JOINT LOADING OF THE LOWER EXTREMITIES DURING NORDIC WALKING COMPARED WITH NORMAL WALKING

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INTRODUCTION

Nordic Walking (NW) is increasingly popular in Europe as a fitness sport and it has been recommended for rehabilitation training. Increased cardiovascular response during NW has been documented in a number of studies [e.g. 1]. However, the potential effect of NW on lower extremity joint loads is less clear.

The aim was to study 1) joint loading during Nordic Walking (NW) compared with normal walking (W) 2) if a modified NW technique with increased pole force and/or pole angle is associated with joint load reduction.

METHODS

Nine experienced female Nordic walkers (mean age 48 years, body mass 75 kg, body height 1.69 m and pole height 66% of body height) performed 5 walking sessions (4.5 km/h) across a force plate: Normal W, normal NW, NW with increased pole angle, NW with increased pole force, NW with increased pole angle and increased pole force. Movements were recorded at 50 Hz (6 Hz Butterworth filter) and foot ground reaction force and pole ground reaction force were recorded at 1000 Hz. A 2D-inverse dynamics model (8-segments (W), 9-segments (NW)) based on video recordings and ground reaction forces were used to calculate ankle, knee and hip net joint moments. Joint compression forces for the ankle, knee and hip joints due do internal forces (muscle forces), external forces (ground reaction forces) and total joint compression forces were calculated. The model suggested by Prilutsky and Gregor [2] was used to estimate muscle moment arms as a function of joint angle and segment length.

RESULTS AND DISCUSSION

NW compared with W did not change the joint compression forces (components due to internal and external forces and total compression force) in the ankle, knee and hip. This may be explained by the mean pole force which corresponded to around 3 % body weight, only. Furthermore, the peak pole force occurs later in the stance phase than the peak joint compression loads. Likewise, increasing the pole angle did not change the joint compression forces for the lower extremity joints. However, by increasing the pole force during NW it is possible to reduce total hip joint compression force significantly by 10-15% relative to NW, NW with increased pole angle, NW with increased pole angle and force (Table 1 and 2).
Even though NW does not reduce joint compression forces unless you push really hard on the poles there may be a positive effect of the poles as walking with poles increases stability due to the increased base support and therefore probably reduces the risk of unintended joint loads.

Table 1. Peak total joint compression forces at ankle, knee and hip. Mean of 3 trials per subject. BW: body weight.

	Ankle (x BW) Mean (SE)	Knee (x BW) Mean (SE)	Hip (x BW) Mean (SE)
W	5.44(0.13)	2.12(0.12)	4.59(0.40)
NW	5.33(0.13)	2.34(0.21)	4.93(0.60)
NW (inc. pole angle)	5.44(0.16)	2.10(0.12)	5.09(0.50)
NW (inc. force)	5.18(0.13)	2.13(0.11)	**4.31(0.36)**
NW (inc. pole angle and force)	5.25(0.16)	2.15(0.09)	4.78(0.40)

Table 2: Pole angle and pole force (n=9). Mean of 3 trials per subject.

	Pole angle (°) (mean (range))	Mean-Fz (N) Mean	Mean-Fres (N) Mean
NW	49.1(40.0-60.7)	19.3	21.6
NW (inc. pole angle)	75.8(57.4-93.9)	24.4	24.7
NW (inc. force)	53.1(41.3-66.0)	34.7	38.1
NW (inc. pole angle and force)	73.6(54.7-91.7)	51.6	52.5

REFERENCES

1. Schiffer T et al, *Eur J Appl Physiol.* **98**: 56-61, 2006.
2. Prilutsky BI and Gregor RJ, *Motor Control.* **1**: 92-116, 1997.