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THE EFFECT OF BACKWARD TRAINING ON THE SPEED, AGILITY AND POWER OF NETBALL PLAYERS

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ABSTRACT

This study investigated the effect of a backward training programme on the speed, agility and power of well-trained netball players. Seventeen women club netball players (aged 19 – 20 years) were divided into an experimental (n=10) and a control group (n=7) and participated in a six-week backward (BW) and forward (FW) training programme after the competitive season. Before and after the intervention, all the subjects completed the following tests: agility-505 test, agility-T, ladder-test, sprint test (5, 10 and 20 meters) and a vertical jump test. The experimental group showed a statistically significant improvement in the agility-505 test, both for the right leg (p=0.03) and left leg (p=0.03), the agility-T test (p=0.01), as well as the ladder-test (p=0.001). No statistically significant differences were found between the experimental and control groups with regards to straight-line speed and leg power. Although it is not uncommon for coaches to include backward running exercises in the conditioning programmes of team sport players, the actual value of this type of training may have been underestimated in the past. Our findings suggest that netball specific exercises, performed backwards, can be successfully included in the conditioning and skills training programmes of team sport players.

Key words: Backward training; Netball; Fitness.

INTRODUCTION

The demands of international sport is such that coaches and trainers constantly have to evaluate their training and conditioning methods to optimize the performances of players and stay ahead in their game. It is therefore not uncommon that coaches sometimes try various combinations of training methods or even unorthodox methods so to develop sport-specific fitness components, such as speed and agility.

A variety of training methods have been described in the literature to improve speed, agility and leg power. These include heavy resistance training (Wilson *et al*., 1996), explosive type resistance training (Adams *et al*., 1992), vibration training (Cardinale & Bosco, 2003), plyometric training (Markovic *et al*., 2007), interval training and sport-specific drills. Many sports, such as tennis, hockey, volleyball, soccer and netball, require powerful, multi-directional movements, i.e. in a lateral-, backward- and forward- movement in an open environment. It is therefore not too farfetched to include backward (BW) training in conditioning programmes. To change direction with speed and precision also needs a high level of leg power, balance and coordination and these qualities have all been suggested to improve with BW locomotion training (Bates & McCaw, 1986).

The inclusion of backward walking and running in training programmes has been suggested for a number of reasons. Originally, Flynn and Soutas-Little (1993, 1995) suggested that it may be useful for the rehabilitation of injuries in the lower extremities due to the lower compressive forces on the knee and hip joint. Consequently, others have found that backward running exercise have a positive effect on cardiovascular fitness levels (Flynn *et al*., 1994; Myatt *et al*., 1995; Terblanche *et al*., 2005) and may be more beneficial in the improvement of body composition, than traditional forward (FW) training alone (Terblanche *et al*., 2005). To date, the effect of a backward training programme, with the aim to improve sports performance, has not yet been investigated.

Agility and speed are some of the major fitness components in netball because of the movement patterns inherent in the game (Steele & Chad, 1992). Players are required to perform repeated short runs, jumps, sudden changes in direction and quick stops and starts. Players must be able to adjust their speed to a variety of situations that involves an opponent and a ball. Netball training also aims to improve the player's ability to perform netball skills as fast and as accurately as possible. The player's ability to accelerate depends on increasing the quickness of limb movement, and this quickness has implications for the enhancement of speed (Brown *et al*., 2000). Therefore, the aim of this study was to determine whether a backward training programme could improve the speed, agility, and leg power of trained netball players.

METHODOLOGY

Experimental approach to the problem

The present study used a pre-post experimental design to compare the effectiveness of a forward and backward training programme to improve speed, agility and leg power in trained netball players. Players performed either a traditional (forward) programme of netball specific drills, or a similar programme in a backwards direction for six weeks. The study was conducted at the end of the competitive season. At this stage, the players' regular training sessions were reduced from five times per week, including matches, to three sessions per week of 40 - 60 minutes each.

Subjects

Seventeen well-trained women club netball players volunteered to participate in the study. These players represented teams who participated in the top league of the club netball competition in the Western Cape and Boland area (South Africa) and would be considered players of above average playing ability and fitness. The experimental protocol was approved by the Ethics Committee of the Faculty of Health Sciences of Stellenbosch University. All subjects were fully informed about the nature and the potential risks of the study. After the subjects were given a detailed explanation of the tests involved and the training programme, they gave their written, informed consent. None of the netball players reported any injuries or illness that could have influenced their responses to the test or the training programme. All players were familiar with the various speed and agility tests, as they performed these tests on a regular basis as part of their fitness evaluations. Players were randomly divided into the backward training group (BW, n = 10) and the forward training group (FW, n = 7).

Procedures

Pre-intervention testing was done five days after the subjects have played their final club match of the season, and post-intervention testing was done the week after completion of the training programme. The subjects did not take part in any intensive exercise either the day before, or the day of testing. The same test administrators conducted the assessments on both occasions. All tests were conducted on the same day on non-slip indoor netball courts. Players were dressed in netball attire and shoes for both testing sessions. All players performed a ten minute standardized warm-up before each testing session. The order of the tests for each testing session was as follows: sprint test, agility-505, agility-T, ladder-test, and lastly the vertical jump. The intraclass coefficient of correlation for all the performance tests was between 0.95 and 0.99. All tests were done in forward running mode.

Speed test

Timing lights (Swift Performance Equipment, Goonellabah, Australia) were used to measure the players' sprint speed. Timing gates were set at 0, 5, 10 and 20 meter intervals. The start and finish lines were marked with masking tape. Sprints were performed from a standing start with the toe of the preferred foot behind the starting line. Subjects were instructed to sprint with maximum effort past the finish line. Split times at 5 and 10 meters, and the final time at 20 meters, were recorded to the nearest 0.01 second. All players completed two trials and the fastest time over 20 m was used as the final result.

Agility-505 test

The 505-test was selected to measure netball-specific agility (Ellis & Smith, 2000). Timing lights were set up at 10 m from the starting line and 5 m from the turning point. Players assumed a standing start position at the start line and were asked to start the test when they were ready. The player was required to sprint from the starting line to the turning point, where she had to turn and then accelerate off the line back through the light gates. Players had to perform two trials turning on the left foot and two trials turning on the right foot. Time to the nearest 0.01 s was recorded and the fastest time for each foot was recorded as the final score.

Agility-T test

Semenick (1990) describes the T-test as "a measure for four-directional agility" to measure the ability to change directions rapidly without loss of speed. The T-test has been established as a valid and reliable method to measure linear to lateral agility (Pauole *et al*., 2000). The player started at the first cone, 10 meters away from the second cone. On command, the player sprinted to the second cone, touched the cone with her right hand and then shuffled sideways to the left to a cone 5 meters away. She touched the cone with her left hand, shuffled 10 meters to the right and touched the cone with her right hand. The player then shuffled to the left for 5 meters, touched the cone with the left hand and backpedaled to the starting line.

The timer stopped the watch when the player passed the first cone at the start. Players had to face the front at all times, were not allowed to cross the feet when shuffling and had to touch all the cones. Each player completed two trials and the best time was recorded to the nearest 0.01 s.

Ladder-test

Dintiman and Ward (2003) proposed the ladder test as a measure of quickness, more specifically the quickness of the lower extremities. The rope ladder with 20 spaces was placed on the floor. The timer started the stopwatch when the player's foot touched the ground between the first and second stick and stopped the watch when contact was made with the ground beyond the last stick. The better of two trials was recorded as the final score.

Vertical jump test

The vertical jump test, using a wall-mounted board, was used to assess explosive leg power (Ellis & Smith, 2000). The player stood with either her left or right side against the wall, with feet flat on the floor. The player chalked her fingertips, elevated her shoulder, stretched out her arm and hand closest to the board, leaving a mark at the height of the full stretch. This was the first height that was recorded. From a stationary, crouched position, the player leapt up as high as possible from both feet to touch the board. Three attempts were allowed. The distance between the initial mark and the highest jump was recorded as the final test score.

Training programme

The backward and forward group followed the same training programme of netball-specific speed, agility and quickness drills for six weeks, consisting of three sessions per week. The backward training group performed the drills backwards, while the forward training group performed the same activities in the forward mode. The drills were performed at maximum intensity and the recovery periods comprised of active phases of jogging and walking. The backward group performed the recovery activities backwards, while the forward group performed it in the forward mode.

The work-rest-ratio was between 1:5 and 1:3 and was controlled by organizing the players into groups (Murphy, 1998; Stewart, 2003). The duration of the sessions was 40 minutes each. The activities for each session were planned by the researchers, while all sessions were administered by a qualified provincial netball coach.

Statistical analysis

Descriptive statistics were calculated as mean $\pm$ SEM. Data were analyzed using a 2x2 ANOVA for repeated measures to test for differences between groups, with subsequent Tukey's post hoc analysis when appropriate. The changed scores, expressed as the percentage change between baseline and follow-up measures, were compared with Student's t-tests. Results were considered statistically significant if $p < 0.05$.

RESULTS

Table 1 depicts the physical characteristics of the participants, both before and after the 6-week intervention period. There were no statistically significant differences in age, stature and body mass between the two groups before the start of the intervention.

Table 1. **PHYSICAL CHARACTERISTICS OF NETBALL PLAYERS. VALUES ARE MEANS ± SD**

	BW training group (n = 10)		FW training group (n = 7)	
	Before	After	Before	After
Age (years)	19.6 ± 1.04	19.6 ± 1.08	19.7 ± 0.77	20.3 ± 0.95 *
Stature (cm)	171.3 ± 7.34	171.9 ± 7.81	169.07 ± 6.06	169.56 ± 6.16
Body mass (kg)	66.1 ± 13.76	65.8 ± 13.41	64.7 ± 7.54	64.3 ± 8.33

* p = 0.03

There were no statistically significant differences in agility between the BW and FW groups before the start of the training programme. The BW group showed a significant improvement in the agility-505 test, both for the right leg (3.3%; p = 0.03) and left leg (3.0%; p = 0.03). The improvement in the agility-505 test was significantly more than the 0.5% (right) and 1.3% (left) change in the FW group.

Table 2 shows that the BW group significantly improved their performance in the agility-T test (p = 0.01), as well as the ladder-test (p = 0.001) by 5% and 10%, respectively. In contrast, the FW group only managed a 2.6% and 1.9% improvement, respectively. The changes in the BW training group was significantly more than in the FW training group.

Table 2. **PERFORMANCE OUTCOMES FOR THE BACKWARD AND FORWARD TRAINING GROUPS. VALUES ARE MEANS ± SD**

	BW training group (n =10)		FW training group (n = 7)	
	Before	After	Before	After
505-Agility				
Left	2.67 ± 0.10	2.59 ± 0.19 *	2.68 ± 0.13	2.65 ± 0.11 #
Right	2.67 ± 0.09	2.58 ± 0.12 *	2.63 ± 0.11	2.62 ± 0.11 #
Agility-T	11.81 ± 0.70	11.24 ± 0.42 *	11.87 ± 0.80	11.64 ± 0.53 #
Ladder-test	3.29 ± 0.28	2.95 ± 0.18 *	3.14 ± 0.31	3.05 ± 0.21 #
Speed:				
5m (s)	1.17 ± 0.06	1.21 ± 0.02	1.15 ± 0.02	1.23 ± 0.02 *
10 m (s)	2.00 ± 0.09	2.05 ± 0.03	1.98 ± 0.03	2.07 ± 0.03 *
20 m (s)	3.50 ± 0.28	3.56 ± 0.07	3.47 ± 0.06	3.53 ± 0.06
Vertical Jump (cm)	39.8 ± 4.59	39.9 ± 1.56	37.0 ± 1.59	38.0 ± 2.66

(* Statistically significant difference in the before and after measurements of each group (p<0.05; # Statistically significant difference in the change scores of the BW and FW training groups, p < 0.05)

The comparisons of horizontal sprint speed and leg power between the BW and FW training groups are also shown in table 2. There was a decline in sprint speed performance in both groups following the training intervention; however, the decrease was significant for the FW group over both 5 m and 10 m. Similarly, there was a decrease in leg power performance of 0.3% and 2.7% for the BW and FW groups, respectively, although these changes were not statistically significant (p > 0.05).

DISCUSSION

This study is the first to compare the effectiveness of a BW and FW conditioning programme on the speed and agility of netball players. The results showed that a 6-week netball specific backward training programme significantly improved the agility of netball players, but had no effect on the horizontal run speed and leg power of the players. The improvements for the BW training group were significantly greater than the changes that were observed in the FW training group, who followed a conventional (forward) training programme.

It is recognized that team sport players should improve their aerobic capacity to maintain a high level of intensity throughout a netball game (Helgerud *et al*., 2001; Wisløff *et al*., 1998). However, Bloomfield (2007) suggests that the speed at which purposeful movements are executed is even of higher importance. Furthermore, in order to perform dynamic, skilled movements with speed and precision, players also need exceptional balance and coordination. It is for these reasons that we explored the use of a BW training programme. From a training perspective, it has been proposed that BW locomotion has a variety of benefits, including the facilitation of balance and coordination, promotion of a more erect posture during performance, development of a stronger foundation (i.e. improved muscle balance) upon which to improve performance and the facilitation of neuro-muscular function (Bates & McCaw, 1986). It is specifically the latter that is very important. If it is the objective to train players to be more skillful at faster speeds and with greater precision, then the neuro-muscular system must be regularly challenged with different recruitment patterns and different stimuli. We propose that novel BW training activities, incorporated into conventional training programmes, may therefore significantly facilitate the improvement of sport performance.

The major finding of this study was that BW training caused a significantly greater improvement in the agility of netball players compared to forward training. Craig (2004) proposed that agility training looses its effectiveness when the athlete learns to anticipate the next move. Therefore, when coaches always use the same agility drills, and these drills do not require the athlete to respond to directional orders, neural adaptation takes place and no further improvement in agility is noted. This is probably what happened to the FW training group. The players were all experienced and trained and they were used to the traditional netball agility drills. The BW training group, however, was challenged with a different movement pattern, where little coordination existed between the CNS signal and proprioceptive feedback. Different muscles were involved with the BW exercises and the central nervous system (CNS) had to re-learn which muscle fibers to stimulate, how many motor units to activate and how frequently to stimulate the motor units. It would therefore seem that the novelty of the BW agility exercises sufficiently stressed the neuro-muscular system which led to improvements in agility.

It is generally believed that sprinting is a fundamental component necessary for success in team-sport competition. In a sport such as netball, however, movements do not occur at a fixed pace, or for a fixed period of time or for specific distance. Therefore, although straight sprinting may be considered an important fundamental fitness requirement, it is not as important as the ability to change direction and to start and stop quickly with good postural control and balance. The short duration of sprint efforts during team-sport competition means that acceleration rather than maximal velocity should constitute the majority of sprint training for team-sport athletes.

Young and Pryor (2001) analyzed the relative importance of different muscle groups to short sprint (10 m) and maximum speed sprints and concluded that the quadriceps and gluteals are most important for short sprints, while the hamstrings are the important muscle group for maximum sprints. BW locomotion is characterized by reduced eccentric function, but increased isometric and concentric activity of the quadriceps muscle (Flynn & Soutas-Little, 1993; Flynn & Soutas-Little, 1995; Vilensky *et al.*, 1987). The muscles of the lower limbs are also active for a longer period during BW locomotion, compared to FW locomotion (Flynn *et al.*, 1994; Kramer & Reid, 1981). This may explain the findings of some reports that BW running enhances quadriceps strength and power (Mackie & Dean, 1984; Threlkeld *et al.*, 1989), although this is not a universal finding (Anderson *et al.*, 1997; Terblanche *et al.*, 2005). It is possible, however, that the training programmes in the latter two studies were not of sufficient duration and/or intensity to induce significant increases in muscles strength. Therefore, it would make sense to include specific exercises that target the quadriceps to improve short sprint ability in netball players.

In light of the explanation above, it was an unexpected finding that BW training did not improve the leg muscle power (i.e. vertical jump performance) and the sprint speed of the netball players. Several reasons may explain this finding. Firstly, our training programme may have been too short, but since our training programme formed part of the post-competition conditioning of the netball players, we were restricted to six weeks. Secondly, the programme may not have included enough sprint and jumping exercises and, together with the short duration of the programme, the programme was therefore ineffective to induce changes in these two fitness components. However, it must be remembered that BW locomotion is associated with a much higher metabolic cost than FW locomotion (Flynn *et al.*, 1994; Williford *et al.*, 1998). Myatt *et al.* (1995) suggested that backward walking requires 38 – 199% more energy expenditure than forward walking at the same speed. The BW training programme was therefore an extremely challenging task for the players and we could therefore not increase either the intensity or duration of the training sessions by too much over the six week intervention period.

A third reason for our finding may be related to the specific biomechanics of BW locomotion. Young and Pryor (2001) stated that the basic training requirement for speed is an increase in stride length and frequency. This is exactly the opposite of what BW training does. Although the latter promotes high stride frequencies, it is achieved through significantly shorter stride lengths in comparison to FW running (Vilensky *et al.*, 1987). BW running training is therefore, strictly speaking, not conducive to improvements in straight running speed. On the other hand, the shorter steps during BW training should promote "quick feet" and faster leg speed. Pauole *et al.* (2000) found that leg speed contributes significantly to the variability in agility (T-test score, $r = 0.48$, $P < 0.05$). This may provide further explanation for our positive findings with regards to the improvement in agility.

It is also possible that the vertical jump test was just not sensitive enough to detect small improvements in leg power. In this study, the vertical jump score of the backward and forward training groups improved on average by 0.1 and 1.0 cm respectively and with a small sample size of 10 and 7, respectively, it is unlikely that a statistical significant difference will be detected. Furthermore, Pauole *et al.* (2000) also questioned the criterion validity of the vertical jump as a measure of leg power and suggested that the Margaria-Kalamen stair test may be a better test of dynamic leg power.

Sprinting requires high force production, so strength and power training methods are almost universally advocated as a form of training to improve running speed (Delecluse, 1997). Seeing that our programme did not significantly improve the leg power of the players, this may also explain why their horizontal sprint times did not improve. However, it should be noted that players in the BW training group were able to maintain their 5m and 10m sprint speed after the competitive season, while there was a significant decrease in the speed of the FW training group. In practice this means that the effect of reduced training is less when performing BW exercise and therefore players will start the pre-competition phase of training at a higher level. Coaches will then be in a position to pick up the intensity of training at a faster rate and therefore gain significantly greater fitness and skill levels prior to the competitive season.

A number of studies reported only a small percentage of shared variance between straight sprint time and agility performance. For example, only 11% and 22% of common variance were reported for straight sprints and a soccer agility test (Buttifant *et al*., 1999) and the Illinois agility test (Draper & Lancaster, 1985). Similarly, Young *et al*. (2001) found a 22% shared variance between straight sprint speed and a complex sprint task with 5 sharp changes of direction at 100^{o} angles. These findings suggest that these two components of fitness, horizontal speed and agility, have little in common and are therefore independent physical qualities (Young *et al.*, 2001). It was therefore not a surprising finding that a straight sprint training programme improved horizontal run speed, but had no significant effect on agility performance (Young *et al*., 2001). Similarly, agility training caused significant improvements in agility performance, but no significant change in straight run sprinting. Our results follow a similar trend. Our training programme, both backward and forward, was more specifically designed to improve agility and quickness, and less so to improve running speed *per se*. Collectively, these findings emphasize the specificity of training and suggest that a conditioning programme should consist of specific drills and activities to improve both sprint and agility according to the requirements of the specific sport.

It is well known that players cannot effectively improve agility and quickness, if this is not accompanied by the maintenance of good body control. Therefore, the concomitant improvement in balance and coordination, together with the improvement in agility, is essential. Although we did not measure changes in balance and coordination in this study, we believe that the significant improvement in agility in this study may be partly explained by improvements in balance. When the players performed the backward exercises, they were facing the opposite direction of training. Kramer and Reid (1981) suggested that in this situation, much less reliance can be placed on visual cues and thus proprioceptive information becomes very important – more so than during forward exercise. Players had to exercise high levels of concentration and maintain a high level of awareness of their movements when performing the speed and agility exercises in backward mode. Furthermore, the reduction in the amplitude of hip movements during BW locomotion increases stability by minimizing the forward-backward displacement of the centre of gravity (Vilensky *et al*., 1987). This will also lead to improved balance, especially when individuals are challenged with various types of BW exercises over a period of time.

An additional advantage of BW training is that one can expect greater improvements in fitness levels, over a shorter period of time, compared to traditional FW training. We have shown previously that a six week BW walk/run training programme significantly improves economy of movement and endurance capacity in young women (Terblanche *et al*., 2005). Overall, a BW training programme can therefore be used to improve the fitness levels of players, but can also be tailored to improve sport-specific qualities, such as agility, balance and leg power.

PRACTICAL APPLICATIONS

The present study is the first to investigate the effectiveness of a sport-specific backward training programme on the speed, agility and leg power of netball players. We concluded that netball-specific agility drills performed backwards induce significant gains in agility and quickness, and help to maintain straight sprinting speed in trained netball players. Conditioning coaches are advised to incorporate BW training drills during the pre-competition, as well as competition phases of a periodized training programme, provided that they introduce the BW movements at a low intensity and speed until the players can comfortably execute the drills. Trainers should be aware of the fact that players may need slightly longer rest periods between BW training drills, as the metabolic cost of BW exercise is significantly higher compared to FW exercise. Furthermore, as we have shown previously (Terblanche *et al*., 2005), backward walk/run training results in significantly greater gains in cardiorespiratory fitness in netball players. Conditioning coaches may therefore also use backward exercise during pre-season training to boost the fitness levels of their players. The use of unorthodox training methods, such as backward locomotion, may help coaches and players to not only achieve superior results compared to FW locomotion training only, but also introduce more variety in training sessions.

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