CHANGES IN RACE WALKING STYLE FOLLOWED BY APPLICATION OF ADDITIONAL LOADS

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The purpose of this study was to compare the effects of different loads in specific power training of race walkers on movement control. Essential aspects of movement control are avoidance of high impact forces and adequate core stability. We investigated three different forms of special power training (walking with 1.8 kg weight waistcoat, walking with 1.6 kg hand-held weights and tethered walking- 2.0-2.5 kg). The clearest changes were caused by tethered walking. We found that additional loads may significant reduce impact forces (-17 %) as well as the duration of the flight phase (-19 %). Additional core training supports the effects on movement control.

KEY WORDS: race walking, power training, core training

INTRODUCTION:

The race walking rules require, “that the walkers makes contact with the ground so that no visible (to the human eye) loss of contact occurs” and that “the advancing leg shall be straightened (i.e., not bent at knee) from the moment of first contact with the ground until the leg is in the vertical upright position” (Rule 230.1, IAAF). That implies very high demands on motor control when aiming at an increased speed.
It is of special importance to control vertical displacements to avoid flight phases during walking (Drake et al. 2005). Therefore the vertical stiffness plays an essential role (Schmidt, 2007). In contrast to running, where the elastic properties of the lower extremities for effective propulsion are applied, the loss of the amortization impulse should be the goal of race walking. This can be supported by the effective application of the leading leg and arms as well as by core movements.
Walking with additional loads attached to limbs increases the metabolic demands (Graves et al., 1988). The effects on walking technique are unknown. The aim of our investigation was to examine to what extent special force and power training exercises can support the development of optimum movement techniques. In our understanding major emphasis is to avoid the loss of ground contact.

METHOD:

Three different power training exercises were examined:

- walking with weight waistcoat (1.8 kg)
- walking with hand-held weights (1.6 kg each), XCO-trainer (http://www.xco-trainer.de/)
- tethered walking (2.0-2.5 kg), the rope is attached to the shoulder.

Three women from the German junior and senior national race walking team participated in the investigations. They performed two tests with and without additional loads on a treadmill with two inserted force measuring platforms (together 0,8 x 1,6 m). The walking speed was selected in such a way that it was lower than the aerobic-anaerobic threshold. The tests took 3 min each. The vertical component of the ground reaction force was measured during the whole time. Additionally the physiological parameters heart rate, lactate as well as oxygen consumption were recorded. In a second part of our investigation one woman performed an 8 weeks training program with tethered walking over 6 x 1000 m. The tractive forces amounted to 2.0-2.5 kg. In addition she performed three times a week a specific trunk force training. Variations of biomechanical and physiological parameters were tested in a 4 x 2000 m step test before and after the training. From the force curves the changes of the intercyclic variations between normal walking and the application of additional load as well as the effects of training were calculated for 20 succeeding cycles (Student-t-test, $p<.001$).

RESULTS:

Table 1 shows an overview of the exercises with different loads.

Table 1 Changes of biomechanical and physiological parameters in tests with different loads (F_{min} force minimum, F_{max2} second force maximum, VO_2 oxygen consumption; t-test, *** p<.001, ** p<.001, * p<.05)

	tethered			handweigths			waistcoat		
	without		with	without		with	without		with
velocity [m/s]	2,6		2,6	2,8		2,8	3,3		3,3
cadence [1/s]	2,57	**	2,77	2,73	***	2,54	3,44	**	3,43
contact time [ms]	359	***	319	325	*	360	245	***	248
flight time [ms]	34	***	42	42	***	34	46	**	43
force									
impact peak [N]	733	***	607	818	***	842	1054	***	1097
F_{min} [N]	435		440	493	***	443	706	***	767
F_{max2} [N]	765	***	824	796		865	851	***	941
VO_{2max} [ml/min*kg]	36,5		45,4	40,9		42,7	42,1		43,3

During tethered walking the athlete increased the moving frequency as well as the duration of flight phase (for the human eye visible loss of contact occurs for flight times greater than 50 ms in our investigation). Simultaneously the stance phase is extended. The force curve showed a significant decrease of the first peak and an adequate enlargement of the second peak (fig. 1). That means that impact forces are significantly reduced during this intervention.

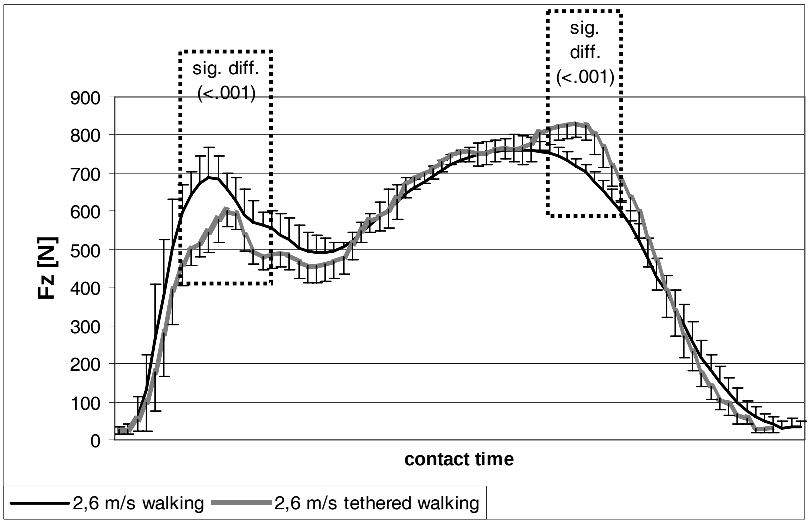

Figure 1: comparison of force time curve of normal race walking and tethered walking

During race walking with hand-held weights the athlete decreased the moving frequency and the duration of the flight phase significantly. At the same time the stance time enhanced. In the force curve we can see a time shift beginning in the mid-stance phase and a clear increase of the second maximum (fig. 2).
When wearing a weight waistcoat the athlete slightly increased their moving frequency accompanied by an increased stance time and a decrease of the duration of flight phase. The changes are statistically overvalued because of the very low variations from step to step by this athlete. In the force curve we found a general increase during the stance phase and an enhanced push-off at the end (fig. 3).

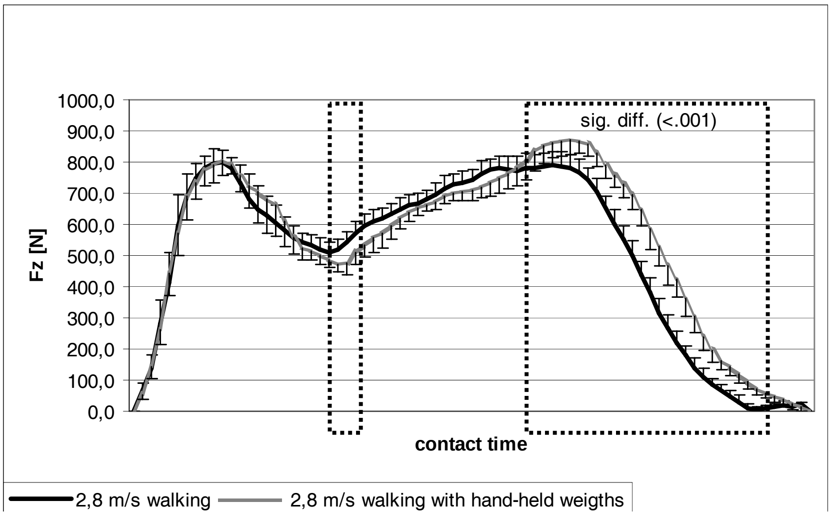

Figure 2: comparison of force time curve of normal race walking and walking with hand-held weigths

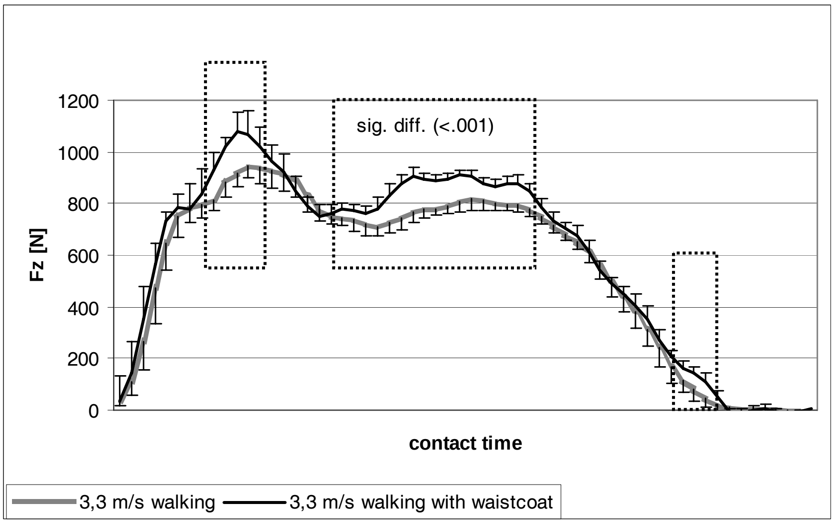

Figure 3: comparison of force time curve of normal race walking and walking with weight waistcoast

After an 8-week training period the athlete reached an average improvement of 27 % of the core strength in the sagittal, frontal and transverse direction.

Positive changes in the cycle structure (increase of the step length and decrease of the flight duration) were measured in the 4 x 2000 m step test (tab. 2). The athlete could demonstrate correct walking even at higher speeds. The force curve showed a significant time shift beginning in the mid-stance phase.

DISCUSSION:

Adding loads can lead to different effects with respect to race walking movements. For tethered walking we found the largest changes, which also were connected with the highest increase in oxygen consumption. With the help of the differentiated use of loads the energetic properties of specific muscle groups may be improved. This can positively affect movement control of long-term cyclic moving sequences.

Above all, tethered walking causes a decrease in impact forces at the beginning of the stance phase, which is an expression of a reduced vertical stiffness. As a consequence this intervention supports the activation of the core muscles. The longer flight time has to be considered critical in this connection.

Table 2 Changes of biomechanical and physiological parameters during training (LA-lactate, HR heart rate, VO_2 oxygen consumption)

	pre	post	pre	post	pre	post	pre	post
velocity [m/s]	2,60	2,60	2,80	2,80	3,00	3,00	3,20	3,20
cadence [1/s]	2,67	2,58	2,78	2,67	2,91	2,77	3,02	2,90
flight time [ms]	34	0	40	0	55	37	71	49
LA [mmol/l]	1,9	0,8	3,2	1,8	5,5	3,7	7,3	7,0
HR [1/min]	171	168	183	180	190	187	193	189
VO2 [l/min*kg]	35,3	37,1	42,1	42,4	46,9	45,3		

Walking with hand-held weights clearly extends the acceleration in the propulsion phase. This intervention requires an increased activation of core muscles too, in order to transfer the braking and/or acceleration movements of the upper limbs to the whole system. Regarding the adherence to IAAF rule 230.1 the clear increases of stance time as well as the decrease of flight time have to be considered positive.

Walking with weight waistcoat had the smallest effects. In relation to the other interventions the weight waistcoat was too light. In contrast to tethered walking higher amortization forces were found here, which are to be seen in connection with a higher vertical stiffness. This is an undesired effect for walking, which probably could be avoided by a combination with uphill walking. Our training procedure could show that a combination of the specific force training and core training may result in very positive changes in movement control, even when aiming at an increased race walking speed.

CONCLUSION:

Based on our investigations and findings individual recommendations for the application of specific force training as part of the annual training plan can be derived. Further investigations are needed to prove the effects of other intervention forms in the specific power training.

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