "structured and repetitive physical activity that produces a higher level of physical fitness and athletic function, optimising performance and minimising the risk of injury" (Brooks et al. 2007, page 241). Multi-intervention training comprises several aspects which may help minimise injury risk including: stretching, structured warm-ups, strength training, endurance training, balance training and sport-specific skills. Previous sections in this chapter have detailed the use and effectiveness of these components individually in the prevention of sports injuries. The review of the literature yielded six studies examining the effect of multi-interventions on the effect of injury prevention, and whether the use of these components together or individually yields the best overall outcome.

Several studies investigated the use of multi-intervention training as part of an injury prevention programme. Aaltonen et al. (2007) reviewed randomised controlled trials from several databases up to December 2005 for relevant trials regarding athletic injury prevention. The studies had to include the injury rate or number of injured individuals as an outcome. The methodological qualities of the studies included were assessed using the PEDRo scale to score articles out of a total of eleven. The authors included thirty-two studies with scores ranging from one to eight out of eleven, and with an average score of 3.8 out of eleven – which was deemed to be poor-to-moderate general methodological quality. True intention-to-treat was only evident in twelve of the studies reviewed. The odds ratios and their ninety-five per cent confidence intervals were calculated on the basis of reported data in independent studies. Quantification of the results was done by counting how many people in the intervention group showed at least a thirty per cent reduction in the occurrence of injuries. The heterogeneity between studies was assessed using I^2 statistics. The results showed that in thirty-two trials with forty comparisons, a significant effect of different preventative methods in preventing sports injuries was reported in nineteen interventions. Analysis of the literature showed that the use of insoles, external joint supports, and training programmes, including different components, were effective in preventing injuries.

Similarly, Abernethy and Bleakley (2007) performed a systematic review to identify randomised controlled trials and controlled intervention studies that evaluated the effectiveness of injury prevention strategies in adolescent sport. The main outcome measure was injury defined as injury rate, injury severity and where individual study effect estimates were calculated. The methodological quality of the studies was independently done by the two authors of the study based on keys used by the Cochrane Collaboration Injuries Group and the Cochrane Collaboration Bone, Joint and Muscular Trauma Group. Studies were first assessed for homogeneity with respect to the nature of the intervention, control group, and the type and timing of outcomes and follow-up. The review found twelve eligible papers for review with scores ranging from five to thirteen out of eighteen. The review found that the evidence for using protective equipment is inconclusive and hampered by confounding factors that are difficult to control for. However, there is significant and consistent evidence to support injury prevention strategies that include a combination of the following elements: pre-season conditioning, functional training, education, strength, and balance and proprioception training programmes that are continued throughout the season. Furthermore the intervention programmes described could easily be reproduced and used across many sports.

When assessing the prevalence of preseason conditioning in high school athletes, Brooks et al. (2007) performed a cross-sectional survey of 451 high school athletes participating in soccer and track athletics. The survey assessed whether the athletes met the criteria for adequate preseason conditioning, consisting of aerobic fitness, stretching and strengthening. The study instrument was a brief, self-administered questionnaire that included demographic data, physical activity questions, and a report of all physical activity that the adolescents participated in. The proportion of athletes that met each of the components was calculated and then the proportion who met all three criteria for components of aerobic, strengthening and stretching was calculated. Bivariate chi-square analyses and multiple log-binomial regression analyses were performed to evaluate the association between the independent and dependent variables. A *p* value of 0.20 was considered significant. The findings of their study showed that although majority of the athletes met the criteria for each individual component of conditioning, only thirty-three per cent met all three criteria. They also found that athletes that who received "help" from their coach with regards to conditioning received "adequate" conditioning. The results showed that female athletes were less likely to meet aerobic criteria than males, and first time high-school athletes were less likely to meet aerobic conditioning than experienced high-school athletes. Females were also more likely to meet criteria for stretching days and less likely to meet criteria for strengthening days when compared to males. However, it is unclear from the study whether these trends reached significant levels.

In their review, Veigel and Pleacher (2007), discuss injury prevention strategies in youth sports. The study reviewed the recent research into injury prevention strategies such as educational programmes, rule changes, safety equipment, and pre-season and in-season conditioning programmes. The methodological quality of the study though is poor, as there is no recording of data searches and inclusion or exclusion criteria. No tool used to assess the methodological quality of the included studies. The authors conclude that "strong" evidence exists that supports the implementation of altered rules, use of safety equipment, and participation in specific conditioning programmes.

Hadala and Barrios, (2009) performed a prospective physiotherapy intervention on a yacht crew during the 2004 to 2006 America's Cup yacht race. Unfortunately only twenty-five of the crew members completed the entire programme which consisted of three phases. The preventative phase consisted of pre-exercise stretches and preventative taping; the physiotherapy phase consisted of joint mobilisations, ice baths and kinesio taping. The recovery phase consisted of "core stability" exercises, post-exercise stretching and twelve hours of compression clothing. The entire programme was developed and supervised by a physiotherapist and a medical doctor working within the team, and there was no blinding of assessors or subjects. The incidence and number of injuries were calculated with the ratio of injury per athlete per day and per 1 000 hours of competition. Z tests were used to compare ratios between the three intervention groups between sailors, and Fisher's exact test was used to compare the severity of injuries. The level of significance was set at p value equal to 0.05. The intervention showed a decrease from 1.66 injuries per day of competition to 0.60 injuries per day of competition, however it is unclear form the study data as to whether this was significant or not. The number of athletes suffering more than one injury was significantly reduced from fifty-three per cent to 6.5 per cent ($p < 0.01$). The programme was highly effective in the prevention of the most frequent injuries in this sport: muscle injuries and overuse injuries.

A systematic review by Hubscher et al. (2010) assessed the effectiveness of proprioceptive/neuromuscular training to prevent sports injuries. Two independent reviewers conducted a computerised search for relevant articles and found twenty-four articles which met the inclusion criteria. Each study was required to measure injury incidence as the main outcome. The methodological quality of the studies was assessed according to nine criteria as proposed by Tulder et al. (2009), with the articles scoring an average of three out of nine. To assess the preventative effect of the proprioceptive/neuromuscular training programmes, incidence rates, relative risks, and ninety-five per cent confidence intervals were extracted as appropriate to the data. Heterogeneity was examined using the Cochrane *Q*-test and the I^2 statistic. The threshold for statistical significance was set as p less than 0.05. Six of the studies demonstrated that balance exercises or multi-intervention training programmes can be effective in reducing the incidence of specific sports type injuries among adolescents. Multi-intervention training was effective in reducing the risk of lower limb injuries ($p < 0.01$), acute knee injuries ($p < 0.01$) and ankle injuries ($p < 0.01$). Balance training alone resulted in a significant reduction of ankle sprain injuries ($p < 0.01$). However, with regards to the effects of multi-intervention programmes, it remains unclear whether and to what extent the various training components may have contributed to the observed reduction in injury risk.

One of the biggest limitations in the research of multi-intervention training is that it remains unclear whether and to what extent various training components may contribute to injury risk reduction. However, several other limitations appeared in the reviewed studies. The review by Aaltonen et al. (2007), failed to perform a meta-analysis due to the limitations in heterogeneity of the studies reviewed. A selection bias was apparent due to the inadequate concealment of allocation in twenty-seven of the trials reviewed, performance and detection bias due to all thirty-two trials having inadequate blinding of participants, care providers, or outcome assessors, attrition bias due to the lack of intention-to-treat analysis in twenty of the trials, and heterogeneity of the follow-up times.

Abernathy and Bleakley (2007) also reviewed twelve articles with respect to injury prevention in adolescent sport. The study identified injury prevention strategies focusing on pre-season conditioning, functional training, education, balance and sport-specific skills are effective. However, the study does not show whether any of the above intervention strategies significantly reduce injury risk, as no *p* values are given.

In Brooks et al. (2007) cross-sectional survey of 451 school athletes, there are several limitations to the study. Firstly, subjects had to include data on self-reported height, weight, level of sport, type of spring sport and whether it was their first time playing a sport for their high-school. The subjectivity of the self-reporting in the questionnaire may have led to some reporter bias on the part of the athletes. Secondly, the schools that participated were not a random population of schools, and so a selection bias exists and the results may not be applicable to other study populations. Thirdly, the study was a retrospective study rather than a prospective self-report which may lead to recall error on the part of the athletes. Lastly, the survey as a whole was not validated prior to being used in the study, only certain sections used validated physical activity questions.

Veigel and Pleacher (2008) demonstrated poor methodological quality in their review of injury prevention in youth sports. As mentioned in the previous section the authors failed to mention their search strategy for the articles reviewed in the study, and they did not mention how the studies methodological quality was assessed. The lack of sound methodological structure to the review, does not allow for much confidence in the strength of the results or conclusion of the study. Although the study touches on relevant concepts in injury prevention, the subjectivity of the review does not lend to a high quality study.

The prospective intervention study by Hadala and Barrios (2009) also showed promising results, but contained some limitations. Firstly, the sample population size was relatively low (n = 25) and it is unclear from the study whether a power calculation was performed to calculate what number of sailors was needed to treat, to show an effective reduction in injury. Secondly, the study was conducted on adult sailors and so the programme was designed specifically to condition the sailors to competition and common biomechanical faults that may occur in sailors. As a result of this fact, it may be difficult to generalise the preventative programme to adolescent populations and/or other sports participants. Thirdly, the authors suggest that the injury rate of the sailors decreased from 1.66 to 0.60 over the course of the study, but there is no indication in the data that this decrease was of significance. Finally, as with most multi-intervention strategies for injury prevention, it remains unclear from this study which and to what degree each component of the programme contributed to the reduced injury rate.

Finally, in review by Hubscher at al. (2010), the methodological quality of the review was very high, but a few small limitations exist. The authors used an assessment tool to validate the methodological quality of the studies; however the interrater reliability of the quality assessment tool was not evaluated statistically during the pilot test phase. Secondly, the authors used an extraction form for use in data extraction, which was pilot tested on a subset of five articles. However, no statistical significant value was given to indicate the said interrater reliability of the extraction form. Similarly to other studies on multi-intervention strategies, it is difficult to compare the data extracted from other studies as there appears to be a lack in heterogeneity between the studies, as well as a discrepancy in the methodological quality of the studies. Finally, as found in many of the other multi-intervention studies, it is unclear which and to what extent the individual components of a multi-intervention strategy contribute to the reduction of injury.

Following the review of studies investigating the effect of multi-intervention strategies in injury prevention, there seems to be a trend towards a beneficial effect on injury prevention. There appears to be a mix of good and poor methodological quality studies in the literature regarding the use of multi-intervention strategies in injury prevention, indicating the need for better methodological quality in future studies of this nature. In previous sections of this literature review the individual components such as stretching, warm-ups, strength training, endurance training and balance training were reviewed for their effectiveness in injury prevention with mixed results. Although there seems to be a beneficial effect of multi-intervention strategies in injury prevention, the impact of the individual components needs to be evaluated. It is also difficult to compare multi-intervention strategies, due to the variability in sport-specific components, as well as the use of general conditioning aspects which may or may not be included.

2.5 Conclusion

Although no definitive conclusions can be made regarding any one specific component of conditioning with regards to its effect on injury reduction, clearly certain aspects of the literature show positive trends towards the reduction of injury; such as warm ups, strength training, balance training and multi-intervention training. The literature review also highlights the fact that there is little evidence supporting the use of stretching as part of an injury prevention programme. Yet according to one study routine stretching is still prescribed amongst high school coaches even though the coaches may be aware of the possible injury risk associated with pre-exercise stretching. There also appears to be a gap in the literature regarding the use of endurance training in adolescents to help prevent injury, with even the one included study having poor methodology to be able to come to a significant conclusion. Conditioning programmes for athletes are quite varied dependant on the type of sport and coaches' level of education and training.

CHAPTER 3 – METHODS

3.1 Introduction

This chapter expands on the methods used during the study to reach the research aim and objectives. The sample population as well as the inclusion and exclusion criteria are explored, and the instrument used to obtain the study results is discussed. The chapter also delves into ethical issues regarding the research and examine the research process that was followed during the study. Finally, the data analyses discussed.

3.2 Research setting

The research was conducted as a cross-sectional study at both public and private high schools within the Johannesburg-North Education District. The different schools consisted of high schools, combined schools (in terms of primary and high-school), single-gender schools and dual gender schools in both urban and per-urban parts of the Johannesburg-North Education District. All the participants had to speak and write in English. The majority of the schools' coaches performed their coaching duty as teachers.

3.3 Population and sampling

A list of all the 71 high-schools in the Johannesburg-North education district was obtained from the Gauteng Department of Education (Appendix A). All 71 high schools were contacted telephonically to determine their eligibility for the study using the inclusion and exclusion criteria, and 42 coaches were eligible to participate in the survey. The response rate to the survey was 79 per cent, with 33 coaches returning their surveys. In the case where there was more than one athletic coach per school, the head coach and/or the coach with the most experience in years were included.

3.4 Inclusion criteria

The following inclusion criteria were used to determine the eligibility of the coaches for use in the sample:

Athletic coaches:

- At high-schools and/or secondary schools, whose students participate in middle- and long-distance running.
- That understands and speaks English.
- Who work at private and/or public schools
- Of either gender

3.5 Exclusion criteria

The following exclusion criteria were used to determine the eligibility of the coaches for use in the sample:

- Athletic coaches who work at high-schools classified as intermediate schools and/or special-needs schools.

3.6 Instrument/Tool

No validated tools were found that could be used to assess coaches' knowledge of conditioning. A tool (Appendix C) was constructed with a section on demographical information, as well as six sections regarding different aspects of physical conditioning based on the literature review.

Statements regarding each aspect of physical conditioning were included in a particular section, and the respondent indicated his/her knowledge of a statement along a Likert scale. Each statement was based on scientific evidence and so the respondents were assessed on whether they strongly agree, agree, strongly disagree or disagree with the statement. Their responses were assessed according to the survey memo (Appendix D). A wrong answer scored 0 and a correct answer scored 1. Although the Likert scale used has four options to choose from in the survey, the options of agree and strongly agree were marked as the same within the context of the memo (Appendix D), with the same applying to strongly disagree and disagree options. Participants did not score more points for marking strongly agree or agree, or strongly disagree or disagree. This was how the survey was developed from the original five-point Likert scale. The level of the coaches' knowledge was determined from their score in each section. The survey had a mark sheet to allow for scoring and easier data capturing (Appendix C).

Establishing the validity of the tool is a debated issue, with regards to the acquisition of scientific data due to reporter bias, differences in the layout of the tool, question interpretation and measurement of data (McColl, Jacoby, Thomas, Soutter, Bamford, Steen, Thomas, Harvey, Garratt and Bond 2001). McColl et al. (2001) suggest from their review of the literature regarding questionnaires, that considerate planning of the layout and design of a questionnaire may minimise the risk of potential inter-rater variability. The study goes on to suggest that the appearance and presentation of the visual information in a questionnaire are vital, as these aspects can have an influence on the subjects' response. In the current survey (Appendix C) care was taken to keep the statements brief and clearly separate from one another to allow ease of reading. Secondly, each response was marked on a modified Likert scale which minimises the risk of inter-rater variability. Lastly, it the survey had clearly marked divisions between each section, which made it possible for the respondent to break between sections, and not allow the sections to become overwhelming.

The tool was validated by a panel of experts prior to being issued to the high-school athletic coaches. The panel consisted of two lecturers from the Physiotherapy Department at the University of Pretoria (one of which has a PhD), a statistician from the Biostatistics Unit at the Medical Research Council with a PhD, and a senior lecturer in Sports Physiotherapy at the University of Cape Town. Several other lecturers from other universities were contacted to participate as part of the panel, but were unavailable.

The content validity was established during the construction of the survey and was based on the domains defined from the literature review (De Vos, Strydom, Fouche and Delport 2002). In order to accommodate construct validity, statements in the survey – which intend to measure the same objective – were worded differently to establish whether there was a correlation to one another (Fowler, 1995). Table 3.1 shows how this was done in regard to the section on static stretching in the questionnaire.

Table 3.1 indicating how the construct validity was accomplished with regards to the static stretching section.

Statement	**Justification**
• Static stretching on its own is an adequate warm up for high school middle and long distance runners prior to training or an athletic event, to prevent injury.	• There is moderate to strong evidence that the application of static stretching does not reduce overall injury rates (Pope et al., 2000, Small et al., 2008, Thacker et al., 2004). In some studies, coaches still believe that pre-exercise stretching prevents injuries even though there is little scientific evidence (Shehab et al., 2006).
• Static stretching alone for high school middle and long distance runners has no beneficial effect in the prevention of injury.	
• Static stretching as a warm up for high school middle and long distance runners can help to prevent muscle cramps, strains and ligament sprains.	
• A warm up for high school middle and long distance runners, should only consist of static stretching.	• There are some negative effects of static stretching, such as reduced sprint performance (Chaouachi et al., 2008), decreased peak torque in women (Cramer et al., 2004)
• Static stretching on its own has a beneficial effect for high	

school middle and long distance runners, as a warm up prior to training or an athletic event.	and stretching has not shown any beneficial effect on the prevention or relief of muscle soreness (Herbert and de Noronha, 2007).

The discriminant validity of a survey measures the extent to which different groups of respondents differ in their response, if it is thought that they differ in what is being measured (Fowler, 1995). Following statistical analyses of the data obtained from the questionnaire used to assess athletic coaches' knowledge of physical conditioning in high school middle and long distance runners, it was found that the α co-efficient for scale reliability was 0.92. Cronbach's alpha is a statistical measure used to investigate the internal consistency of a questionnaire. The alpha value can be any value equal to or less than 1, including negative values, although only high positive values are desirable. An α co-efficient equal to or higher than 0.70 to 0.80 is considered as acceptable to support internal consistency. The questionnaire used in this study scored an α coefficient of 0.92, thus making it a reliable measure for coaches' knowledge of physical conditioning in high school middle and long distance runners.

3.7 Research process

The high schools and their relevant athletic coaches were contacted telephonically to set up a date to deliver the survey. The survey, together with an instruction letter regarding the questionnaire was then dropped off, faxed or emailed to the athletic coach at the relevant schools. A follow-up visit to the schools was arranged for 48 hours after the initial contact with the coaches to collect the surveys, however, not all schools and/or coaches were available within 48 hours after initial presentation of the survey. The coaches were then contacted telephonically on a weekly basis for a period of three months, and follow-up visits to the schools occurred once a month until such time as they had completed the survey. Once the surveys had been collected and marked, the score for each survey was captured on Microsoft Excel (2007) spread sheet for comparisons.

The duration of the study was from the period of June 2010 to September 2010. This process is supposed to ensure a more effective way of capturing the data from the schools and a better response rate (De Vos et al., 2002). The response rate is improved due to the personal contact made between the researcher and the respondents, and the process is also more time-efficient than posting. Lastly, due to the fact that an appointment is made to follow-up, the researcher did not bother the respondent at inconvenient times (De Vos et al., 2002).

3.8 Ethical considerations

Authorisation to do the study was obtained from the Department of Education (Appendix E) and from the Faculty of Health Sciences Ethics Committee (Appendix G). A letter of informed consent was forwarded to each participant together with the survey (Appendix B) once the head of the school had granted permission. The risks and benefits of the study were fully disclosed to the athletic coaches prior to the survey (Appendix B), but the risks and benefits of different types of conditioning were not, so as to avoid respondent bias. The results of the study shall be made available to all participating schools whereby a formal lecture will be arranged for all the coaches to attend should they wish to do so.

The personal details of all participants remained confidential, as the respondents remained anonymous on the survey response sheet. Participation in the survey was voluntary. The coaches from private and public sectors were treated equally.

3.9 Data analyses

The data obtained from the survey was captured on a Microsoft Excel spread sheet (2007) following scoring of each section by the researcher on the mark sheet. The score for each survey was stored on a computer for comparisons. Single-score comparisons (scoring individuals' scores between different sections) and comparisons between scores for different respondents was stored and compared using the StataCorp, 2009 Stata: Release 11. Statistical Software, College Station, TX: Statacorp LP. Data from the scores of each section was analysed (Appendix F) using descriptive statistics for objectives one and two, and summary of the data was recorded as proportions of success and standard deviations. To analyse the data for objective two, a Kruskal-Wallis test was used to determine the proportion of success for each section. The Kruskal-Wallis one-way analysis of variance by ranks is a non-parametric method for testing whether samples originate from the same distribution. It is the non-parametric version of the one-way analysis of variance (ANOVA). The Kruskal-Wallis test allows for one independent variable with two or more levels and an ordinal dependant variable. When the Kruskal-Wallis test leads to significant results, then at least one of the samples is different from the other samples. The test does not identify where the differences occur or how many differences actually occur (Kruskal and Wallis, 1952).

To establish whether there was an association in objective three between biographic variables and coaches' physical conditioning knowledge, a Fishers exact test was used. The Fishers exact test is a version of a Chi-Square test used when no assumption is made regarding the expected frequency of each cell, and can be used regardless of how small the expected frequency is (Fisher, 1922). This statistical analysis was best suited to this study. The level of significance for any differences between scores in each section was set at $p \leq 0.05$. The level of marginal significance for any differences between scores in each section was set at $p \leq 0.09$.

In two cases (years of coaching and coaches age), the data was collapsed into fewer categories. Initially the number of years coaching was categorised into five groups. However, due to the small number of coaches in the "over 20 years" group, and the abnormal distribution, the statistician suggested that this data be grouped into two groups for ease of data analysis. The two groups were categorised as: one to five years' experience, and more than five years' experience. Secondly the coaches' age was initially grouped into eight groups. Due to the small distribution of coaches in some of the age groups, it was suggested to collapse the number of coaches' age groups for ease of data analysis.

3.10 Conclusion

The discussion of the methods used while conducting the study is now followed by the chapter which explores the results that were obtained from the analysis of the survey data. The results of the study are discussed aim by aim.

CHAPTER 4 – RESULTS

4.1 Introduction

This chapter details the results obtained from the study. The results are discussed aim by aim to align with the research purpose, and graphs are presented for ease of reference to the descriptive and analytical statistics. The results are shown comparing distribution of age categories, distribution of working experience, and the level of education amongst the high school athletic coaches. The results also show the proportion of success in each section (B-G) for each biographic variable, as well as the association between biographic variables and the coaches' level of knowledge.

4.2 Biographic profile of the coaches

The age of the high-school athletics coaches that participated in the survey ranged from 24 to 57 years (mean 41 ± 9.25 years) (Figure 4.1). The majority of the athletic coaches were male (91 per cent) in the 33 schools that completed the survey (response rate of 78.6 per cent), and 79 per cent of the schools participating were classified as public schools. The years of coaching experience ranged from one to 32 years among the athletic coaches with a mean of 11.8 ± 8.55 years (Figure 4.2). Female coaches had a mean of 7.3 ± 6.66 years coaching experience, whilst male coaches had a mean of 12.2 ± 8.68 years coaching experience.

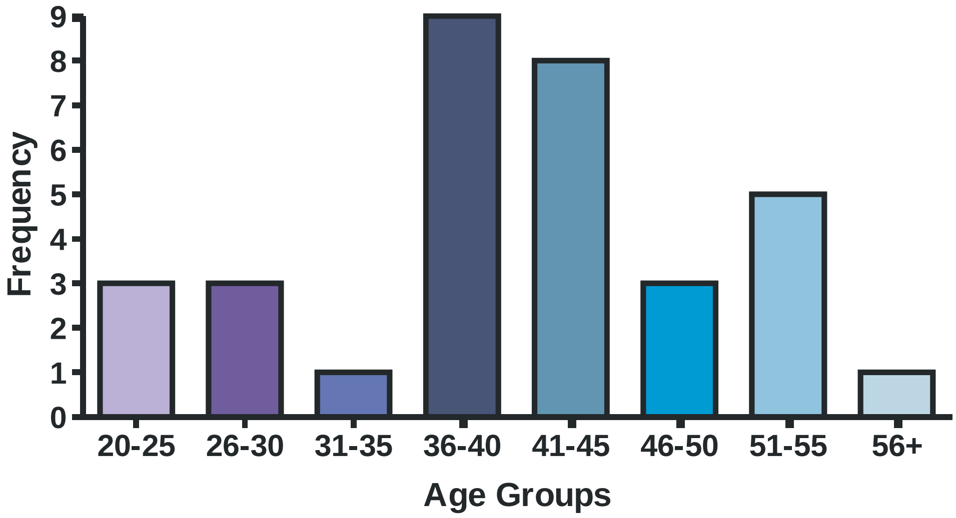

Figure 4.1 the distribution of age categories amongst high school athletic coaches (n = 33)

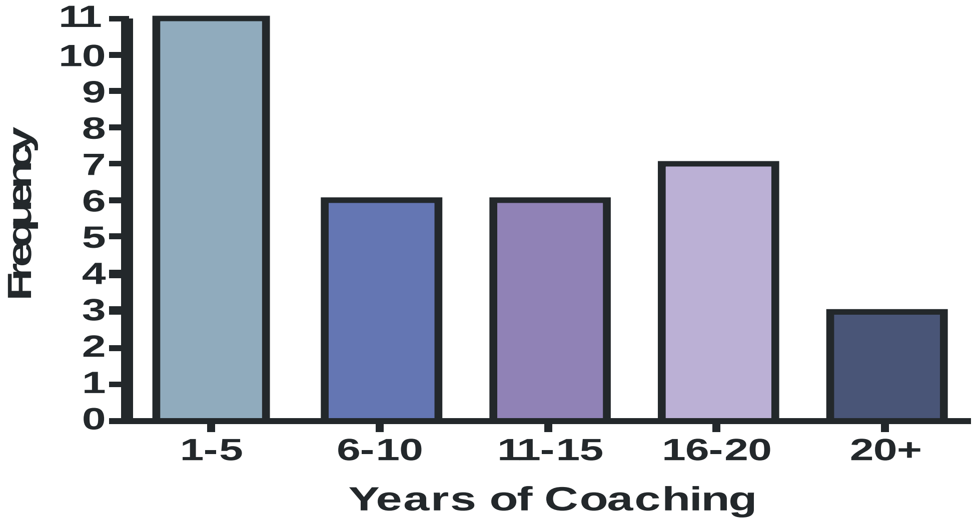

Figure 4.2 the distribution of the number of years of working experience of the high school athletic coaches (n = 33)

The coaches' level of education is represented in Table 4.1. All the coaches had some form of tertiary education. A total of 70 per cent (i.e. 23 out of 33) of the coaches had a university degree; however, only 6 out of the 33 coaches had a sports or science degree.

TABLE 4.1 Coaches level of education

Coaches' Education Level	Frequency (n = 33)
Diplomas	10
Bachelor's Degrees	20
Masters Degrees	3

4.3 Athletic coaches' physical education knowledge

Following the survey of the coaches knowledge of conditioning, the mean score amongst the respondents within the 26 items on the scale was 16.6 (63.9 per cent) out of 26 ± 2.56. The coaches' level of knowledge was considered good (high) if they scored above the mean score of 63.9 per cent for each section. If the coaches' scored below the mean of 63.9 per cent for each section, then their level of knowledge was considered poor (low). The coaches' level of knowledge was considered fair (acceptable) if their score equalled the mean score for each section. Within the individual sections, scores varied amongst the coaches, with coaches scoring on average the poorest in section B (43.6 per cent correct) and section G (9.1 per cent correct) (Appendix F). This indicates that on average the coaches were poor knowledge regarding static stretching as a warm-up session and regarding the use of cool downs as part of a physical conditioning programme amongst high school middle and long distance runners. The highest scores and thus the sections the coaches had the best knowledge about on average were section C (90.1 per cent correct) and section F (93.3 per cent correct). This result indicates that on average the coaches scored highest on knowledge regarding using active exercises during a warm-up session and using cardiovascular endurance exercise as part of a physical conditioning programme during pre-seasonal and seasonal athletic training. A summary of the coaches' correct answers can be seen in Figure 4.3.

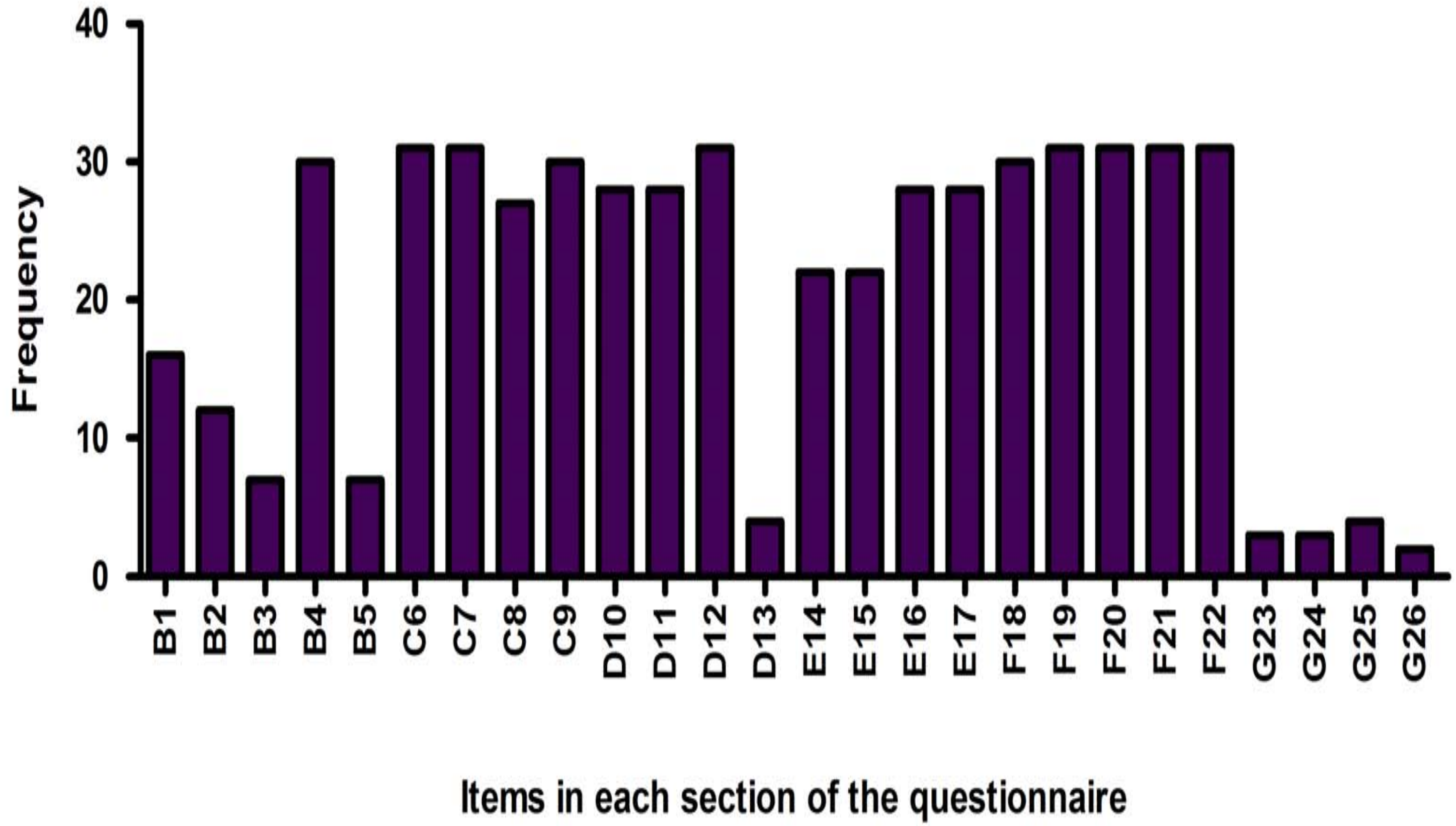

Figure 4.3 Frequency of correct answers for each item in each section of the questionnaire

4.4 The use of static stretching solely as a warm-up session (section B)

When analysing the data from the study, the high school athletic coaches scored low in section B. Section B consisted of assessing the coaches' knowledge of using static stretching in isolation as a warm-up session for high school middle and long distance runners, as well as the effects of static stretching on injury prevention. The items in section B consisted of the following statements:

B1: static stretching on its own is an adequate warm up for high school middle and long distance runners prior to training or an athletic event, to prevent injury.

B2: static stretching on its own has a beneficial effect for high school middle and long distance runners, as a warm up prior to training or an athletic event.

B3: static stretching as a warm up for high school middle and long distance runners can help to prevent muscle soreness, strains and ligament sprains.

B4: a warm up program for high school middle and long distance runners, should only consist of static stretching.

B5: static stretching alone for high school middle and long distance runners has no beneficial effect in the prevention of injury.

As one can see from Figure 4.3, items B1, B2, B3 and B5 scored low amongst the coaches. This shows that the majority of the coaches identify that static stretching on its own is an adequate warm up for high school middle and long distance runners prior to training or an athletic event, to prevent injuries. Figure 4.3 also shows in item B2 that coaches discern that static stretching on its own has a positive beneficial effect for high school middle and long distance runners, as a warm up prior to training or an athletic event.

Table 4.2 Comparison of proportions of success rates between age groups for the use of static stretching as a warm-up

	Proportions	SD	95% CI	Probability (Kruskall-Wallis)	Significance
B1					
Below 36	0.429	0.202	0.017 – 0.840	0.872	No significance
36-45	0.471	0.125	0.216 – 0.725		
Over 45	0.556	0.176	0.198 – 0.913		
B2					
Below 36	0.429	0.202	0.017 – 0.840	0.920	No significance
36-45	0.353	0.119	0.110 – 0.596		
Over 45	0.333	0.167	-0.006 – 0.673		
B3					
Below 36	0.286	0.184	-0.090 – 0.661	0.668	No significance
36-45	0.235	0.106	0.019 – 0.451		
Over 45	0.111	0.111	-0.115 – 0.337		
B4					
Below 36	0.857	0.143	0.566 – 1.148	0.791	No significance
36-45	0.941	0.059	0.821 – 1.061		
Over 45	0.889	0.111	0.663 – 1.115		
B5					
Below 36	No observations	-	-	0.116	No significance
36-45	0.353	0.119	0.110 – 0.596		
Over 45	0.111	0.111	-0.115 – 0.337		

Table 4.3 Comparison of proportions of success rates between male and female coaches for the use of static stretching as a warm-up

	Proportions	**SD**	**95% CI**	**Probability (Kruskal-Wallis)**	**Significance**
B1					
Female	0.333	0.333	-0.346 – 1.012	0.588	No significance
Male	0.500	0.093	0.311 – 0.689		
B2					
Female	0.333	0.333	-0.346 – 1.012	0.910	No significance
Male	0.367	0.089	0.184 – 0.549		
B3					
Female	No observations	-	-	0.353	No significance
Male	0.233	0.079	0.073 – 0.393		
B4					
Female	1	0	0	0.572	No significance
Male	0.900	0.056	0.787 – 1.013		
B5					
Female	No observations	-	-	0.353	No significance
Male	0.233	0.079	0.073 – 0.393		

Table 4.4 Comparison of proportions of success rates between levels of highest education for the use of static stretching as a warm-up

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
B1					
Diploma	0.400	0.163	0.674 – 0.733	0.645	No significance
B Degree	0.550	0.114	0.318 – 0.782		
Masters	0.333	0.333	-0.346 – 1.012		
B2					
Diploma	0.200	0.133	-0.072 – 0.472	0.114	No significance
B Degree	0.500	0.115	0.266 – 0.734		
Masters	No observations	-	-		
B3					
Diploma	0.200	0.133	-0.072 – 0.472	0.619	No significance
B Degree	0.250	0.099	0.048 – 0.452		
Masters	No observations	-	-		
B4					
Diploma	0.900	0.100	0.696 – 1.104	0.852	No significance
B Degree	0.900	0.069	0.760 – 1.040		
Masters	1	0	0		
B5					
Diploma	0.300	0.153	-0.011 – 0.611	0.536	No significance
B Degree	0.200	0.092	0.013 – 0.387		
Masters	No observations	-	-		

Table 4.5 Comparison of proportions of success rates between two groups for years of coaching for the use of static stretching as a warm-up

	Proportions	SD	95% CI	*Probability* (Kruskal-Wallis)	Significance
B1					
1-5 Years	0.364	0.152	0.054 – 0.673	0.332	No significance
Over 5 Years	0.545	0.109	0.324 – 0.767		
B2					
1-5 Years	0.273	0.141	-0.014 – 0.560	0.450	No significance
Over 5 Years	0.409	0.107	0.191 – 0.628		
B3					
1-5 Years	0.182	0.122	-0.067 – 0.430	0.767	No significance
Over 5 Years	0.227	0.091	0.041 – 0.414		
B4					
1-5 Years	0.909	0.091	0.724 – 1.094	1.000	No significance
Over 5 Years	0.909	0.063	0.781 – 1.037		
B5					
1-5 Years	0.091	0.091	-0.094 – 0.276	0.236	No significance
Over 5 Years	0.273	0.097	0.075 – 0.471		

Table 4.6 Comparison of proportions of success rates between private and public schools for the use of static stretching as a warm-up

	Proportions	**SD**	**95% CI**	**Probability** **Z-statistics**	**Significance**
B1					
Private	0.571	0.202	0.160 – 0.983	0.629	No significance
Public	0.461	0.100	0.258 – 0.665		
B2					
Private	0.571	0.202	0.160 – 0.983	0.243	No significance
Public	0.308	0.092	0.120 – 0.496		
B3					
Private	0.286	0.184	-0.090 – 0.661	0.645	No Significance
Public	0.192	0.079	0.032 – 0.353		
B4					
Private	1	0	0	**0.08**	**Marginal significance**
Public	0.885	0.064	0.754 – 1.015		
B5					
Private	0.286	0.184	-0.090 – 0.661	0.645	No significance
Public	0.192	0.079	0.032 – 0.353		

***The direction of significance for item B4 indicated that coaches from private schools scored higher than coaches from public schools.**

Table 4.2 – 4.6 show that there was no significance in terms of proportions of success in the scores obtained in items B1-B5. This suggests that none of the samples were different from one another within groups and so did not determine the coaches' proportion of success (knowledge) with regards to pre-exercise stretching. The only sample that showed marginal significance was that of private school coaches with regards to only using static stretching as a warm up program for high school middle and

long distance runners. This suggests that private school coaches tended to score better with regards to the above statement.

4.5 The use of active exercises during a warm-up session (section C)

The coaches scored high in response to the items regarding active exercises. Section C consisted of assessing coaches' knowledge of using active exercises as part of a warm-up session, and the effect thereof on injury prevention. The items in section C consisted of the following statements:

C6: active exercises that mimic the running activity, such as walking lunges, are beneficial when used as part of a warm up for high school middle and long distance runners.

C7: active exercises that involve the muscles to be used during running, such as jogging whilst kicking the knees high, help to prevent injury in high school middle and long distance runners.

C8: active exercises, such as the ones described above, are not effective in preventing injuries if combined with static stretches in high school middle and long distance runners.

C9: active exercises as well as static stretching should be used in combination when performing a warm up in high school middle and long distance runners.

Currently it would seem that the high school athletic coaches in the Johannesburg-North education district have a good understanding of the benefits of using active exercises as part of a warm up in a physical conditioning programme used in the prevention of injuries in adolescents (Figure 4.3).

Table 4.7 Comparison of proportions of success rates between age groups for use of active exercises during a warm-up session

	Proportions	SD	95% CI	Probability (Kruskall-Wallis)	Significance
C6					
Below 36	1	0	0	0.379	No significance
36-45	0.882	0.081	0.718 – 1.046		
Over 45	1	0	0		
C7					
Below 36	0.857	0.143	0.566 – 1.148		No significance
36-45	0.941	0.059	0.821 – 1.061	0.504	
Over 45	1	0	0		
C8					
Below 36	0.857	0.143	0.566 – 1.148		No significance
36-45	0.824	0.095	0.629 – 1.018	0.919	
Over 45	0.778	0.147	0.478 – 1.077		
C9					
Below 36	1	0	0		No significance
36-45	0.941	0.059	0.821 – 1.061	0.259	
Over 45	0.778	0.147	0.478 – 1.077		

Table 4.8 Comparison of proportions of success rates between male and female coaches for use of active exercises during a warm-up session

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
C6					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		
C7					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		
C8					
Female	0.667	0.333	-0.012 – 1.346	0.482	No significance
Male	0.833	0.069	0.692 – 0.974		
C9					
Female	1	0	0	0.572	No significance
Male	0.900	0.056	0.787 – 1.013		

Table 4.9 Comparison of proportions of success rates between levels of highest education for use of active exercises during a warm-up session

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
C6					
Diploma	0.900	0.100	0.696 – 1.104	0.783	No significance
B Degree	0.950	0.050	0.848 – 1.052		
Masters	1	0	0		
C7					
Diploma	0.900	0.100	0.696 – 1.104	0.783	No significance
B Degree	0.950	0.050	0.848 – 1.052		
Masters	1	0	0		
C8					
Diploma	0.800	0.133	0.528 – 1.072	0.701	No significance
B Degree	0.800	0.092	0.613 – 0.987		
Masters	1	0	0		
C9					
Diploma	0.900	0.100	0.696 – 1.104	0.852	No significance
B Degree	0.900	0.069	0.760 – 1.040		
Masters	1	0	0		

Table 4.10 Comparison of proportions of success rates between two groups for years of coaching for use of active exercises during a warm-up session

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
C6					
1-5 Years	0.909	0.091	0.724 – 1.094	0.612	No significance
Over 5 years	0.955	0.045	0.862 – 1.047		
C7					
1-5 Years	0.818	0.122	0.570 – 1.067	**0.042**	**Significant**
Over 5 Years	1	0	0		
C8					
1-5 Years	0.727	0.141	0.440 – 1.014	0.346	No significance
Over 5 Years	0.864	0.075	0.711 – 1.016		
C9					
1-5 Years	0.909	0.091	0.724 – 1.094	1.000	No significance
Over 5 Years	0.909	0.063	0.781 – 1.037		

***The direction of the significance for item C7 suggests that coaches with over five years' experience scored higher than coaches with less experience.**

Table 4.11 Comparison of proportions of success rates between private and public schools for use of active exercises during a warm-up session

	Proportions	SD	95% CI	Probability Z-statistics	Significance
C6					
Private	0.857	0.143	0.566 – 1.148	0.486	No significance
Public	0.962	0.038	0.883 – 1.040		
C7					
Private	1	0	0	0.159	No significance
Public	0.923	0.053	0.815 – 1.032		
C8					
Private	1	0	0	**0.010**	**Significant**
Public	0.769	0.084	0.598 – 0.941		
C9					
Private	1	0	0	**0.082**	**Marginal significance**
Public	0.885	0.064	0.754 – 1.015		

***The direction of the significance for items C8 and C8 indicates that coaches in private schools scored higher than the coaches in public schools.**

Tables 4.7-4.11 show that within groups, the coaches' age, gender and highest level of education were not significantly different to one another in terms of proportion of success (coaches' knowledge) obtained in section C. However, coaches with more than five years' experience scored higher than those with less experience with regards to the use of active exercises that involve the muscles to be used during running to help prevent injury in high school middle and long distance runners. The coaches in private schools scored significantly higher with regards to active exercises not being effective in preventing injuries if combined with static stretches in high school middle and long distance runners. Similarly, private school coaches scored higher by a marginal significance in the use of active exercises as well as static stretching in combination, when performing a warm up in high school middle and long distance runners.

4.6 The use of strengthening exercises during pre-seasonal and in-seasonal athletic training sessions (section D)

The items in Section D assessed the coaches' level of knowledge of using strengthening exercises during pre-season and in-season training, as well as the effect thereof on injury prevention. The items in section D consisted of the following statements:

D10: active strengthening exercises, such as squats, to strengthen muscles used whilst running, do not provide any benefit to high school middle and long distance runners.

D11: active strengthening exercises, such as squats, to strengthen muscles used during running, may help to prevent injury in high school middle and long distance runners.

D12: active strengthening exercises of the core muscles do not improve performance of high school middle and long distance runners.

D13: active strengthening exercises of the core muscles may prevent injuries in high school middle and long distance runners.

The majority of the coaches scored high in section D except for item D13 (Figure 4.3), which indicates that coaches think that core strengthening exercises may help prevent injuries in high school middle and long distance runners.

Table 4.12 Comparison of proportions of success rates between age groups for the use of strengthening exercises

	Proportions	SD	95% CI	Probability (Kruskall-Wallis)	Significance
D10					
Below 36	0.857	0.143	0.566 – 1.148		No significance
36-45	0.765	0.106	0.549 – 0.981	0.292	
Over 45	1	0	0		
D11					
Below 36	1	0	0		No significance
36-45	0.765	0.106	0.549 – 0.981	0.329	
Over 45	0.889	0.111	0.663 – 1.115		
D12					
Below 36	1	0	0		No significance
36-45	0.882	0.081	0.718 – 1.046	0.379	
Over 45	1	0	0		
D13					
Below 36	No Observations	-	-		No significance
36-45	0.118	0.081	-0.046 – 0.282	0.412	
Over 45	0.222	0.147	-0.077 – 0.522		

Table 4.13 Comparison of proportions of success rates between male and female coaches for the use of strengthening exercises

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
D10					
Female	1	0	0	0.450	No significance
Male	0.833	0.069	0.692 – 0.974		
D11					
Female	1	0	0	0.450	No significance
Male	0.833	0.069	0.692 – 0.974		
D12					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		
D13					
Female	No observations	-	-	0.507	No significance
Male	0.133	0.063	0.005 – 0.262		

Table 4.14 Comparison of proportions of success rates between levels of highest education for the use of strengthening exercises

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
D10					
Diploma	0.900	0.100	0.696 – 1.104	0.584	No significance
B Degree	0.800	0.092	0.613 – 0.987		
Masters	1	0	0		
D11					
Diploma	0.900	0.100	0.696 – 1.104	0.584	No significance
B Degree	0.800	0.092	0.613 – 0.987		
Masters	1	0	0		
D12					
Diploma	0.900	0.100	0.696 – 1.104	0.783	No significance
B Degree	0.950	0.050	0.848 – 1.052		
Masters	1	0	0		
D13					
Diploma	0.100	0.100	-0.104 – 0.304	0.743	No significance
B Degree	0.150	0.082	-0.017 – 0.317		
Masters	No observations	-	-		

Table 4.15 Comparison of proportions of success rates between two groups for years of coaching for the use of strengthening exercises

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
D10					
1-5 Years	0.818	0.122	0.570 – 1.067	0.735	No significance
Over 5 Years	0.864	0.075	0.711 – 1.016		
D11					
1-5 Years	0.909	0.091	0.724 – 1.094	0.499	No significance
Over 5 Years	0.818	0.084	0.647 – 0.990		
D12					
1-5 Years	0.909	0.091	0.724 – 1.094	0.612	No significance
Over 5 Years	0.955	0.045	0.862 – 1.047		
D13					
1-5 Years	0.091	0.091	-0.094 – 0.276	0.710	No significance
Over 5 Years	0.136	0.075	-0.016 – 0.289		

Table 4.16 Comparison of proportions of success rates between private and public schools for the use of strengthening exercises

	Proportions	SD	95% CI	Probability Z-statistic	Significance
D10					
Private	0.857	0.143	0.566 – 1.148	0.946	No significance
Public	0.846	0.072	0.699 – 0.993		
D11					
Private	0.857	0.143	0.566 – 1.148	0.946	No significance
Public	0.846	0.072	0.699 – 0.993		
D12					
Private	1	0	0	0.159	No significance
Public	0.923	0.053	0.815 – 1.032		
D13					
Private	No observations	-	-	**0.04**	**Significant**
Public	0.154	0.072	0.007 – 0.301		

***The direction of the significance in item D13 suggests that coaches in public schools scored higher than coaches in private schools.**

Table 4.12-4.16 show that within groups of the coaches' age, gender, highest level of education, number of years coaching and school type there were no significant differences in proportion of success for items D10-D13. Coaches in public schools scored significantly higher with regards to good knowledge of the use of active strengthening exercises of the core muscles and injury prevention in high school middle and long distance runners, for item D13.

4.7 The use of balance exercises during pre-seasonal and in-seasonal athletic training sessions (section E)

Section E assessed the coaches' knowledge of using balance exercises during pre-season and in-season athletic training, with regards to preventing injuries in high school middle and long distance runners. The items in section E consisted of the following statements:

E14: balance exercises, such as single leg balancing, may be beneficial in the prevention of injuries in high school middle and long distance runners.

E15: balance exercises, such as single leg balancing, has no positive effect on performance of high school middle and long distance runners.

E16: high school middle and long distance runners should not perform balance exercises, as the exercises do not help in the prevention of injuries.

E17: high school middle and long distance runners require balance exercises when rehabilitating from injury and so these exercises should be included in a preseason conditioning programme.

Figure 4.3 shows how well the coaches performed in section E, where a majority of the coaches scored correct answers. However, there were a small percentage of the coaches who scored incorrectly with regards to their answers of items on the beneficial effect of balancing exercise in the prevention of injury. This indicates that overall the coaches had a good knowledge with regards to using balance exercises in athletic training exercises.

Table 4.17 Comparison of proportions of success rates between age groups for the use of balance exercises

	Proportions	SD	95% CI	Probability (Kruskall-Wallis)	Significance
E14					
Below 36	0.429	0.202	0.017 – 0.840		
36-45	0.588	0.123	0.338 – 0.839	**0.038**	**Significant**
Over 45	1	0	0		
E15					
Below 36	0.571	0.202	0.160 – 0.983		
36-45	0.647	0.119	0.404 – 0.890	0.674	No significance
Over 45	0.778	0.147	0.478 – 1.077		
E16					
Below 36	0.857	0.143	0.566 – 1.148		
36-45	0.765	0.106	0.549 – 0.981	0.292	No significance
Over 45	1	0	0		
E17					
Below 36	1	0	0		**Marginal significance**
36-45	0.706	0.114	0.474 – 0.938	**0.068**	
Over 45	1	0	0		

***The direction of significance for item E14 suggests that coaches over the age of 45 years, scored significantly higher than coaches below the age of 45 years.**

***The direction of significance for item E17 suggest that coaches over the age of 45 years and below the age of 36 years scored higher than the coaches aged between 36 and 45 years.**

Table 4.18 Comparison of proportions of success rates between male and female coaches for the use of balance exercises

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
E14					
Female	0.667	0.333	-0.012 – 1.346	1.000	No significance
Male	0.667	0.088	0.488 – 0.845		
E15					
Female	1	0	0	0.206	No significance
Male	0.633	0.089	0.451 – 0.816		
E16					
Female	1	0	0	0.450	No significance
Male	0.833	0.069	0.692 – 0.974		
E17					
Female	1	0	0	0.450	No significance
Male	0.833	0.069	0.692 – 0.974		

Table 4.19 Comparison of proportions of success rates between levels of highest education for the use of balance exercises

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
E14					
Diploma	0.600	0.163	0.267 – 0.933	0.865	No significance
B Degree	0.700	0.105	0.486 – 0.914		
Masters	0.667	0.333	-0.012 – 1.346		
E15					
Diploma	0.600	0.163	0.267 – 0.933	0.433	No significance
B Degree	0.650	0.109	0.427 – 0.873		
Masters	1	0	0		
E16					
Diploma	0.700	0.153	0.389 – 1.011		
B Degree	0.900	0.069	0.760 – 1.040	0.275	No significance
Masters	1	0	0		
E17					
Diploma	0.700	0.153	0.389 – 1.011		
B Degree	0.900	0.069	0.760 – 1.040	0.275	No significance
Masters	1	0	0		

Table 4.20 Comparison of proportions of success rates between two groups for years of coaching for the use of balance exercises

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
E14					
1-5 Years	0.545	0.157	0.225 – 0.866	0.304	No significance
Over 5 Years	0.727	0.097	0.529 – 0.925		
E15					
1-5 Years	0.636	0.152	0.327 – 0.946	0.797	No significance
Over 5 Years	0.682	0.102	0.475 – 0.889		
E16					
1-5 Years	0.909	0.091	0.724 – 1.094	0.499	No significance
Over 5 Years	0.818	0.084	0.647 – 0.990		
E17					
1-5 Years	0.909	0.091	0.724 – 1.094	0.499	No significance
Over 5 Years	0.818	0.084	0.647 – 0.990		

Table 4.21 Comparison of proportions of success rates between private and public schools for the use of balance exercises

	Proportions	SD	95% CI	Probability Z-statistics	Significance
E14					
Private	0.714	0.184	0.339 – 1.090	0.773	No significance
Public	0.654	0.095	0.460 – 0.848		
E15					
Private	0.857	0.143	0.566 – 1.148	0.171	No significance
Public	0.615	0.097	0.417 – 0.814		
E16					
Private	1	0	0	**0.02**	**Significant**
Public	0.808	0.079	0.647 – 0.968		
E17					
Private	0.857	0.143	0.566 – 1.148	0.946	No significance
Public	0.846	0.072	0.699 – 0.993		

***The direction of significance for item E16 suggests that coaches from private schools scored significantly higher than coaches from public schools.**

Table 4.17-4.21 show that there is no significant differences within groups with regards to coaches' gender, highest level of education or number of years coaching, and their proportions of success in regards to the use of balance exercises as part of a physical conditioning programme. However, there was a significant difference in proportions of success found between differing age groups in item E14, and a marginal significance in item E17. This shows that the coaches' older than 45 years scored higher with regards to the use of balance exercises in a physical conditioning programme and in the use of injury prevention was significant different between age groups. Similarly, coaches in private schools scored significantly higher than coaches in public school with regards to the requirement of balance exercises when rehabilitating from injury.

4.8 The use of cardiovascular endurance training during pre-seasonal and in-seasonal athletic training sessions (section F)

Section F assessed the coaches' level of knowledge with regards to the use of cardiovascular endurance training during pre-season and in-season training, as well as part of an injury prevention strategy. The items in section F consisted of the following statements:

F18: endurance training should not be included in a conditioning programme as there may be no beneficial effect on running performance in high school middle and long distance runners.

F19: endurance training should form part of a conditioning programme due to the beneficial effects on running performance in high school middle and long distance runners.

F20: endurance training should form part of a conditioning programme due to the beneficial effects on the heart muscle in high school middle and long distance runners.

F21: endurance training should form part of a conditioning programme due to the increase in muscle blood flow and oxygen delivery to muscles in high school middle and long distance runners.

F22: endurance training should not be included in a conditioning programme as there are no beneficial effects on the heart muscle, oxygen delivery and blood flow to muscles in high school middle and long distance runners.

Figure 4.3 shows the majority of the coaches scored high in this section, indicating that they had correct knowledge regarding the use of cardiovascular endurance training and the beneficial effects this type of training has on running performance and physiological parameters. Although one would expect this to be the case in coaches who are training middle and long distance runners.

Table 4.22 Comparison of proportions of success rates between age groups for the use of cardiovascular endurance training

	Proportions	SD	95% CI	Probability (Kruskall-Wallis)	Significance
F18					
Below 36	1	0	0		
36-45	0.824	0.095	0.629 – 1.018	0.222	No significance
Over 45	1	0	0		
F19					
Below 36	1	0	0		
36-45	0.941	0.059	0.821 – 1.061	0.660	No significance
Over 45	0.889	0.111	0.663 – 1.115		
F20					
Below 36	1	0	0		
36-45	0.941	0.059	0.821 – 1.061	0.660	No significance
Over 45	0.889	0.111	0.663 – 1.115		
F21					
Below 36	1	0	0		
36-45	0.941	0.059	0.821 – 1.061	0.660	No significance
Over 45	0.889	0.111	0.663 – 1.115		
F22					
Below 36	0.857	0.143	0.566 – 1.148		
36-45	1	0	0	0.323	No significance
Over 45	0.889	0.111	0.663 – 1.115		

Table 4.23 Comparison of proportions of success rates between male and female coaches for the use of cardiovascular endurance training

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
F18					
Female	1	0	0	0.572	No significance
Male	0.900	0.056	0.787 – 1.013		
F19					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		
F20					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		
F21					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		
F22					
Female	1	0	0	0.650	No significance
Male	0.933	0.046	0.839 – 1.028		

Table 4.24 Comparison of proportions of success rates between levels of highest education for the use of cardiovascular endurance training

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
F18					
Diploma	0.900	0.100	0.696 – 1.104	0.852	No significance
B Degree	0.900	0.069	0.760 – 1.040		
Masters	1	0	0		
F19					
Diploma	0.900	0.100	0.696 – 1.104	0.783	No significance
B Degree	0.950	0.050	0.848 – 1.052		
Masters	1	0	0		
F20					
Diploma	0.900	0.100	0.696 – 1.104	0.783	No significance
B Degree	0.950	0.050	0.848 – 1.052		
Masters	1	0	0		
F21					
Diploma	1	0	0	0.511	No significance
B Degree	0.900	0.069	-0.040 – 0.240		
Masters	1	0	0		
F22					
Diploma	1	0	0	0.511	No significance
B Degree	0.900	0.069	0.760 – 1.040		
Masters	1	0	0		

Table 4.25 Comparison of proportions of success rates between two groups for years of coaching for the use of cardiovascular endurance training

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
F18					
1-5 Years	0.909	0.091	0.724 – 1.094	1.000	No significance
Over 5 Years	0.909	0.063	0.781 – 1.037		
F19					
1-5 Years	0.909	0.091	0.724 – 1.094	0.612	No significance
Over 5 Years	0.955	0.045	0.862 – 1.047		
F20					
1-5 Years	0.909	0.091	0.724 – 1.094	0.612	No significance
Over 5 Years	0.955	0.045	0.862 – 1.047		
F21					
1-5 Years	1	0	0	0.310	No significance
Over 5 Years	0.909	0.063	0.781 – 1.037		
F22					
1-5 Years	0.909	0.091	0.724 – 1.094	0.612	No significance
Over 5 Years	0.955	0.045	0.862 – 1.047		

Table 4.26 Comparison of proportions of success rates between private and public schools for the use of cardiovascular endurance training

	Proportions	SD	95% CI	Probability Z-Statistics	Significance
F18					
Private	0.857	0.143	0.566 – 1.148	0.668	No significance
Public	0.923	0.053	0.815 – 1.032		
F19					
Private	1	0	0	0.159	No significance
Public	0.923	0.053	0.815 – 1.032		
F20					
Private	1	0	0	0.159	No significance
Public	0.923	0.053	0.815 – 1.032		
F21					
Private	0.857	0.143	0.566 – 1.148	0.486	No significance
Public	0.962	0.038	0.883 – 1.040		
F22					
Private	1	0	0	0.158	No significance
Public	0.923	0.053	0.815 – 1.031		

Table 4.22-4.26 show that there was no significant difference in the coaches' proportion of success with regards to the use of cardiovascular endurance training, within groups of the coaches' age, gender, highest education qualification, number of years of coaching or school type.

4.9 The use of static stretching during a cool-down period following an athletic event or training session (section G)

Section G assessed the coaches' level of knowledge of using static stretching during a cool-down period following an athletic event or training session. The items in section G consisted of the following statements:

G23: static stretching should be performed after an athletic event or training to prevent muscle stiffness in high school middle and long distance runners.

G24: static stretching has no beneficial effect on recovery and so should not be routinely done after an athletic event or training in high school middle and long distance runners.

G25: static stretching that is performed after an athletic event or training has no beneficial effect on the prevention of injury in high school middle and long distance runners.

G26: static stretching that is performed after an athletic event or training may help reduce the number of injuries in high school middle and long distance runners.

Section G showed the lowest scores out of any of the items tested during the questionnaire, with an average of 9.1 per cent of all answers correct. There is an indication that high school athletic coaches in the Johannesburg North education district have poor knowledge regarding the use of stretching as part of a cool down following an event or training session (Figure 4.3).

Table 4.27 Comparison of proportions of success rates between age groups for the use of static stretching during a cool-down period

	Proportions	SD	95% CI	Probability (Kruskall-Wallis)	Significance
G23					
Below 36	No observations	-	-		
36-45	0.176	0.095	-0.018 – 0.371	0.222	No significance
Over 45	No observations	-	-		
G24					
Below 36	No observations	-	-		
36-45	0.118	0.081	-0.046 – 0.282	0.649	No significance
Over 45	0.111	0.111	-0.115 – 0.337		
G25					
Below 36	No observations	-	-		
36-45	0.235	0.106	0.019 – 0.451	0.125	No significance
Over 45	No observations	-	-		
G26					
Below 36	No observations	-	-		
36-45	0.118	0.081	-0.046	0.379	No significance
Over 45	No observations	-	-		

Table 4.28 Comparison of proportions of success rates between male and female coaches for the use of static stretching during a cool-down period

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
G23					
Female	No observations	-	-	0.572	No significance
Male	0.100	0.056	-0.013 – 0.213		
G24					
Female	No observations	-	-	0.572	No significance
Male	0.100	0.056	-0.013 – 0.213		
G25					
Female	No observations	-	-	0.507	No significance
Male	0.133	0.063	0.005 – 0.262		
G26					
Female	No observations	-	-	0.650	No significance
Male	0.067	0.046	-0.028 – 0.161		

Table 4.29 Comparison of proportions of success rates between levels of highest education for the use of static stretching during a cool-down period

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
G23					
Diploma	0.100	0.100	-0.104 – 0.304	0.852	No significance
B Degree	0.100	0.069	-0.040 – 0.240		
Masters	No observations	-	-		
G24					
Diploma	0.100	0.100	-0.104 – 0.304	0.852	No significance
B Degree	0.100	0.069	-0.040 – 0.240		
Masters	No observations	-	-		
G25					
Diploma	0.100	0.100	-0.104 – 0.304	0.743	No significance
B Degree	0.150	0.082	-0.017 – 0.317		
Masters	No observations	-	-		
G26					
Diploma	0.100	0.100	-0.104 – 0.304	0.783	No significance
B Degree	0.050	0.050	-0.052 – 0.152		
Masters	No observations	-	-		

Table 4.30 Comparison of proportions of success rates between two groups for years of coaching for the use of static stretching during a cool-down period

	Proportions	SD	95% CI	Probability (Kruskal-Wallis)	Significance
G23					
1-5 Years	0.091	0.091	-0.094 – 0.276	1.000	No significance
Over 5 Years	0.091	0.063	-0.037 – 0.219		
G24					
1-5 Years	0.091	0.091	-0.094 – 0.276	1.000	No significance
Over 5 Years	0.091	0.063	-0.037 – 0.219		
G25					
1-5 Years	0.091	0.091	-0.094 – 0.276	0.710	No significance
Over 5 Years	0.136	0.075	-0.016 – 0.289		
G26					
1-5 Years	0.091	0.091	-0.094 – 0.276	0.612	No significance
Over 5 Years	0.045	0.045	-0.047 – 0.138		

Table 4.31 Comparison of proportions of success rates between private and public schools for the use of static stretching during a cool-down period

	Proportions	SD	95% CI	Probability Z-Statistics	Significance
G23					
Private	0.143	0.143	-0.148 – 0.434	0.668	No significance
Public	0.077	0.053	-0.032 – 0.185		
G24					
Private	0.143	0.143	-0.148 – 0.434	0.668	No significance
Public	0.077	0.053	-0.032 – 0.185		
G25					
Private	0.143	0.143	-0.148 – 0.434	0.861	No Significance
Public	0.115	0.064	-0.015 – 0.246		
G26					
Private	0.143	0.143	-0.148 – 0.434	0.486	No significance
Public	0.038	0.038	-0.040 – 0.117		

Table 4.27-4.31 show the proportions of success for the use of static stretching solely as a cool-down within groups with regards to coaches' age, gender, highest education qualification, number of years coaching and school type. There were no significant differences found between groups with regards to their proportions of success for the use of static stretching as part of a cool-down.

4.10 Establishing the association between level of coaches' physical conditioning knowledge and biographic variables

To establish whether there was any association between the coaches' level of physical conditioning knowledge and biographic variables, a Fishers exact test was performed. The results of this analysis are summarised in table 4.32.

Table 4.32 a summary of association of items with demographic parameters between

Item	**Age**	**School type**	**Gender**	**Highest qualification**	**Years of Coaching**
	Fisher's Exact	Fisher's Exact	Fisher's Exact	Fisher's Exact	Fisher's Exact
B1	1.000	0.688	1.000	0.672	0.465
B2	1.000	0.377	1.000	0.146	0.703
B3	0.739	0.623	1.000	1.000	1.000
B4	0.776	1.000	1.000	1.000	1.000
B5	0.145	0.623	1.000	0.684	0.378
C6	0.710	0.384	1.000	1.000	1.000
C7	0.453	1.000	1.000	1.000	0.104
C8	1.000	0.301	0.464	1.000	0.375
C9	0.280	1.000	1.000	1.000	1.000
D10	0.373	1.000	1.000	0.784	1.000
D11	0.464	1.000	1.000	0.784	0.643
D12	0.710	1.000	1.000	1.000	1.000
D13	0.641	0.555	1.000	1.000	1.000
E14	**0.024**	1.000	1.000	0.856	0.437
E15	0.709	0.378	0.534	0.642	1.000
E16	0.373	0.559	1.000	0.328	0.643
E17	0.099	1.000	1.000	0.328	0.643

F18	0.405		0.523		1.000		1.000		1.000	
F19	1.000		1.000		1.000		1.000		1.000	
F20	1.000		1.000		1.000		1.000		1.000	
F21	1.000		0.384		1.000		0.621		0.542	
F22	0.227		1.000		1.000		0.621		1.000	
G23	0.405		0.523		1.000		1.000		1.000	
G24	1.000		0.523		1.000		1.000		1.000	
G25	0.152		1.000		1.000		1.000		1.000	
G26	0.710		0.384		1.000		1.000		1.000	

***There were no significant associations found at level >0.05, except for E14 with regards to coaches age (0.024).**

There was no significant association found between coaches' knowledge of physical conditioning and biographic variables for gender, highest education qualification, number of years coaching or school type. However there was a significant association (p = 0.024) found between coaches' knowledge with regards to balance exercises in the prevention of injuries in high school middle and long distance runners and the coaches 'age. This suggests that the coaches that were older would have scored higher in the section regarding the use of balance exercises.

4.11 Conclusion

The results from the study indicate that the high-school athletic coaches in the Johannesburg-North Education District have good knowledge with regards to the physical conditioning of middle- and long distance runners. No significant associations were found between the coaches' biographic variables and the items in each domain of static stretching, active warm-ups, strengthening exercises, balance exercises, endurance training and/or cool-down sessions. However, the sample in this study all had a mean of 11.8 years of coaching experience, a mean age of 41 years, and 70 per cent of the sample had a tertiary education. The discussion of the results now follows.

CHAPTER 5 – DISCUSSION

5.1 Introduction

This chapter discusses the current knowledge of athletic coaches in the Johannesburg-North Education District, about the physical conditioning of high-school middle- and long-distance runners. The coaches' overall scores for the survey, as well as scores for each objective are explored and possible reasons for these scores are discussed. The biographic profile of the coaches is not discussed, as this is found in the results section. The coaches' current knowledge regarding the use of pre-exercise stretching, warm-up sessions, strength training, endurance training, balance and proprioception exercises and static stretching as a cool down is discussed individually. The significance of the coaches knowledge in each objective is discussed, compared to previous studies of a similar nature, and the implications of the results are explored. Lastly the relationship between the coaches' level of physical conditioning knowledge and their biographic profile is examined and recommendations from these results are then suggested.

The chapter is completed with the evaluation of the research, discussing the strengths and limitations, as well as recommendations for practice, policy and research.

5.2 Coaches' physical conditioning knowledge

The coaches scored on average good (high) with regards to the use of active exercises as part of a warm-up, the use of cardiovascular endurance training, the use of strength exercises, as well as the use of balance and proprioceptive exercises during pre- and in-seasonal physical conditioning. The coaches had poor (low) knowledge with regards to the use of static stretching solely as a warm up, as well as static stretching as a cool down during pre- and in-seasonal physical conditioning. The possible reasons for the scores in each section of the survey will now be discussed individually.

5.2.1 The use of static stretching solely as a warm-up session

Following analysis of the results from the survey, the coaches in this study scored the lowest with regards to using static stretching solely as a warm-up session. The mean score for the coaches' in regards to the use of static stretching solely as a warm-up was 43.6 per cent, indicating a poor level of knowledge. Similarly, no significant difference within groups was found for coaches' knowledge regarding static stretching. There was a marginal significance (*p = 0.08)* found between public and private school coaches' scores for a statement regarding the sole use of static stretching as part of a warm-up. The trend of the significance suggests that private school coaches know that static stretching on its own may not be an appropriate means of injury prevention. The reason for this finding maybe due to the nature of the study – being a cross-sectional survey, or perhaps due to the limitation of the statement in the survey.

The low average score overall for the static stretching component of the survey suggests that the majority of the coaches identify that static stretching on its own is an adequate warm-up for high-school middle- and long-distance runners to prevent injury. The implication of this result is that high-school athletic coaches have the knowledge that static stretching is an adequate warm-up, whereas many recent studies suggest that there are negative effects of performing static stretching in isolation (Small et al. 2008; Shehab et al. 2006; Cramer et al. 2004; Thacker et al. 2004; Pope et al. 2000). Although Shehab et al. (2006) surveyed coaches' beliefs – instead of knowledge – they found that almost 95 per cent of the coaches they surveyed believed static stretching is beneficial in reducing injury risk, with almost 73 per cent of the coaches believing there was no negative effect of static stretching. Shehab et al. (2006) did not question whether the coaches used any other element as part of a warm-up session. The findings in both of these studies are intriguing because – despite conflicting evidence – the majority of the coaches identify that static stretching may help prevent injury.

The reason for the above findings are controversially discussed by Shehab et al. (2006) who suggest that coaches used personal experience as well as scientific research when recommending exercises to their athletes. However, this is contradictory because if the

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coaches were using current knowledge, their belief may also have been that static stretching alone is not beneficial in the prevention of injuries. Therefore education of coaches regarding the latest scientific evidence in relation to static stretching and the effects of using static stretching as part of an injury prevention programme is essential. The current body of evidence regarding static stretching suggests that routine stretching prior to an athletic event may predispose the athlete to injury or negatively affect their performance because of the changes in mechanical properties of the muscle and/or strength deficits (Small et al. 2008; Shehab et al. 2006; Cramer et al. 2004; Thacker et al. 2004; Pope et al. 2000). Similarly de Noronha (2008) found that warm-ups that include stretching have not been shown to reduce muscle soreness when compared to studies that only performed post-exercise stretching. However, programmes that combine warm ups, strength and balance training have demonstrated effectiveness in the prevention of knee and ankle injuries. In summary, the authors concluded that there was not enough evidence to support or discourage the regular use of stretching before or after exercise. Cramer et al. (2004), also suggest that static stretching impairs maximal force production, while Chaouachi et al. (2008) did investigate the effect of stretching in the adolescent athlete and found impairment in sprint times after stretching. This evidence indicates that the use of static stretching as a warm-up session may not benefit the athlete, and the majority of the coaches in the current sample scored poorly in this regard. This indicates a need for the coaches to be educated regarding the use of static stretching as a warm-up session, as the results of the study implicate that the coaches may still be using this strategy as part of a conditioning programme.

5.2.2 The use of active exercises during warm-up session

The coaches scored high (90.1 per cent) regarding their knowledge of using active exercises during a warm-up session. Although this result indicated a high level of correct answers, it contravenes the results found with regards to static stretching, where the coaches thought static stretching was sufficient in isolation as a warm-up session. The reason for this contradiction maybe due to the limitation of the statements within the survey, as well as a recall bias by the respondent. Coaches with more than 5 years' experience had a significantly higher score with regards to their knowledge of using active exercises as part of a warm-up (*p* = 0.042. Secondly, private school coaches scored significantly higher in terms of their knowledge of determining that active exercises are an appropriate component of a warm-up to help prevent injury (*p* = 0.010). Lastly private school coaches' scored marginally significant results for their knowledge of combining static stretching and active exercises as part of a warm-up session (*p* = 0.082). The reason for the private school coaches scoring higher in this section may have been significant, but whether there is a relationship between the type of school and the level of knowledge will be discussed later.

Secondly, this result was not expected as the author – as suggested in the research problem initially – suggested that coaches may lack physical conditioning knowledge to help prevent injury in this population. There are no current studies to the author's knowledge that investigated coaches' knowledge of using active exercises during a warm-up session, so it is difficult to compare the results of the current study to any existing information.

The conflicting results regarding the use of static stretching on its own and the use of active exercise as part of a warm-up, suggests that the coaches either are not up to date with the most relevant evidence, or there may be some confusion in interpreting the results of the current literature. Similarly the interpretation of the statements in the survey, as well as the nature of a cross-sectional survey may have affected the results. Although no significant correlations were found in the knowledge of using active exercises as part of a warm-up, the paradoxical results compared those obtained for static stretching solely as a warm-up again touch on the need to provide clarity in educating coaches regarding different aspects of a warm-up session. Perhaps the reason for the above result may be due to the coaches' not reading empirical research, the lack of knowledge resources, and/or the availability of current research.

5.2.3 The use of active strengthening exercises during in-seasonal and pre-seasonal athletic training sessions

The majority of coaches scored high regarding their knowledge of using active strengthening exercises during pre-seasonal and in-seasonal athletic training sessions. Coaches in public schools scored significantly higher with regards to their knowledge of the use of core strengthening exercises in the prevention of injury ($p = 0.04$). This finding suggests that public school coaches' know that core strengthening exercises do not have a beneficial effect in preventing injuries. The reason for this finding may be due to the public school coaches having better knowledge resources regarding core strengthening or perhaps the term "core strengthening" was misinterpreted by private school coaches as it is a broad description. Another possible cause of the private school coaches' low scores may be due to the fact that coaches in public schools may be employed for longer periods due to public schools limited resources.

The current finding again shows that contrary to the authors' initial problem statement, the coaches appear to have a good understanding of the use of strength exercises as part of a physical conditioning programme.

5.2.4 The use of balance exercises during pre-seasonal and in-seasonal athletic training sessions

Similarly, the coaches scored high with regards to their knowledge of using balance exercises to help prevent injury in high-school athletes. There was a significant difference ($p = 0.038$) found in coaches' knowledge of balance exercises between age groups being beneficial in injury prevention. Coaches older than 45 years of age tended to score higher. There was also a marginal significance ($p = 0.068$) found between coaches' age groups with regards to their knowledge of using balance exercises as part of an injury recovery programme. Coaches older than 45 years of age and younger than 36 years of age tended to score higher. This finding may be due to the fact that coaches with more experience tend to have more knowledge than those with less experience.

Dorgo (2009) gives some insight why the results obtained with regards to coaches' knowledge may not be what was expected. Although Dorgo (2009) investigated the practical knowledge of expert strength and conditioning coach, the research was qualitative, with one coach providing the insight into different domains involved as a conditioning coach. The knowledge of the coach was not classified, as the participant was included following a thorough search of experienced and senior physical conditioning coaches. The participant in the study had 16 years of strength and conditioning experience, and 12 years as a head strength and conditioning coach. Dorgo (2009) concluded that coaching educational programmes should be expanded to include all aspects of knowledge as well as applied practical knowledge. Similarly to Dorgo (2009) the current study's participants were also experienced in terms of years coaching, and this is shows why the participants scored correctly regarding active strengthening exercises. So although this study examined the current muscle strength knowledge of high-school athletic coaches, one should perhaps focus on how the coaches apply this knowledge in future studies of a similar nature.

Lastly, there was a significant difference ($p = 0.02$) found between coaches' school type and the knowledge regarding the use of balance exercises and their beneficial effect in injury prevention. Coaches' in private schools scored higher than coaches in public schools. This result may be due again to interpretation of the statements in the survey, as well as the available resources and empirical evidence that coaches at different school types have available to them.

This result was not expected as identified in the research problem, but according to the author's knowledge there are no other studies which investigated coaches' knowledge of using balance exercises as part of a conditioning programme. The majority of research regarding the use of balance exercises has involved their use as part of a conditioning programme (Hubscher et al. 2010, Emery et al. 2007, McHugh et al. 2007 and Emery et al. 2005). The result suggests that perhaps the research problem was not extensively researched enough in high school athletic coaches prior to undertaking the construction of this particular survey. Secondly, the coaches may have good knowledge of the use of balance and proprioceptive exercises, as these are routinely used in rehabilitation programmes when recovering from injury. The coaches may have access to good quality evidence regarding the use of balance and proprioceptive exercises. Also the matter of whether the coaches actually practice this knowledge also needs to be kept in mind for future studies.

5.2.5 <u>The use of cardiovascular endurance exercise during pre-seasonal and in-seasonal athletic training sessions</u>

The coaches scored high again in the section regarding the use of cardiovascular endurance exercise in high-school athletes (93.3%). There were no significant differences found within groups for the coaches' knowledge regarding the use of cardiovascular endurance training as part of an injury prevention programme.

However, this result was to be expected in coaches who work with middle- and long-distance athletes, as cardiovascular endurance training forms the basis of all training in these athletes, as well as the basis of fitness in all athletes. No relevant articles which tested coaches' knowledge of cardiovascular endurance exercise could be sourced for comparison in this study.

5.2.6 <u>The use of static stretching during a cool-down session following an athletic event or training session</u>

The coaches scored the lowest with regards to their knowledge of using static stretching solely as a cool down (9.1 per cent). No significant differences were found within groups of age, school type, years of coaching, gender or highest education level for the coaches' scores in relation to using static stretching solely as a cool down. The results of this section could well be expected as indicated in the research problem – which suggests that high-school athletic coaches may lack physical conditioning knowledge. One of the reasons that the coaches may have scored poorly with regards to the use of static stretching solely as a cool down is due to the low number of research articles regarding this topic. However, this may also be linked to the fact that the coaches may have limited access to good empirical research that is current. Lastly the scores for this particular section may be due to the inclusion of the section by the author even though there is low yield of evidence regarding cool downs in injury prevention. So the coaches may have been justified in their low scores obtained. As mentioned previously this indicates a need for more in depth education of athletic coaches with regards to current literature on physical conditioning.

5.3 To establish the association between coaches' physical conditioning knowledge and biographic variables

The results of the study show that there are few significant associations between the variables of coaches' gender, highest education qualification, number of years of work experience or the type of school the coaches worked at, and the scores obtained in each section. The analysis was done of association between these variables and scores for each item in the survey.

This result conflicts with Shehab et al. (2006), who found statistically significant differences between male and female coaches, and experienced and inexperienced coaches. Firstly, it must be made clear that Shehab et al. (2006) did measure coaches' practice and not just their knowledge, and this may indicate why the results were not similar to the current study. Shehab et al. (2006) found that coaches with more experience tended to recommend pre-exercise stretching more than coaches with less experience. Secondly the study found that male coaches scored significantly better than female coaches with regards to recommending pre-exercise stretching. Secondly, consideration must be given to the fact that the current study only had three female participants, which may rendered the analysis of coaches' gender irrelevant. The reasons why the coaches' level of knowledge did not correlate with the biographic variables maybe due to the fact that too few questions were asked about each element of physical conditioning. The questionnaire may not have been sensitive enough to establish a correlation between the variables. Another possible reason that there was no correlation found was perhaps that none of the factors such as age, coaches' number of years' experience, or type of school had any significant relationship to the scores. Perhaps the questionnaire could have included more extensively researched statements for each item in the survey, to increase the sensitivity of the relationship to the biographic variables.

The only significant association found was that of coaches' age and their level of knowledge for the use of balance exercises in the prevention of injuries ($p = 0.024$), which suggests that the coaches over the age of 45 years had a better chance of scoring higher than coaches under the age of 45 years. This relationship again touches on the study by Shehab et al. (2006) which suggests that coaches with more experience tended to suggest the routine use of certain exercises. As discussed balance and proprioceptive exercises are routinely prescribed as part of an injury rehabilitation programme, and thus the more experiences coaches may have this knowledge.

5.4 Evaluation of the research

5.4.1 Strengths

The research was conducted within the Johannesburg-North Education District and so was a good indication of the level of coaches' physical conditioning knowledge in that particular district of South Africa. Secondly, the aim and sub-aims were systematically researched and then included in the study to wholly assess the coaches' level of physical conditioning knowledge. The development of the aims and objectives allowed for the development of the questionnaire as a new tool to establish coaches level of physical conditioning knowledge within a school setting based on current literature. The sample was obtained from a large population with a response rate of 79 per cent. Only the most senior coach or head coach at each school was surveyed, and this may indicate why the coaches did so well in their scores obtained in the survey. The high score is also justified by the fact that the coaches with the most experience scored better.

The instrument/tool used in the study was a newly developed survey that was validated by a panel of experts as well as scoring well in terms of scale inter-class reliability (α coefficient = 0.92) following statistical analysis. This indicates a good internal consistency of the questionnaire. Construct validity was established by wording statements that intended to measure the same objective differently.

The research process was thorough and effective as follow-up appointment were made to collect surveys from the participants 48 hours after the coaches received them. If the coaches had not completed the surveys by such time, a weekly phone call was made to each participant to follow-up. The response rate is improved due to the personal contact made between the researcher and the respondents, and the process is also more time-efficient than posting. Lastly due to the fact that an appointment is made to follow-up, the researcher did not bother the respondent at inconvenient times (De Vos et al., 2002).

5.4.2 Limitations of the research

Firstly, due to the nature of the survey the data obtained was self-reported and so the results obtained may have been subject to recall bias on the part of the coaches. Secondly, questionnaires were sent to both public and private schools; however the majority of the feedback was from public schools. The pre-requisites for the statistical test determines which sub set analyses can be done and which ones not. The low number of female coaches should have been realised prior to attempting a data analysis of this biographic. This low number of female coaches could explain why there was no correlation between the coaches' biographic variables and their level of knowledge.

The instrument/tool may have contained too few statements for each element of physical conditioning for validity. There was no factor analysis and/or a test of level of agreement between different sections of the instrument. This limitation suggests that the survey was not sensitive enough to determine a correlation between coaches' level of knowledge and their biographic variables. In the section regarding demographic information, one of the statements reads "level of education" which in retrospect is unclear in terms of its meaning. A suggestion for future use of the tool would be to use the statement “highest level of education achieved”.

The term “active exercises” used in Chapter one was not defined in the questionnaire and this may not have been interpreted inappropriately within the survey when the coaches were providing their answers for this section. In addition, within the objectives set out in chapter one, the use of static stretching as part of a cool down was included. However, there was limited research regarding the use of static stretching as part of a cool down, and perhaps this section could have been omitted from the survey altogether.

The tool/instrument also did not explore whether the coaches actually implemented the knowledge they had into everyday use as a high-school athletics coach.

The sample may not have been a sufficient representation of Gauteng North or the smaller rural municipalities of Johannesburg –North which may not have been recorded on the list of schools obtained from the Department of Education. The results of this study may not necessarily be generalised into other sectors of sport, particularly those that do not involve and middle and/or long distance running.

5.5 Conclusion

High-school middle- and long-distance running coaches have good knowledge with regards to physical conditioning of their athletes in the prevention of injuries in the Johannesburg-North Education District. However, their knowledge is not sufficient in all elements of physical conditioning. Although coaches’ education forms an integral part of the injury prevention system, they need to be continually updated on on-going literature – particularly in elements that they scored poorly in - either through self-educating or with the help of physiotherapists.

5.6 Recommendations

5.6.1 Implications for practice

The coaches' application of their knowledge needed to be established to understand whether the coaches' are applying current evidence when conditioning their athletes. Should it be found that the coaches are not applying the most current physical conditioning knowledge, the coaches can then be educated regarding the latest research of using static stretching solely as a warm-up session and the use of static stretching during a cool-down session, as they scored poorest in these domains. This is a good implication in terms of physiotherapist's involvement in high-school athletics. The usual role of the physiotherapist in preventing and treating injuries may now extend into continually educating coaches on the current literature, with respect to the use of static stretching as part of a warm-up session and/or a cool down session within the conditioning process.

5.6.2 Recommendations for policy

Due to the finding that the coaches' knowledge - of using static stretching solely as a warm-up and using static stretching as part of a cool-down – was incorrect, it is indicated that the most recent physical conditioning literature regarding static stretching is included in coaching courses. Secondly, this information could be directed to the education department at high-school level and/or the coaches' associations to include to perhaps suggest changes in policy or protocol with regards to the coaches' education by sharing results of the current study with the coaches that participated, as well as the education department.

5.6.3 Recommendations for research

Future research should involve testing the coaches' practical application of their knowledge, as this may yield more valid results about actual practice than just testing their knowledge. Similar studies could improve on perhaps surveying a larger population of schools to improve the ratio of public to private schools. Secondly future studies of a similar nature could look at surveying all the coaches at each school, and not just the most senior one. In terms of the questionnaire development, one could ask more questions about each element and then use statistical methods to see if all the items in actual fact measured the same factor.

There is a need for more studies to investigate the current knowledge of high-school athletic coaches with respect to each individual aspect of physical conditioning in addition to what was tested in this study, such as static stretching in isolation as a warm-up session, active warm-up sessions, strengthening exercises, cardiovascular endurance exercise, balance exercise and static stretching as part of a cool-down session.

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APPENDICES

Appendix A

700400173	7	GT	ABBOTTS COLLEGE-NORTHCLIFF	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT			GEOCODED MARCH 2008	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700131854	7	GT	ALTEM SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			DOE	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700150110	7	GT	BLAIRGOWRIE PRIMARY SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700131961	7	GT	BONA COMPREHENSIVE SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140426	7	GT	BOPASENATLA SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700131979	7	GT	BOPHELO-IMPILO PRIVATE	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT			DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700141523	7	GT	BOSMONT MUSLIM SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT			TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400032	7	GT	BRANDCLIFF HOUSE	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT			TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140053	7	GT	CORONATIONVILLE SEKONDÊR	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400180	7	GT	COSMO CITY SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400210	7	GT	COSMO CITY SECONDARY SCHOOL NO. 2	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	TO BE UPDATED	PUBLIC			TO BE UPDATED		CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152859	7	GT	DAMELIN COLLEGE HIGH SCHOOL - RANDBURG	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT			DOE	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700130260	7	GT	DEUTSCHE SCHULE JOHANNESBURG	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT			DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152728	7	GT	DIANFERN COLLEGE	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT			TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140434	7	GT	DIEPDALE SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400010	7	GT	DIEPSLOOT COMBINED SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	ODI I	CITY OF TSHWANE METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400149	7	GT	DIEPSLOOT WEST SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN	CITY OF JOHANNESBURG METROPOLITAN

													MUNICIPALITY	MUNICIPALITY
700400250	7	GT	DIEPSLOOT WEST SECONDARY SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140467	7	GT	EKUTHULENI PRIMARY	OPEN	PUBLIC	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700121301	7	GT	EMSHUKANTAMBO SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700150441	7	GT	FERNDALE HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC		NEIMS 2007	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140517	7	GT	FIDELITAS COMPREHENSIVE S.	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140525	7	GT	FONS LUMINIS SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700150466	7	GT	FOURWAYS HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700130427	7	GT	GREENSIDE HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152694	7	GT	HEARTWOOD INDEPENDENT SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		DOE	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400073	7	GT	HERON BRIDGE COLLEGE	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700130559	7	GT	HOËR TEGNIESE SKOOL LANGLAAGTE	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC		NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700150623	7	GT	HOËRSKOOL LINDEN	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700150631	7	GT	HOËRSKOOL RANDBURG	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140186	7	GT	HOËRSKOOL VORENTOE	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC		NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140558	7	GT	IKANENG PRIMARY	OPEN	PUBLIC	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140566	7	GT	IMMACULATA SECONDARY	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT		DOE	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152181	7	GT	ITIRELE-ZENZELE COMPREHENSIVE SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	ODI I	CITY OF TSHWANE METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

700130062	7	GT	JOHANNESBURG SECONDARY SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC			NEIMS 2007	RANDFONTEIN	WEST RAND DISTRICT MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700150698	7	GT	KING DAVID HIGH SCHOOL (VICTORY PARK)	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT			DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152223	7	GT	KWENA MOLAPO COMPREHENSIVE FARM SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	KRUGERSDORP	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700132449	7	GT	LOFENTSE GIRLS HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140756	7	GT	MADIBANE COMPREHENSIVE SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700130971	7	GT	MCAULEY HOUSE SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT			DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700121608	7	GT	MUSI COMPREHENSIVE	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140848	7	GT	NAMEDI SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140087	7	GT	NOORDGESIG SEKONDÊR	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140285	7	GT	NORTHCLIFF HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	WEST RAND DISTRICT MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700132670	7	GT	ORLANDO SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700131136	7	GT	PARKTOWN GIRLS' HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700121715	7	GT	PROGRESS COMPREHENSIVE SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC			NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140095	7	GT	R W FICK SEKONDER	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152851	7	GT	RABASOTHO COMBINED SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT			DOE	PRETORIA	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700133976	7	GT	RADLEY COLLEGE	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT			GEOCODED MARCH 2008	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700151241	7	GT	RAND PARK HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700132811	7	GT	RAUCALL SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

700151357	7	GT	RHEMA CHRISTIAN SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140111	7	GT	RIVERLEA SEKONDER	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	RANDFONTEIN	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700131367	7	GT	ROOSEVELT HIGH SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400136	7	GT	SAMA INDEPENDENT PRIMARY AND SECONDARY SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152348	7	GT	SEKOLO SA BOROKGO	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT		DOE	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700132902	7	GT	SELELEKELA SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152363	7	GT	ST ANSGAR'S COMBINED SCHOOL	OPEN	PUBLIC	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	KRUGERSDORP	WEST RAND DISTRICT MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700151621	7	GT	ST STITHIANS COLLEGE	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		DOE	RANDBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700133074	7	GT	TASK ACADEMY SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700121798	7	GT	THABA-JABULA SECONDARY	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700131631	7	GT	THE JAPANESE SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700151787	7	GT	THE KING'S SCHOOL (ROBIN HILLS)	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700141028	7	GT	TIYANI PRIMARY	OPEN	PUBLIC	ORDINARY SCHOOL	INTERMEDIATE SCHOOL	ORDINARY	PUBLIC		NEIMS 2007	SOWETO	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700152715	7	GT	TRINITY HOUSE HIGH SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400023	7	GT	VINE COLLEGE	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700141184	7	GT	WEST RAND SDA PRIMÊR	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		DOE	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700140137	7	GT	WESTBURY SEKONDER	OPEN	PUBLIC	ORDINARY SCHOOL	SECONDARY SCHOOL	ORDINARY & TECHNICAL	PUBLIC		NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY
700400026	7	GT	WILLOW RIDGE PRIVATE SCHOOL	OPEN	INDEPENDENT	ORDINARY SCHOOL	COMBINED SCHOOL	ORDINARY	INDEPENDENT		TO BE UPDATED	TO BE UPDATED	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY

700133314	7	GT	ZIFUNELENI JUNIOR SECONDARY (COMB. PRIMARY)	OPEN	PUBLIC	ORDINARY SCHOOL	INTERMEDIATE SCHOOL	ORDINARY	PUBLIC			NEIMS 2007	JOHANNESBURG	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY	

Appendix B

Juan Eekhout

S29514577

Department of Physiotherapy

University of Pretoria

University of Pretoria

PO Box 677 Pretoria 0001

Republic of South Africa

http://www.up.ac.za

Tel: (012) 354 1352

Fax: (012) 354 1226

Dear Participant,

A Survey of Current Physical Conditioning Knowledge

Of High School Athletic Coaches in the Johannesburg-North Education District.

I am a second year student in Masters of Sports Medicine in the Department of Physiotherapy, University of Pretoria. You are invited to volunteer to participate in my research project on the Current Physical Conditioning Practice – as the Application of Knowledge - of High School Athletic Coaches in the Johannesburg-North Education District.

This letter gives you information to help you decide if you want to take part in the study. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask me. You should not agree to take part unless you are completely happy about what we

expect of you.

The purpose of the study is to establish the current practice – as the application of knowledge – of athletic coaches in the Johannesburg-North education district, in the physical conditioning of high school middle and long distance runners.

I would like you to complete a survey. This may take about 20-30 minutes. I will collect the survey from you after 48 hours. It will be kept in a safe place to ensure confidentiality. Please do not write your name on the survey.

I will be available to help you with the survey or to fill it in on your behalf.

The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences granted written approval for this study.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. As you do not write your name on the survey, you give me the information anonymously. Once you have given the survey back to me, you cannot recall your consent. We will not be able to trace your information. Therefore, you will also not be identified as a participant in any publication that comes from this study.

Once the survey has been completed, all the results will be made available to you. Additionally an informative lecture will be organised, regarding current physical conditioning concepts, to those who wish to attend.

I sincerely appreciate your help.

Yours truly,

Juan Eekhout.

Appendix C

Dear Participant,

Thanks you for agreeing to participate in this survey, please can you answer the survey as accurately as possible with regards to the way in which you coach your runners.

When completing the survey, please mark only one option with an 'X' as shown below:

1. I am an athletics coach at my school.

The following terms are used in this survey and so shall be defined to avoid misunderstanding:

The term warm-up is defined as "a period of preparatory exercise in order to enhance subsequent competition or training performance," (Fradkin et al., 2006, Fradkin et al., 2010).

Conditioning is defined as "a structured and repetitive physical activity program that produces a higher level of physical fitness and athletic function, optimizing performance and minimizing risk of injury," (Brooks et al., 2007).

Balance is defined as "the ability to maintain the body's centre of gravity within its base of support and can be categorized by either static or dynamic balance," (DiStefano et al., 2009).

Thanks for your Co-operation.

Juan Eekhout.

Section A - Demographics

School: Private / Public (Please circle one)

Age of coach: Gender:

Level of education: Years of coaching:

Section B – Practice of using stretching as part of a warm up program:

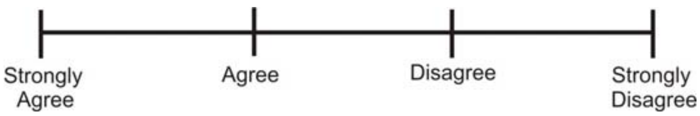
1) Static stretching on its own is an adequate warm up for high school middle and long distance runners prior to training or an athletic event, to prevent injury.

2) Static stretching on its own has a beneficial effect for high school middle and long distance runners, as a warm up prior to training or an athletic event.

3) Static stretching as a warm up for high school middle and long distance runners can help to prevent muscle soreness, strains and ligament sprains.

4) A warm up program for high school middle and long distance runners, should only consist of static stretching.

5) Static stretching alone for high school middle and long distance runners has no beneficial effect in the prevention of injury.



Section C – Practice of using active exercises as part of a warm up program:

6) Active exercises that mimic the running activity, such as walking lunges, are beneficial when used as part of a warm up for high school middle and long distance runners.

7) Active exercises that involve the muscles to be used during running, such as jogging whilst kicking the knees high, help to prevent injury in high school middle and long distance runners.

8) Active exercises, such as the ones described above, are not effective in preventing injuries if combined with static stretches in high school middle and long distance runners.

9) Active exercises as well as static stretching should be used in combination when performing a warm up in high school middle and long distance runners.

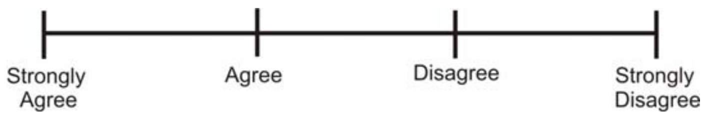
Section D – Practice of using active strengthening exercises as part of a physical conditioning program during pre-seasonal and seasonal athletic training:

10) Active strengthening exercises, such as squats, to strengthen muscles used whilst running, do not provide any benefit to high school middle and long distance runners.

11) Active strengthening exercises, such as squats, to strengthen muscles used during running, may help to prevent injury in high school middle and long distance runners.

12) Active strengthening exercises of the core muscles do not improve performance of high school middle and long distance runners.

13) Active strengthening exercises of the core muscles may prevent injuries in high school middle and long distance runners.



<u>Section E – Practice of using balance exercises as part of a physical conditioning program during pre-seasonal and seasonal athletic training:</u>

14) Balance exercises, such as single leg balancing, may be beneficial in the prevention of injuries in high school middle and long distance runners.

15) Balance exercises, such as single leg balancing, has no positive effect on performance of high school middle and long distance runners.

16) High school middle and long distance runners should not perform balance exercises, as the exercises do not help in the prevention of injuries.

17) High school middle and long distance runners require balance exercises when rehabilitating from injury and so these exercises should be included in a preseason conditioning programme.

<u>Section F – Practice of using cardiovascular endurance exercise as part of a physical conditioning program during pre-seasonal and seasonal athletic training:</u>

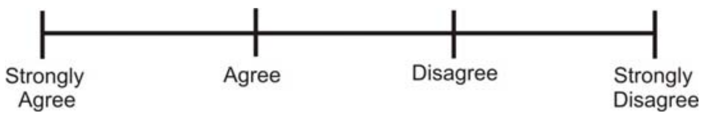
18) Endurance training should not be included in a conditioning programme as there may be no beneficial effect on running performance in high school middle and long distance runners.

19) Endurance training should form part of a conditioning programme due to the beneficial effects on running performance in high school middle and long distance runners.

20) Endurance training should form part of a conditioning programme due to the beneficial effects on the heart muscle in high school middle and long distance runners.

21) Endurance training should form part of a conditioning programme due to the increase in muscle blood flow and oxygen delivery to muscles in high school middle and long distance runners.

22) Endurance training should not be included in a conditioning programme as there are no beneficial effects on the heart muscle, oxygen delivery and blood flow to muscles in high school middle and long distance runners.



<u>Section G – Practice of using stretching during a cool down as part of a physical conditioning program after an event or training session:</u>

23) Static stretching should be performed after an athletic event or training to prevent muscle stiffness in high school middle and long distance runners.

24) Static stretching has no beneficial effect on recovery and so should not be routinely done after an athletic event or training in high school middle and long distance runners.

25) Static stretching that is performed after an athletic event or training has no beneficial effect on the prevention of injury in high school middle and long distance runners.

26) Static stretching that is performed after an athletic event or training may help reduce the number of injuries in high school middle and long distance runners.

Marking Sheet

Section	**Score**
Section B	
Section C	
Section D	
Section E	
Section F	
Section G	

Appendix D

Memo for Survey showing correct answers (which scored 1)

Section B:

1. Disagree/Strongly Disagree

2. Disagree/Strongly Disagree

3. Disagree/Strongly Disagree

4. Disagree/Strongly Disagree

5. Agree/Strongly Agree

Section C:

6. Agree/Strongly Agree

7. Agree/Strongly Agree

8. Disagree/Strongly Disagree

9. Agree/Strongly Agree

Section D:

10. Disagree/Strongly Disagree

11. Agree/Strongly Agree

12. Disagree/Strongly Disagree

13. Disagree/Strongly Disagree

Section E:

14. Agree/Strongly Agree

15. Disagree/Strongly Disagree

16. Disagree/Strongly Disagree

17. Agree/Strongly Agree

<u>Section F:</u>

18. Disagree/Strongly Disagree

19. Agree/Strongly Agree

20. Agree/Strongly Agree

21. Agree/Strongly Agree

22. Disagree/Strongly Disagree

<u>Section G:</u>

23. Disagree/Strongly Disagree

24. Agree/Strongly Agree

25. Agree/Strongly Agree

26. Disagree/Strongly Disagree

Appendix E

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	01 April 2010
Name of Researcher:	Eekhout Juan Darryl
Address of Researcher:	Unit 30 Oliver's Court
	10 Huperion Drive
	North Riding 2162
Telephone Number:	0117936430/0834568190
Fax Number:	0117936059
Research Topic:	A Survey of the Current Physical Conditioning Practice – As the Application of Knowledge – of High School Athletics Coaches
Number and type of schools:	71 Secondary Schools
District/s/HO	Johannesburg North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*

Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0809 Fax: (011) 355-0734

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Martha Mashego
ACTING DIRECTOR: KNOWLEDGE MANAGEMENT & RESEARCH

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	

Appendix F

respondent	Age	sch_type	gender	education level	Years of coaching	b1	b2	b3	b4	b5	c6	c7	c8	c9	d10	d11	d12	d13	e14	e15	e16	e17	f18	f19	f20	f21	f22	g23	g24	g25	g26	score_B	score_C	score_D	score_E	score_F	score_G
1	48 years	Private	Female	BSc Degree (HDE)	15 years	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	3	4	3	4	5	0
2	31 years	Public	Male	Teaching Diploma	1 year	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	4	3	1	5	0
3	40 years	Public	Male	B. Ed Degree	16 years	0	0	0	1	0	1	1	0	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	1	0	1	3	1	2	4	1
4	4	Pu	M	Tea	19	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	4	4	3	4	5	0

	0 years	blic	ale	ching Degree	years																																
5	41 years	Public	Male	Teaching Diploma	17 years	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	4	4	3	4	5	0
6	37 years	Public	Male	B. Ed Degree	8 years	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	0	4	4	3	1	5	1
7	26 years	Public	Male	B. Ed Degree	3 years	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	4	4	2	4	5	0
8	30 years	Public	Male	BSc Degree	2 years	0	0	0	1	0	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	3	3	3	4	0

9	39 years	Public	Male	Teaching Diploma	8 years	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	4	3	4	5	0
10	51 years	Private	Male	MSc Degree	15 years	1	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	2	4	3	4	5	0
11	44 years	Public	Male	Teaching Diploma	4 years	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	1	1	1	1	2	0	1	1	2	4
12	55 years	Public	Male	Management Degree	30 years	0	0	0	1	0	1	1	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	1	2	3	3	5	0
13	24 year	Public	Male	B. Ed Degree	1 Year	0	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	3	3	4	5	0

	s																																				
14	39 years	Public	Male	B. Ed Degree	4 years	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	4	3	4	5	0
15	43 years	Public	Male	Honours Degree	13 years	1	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	2	4	3	1	5	1
16	43 years	Public	Male	Teaching Diploma	16 years	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	5	4	3	4	5	0
17	57 years	Public	Male	Masters Degree in Ed.	32 years	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	4	3	4	5	0
18	28 yea	Private	Male	Sports Scienc	5 years	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	4	4	3	3	5	0

	rs			e Degree																																	
19	53 years	Public	Male	B. Ed Degree + Bcomm	30 years	1	1	1	1	1	1	1	0	0	1	0	1	1	1	0	1	1	1	1	1	1	1	0	0	0	0	5	2	3	3	5	0
20	43 years	Public	Male	Teaching Diploma	15 years	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	4	3	0	5	0
21	53 years	Public	Male	B. Ed Degree	20 years	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	3	4	3	4	5	0
22	24 years	Public	Male	B. Ed Degree	2 years	1	1	0	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	3	4	3	2	5	0
23	2	Pri	F	MP	3	0	0	0	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	4	3	3	5	0

	5 years	vate	emale	hil Sport Management	years																																
24	44 years	Public	Male	B. Ed Degree	15 years	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	4	3	4	5	0
25	55 years	Public	Male	B. Ed Degree	9 years	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	1	4	3	4	1	1
26	42 years	Private	Male	Teaching Diploma	5 years	0	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	2	4	3	4	5	0
27	45 year	Private	Male	B. Ed Degree	20 years	0	1	0	1	1	0	1	1	1	0	0	1	0	0	1	1	0	0	1	1	0	1	1	1	1	1	3	3	1	2	3	4

	s																																				
28	48 years	Public	Male	BA Ed Degree	14 years	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	4	4	4	5	0
29	38 years	Private	Male	B Comm + Higher Ed Degree	18 years	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	4	4	3	4	5	0
30	40 years	Public	Female	Teaching Diploma	4 years	0	0	0	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	3	3	4	5	0
31	38 years	Public	Male	BSc Maths & Stats	10 years	1	0	0	1	1	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	0	0	0	0	3	4	1	3	5	0
32	4	Pu	M	Tea	9	1	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	2	4	3	4	5	0

	9 years	blic	ale	ching Diploma	years																																
33	40 years	Public	Male	Education Diploma	6 years	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	4	3	0	5	0

Appendix G

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences Research Ethics Committee

3/05/2010

Number	:	**S47/2010**
Title	:	A survey of current physical conditioning knowledge of high school athletic coaches in the Johannesburg-North Education District (NEW TITLE)
Investigator	:	J D Eekhout, Department of Physiotherapy, University of Pretoria (SUPERVISOR: MRS A M MARAIS)
Sponsor	:	**None**
Study Degree:		**M. PhysT (Sports Medicine)**

This Student Protocol was approved by the Faculty of Health Sciences Research Ethics Committee, University of Pretoria on 3/05/2010. The approval is valid for a period of 3 years.

Prof M J Bester	BSc (Chemistry and Biochemistry); BSc (Hons)(Biochemistry); MSc(Biochemistry); PhD (Medical Biochemistry)
Prof R Delport	(female)BA et Scien, B Curationis (Hons) (Intensive care Nursing), M Sc (Physiology), PhD (Medicine), M Ed Computer Assisted Education
Prof V.O.L. Karusseit	MBChB; MFGP (SA); MMed (Chir); FCS (SA)
Prof J A Ker	MBChB; MMed(Int); MD – Vice-Dean (ex officio)
Dr M L Likibi	MBChB; Med.Adviser (Gauteng Dept.of Health)
Dr MP Mathebula	Deputy CEO: Steve Biko Academic Hospital
Prof T S Marcus	(Female) BSc (LSE), PhD (University of Lodz, Poland)
Prof A Nienaber	(Female) BA (Hons) (Wits); LLB (Pretoria); LLM (Pretoria); LLD (Pretoria); PhD; Diploma in Datametrics (UNISA)
Prof L M Ntlhe	MBChB(Natal); FCS(SA)
Mrs M C Nzeku	(Female) BSc(NUL); MSc Biochem(UCL,UK)
Snr Sr J. Phatoli	(Female) BCur (Et.Al); BTech Oncology
Dr R Reynders	MBChB (Pret), FCPaed (CMSA) MRCPCH (Lon) Cert Med. Onc (CMSA)
Dr T Rossouw	(Female) MBChB.(cum laude); M.Phil (Applied Ethics) (cum laude), MPH (Biostatistics and Epidemiology (cum laude), D.Phil
Mr Y Sikweyiya	MPH (Umea University Umea, Sweden); Master Level Fellowship (Research Ethics) (Pretoria and UKZN); Post Grad. Diploma in Health Promotion (Unitra); BSc in Health Promotion (Unitra)
Dr L Schoeman	(Female) BPharm (NWU); BAHons (Psychology)(UP); PhD (UKZN); International Diploma in Research Ethics (UCT)
Dr R Sommers	**Vice-Chair** (Female) - MBChB; MMed (Int); MPharMed.
Prof T J P Swart	BChD, MSc (Odont), MChD (Oral Path), PGCHE
Prof G van Biljon	(female)FCP (Paed)SA
Prof C W van Staden	**Chairperson** - MBChB; MMed (Psych); MD; FCPsych; FTCL; UPLM; Dept of Psychiatry

Student Ethics Sub-Committee

Prof R S K Apatu	MBChB (Legon,UG); PhD (Cantab); PGDip International Research Ethics (UCT)
Dr A M Bergh	(female) BA (RAU); BA (Hons) (Linguistics) (Stell); BA (Hons) (German) (UNISA); BEd (Pretoria); PhD (Pretoria); SED (Stell)
Mrs N Briers	(female) BSc (Stell); BSc Hons (Pretoria); MSc (Pretoria); DHETP (Pretoria)
Dr S I Cronje	BA (Pretoria); BD (Pretoria); DD (Pretoria)
Prof D Millard	(female) B.Iur (Pretoria); LLB (Pretoria); LLM (Pretoria); AIPSA Diploma in Insolvency Law (Pretoria); LLD (UJ)
Dr S A S Olorunju	BSc (Hons). Stats (Ahmadu Bello University –Nigeria); MSc (Applied Statistics (UKC United Kingdom); PhD (Ahmadu Bello University – Nigeria)
Dr L Schoeman	CHAIRPERSON: (female) BPharm (North West); BAHons (Psychology)(Pretoria); PhD (KwaZulu-Natal); International Diploma in Research Ethics (UCT)
Dr R Sommers	**Vice-Chair** (Female) MBChB; M.Med (Int); MPhar.Med

DR L SCHOEMAN; BPharm, BA Hons (Psy), PhD; Dip. International Research Ethics **CHAIRPERSON** of the Faculty of Health Sciences Student Research Ethics Committee, University of Pretoria

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