A Comparative study biomechanical differences between Egyptian and international race walkers 20 km men

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Introduction :

Race walking form part of the athletics program in the Olympic Games and all major athletics championships. Arcelli E (1996), race walking is an abnormal form of gait with rules that dictate that no visible loss of contact should occur and that the knee should be straightened from first contact with the ground until the ‘vertical upright position . (IAAF Competition rules (2013).

In race walking, the most important factor in competitive success is speed, although this is restricted by the two unique rules of race walking technique. At the most basic level, speed is determined by step, or stride, length and stride frequency.

According to IAAF Rule 230.2, “ Race walking is a progression of steps taken so that the walker makes contact with the ground, so that no visible (to the human eye) loss of contact occurs. the advancing leg must be straightened (i.e. not bent at the knee) from the moment of first contact with the ground until the vertical upright position” . (IAAF Competition rules)

Because of the implications of this rule, previous research in race walking has focussed on the knee’s movement during the stance phase rather than during swing. However, the swing phase might also be affected by the rules of race walking, thereby having an influence on key kinematic variables such as stride length and making it different from distance running technique. (Donà G. et al 2009), HANLEY, B. et al (2011) .

the stride lengths of even the world’s best race walkers only range between 2.44 and 2.72 m (men). (HANLEY, B. et al (2008).

The swing phase is influenced by a number of variables, including joint angles and inertial properties of the segments, Knee flexion during

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the swing phase reduces the moment of inertia of the lower limb(MOI) . (Barrett RS, et al. (2007).

This is because a reduction in moment of inertia facilitates a faster and more efficient swing phase that increases cadence and speed .It is possible that this requirement means the race walker must avoid flexing the knee to an extent that a rapid reversal to full extension by initial contact could be problematic (due to the requirement for a high angular velocity of the knee during late swing that might lead to injury . (Chumanov ES, et al (2011) .

The maximum knee flexion angle during swing in race walking, with a range found between 87 and 108° (where the knee sagittal plane angle is considered to be 180° in the anatomical position). (Donà G. et al 2009) .

The straightened knee rule in race walking only applies during the stance phase, but it is possible knee kinematics during swing are also affected. While the knee swing angle in race walking has been measured in some earlier studies, its importance has not been established with regard to key performance parameters such as speed and stride length and further research is therefore warranted.

It was hypothesized that due to the rule of race walking, that (i) race walkers would experience less knee flexion during swing, and therefore have greater lower limb moments \of inertia; (ii) that race walkers would have shorter strides and shorter swing times; and (iii) that smaller leg moments of inertia would correlate with speed and cadence.

A Gait cycle has two step –a left step and right step. The basic spatial description of gait cycle include the length of a stride , the length of step, step width ,foot angle .Stride length is the distance between two successive heel contacts of the same foo. step length on the contrarily is the distance between successive heel contacts of the two different feet. The basic temporal descriptor of gait cycle is stride frequency (step rate) other temporal descriptor of gait cycle are stride time (time for the full gait cycle), step time (the time for the completion of a right or a left step) and walking speed (combines both spatial and temporal measurement). A full gait cycle for the right lower extremity can be divided into two major phases: stance phase include 60 % of gait cycle (from right heel contact to right toe off) and swing phase include 40% of gait cycle (from right toe off to the next right heel contact).In the normal walking the center of mass total vertical displacement 5 cm and total side to side displacement 4 cm during gait .(Donald A. Neumann,2010, pp631-637)

This study aims to a compare the biomechanical differences between Egyptian walker and international walker (men) 20 km. walking to improve the technique .

Methods

The Researcher analysed competitor's biomechanical Defiance in the 25th World Race Walking Cup held in Saransk, Russia, in May 2012. And the top First completed the race Walk in Egyptian competition at November 2013 in Cairo .

Video data of the player race walking were recorded. Two stationary cameras (Sony) were placed at the side of the course at approximately 45º and 135º to the plane of motion respectively; the sampling rate of The video data were digitised to obtain kinematic data using motion analysis software (SIMI Motion).

Sample :

The top First 3 completed the race Walk in Egyptian competition at November 2013 in Cairo , were analysed and their results are reproduced here And comparative differences with the result in the IAAF World Race Walking Cup ٢٠١٢ .

Table (1)

Race walking performance parameters (Age, Body Height and Body mass)

parameters	Egyptian		International	
	Mean	SD.	Mean	SD.
Age	24.33	1.53	28.67	0.58
Height	171.33	3.21	186.67	2.89
Mass	69.00	3.61	72.33	2.52

Data

The video data were analysed using motion analysis software (SIMI MOTION). Variables and gait events of interest were defined as follows:

- Velocity – the average horizontal velocity during one complete gait cycle,
- Stride length – the distance the body travelled between a specific phase on one leg and the same phase on the other leg,
- Stride length difference – the difference in length between right-to-left and left-to right strides,
- Stride frequency – the number of strides taken per second, measured in hertz (Hz),
- Contact – the first visible point during stance where the athlete's foot clearly makes contact with the ground,
- Toe-off – the last visible point during stance before the athlete's foot clearly loses contact with the ground,
- Midstance – the point where the athlete's foot was directly below their body's centre of mass, used to determine the 'vertical upright position' (IAAF rule 230.1).

Results :

Table (2)

Race walking performance parameters (Time , Speed , Stride length , stride frequency , contact time and push time)

parameters	**Egyptian**		**International**	
	Mean	**SD.**	**Mean**	**SD.**
Time (min.)	2.08	1.47	2.52	0.15
Speed (m/s)	0.52	0.04	0.33	0.02
Stride length	1.32	0.21	1.48	0.29
stride frequency	1.86	0.11	3.23	0.17
Contact time (s)	0.52	0.04	0.26	0.02
push time (s)	0.07	0.02	0.05	0.01

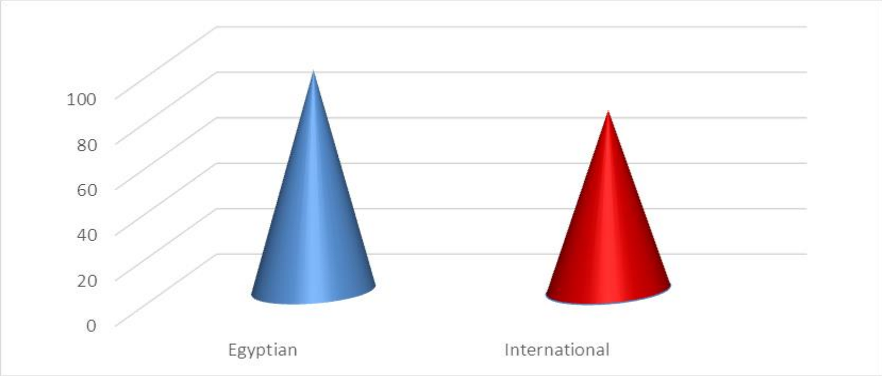

Figure 1 : Race walking performance Time

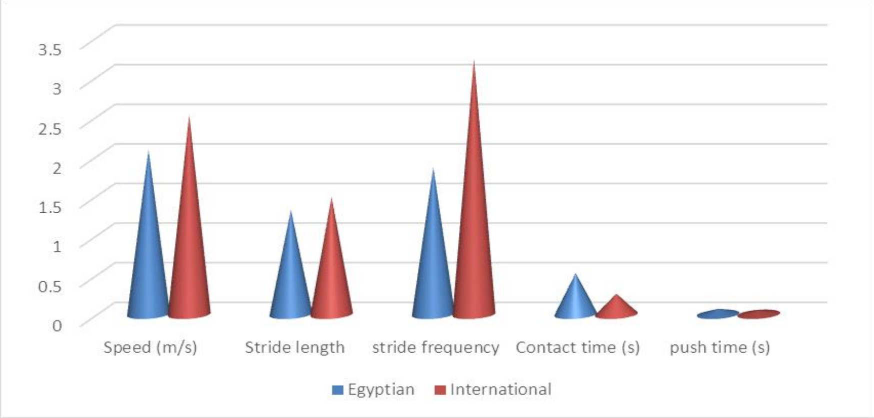

Figure 2: Race walking performance Speed , Stride length , stride frequency , contact time and push time .

Table (3)

Race walking performance Joints parameters (Knee, Ankle and Elbow)

Joints parameters		**Egyptian**		**International**	
		Mean	**SD.**	**Mean**	**SD.**
Knee	Contact	174.33	0.58	176.00	2.00
	Push	122.33	4.51	153.33	6.51
Ankle	Contact	95.67	4.04	87.67	3.06
	Push	138.33	7.64	142.67	3.06
Elbow	Contact	70.33	7.51	84.00	2.00
	Push	103.33	19.04	75.00	17.00

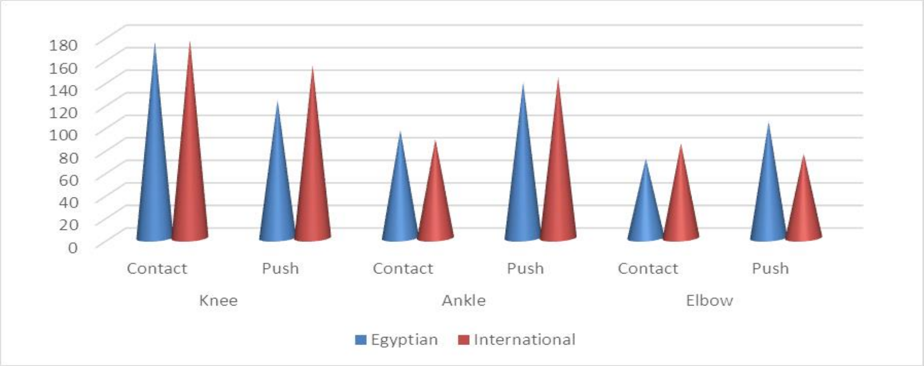

Figure 2: Race walking performance Joints parameters

Discussion :

The race walking performance parameters for athlete are shown Table 1. Race walking performance parameters (Time, Speed, Stride length, stride frequency , contact time and push time), The velocities recorded for the International player is better than Egyptian walker and all of the parameters in the 20 Km. race walking the averages of performance time for international walker is 1.19.28 h. but the Egyptian player recorded 1.36.86 h. .

The averages of performance speed for international walker is 2.52 m/s. but the Egyptian player recorded 2.08 m/s., the averages of performance Stride length for international walker is 1.48 m. but the Egyptian walker recorded 1.32 m. The averages of performance stride frequency for international walker is 3.23. but the Egyptian walker recorded 1.86,

The importance of stride length in fast race walking was also shown in the results found for the 20km men , in addition the positive relationship between stride length and stride frequency was underlined, Race walking velocity is the product of stride length and stride frequency . HANLEY, B.; BISSAS, A. & DRAKE, A. (2011), (hanley, b. & bissas, A. (2012).

The averages of performance contact time for international walker is 0.26 s . but the Egyptian walker recorded 0.52 s. and the averages of performance push time for international walker is 0.05 s . but the Egyptian walker recorded 0.07 s.

The race walkers are required to be as fast as possible but not so fast that they start running, The influence of walking velocity on rule adherence (keeping contact with the ground and the knee straightened) was investigated .

The distance to the support foot at toe-off is important in generating adequate stride length and forward propulsion (HOGA et al., 2003).

The race walking performance parameters for athlete are shown Table 2 Race walking performance Joints parameters (Knee, Ankle and Elbow and flight time), The averages of the knee joint angles at both contact 176.00 ° and push 153.33 ° for international player but the knee joint angles at both contact 174.33 ° and push 122.33 ° for Egyptian player .

The averages of the ankle joint angles at both contact 87.67 ° and push 142.67 ° for international player but the knee joint angles at both contact 95.67° and push 138.33 ° for Egyptian player .

The averages of the elbow joint angles at both contact 84.00 ° and push 75.00 ° for international player but the knee joint angles at both contact 70.33° and push 103.33 ° for Egyptian player .

Some walkers have exceptional mobility of the knee joint and are able to exploit this by hyperextending it during the support phase.

Most race walkers hold their elbows in whatever position feels comfortable but the best angle might not be adopted naturally . The comparable large variations for the elbow joint at toe-off were also caused by such large discrepancies between athletes. The fact that world-class race walkers can differ so greatly in appearance shows that there is little effect of the race walking rule on the arm’s movements (as there is on the legs) and that there is not just one successful technique . Race walkers generally hold and move their arms in balancing the movement of the legs but coaches should consistently observe their athletes in order to ascertain if arm swing is helping or hindering the legs' rhythm. (Brian Hanley (2013) .

Recommendation :

- The Race walkers should note that there is a limit on how much stride length can be increased before stride frequency is reduced to detrimental levels.
- The Race walkers can increase stride length which might be achieved through optimize longer flight times, to avoid disqualification.
- The Coaches and athletes should note that every race walker's technique is different.
- Emphasise the variations in upper and lower limb joint angles and each individual's strengths and weaknesses need to be identified to achieve their own optimal race walking technique.

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