# EFFECT OF INCREASED POLE LOAD ON THE KNEE JOINT COMPRESSION FORCE DURING WALKING

[1]Simon B. Jensen, [2]Marius Henriksen, [2]Jens Aaboe, [3]Lone Hansen, [1]Erik B. Simonsen and [1]Tine Alkjær

[1]Department of Neuroscience and Pharmacology, University of Copenhagen, Denmark, email: talkjaer@sund.ku.dk
[2]The Clinical Motor Function Laboratory, The Parker Institute, Frederiksberg Hospital, Denmark.
[3]Team Danmark, Denmark.

## INTRODUCTION

Walking with poles (e.g Nordic Walking) as a rehabilitation modality has increased considerably. Walking with poles is advocated as a health promoting physical activity that reduces the load on the knees. However, we have recently showed that walking with poles does not reduce the load of the knee joint [1]. The purpose of the present study was to investigate if an increased load transmitted through the arms to the poles could reduced the knee joint compression force during walking.

## METHODS

10 healthy subjects (6 females, 4 males) volunteered to participate in the study (mean age: 30, weight 72 kg, and height 1.76). Three-dimensional gait analyses of walking with Nordic Walking poles were performed by using the VICON system (Vicon MX, Vicon Motion Systems, Oxford, UK) with 6 cameras (MX-F20, Vicon Motion Systems, Oxford, UK) operating at 100 Hz. Two force platforms (AMTI OR 6-5-1000, Watertown, MA, USA) embedded in the laboratory floor captured ground reaction force data at 1500 Hz synchronized with the kinematic data. A strain gauge (U2B, Hottinger Baldwin Messtechnik, Germany), was mounted in one of the poles to measure the force in the longitudinal direction. The force signal from the pole was sampled in synchrony with the kinematic and kinetic data. The subjects were instructed to walk with poles according to the guidelines of the International Nordic Walking Association (INWA) with the poles in a diagonal position [2]. After familiarization with pole walking, five trials of normal pole walking were recorded. Subsequently, the subjects were asked to increase the load transmitted to the pole to a level that at least the double as during the normal situation but without changing their walking technique. The walking speed was self-selected by each subject but should be identical for both normal pole walking (NPW) and walking with an increased load on the pole walking (LPW). The walking speed was controlled in each trial.

To assess the knee joint compression force, a statically determinate knee model was applied [3]. The compression force was calculated as the vector sum of a) the knee joint reaction force resolved along the long axis of the tibia, b) the compression component of the active muscle group and c) the axial component of the cruciate ligament tension. The muscle forces were calculated by combining the net sagittal plane joint moments with the muscle moment arms derived from a third-order polynomial relating the knee joint angle to the muscle moment arms. The predicted joint compression values, the resultant ground reaction force, and the pole force were normalized to body mass (N/kg).

## RESULTS AND DISCUSSION

On average the subjects increased the pole force by 2.4 times from NPW to LPW (Table 1). However, this extra load transmitted from the arms to the poles did not result in an unloading of either the resultant ground reaction force or the total knee compression force during LPW (Table 1, Figure 1).

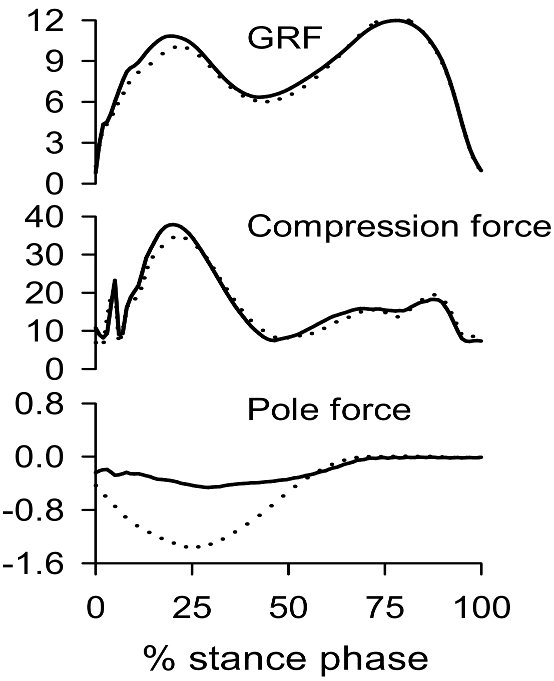


**Figure 1**: Resultant ground reaction force (GRF), knee joint compression force and pole force during NPW (solid lines) and LPW (dotted lines) for a representative subject. All representet as N/kg.

## CONCLUSIONS

The results show that an increased load on the poles during walking does not lead to a reduction in the loading of knee joint.

## REFERENCES

1. Hansen L, et al. *Scand J Med Sci Sports.* **18**(4):436-41, 2008.
2. International Nordic Walking Association, INWA
3. Schipplein OD et al. *J Orthop Res* **9**, 113-119, 1991.

**Table 1** Pole force, resultant ground reaction force (GRF) and knee compression force (N/kg). Values are means±SD.

| | Normal pole load (NPW) | Increased pole load (LPW) | p-value |
|---|---|---|---|
| **Pole force (N/kg)** | 0.69±0.34 | 1.66±0.73 | <0.0001 |
| **GRF (N/kg)** | 11.97±0.16 | 11.99±0.16 | 0.8294 |
| **Compression force (N/kg)** | 33.39±1.75 | 34.45±1.75 | 0.966 |