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The effect of a sport development programme on sprinting and long jump abilities among 10-15 year old black girls from farm schools in the North West Province, South Africa

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Abstract

Development of previously disadvantaged communities was identified in South Afria (SA) as a national priority and sport was indicated to be part of such a strategy. Farm schools are among the poorest with regards to financial resources and physical structures in SA and consequently learners are confronted with many constraints regarding sport participation. The aim of this study was to develop a sport development programme for sprinting and long jump that is time effective and requires inexpensive equipment for 10-15 year old black children from farm schools. A pre-test/post-test 2-group research design was used. All girls between the ages 10 and 15 from 2 schools (N=66) who consented to participate in the study were tested by means of the Australian Talent Search protocol and the most talented girls (top 30%) in each school were selected by rank order for further testing by means of a sport specific test battery for the motor abilities underlying successful participation in sprint and long jump. The intervention group (n=19) underwent a development programme for ten weeks conducted twice a week for 1.5 hours and their results were compared to that of a control group (n=18) who did not follow a development programme. The results were analysed by means of independent t-testing and the practical significance of differences was determined by means of effect size. Covariance analysis (ANCOVA) was performed to adjust for pre-testing differences. The intervention programme contributed to improved motor and physical abilities important for performance in both sprints and long jump, namely: flexibility, explosive power, muscle endurance, reaction time, speed, speed endurance, acceleration and long jump. The development programme can successfully develop motor abilities important for successful participation in sprinting and long jump despite various limitations South African farm schools have to deal with.

Keywords: Sport participation, farm schools, constraints, limitations, girls.

Introduction

In 1994, with transformation as a priority, the new National Government of South Africa (SA) identified the development of the previously disadvantaged communities in South Africa as a national priority. Sport is part of the strategy to improve and change the circumstances of people from such backgrounds (Boshoff, 1997). Sport development in disadvantaged communities is regarded as essential because without ongoing support of potentially talented athletes, sporting potential will remain undeveloped (Australian Sports Commision, 1995). Consequently, potentially talented athletes will be lost, thus affecting the quality and composition of National sport teams and will also reflects negatively on the transformation in South African sport.

Sport participation has a positive influence on several aspects of a child's development. It contributes to the development of life skills within the sport environment, such as problem-solving, decision-making and analytic behaviour (Danish & Nellen, 1997). Other advantages which are reported are improved health status and a better self-image among children (Boreham & Riddoch, 2001). The identification of children's sporting talent may contribute to the development of life skills and guide the child to the sport that they will most likely achieve success in.

Bompa (1999) stated that children can specialise in sprinting at the age of 14-16 years and in long jump between 17 - 19 years of age. Both athletic events can be linked to the natural movement development of children from disadvantaged communities. Herbst and Huysamen (2000) indicate in this regard that children from disadvantaged communities excel in gross motor skills, such as running, jumping and ball games. It is also reported that children from poorer socio-economic environments are physically more active which can lead to a better ability of developing basic motor skills (Lee, 1980; Prista, Marque & Maia, 1997).

Farm schools constitute 13 percent of all state-funded schools and provide education to about 3 percent of learners in the public school system. These schools are among the poorest with regards to financial resources, physical structure and quality in South Africa. Many of these farm schools comprised only a classroom and a temporary playground (Human Rights Watch, 2004). Farm schools are often distant from the homes of many of the learners. A lack of transportation in rural areas leads to children walking far distances to and from schools, resulting in no time for sport participation after school. Some of the children perform household activities and have to work after school to contribute to the household income, while others have to look after younger family members (Human Rights Watch, 2004).

Minimum funding is available to spend on sports equipment or facilities in order to expose learners from farm schools to sport. Coetzee (2001) indicates time constraints, family responsibilities, no talent/skills, a lack of information and no available training programmes as the main limitations for sport participation among children.

The aim of this study was therefore to develop a sport specific development programme, which is not time consuming and requires inexpensive equipment, in order to improve sprinting and long jumping abilities among 10-15 year old black girls from farm schools.

Materials and Methods

Participants and study design

This study received ethics approval from the North-West University (Number 04M12). Sixty-six girls between 10 and 15 years of age from two different farm schools (school A = 27; school B = 39) in the Potchefstroom district were recruited on an availability basis and voluntarily participated in the study. Both the children and their parents were informed regarding the nature and aims of the project and subsequently the parents had to sign an informed consent form to allow their children to participate in the project. The socio-economic status of the children involved in the study can be regarded as equal and low, since they are mainly children of farm workers in the vicinity, or of those living on farms close to the school. Farm work is considered part of occupations that contribute to low socio economic conditions.

All the girls (N=66) were subjected to the Australian Talent Search protocol (Australian Sports Commission, 1995) which is an existing protocol that can be used to identify general sport talent. It consists of 10 test components namely, body mass, stature, sitting height, arm span, basket ball throwing, throwing and catching, vertical jump, 40-metre sprint, agility and endurance. The most talented children were identified by means of percentiles that were compiled for 10-15 year old children in the North West Province of SA in the Thusa-Bana study (Van Gent, 2001). From this the most talented girls (top 30%) (n=37) from the initial 66 participants were identified. Nineteen girls (mean age of 12.3±1.63 years) were then grouped into an intervention group and 18 (mean age of 12.8±1.59 years) into the control group. These girls were then tested again with a sport specific test battery consisting of sport specific tests focussing on sprinting and long jumping motor and physical abilities. The sport specific test battery was compiled by firstly doing an analysis of the demands of sprinting and long-jump from the literature (Botha & De Villiers, 1979; Chu, 1998; Bompa, 2000; Dintiman & Ward, 2003) and this was then used for the selection of the physical and motor tests. Subsequently a more complete description of the sport specific test battery will follow.

Physical and motor tests

Flexibility: The sit and reach test was used to determine the flexibility of the hamstrings as described by Kirby (1991). Iliopsoas, quadriceps and ankle flexibility were determined by means of a goniometer in accordance with the method of Harvey and Mansfield (2000). A smaller value in the iliopsoas and hamstring muscle flexibility indicates better performance whereas a larger value in the quadriceps and ankle values indicate better performance.

Strength: Abdominal muscle strength was determined by means of the 7-level abdominal muscle power test (Ellis *et al.*, 2000).

Motor components

Explosive power was determined by means of the vertical and horizontal jumps as described by Kirby (1991). The better of two attempts jumping as high or as far as possible was recorded.

Reaction time was determined by means of a 0-5 m speed test where the participant had to start in a crouched position and reacting to the sound of a whistle. Electronic speed lights (Brower timing systems) were used in this test and the better of two attempts were recorded.

Maximum speed was tested across 0-40, 0-60, 0-80 and 0-100 meter distances. Electronic speed lights (Brower timing systems) were used and the better of two attempts were recorded.

Muscle endurance

Abdominal and upper body muscle endurance was determined by means of sit-ups, push-ups and pull-ups until exhaustion, as described by Kirby (1991).

Speed endurance was tested with the 120 meter speed endurance test, as described by Dintiman and Ward (2003). Speed endurance is calculated by means of a formula where the flying 40-m time is compared to the 80-m and 120-m times. When the flying 40-m time differs more than 0.2 seconds from the 80-m and 120-m time, endurance is considered poor.

Anaerobic power: Anaerobic power was determined by using the RAST (running-based anaerobic sprint test (Mackenzie, 2004). Power output (force x velocity) for the six sprints (with 10 seconds rest between each sprint) over 35 m was determined by using the following equations.

Velocity = distance/time; **Acceleration** = velocity/time; **Force** = weight x acceleration.

Power = force x velocity

Calculate the power output for each of the six runs and then also determine:

Maximum power – the highest value; **Minimum power** – the lowest value; **Average power** – sum of all six power output values/6; **Fatigue index** – (maximum power-minimum power)/total time for the six sprints.
Stride length: The stride length of the participants was determined by means of the stride length test, as prescribed by Dintiman and Ward (2003). Two markers were placed 25-m apart on a smooth dirt surface approximately 50-m from the starting line. On the first trail, two helpers identify the subject's footprints and measure and record the stride length to the nearest cm from the tip of the left toe to the tip of the right toe. The second trail is recorded from the tip on the right toe to the tip of the left toe. The better of two attempts was recorded.

Acceleration: Acceleration is determined where the flying 40-m time is subtracted from the stationary 40-m time and this difference is taken as the time delay required to accelerate. A difference of more than 0.7 seconds in these scores is considered as poor (Dintiman & Ward, 2003).

Long-jump: The long-jump ability of the participants was determined by means of a long-jump attempted with a 7-stride approach without any prior technical coaching. The better of two attempts was recorded.

Sport development programme

After both groups were subjected to the sport specific test battery, the intervention group participated in the sport development programme (Table 1) twice a week during school hours for a period of 10 weeks, while the control group continued with their normal daily activities. The duration of the intervention programme was approximately 1.5 hours per session. Following is an explanation of an intervention session in the programme. The basic components of each session incorporate warming up, speed and reaction time, running form drills, speed endurance, plyometry, power and warming down. The exercises and components that was included in the training programme was selected using own sport scientific experience as well as a task analysis (Botha & De Villiers, 1979; Chu, 1998; Bompa, 2000; Dintiman & Ward, 2003), taking into consideration age appropriateness and minimum use of equipment.

Static and ballistic stretches were done for approximately 10 to 15 minutes before and after the practice session. The practice session consisted of different age-appropriate exercises to develop speed and reaction time in a playful manner, while sport-specific exercises were used to improve running performance. The correct execution and technique of the exercises were strongly accentuated.

Table 1: Basic exercises and components of an intervention session in the development programme

Components	Duration (minutes)	Exercise
Warming up	15	• Jog – 2 minutes • Aerobic circuit programme • Static stretches • Ballistic stretches
Speed and reaction time The duration of the exercises or the distance should not be too long. Children should not run fast and continuously for longer than 6-8 seconds. All sets & repetitions must be followed by adequate rest. The participant's heart rate and respiration should return to almost normal levels after the drill. A 1:4-6 work-to-rest ratio is recommended as a general rule (Botha & De Villiers, 1979; Bompa, 2000, Dintiman & Ward, 2003).	20	• File relay – speed • Pass – speed • Skipping-running – speed • Bean bag relay – speed • Reaction exercises – reaction time • Fox and squirrel – reaction time • Underhand slap – reaction time • Tail catching – reaction time
Motor skills: **Running form drills** (Proper sprinting technique must be taught and mastered by the athletes. It is important that correct repetitions using proper form are essential in every drill) (Dintiman & Ward, 2003).	10	• Butt kickers (from a jog, allow lower leg to swing back and bounce off buttocks. Upper leg should stay vertical with minimum movement. Emphasize allowing heel to come up to butt). • Down and offs (jog in place with high knees. Emphasize decreasing foot contact by hitting the ground with the ball of your foot, getting off as quickly as possible. Effort on ground should bounce leg up into high knee position). • Ladders (sprint through ladder as fast as possible, touching one foot down in each block. Emphasize high knee lift & quick ground contact). • African dance (while running forward, raise each leg to the side of body as in hurdling & tap each heel with hand). • Drum major (while running forward, rotate leg in to the midline of the body and tap heel at midline)
Speed endurance ("Hollow sprints" involve the performance of two sprints interrupted by a hollow period of recovery that includes walking or jogging. One repetition may include a 40 m sprint, 40 m jog, 50 m sprint, and a 40 m walk for recovery.) (Dintiman & Ward, 2003).	10	• Hollow sprints

Plyometry (Plyometric training is extremely strenuous, about 48 hours of rest is needed for full recovery. Plyometric exercises should be complete near the end of a workout. Ideally, the number of jumps should not exceed 80-100 per session for beginners. Adequate rest between repetitions, sets and workouts is required.)(Chu, 1998; Dintiman & Ward, 2003)	10	• Plyometric circuit programme • Bunny hops • Hop scotch • Lateral leaps • Single runs • Double leg bound • Single leg bound
Power and core stabilizers	10	• Leg power • Half squat jumps • Straddles • Core stabilisers • Crunches – knees up • Bridges
Cool-down	15	• Slow jog • Static stretches of major muscle groups

Speed endurance was exercised by using "hollow sprints" where the learners started with two sets of 25 metres. Sets were gradually increased by one set every second week until the participants performed 7 sets of 25 metres by week 10. One set consists of a 25-metre sprint, 25-metre jog, 25-metre sprint, 25-metre walk, where the walk served as the recovery period. A plyometric circuit programme was used to improve explosive power. Mahoe (2006-2012) states that with age-appropriate instructions and professional supervision, plyometric training can be a safe, effective, and a fun form of conditioning and athletic training for children and adolescents. Two repetitions of the plyometric circuit programme were executed during the practice session with a one minute rest between each repetition. Leg strength training consisted of half squats (10 in weeks 1-5 and 20 in weeks 6-10) and straddles (20 in weeks 1-5 and 30 in weeks 6-10). Strength and power exercise sessions were not executed on the same day. Core stabilisers were strengthened by means of crunches (2 sets of 10 repetitions in weeks 1-5 and 2 sets of 15 repetitions in weeks 6-10 with a 45-second rest between sets) and bridges (3 repetitions where each had to be maintained for 15 seconds).

Statistical analyses

The Statistica for Windows computer programme was used to analyse the results. A dependent t-test was used to determine the differences between the post-test results of the intervention and control groups respectively. Between-group comparisons were analysed with independent t-testing in order to determine statistically significant differences between the pre and post-test results of the groups. The practical significance of differences was determined by means of effect sizes (ES) (0.3 is seen as small, 0.5 as medium and 0.8 as large). As differences were found between the pre-test values of the groups, an ANCOVA was calculated to adjust for these differences. Adjusted means (Table 2) were therefore calculated with the pre-test as a co-variate to determine the effect of the development programme. The level of significance was set at $p<0.05$.

Results

The attendance rate of the intervention group of the development programme was 85%. Table 2 displays the results of the groups with regard to the pre and post-tests and the statistical significance of differences between the testing opportunities.

The development programme contributed to practically significant improvement in the intervention group in flexibility, explosive power, abdominal muscle endurance, reaction time, speed, acceleration, speed endurance and the long jump (using a 7-stride approach). Although not statistically significant, improvement was also seen in the mean values of the vertical jump, push-ups until exhaustion and reaction time on the right-hand side.

The motor abilities that showed no significant improvement after the development programme were flexibility of the quadriceps (left and right), neutral position of the ankle (left), plantarflexion of the ankle (left), dorsiflexion of the ankle (left and right), abdominal power and stride length.

In order to determine which of the above changes can be ascribed to the programme the changes that were found between the pre- and post test were compared to the results obtained for the control group during this period.

Table 2 indicates that only one component improved statistically significantly in the control group, namely flexibility of the quadriceps on the left ($p<0.05$). The results of the ANCOVA of the intervention group, where the pre-test was used as a co-variate in the analysis led to a significant increase in 2 components of flexibility, muscle endurance, reaction time, speed, speed endurance and long jump ability. Increased flexibility was found in the right hamstring $F_{1.34}=9.49; p=0.004$, which also showed a large practical significance (ES=1.01). Plantar flexion of the right ankle also demonstrated improvement $F_{1.34}=4.97; p=0.03$ with a medium practical significance (ES=0.73). Upper body muscle endurance improved with an increased number of modified push-ups $F_{1.34}$=21.64; p=0.00, which reflected a large practical significance (ES=1.56) as well as reaction time on the left $F_{1.34}$=7.96;p=0.01 and the right sides $F_{1.34}$=11.67;p=0.00.

Table 2: Pre- and post-test results of the intervention and control groups

Sport-specific tests	Intervention group (n=19)				Control group (n=18)			
	Pre-test		Post-test		Pre-test		Post-test	
	M	SD	M	SD	M	SD	M	SD
Flexibility (grades)								
Hamstring (L)	91.53	12.63	85.26*	8.25	90.72	10.66	87.06	7.99
Hamstring (R)	93.0	10.99	85.47*	6.91	92.22	6.30	92.11	9.27
Iliopsoas (L)	1.63	9.85	-11.89*	8.53	-11.11	7.86	8.22	6.29
Iliopsoas (R)	-1.0	10.86	-7.68*	9.26	-6.78	4.25	7.28	6.42
Quadriceps (L)	62.47	12.64	61.00	10.29	49.83	12.99	63.06*	10.91
Quadriceps (R)	61.95	14.75	66.37	15.21	56.50	11.38	61.22	12.60
Neutral position of ankle (L)	46.05	7.43	45.26	8.94	57.89	9.04	51.83*	7.85
Neutral position of ankle (R)	45.16	8.24	49.79*	6.70	53.50	6.38	53.50	9.53
Plantarflexion of ankle (L)	74.21	7.66	72.37	7.68	76.72	5.96	71.50*	5.11
Plantarflexion of ankle (R)	71.63	8.07	74.74*	6.00	72.00	6.91	70.94	7.48
Dorsiflexion of ankle (L)	18.11	7.26	19.37	8.22	26.72	9.38	27.56	12.54
Dorsiflexion of ankle (R)	18.21	7.22	17.89	9.55	24.21	8.55	21.11	9.48
Explosive power (cm)								
Vertical jump	27.16	5.78	29.11	9.43	27.06	4.22	28.61	5.69
Horizontal jump	153.21	15.50	163.84*	14.62	156.56	19.06	158.44	23.35
Strength (levels)								
Abdominal strength (7-level)	3.79	1.72	3.05*	1.93	1.28	1.36	1.22	1.35
Muscle endurance (number)								
Sit-ups	10.84	5.64	24.37*	5.79	28.83	6.76	27.33	5.30
Push-ups	19.26	6.80	22.63	9.74	21.50	5.85	12.33*	6.77
Reaction time (cm)								
Ruler test (L)	18.11	7.90	13.37*	5.35	23.22	8.51	20.39	7.25
Ruler test (R)	16.79	9.24	12.05	6.48	21.03	8.03	19.97	6.87
Speed (seconds)								
0-5 metre	1.68	0.14	1.61	0.17	1.37	0.11	1.39	0.09
0-60 metre	10.88	0.77	10.52*	0.79	10.40	0.71	10.50	0.66
0-80 metre	14.35	1.06	13.77*	1.03	13.80	0.95	13.91	0.89
0-100 metre	18.03	1.37	17.32*	1.34	17.56	1.33	17.68	1.13
Speed endurance (sec)								
150- m speed endurance	29.96	2.46	26.49*	1.96	27.27	2.09	27.69	1.95
Stride length (cm)								
Stride length (left to right)	179.42	19.57	166.68*	19.00	177.33	22.68	177.89	23.04
Stride length (right to left)	178.63	16.85	173.00	23.84	187.06	27.40	176.56	23.06
Acceleration (m/sec/sec)	0.31	0.05	0.34*	0.06	0.33	0.05	0.29	0.05
Long jump (metres)								
Long jump with 7-stride approach	314.47	44.53	341.32*	38.00	345.17	54.95	339.39	40.44

* p<0.05; (R) - right side; (L) – left side; M – mean; SD – standard deviation

Table 3: Adapted means calculated with an ANCOVA with the pre-test as a co-variate

Variables	Group	N	M	SE
Flexibility (grades):				
Straight-leg hamstring (R)	1	19	85.29	1.59
	2	18	92.31	1.63
Ankle plantarflexion (R)				
	1	19	74.83	1.25
	2	18	70.84	1.28
Muscle endurance (number):				
Modified push-ups	1	19	23.32	1.74
	2	18	11.61	1.79
Reaction time (cm):				
Reaction time (L)	1	19	13.82	1.47
	2	18	19.92	1.51
Reaction time (R)				
	1	19	12.09	1.58
	2	18	19.93	1.62
Speed (seconds):				
0-5 metre speed	1	19	1.66	0.04
	2	18	1.41	0.04
Speed endurance (seconds):				
150-metre speed endurance	1	19	25.59	0.30
	2	18	28.63	0.31
Long jump (metres):				
Long jump with 7-stride approach	1	19	349.94	6.34
	2	18	330.29	6.52

1 = Intervention group; 2 = Control group; M = adjusted mean; SE = standard error; (R) = right side; (L) = left side

Both of these differences (left, ES=0.97, right, ES=1.16) displayed large practical significance. An improvement was seen in the 0-5 metre speed $F_{1.34}$=14.32; p=0.00, which reflected a large practical significance (ES=1.77). An improved time was also seen in the 150 metre speed endurance $F_{1.34}$=44.25; p=0.00, which also reflected a large practical significance (ES=2.6). Long jump ability (with a 7-stride approach $F_{1.34}$=4.46; p=0.04), improved with a medium practical significance (ES=0.73).

Discussion

The objective of this study was to determine the effect of a sport development programme for improving speed and long-jump ability among girls from a disadvantaged farming community. The results showed an improvement in flexibility, explosive power, muscle endurance, reaction time, speed, speed endurance, acceleration and long jump.

The improvement of flexibility in six muscle groups in the intervention group compared to one muscle group in the control group can be attributed to the development programme. These results are supported by literature findings which indicate that flexibility can be improved by regular stretching exercises (Bompa, 1999; Bloomfield & Wilson, 1998). Plyometric exercises for improving explosive power, which are regarded as an important component for performance in the long jump, contributed to the improvement of both the vertical and horizontal jumping ability as supported by various researchers (Dintiman & Ward, 2003; Chu, 1998; McNaughton, 1988; Hancock, 1993; Othersen, 1992; Delescluse, Van Coppenolle, Willems, Van Leemputte, Diels & Goris, 1994; Jacoby & Fraley, 1995; Fulcher & Fox, 1998). The development programme did not improve abdominal muscle power, probably due to the insufficient intensity of the exercises or that the frequency and period of training was too short. Improvement in muscle endurance as depicted by the maximum number of sit-ups can be attributed to the 10 week development programme, since no improvement occurred in the muscle endurance of the control group. The control group showed a significant decrease in muscle endurance, which can be attributed to the lack of training. The literature indicates that training frequency of at least three times per week is necessary to improve muscle endurance (Wilmore & Costill, 2004; Howley & Franks, 2003).

Improved reaction time occurred in both the intervention and control groups. The improved reaction time in the intervention group can possibly be attributed to the exercises done during the development programme, noting that the improvement is considerably larger than that of the control group. Speed showed a statistically significant improvement in the intervention group which can possibly be ascribed to the development programme, as no improvement was found in this regard in the control group.

The development programme had a positive influence on speed endurance, as indicated by the statistically significant decrease in the intervention group's time in the 150-metre speed endurance test compared to no improvement in the control group. This result is supported by Dintiman and Ward (2003) and Schmid and Alejo (2002) who reported that speed endurance can be improved by means of pick-up sprints, hollow sprints, fartlek and interval exercises.

A reduction was found in the stride length of the intervention group. It can probably be ascribed to the significant improvement in acceleration, since the faster movement associated with acceleration is reported to cause a reduction in stride length (Van Holmes, 2005).

The improvement in reaction time in the intervention group is also attributed to the development programme, noting that no improvement was recorded in the control group.

Conclusion

From the results of this study, it is clear that a 10-week intervention programme could be applied successfully in practice to improve the motor abilities important for successful participation in sprinting and long jump among 10 to 15-year old girls in disadvantaged communities. However, sprinting ability benefited from the programme to a lesser degree. This coud be ascribed to different reasons. The programme could, consequently, be improved through slight adjustments with regard to abdominal power, speed, stride length and acceleration. With regard to long jump, more time can be devoted to explosive power and leg power, while additional and/or more sport-specific exercises for improving speed can be implemented in order to improve sprinting performance.

The results indicate that a 10-week programme presented twice a week for sport talent development is an effective method for the development of motor and physical abilities and skills that are important for performance in sprinting and long jump among talented 10 to 15-year old girls, despite poor socio-economic circumstances and a deprived environment. Learners attending farm schools do not usually have the opportunity to participate in sport development programmes after school which can be ascribed to limited time or the lack of teachers' willingness and or ability to coach after school. This intervention programme can, however, be successfully applied during school hours and teachers at farm schools should be empowered to make such programmes sustainable in farm schools.

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