

The effect of

speed change in uphill on some biomechanical parameters and physiological Variables of the 10 km men's walker

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Introduction

The purpose of this study was to examine the physiological and biomechanical changes occurring in a subject after Three months (POST) training on the program. Sample 6 trained male competitive walkers volunteered as subjects for this study, 3 training sessions on uphill (treadmill with angel of 2, 3, 5, for speed sessions) Applied per week plus 3 training sessions on a track. Pre test at 13-14 /2/2011, start the program at 18/2/2011 until 9/6/2011 and post test at 8-9/6/2011, The investigating period was in the pre competition season, The investigation included an aerobic training and an aero-anaerobic training program for 3 months . To control the metabolic cost, Hart rate, VO2max, Vital capacity and the blood lactate concentration was determined. Data Analysis: Use Dartfish v4.5 program to calculate angel of support, angel of attack, angel of

push and stride length . Statistical analyses. Z-tests were used to compare the differences between pre- and post-training and Correlation coefficients between biomechanical and physiological variables with Performance time, probability level of 0.05 was accepted as significant. The physiological parameters which changed significantly after training program were improved vital capacity which proves the economy of walking performance technique, improved $\dot{V}O_2$ max, and blood lactate level. The uphill improves angle of push, angel of attack, angel of support for subject of the research, contributes in the improving of performance technique and performance time for walkers.

Introduction:

Generally There are two techniques of walking adopted by most of the race walker Mexican style and European style. The Mexican style of walkers have high frequency and low stride length and their single support start with heel sole of the foot. The front support phase is almost performed flat footedly. The knee is also bent at contact time. While arms action are also restricted at angle slightly above the waist level. The hip tilt is very less while center of gravity is also very low.

The definition of speed walking has been changed three times during the recent 15 years, which has certain influence on its technique. The first change brought about the revolution of technique, producing the modern high-speed walking technique. The second change just stayed at the change of writing, which had no influence on technique. The third change had also no influence on the "stride" walking technique. The forecast of the future development of walking speed technique was made. High-speed walking will also be the developing direction of walking speed technique in the future.

Due to the nature of the race walking movement which is characterized by difficulties in the movement of the pelvis either to the front, back, up or down, as well as the alternative movement of the shoulders with pelvic to the front, back, up and down, and also the movement of knees during the support phase which required full extension of the knee joint as well as the attack angle and support of the foot. Race walking also requires efficiency of the Cardio vascular system to endure the race distance and perform without losing either the performance level or record level which is crystal clear when observing many national and international competitions when an athlete is subjected to disqualification from the race because of the violations caused by a defect in motor performance or as a result of decreasing in the physiological efficiency of the athlete which may lead to violate the rules and get disqualified.

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Therefore, we can say that each stride is divided into two phases until one foot reaches its initial position. When analyzing the movement of walking, we find that the athlete is in the support phase on one of his foot, followed by a forward swing movement of the lead leg so that the lead leg lands on the ground. At this moment, the feet land on the ground then the rear foot push to support on the front foot. It is noted that we can see with the naked eye that the support duration lasts longer than the swing phase due to the long duration of support phase. (27:108)

We find that the feet of the race walking athlete, during walking, are on a permanent contact with the ground either with one foot or feet together. If we analyze the walking movement from the motor side, we find that it consists of several cycles, continuously repeated during the progress of the athlete while each cycle is divided into two motor phases

confined between two similar positions, where each position is intervene with a series of successive movements.

The average frequency of an average individual is 115 to 125 strides per minute, and thus foot support vary from double to three times of the duration of foot support while the average speed of race walking athlete is up to 190 to 200 steps so the feet support period is reduces or may disappears and turn into flight process as in the case of running events. (27: 109) (22: 175)

The arms and shoulders movement play an important role in the progressing of race walking, thus the race walking coaches should take care of the exercises of the upper part of the body beside the lower part, especially on weightlifting exercises. (21: 110, 111)

VO_{2max}. well-accepted concepts (Bassett & Howley, 2000) have emerged related to endurance exercise performance velocity and the first component issue is the level of aerobic metabolism that can be maintained during a race . This is usually achieved during relatively large muscle group exercise and represents the integrative ability of the heart to generate a high cardiac output, total body myoglobin, high muscle blood flow and muscle oxygen extraction, and in some cases the ability of the lungs to oxygenate the blood (Bassett & Howley, 2000)(4).

The heart rate is the best physiological measurements to determine the physiological response during training and one of the vital signs which regulate the intensity of training and rest periods. (15:109) (19: 43)

Coaching is one of the sciences that take care of the preparation of the athlete from the physical, physiological and psychological aspects to reach the highest levels and to obtain top places in the international championships.

Both "Mohammad Hassan Allawi and Abul Ela Ahmed Abdel Fattah" (1984) indicated that the regulated training lead to physiological changes on all organs of the body and leads to the progress of the level of athletic performance whenever it is positive (12: 24 - 27).

Throughout the experience of the researcher as a former international athlete and a current coach of the research sample in 10 km race walking, so the researcher design regulated training programs for the athletes in order to improve the Race Waking Technique (foot placement, angle of attack for the foot, angle of Support, angle of push and stride length, as well as the walking economy (race pace)), Performance time, beside identifying the impact of the regulated training program on some physiological Variables of the athlete who is the research sample.

Objectives:

The research aims to design a training program for 10 km race walking athletes to identify the following:

1- The effect of the suggested training program to develop of some biomechanical parameters (angle of attack, push, support stride length, efficiency - performance).

2- effect of the suggested training program on developing of the performance level.

3- The effect of the suggested training program on development of some physiological parameters (Hart rate - the maximum oxygen consumption (VO_{2max}) - blood lactate – Vital Capacity).

Research Questions:

1- Does the suggested training program affect the development of some biomechanical and physiological changes?

2- Does the suggested training program affect the development of the performance?

Methodology:

Data Collection: Subjects. 6 trained male competitive walkers volunteered as subjects for this study 3 training sessions on up hill (treadmill with angel of 2, 3, 5 Degree, for speed sessions) Applied per week plus 3 training sessions on a track. Pre test at 13-14 /2/2011, start the program at 18/2/2011 until 9/6/2011 and post test at 8-9/6/2011, The investigating period was in the pre competition season, which include an aerobic training and an anaerobic training program for 3 months .All athletes were given the order to preform compliant to the competition rules. Further more, to control the metabolic cost, Hart rate, VO_{2max} , Vital capacity and blood lactate concentration were calculated. Data Analysis: Use Dartfish v4.5 program to calculate stride length, angel of (support, attack and push). Statistical

analyses. Z-tests were used to compare the differences between pre- and post-training and Correlation coefficients between biomechanical and physiological parameters according to time Performance, probability level of 0.05 was accepted as significant.

Table (2)

Physiological Parameters of post-training sessions

Measurement	Rest		after effort	
	Mean	± SD	Mean	± SD
Hart rate (p/m)	67.43	±4.32	160.65	±5.65
Blood Lactate Concentration (mmol/L)	1.63	±0.37	5.17	±0.43
	Pre		Post	
VO _{2max} (ml kg ⁻¹ min ⁻¹)	51.24	±4.55	57.66	±4.56
Vital capacity (L)	3.70	±0.52	4.23	±0.59

Results And Discussion

Table 2 & 3. The results indicate heart rate as shown, that average pulse rate at rest 67.43p/ m and average pulse rate after effort 160.56 p/ m, decrease of blood lactate levels is due to that the suggested training program contributed in the increasing efficacy of cardiovascular and muscles, increasing disposing of lac-

Table (1):

Physical characteristics of the subjects

Measurement	Mean	± SD
Age (years)	17.50	1.527±
Height (cm)	196.00	3.61 ±
weight (kg)	57.77	± 7.47

tic acid accumulated during performance .This comply with results of Drake, A., Cox, V., Godfrey, R., Brooks, S. (2005) (11) "Salem Hassan Salem"1996"(25) "Atef Sayed Ahmed"(1999)(2) "Osama Ibrahim Hassan"(1999)(23) "Atef Sayed Ahmed"(2003)(3) as they mentioned that sports training affects on capacity of cardiovascular system, capacity of lungs, improving level of movement and time performance.

Table (3):

Deference Between pre- and post-training sessions for physiological Parameters

Measurement	Ranks	N	Mean Rank	Sum of Ranks	Z	P
Blood Lactate Concentration (mmol/L)	-	0	0.00	0.00	2.201*	.028
	+	6	3.50	21.00		
VO _{2max} (ml kg ⁻¹ min ⁻¹)	-	0	0.00	0.00	2.201*	.028
	+	6	3.50	21.00		
Vital capacity (L)	-	0	0.00	0.00	2.207*	.027
	+	6	3.50	21.00		

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The results indicated that training sessions has led to increase efficacy of cardio vascular system as percentage of improvement vital capacity has reached (14.40%), VO_{2max} (12.54%) after applying program which indicate increasing the physiological efficacy which contributed in the improving of their achievement record. "Khairiah Ibrahim El syokary Mohamed El sayed Abed elhalim,(1997)(18: 155-153) Yoshida, T., Udo, M., Chida, M., Ichioka, M., Makiguchi, K., & Yamaguchi, T. (1990) (31) as they mentioned that VO_{2max} is one of important influencing parameter in results of long distance competitions specially walking as it depends on aerobic capacity, efficacy of cardiovascular system and VO_{2max} is affected by training, as more elevated the level of the better VO_{2max} results.

Table (4):

biomechanical parameters post-training sessions

Measurement		Pre		Post		$\Delta\%$
		Mean	SD	Mean	\pm SD	
Angel of Support (Degree)	R	26.17	± 4.70	32.44	± 1.98	23.96
	L	28.23	± 6.11	32.68	± 1.25	15.76
Angle of push (Degree)	R	57.41	± 2.10	61.89	± 0.72	7.80
	L	56.72	± 3.28	61.31	± 0.97	8.10
Angle of attack (Degree)	R	68.16	± 1.64	72.36	± 0.42	6.16
	L	68.44	± 1.07	72.34	± 0.49	5.71
stride length (m)		1.45	± 0.10	1.88	± 0.16	29.43
Race Pace (m:min)		3.22	± 0.32	3.54	± 0.29	9.82
Performance time (m:s)		49.34	± 1.35	48.05	± 1.27	2.61

Table (5):

The deference between pre- and post-training sessions for biomechanical parameters

Measurement	Ranks	N	Mean Rank	Sum of Ranks	Z	P
Angel of Support (Degree)	R	-	0	0.00	2.207*	.027
		+	6	3.50		
	L	-	0	0.00	2.22*	.026
		+	6	3.50		
Angle of push (Degree)	R	-	0	0.00	2.201*	.028
		+	6	3.50		
	L	-	0	0.00	2.201*	.028
		+	6	3.50		
Angle of attack (Degree)	R	-	0	0.00	2.201*	.028
		+	6	3.50		
	L	-	0	0.00	2.201*	.028
		+	6	3.50		
Stride length (m)	-	0	0.00	0.00	2.22*	.026
	+	6	3.50	21.00		
Race Pace (m:min)	-	0	0.00	0.00	2.201*	.028
	+	6	3.50	21.00		
Performance time (m:s)	-	6	3.50	21.00	2.201*	.028

Table (6):

Correlation coefficients (r) The relationship between 10 km performance and biomechanical and physiological Parameters

Measurement	r ²
Hart rate (p/m)	0.754
Blood Lactate Concentration (mmol/L)	0.571
VO _{2max} (ml kg- min)	0.843*
Vital capacity (L)	0.857*
Angel of Support (Degree)	R 0.912*
	L 0.956*
Angle of push (Degree)	R 0.730
	L 0.843*
Angle of attack (Degree)	R 0.886*
	L 0.861*
stride length (m)	0.828*
Race Pace (m:min)	0.989*

Table 4 &5 .The results indicate to training using uphill (use 2, 3 ,5 degree) during speed sessions has led to improve angel of support, attack, and push to get them almost to an angel which enable them to move smoothly. This comply with what has been mentioned by “Talha Hossam El din and others”(1998)(28 : 203) as he mentioned that amount of the produced movement is descending when power is in opposite direction of movement, while it is ascending when produced power is in correct direction of movement, This comply with what has been mentioned by “Talha Hossam El din and others”(1994)(3 :101) “Burkett,

B., Smeathers, J. and Barker, T. (2003) (8) that moving forward depend on offering sufficient and enough pushing for movement.

This differences may be due to that subject of the research used up hill (different angels) to improve pushing and amount of produced movement from ankle joint to increase feet pushing, helps in increasing muscular power for gastrocnemius muscles, it also increases time of feet pushing which helps the athlete to increase moving speed, also increase moving range of the joint. This comply with what has been mentioned by "Atef Sayed Ahmed" (1999) (2) in developing muscular power of muscles that help in elevating achievement record of walker, This comply with what has been mentioned by "Salem Hassan Salem" (2002) (Atef Sayed Ahmed) (2003) (3) "Gagnon J.L. (1997) (14) in improving movement performance of walking, improving body angels which led to improve technique of race walking.

The improvement of technique has led to improve performance time and race pace which indicate to increasing efficiency. This comply with (Drake, A., Cox, V., Godfrey, R., Brooks, S. (2005); Maggio, Nicola, (2008), Williams KR (2007) (30), Zifchock, R.A., Davis, I. and Hamill, J. (2006) (13)

Table 6. There was correlation between performance race walk and parameters analyzed. VO_{2max} and Vital capacity had statistically significant correlations ($p < 0.05$), however VO_{2max} is strongly affected by race walking economy (Bassett and Howley, 2000, Saunders et al. 2004) (4) so it may be unwise to dismiss importance of VO_{2max} in the other athletes. VO_{2max} has been found to increasing about 12.54 % in athletes following endurance training, highlighting large genetic component to this measure (Bouchard et al. 1999) (5), largely via its economy component. The efficacy of investigating training response, VO_{2max} to race walking training is worthy of research; moreover the role of race walking biomechanics parameters in race walking economy warrants investigation despite no correlations between race walking performance and economy in the present studies.

There was correlation between performance race walk and parameters analyzed angle of support, attack and push, stride length and race pace for performance had statistically significant correlations ($p < 0.05$) so that component importance to Vertical oscillation of center of mass Explained 19 % of variance in race walking economic (Drake, A., Cox, V., Godfrey, R., Brooks, S. (2005) (11)

Conclusion

- ✓ The parameters which changed significantly after training program were improved vital capacity which proves economy of walking performance technique, improves VO_{2max} , blood lactate level and vital capacity .
- ✓ Use of uphill (different angels) improves angle of push ,attack, support for subject of research, contributes in improving of performance technique for walker.
- ✓ The maintenance of efficient walking technique is crucial to successful racing performances and the reduction risk of injury.
- ✓ In competition, race walker have to demonstrate ground contact and knee straightening stable, although the coordination of the body segments varies comes from optimal technique for race walking.

Recommendations:

- ✓ A correct race walking technique permits to integrate physiological aspects with energy cost (economy race walking).
- ✓ The training program must be include an aerobic training and an anaerobic training session .
- ✓ Use strategy in the race depend on pace to get performance time .
- ✓ The optimal technique is crucial to successful racing performances and reduction the risk of injury.
- ✓ Use of uphill with a different angels to improve angle of push ,attack, support with speed.

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