CROSS-SHAPING – THE MORE EFFECTIVE NORDIC WALKING? RESULTS OF A BIOMECHANICAL FIELD STUDY

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Cross-shaping is a new developed kind of nordic walking. The main difference between nordic walking and cross-shaping is the use of special sticks with forearm shells and wheels. The purpose of this study was to analyze the health effects of cross-shaping and to compare the results with own previous studies of nordic walking. Results clearly show positive health effects from cross-shaping, which are more extensive than in walking and nordic walking. Cross-shaping is harmonious similar to cross-country skiing in classic style. Push off is more effective than in nordic walking. Upper body is more erected and spine is relieved and mobilized effectively. Large parts of muscles of the upper and lower extremities were physiologically trained effective. Positive effects on the cardiovascular system are increased considerably compared to walking and nordic walking.

KEY WORDS: prevention, health, spine, cross-shaping, nordic walking, walking.

INTRODUCTION: In Germany 2-4 million people practice nordic walking (Gesellschaft für Konsumforschung [GfK], 2005). Nordic walkers are mainly middle aged and with a percentage of 69% female. Nordic walking is considered as prevention and health sport (Gesellschaft für Konsumforschung [GfK], 2010). Performed with high intensity a more increased oxygen uptake, energy assumption and heart rate is possible compared with walking (Jöllenbeck & Grüneberg, 2006). Cross-shaping is a new developed kind of nordic walking. The upper body is included more effectively in the motion sequence and erects and relieves the spine (figure 1). Cross-shaper sticks are adjustable in length. The forearms are positioned on forearm shells connected at centre by joint with the proximal end of the cross-shaper and tensioned with an adjustable expander. The hands moderately grasp an ergonomic hand grip. Wheels at the end rolling forward unresistingly with a nonreturn device. Moving forward the forearm shell is active flexed with force against the expander. Moving backward the blocking wheel enables an active push off from the forearm shell by the upper arm and shoulder in forward upward direction supported by the relaxing expander. Purpose of this study was to analyze the health effects of cross-shaping particularly related to the upper part of the body activity and spine erection and to compare the results with own previous studies of nordic walking.

METHODS: 13 persons (23-71y, 3 female, 10 male) participated: 8 trained cross-shapers (“experts”, 2 times weekly at least), 5 beginners (30 min. exercise at most). Task was to complete a 770m course with different profiles (plain, ascent 5% and descent 5%) twice in randomized order, once walking and once cross-shaping, quickly in preferably the same speed. Trained persons should provide evidence to the effectiveness of cross-shaping as a whole, the beginners to instant effects. The first part of course (470m) served as familiarization, second part (300m) as section of measurements. Subjects wore a back-pack with mobile measurement technique (novel pedarX, Biovision PLab, figure 1), a chest strap and a heart rate watch (Ciclo HAC 4). Vertical ground reaction forces were captured by insoles (Novel pedarX, 100 Hz), cross-shaper forces, inclination angles and forearm shell angles as well as body inclination at C7 by force transducers, inclinometers and goniometers (Biovision, 500 Hz, figure 1). The data were pulse synchronized and saved on two PDA (HP 5550). Times and interims of course sections were captured manually (Sports-Tracker). Overall data of about 20,000 steps were recorded, prepared with own software and imported in Simi Motion (V 7.2). Finally 5,800 steps from relevant course sections were analyzed. The design and analysis were widely identical to own previous field studies of nordic walking compared to walking (Jöllenbeck, Leyser, Grüneberg, Mull, & Classen, 2007). Statistics were performed by t-test with significance level of 5%.

RESULTS: Compared with walking cross-shaping increases the heart-rate significantly by 22.4 bpm at same speed (table 1). Experts perform significant longer step cycles in plain and descent as well as swing phase durations in all course profiles. The number of steps is significantly lower. The erection of the upper part of the body decreases significantly from descent to plain to ascent, i.e. it is most erected at descent (figure 2). The experts' upper part of the body shows a significantly increased range of motion (Ø 10.8°) in all course profiles and is in mean and maximum significantly more erected, whereas beginners' bodies show not yet significant effects. Normalized to body weight the vertical ground reaction forces show a significantly reduced 2nd force maximum (Ø 6.9%) in all course profiles (figure 3). Experts also show significantly reduced vertical impulses (Ø 2.8%) in plain and ascent. The reductions correspond to impulses generated in cross-shaping. Related to body weight the overall impulse of cross-shaping amounts to 19.6% and consists of active generated forearm flexion (8.9%) and push off (1.8%) without differences between experts and beginners. Thereby mean pretension of the expanders was 35.4 N. Finally experts show a significantly higher range of motion of overall cross-shaper movement and isolated forearm flexion.

Table 1
Main Results (Cr: cross-shaping, Wa: walking, Cr-Wa: difference, GRF: ground reaction force)

All subjects	Cr	Wa	Cr-Wa	p
Speed [m/s]	1.89 ±0,15	1.87 ±0.11	+0.02	.574
Heart rate [bpm]	136.9 ±22.9	114.4 ±22.8	+22.4	.000

Experts	p	p	descent		plain		ascent	
	Cr	Wa	Cr	Wa	Cr	Wa	Cr	Wa
Upper body erection [°]	<.002	<.003	46.6	42.7	44.8	40.5	40.4	36.2
GRF, push off [%BW]	<.000	<.000	101.7	109.3	115.6	122.5	124.9	131.1

Impulse of cross-shaper, experts	descent	plain	ascent
overall [%BW]	19.5 ±4.7	19.3 ±4.9	19.9 ±4.8
active [%BW]	10.3 ±2.7	10.5 ±2.9	11.2 ±3.1
push off [%BW]	1.1 ±1.2	1.7 ±1.5	2.6 ±1.7

Experts	descent		plain		ascent	
Differences cross-shaping - walking	Cr-Wa	p	Cr-Wa	p	Cr-Wa	p
Step cycle [%]	+3.9	.028	+3.7	.025	+3.0	.060
Swing phase [%]	+5.3	.008	+5.0	.006	+4.4	.016
Steps, [N]	-2.0	.003	-3.3	.004	-2.3	.005
Upper body erection [°]	+3.9	.002	+4.3	.002	+4.2	.002
Range of motion [°]	+10.9	.000	+11.5	.001	+9.9	.005
Mean [°]	+5.1	.000	+5.7	.001	+5.4	.002
Maximum [°]	+11.2	.000	+11.9	.000	+10.1	.001
GRF, push off [%BW]	-7.6	.000	-6.9	.000	-6.3	.007
Impulse whole body, vertical [%BW]	-2.1	.158	-2.3	.015	-3.3	.000

DISCUSSION: The participants implemented the task without speed differences indicating that cross-shaping and walking results are comparable. The considerably higher heart rate in cross-shaping leads to an estimated increment of the cardiovascular system strain from 64% to 76% HR-max. A previous study with the same design shows that the heart rate in nordic walking compared with walking increased only by 10.1 bpm. This increment was partly a result of a significantly higher velocity of 5% (Jöllenbeck et al., 2007). The considerably increased cardiovascular strain during cross-shaping can be interpreted as an extensive effort of additional muscle groups of the upper part of the body in accordance with a study showing an increased metabolic reaction (Institute of Medical Physics [IMP], 2012). Overall strain in cross-shaping complies with health related range of American College of Sports Medicine (ACSM, 1995), but intensity and energy consumption are assessed to be considerably higher as in nordic walking and walking.

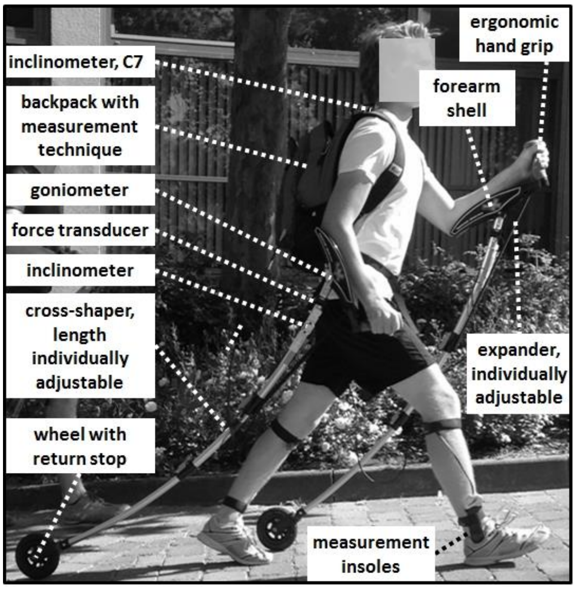

Figure 1: Cross-shaper, construction and measurement technique

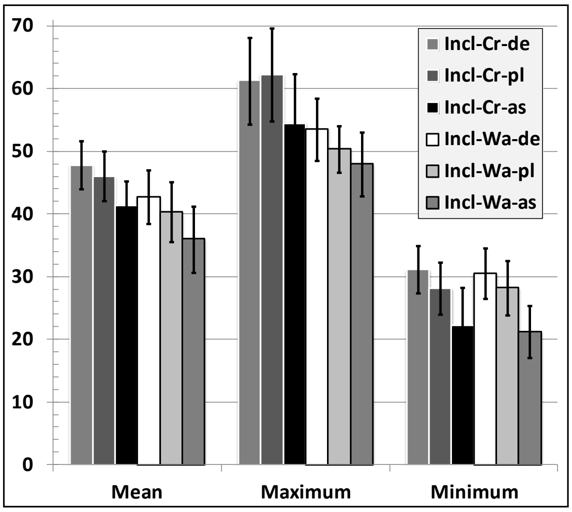

Figure 2: Inclination angle (C7, Incl), cross-shaping (Cr) vs. walking (Wa), distinguished by profile descent (de), plain (pl), ascent (as)

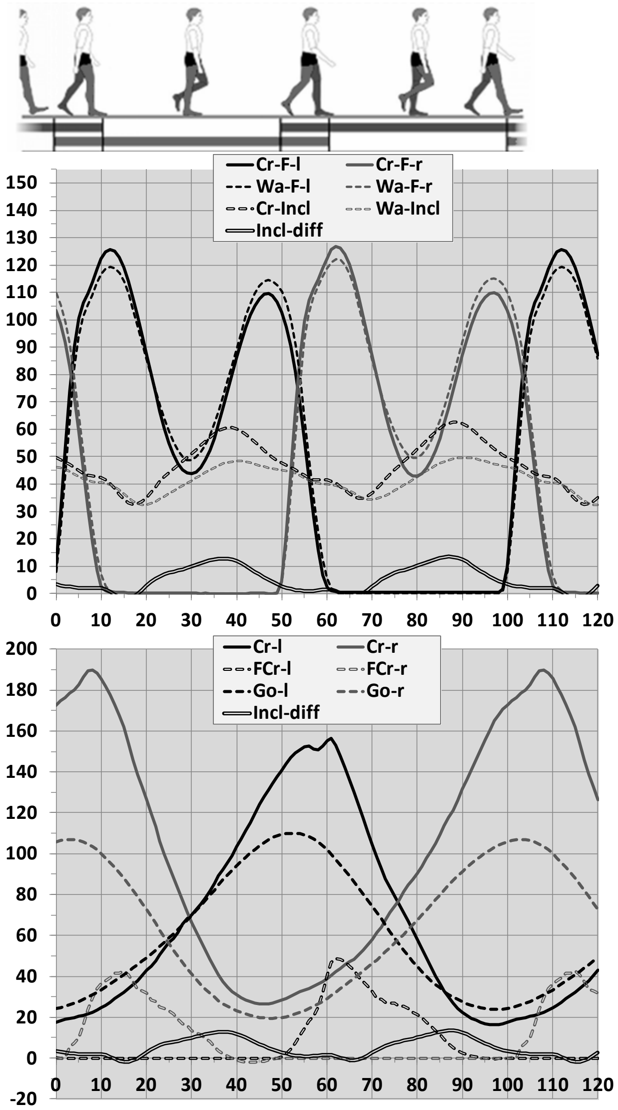

Figure 3: Time-curves of cross-shaping (Cr) and walking (Wa) in gait-cycle [%]; experts in plain. Top: force (F), inclination angle (C7, Incl), Inclination difference Cr-Wa (Incl-diff); bottom: cross-shaper angle (Cr) and force (FCr), Goniometer angle (Go); left (l), right (r)

The reduced 2nd force maximum in cross-shaping implies as contrasted with nordic walking (Kleindienst, Steif, Wedel, Campe, & Krabbe, 2006; Jöllenbeck et al., 2007) a reduced load of upper extremities between mid-stance and push off phase, in timeline associated with phases of increased erection of the upper of the body (figure 3). The cross-shaping impulse contribution of about 3% related to body weight leads to an elongation of the swing phase and a reduced number of steps at the same velocity as in walking. Combined with the reduced 2nd force maximum in timeline with the increased body erection these results can be interpreted as strengthened forward upward propulsion by cross-shaping (figure 3). Cross-shaping also leads to a distinct erection and an extended vertical range of motion of the upper body (figure 3). Additionally the generated active impulse by upper extremities of about 11% related to body weight is widely higher as in nordic walking with about 3% (Jöllenbeck et al., 2007). Thereby the extensive activation of additional muscle groups of the upper part of the body in cross-shaping is responsible for the considerable additional strain of the cardiovascular system compared with nordic walking and walking. The construction of the cross-shaper supporting the forearm on the forearm shell enables, in contrast to nordic walking, a direct and mechanically effective force transmission, which alternatingly exists during the whole stride cycle and is directed forward upward. This effect is enhanced by an additional active push off from the cross-shaper forearm shell. The increased erection and vertical movement in cross-shaping are generated by lifting the shoulder following the forearm push off from the shell. It may be interpreted as an effective relief of the spine. Moreover the alternating pre- and backswing movement combined with rotation and tilting of the shoulder girdle give reason to expect a mobilization of the spine. Although the pretension of the expander is individually adjustable the cross-shaper requires at least a moderate pretension. Therefore in contrast to nordic walking an unloaded cross-shaping is not possible. Beginners seem to need expert advice instructions and sufficient time for familiarization in the cross-shaping technique to obtain comprehensive health benefits.

CONCLUSION: The present study shows distinctly more extensive positive health effects from cross-shaping than from walking and nordic walking (Jöllenbeck & Grüneberg, 2006). Cross-shaping is harmonious similar to cross-country skiing in classic style. The push off is more effective than in nordic walking, but nevertheless distinctly shock reduced. The upper part of the body is more erected and the spine is relieved and mobilized effectively. Large parts of muscles of upper and lower extremities were physiologically trained equally effective. Positive effects on the cardiovascular system are increased considerably compared to walking and nordic walking. Recommended maximum strains for health effects are not exceeded. Altogether cross-shaping is the more effective nordic walking.

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