



Efficacy of backward training on agility and quadriceps strength

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ARTICLE INFO

Article history:

Received: 10 October 2012;

Received in revised form:

20 November 2012;

Accepted: 5 December 2012;

Keywords

Backward walking,
Backward running,
Quadriceps strength and agility.

ABSTRACT

Objectives: To Study the efficacy of backward training program me on agility and quadriceps strength. **Design:** Pre Post test study. **Setting:** Jamia Hamdard University, **Participants:** 30 healthy university students (18 -25 yrs). **Interventions:** Subjects were randomly assigned into three groups (A,B and C). Group A (N = 10) performed backward walking (4 kmph), Group B (N=10) performed backward running(5.6 kmph) for 6 weeks (3 sessions per week) and Group C (N=10) was the control group. Before and after the intervention, all the subjects completed the following tests: agility- T test and measurement of quadriceps strength. **Outcome Measures:** Agility, quadriceps strength. **Conclusions:** The results of the study showed that both the backward walking and backward running improved the quadriceps strength after 6 week of training. In addition, while backward running was found to be effective in improving the agility performance, the backward walking group did not show significant increase .Control group showed no improvement in agility and quadriceps strength.

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Introduction

The World Health Organization had stated that overall physical inactivity is estimated to cause 1.9 million deaths and 19 million disability adjusted life years globally. The ACSM guidelines for physical activity of healthy adults recommended at least 30 minutes of moderate intensity physical activity on five or more days of the week or 20 minutes of vigorous exercise on three days of the week.¹

When walking backward, the leg not only reverses its direction of movement but it travels in the opposite direction along virtually the same path as in walking forward.²

Backward walking, as opposed to forward walking, reduces the compression forces at the patellofemoral joint and decreases the force absorption at the knee. This is mainly because of the reduced eccentric function of the quadriceps muscle.³

Both Vilensky et al⁴ and Kramer and Reid⁵ concluded that backward walking was associated with increased cadence and decreased stride.

The knee is the most common area of pain in runners, with the patellofemoral joint frequently the joint of dysfunction⁶. The quadriceps are active for a longer period of stance during backward running than during forward running.⁶

By enhancing balance and control of body positions during movement, agility theoretically should improve.

Elmarie Terblanche and Ranel E.Venter⁷ showed significant improvement in the agility after backward training.

Therefore, the purpose of this study was to determine the effects of backward training on agility performance and quadriceps strength

Methodology: A randomized selection of 30 male subjects was done. Subjects were recruited on the basis of voluntary participation through informed consent. Subjects were recruited from Jamia Hamdard University .All the three groups were recruited according to inclusion and exclusion criteria.

Inclusion criteria: Healthy young male, age group 18-25, normal BMI value.

Exclusion criteria: Any lower extremity injury in the past 6 months, any cardiac or metabolic condition, Subjects involved in any form of physical exercises for lower extremity for at least 3 months.

Samples were assigned to backward walking group, backward running group and control group randomly based on lottery method.

Chosen subjects were randomly allocated to the three groups, each having 10 subjects where group A (BWG) and group B (BRG) performed backward walking and backward running respectively on treadmill at 0% inclination.

Pre test measurement included measuring weight, height, computing BMI values from respective weight height data and all the dependent variables.

BMI = Body Mass (kg) ÷ Stature (m²)

Measurement of Quadriceps strength^{8,9,10}

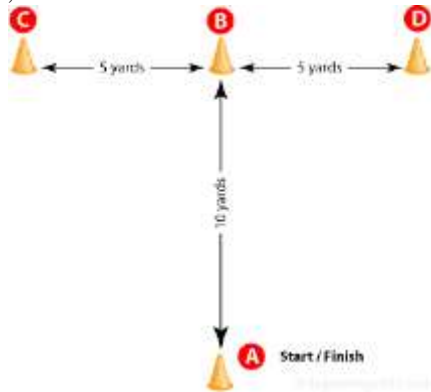
Subjects were seated on a chair to measure quadriceps strength. A restraining belt strapped around waist to minimize substitution .A non-extensible strap was placed around their lower leg just above the malleoli and the other end was attached to a strain gauge that was clamped onto the frame of the chair. The subjects were instructed to straighten their knee to attain 60° flexion: Isometric maximum voluntary contraction (MVC) was produced.

Measurement of Agility¹¹

The T-test was used to determine speed with directional changes such as forward sprinting, left and right side shuffling, and backpedaling.

Cones are placed (4.57 m and 9.14 m). The subject starts at cone A. On the command of the timer, the subject sprints to cone B and touches the base of the cone with their right hand. They then turn left and shuffle sideways to cone C, and also touch its base, this time with their left hand. Then shuffling

sideways to the right to cone D and touching the base with the right hand. At last they shuffle back to cone B touching with the left hand, and run backwards to cone A.



Averages of three readings were taken for analysis. All subjects were familiarized for backward walking or backward running as per their group. Group A (BWG) performed backward walking on treadmill and Group B (BRG) performed backward running on treadmill without any inclination. All subjects were required to complete 3 supervised 10 minute session without any inclination in the first week.

On the day of data collection, the treadmill was calibrated and adjusted to produce a speed of 4.0 kmph^{12,14} (0 % inclination). The subjects performed 3 to 5 minutes of lower extremity stretching and running in place¹⁵. The subjects were given 1 minute accommodation¹⁶ on treadmill followed by 6 minute of training¹⁷. The protocol used was Group A -backward walking , 4kmph, 3 sessions/week for 6 weeks
Group B- backward running , 5.6kmph,3 sessions/week for 6 weeks

Result: A total of 30 participant subjects were grouped in three groups of 10.

	Group1 backward walking	Group 2 Backward running	Group3 Control group
Mean age	24.30 ± 0.82years	24.10 ± 0.87	24.30 ± 1.05
Mean height	1.74 ± 4.02m	1.74 ± 3.56m	1.75 ± 5.97m
Mean weight	66.70 ± 5.65 kg	67.20 ± 6.17kg	68.70 ± 8.38 kg

Table 1. Demographic data of three groups

The p values indicated no significant difference between these groups on baseline demographic characteristics including age, weight and height

The comparison for within group significance was done using Paired sample 't' test for three groups. Pre- post measurements were compared for each outcome measure of quadriceps strength and agility

	QS Pre Test Value	QS Post Test Value	Paired t test
	Mean ± S.D	Mean ± S.D	'p' value
Group 1	17.43 ± 3.66	18.52 ± 2.87	0.018*
Group 2	18.01 ± 4.72	19.77 ± 4.89	0.00*
Group3	17.48 ± 2.70	17.52 ± 2.72	0.669

Table 2. Quadriceps strength pre post readings in 3 groups

In within group analysis(table 2) of group 1, mean value during post test significantly differ from the pre test values.

In within group analysis(table 2) of group 2, value during post test significantly differ from pre-test values (p = 0.00).

In within group analysis(table 2) of group 3, value during post test did not significantly differ from pre-test values (p = 0.669).

In within group analysis(table 3) of group 1, mean value during post test significantly differ from the pre test values. ('p' value =0.022).

	AG Pre test value	AG Post test value	Paired t test
	Mean ± S.D	Mean ± S.D	'p' value
Group 1	13.00 ± 0.734	12.69 ± 0.608	0.022*
Group 2	12.43 ± 0.778	11.95 ± 0.883	0.003*
Group 3	13.67 ± 0.769	13.58 ± 0.719	0.199

In within group analysis(table 3)of group 2, the mean value during post test significantly differ from the pre test values. ('p' value =0.003)

In within group analysis(table 3) of group 3, the value during post test did not significantly differ from pre-test values (p = 0.199) .

When all the three groups were compared using ANOVA, it was found that there was statistically significant difference ('p' value = .001) in quadriceps strength values.(table 4)

	Group 1 Mean ± SD	Group 2 Mean ± SD	Group 3 Mean ±SD	'p' value
Pre-Post Difference QS	1.09± 1.196	1.75± 0.965	0.03± 0.257	.001

Table 4. Between group analysis of difference in QS of three groups

After doing ANOVA, Post Hoc analysis was done to do comparisons between different groups. When group 1 was compared with group 3, it was found that there was statistically significant difference ('p' =.037) in quadriceps strength values .

When Group 2 was compared with group 3, it was found by post hoc analysis that there was statistically significant difference ('p' =.000) in quadriceps strength values.

When Group 1 was compared with group 2, it was found that there was no statistically significant difference ('p' =.189) in quadriceps strength values.

When all the three groups were compared using ANOVA, it was found that there was statistically significant difference ('p' value = .034) in agility values. (table 5)

	Group 1 Mean ± SD	Group 2 Mean ± SD	Group 3 Mean ± SD	'p' value
Pre-Post difference AG	0.312±0.357	0.475±0.362	0.086±0.196	.034

Table 5. Between group analysis of difference in AG of three groups

When group 1 was compared with group 3, it was found by post hoc analysis, that there was no statistical significant difference ('p' = .261) in agility performance values.

When Group 2 was compared with group 3, it was found that there was statistically significant difference ('p' value = .008) in agility performance values.

When group 1 was compared with group 2, it was found post hoc analysis, that there was no statistical significant difference ('p' = .489) in agility performance values.

Discussion

The study reported significant difference in quadriceps strength for both the training. In contrast, pre post analysis which is before and after 6 weeks of intervention on agility for backward walking revealed that the results were not statistically significant. The improvement in agility was found significant in backward running group. In contrast backward walking showed

some mean improvement after 6 weeks intervention which was statistically insignificant.

The study reported statistically significant increase in quadriceps strength (p value ≤ 0.05) for backward walking and backward running group.

The data clearly indicated that backward training benefitted to improve quadriceps performance.

Several reasons have been postulated for the improvement seen in quadriceps strength. Firstly, novel tasks required a larger number of motor units to be recruited, which resulted in increased energy utilization because backward walking/running was a novel task for most individuals, increased motor unit recruitment would result in a greater amount of skeletal muscle activation compared with equivalent familiar task¹³. Schwane et al¹⁸ had reported that a relatively new motor task increased motor unit recruitment, thus increasing the metabolic cost of the activity.

Threlkeld et al¹⁵ concluded that backward running had a shorter stance time, a similar swing to stance ratio, the maximum vertical force (Fzmax) and the vertical impulse (FzimP) in runners over 8 week program.

Flynn et al³ compared selected EMG and kinetic parameters in the stance phase of forward running (FR) and backward running (BR) during three trials of FR and BR in six male subjects. Lower peak power occurred during BR than FR and greater peak power and total work occurred at the knee in FR than during BR. The last 50% of stance in BR had a large positive power burst. The quadriceps remained electrically active into this phase, particularly the vastus medialis. This finding suggested the quadriceps was acting concentrically for power generation. Muscle action of the Vastus medialis oblique and vastus lateralis were described as primarily isometric and concentric during BR and eccentric and concentric during FR. It was also concluded that backward training might be useful in clinical conditions that require an increase in knee extensor strength.^{3,6}

It was stated that peripheral muscle requirements were different during backward walking than forward walking. During backward walking, the quadriceps group worked isometrically as a knee stabilizer and concentrically as an accelerator.^{3,4,5}

In a backward running, EMG analysis showed 22 % increase in duty cycle of hamstrings during stance phase as it contracts eccentrically.³ The knee flexors tend to be reciprocally co-activated with knee extensors in BW gait, whereas they are roughly co-activated in FW gait.¹⁹ Holocomb WR et al²⁰ studied the effect of hamstring-emphasized resistance training on hamstrings : quadriceps strength ratios. Subjects then completed 6 weeks of strength training that included the addition of 2 hamstring specific exercises, followed by a posttest. The peak torque for concentric and eccentric contraction (quads and hamstrings) increased to 1.08 +/- 0.11 in posttest These results suggested strength training that emphasizes hamstrings is sufficient to significantly increase the functional ratio. This is recommended for prevention of ACL injuries. Therefore, quadriceps and hamstrings ratio does not get disturbed.

In this study, it was analyzed that there was significant improvement in agility performance in backward running group than in backward walking. This could be explained by several following reasons.

According to the principle of specificity of training²¹, the adaptation that the body makes to exercise loads (training effect)

one to a large degree specific to the structured and functions that are loaded.

The components of agility training are strength, body control and awareness (balance), recognition and reaction; starting and acceleration speed, complex footwork, dynamic flexibility and change of direction.^{22,23,24}

As running was performed at higher speed, it had more positive effect on agility of the person when compared to backward walking which was done at slow speed.

Backward running as compared to walking gives more proprioceptive input for body control and awareness. Thereby increasing balance which helps to improve agility. Collardeau M et al²⁵ reported that a simple cognitive performance could be improved during exercise, despite the negative effect of the dual task. This improvement in reaction time could be explained mainly by an increase in arousal induced by a prolonged exercise.

Sarah Clary et al²⁶ examined the effectiveness of 13 wks of Ballates training, step aerobics and walking, on balance. Step aerobics and walking programs resulted in better improvements in static balance when compared to the Ballates program .Therefore balance might have improved significantly for the backward walking group if the training period was longer.

Strength and Agility training are important aspects of conditioning program for a sports person. This study showed a significant improvement in quadriceps strength and agility.

Future studies can take the use of proper laboratory set up and instruments like isokinetic dynamometer may be used.

Conclusion:

The results of the present study showed that both the backward walking and backward running improved the quadriceps strength after 6 week of training. However, the improvement in backward running was found to be much more than backward walking group. The control group showed no significant changes in quadriceps strength.

In addition, while backward running was found to be effective in improving the agility performance, the backward walking group did not show significant increase in agility performance.

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