# TIMES OF FLIGHT, FREQUENCY AND LENGTH OF STRIDE IN RACE WALKING

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## INTRODUCTION

Today's Competitive Race Walking requires the athlete to mantain a very high speed throughout the race, while abiding by the severe regulations, according to which the athlete is required to remain in contact with the ground at all times. The breaking of this regulation, according to the subjective and unquestionable judgement of a judge who mantains to have observed a "lifting phase", will lead to the immediate disqualification from the competition and to the uselessness of long periods of hard training.

Due to the obvious energy saving and speed gain that can be achieved through short flight phases, which nevertheless radically transform the mechanics of the movement from race walking into running, all too often athletes attempt to remain temporarily in flight or, at least, are unable to prevent themselves from doing so. The biomechanics of running, even with very brief flight phases, are correlated to kinematics laws totally different from those of race walking, permitting above all a major recovery of stored elastic energy, due to the omnipresent force of gravity, evolutionally integrated within the neuromuscolar pattern of running. The natural passage from walking to running, which normally occurs, for the precise scope of saving energy, at speeds above 3-4 km/h, is inhibited in this discipline, also due to the regulation regarding the straightening of the supporting knee, at speeds far superior to the above.

In order to determine if a top level athlete can race walk at today's race speeds without adopting lifting phases or, on the other hand, to measure the entity of such a phase, we let 16 athletes of international level walk at different speeds along a long course (16 m) on a footboard capable of measuring flight times, the length of the stride and its frequency.

## METHODOLOGY

The athletes (10 men and 6 women) examined by us were all of international level. The conductance-footboard (1x8m) (Globus-Italy), was placed at ground level on an athletics track at the end of a 100m straight in a 200m course. The speeds were set by an electronic gadget emitting acoustic signals at regular intervals. The athlete had to coincide his passage at a flag positioned every 10m with the acoustic signal. In doing so, the athlete had 100m before the first crossing of the footboard and 300m before the second crossing, to regulate his pace and technique. A strip (about 0.5cm high, 1m wider and 2m longer than the footboard), made of the same material as the track in order to permit an identical ground-foot interaction, was attached to the track on the footboard. Each athlete thus completed the course, and

FLIGHT TIME

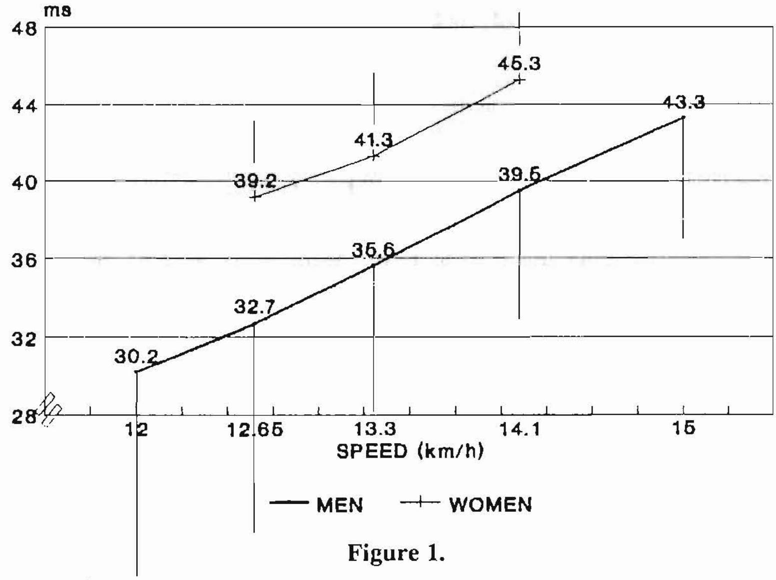


Figure 1.

STRIDE LENGHT

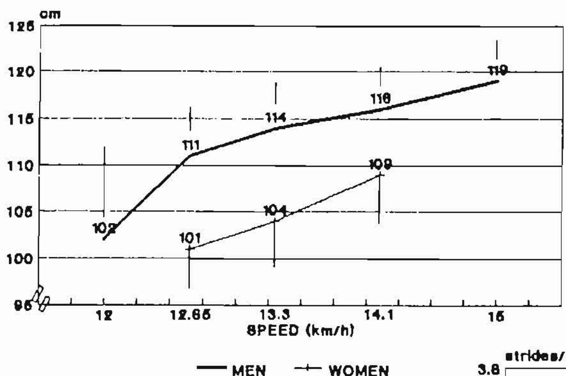


Figure 2.

STRIDE FREQUENCY

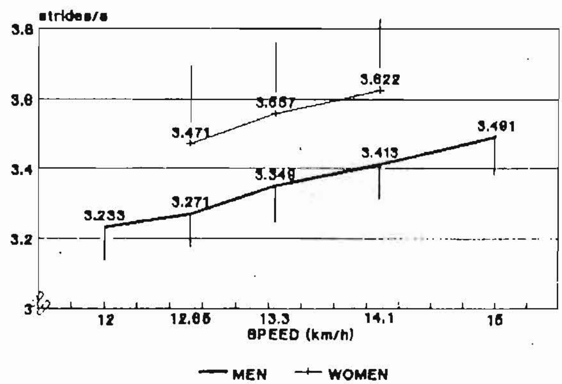


Figure 3.

crossed the footboard, twice at each of the predetermined speeds: 5 for male athlete (12, 12.65, 13.3, 14.1, 15 km/h) and 3 for female athletes (12.65, 13.3, 14.1 km/h).

When, during the passage of the athlete across the footboard, there appeared a loss of contact with the ground, the gadget measured the flight time, the length and frequency of the stride with "lifting". By subtracting the first and the last meter from the length of the footboard (they could have been involved with steps taken before or terminating after the footboard), and dividing the remaining length by the measured average length of the stride of that athlete at that speed, we obtained the total number of strides effectively taken on the footboard. We could measure, in this way, for each subject at each speed, both the ratio between the strides taken with lifting and those taken normally, as well as the average flight times at each speed (having also considered the strides without any flight time).

## RESULTS AND DISCUSSION

On a 16m course, reduced in our calculations to 12, we evaluated about 60 strides for each male athlete and 36 for each female athlete. Flight phases were noticed in all athletes, at all speeds and almost in all strides (fig 1). The minimum and maximum values (on average) were, for male athletes, 30 and 43 milliseconds (ms), for female athletes, 39 and 45ms. It was also observed that flight times tended to increase at a rather steady rate with increases in speed - coefficient of correlation (r)=0.999 (SEE=0.21) and coefficient of regression (b)=4.43 for male athletes; r=0.993 (SEE=0.52) and b=4.23 for female athletes. The following flight times (in ms) were measured in male athletes (mean values +/- SD): at 12 km/h 30.2+/-12.7, at 12.65 km/h 32.7+/-10.9, at 13.3 km/h 35.6+/-7.9, at 14.1 km/h 39.5+/-6.9, at 15 km/h 43.3+/-6.3; the following for female athletes: at 12.65 km/h 39.2+/-4.2, at 13.3 km/h 41.3+/-4.4, at 14.1 km/h 45.3+/-3.7. It is clear that the female athletes recorded flight times always greater, of approximately 6ms, than those of male athletes. Also the frequency and length of the strides clearly showed a strong correlation with speed (fig 2,3): respectively, from 3.23 to 3.49 strides/s, r=0.997 (SEE=0.001), b=0.09 and from 102 to 118cm, r=0.928 (SEE=2.79), b=5.1 for male athletes; from 3.47 to 3.62 strides/s, r=0.990 (SEE=0.01), b=0.10 and from 101 to 109cm, r=0.996 (SEE=0.47), b=5.54 for female athletes. Female athletes, obviously, recorded a stride length of about 9cm shorter than that taken by male athletes and a frequency of about 0.2 strides/s superior. It is thus impossible, at the speeds examined by us, to mantain a constant contact with the ground.

We also asked a coach of long-standing international experience to visually evaluate any occurrence of flight phases, as well as their magnitude. Generally, the athlete was evaluated by the coach in "lifting" when the time of flight measured with the platform approached and/or exceeded 40 ms. The coach's subjective evaluation of the occurrence and/or the extent of flight phases, however, did not always tally with instrumental findings, as differences - at times even substantial - were noted between the objective and subjective assessment. With this regard, a role is also likely to be played by an "aesthetic" kind of subjective assessment on the individual walking technique, which, however, can mislead the judge as far as the actual lifting is concerned.

## CONCLUSIONS

Speeds as currently observed during international competitions and the technique required to reach such speeds do not enable the athlete to avoid flight phases altogether. In the light of this investigation, we belive that the regulations should be changed. Indeed, leaving the assessment entirely up to the judge'sight seems to be rather unsatisfactory. We also feel that an apparatus such as the one we used or any other equipment of today's technology could be easily used to make evaluation more objective.

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