

**THE ASSESSMENT OF THE EFFICACY OF THE MOBILE TRAINING
SYSTEM AFTER IMPLEMENTATION IN SOUTH AFRICAN RUGBY
PLAYING SCHOOLS**

By

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(VRDROE001)

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Declaration

I, **Roedolf Frederik van Aarde** hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Signature:

Date:

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List of Abbreviations

1RM: 1 Repetition Max

CI: Confidence Interval

EP: Eastern Province

HPC: High Performance Centre

ICC: Intraclass Correlation Coefficient

IRB: International Rugby Board

ISSP: International Society of Sports Psychology

MSST: Multi-Stage Shuttle Test

MSTS: Mobile Schools Training System

NSCA: National Strength and Conditioning Association

RFU: Rugby Football Union

SARU: South African Rugby Union

SSISA: Sports Science Institute of South Africa

SWD: South Western District

TEM: Typical Error of Measurement

U14: under 14 age group

U16: under 16 age group

U18: under 18 age group

VO₂ Max: Maximum Oxygen Consumption

WP: Western Province

Abstract

Introduction

Rugby Union is a sport where physical size matters and the bigger, stronger and better conditioned players have an advantage over smaller and less powerful opponents. Research of adolescent rugby players in South Africa showed that Coloured and Black players weighed 8 kg less than their White counterparts. A possible explanation for the difference in size was the lack of weight training facilities in the disadvantaged areas. Therefore to address the potential handicap for these players having to compete against bigger players, the South African Rugby Union and the High Performance Centre at the Sport Science Institute of South Africa developed a mobile schools training system (MSTS). These are fully equipped units with sufficient weight training equipment for an entire team. The aim of this study was to determine whether the fitness characteristics associated with rugby, changed in players after the MSTS was given to a school for several months. Training of players was not controlled or supervised by any personal outside the infrastructure of the school. A secondary aim was to interview the staff member at each school responsible for the MSTS to enquire about their perceptions of the MSTS and whether there were any barriers to the uptake by the schools and players.

Methods

Schools with a “rugby ethos” and from a previously disadvantaged background were selected by SARU for the MSTS Programme. Players (U16 and U18 age groups) at these schools participated in the study. A total of 382 players were tested both before they had exposure to the MSTS and approximately 16 weeks later. They were divided into two age groups; U18 (n = 224 forwards and backs) and U16 (n = 158 forwards and backs). The following characteristics were measured; stature, body mass, body % body fat, muscular strength (bilateral grip strength and bench press), muscular endurance (1min push-ups), sprint times (10 m and 40 m) and aerobic capacity (multi-stage shuttle run test). All Tests were conducted during February and October of 2013. A rating of the extent to the players used the MSTS was also calculated and this was used to categorise schools. Data are represented as means \pm standard deviation. A repeated measures of analysis of variance (repeated measures of ANOVA) was used to determine whether there were significant differences between the ‘pre and post’ round of testing using either ‘age’, ‘provinces’ and whether the ‘gym was used or not’ as main effects. The interaction between ‘age x time’ and ‘province x time’ and ‘gym usage x time’ was calculated. If any interactions were significant, a Tukey *post hoc* test was used to identify specific differences. Statistical significance was accepted when $p < 0.05$.

Coaches at the schools participated interviews to determine the barriers to implementation of the programme, and which areas need to be improved.

Results

Changes over time was only shown for body mass ($p < 0.037$) and bench press ($p < 0.001$) in schools where the gym was used compared to schools who did not use the gym. When comparing U16 vs. U18 age groups, the U18 players were significantly taller, and heavier, had less % body fat, and a better performance for grip strength, bench press, push-ups, 10 m and 40 m sprint time and Multi-stage shuttle test (MSST) compared to the U 16 players ($p < 0.04$). There was also a significant interaction (age x time) for stature ($p < 0.002$), body mass ($p < 0.011$), % body fat ($p < 0.002$). When comparing the 5 provinces of the U16 age group, pre-post differences were noted for stature, body mass bench press and the multi stage shuttle test (MSST) between provinces $p < 0.0001$. Interactions (province x time) for changes over time between the 5 provinces was shown for stature, body mass, % body fat, bench press, push-up's, 10 m sprint time and MSST. There were significant pre-post differences between provinces (U18) for stature, body mass, skinfolds, % body fat, bench press and the multi stage shuttle test (MSST) for all $p < 0.0001$ except skinfolds showed $p < 0.041$. Interactions (province x time) change over time between the 5 provinces was shown for stature, body mass, % body fat, bench press and push-up's. An interaction for the age groups was determined for a variable if a level of significance was $p < 0.05$.

The interviews with the coaches raised various issues which comprised the usage of the MSST with the most important being lack of resources at the school, inadequate knowledge of strength and conditioning training, lack of facilities to store the mobile gym and poor nutrition of the players.

Conclusion

There is overwhelming evidence in the literature about the benefits of resistance training for youth, from the perspective of improving performance to reducing the risk of injury. The results from the MSTs programme were not as overwhelming as one would believe from the literature. This can be attributed to various reasons; inadequate facilities to house the MSTs, inadequate coaches' knowledge and experience in strength and conditioning, and poor nutrition. With increased provision of equipment at schools without adequate support of trained strength and conditioning specialists at each school the programme will be ineffective.

To ensure future success of the programme it is recommended that; (i) a needs analysis is done at each school to determine which school has the correct facilities to house the mobile gym so that regular training sessions can take place, (ii) SARU employs qualified trainers at

the schools involved in the MSTS programme to supervise all strength and conditioning sessions, (iii) there are regular follow up visits at schools to check on compliance, (iv) objective and subjective assessments are conducted at regular intervals to determine if there are improvements in the targeted variables.

Background and Motivation for the Study

A study undertaken/performed by the South African Rugby Union (SARU) in 2002 at the U18 Craven Week showed that Black and Coloured* players weighed 8 kg less than the White players¹. This study also provided evidence that these players did not have access to weight training facilities¹. It is clear from this study that players who do not train with weights are at a distinct disadvantage in rugby, as research has previously shown that success in International rugby union competitions is highly correlated with anthropometric variables².

The study also found that two main reasons for non-participation in strength training were:

1. a lack of access to weight training facilities, and
2. the players did not have access to training programmes.

As a result SARU, in conjunction with the Discovery High Performance Centre (HPC), designed a mobile schools training system specifically for schools that did not have weight training equipment. These were donated to 20 schools catering for pupils from predominantly disadvantaged backgrounds around the country. SARU and the HPC approached the University of Cape Town/MRC Research Unit for Exercise Science and Sports Medicine to measure the efficacy of this programme, defined by the changes in fitness characteristics associated with rugby as a direct result of the implementation of this out-reach programme. Another goal was to attempt to identify factors in the school and staff that could be associated with successful implementation of this programme.

* The ethnic term “*coloured*” is used by SA Rugby to classify the different ethnic groups. This has context in South Africa where transformation is high on the agenda.

Chapter One:

Literature Review and Scope of Thesis

1.1 Introduction

Rugby is a sport where physical size matters and the bigger, stronger and better conditioned players have an advantage over smaller and less powerful opponents³. In South Africa adolescent rugby players from low socio-economic environments are generally smaller and less powerful than their counterparts from more affluent areas³. Schools in disadvantaged areas have little access to resources, as well as being characterised by inadequate facilities and minimal involvement from parents⁴. A study undertaken by SARU in 2002 at the U18 Craven Week showed that Black and Coloured players weighed 8kg less than the White peers. This study also provided evidence that these players did not have access to weight training facilities¹.

The Mobile Schools Training System (MSTS) is a program of SARU developed in conjunction with the Discovery High Performance Centre (HPC) at the Sport Science Institute of South Africa (SSISA). The programme provides a gymnasium facility to underprivileged schools in selected developing areas in South Africa, such as the Western Province, Boland, Eastern Province and Border. SARU and HPC worked with the selected schools in these regions with the goal of promoting and improving physical activity in the schooling community. The schools that were selected to the programme had to come from a previously disadvantaged background, had to be a rugby playing school and the school had to have a strong rugby tradition/ethos.

The MSTS is a mobile container of equipment that can be moved around to different locations within the school. The following equipment is contained within the MSTS; dumbbells ranging from 3 to 20 kilograms, barbells with a range of various weight plates that can be added, resistance bands, kettlebells, medicine balls, and a multi-adjustable bench, with a squat and bench rack. Dip bars, which attach to the outside of the mobile container, are provided.

Strength and conditioning programmes (Appendix F) specific to rugby were provided to each school. There are three programmes ranging from a programme for the beginner level at U14 to an advanced level at U18. The programmes consist of various resistance training exercises to rugby specific conditioning type exercises. All exercises are based on the available equipment in the mobile training container. Each of the three programmes consists of twenty exercises. The exercises are performed in a circuit format, which allows at least twenty players at a time to participate in the exercise session. Each exercise lasts 30 seconds before the player moves onto the next exercise in the circuit. A rest period is given once each player has successfully completed all twenty exercises. The goal is for the player

to complete as many repetitions possible of each exercise within the 30 seconds, provided that the correct posture and techniques for the exercise is maintained at all times.

In particular, the MSTS program is designed so that rugby players at the selected schools can prepare adequately for the game, and not be at a competitive disadvantage when competing against players who do resistance training. As previously discussed by *Lambert and Durandt (2010)* it is clear that the smaller players have a distinct competitive disadvantage over their bigger and stronger counterparts³.

The strength and conditioning guidelines for the MSTS are based on the recommendations of the National Strength and Conditioning Association (NSCA), an authoritative body governing strength and conditioning. The NSCA in 2009 released a position statement confirming that resistance training for the youth can safely improve the conditioning and strength of the individual⁵.

The position statement provides the following guidelines: A properly designed and supervised resistance-training programme:

1. is relatively safe for youth.
2. can enhance the muscular strength and power of youth.
3. can improve the cardiovascular risk profile of youth.
4. can improve motor skill performance and may contribute to enhance sports performance of youth.
5. can reduce the risk a young athlete getting a sports related injuries.
6. can improve the psychosocial well being of youth.
7. can promote and develop exercise habits during childhood and adolescence.

Lloyd et al. (2014) released an updated position statement regarding youth resistance training. The position is endorsed by the following bodies, American Academy of Paediatrics (AAP), American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD), American Medical Society for Sports Medicine (AMSSM), British Association of Sports Rehabilitators and Trainers (BASRaT), International Federation of Sports Medicine (FIMS); Faculty of Sport and Exercise Medicine UK (FSEM), North American Society for Paediatric Exercise Medicine (NASPEM), National Athletic Trainers' Association (NATA), Chief Medical Officer, National Collegiate Athletic Association (NCAA), National Strength and Conditioning Association (NSCA).

The position statement highlighted the following important facts⁶:

1. The use of resistance training by children and adolescents is supported on the *proviso* that qualified professionals design and supervise training programmes that are consistent with the needs, goals and abilities of younger populations.

2. Parents, teachers, coaches and healthcare providers should recognise the potential health and fitness-related benefits of resistance exercise for all children and adolescents. Youth who do not participate in activities that enhance muscle strength and motor skills early in life may be at increased risk for negative health outcomes later in life.
3. Appropriately designed resistance training programmes may reduce sports-related injuries, and should be viewed as an essential component of preparatory training programmes for aspiring young athletes.
4. Regular participation in a variety of physical activities that include resistance training during childhood and adolescence can support and encourage participation in physical activity as an on-going lifestyle choice later in life.
5. Resistance training prescription should be based according to training age, motor skill competency, technical proficiency and existing strength levels. Qualified professionals should also consider the biological age and psychosocial maturity level of the child or adolescent.
6. The focus of youth resistance training should be on developing the technical skill and competency to perform a variety of resistance training exercises at the appropriate intensity and volume, while providing youth with an opportunity to participate in programmes that are safe, effective and enjoyable.

Schools in underprivileged areas have little access to resources, inadequate facilities and minimal involvement from parents⁴. The MSTS has the potential to provide the schools with the opportunity to physically develop and condition their rugby players from the U14 levels to the senior levels, using principles of resistance training. The resistance training guidelines for youth are designed to ensure that the risk of injury is low⁷.

Whilst the position document provides overwhelmingly positive evidence to support the implementation of a resistance-training program, there are no data on the efficacy of such a program in an underprivileged area. This warrants further investigation with the aims of determining: (1) whether players exposed to the MSTS exhibit any meaning physical changes; and (2) whether there are any barriers which would impact on the implementation of the programme.

Looking at models of previously conducted community based projects, one gets a sense of important factors for this programme to be successful. For example, *Draper et al.* (2009) used a model called “indicators to success” for a successful programme that was conducted

in the disadvantaged communities in the Western Cape⁸. The main contributing factors that led to the success of this programme were to better the knowledge, understanding and behaviours of people in the community⁸.

The interpersonal and intrapersonal factors of key individuals that can contribute to the project should also be studied⁸. For example, understanding the influence of the HPC staff on the teachers, coaches as well as the scholars of the school play a major role in determining the factors contributing to the success of the project. HPC staff trained the teachers and coaches how to use the equipment of the MSTS gym.

To summarise, it was expected that the MSTS programme would make the players from underprivileged schools physically stronger and better conditioned. It followed that this would improve their sporting performance and make them more competitive. These outcomes were important because sport has become so competitive and every player, coach and parent is striving for the best possible performance. However, before these claims about the MSTS can be made the efficacy of the programme was assessed. The next phase will discuss the background to rugby, testing of physical characteristics and aspects relating to supervision of resistance training. This will be followed by an explanation of the research questions and then a description of the research.

1.2 History of rugby

A variety of early ball games were played during the middle ages (5th to 16th century) and are sometimes referred to as folk football, mob football or Shrovetide football. Such games were usually played between neighbouring towns and villages, involving an unlimited number of players on opposing teams, who would fight and struggle to move an inflated pig's bladder by any means possible to markers at each end of a town. Authorities later attempted to outlaw such dangerous and unproductive pastimes⁹

Many believe that the game of rugby was conceptualised in 1823 when William Webb Ellis (a young boy attending the Rugby School in the United Kingdom) was playing football, and against the rules of the game, picked up the ball, placed it in his arms and ran with it to the opposition's goal line. Although this story is regarded as the basis for the formation of rugby, there is little evidence to substantiate its accuracy. However, the International Rugby Board (IRB) have accepted this and named the Rugby World Cup the "William Webb Ellis Trophy"^{9,10}.

Rugby Football Union (RFU) was founded in the Pall Mall Restaurant in Regent Street, Charing Cross, London to standardize the rules and removed some of the more violent aspects of the Rugby School game.

As a consequence of the influx of working class players into the game during the 1870s and 1880s there was a split between rugby league and rugby union in 1895. This split occurred because the administrators did not make provisions for the working class, which would have allowed them to participate at the same level as the middle and upper classes. This established a situation that could only resolve itself with a split of the game into differing codes. They imposed a freeze on professionalism for RFU which lasted a 100 years. During late August 1995 a decision was made in Paris to allow professionalism of the Rugby Union game. So much money was flowing into the game from advertising and television coverage that the IRB did not really have a choice in making the decision. Although many of the top Union players were getting paid unofficially, these underhand dealings became known as "Shamateurism" and in March of 1995 an IRB working party reported that the "*breaches of the amateurism regulations were wholesale*". Therefore the announcement about accepting professionalism in the sport in August was inevitable⁹.

1.3 Technical side to schoolboy rugby

Rugby Union (henceforth referred to as rugby) consist of two teams consisting of 15 players per side, competing against each other for 60 minutes (30 minutes per half) at an U16 level and 70 minutes (35 minutes per half) at an U18 level¹¹. Rugby Union consists of a number of maximal sprints and collisions between players, with players being involved with large amounts of physical contact at the ruck, tackle and during scrums¹².

Schoolboy rugby is played on a rugby field that is not more than 100 metres in length excluding the 22-meter touch-in goal area and the field is not more than 70 metres in breadth. The field is then further divided into a halfway line, a 10-metre line, a 22-metre line, a 5-metre line and a goal line running through the length of the field. The breadth of the field is divided into 5 and 15 metre lines¹⁰.

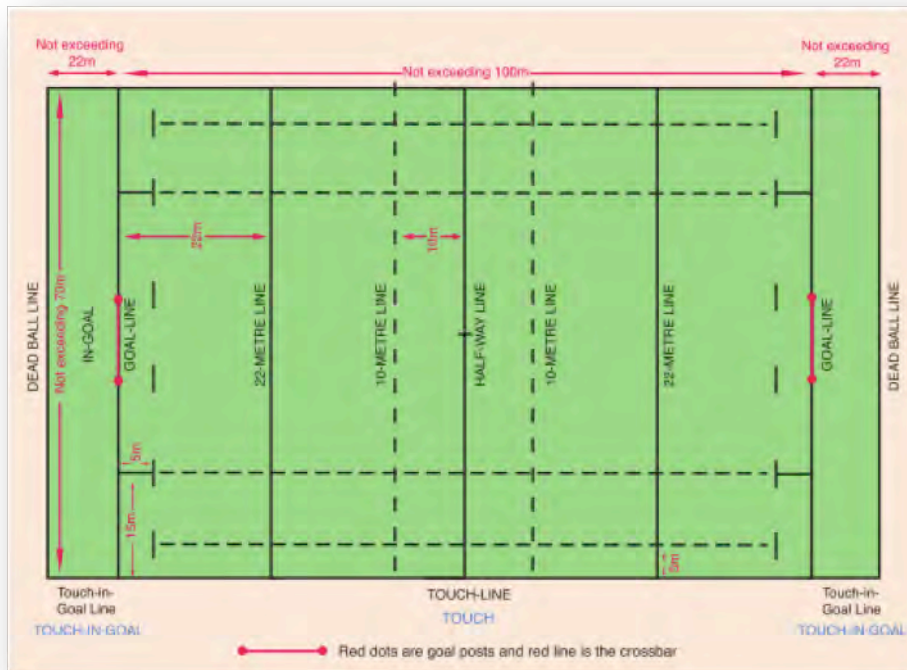


Figure 1: Rugby Union playing field. (Image adapted from the IRB Beginner's Guide to Rugby, - their copyright law allows for publication of their work for educational purposes)¹⁰

Schoolboy rugby consists of two teams having 15 players on the field at a time¹³. The players are divided into two main categories namely forwards (numbers 1-8) and backs (number 9-15). The forwards are further divided into the front row (numbers 1 & 3 called props, number 2 called a hooker), the second row (numbers 4 & 5 are called locks) and the loose forwards (numbers 6 & 7 are called the flanks and number 8 the 8th man). The backs are also divided into various playing positions namely half backs (numbers 9-10 called the scrumhalf and flyhalf), the inside backs (numbers 11-12 are called the left wing and inside centre) and lastly the outside backs (numbers 13-15 called the outside centre, right wing and fullback)¹⁰.

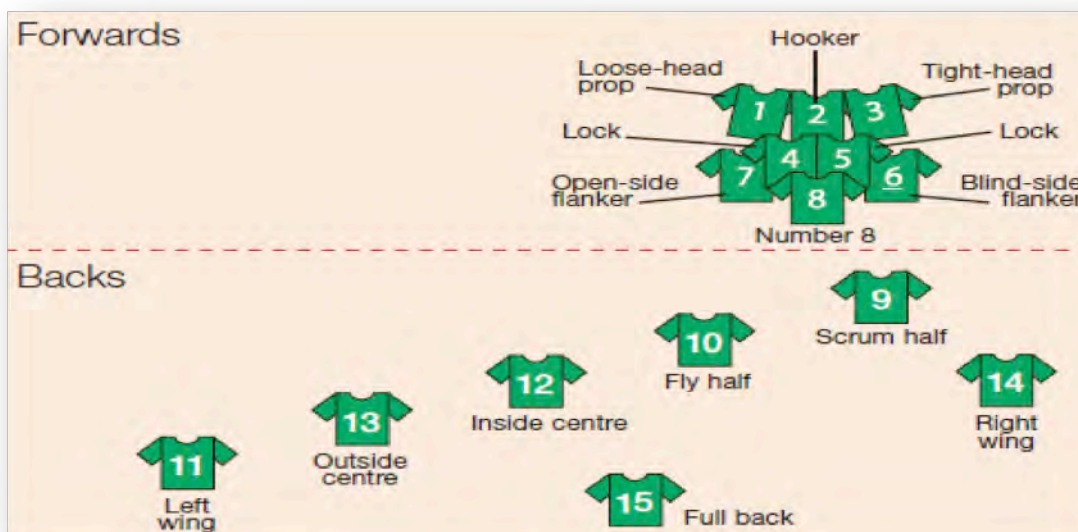


Figure 2: Rugby Union playing positions. (Image adapted from IRB Beginner's Guide to Rugby, - their copyright law allows for the publication of their work for educational purposes)¹⁰

1.4 Physical side of rugby

Players who are bigger, stronger and faster have a clear advantage over smaller, less powerful opponents³. These differences in size at junior levels of rugby are as a result of the adolescents reaching puberty at different stages³. To some extent physical training can reduce the advantages gained from size mismatch¹⁴. However, the main training goal is to prepare the players for collisions and sudden bursts of energy with lower or insufficient recovery, so the players can cope with, and recover from, intermittent high intensity activities¹⁵.

Rugby is a dynamic sport with intermittent high intensity bouts of activity which include directional changes during the match¹⁶. *Cunniffe et al.* showed in elite rugby players with a mean age of 25, that during a match that lasted approximately 83 minutes, 72% of the time was spent standing or walking, 17% jogging, 3% cruising, 4% striding, 1% high intensity running and 12% sprinting¹⁶. This study also showed that forwards were 60% more involved in high level impact than the backs, and furthermore 66% of the high level impacts the forwards received occurred during the second half¹⁶. *Gabbett et al. (2012)* showed in elite Rugby League players with a mean age of 23, that forwards also have higher collision rates and repeated effort demands than the backs¹⁷. Backs also covered a greater distance during match-play¹⁷.

Hartwig et al. (2011) compared adolescent forwards and backs during matches and training sessions to examine the differences in time spent in the various levels of activity. They showed the following; percentage time spent stationary (38% vs. 45%; games vs. on field training sessions) and walking (42% vs. 45%; games vs. on field training sessions). These differences were not different¹⁸. However, more time was spent in higher intensity movements of jogging (14% vs. 8%; games vs. on field training sessions), striding (3.2% vs. 1.3%; games vs. on field training sessions), and sprinting (1.3% vs. 0.1%; games vs. on field training sessions) ($p < 0.001$) during games compared with training sessions¹⁸. During matches backs tended to spend less time stationary (45% vs. 33%; forward vs. backs) and more time walking (36% vs. 49%; forward vs. backs) than forwards¹⁸. Backs also tended to sprint more frequently and for longer durations than forwards during both games and training¹⁸.

1.5 Differences between forwards and backs

Duthie et al. (2003) stated that the physical demands of rugby vary depending on the playing position. This has been confirmed in many subsequent studies^{19–22}. Forwards require more strength and size to enable them to contest for the ball, while backs need to be more agile and have more speed to be able to carry the ball past the opposition. Forwards spend more

time competing for the ball against the opposition while backs spend more time being involved in intense running and running into open spaces to evade the opposition^{13,15,23}. Forwards are also involved in more contact situations that results in a greater work load whereas backs cover more distance during a game¹⁵. Forwards are typically heavier, taller, stronger, and have a greater proportion of body fat than backs^{13,15,19}

1.6 Benefits of strength and conditioning in adolescents

Adolescence refers to boys and girls between the childhood and adulthood stages with the age of boys between 14 and 18 years and girls between 12 and 18 years²⁴. The childhood and adolescence stages are normally separated by the onset of puberty.

“Resistance training” is the use of any resistive load (which may include the use of free weights, weight machines, elastic tubing, or an athlete’s own body weight), which is designed to enhance muscular strength and endurance^{6,25}. The term resistance training is synonymous with other terms such as “strength training”, “weight training” and “weight lifting”²⁴.

Many misconceptions exist regarding the possible risks to children and adolescents participating in resistance training²⁶. A classic myth is that resistance training will stunt their growth²⁷. This myth, together with other misconceptions, such as the fact that resistance training will lead to youths becoming muscle-bound and slower, has made the lay public believe that children and adolescents should not participate in resistance training²⁴. However, no scientific evidence exists to support these misconceptions^{5,25}. There are numerous position statements, that conclude that resistance training, when performed using proper technique and strict supervision, is a safe, effective and recommended as a training modality for children and adolescents^{5,6,25}.

In properly designed resistance-training programmes in adults the adaptation of muscle, including changes of fibre type composition and muscle hypertrophy are well established²⁸. The morphological changes in children and adolescents following resistance training are, however, not as well characterised²⁷. Despite youths showing no difference, or very modest changes in muscle size during progressive resistance training programmes, both children and adolescents have shown significant increases in muscle strength, beyond the strength changes which occur during normal healthy growth and maturation²⁴. For example, two meta-analyses on the effectiveness of youth resistance training on strength adaptation have been performed^{29,30}. *Falk and Tennebaum (1996)* calculated an effect size of 0.57 (*medium effect*) for girls and boys (12 and 13 years of age respectively), whereas *Payne et al. (1997)*

revealed effect sizes between 0.65 and 0.83 (*medium to large*) for youth's aged 6 to 18^{29,30}. *Faigenbaum et al. (1993)* showed strength gains of up to 74% after only 8 weeks of progressive resistance training in children using weight machines³¹.

Since there is minimal evidence of increased muscle size, neurological adaptation has been proposed as the primary mechanism of strength gain in youths²⁷. Neurological adaptation refers to modifications in coordination and learning that facilitate better recruitment and activation of muscle²⁷. It is evident from the literature that the benefits of resistance training are gains in strength as opposed to gains in muscle size and that neurological adaptations occur^{24,27,29-31}.

1.7 Guidelines for adolescent resistance training

A qualified strength and conditioning specialist should always provide the child or adolescent who participates in resistance training with good clear instruction and he/she should always be closely supervised²⁴. As each child and adolescent is physically unique, resistance training programmes that will meet the individual needs according to physical maturation, training experience and adaptation to the training programme should be prescribed with caution²⁴. Children and adolescents should not be pressured or forced to participate in exercise and their interests and goals should also be considered²⁴. Only children or adolescents who are mentally and physically ready should do resistance type exercises. However, if the child/adolescent is already playing rugby it is generally assumed they are mentally and physically ready. Before the child or adolescent starts with resistance training a pre-participation medical examination is recommended to identify any possible underlying health issues such as orthopaedic injuries or any chronic diseases which may impose an increased risk of injury or ill health²⁴.

A weight room or gymnasium should also be free of any hazards, to reduce the risk of injury during resistance training. Basic education on correct training technique, training guidelines, exercise-room etiquette, spotting techniques and the use of collars should be part of resistance-training programmes. Youth should be encouraged to embrace self-improvement. Emphasis should not be to just lift heavy weights, but rather to correctly perform the more difficult multi-joint exercises²⁴.

In designing a resistance training programme, the following needs to be considered^{24,32}:

1. warm-up and cool down,
2. choice and order of exercises,
3. training intensity and volume,

4. rest intervals between sets and exercises,
5. repetition velocity,
6. training frequency,
7. programme variation

Static stretching is no longer used as a warm up to prepare the athlete for the activity as it has been shown to reduce the lower extremity power and isokinetic peak torque in youth²⁷. A dynamic warm up consisting of hopping, skipping, jumping, movements based on the movements of the event should be done as part of the warm up^{27,33,34}. A study published in 2014 showed that static stretching done as a warm up can impair explosive performance for up to 24 hours after the bout of static stretching, whereas improvements have been shown in explosive performance 24 hours after a bout of dynamic stretching³⁵. Static stretching can be done after the training session as part of the cool down period²⁷.

A wide variety of resistance exercises can be done providing the correct exercise selection, training technique, prescription and the player's physical state is considered. Exercises can range from single joint to multi joint exercises and can be performed on weight machine, free weights, with elastic bands, medicine balls or even with body weight^{24,27}.

Adolescents who are engage in resistance training should follow a resistance-training programme on 2 or 3 non-consecutive days each week⁶. The programme should include 8 to 12 exercises that strengthen the whole body. In the beginning 1 or 2 sets of 8 to 15 repetitions should be performed with a light to moderate load to enable adolescents to learn proper technique. Emphasis should be on correct exercise technique and not the load that is lifted^{24,27}.

With regards to programme design large muscle groups should be stimulated before smaller muscle groups and further multi-joint exercises should be completed before single joint exercises³². Experienced players performing exercises such as Olympic lifts and plyometric exercises, should include these exercises in the early parts of the training session before muscular fatigue develops^{24,32}.

The training programmes of adolescent players with more resistance training experience may be progressed to meet specific training objectives. These players may perform 3 sets with a heavier load that allows between 6 to 10 repetitions before the onset of fatigue. This type of training may increase strength particularly in exercises involving large muscle groups. Progression may also be achieved by performing certain selected exercises to

enhance movement speed, and therefore power generation. Olympic lifts and plyometric drills are examples of such exercises^{24,27}.

Balance, coordination, abdominal, hip and lower-back exercises aimed at strengthening the trunk should also be included as these exercises have been proposed to reduce the risk of injury²⁴. A rest for about 1 minute between sets is recommended for adolescents while longer rest periods are recommended for adults. Adolescents are able to resist fatigue to a greater extent than adults during several repeated sets of exercise²⁴.

To keep the training programme challenging and effective, systematic variation in exercise intensity, volume and recovery should be incorporated^{24,27}. A variation as simple as less-intense training sessions may provide youth and adolescents the required variation during long-term sports resistance training programmes^{24,27}.

Table 1: Summary of general youth/adolescent resistance training guidelines.^{24,27}

1.	All children and adolescents require qualified instruction and close supervision by a qualified strength and conditioning professional to ensure safe and effective resistance training
2.	There is no minimum age, rather young children should be physiologically and psychologically ready to participate in a resistance training programme
3.	The exercise environment (weights room or gymnasium) should be safe and free of hazards
4.	The strength and conditioning professional should educate the players on correct training technique, training guidelines, exercise-room etiquette and correct spotting techniques
5.	Each exercise session should begin with a dynamic warm up of a 5 to 10 minute period
6.	Start resistance training on 2 or 3 non consecutive days of the week
7.	Begin with 8 to 12 exercises that strengthen the whole body (upper body, lower body and the midsection)
8.	Initially perform 1 or 2 set of 8 to 15 repetitions (approximately 60% of 1RM) with light to moderate load to learn proper technique
9.	The focus should be on learning the correct exercise technique and safe training procedures instead of the amount of weight lifted
10.	Balance and coordination exercises, as well as abdominal, hip and lower back exercises should be included to reduce injuries
11.	Gradually progress to more advanced movements that enhance power production
12.	Cool down with static stretching
13.	Vary the training programme over time to optimize adaptation and to reduce boredom

1.8 Effect of direct supervision on adolescent resistance training

Qualified and experienced strength and conditioning coaches should supervise training as they have the expertise to prescribe appropriate training techniques and be cognisant of the risk of overuse injuries⁶. The first study to investigate the influence of direct supervision was a study published in 2000 by *Mazzetti et al.*³⁶. This study investigated the influence of direct supervision of resistance training on strength gains in a group of moderately trained men³⁶. The study showed that the supervised group had greater load increases in upper and lower body maximal strength gains³⁶. *Smart and Gill (2013)* showed that in a 15 week off-season

strength and conditioning programme between a supervised and unsupervised group of players, the supervised group had greater improvements in strength, body composition and acceleration¹². They stated that the results of their study¹² are comparable to the results of the study of *Coutts et al.*³⁷. This study showed that after 12 weeks of supervised and unsupervised resistance training the mean percentage change for bench press increased twice as much for the supervised group compared to the unsupervised group ($30 \pm 9\%$ vs. $15 \pm 7\%$)³⁷. Similar results were found for a 3RM squat strength test where the mean percentage change increase was $40 \pm 27\%$ (supervised) and $26 \pm 16\%$ (unsupervised)³⁷. Supervision also led to greater adherence and training intensity in the supervised group compared to the unsupervised group³⁷. *Gentil and Bottaro (2009)* reported that all the studies up to that point were on trained subjects³⁸. Therefore they studied the effect of direct supervision on untrained subjects. They assigned untrained subjects to either a high or low supervision groups. The results were consistent with the other studies, with the high supervision group having the greatest strength gains in upper and lower body strength. One of the reasons stated for this increase was the higher training intensity of the high supervision group³⁸.

1.9 When to test and not to test

The main reason for testing the physical ability and skill level of young athletes is to determine their physical abilities and motor skill level across different phases of the prescribed training program. For example, there are specific desired outcomes in the preparation, competition, and transition phases of training. The outcomes of testing can also predict the athletes' potential and future success and can serve as a positive motivator to train³⁹.

Lidor et al, (2009) stated that coaches should factor in the athlete's multi-faceted developmental stage. Some of the children who are involved in sport activities at an early age are sufficiently mature from a biological and psychological perspective to perform maximally in the tests assessing physical ability and skill level. The opposite is true for children that may not have reached the required maturation levels that would enable them to cope with the challenge, as well as the specific requirements of the tests, and thus will underperform in the tests³⁹.

Falk et al, (2004) performed three physiological testing batteries with a water polo team between the ages of 14 and 15 over a two-year period before a junior national team was selected. Players that were selected into the junior national team were compared to the players that did not make team selection. The comparison revealed that the selected players

were already superior in physical and skill tests in the two years before the national team was selected when the initial testing took place. The results showed that the superiority that was evident at baseline testing was maintained over the two-year period. Based on initial testing results it was shown that 67% of the selected players was in agreement with the team that was selected³⁹.

Gabbett et al (2007), stated that anthropometrical and physiological characteristics are related to playing ability but do not necessarily discriminate between successful and less successful players in rugby league⁴⁰. A paper published in 2009, concluded that variables derived from anthropometric, physical, and biomechanical testing play an important role in high performance sports⁴¹. Physiological testing can be used to set normative standards for each testing variable for the identification of potential talent⁴¹. Physiological testing also provides the coach, medical staff and selectors with an overall impression of an athlete's physiological profile, providing that the testing battery was valid, reliable and meaningful⁴². Therefore, published peer reviewed articles support the concept of physiological testing.

Lidor et al, (2009) made two recommendations about testing young athletes. The first recommendation is that coaches should limit the use of physical skill tests for the objective of talent detection during early phases of sport development, particularly among pre-pubescent prospects. Secondly, coaches and researchers specializing in measurement and evaluation in physical education and sport should have mutual cooperation to improve the use of various items included in the batteries of the physiological tests³⁹.

1.10 Benefits and implications of physiological testing

Testing provides the athlete and the coaching staff with the ability to assess athletic talent and identify physical abilities, and monitor progress of a conditioning programme. Baseline testing scores are used as a measure of the starting point of various fitness characteristics for training and also allows the trainer to set achievable training goals for the athlete. Testing at regular intervals provides information for the trainer to determine if the necessary improvements are being made to the athlete's conditioning. The training goals derived from testing results can be specific to the individual athlete, or they can be applicable to the team⁴³.

In summary, although testing provides the opportunity to measure the physical characteristics of the athlete as discussed above, there are factors that have to be considered. For example, the unpredictability of growth and critical environmental factors confound the accuracy of most tests of physical performance used in talent identification.

Also there is varying trainability between individuals⁴⁴. All these factors point to a need for careful interpretation of testing results particularly when it relates to talent identification. This view lead to a position stand on physical testing prepared by the International Society of Sports Psychology (ISSP). The position stand summarized the benefits and limitations of testing as follows³⁹:

Benefits of Testing:

1. Testing results can be used to provide feedback to the athlete so they can monitor their progress.
2. Information enables coaches to customize training programmes, to improve on the athlete's identified weakness.
3. Normative values can be developed for different test variables. These values can be adjusted for different ages and levels of proficiency.

Limitations of Testing:

1. Physical testing does not allow for the assessment of players' cognitive skills.
2. Most physical tests are conducted individually and in stationary conditions and may not be sports specific.
3. Physical skills testing often occurs when the athlete is in a rested, and in a non fatigued state.

Physical skill is only one aspect of testing in the process of detecting talent during early development in sport. In South Africa, where the inhabitants have a range of socioeconomic statuses, the test results from previously/existing disadvantaged communities have to be interpreted in context. There are also specific points about promoting physical activity in low socioeconomic regions that have to be considered. This will be discussed in the next section.

1.11 Community based physical activity interventions in low income areas of South Africa

Promoting physical activity and a healthy diet has become an important goal for health legislators. This is done in an attempt to control obesity and minimise the burden of non-communicable diseases⁴⁵. Therefore efforts to increase physical activity levels in communities and populations have become very important for health promotion⁴⁵.

Therefore to help with health promotion various programmes and interventions have been implemented in communities to try and improve the health status and decrease physical inactivity levels within these communities. When implementing a physical activity intervention programme there are various unique factors in each community that will contribute to the programme being implemented successfully or not. For a community intervention programme there must be an existing infrastructure where the programme can take place; namely schools, churches or primary healthcare facilities⁸. There are also numerous challenges with programme implementation. For example, a culture or community which has a lack of physical activity which will require more education on the benefits of exercise. Also barriers to participation such as poverty within the community, safety and security of members who have to walk to attend programmes and the protection of the equipment needed for the programmes, are challenges which have to be considered⁸. In an intervention programme at a school the principal and the teachers are the biggest influence of a programme being implemented successfully or not⁸.

When implementing a physical activity programme in a school, there are a number of specific barriers. *Draper et al. (2010)* mentioned that one of the major barriers occurred after Life Orientation became a stand alone subject and part of the revised national curriculum. Physical activity was only one of the four learning outcomes of the Life Orientation curriculum and this resulted in less time for physical activities at school⁴⁶. Another barrier is that schools have a need for sporting equipment, uniforms and the appropriate sporting facilities; these needs are often not met in underprivileged regions. The difficulty of transport to other schools for sporting events and the lack of pupils with birth certificates to classify their age groups has also negatively impacted the participation of school pupils in physical activity⁴⁶. If barriers can be overcome the implementation of physical activity programmes has a better chance of being successful. This provides the catalyst for the MSTs programme which is designed to aid the schools overcome some of the barriers that are mentioned above.

1.12 Effects of nutrition on resistance training and rugby

Apart from the physical attributes, there are various factors that influence performance. These include the environment in which the performance occurs (e.g. temperature, altitude, humidity), and the availability of adequate nutrition⁴⁷. Appropriate nutrition compliments training and recovery and can induce metabolic adaptations to training⁴⁸. A balanced nutritional diet will provide sufficient energy requirements. Carbohydrates and protein intake will ensure sustained exercise performance and optimal nutritional support during exercise⁴⁸.

Recovery after exercise is important because it has a direct influence on subsequent performance. If one is not adequately recovered it may result in becoming over trained and may increase the risk of injury. Ingesting the right types of food after training aids the adaptive and recovery processes^{49,50}

Lack of proper nutrition in disadvantaged areas in South Africa is a major concern and contributes to the lack of physical development of adolescents⁵¹. South Africa has a growing burden of non-communicable diseases. South Africa has a complex mix of over- and under nutrition in schools situated in low-income communities and there is a noted increase in levels of physical inactivity among children and youth⁵².

It can be concluded from what has been mentioned above that nutrition is very important for development and recovery when undertaking resistance training programmes. Considering the socioeconomic status of the communities where the schools involved in the MSTS programme are situated it will be difficult for these adolescents to show the same physical development as their counterparts from more affluent areas in South Africa.

1.13 Conclusion

The demands associated with performing at a high level in rugby have increased. The bigger and stronger players have an advantage over their smaller counterparts. Adolescents exhibit gains in strength and muscle mass when a well prescribed strength and conditioning programme is followed. The risk of injury is also decreased after resistance training^{12,53}. Therefore there are benefits for adolescent rugby players to participate in strength and conditioning training. Players from underprivileged areas do not have access to resistance training equipment and are therefore disadvantaged when trying to compete against players who are able to train. As a result of these circumstances the MSTS programme has been developed to provide players from these areas an opportunity to train. However, whether such a programme is has the desired effect is not known.

1.14 Research aims and objectives

The study was an observational study. Approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (*HREC REF 646/2013*). All the players participating in the study were required to complete a consent form (Appendix A) as set out by the High Performance Centre of the Sports Science Institute of South Africa.

1.14.1 Aim of the study

The overall aim of the study was to determine the efficacy of the implementation of the MSTs in underprivileged schools. Specifically, the first aim was to determine whether there were changes in fitness characteristics associated with success in rugby, after a group of U16 and U18 schoolboy rugby players have had an opportunity to train using the MSTs. A second aim was to assess the efficacy of the programme by gathering subjective information from the coaches of the schools based on their views, experiences and expectations of the programme. The objective and subjective data will provide information for SARU and the High Performance Centre of the Sports Science Institute of South Africa to determine how to modify the programme should any shortcomings be identified.

1.14.2 Research questions

1. Do the fitness characteristics associated with performance in rugby (stature, body mass, % body fat, grip strength, upper body strength and endurance, 10 and 40 m sprinting time, and aerobic capacity) of U16 and U18 players improve after exposure (4 to 6 months) to the Mobile Schools Training System?
2. What are the coaches' perceptions on the effectiveness of the Mobile Schools Training System?

1.15 Hypothesis

Research aim 1:

H1: It is hypothesized that there will be a change in fitness characteristics associated with rugby performance of U16 and U18 players after exposure to the Mobile Schools Training System for at least 4-6 months

Ho: No changes in fitness characteristics associated with rugby performance of U16 and U18 players after exposure to the Mobile Schools Training System for at least 4-6 months.

Research aim 2:

H1: It is hypothesized the coaches view the Mobile Schools Training System as being effective and associated with improved rugby performance.

Ho: The coaches do not view the Mobile Schools Training System to be effective.

Chapter Two:

Methodology

2.1 Study population

The sample consisted of male rugby players between 15 and 18 years of age. To play at an U16 level the players had to be born in 1998 or 1997 (n= 371). To play at an U18 level the players were born either in 1996 or 1995 (n= 478). The players of both age groups were divided into forwards (u16= 182, u18 = 258) and backs (u16= 189, u18 = 219). The players that participated in the MSTs programme were all pupils in the schools involved with SARU's Coca-Cola Schools of Excellence Programme.

All players provided signed consent (Appendix A), if the player was under the age of 18 the parent/guardian provided signed consent for the player to participate in testing. All testing took place between February and October 2013.

2.2 Validity and reliability

Validity and reliability of testing protocols are the two most fundamental aspects that need to be adhered to when testing athletes. Validity refers to the degree to which the test measures, what it is supposed to measure⁴³. Hence, construct validity is important to ensure that the selected tests are valid and measure what has been set out to measure⁴³.

Reliability is a measure of the degree of consistency and repeatability of a test⁴³. According to the National Strength and Conditioning Association (NSCA) there are a few factors that may affect the reliability of a test battery, namely⁴³.

1. Intra-subject (within subjects) variability
2. Lack of inter-rater (between raters) reliability or agreement
3. Intra-rater (within raters) variability
4. Failure of the test itself to provide consistent results

According to *Thomas et al (2005)*, the technical error of measurement (TEM) can be attributed to four different sources⁵⁴:

1. Participants: This may include many factors such as mood, motivation, health and familiarity with the tests.
2. The testing: Testing instruction and the lack of clarity of these instructions may induce errors with the procedures of the tests.
3. Scoring: errors are associated with scoring due to the competence, dedication and experience of the scorers.
4. Instrumentation: it is important that all mechanical and electronic equipment used in the testing batter are calibrated prior to testing to ensure reliability of the scores obtained.

The typical error of measurement (TEM) was determined using the spread sheet “Reliability from consecutive pairs of trials”, downloaded from www.sportsci.org⁵⁵. TEM is the magnitude of the error expressed as the standard deviation of the estimate for a particular variable^{54,55}. While it is best practice to generate the TEM from one’s own data, this was not always possible, therefore previously established values from other laboratories have sometimes been used (in this case a reference will be provided). TEM generated in this laboratory will be referenced as HPC data. These were determined in a previous study conducted at about the same time as this study⁵⁶.

2.3 Statistical analysis

The measurements were entered into a Microsoft Excel spread sheet. The % change for the differences between the pre and post rounds of testing were calculated as follows;

$$\frac{(\text{Pre round value} - \text{post round value}) \times 100}{(\text{Pre round value})}$$

A negative percentage change reflected an improvement, with the exception of % body fat and sprint times where a positive % change reflected an improvement. Group averages and standard deviations (mean \pm SD) for the U16 and U18 player were calculated using Statistica version 12 (StatsSoft Inc. USA). A repeated measures of analysis of variance (ANOVA) was used to determine whether there were significant differences between the ‘pre and post’ round of testing using either ‘age’, ‘provinces’ and whether the ‘gym was used’ or ‘not used’ as main effects. The interaction between ‘age x time’ and ‘province x time’ and ‘gym usage x time’ was calculated. If any interactions were significant, a Tukey *post hoc* test was used to identify specific differences. Statistical significance was accepted when $p < 0.05$. Graphical representation of the pre post differences between U16 and U18 testing variables (i.e. showing changes over time) are displayed in chapter 3. For certain variables (bilateral grip strength, bench press, push-ups sprint time (10m and 40m) and MSST) the number of U16 and U18 players differs from the total number of subjects due to missing data from the database. This can be attributed to either an injury or players not being able to take part in that testing variable for some other reason. When an analysis was done on variables where data were missing a coding framework was used to ensure that statistical analyses was done only on players that tested on both ‘pre and post’ testing rounds.

2.4 Physiological testing battery

The players were divided into U16 and U18 age groups. Prior to testing each player was provided with a consent form, which the parent/guardian of the players had to sign and give formal consent that the player was allowed to participate in testing (Appendix A). Only

players who return the signed form were eligible for testing. Each player provided the testing staff their full name and surname, position and date of birth.

Each player underwent a full physiological testing battery specific to rugby. The test battery consisted of stature, body mass, sum of 4 skinfolds (triceps, biceps, subscapular and supra iliac), grip strength, bench press, push-ups, 10m and 40m sprint time test and finally all players did a multistage shuttle test (MSST)⁵⁷. Qualified Biokineticists employed by the HPC conducted the testing; therefore ensuring validity and reliability was maintained throughout the study.

Players were excluded from the testing for muscular strength (bench press) and muscular endurance (push-ups) if they presented with an upper limb injury. Players who presented with a lower limb injury were excluded from the sprint time (10 m and 40 m distance) and aerobic capacity tests (MSST).

2.4.1 Anthropometrical evaluation

Anthropometry is the science of measuring the physical parameters of the human body. Anthropometry is often used to evaluate a player's size, shape, body proportions, body composition and degree of asymmetry between the dominant and non-dominant limbs. A qualified person needs to perform the measurements and these should be completed by the same person during successive measurements to ensure repeatability²³.

The anthropometric evaluation for each subject consisted of body stature (cm), body mass (kg) and body fat (%).

2.4.1.1 Stature

Stature of each player (without shoes) was recorded to the nearest millimetre, using a stadiometer (Seca, Leicester Height Measure)¹⁹. The measurement is recorded as the height from the floor to the vertex of the head. The vertex is defined as the highest point on the skull when an imaginary line between the lower margin of the eye socket and the upper margin of the zygomatic bone is parallel to the ground. The player stood barefoot with his arms hanging by his sides. The heels, buttocks, upper back and head were in contact with stadiometer. Prior to measurement the player was instructed to look ahead and take a deep breathe^{23,57}. A second measurement was done to confirm the first was correct. (TEM = 0.33cm, CI 0.26 – 0.44cm; TEM as % CV = 0.2%, CI 0.2 -0.3%)(HPC data).

2.4.1.2 Body mass

Body mass was recorded on a calibrated scale (Seca Robusta 813, Hamburg, Germany) to the nearest 0.1kg^{19,23}. The players were weighed in minimal clothing and without shoes,

preferably before a large meal^{23,57}. A second measurement was done to confirm the first was correct. (TEM = 0.48kg, CI 0.33 – 0.83kg; TEM as % CV = 0.6%, CI 0.4 -0.7%)(HPC data).

2.4.1.3 Skinfold measurement

Method

The skinfold calliper reading is a measurement of the compressed thickness of a double layer of skin and the underlying subcutaneous tissue, which is assumed to be adipose tissue. The skinfold thickness was measured by grasping a fold of skin and the underlying subcutaneous tissue between the thumb and forefinger, 1-2 cm above the site that was to be measured. The fold was pulled away from the underlying muscle and the jaws of the callipers are placed on either side of the site, at a depth of approximately 1 cm. The skinfold was held firmly throughout the application of the calliper and the reading was recorded in millimetres^{23,57} when the needle became steady after the full pressure of the calliper jaws were applied. The callipers were applied at right angles to the fold at all times. All measurements were recorded on the player's right side. A Biokineticist trained in anthropometry did all measurements. Therefore it is expected that the inter-rater variability would be relatively low.

Triceps skinfold

Measured from the back on the posterior surface of the arm midway between the acromion process and the olecranon process. The upper limb hung loosely by the side with the player in a standing position^{23,57}. (TEM = 0.6mm, CI 0.49 – 0.76mm; TEM as % CV = 7.2%, CI 5.9 - 9.2%)(HPC, data).

Biceps skinfold

Measured from the front of the anterior surface of the arm midway between the top of the shoulder and the elbow. The athlete stood in the same position as for the triceps skinfold measurement^{23,57}. (TEM = 0.30mm, CI 0.24 – 0.40mm; TEM as % CV = 9.6%, CI 0.8 - 13.1%)(HPC data).

Subscapularis skinfold

Measured just below the inferior angle of the scapula with the fold in an oblique plane descending laterally (outwards) and downwards at an angle of approximately 45° to the horizontal^{23,57}. (TEM = 0.64mm, CI 0.51 – 0.86mm; TEM as % CV = 7.4%, CI 5.9 - 10.0%)(HPC data).

Supra-iliac skinfold

Measured 5 cm above the iliac crest with the fold oblique, descending medially (inwards) and downwards at an angle of about 45° to the horizontal. The player stood upright with the upper limbs by the side and the abdominal muscles relaxed^{23,57}. (TEM = 0.64mm, CI 0.51 – 0.86mm; TEM as % CV = 6.1%, CI 4.8 -8.2%)(HPC data).

2.4.1.4 Body fat percentage

Percentage body fat was calculated from the skinfolds measurements using the *Durnin and Womersley* (1974) body density equation together with the Siri equation⁵⁸. The *Durnin and Womersley* equation is used to estimate the body density, calculated from age (years), sum of 4 skinfold sites (Biceps, Triceps, Subscapularis and Supra-Iliac)(mm) and body mass (kg)⁵⁹. The body density was then substituted into the Siri equation (1961) (*Body Fat % = 495 / Body Density) – 450*) to calculate the percentage body fat⁶⁰. (TEM = 0.34%, CI 0.27 – 0.46%; TEM as % CV = 2.7%, CI 2.2 - 3.7%)(HPC data).

2.4.2 Physical evaluation

2.4.2.1 Grip strength

The player stood with his elbow extended and arm abducted 45° next to the body and then proceeded to squeeze the handgrip dynamometer (Grip D TTK5401 by Takei, Yashiroda, Akiha-Ku, Niigata City, Niigata Prefecture 956-0113, Japan) as vigorously as possible. The elbow was not allowed to bend or the arm to move in any direction while the dynamometer was being squeezed. The test was conducted on both hands and the test was executed twice per hand⁵⁷. (LEFT: TEM = 2.14Nm, 95% CI 1.74 – 2.85Nm; ICC= 0.83Nm, 95% CI 0.67-0.91Nm) (RIGHT: TEM = 2.45Nm, 95% CI 2.00 – 3.27Nm; ICC= 0.86Nm, 95% CI 0.73-0.93Nm) (HPC data).

2.4.2.2 Muscular strength (Bench Press)

The one repetition maximum (1RM) bench press test is used to evaluate the player's maximal upper body strength. The test was conducted according to the National Strength and Conditioning Association (NSCA) 1RM testing protocol. According to this protocol players are supine on a bench in the five point contact position, with their feet flat on the floor and their hips and shoulders in contact with the bench. The players were instructed to grip the bar with a hand spacing of 1.5 times the biacromial width. All players completed a light warm-up including dynamic movements of the upper torso as well as set of 5 - 10 repetitions at 40-50% of their estimated 1RM. The weight was then increased to 60 - 70% of predicted 1RM and three repetitions were completed. Subjects rested for five minutes before the weight was increased to the estimated 1RM. If the subject completed the repetition

successfully the weight was increased by 5-10%. If the attempt was unsuccessful the weight was decreased by 2.5-5%. The next repetition was only attempted after a 4 minute rest period. The maximum weight lifted was recorded as the player's 1RM^{32,61}. The tester gave verbal coercion throughout the lift. An attempt was deemed correct if the player lifted the bar in a controlled manner and lowered the bar to the centre of his chest (lightly touching the chest), followed by extending the arms into a fully extended position. The attempted lift was disqualified if the player lifted his buttocks off the bench during the movement, if he bounced the bar off his chest, or if the spotter was required to assist in the lift. The 1RM bench press test is reliable (ICC, R = 0.99; CV = 1.4%) and valid⁶².

2.4.2.3 Muscular endurance (Push-ups)

The player began in a prone position with his hands on the floor, thumbs shoulder width apart and elbows fully extended. Keeping the back and body straight the player descended to the tester's fist, placed on the floor below the players sternum, and then ascended until the elbows were fully extended. If the player did not adhere to these specifications the repetition was not counted. The test was scored as the number of push-ups performed in 1 minute^{19,23,57}. *Gabbett et al (2008)*, showed test-retest reliability of the 1 minute push up test to be R= 0.94, with a TEM of 7.3%⁶³.

2.4.2.4 Sprint time (10 m and 40 m)

The warm up before the test consists of a minimum of 10 minutes of submaximal running, followed by an appropriate stretching regimen and some acceleration sprints to familiarise the players with the pacing. An electronic sprint timer with photoelectric sensors (Brower Timer Systems) was set up at 0, 10, and 40 metre intervals. The start line was defined as the zero metre interval. The players are instructed to crouch in the start position 30 centimetres away from the start line, after which they sprinted, one player at a time maximally for 40 metres through all the sensors. The players were tested on a grass surface and playing boots were worn. No starting blocks were allowed for the testing^{19,23}. *Gabbett et al (2008)*, showed test-retest reliability of the 10 m and 40 m sprint to be R= 0.95 and 0.97 respectively, with a TEM of 1.8% and 1.2% respectively⁶³.

2.4.2.5 Aerobic capacity (20 m Multi-stage Shuttle Test)

The multi stage shuttle test was used to measure the player's aerobic capacity⁶⁴. This progressive multistage shuttle test (MSST) was based on the protocol of Lèger *et al.*⁶⁵. A 20 metre distance is measured out on the running surface. The players run between these two lines. Players were instructed to complete each 20 metre distance (lap) and turn according to the pace determined by the recorded sound signal. A foot of each player was required to touch the marked line, coinciding with the sound signal. The timing between signals starts

slowly and becomes progressively faster each minute. The players were warned if they failed to complete the 20 meter distance in the required time of two consecutive laps. If this continued for the next lap the player was withdrawn from the test^{19,23,57}. Players were allowed to voluntarily withdraw from the test if they were unable to maintain the required pace. The score was recorded as the number of last lap completed. The MSST is reliable (ICC, R = 0.90; TEM = 3.1%) and valid⁶³.

2.5 Methods for data collection for community intervention

2.5.1 Methods used

In-depth interviews were used to gather information from the coaches about their descriptive and subjective experiences of the MSTs. The researcher prepared open-ended questions that were structured to get this information from the coaches. The interview was also recorded on a digital recording device (Apple iPhone 5). Coaches were free to withdraw from the interview and were then excluded from the interview process.

2.5.2 Description of sample including selection criteria

Twenty Schools were selected by SARU to be part of the Coca-Cola Schools of Excellence Programme/MSTs. A minimum of 20 players in each of the U16 and U18 groups in each school were required for both pre and post testing.

The head coaches were selected from the twenty schools participating in the Coca-Cola Schools of Excellence programme/MSTs. Head coaches underwent an in-depth interview.

2.5.3 Rationale for choice of methods

A one-on-one interview provides the researcher with more honest and valuable answers, which improves the quality of the information. The benefit of the researcher using interviews for this study was to allow information to be collected that could not be observed directly during testing or informal conversations with coaches. It also allowed the interviewer to further probe the interviewee to give further information and also more understanding towards certain behaviours. By doing the one-on-one in depth interview one was able to examine personal issues, views, experiences and the unique perspectives that the coaches and schools have with the program^{66,67}.

Guide Questions to be Used During In-Depth Interviews

Section A: Past experience of rugby conditioning

1. Describe your past experiences regarding strength and conditioning training for the players

2. Explain the type of equipment or techniques used to improve the physical development/conditioning of the players before having the Mobile training System
3. How do you think the facilities at your school helped to develop the rugby players before you received the MSTS?
4. How do you think your players' diet influences their development as young athletes?
5. If offered the opportunity what kind of additional training would you like to receive as a coach?

SECTION B: Experiences and expectations of Mobile Schools Training System

1. How do you think the new system could influence rugby development at your school?
2. How do you think the players will benefit from the new mobile training system?
3. How do you think you will benefit from the training programs you received with the MSTS?
4. Which other sports and physical education classes at the school be using the Mobile Training Facility?
5. Is there anything else you, as a coach needs to make the MSTS programme more successful? EG: more equipment, additional training

2.5.4 Procedure for data collection

The in-depth one-on-one interview of the head coaches took place during the post testing.

Logbooks were provided to each school (Appendix B). The head coach of age groups involved in the programme filled in the logbook once a week to document how many training sessions that specific age group had that week with the MSTS equipment. The type of training did not have to be specified because each age group received a specifically designed strength and conditioning programme, appropriate to that age group. The duration of the interviews was between 10-15 minutes, depending on the participating coach's personality and willingness to answer the questions. The coach and the researcher sat around a table with the recording device (Apple iPhone 5) placed in the middle of the table.

2.5.5 Transcription and analysis methods

Each individual recording was listened to and point form notes were made from the answers the coaches gave on questions asked. The recordings were paused during the discussion to allow the researcher time to write down the correct information. The information gathered

from the interviews was later used in the discussion section to provide additional evidence for the efficacy of the programme.

After all the interviews were listened to and main points noted the researcher was able to develop themes and categories. A coding system was used to identify common themes and group statements into these categories^{67,68}. This helped the researcher to establish how many times certain issues came up during the interviews.

Chapter Three:

Results

3.1 Section A: Quantitative analysis

3.1.1 Sample description

From 20 schools selected for the study, 17 schools had data for both rounds at the U18 level, and 18 schools had complete data for the U16 level. At two of the schools (U16 and U18 players), upon arrival on the day of testing, the schools failed to present players for testing. At the one remaining school for U18 players only one round of testing could take place due to unforeseen circumstances.

At the U16 level 158 boys tested both rounds (before and after) and at the U18 level 224 boys were tested on both occasions. In the data analysis schools were not compared to each other because of the lack of statistical power. However, schools in provinces were clustered and the provinces were compared to each other. Three players were omitted from statistical analysis due to inexplicable and unrealistic changes in their data that might have been due to tester and recording miscommunication when testing took place. The data of 4 U16 players for push-ups and 8 players for MSST, had unrealistic changes, and were also excluded from analysis. At the U18 level, the data of 2 players for push-ups and 7 players for MSST were omitted from analysis for the same reason. Consultation about the verity of the data took place with people who did not have a vested interest in the outcomes of the study, before the data were excluded.

The statistical analysis was only done on players that tested at both the 'pre and post' testing rounds. There were missing data for bilateral grip strength, bench press, push-ups sprint time (10m and 40m) and MSST. This will be reflected in the sample size for each comparison.

The groups were also divided in those schools that used the gyms frequently compared to the schools that used the facilities infrequently. The rating was made in a subjective manner where the players at each school were asked if they had access to the gym to train between pre-post round testing. The Biokineticists involved with post round testing also gave a subjective opinion to whether the gym has been used based on signs and symptoms of usage wear and tear on the equipment.

3.1.2 Pre-post differences across age groups

The measures of size and body composition of U16 and U18 boys are shown in table 2. As expected the U18 boys were taller and heavier than the U16 boys ($p < 0.0001$). The % body fat was lower in the U18 boys compared to the U16 boys ($p < 0.0001$). Pre-post testing revealed significant differences for both the U16 and U18 age groups. The details of the differences are shown in table 2. There was also a significant interaction (age x time) for stature, body mass and % body fat. The specifics of the interactions and level of significance for the different variables are shown in and beneath table 2.

Table 2: Comparison of measures of size and body composition between the U16 and U18 boys, before and after the exposure to the mobile training system

Variable	U16 (n = 158)			U18 (n = 224)		
	Pre	Post	% Diff	Pre	Post	% Diff
Age	15.7 ± 0.7	16.1 ± 0.7	2.9 ± 0.7	17.7 ± 0.9	18.1 ± 0.9	2.6 ± 0.7
Stature (cm) ^{\$@}	166.9 ± 8.0	167.8 ± 7.6 [#]	0.5 ± 1.0	171.5 ± 6.7	171.9 ± 6.8 [#]	0.3 ± 0.7
Body mass (kg) ^{\$@}	60.5 ± 13.0	63.2 ± 12.4 [#]	5.0 ± 5.2	69.6 ± 14.7	71.6 ± 13.9 [#]	3.2 ± 5.1
Skinfolds (mm)	33.6 ± 19.4	32.9 ± 20.7	-0.3 ± 20.5	36.3 ± 20.3	35.6 ± 20.2	-0.9 ± 16.8
% Body fat ^{\$@}	17.6 ± 5.0	17.5 ± 5.5 [#]	-0.3 ± 13.5	15.0 ± 5.1	14.0 ± 5.1 [#]	-5.4 ± 17.7

Stature

Pre-Post $p < 0.0001$

\$ u16 vs. u18 $p < 0.0001$

@ Age x Time $p < 0.002$

Body mass

Pre-Post $p < 0.0001$

\$ u16 vs. u18 $p < 0.0001$

@ Age x Time $p < 0.011$

Body fat %

Pre-Post $p < 0.0001$

\$ u16 vs. u18 $p < 0.0001$

@ Age x Time $p < 0.002$

The measures of strength, endurance and sprint time between U16 and U18 age groups are shown in table 3. As expected the U18 boys were stronger and faster than the U16 boys ($p < 0.0001$). The U18 boys showed a significant difference in aerobic capacity ($p < 0.04$). Pre-post testing revealed significant differences for strength and aerobic capacity in both the U16 and U18 age groups ($p < 0.0001$). No interaction over time (age x time) was shown between the two age groups for physical performance measures.

Table 3: Comparison of measures of strength, endurance and sprint time between the U16 and U18 boys, before and after exposure to the mobile training system

Variable	n	U16 (n = 158)			U18 (n = 224)			% Diff
		Pre	Post	% Diff	n	Pre	Post	
Grip strength L (Nm) ^{\$}	156	36.3 ± 7.0	36.8 ± 7.1	2.2 ± 13.6	216	43.1 ± 6.9	43.5 ± 6.8	2.2 ± 15.6
Grip strength R (Nm) ^{\$}	157	37.8 ± 7.4	38.4 ± 7.1	2.7 ± 13.8	219	44.3 ± 7.2	44.6 ± 7.5	1.9 ± 15.7
Bench press (kg) ^{\$\$}	144	45 ± 13	50 ± 14	15.3 ± 22.4	190	67 ± 16	72 ± 16	8.6 ± 17.1
Push-up (n) ^{\$}	145	27 ± 11	29 ± 11	16.9 ± 82.4	185	39 ± 12	38 ± 13	3.6 ± 32.9
10 m time (s) ^{\$}	129	1.90 ± 0.2	1.90 ± 0.2	0.1 ± 7.9	162	1.83 ± 0.2	1.85 ± 0.2	1.6 ± 9.2
40 m time (s) ^{\$}	129	6.00 ± 0.7	5.95 ± 0.6	-0.7 ± 5.5	162	5.72 ± 0.5	5.74 ± 0.5	0.5 ± 5.3
MSST (shuttles) ^{*#}	122	56 ± 21	66 ± 21	27.7 ± 38.3	146	62 ± 24	71 ± 23	22.7 ± 41.3

^{\$} u16 vs. u18 $p < 0.0001$

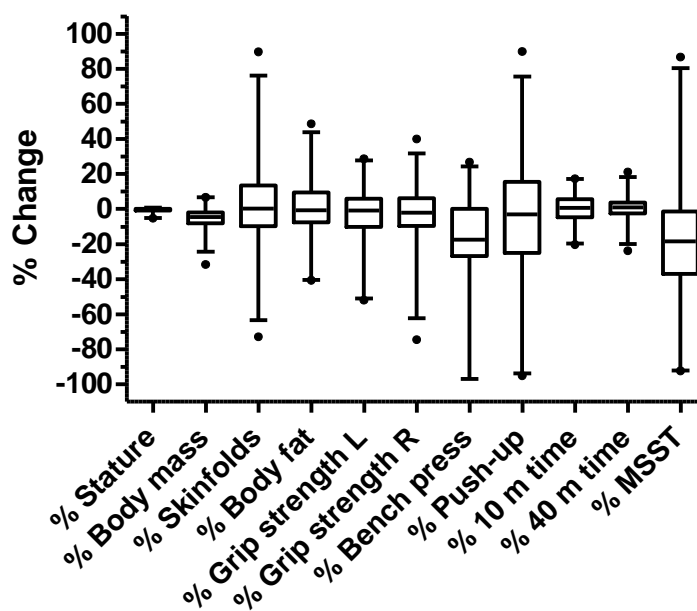
*u16 vs. u18 $p < 0.04$

Pre-Post $p < 0.0001$

3.1.3 Graphical representation of percentage change

The variation in the percentage change of the variables before and after exposure to the mobile training system are shown in a box and whisker plot (figure 3). Based on the format of the calculations a negative percentage change for stature, body mass, grip strength, bench press, push-up and MSST can be equated to an improvement, whereas a positive percentage change for skinfolds, % body fat and sprints time illustrate improvement in these testing variables respectively. A description of the various aspects of the box and whisker plot is shown beneath the graph.

Under 16



Under 18

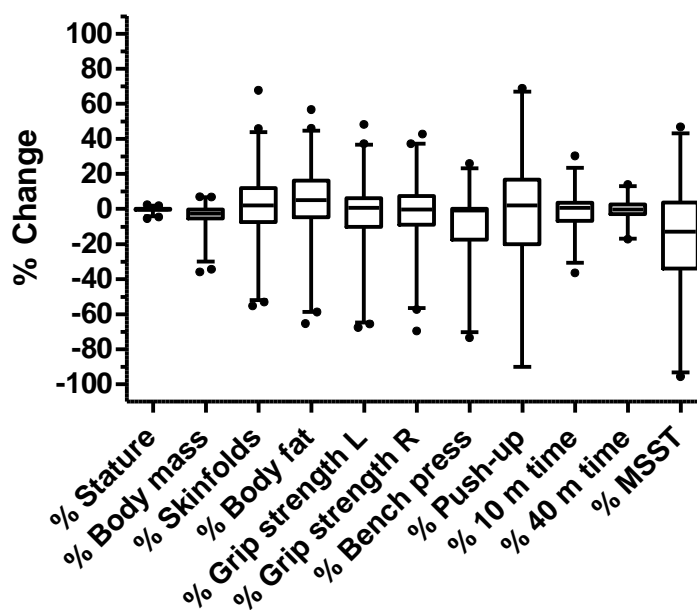


Figure 3: Percentage change in the variables of U16 (n = 158) and U18 (n = 224) boys after exposure to the mobile training system. The line at the centre of the box represents the median while the line above it represents the 75th percentile and the line below the mean represents the 25th percentile. The whiskers represent the minimum and maximum values. The dots illustrate the outliers for each variable.

3.1.4 Comparison of the 5 provinces for U16

The measures of size and body composition between the five provinces for U16 boys are shown in table 4. A significant difference of pre-post results were shown for Age, stature and body mass for the 5 provinces ($p < 0.0001$). When there was a significant difference between the 5 provinces, a Tukey *post hoc* test was used to reveal the specific differences. The specific differences from the *post hoc* test between the provinces are shown beneath table 4. Analysis revealed an interaction over time (province x time) for age, stature, body mass and % body fat ($p < 0.0001$).

Table 4: Comparison of measures of size and body composition of U16 boys from different provinces, before and after exposure to the mobile training system

Variable	Pre	U16 Post	% Diff	@ Province x time	# Pre-Post
Age (n = 158)	15.7 ± 0.7	16.1 ± 0.7	2.9 ± 0.7	p < 0.0001	p < 0.0001
Boland (n = 41)	15.6 ± 0.3	16.2 ± 0.3	3.5 ± 0.5	NS	NS
Border (n = 35)	15.8 ± 0.9	16.2 ± 0.9	2.6 ± 0.2	NS	NS
EP (n = 36) [§]	15.4 ± 0.7	15.8 ± 0.8	2.4 ± 0.3	NS	NS
SWD (n = 24)	15.8 ± 0.4	16.2 ± 0.4	2.6 ± 0.1	NS	NS
WP (n = 22) [§]	15.9 ± 0.6	16.5 ± 0.6	3.4 ± 0.9	NS	NS
Stature (cm) (n = 158)	166.9 ± 8.0	167.8 ± 7.6	0.5 ± 1.0	p < 0.0001	p < 0.0001
Boland (n = 41) [§]	170.5 ± 9.1	170.8 ± 8.8	0.2 ± 0.8	NS	NS
Border (n = 35) [§]	163.6 ± 7.1	165.5 ± 6.5	1.2 ± 1.1	NS	NS
EP (n = 36) [§]	164.4 ± 6.9	165.3 ± 6.9	0.5 ± 1.0	NS	NS
SWD (n = 24)	167.9 ± 6.7	168.3 ± 6.5	0.2 ± 0.4	NS	NS
WP (n = 22)	168.5 ± 7.2	169.3 ± 7.0	0.5 ± 0.8	NS	NS
Body mass (kg) (n = 158)	60.5 ± 13.0	63.2 ± 12.4	5.0 ± 5.2	p < 0.0001	p < 0.0001
Boland (n = 41) [§]	64.9 ± 14.2	66.7 ± 13.3	3.4 ± 4.7	NS	NS
Border (n = 35) [§]	54.0 ± 8.8	59.3 ± 9.1	10.0 ± 5.7	NS	NS
EP (n = 36)	60.7 ± 13.7	62.7 ± 13.7	3.5 ± 3.0	NS	NS
SWD (n = 24)	60.2 ± 11.3	61.9 ± 11.7	2.7 ± 3.0	NS	NS
WP (n = 22)	62.5 ± 13.7	65.2 ± 12.8	5.0 ± 5.3	NS	NS
Skinfolds (mm) (n = 158)	33.6 ± 19.4	32.9 ± 20.7	-0.3 ± 20.5	NS	NS
Boland (n = 41)	36.6 ± 18.0	36.4 ± 15.4	4.3 ± 19.5	NS	NS
Border (n = 35) [§]	27.5 ± 11.1	24.0 ± 12.9	-14.0 ± 13.4	NS	NS
EP (n = 36) [§]	37.7 ± 27.2	38.4 ± 28.6	6.4 ± 21.2	NS	NS
SWD (n = 24)	34.4 ± 18.2	35.3 ± 25.2	0.6 ± 26.0	NS	NS
WP (n = 22)	30.1 ± 16.5	29.3 ± 13.7	0.9 ± 14.3	NS	NS
% Body fat (n = 158)	17.6 ± 5.0	17.5 ± 5.5	-0.3 ± 13.5	p < 0.0001	NS
Boland (n = 41) [§]	18.8 ± 5.1	19.1 ± 4.6	3.5 ± 11.4	NS	NS
Border (n = 35) [§]	16.0 ± 3.9	14.1 ± 4.4	-12.2 ± 10.8	NS	NS
EP (n = 36)	18.4 ± 6.2	19.3 ± 6.4	5.6 ± 8.2	NS	NS
SWD (n = 24)	18.0 ± 5.1	17.7 ± 6.1	-1.9 ± 15.5	NS	NS
WP (n = 22)	16.2 ± 3.4	16.7 ± 3.9	3.5 ± 14.6	NS	NS

Age

§ EP vs. WP p < 0.012

Stature

§ Border vs. Boland p < 0.001

§ EP vs. Boland p < 0.001

Body mass

§ Border vs. Boland p < 0.03

Skinfolds

§ Border vs. EP p < 0.044

Body fat %

§ Border vs. Boland p < 0.004

The measures of strength, endurance and sprint time between the 5 provinces for U16 boys are shown in table 5. A significant difference of pre-post results were shown for bench press and MSST between the 5 provinces ($p < 0.0001$). There was a significant difference for bench press, sprint time (10 m and 40 m) and MSST. The specific significant differences between the 5 provinces are shown beneath table 5. The analysis revealed an interaction over time (province x time) for bench press, push-ups, 10 m sprint time and MSST. The specifics of these interactions are shown in table 5.

Table 5: Comparison of measures of strength, endurance and sprint time of U16 boys from different provinces, before and after exposure to the mobile training system

Variable	Pre	U16 Post	% Diff	@ Province x time	# Pre-Post
Grip strength L (Nm) (n = 156)	36.3 ± 7.0	36.8 ± 7.1	2.2 ± 13.6	NS	NS
Boland (n = 39)	39.2 ± 8.1	38.9 ± 7.5	0.2 ± 13.6	NS	NS
Border (n = 35)	34.9 ± 6.9	35.0 ± 7.8	0.7 ± 14.6	NS	NS
EP (n = 36)	35.4 ± 6.6	35.5 ± 7.0	0.7 ± 10.3	NS	NS
SWD (n = 24)	34.9 ± 6.3	36.6 ± 5.6	6.5 ± 16.8	NS	NS
WP (n = 22)	36.2 ± 5.4	38.0 ± 6.1	5.5 ± 12.5	NS	NS
Grip strength R (Nm) (n = 157)	37.8 ± 7.4	38.4 ± 7.1	2.7 ± 13.8	NS	NS
Boland (n = 40)	40.7 ± 7.4	40.1 ± 7.4	-0.5 ± 14.9	NS	NS
Border (n = 35)	35.8 ± 7.7	36.8 ± 7.4	4.2 ± 18.0	NS	NS
EP (n = 36)	36.6 ± 7.7	37.5 ± 6.4	3.7 ± 9.9	NS	NS
SWD (n = 24)	35.9 ± 6.3	37.1 ± 7.4	3.6 ± 1.8	NS	NS
WP (n = 22)	39.9 ± 5.5	40.9 ± 5.9	3.0 ± 11.6	NS	NS
Bench press (kg) (n = 144)	45 ± 13	50 ± 14	15.3 ± 22.4	p < 0.001	p < 0.0001
Boland (n = 37) [§]	50 ± 13	52 ± 12	5.1 ± 20.0	NS	NS
Border (n = 35) [§]	36 ± 12	44 ± 14	26.4 ± 26.9	NS	NS
EP (n = 34)	43 ± 11	50 ± 14	15.6 ± 16.9	NS	NS
SWD (n = 17) [§]	52 ± 12	55 ± 12	5.7 ± 14.7	NS	NS
WP (n = 21)	46 ± 13	55 ± 14	22.0 ± 21.4	NS	NS
Push-up (n) (n = 145)	27 ± 11	29 ± 11	16.9 ± 82.4	p < 0.037	NS
Boland (n = 37)	27 ± 10	28 ± 10	27.6 ± 143.1	NS	NS
Border (n = 35)	26 ± 9	31 ± 9	29.3 ± 52	NS	NS
EP (n = 35)	27 ± 12	29 ± 14	10.7 ± 48.5	NS	NS
SWD (n = 18)	29 ± 12	26 ± 13	-11.4 ± 24.8	NS	NS
WP (n = 20)	28 ± 11	30 ± 12	11.6 ± 40.5	NS	NS
10 m time (s) (n = 129)	1.90 ± 0.17	1.90 ± 0.16	0.05 ± 7.9	p < 0.024	NS
Boland (n = 38) [§]	1.87 ± 0.14	1.80 ± 0.12	-3.1 ± 6.9	NS	NS
Border (n = 35) [§]	1.92 ± 0.17	1.96 ± 0.15	2.6 ± 7.6	NS	NS
EP (n = 33) [§]	1.98 ± 0.22	1.97 ± 0.19	-0.3 ± 8.2	NS	NS
SWD (n = 7)	1.80 ± 0.08	1.87 ± 0.14	3.9 ± 7.2	NS	NS
WP (n = 16) [§]	1.84 ± 0.10	1.85 ± 0.11	1.0 ± 8.2	NS	NS
40 m time (s) (n = 129)	6.00 ± 0.65	5.95 ± 0.57	-0.65 ± 5.5	NS	NS
Boland (n = 38) [§]	5.87 ± 0.44	5.72 ± 0.39	-2.4 ± 3.5	NS	NS
Border (n = 35) [§]	6.16 ± 0.61	6.16 ± 0.52	0.3 ± 7.5	NS	NS
EP (n = 33) [§]	6.27 ± 0.90	6.17 ± 0.75	-1.1 ± 4.8	NS	NS
SWD (n = 7)	5.58 ± 0.19	5.75 ± 0.40	3.0 ± 4.6	NS	NS
WP (n = 16) [§]	5.62 ± 0.29	5.65 ± 0.20	0.8 ± 5.4	NS	NS
MSST (shuttles) (n = 122)	56 ± 21	66 ± 21	27.7 ± 38.3	p < 0.002	p < 0.0001
Boland (n = 38)	59 ± 22	65 ± 22	17.6 ± 32.8	NS	NS
Border (n = 34)	58 ± 21	70 ± 21	27.4 ± 41.8	NS	NS
EP (n = 34)	48 ± 20	66 ± 24	47.0 ± 37.8	NS	NS
SWD (n = 7)	65 ± 18	61 ± 16	-1.9 ± 24.3	NS	NS
WP (n = 9)	58 ± 16	68 ± 17	21.7 ± 28.4	NS	NS

Bench press

§ Border vs. Boland p < 0.001

§ Border vs. SWD p < 0.001

10 m time

§ EP vs. WP p < 0.0001

§ Border vs. Boland p < 0.0001

§ EP vs. Boland p < 0.0001

40 m time

§ EP vs. WP p < 0.0001

§ WP vs. Border p < 0.0001

§ Border vs. Boland p < 0.0001

§ EP vs. Boland p < 0.0001

3.1.5 Comparison of the 5 provinces for U18

The measures of size and body composition between the five provinces for U18 boys are shown in table 6. Although there were significant main effects of the pre-post results, there were no differences in these changes between the 5 provinces. The analysis revealed an interaction over time (province x time) for age, stature, body mass and % body fat. The specifics of the pre-post differences and interaction between the 5 provinces are shown in table 6.

Table 6: Comparison of measures of size and body composition of U18 boys from different provinces, before and after exposure to the mobile training system

Variable	Pre	U18 Post	% Diff	@ Province x time	# Pre-Post
Age (n = 224)	17.7 ± 0.9	18.1 ± 0.9	2.6 ± 0.7	p < 0.0001	p < 0.0001
Boland (n = 48)	17.5 ± 0.8	18.0 ± 0.8	3.1 ± 0.5	NS	NS
Border (n = 37)	17.7 ± 0.8	18.1 ± 0.8	2.4 ± 0.1	NS	NS
EP (n = 55)	17.9 ± 0.9	18.2 ± 0.9	2.0 ± 0.2	NS	NS
SWD (n = 28)	17.7 ± 0.9	18.1 ± 0.9	2.4 ± 0.1	NS	NS
WP (n = 56)	17.6 ± 0.9	18.1 ± 0.9	3.1 ± 0.8	NS	NS
Stature (cm) (n = 224)	171.5 ± 6.7	171.9 ± 6.8	0.3 ± 0.7	p < 0.001	p < 0.0001
Boland (n = 48)	172.3 ± 6.5	172.6 ± 6.6	0.2 ± 0.4	NS	NS
Border (n = 37)	170.8 ± 7.8	172.0 ± 7.9	0.7 ± 1.0	NS	NS
EP (n = 55)	171.0 ± 6.1	171.5 ± 6.1	0.3 ± 0.9	NS	NS
SWD (n = 28)	172.2 ± 5.4	172.6 ± 5.5	0.2 ± 0.5	NS	NS
WP (n = 56)	171.4 ± 7.3	171.4 ± 7.4	0.0 ± 0.5	NS	NS
Body mass (kg) (n = 224)	69.6 ± 14.7	71.6 ± 13.9	3.2 ± 5.1	p < 0.021	p < 0.0001
Boland (n = 48)	73.3 ± 15.7	74.9 ± 15.1	2.5 ± 4.1	NS	NS
Border (n = 37)	63.7 ± 14.6	67.0 ± 13.1	6.4 ± 9.0	NS	NS
EP (n = 55)	70.3 ± 15.0	71.9 ± 14.4	2.5 ± 3.2	NS	NS
SWD (n = 28)	67.8 ± 12.8	69.0 ± 12.9	1.8 ± 3.5	NS	NS
WP (n = 56)	70.7 ± 13.6	72.8 ± 12.9	3.3 ± 3.9	NS	NS
Skinfolds (mm) (n = 224)	36.3 ± 20.3	35.6 ± 20.2	0.9 ± 16.8	NS	p < 0.041
Boland (n = 48)	39.8 ± 24.5	39.7 ± 23.6	2.1 ± 14.9	NS	NS
Border (n = 37)	32.1 ± 15.4	28.6 ± 15.6	-10.8 ± 17.9	NS	NS
EP (n = 55)	37.1 ± 23.1	37.6 ± 23.0	3.6 ± 19.9	NS	NS
SWD (n = 28)	32.7 ± 16.7	30.1 ± 15.2	-7.4 ± 8.0	NS	NS
WP (n = 56)	37.2 ± 17.6	37.6 ± 17.7	1.8 ± 14.0	NS	NS
% Body fat (n = 224)	15.0 ± 5.1	14.0 ± 5.1	5.4 ± 17.7	p < 0.0001	p < 0.0001
Boland (n = 48)	16.4 ± 5.8	15.0 ± 5.6	-7.6 ± 16.9	NS	NS
Border (n = 37)	14.1 ± 4.2	11.8 ± 4.6	-16.7 ± 18.0	NS	NS
EP (n = 55)	14.5 ± 5.3	14.4 ± 5.1	1.5 ± 17.8	NS	NS
SWD (n = 28)	14.4 ± 5.2	12.4 ± 4.6	-13.0 ± 11.6	NS	NS
WP (n = 56)	15.1 ± 4.6	15.1 ± 4.6	1.1 ± 15.2	NS	NS

The measures of strength, endurance and sprint time between the 5 provinces for U18 boys are shown in table 7. There was a significant difference for the pre-post results for bench press and MSST between the 5 provinces ($p < 0.0001$). There was a significant difference for bench press, 40 m sprint time and MSST between provinces. This is shown beneath table 7. There was also an interaction between the provinces over time (province x time) for bench press ($p < 0.0001$) and push-ups ($p < 0.003$).

Table 7: Comparison of measures of strength, endurance, and sprint time of U18 boys from different provinces, before and after exposure to the mobile training system

Variable	Pre	U18 Post	% Diff	@ Province x time	# Pre-Post
Grip strength L (Nm) (n = 216)	43.1 ± 6.9	43.5 ± 6.8	2.2 ± 15.6	NS	NS
Boland (n = 48)	44.4 ± 6.9	44.2 ± 6.9	0.5 ± 14.0	NS	NS
Border (n = 35)	44.2 ± 7.3	45.0 ± 7.1	4.4 ± 23.8	NS	NS
EP (n = 53)	43.0 ± 6.6	43.7 ± 6.8	2.8 ± 16.1	NS	NS
SWD (n = 27)	42.1 ± 7.0	41.7 ± 6.2	-0.3 ± 10.4	NS	NS
WP (n = 53)	41.8 ± 6.7	42.8 ± 6.7	3.0 ± 11.4	NS	NS
Grip strength R (Nm) (n = 219)	44.3 ± 7.2	44.6 ± 7.5	1.9 ± 15.7	NS	NS
Boland (n = 48)	44.7 ± 7.1	45.4 ± 7.0	2.6 ± 14.7	NS	NS
Border (n = 35)	45.0 ± 6.5	45.8 ± 7.2	3.7 ± 21.4	NS	NS
EP (n = 54)	45.1 ± 7.3	44.2 ± 7.8	-0.9 ± 16.0	NS	NS
SWD (n = 27)	41.8 ± 6.9	44.7 ± 6.0	8.0 ± 12.3	NS	NS
WP (n = 55)	43.9 ± 7.8	43.6 ± 8.4	-0.2 ± 12.6	NS	NS
Bench press (kg) (n = 190)	67 ± 16	72 ± 16	8.6 ± 17.1	p < 0.0001	p < 0.0001
Boland (n = 40) [§]	70 ± 19	74 ± 15	8.9 ± 17.2	NS	NS
Border (n = 35) [§]	61 ± 10	61 ± 12	-0.2 ± 13.6	NS	NS
EP (n = 48) [§]	69 ± 19	77 ± 19	14.1 ± 17.7	NS	NS
SWD (n = 23)	67 ± 11	65 ± 11	-2.3 ± 10.9	NS	NS
WP (n = 44) [§]	67 ± 15	76 ± 15	15.0 ± 16.5	NS	NS
Push-up (n) (n = 185)	39 ± 12	38 ± 13	3.6 ± 32.9	p < 0.003	NS
Boland (n = 38)	33 ± 10	37 ± 10	15.1 ± 26.1	NS	NS
Border (n = 33)	40 ± 9	39 ± 12	-0.6 ± 24.5	NS	NS
EP (n = 49)	41 ± 14	36 ± 15	-7.2 ± 34.8	NS	NS
SWD (n = 22)	38 ± 10	37 ± 11	-1.9 ± 19.2	NS	NS
WP (n = 43)	40 ± 14	42 ± 14	11.5 ± 42.1	NS	NS
10 m time (s) (n = 162)	1.83 ± 0.16	1.85 ± 0.15	1.60 ± 9.2	NS	NS
Boland (n = 31)	1.83 ± 0.18	1.77 ± 0.15	-2.5 ± 8.0	NS	NS
Border (n = 33)	1.86 ± 0.14	1.89 ± 0.11	1.9 ± 6.9	NS	NS
EP (n = 48)	1.84 ± 0.18	1.90 ± 0.18	3.5 ± 10.3	NS	NS
SWD (n = 12)	1.77 ± 0.11	1.83 ± 0.08	3.2 ± 5.2	NS	NS
WP (n = 38)	1.81 ± 0.14	1.83 ± 0.16	1.6 ± 10.8	NS	NS
40 m time (s) (n = 162)	5.72 ± 0.49	5.74 ± 0.46	0.5 ± 5.3	NS	NS
Boland (n = 31) [§]	5.63 ± 0.49	5.56 ± 0.42	-1.1 ± 4.9	NS	NS
Border (n = 33) [§]	6.00 ± 0.60	5.95 ± 0.49	-0.5 ± 5.8	NS	NS
EP (n = 48)	5.75 ± 0.45	5.84 ± 0.48	1.8 ± 5.6	NS	NS
SWD (n = 12) [§]	5.49 ± 0.34	5.50 ± 0.32	0.3 ± 1.5	NS	NS
WP (n = 38) [§]	5.59 ± 0.38	5.63 ± 0.38	0.9 ± 5.3	NS	NS
MSST (shuttles) (n = 146)	62 ± 24	71 ± 23	22.8 ± 41.3	NS	p < 0.0001
Boland (n = 30)	56 ± 21	65 ± 21	21.5 ± 30.8	NS	NS
Border (n = 31)	55 ± 23	65 ± 22	31.7 ± 51.2	NS	NS
EP (n = 48)	66 ± 26	78 ± 25	27.3 ± 43.1	NS	NS
SWD (n = 12)	58 ± 19	61 ± 13	16.1 ± 40.5	NS	NS
WP (n = 25)	72 ± 22	74 ± 23	7.4 ± 32.5	NS	NS

Bench press

§ Border vs. Boland p < 0.003

§ Border vs. EP p < 0.003

§ WP vs. Border p < 0.003

40 m time

§ Border vs. Boland p < 0.001

§ WP vs. Border p < 0.001

§ Border vs. SWD p < 0.001

3.1.6 Comparison of gym used vs. gym not used

According to the criteria described in the methods (page 44), there were 56 players (15%) at schools who did not use the gyms, compared to 326 players who did use the gym (85%). There was no difference in the measures of size and body composition in the players who attended schools where the gym was used compared to players who attended schools where the gym was not used (table 8). There were pre-post differences for stature, body mass ($p < 0.0001$) and body fat ($p < 0.001$) for both groups (table 8). There was an interaction (gym usage x time) for body mass ($p < 0.037$) with the schools using the gyms increasing body mass by 4.2% compared to the 2.4% (gym not used) (table 8).

Table 8: Comparison of measures of size and body composition related to gym usage of the mobile training system

Variable	Did not use gym (n = 56)			Used gym (n = 326)		
	Pre	Post	% Diff	Pre	Post	% Diff
Age	16.8 ± 1.2	17.2 ± 1.2	2.5 ± 0.2	16.9 ± 1.3	17.3 ± 1.3	2.8 ± 0.7
Stature (cm)	167.9 ± 6.1	170.1 ± 6.0 [#]	0.2 ± 0.5	169.6 ± 7.8	170.2 ± 7.6 [#]	0.4 ± 0.9
Body mass (kg) [@]	63.7 ± 11.9	65.2 ± 12.2 [#]	2.4 ± 3.8	66.2 ± 15.1	68.6 ± 14.2 [#]	4.2 ± 5.4
Skinfolds (mm)	32.4 ± 15.1	33.3 ± 19.3	1.6 ± 21.2	35.7 ± 20.6	34.7 ± 20.6	-1.1 ± 17.9
% Body fat	16.0 ± 5.0	15.3 ± 5.9 [#]	-4.7 ± 16.2	16.1 ± 5.3	15.5 ± 5.5 [#]	-3.0 ± 16.3

Stature

Pre-Post $p < 0.0001$

Body mass

Pre-Post $p < 0.0001$

@ Gym usage x Time $p < 0.037$

Body fat %

Pre-Post $p < 0.001$

The measures of strength, endurance and sprint time related to the schools where the gym was used and schools where gym was not used is shown in table 9. There was a pre-post difference in both groups for grip strength R, bench press and MSST. When comparing the groups to one-another significant differences were shown between the two groups for grip strength R and 40 m sprint time. Analysis revealed an interaction (gym usage x time) for bench press. The specific differences of significance are shown in and beneath table 9.

Table 9: Comparison of measures of strength, endurance and sprint time related to gym usage of the mobile training system

Variable	n	Did not use gym (n = 56)			n	Used gym (n = 326)		
		Pre	Post	% Diff		Pre	Post	% Diff
Grip strength L (Nm)	55	39.2 ± 7.6	39.6 ± 7.3	2.0 ± 13.3	317	40.4 ± 7.7	40.9 ± 7.7	2.2 ± 15.0
Grip strength R (Nm) [§]	55	39.1 ± 7.0	40.6 ± 8.3 [#]	4.2 ± 13.8	321	42.0 ± 8.0	42.3 ± 7.9 [#]	1.9 ± 15.1
Bench press (kg) [@]	41	59 ± 15	60 ± 13 [#]	2.5 ± 15.9	293	57 ± 19	63 ± 19 [#]	12.7 ± 20
Push-up (n)	44	33 ± 12	32 ± 13	-2.8 ± 26.4	286	34 ± 13	34 ± 13	11.3 ± 63.6
10 m time (s)	20	1.84 ± 0.2	1.83 ± 0.1	-0.1 ± 7.7	271	1.86 ± 0.2	1.87 ± 0.2	1.0 ± 8.7
40 m time (s) [§]	20	5.59 ± 0.4	5.58 ± 0.2	0.1 ± 5.2	271	5.86 ± 0.6	5.85 ± 0.5	0.0 ± 5.4
MSST (shuttles)	19	68 ± 20	72 ± 20 [#]	8.1 ± 19.6	249	59 ± 23	68 ± 23 [#]	26.3 ± 40.8

Grip strength R

Pre-Post $p < 0.048$

§ Gym usage vs. no gym usage $p < 0.029$

Bench press

Pre-Post $p < 0.0001$

@ Gym usage x Time $p < 0.001$

40 m time

§ Gym usage vs. no gym usage $p < 0.026$

MSST

Pre-Post $p < 0.001$

3.1.7 Summary of results

- There were differences in the measures of size and body composition between U16 and U18 boys for stature body mass and body fat %. Each variable also showed that there was an interaction between the main effect of age over time, suggesting the two groups responded differently over time.
- There were differences in measures of strength, endurance and sprint time between age groups of U16 and U18 boys.
- There were pre-post differences for bench press and MSST in both groups.
- There were differences between the 5 provinces for U16 boys for age, stature, body mass, skinfolds, body fat%, bench press, 10 m sprint time and 40 m sprint time. Most differences were noted between Border vs. Boland and EP vs. Boland.
- There were differences between the 5 provinces for U18 boys for bench press and 40 m sprint time. Most differences were between Border vs. Boland and WP vs. Border.
- When comparing the schools that used the mobile training system to those schools who did not use it pre-post differences were noted for stature, body mass, body fat %, grip strength R, bench press and MSST for both groups. An interaction for these variables was only shown for body mass and bench press.

3.2 Section B: Qualitative analysis

3.2.1 Sample description

Interviews were conducted with the head coach of a team at 15 schools involved in the mobile schools training system programme. Interviews were not conducted at 5 schools due to the head coach who was involved with the usage of the gym not being available.

3.2.2 Feedback from coaches

Following the one-on-one in-depth interviews, group themes were identified, which allowed the researcher to make the following conclusions. A coding from that was drawn up from the interviews and can be found in Appendix D.

3.2.2.1 Past experience to condition players without a gym facility

- *Difficulty to get players stronger,*

The coaches continually mention how difficult it was to get the players stronger and more conditioned for the rugby season. Some of the coaches mentioned the following “*not having a gym to get our players stronger put us in a direct disadvantage when we played against bigger schools who had gym facilities*”

- *Keeping the players motivated,*

One of the biggest problems the coaches had was to keep the players motivated to keep playing at a high level of competitiveness when playing against schools with “*physically bigger players*”

“Our boys struggled to keep on playing rugby when they kept on losing against schools where the players were much bigger and stronger than them”

- *Having player's lose interest in rugby because of not have a gym facility*

Not having the facility for the players to train in was an issue before receiving a gym for the participating schools in the program. The number of boys willing to play rugby without having a gym facility was low and even boys that did play rugby did not want to play anymore because they saw they were “*smaller and not as strong*” as their opponents.

3.2.2.2 Types of equipment used to get the players stronger without a gym

- *The use of vehicle tyres,*

One of the most popular items that came up while conducting the interviews with the coaches was the use of vehicle tyres. Although using tyres as training modalities for

increasing strength may help, the players will reach a plateau in their strength as soon as they have adapted to the exercises.

“I made my boys carry the tyres above their heads and do presses with them, they tied a rope them and the tyre and then ran with them by pulling the tyre, they also did lunges and squats while hold the tyre”

- *Body weight training,*

When no gym equipment is available one can do body weight exercises. It will help to improve strength but no drastic results will be shown. The coaches used body weight exercises like push-ups, crunches, squats and lunges. They also carried a partner on their backs to add extra weight.

“I made my boys do push ups, sit ups and carry another boy and run with him to get the stronger because I had no weights”

3.2.2.3 Did the available equipment physically change players before having a gym

- *Players did show change, they quickly plateaued and coaches continuously had to think of new exercise*

The players did show a physical change in profile when they did the strengthening exercises the coaches provided. The one problem the coaches had was that the players at a certain stage got too strong for the equipment they had available. Challenges for the coaches were to think of ways to keep boys interested and to get them even stronger to get out the plateau they reached.

“My players got stronger until a certain point but then I had to think of ways to get them stronger. I started to use ropes and bottles filled with sand and gave them exercises with that”

3.2.2.4 Effect of the diet the players has on their development

- *Diet at home is poor*

In underprivileged areas in South Africa diet is always a big issue because there is not always the education available to tell parents which foods are healthy and will be of benefit to the child. Money is another big issue, the parents of the child do not have the money to provide the child with the necessary diet or there is just not money to buy food.

“Some of my players do not even bring food to school or have breakfast because the parents don’t have money for food”

“The type of food the players get at home consists just of mielie pap because that’s all they can afford”

- *There is a feeding scheme in the community and schools provide one meal per day*

Some schools are fortunate enough to have become part of a feeding scheme where certain companies or sponsors provide food to the school to prepare for the children at the school. Through this the school ensures that the child has at least one balanced meal a day.

“We give our children at school one meal during school even if it is just a bit of pasta with mince to ensure that they have one meal per day because some of the children do not even get food at home, so this will be there only meal”

3.2.2.5 Additional training the coaches want to broaden the knowledge

- *Unions to offer monthly workshops and more training for physical education teachers*

Most coaches are always eager to broaden their knowledge for the sport they are involved in. One coach mentioned the following; *“I would like the union to get involved more and offer more workshops and give us some new ideas on exercises to do with boys”*.

Physical educators do not always have the practical experience to be able to take children for a gym session. This was one comment from a rugby coach *“I do not think the physical educators always have the practical experience to train the children, they might have the theoretical knowledge but need practical experience”*

3.2.2.6 New MSTS gym and rugby development at the school

- *More boys interested in playing rugby and other sporting codes also want to gym*

By upgrading the old MSTS system and providing schools with a new gym, which has new equipment and exercises, the scholars showed much interest. Boys who have never played rugby wanted to play rugby now because the school received a new gym. Other sports like athletics and netball also showed interest to use the gym to get their teams stronger.

“This boy never played rugby but when he saw the gym being delivered he immediately wanted to play rugby”

“The netball coaches also want to use it know because they saw the difference it made in the rugby at the school”

- *New equipment used to get players stronger and better devolved*

The new equipment in the new MSTS system like the kettle bells and battling rope will be of great benefit to get the players stronger. These new pieces of equipment and training techniques will help players to get strong.

“I like the new equipment we received in the new gym and the boys are excited to work with new equipment. I cannot get the boys out of the gym, all they want to do is train.”

3.2.2.7 Benefits of having a provided gym programme for each age group

- *The programme adds structure, allows players to become stronger and fitter quicker*

Each school received a rugby specific designed strength and conditioning programme for three age groups. This allows the coaches to know what type of exercises to do with a specific age group and as the player moves into the next age group, he is provided with the opportunity to gym with a new programme. The prescribed repetitions, sets, time per exercise and rest help to add structure to the exercise session. The prescribed program also helps the player to get fitter and stronger quicker than in the past.

“I was wondering what type of exercise to do with the players with the new gym. I am glad you provided us with training programs for the different age groups. It provides us with structure and the exercises will keep players interested”

3.2.2.8 Use of the gym by other sporting codes

- *Other sports and physical education classes will also use the MSTS system*

Other sporting codes are provided with the opportunity to use the MSTS system. Physical education classes may also use the gym. The u14 prescribed programme is specifically designed so not just rugby players may use it.

“The fact that we were provided with an exercise program that other sports may also use we will get more people using the facility and will provide all scholars the opportunity to experience the gym”

“Physical education classes also have the opportunity to do something new with scholars, now we don’t have to just let them run around the field and make them do push ups and sit up”

3.2.2.9 Any improvement that can benefit the programme

- *Providing more than one set of a certain piece of equipment*

Only one set was provided with certain pieces of equipment. More than once coaches mentioned that if they just had a second set with a certain piece it will help to accommodate more players at a time.

“If I just had another set of these dumbbells, then two players can train at a time and now one will have to wait to train”

3.2.2.10 How often is the MSTS system used

- *Low usage rate because of time and the school does not facility to leave gym unpacked at all times*

By providing the gym and required information to the school does not mean that it will be used every day. One requires time to be able to unpack the gym and place the pieces of equipment at each station and then also be able to pack away the equipment after it has been used. If equipment is left lying around it will get stolen or get lost. Several schools do not have an adequate facility to be able to house the gym, so most of the time the gym is in a store room. This results in every time the scholars need to train, the gym must be moved. Female teachers or coaches do not have the physical strength to be able to move and unpack the gym without help.

“You can see we store the gym outside in this room, so to gym takes a lot of time because we have to move the box, unpack it and then pack it away again. It all takes time and I do not always have the time so I just take the boys to the field”

3.2.2.11 Implementation of training and hindering factors at the school with the MSTS

- *Training frequency and implementing other sports to use the MSTS system*

The training frequency that is recommended the school follow may be a logistical problem to implement and may result in the gym not being used as often as needed to. When the other sporting codes or physical education classes want to use the gym they normally want a male figure to be present. This is not always possible, which will lead to the gym not being implemented into other sports.

“I always have to help out when other teachers want to use the gym. I do not always have the time and if I’m not there when they want to train, they just do not bother to use the gym because of the amount of work it is to unpack and re-pack the box again.”

- *Female staff and having the needed qualified staff*

Schools have struggled to get female staff involved with the use of the gym, the reason for this is that it requires a certain amount of physical activity to be able to get the equipment in and out of the box and pack the circuit out. The school does not always have the qualified staff to be able to train the children.

“The female staff struggles to pack out the equipment because its heavy and it take time, which results in them just not using it.”

“The school needs someone like you people from Sport Science to work at the school to train boys because we don’t always have the skill to train the scholars.”

3.2.2.12 Reason for better implementation from one school to the next

- *Suitable facility, more eagerness from scholars and time availability*

The facility the school has will play a direct role on how frequently the gym will be used. The more effort it takes to be able to use the gym the less it will be used. If the players are eager to help with packing the gym it will also be used more and this will result in more time being available to train using the equipment. But the opposite is also true; if the players do not want to help with the packing of the gym the coaches will not being willing to do it on their own and the gym will just be used less.

“We have a nice hall were we can train and the boys help to pack equipment away.”

“Look where we have to store the gym, it takes a lot time if we want gym and effort to move it and I’m the only one who knows how the equipment works and how to pack the equipment away.”

“The boys just want to train but they do not want to help unpack the box or help pack it up again. I have to do it by myself and as a teacher and coach I don’t have a lot of extra time.

To summarise, from the results obtained from the interviews it is evident that there are both positive and negative factors that contribute to the usage of the mobile schools training system. In chapter 4 recommendations will be made on the areas where there is major concern and possible solutions will be provided so that the necessary improvements can be made in future projects of this nature.

Chapter Four

Discussion

4.1 Section A: Quantitative discussion

4.1.1 Pre-post differences across age groups

The U16 and U18 age groups differed significantly in stature, body mass, % body fat, bilateral grip strength, bench press, push-ups, sprint times (10 m and 40 m) and the multi stage shuttle test. These significant differences can be attributed to maturation^{69,70}, the effect of having direct supervision^{37,38} or a combination of the two.

The post testing results for stature for U16 (167.8 ± 7.6 cm) and U18 (171.9 ± 6.8 cm) showed the players were shorter than the junior high level players in a study in South Africa in 2003¹⁹. The average stature for these players was 175.6 ± 57 cm and 179.2 ± 6.7 cm for the U16 and U18 age groups respectively. These players were part of the junior squads that were selected from the teams that participated in the South African U16 National Grant Khomo and U18 Craven Week youth tournaments. A recent study (2014) showed that English Academy rugby players that participated in the U16 and U18 age groups were also taller than the subjects of this study⁷¹.

Both the U16 (63.2 ± 12.4 kg) and U18 (71.6 ± 13.9 kg) players weighed less than similar aged Rugby Union and Rugby League players^{19,71}. The average body mass for the elite players were 76.6 ± 8.2 kg and 84.9 ± 8.3 kg for the U16 and U18 age groups respectively. These results are consistent with a study that showed that Coloured and Black U18 players weighed on average 8 kg's less than White counterparts¹.

There were no differences between the two age groups for the sum of 4 skinfolds. These results were similar to the findings in a group of English Academy rugby players by Till *et al.* (2014)⁷¹. However, when the sum of 4 skinfolds were converted into a percent body fat the U18 players ($14.0 \pm 5.1\%$) had less body fat than the U16 players ($17.5 \pm 5.5\%$). It is unlikely that these differences can be attributed to maturation. Rather the differences can be attributed to the fact that the *Durnin and Womersley* equation differs for U16 and U18 age groups – it should be considered that this is perhaps a type 1 error (i.e. differences that are not real). The results should also be considered in the context of a study of high level U16 and U18 players, which showed that there were no differences in body fat between age groups (both age groups had just over 14%)¹⁹. This study also used the *Durnin and Womersley* equation to calculate body fat. The sum of 7 skinfolds was reported in this study (no difference between age groups), so it is not possible to determine whether the 4 skinfolds which are used to calculate body fat were different between age groups or not.

On the assumption that this is a real finding, the lower % body fat will have a positive benefit for the U18 age group as it has been shown that a lower % body fat results in a higher aerobic capacity⁷². Body fat does not contribute to muscle power, therefore having excess body fat will decrease ones sprinting ability⁷³.

As expected the bilateral grip strength of the U18 players was 12% higher than the U16 players. This was also shown in a study of Scottish players in rugby-playing schools where as the players got older there was an increase in grip strength⁷⁴. This study mentioned that during puberty there is an increase in body mass and strength is proportional to the grip strength⁷⁴. The Scottish Rugby Union therefore recommends using body mass and grip strength as an effective method to avoid a mismatch between younger boys wanting to compete in an older age group. As a result of these findings the Scottish Rugby Union has adopted a selection criteria that a young player wanting to play at an U18 age group level must match the weight and grip strength of an adolescent 17 years of age⁷⁴, except for the prop position where the criteria are more stringent and based on age. When looking at the U16 and U18 MSTs age group result there is a clear lack of change over time for an increase in grip strength. From the above mentioned literature it would be expected that grip strength should show improvement as the body mass increases as a result of maturity. But even though the body mass showed to increase between the pre-post testing rounds the grip strength results failed to show the same proportional increase. Further investigation is required to note why this occurred as there could be various contributing factors.

The bench press results, and by implication overall strength of the U18 players were about 36% more than the U16 players. As body mass increases as a consequence of maturation so too does gains in strength^{6,71}. Therefore the differences between U16 and U18 were expected. However, both age groups lifted less weight compared to high level South African¹⁸ and English players⁷⁰ of the same age group. For example, the U16 group was 43% lower than the South African¹⁸ players and 39% lower than the English players⁷⁰. The U18 group was 28% and 36% lower than South African¹⁸ and English⁷⁰ players respectively.

Baker documented that there is a age specific weakness between junior high school, senior high school, college age group players and elite professional players, where the performance of the 1RM bench press was significantly correlated in rugby league players with regards to playing achievement in untrained (70 kg), junior (85 kg), senior (98.2 kg), college (110.5 kg) and national (144.5 kg) with a correlation coefficient of $r = 0.80$ ⁷⁵.

The MSTs age groups showed that during the time they were exposed to the mobile gym (i.e. between testing rounds) there was an increase in bench press strength. Even though the MSTs age groups were still weaker than other study populations, within the U16 and

U18 age groups the players were able to increase their strength over time. The increase in strength can also be as a result of these players in the MSTs programme being exposed to resistance training for the first time, as before receiving the mobile training system they never had the opportunity to engage in these specific strength and conditioning activities. This supports previous mentioned literature that as a result of maturation there will be an increase in body mass that is accompanied with an increase in strength.

The U16 age group performed about 27% fewer push-ups than the U18 age group. Both age groups also performed fewer push-ups than the high level U16 and U18 South African players¹⁹.

The U16 age group players were able to perform on average two more repetitions with the push-up test during their post round testing where the U18 age group on average performed one repetition less during their post round testing. Even though the U18 age group performed fewer push-ups during post round testing they still were able to perform more push ups than the U16 players. It was expected that the U18 players perform more push-up repetitions than the U16 group but it was not expected that they perform less repetitions in the post-round testing than the pre-round of testing. Over time and after being exposed to the mobile gym the U16 age group showed the expected improvement. It was not expected that the U18 age group would not show an improvement but actually decrease in their muscular endurance capability between testing rounds. A reason for this could be that the U18 players focused their training more on upper body strength work to be able to be stronger and neglecting to also incorporate muscular endurance exercises into there training.

The U18 group was 3% faster over 10 m and 4% over 40 m compared to the U16 players. The 10 m sprint times were comparable to high level South African players¹⁸ but slower when compared to English players of the same age⁷⁰.

The 40 m sprint times were 8% and 4% slower (U16 and 18 respectively) compared to the high level South African players¹⁹. The U18 40 m sprint time was also about 4% slower compared to a study of 17 to 18 year old junior rugby league players in Australia⁷².

The U16 age group ran 7% fewer shuttles than the U18 age group; these values were similar to the results of the high level rugby players of similar ages¹⁹. The specific findings that the U18 players ran more shuttles can be a result of maturation, where the VO_2 continues to increase through the age of 18 as well as the contribution that genetics and training might have^{69,76}. The results are similar to the high level players because of the fitness level of the players that increased during the duration of the rugby season. As well as

the testing of the high level players and the players of the MSTS programme were during a similar period during the year and schoolboy rugby season.

The U16 and U18 age groups of the MSTS programme showed that over time they were able to improve their aerobic capacity and run more shuttles during the second (post) round testing. The increase in shuttles can be a result of an improvement in fitness as a result of the field training sessions. It was expected that over time the players would show an improvement in their aerobic capacity as they were more exposed to running, fitness drills and by playing matches between the pre-post rounds of testing.

In summary, both age groups got taller as a result of maturation. Both groups also increased in body mass, performed better in the bench press and MSST following exposure to the MSTS. This suggests they got stronger and their endurance improved. Unfortunately the design of the study does not allow the effects of maturation and training to be separated. However, although these values changed these results are still not comparable to players of the similar age. Some of the contributing factors for the lack of change over time will be discussed in the qualitative discussion section to follow.

4.1.2 Comparison of gym used vs. gym not used

The success of a programme is determined by the degree of compliance of the participants. In this study the compliance in some schools was very poor. This conclusion was reached following the interviews with coaches and informal discussion with players during the testing. There were clear indications, based on the symptoms of wear and tear on the equipment that it was used infrequently between testing rounds. Furthermore, in many cases logbooks were completed poorly. This explains the lack of improvement in some fitness parameters, that other studies have shown clearly adapt after systematic exposure to weight training exercises²⁹⁻³¹.

After dividing the schools into those that did use the gym equipment and those who did not use the gym equipment there were marginal differences over time in the schools that used the equipment. The major difference was for body mass and bench press where the boys who used the gym got heavier and stronger.

It is well documented that resistance training in adolescents increases strength, improves sporting performance and decreases the risk of injury¹². *Smart and Gill (2013)* mention that one of the reasons for conducting their study was that strength and conditioning within adolescents players of Rugby Union is generally unstructured and unsupervised¹². Supervision by a qualified strength and conditioning coach during resistance training sessions is recommended mainly to ensure safety and prevent injury⁶. Many studies have

shown the benefits that direct supervision has on strength gains^{36,37}. *Gentil and Bottaro (2009)* and *Smart and Gill (2013)* once again showed the importance of supervision on improvement to be made in strength gains^{12,38}.

One of the rules, outlined in a signed contract (Appendix C), between the schools and SARU was that a coach needed to be present to supervise the players for a strength and conditioning training session. If supervision could not be provided the players could not use the mobile training system. As most coaches involved in the MSTS programme were teachers it was not always possible for them to be able to provide supervision outside of a scheduled field practice as they had other commitments or had to attend to other schoolwork. This led to the difficulty of always being able to provide supervision for a gym session, which in effect led to less utilisation of the gym.

The results of an increase in body mass and strength over time correspond with the position statement of *Lloyd et al. (2014)*. It is stated that especially in adolescent males resistance training results in an increase in lean body mass, cross sectional area of the muscle and strength gains⁶. Some of the reasoning behind this can be related to maturation of the central nervous system, for example improvements in the motor unit recruitment, firing frequency, synchronisation and neural myelination⁶. Further strength gains in adolescents are typically driven from neural development but especially in males these structural and architectural changes result from increased hormonal concentrations that include testosterone, growth hormone and insulin-like growth factor⁶.

4.1.3 Comparison of the 5 provinces for U16 and U18

The five provinces involved in the programme were Western Province, Boland, South Western District, Eastern Province and Border. The ethnicity in these low-income areas in the MSTS programmes is mainly a Coloured and Black population. In the Western Province, Boland and South Western District the population is mainly people of a Coloured ethnicity and in Border and Eastern Province mainly a Black ethnicity population.

There are noted differences between the 5 provinces for both the U16 and U18 age groups. There are various factors that may contribute to this. Although the contributing factors are beyond the scope of this thesis but they may include socioeconomic, ethnicity and cultural differences between the study populations.

When comparing the 5 provinces to each other in the U16 age group most of the differences occurred between Border and Boland. As mentioned earlier the ethnicity of the population in these two areas is quite different. When looking at specific testing variables one notices that the Boland players are 12% heavier in body mass. This had a direct influence on bench

press strength that revealed the Boland players being 17% stronger than the players from Border. As mentioned earlier in the discussion, as the body mass increases so to does the strength⁷¹. When comparing sprint times for 10 m and 40 m distances players from Boland, Western Province and South Western Districts were faster than players from Eastern Province and Border. Players from Eastern Province presented with the slowest times for 10 and 40 m whereas Boland had the fastest 10 m sprint time and Western Province the fast 40 m time. Boland was 9% faster over 10 m than Eastern province and over 40 m sprinting distance Western Province was 9% faster than Eastern Province.

When comparing the U18 group of the 5 provinces to each other there were only differences between the provinces for bench press and 40 m sprinting time. The bench press results are quite different to those of the U16 players. In the U18 group players from Eastern Province were 23% stronger than the players from Border. South Western District revealed they cover the 40 m sprinting distance is the fastest time with Border being the slowest to cover the distance. South Western District covered the distance 8% faster than Border.

In summary, it may be concluded that there are differences between provinces for U16 and U18 age groups. The specific reasons for this are not known. It is recommended that further research should investigate the impact of socioeconomic status, ethnicity and cultural differences have on these variables.

4.2 Section B: Qualitative discussion

4.2.1 Discussion

The interviews showed that schools that utilised the mobile gym enjoyed using the equipment and the quality of the rugby benefited following the training. However, some problems were also identified.

Major implications that came out the interviews were;

- (i) not having the correct facility to house the mobile gym,
- (ii) the significant amount of time taken to unpack and pack the equipment away before and after training,
- (iii) boys not always willing to help with unpacking and packing up of equipment, and
- (iv) the female staff always having to rely on a male staff member to unpack the equipment for them.

Lack of facilities at the schools were one of the major problems identified which resulted in the mobile gym not being used to its full potential. Some of the schools do not always have a hall or adequate facility at the school to store the mobile gym, which resulted in the gym being kept in either a classroom or a storeroom. This meant that the mobile gym had to be moved every time a gym session had to take place. This requires a physical effort for the coach before each strength and conditioning session. Each time that the players wanted to train the mobile gym firstly had to be unpacked and moved to the correct area. The coaches said that they did not always have the time to move the whole mobile gym and generally the boys did not want assist with the unpacking and repacking of the training equipment.

The female staff who are involved with physical education at the schools found it difficult to unpack equipment each time they wanted to use it, so eventually they just stopped using the mobile gym and let the children do the type of activities before they had a gym. The activities included running around the field.

Another problem was that staff did not always have the self-confidence to help the boys with correct training technique when they trained. Some of the teachers/coaches mentioned that although they had some form of theoretical knowledge, they struggled with the practical aspects. A recent American study showed that coaches and teachers did not have adequate knowledge to design, implement and correctly supervise youth resistance training⁷⁷. This study⁷⁷ agrees with what some of the coaches mentioned during the interviews.

In communities, similar to those involved in the mobile schools training project, adequate nutrition for the scholars at these schools will always be a problem. The coaches kept mentioning the lack of proper nutrition the pupils in the school have and that it is of concern in the community. The communities are relatively poor and there are limited school food programmes. As a result the physical development of the pupils is a bit delayed compared to pupils from more privileged schools where these resources are much more readily available.

4.2.2 Limitations

For this part of the study to have been conducted there were a few limitations. Firstly, the researcher may have had an influence on the type of answers that was received. The reason for this is that the respondents may have thought the researcher was aligned to HPC and SARU, the two major bodies involved in the project. This could have resulted in the interviewee not being fully open and honest in fear of saying something that may have resulted in the mobile schools training system being removed from the school.

Secondly, language was also a problem in certain schools, especially those in the Eastern Cape.

4.2.3 Reflexivity

The role of the researcher in the interviews was closely related to the work the researcher does for the mobile schools training system project; therefore it was possible that it would have had an impact on the interviews conducted with coaches. A future study of this nature should have a completely neutral person to conduct the interviews.

Chapter Five

Conclusion

5.1 Conclusion

The literature (Chapter 1) shows that there are several benefits for adolescents who engage in resistance training. In particular, the strength gains are optimised and the risk of injury reduced when a qualified trainer supervises the training. However, in this study body mass and bench press, and by implication strength, were the only variables that improved over time when the group was divided into the schools that used the gym as expected compared to the schools that did not use the gym. The rather modest changes in these variables can be explained by the quality of the supervision where the supervisors may have lacked the expertise and experience to supervise. Another explanation may be the lack of adequate nutrition in this population, which would have compromised the ability to adapt to resistance training. This was not measured in the study but it was something some coaches mentioned during the interview. Studies have shown that adaptations to resistance training are blunted when nutrition is inadequate⁴⁸.

As this study is the first of its type where a programme of this nature is implemented in disadvantaged areas in South Africa, it may be speculated that the schools that were successful and showed improvement will continue to be successful in the future. The reasons for this is that they have the available facilities, support from the schooling community, eagerness from players and the time to use the MSTs.

For the programme to be successful in the future for all the participating schools, it is important that each school has the necessary support structure. Each school needs a facility to house the gym so it is not a logistical challenge to unpack the equipment before training, and then have to pack it up again after training.

The results of this study provided the information about the strengths and weaknesses of the MSTs programme and identified barriers that need to be addressed to improve the outcomes. Areas of concern that were raised in the qualitative analysis will be discussed in the practical applications section. Recommendations will also be made on where the needed improvements to the program can be made to ensure that better training efficacy and strength gains, shown in the literature for adolescents, can be achieved.

A brief summary of the answers to the research questions identified in chapter 1 follow:

Do the fitness characteristics associated with performance in rugby (body mass, % body fat, grip strength, upper body strength and endurance, 10 and 40 m sprinting time, and aerobic capacity) of U16 and U18 players improve after exposure (4 to 6 months) to the Mobile Schools Training System?

On completion of the statistical analysis the schools where the gym was used were compared to schools where the gym was not used and the results indicated that the schools who did utilise the gym over time only showed improvement in body mass and bench press. For all other testing variables there were no differences between the two groups. This would indicate that the implementation of the MSTS was unsuccessful in achieving the goals of improving the fitness characteristics of body fat, grip strength, upper body endurance, 10 and 40 m sprinting time, and aerobic capacity.

Therefore the H_0 can be accepted as no improvement was shown in physical characteristics that can be associated with rugby performance.

How do the coaches view the effectiveness of the Mobile Schools Training System on their sporting performance based on past and present experiences?

The coaches from the schools in the MSTS programme mention that the schools benefited from the mobile gym facility, but the lack of adequate facilities to house the gym, lack of time and the adequate knowledge made it difficult to assist the boys with quality, well supervised strength and conditioning sessions. The coaches also mentioned the lack of proper nutrition of the boys, as the schools were selected in low socioeconomic areas. Although there are feeding schemes at some of the schools, designed to provide each pupil with a balanced meal, it may be argued that lack of adequate nutrition compromised the efficacy of the strength and conditioning training.

The coaches all mentioned that a better support structure or a qualified person to assist the boys with their strength and conditioning programmes would be a most effective solution.

Therefore the H_0 can be accepted as from the interviews with coaches it was revealed that there are certain barriers that prevent the programme from being fully successful at the schools.

5.2 Practical recommendations

Based on the data in this study, the following practical recommendations can be made.

- Before the MSTS gyms are allocated, an adequate needs analysis at each school should be done to determine if they have the facilities to house the equipment to ensure that training sessions can take place. The needs analysis must also determine the current perceptions of the boys i.e. are they serious about sport and have an intention of utilizing the gym or do they just practice rugby once a week and

play matches? It is important to also determine the support structure at each of these schools and whether the coaches have the adequate knowledge to be able to supervise strength and conditioning sessions with the boys. If they do not have the knowledge and experience they should be provided with the opportunity to further educate themselves in this area.

- SARU employs a qualified trainer assigned to each of the schools involved in the MSTS programme that will conduct all strength and conditioning sessions with pupils at the school.
- If SARU cannot employ qualified trainers they can educate and train the SARU development officers that are employed at each one of the rugby unions across South Africa. The development officers can in this way get involved in the MSTS programme to ensure that it is implemented effectively.
- Have regular visits at schools and do objective and subjective assessments to determine whether there are improvements and the equipment is being used properly.
- The Western Cape Government has a programme called the “MOD Programme” that delivers sports and recreation facilities to 181 previous disadvantaged schools across the Western Cape⁷⁸. A qualified trainer is assigned to each of these schools where activities take place each afternoon from 14:00-18:00. The schools in the Western Cape that are part of the MSTS programme should also get involved in the MOD Programme. This will ensure that a qualified trainer can supervise the strength and conditioning sessions of the boy.
- Provide more intensive training opportunities to teachers at school, particularly an opportunity to attend training courses where they are educated on the correct methods and techniques of strength and conditioning.
- Lastly it would be recommended that all schools involved in the MSTS programme be placed in a feeding scheme programme. This will ensure that the boys involved get at least one balanced meal a day. Some, but not all of the schools are already involved with such schemes.

Chapter Six

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Chapter Seven

Appendices

Appendix A

Consent Form

I (print name) _____ hereby consent to participating in the physiological assessment on the following terms:

1. I have been informed about the procedures of the tests of physical assessment and understand what I will be required to do.
2. I understand that I will be participating in physical exercise some of which is at maximal intensity. I understand that there is always a small risk of injury associated with high intensity exercise.
3. I understand that I can withdraw my consent, freely and without prejudice, at any time.
4. I have told the personnel doing the testing about any illness or physical defect I have that may contribute to the level of risk.
5. I understand that the information obtained from the test will be treated confidentially with my right to privacy assured. However the information obtained may be used for scientific purposes with my right to privacy retained.
6. I accept however that the testing personnel will take every precaution to ensure that no incidents will occur.

Participant signature _____ Date _____

Parent/Guardian name (if under the age of 18) _____

Parent/Guardian signature _____ Date _____

Players ID number:

Appendix B

Logbook

U14 Rugby Logbook					
	Week	Date	Sport	Age Group	Session/week
1	EG: 1	4-10 February 2013	Rugby	U14	2
2					
3					
4					
5					
6					
7					
8					
9					
10					

U16 Rugby Logbook					
	Week	Date	Sport	Age Group	Session/week
1	EG: 1	4-10 February 2013	Rugby	U16	2
2					
3					
4					
5					
6					
7					
8					
9					
10					

U18 Rugby Logbook					
	Week	Date	Sport	Age Group	Session/week
1	EG: 1	4-10 February 2013	Rugby	U18	3
2					
3					
4					
5					
6					
7					
8					
9					
10					

Appendix C

SARU MSTS contract



AGREEMENT ENTERED INTO BY AND BETWEEN

THE SOUTH AFRICAN RUGBY UNION (“SARU”)

AND

.....

It is recorded that:

1. SARU is the owner of the MOBILE SCHOOL TRAINING SYSTEM (“MSTS”)
2. The is desirous to make use of the MSTs under the following conditions:

Now therefore it is agreed:

3. SARU will allocate the MSTs in consultation with the union and other parties if necessary, but the final placement will be at the discretion of SARU.
4. On date of delivery the designated school will accept certain responsibilities in return for use of the MSTs. These responsibilities are as follows:
 - 4.1 The school has to maintain the MSTs so that it is in operational condition at all times.
 - 4.2 SARU retains the right to move the MSTs to another school or area within the same province if the MSTs is not fully used or maintained.
5. The parties agree that SARU and the Sport Science Institute of South Africa (SSISA), at Boundary road Newlands will not be held responsible for any injuries and or damage whatsoever to people utilising the MSTs.
6. The MSTs may only be used with trained supervision and utilizing the training programmes handed to the dedicated coaches.

7. The training manual designed should be used in conjunction with the MSTS
8. The current signage may not be removed or other signs added without the written permission of SARU
9. Periodic feedback (including questionnaires and log books) will be required by the SSISA and SARU.
10. The school hereby indemnifies SARU and or the SSISA for personal and/or other injuries, and/or damage or loss of property of people utilizing the MSTS.
11. The school has to ensure that the people who utilize the MSTS sign a form, which indemnifies the school from any claim as a result of personal and/or other injuries, and/or damage or loss of property of people utilizing the MSTS.
12. A sign shall be placed in the container making sure people are aware that they use the facility at their own risk.
13. The school takes responsibility for controlling access to the MSTS.

Signed in acceptance

For

Principal

_____ Name _____ Date _____

For South African Rugby union

_____ Name _____ Date _____

Appendix D

MSTS coding framework

Past experience without a gym	
Difficult to get players stronger	Experience: difficult
Difficult to stay motivated to get players stronger	Experience: motivation
Boys were not interested in rugby before not having a gym	Experience: boys not interested
Type of Equipment	
Pulled and pushed vehicle tyres	Type: vehicle tyres
Did body weight exercises e.g. push ups	Type: body weight
Did training by carrying partner e.g. squats with partner or running	Type: partner work
Did available equipment physically change players before getting a gym	
Players did show a strength change	Change: players stronger
Players did show a strength change but quickly plateaued	Change: players plateaued
Always made coaches look for new ways to use the equipment	Change: kept coach thinking
Effect diet of players	
Diet at home is very poor	Effect: poor diet
Feeding scheme at school for players to help with proper diet	Effect: balanced meal
Some schools provide food to players out of own pocket	Effect: school provides a meal
Additional Training as Coach	
The Union to offer a monthly workshop for coaches	Training: workshops
Addition workshops to be offer to Physical Education teachers	Training: PE Teachers
Previous Experience of old MSTS	
Players had a advantage over schools without a gym	Experience: advantage
Could compete with schools who had a gym at same physical level	Experience: better competition
Players showed a very good improvement	Experience: physical improvement
New gym and rugby Development	
More boys are now interested to play rugby	Development: more boys for rugby
New equipment will physically develop players more to become stronger	Development: boys Stronger
Other sports also show interest in gym work	Development: other sports & Gym
Benefit of training programme	
Players to become stronger	Benefits: players stronger
Adds structure to gym work	Benefits: structure
Gets players conditioned quicker	Benefits: quicker conditioned
Usage by other sport codes	
Sports like netball and athletics will gym as well	Other: usage other sports
Physical education will also use the gym	Other: physical education
Anything else to improve programme	
Adding more than one set of a certain piece of equipment	Improve: Equipment
Is MSTS used or not	
Low usage rate as a result of time	Usage: time available
Gym not used because don't have proper facility or space	Usage: poor facility
Implementation at the School	
Training at least twice week during rugby	Implementation: training

	frequency
other sports and PE classes use the MSTs	Implementation: other sports usage
Factors hindering implementation at the School	
Not enough time to pack and unpack to unpack circuit	Hindering factors: time
Female teachers don't want to use it	Hindering factors: gender
Not having there required qualified staff to train players	Hindering factors: qualified staff
Reasons for better usage from one school to the next	
More suitable facility to keep the gym	Reason: facility
The boys being more eager at one school to gym that at the other	Reason: eagerness
Teachers and players have the time to unpack equipment	Reason: time

Appendix E

Synopsis

Introduction

Rugby is a sport where size matters and the bigger, stronger and better conditioned players have a advantage over smaller and less powerful opponents³. In South Africa adolescent rugby players from low socio-economic environments are generally smaller and less powerful than their counterparts from more affluent areas³. Schools in disadvantaged areas have little access to resources, inadequate facilities and minimal involvement from parents⁴. A study done by the South African Rugby Union (SARU) in 2002 at the U18 Craven Week showed that black and coloured players weighed 8kg less than the White players. This study also provided evidence that these players did not have access to weight training facilities¹.

This finding led to the development of a joint program between SARU and the Discovery High Performance Centre (HPC) at the Sport Science Institute of South Africa (SSISA). Twenty underprivileged schools in developing areas in South Africa (Western Province, Boland, Eastern Province and Border) were selected and a Mobile Schools Training System (MSTS) was allocated to each school. The MSTS is a gymnasium facility enables about thirty players to train simultaneously in a supervised environment to improve their strength and conditioning. SARU and HPC work with the selected schools with the goal of promoting and improving physical activity in the schooling community.

The training guidelines for the MSTS are based on the recommendations of the National Strength and Conditioning Association (NSCA), an authoritative body governing strength and conditioning. The NSCA in 2009 released a position statement confirming that resistance training for the youth can safely improve the conditioning and strength of the individual⁵.

Whilst the position document provides overwhelmingly positive evidence to support the implementation of a resistance-training program, there are no data on the efficacy of such a program in an underprivileged area. This warrants further investigation to determine whether the players have meaningful physical changes and also whether there are any barriers which would impact on the implementation of the program.

Study design

A study on the efficacy of the MSTS in underprivileged schooling communities in South Africa should include both qualitative and quantitative data. The reason for this is that to improve the programme one will need to gather the perspective of the people involved with

the training of the players and at the same time the testing conducted by the HPC will show if the players are improving from the training they have received.

The Quantitative part consists of the rugby players from the U16 and U18 age groups that will undergo a full testing battery designed to test the fitness components relevant to rugby. Two rounds of testing will take place. The first round will be to measure baseline values before they have been exposed to the MSTs. A second round of testing will take place within a 4-6 month period after the first round of testing.

The testing battery consists of the following:

1. Height
2. Weight
3. Sum of four skin folds (Bicep, Tricep, Supra-iliac, Subscapular)
4. Bilateral Grip Strength
5. 1 Repetition maximum bench press
6. 1min maximum push-ups
7. 10m and 40m sprint time
8. Multi stage shuttle test

The qualitative part of the study consists of in-depth one-on-one interviews with the head coach of each school. This will take place during the post testing. During the interview they will be asked questions about their past experiences on the effectiveness of the mobile training system at the school. They will also be questioned on their expectations for the new MSTs system and how it will benefit the scholars. Logbooks will be provided. The head coach of each age group from U14 to U18 age groups has to fill in the logbook once a week and document how many training sessions that specific age group had that week with the MSTs equipment. The type of training does not have to be specified because each age group will receive a specifically designed strength and conditioning programme, appropriate to that age group.

Ethical considerations and inclusion/exclusion criteria

Prior to first bout of testing each player will be provided with a consent form, which the parent/guardian of the players has to sign and give consent that the player may take part in testing. Only those players who return the signed form will be eligible for testing. The consent forms will be provided to the school days prior to testing to allow players to take the consent forms home and have them signed. Each player will provide the testing staff with their full name and surname, position and date of birth on a testing sheet.

Players will be excluded from the testing for strength (bench press) if they present with an upper limb injury. Players presenting with a lower limb injury they will be excluded from the sprint time (10m and 40m distance) and aerobic capacity tests (MSST)

All testing is conducted by qualified Biokineticists who are employed at the HPC.

Risks

The risks associated with the study are small. The players will not be asked to do any physical task, which is more demanding than what they might expect during a rugby practice or match.

There is no risk for the coaches who participate in the interview. They can withdraw from the study at any time.

Scientific Benefit

This study will provide SARU and the HPC with an accurate measurement on the effectiveness of the Mobile Schools Training System. The interviews with the head coaches will provide information on where the program can be improved to make it more successful. Testing results will provide evidence on the effectiveness of the programme in improving fitness characteristics.



Appendix F


Example of a age groups strength and conditioning programme

BARBELL SQUATS


Key Factors:

- Stand with feet shoulder width apart
- A chair or bench may be used to perfect technique
- Relax shoulders
- Maintain a flat back posture





Mobile Training System
U18 CIRCUIT
1




WEIGHTED TRICEPS DIPS


Key Factors:

- Slow and steady (hold end position for 2sec)
- Keep rest of body still
- Weight can be placed between ankles or knees



Mobile Training System
U18 CIRCUIT
2



BARBELL BENCH PRESS

Key Factors:

- Slow and steady
- Bar should touch the top of the chest
- Do not bounce bar off chest
- Maintain 5 point contact position: head, back, glutes, left and right foot



Mobile Training System
U18 CIRCUIT

3



AGILITY DODGE

Key Factors:

- The aim is not to let the attachment cord break
- One player leads and the other must try catch him



Mobile Training System
U18 CIRCUIT

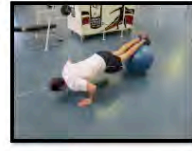
4



PEZZI BALL KNEE TUCKS WITH PUSH UP

Key Factors:

- Slow and steady
- Perform a standard push up with your feet on the ball
- Then do the crunch, breathe out when performing the crunch
- Move feet closer together to increase difficulty
- Knees to chest



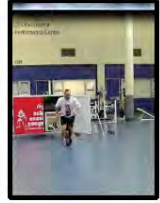
Mobile Training System
U18 CIRCUIT
5



RESISTED FORWARDS RUNS

Key Factors:

- Drive with the legs
- Use arms for momentum



Mobile Training System
U18 CIRCUIT
6



SINGLE ARM JERK

Key Factors:

- Stand with feet shoulder width apart
- Perform press and finish with a split stance
- Torso should remain upright throughout the exercise



Mobile Training System
U18 CIRCUIT
7



MEDICINE BALL ROTATIONS

Key Factors:

- Core should remain strong through motion with the rotation happening from upper body rather than hips and lower back
- Make sure position is stable before performing rotation



Mobile Training System
U18 CIRCUIT
8



RESISTED RUNNING

Key Factors:

- Foot speed is essential
- Concentrate on knee drive and toe off
- Arm drive is key
- Head should remain stable and down
- Be sure to lean forward throughout run



Mobile Training System
 U18 CIRCUIT
 9



PEZZI BALL PUSH UP

Key Factors:

- Keep feet stable on the pezzi ball
- Do not arch back when performing push up



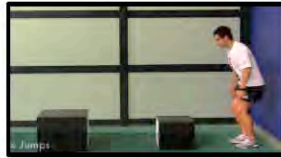
Mobile Training System
 U18 CIRCUIT
 10



BOX JUMPS

Key Factors:

- Soft landing
- Use arms for momentum
- Explode vertically



Mobile Training System
U18 CIRCUIT
11



STANDING ARNOLD PRESS

Key Factors:

- Should be one fluid motion
- Shoulder s back
- Neck should be relaxed
- 90/90° bend at the shoulder and elbow
- Upper body should remain static
- Core should be stable with no arching in the back



Mobile Training System
U18 CIRCUIT
12



FURY CRAWLS

Key Factors:

- Maintain a low hip position and a stable pelvis
- No rocking while performing the exercise
- Ensure TA activation is maintained throughout the exercise
- Slow and controlled movements



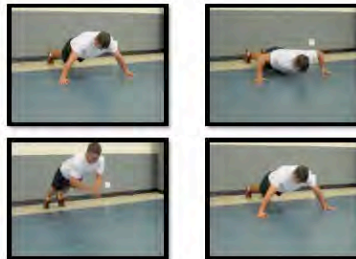
Mobile Training System
U18 CIRCUIT
13



CLAP PUSH-UPS

Key Factors:

- Do not arch back during push-up
- Hands should be placed just outside shoulder width



Mobile Training System
U18 CIRCUIT
14



MEDICINE BALL CEILING CRUNCHES

Key Factors:

- Slow and steady
- Breathe out when performing the crunch
- Leg angle should remain constant throughout exercise
- Relax Neck



Mobile Training System
 U18 CIRCUIT
 15



FARMERS WALK

Key Factors:

- Weighted walking
- Athlete should be encouraged to push ground away behind them when performing this exercise concentrating on forward momentum




Mobile Training System
 U18 CIRCUIT
 16




BICEP CURLS


Key Factors:

- Brace core
- Upper body should remain still through motion
- Shoulder should be relaxed to isolate biceps





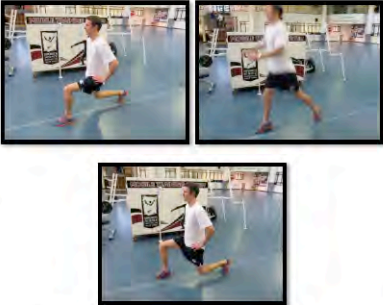
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 17




SPLIT SQUAT JUMPS


Key Factors:

- Explode up, driving arms upward
- Knee should remain directly over ankle through motion and landing
- Soft landing
- Rapid change in leading leg





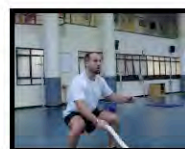
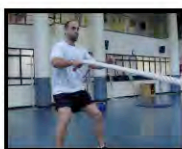
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 18



ROPE SQUAT AND PULL

Key Factors:

- Stand with feet shoulder width apart
- Perform a squat
- Ensure that knees do not pass the over the toes
- Perform a pull while coming up from the squat



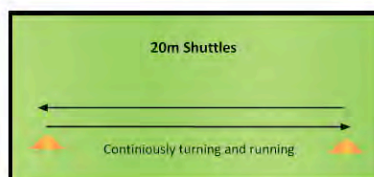
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 U18 CIRCUIT
 19



20M SHUTTLES

Key Factors:

- Be sure to alternate turning foot
- Power off the line and ease into turns



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 U18 CIRCUIT
 20

