

## BASIC GAIT PARAMETERS OF HEALTHY AND CP CHILDREN ASSESSED BY ACCELEROMETRY

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### INTRODUCTION

With modern technology, it is possible to assess and analyze human activities precisely in laboratory settings. However, there is an increasing demand to acquire information about physical activities of subjects under free-living conditions. Spatio-temporal gait parameters can be assessed based on a three-dimensional accelerometer attached to the lower trunk [1]. Until quite recently the measurement systems that are needed for obtaining these acceleration signals were rather bulky and heavy. Recently, the DynaPort MiniMod (McRoberts B.V., The Netherlands) was developed. This miniature device includes three orthogonally mounted accelerometers and it can be used for monitoring human posture and gait parameters. In order to become a useful tool for the assessment of daily activities and gait parameters of children, the system ought to be able to discriminate single steps and to determine the walking distance from the acceleration signals.

### METHODS

Group 1: 20 healthy children (aged 3 to 16 years) walked four times 40 meters for the detection of steps in an indoor environment, with no obstacles nearby, at the University Hospital of Muenster. An additional distance, blinded for the analyzer of the data, was walked for detection of walking distance.

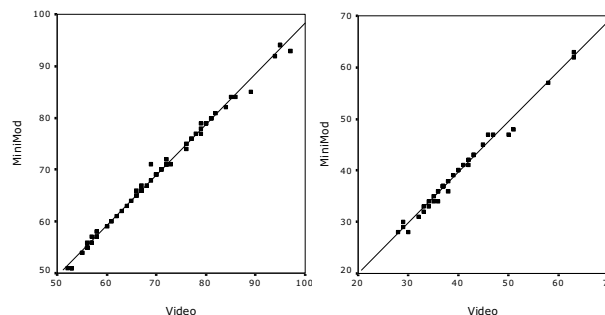
Group 2: 20 CP children (aged 5 to 17 years) from the outpatient clinic of the Orthopedic Department walked twice a distance of 20 meters for the detection of steps on a floor in the hospital. Like in group 1, an additional distance was walked for detection of walking distance. The degree of limitations caused by CP was assessed using a self-made classification scale.

Both groups were videotaped for counting steps and distance. Accelerometer signals of the lower back were measured by the MiniMod, a small and lightweight device (5.6 x 6.1 x 1.5 cm, 54g, 100 Hz) and stored on a SD card. The device was firmly fixed to the lower lumbar spine at the level of the second sacral vertebrae with double-sided adhesive tape to avoid movement artifacts. The data sets were sent to McRoberts for analysis [2] and compared to the results taken from the video.

### RESULTS AND DISCUSSION

Group 1: On average, the healthy children needed 273.7 steps (MIN: 207, MAX: 377) on the 160m tracks for step detection, as counted from the video. The software detected 273.5 steps on average (99.97%, range: 98.5 – 101.5%) regarding the total number of steps. If each misclassified step is counted as an error, regardless if under- or overestimated, the accuracy is 99.6%. The automatically computed walking distance revealed

100.6% of the actually walked distance. The correlation between the medio-lateral displacement of the COM and the age of the subjects was significant ( $r = -0.63$ ,  $p < 0.01$ ).



**Figure 1: Steps calculated from the MiniMod compared to the counting from the video for healthy (left) and CP (right) children.**

Group 2: One track of one child had to be excluded because of a handling error. On average, the CP children needed 79.8 steps (MIN: 57, MAX: 126) on the 40m tracks for step detection, as counted from the video. The software detected 78.9 steps on average (98.9%, range: 94.1 – 101.8%) regarding the total number of steps. If each misclassified step is counted as an error, the accuracy is 98.7%. The computed distance revealed 101% of the actually walked distance.

The DynaPort MiniMod allows for an accurate assessment of important spatio-temporal walking parameters. Due to its small size and the placement on the back, it does not interfere with most activities and it is comfortable to wear. The opportunity to estimate the medio-lateral displacement of the COM with the MiniMod offers a new tool to analyze the variation of gait within non-laboratory environments.

In healthy children, the displacement decreases with age, whereas this trend does not exist in CP children. Provided that our scale truly reflects the degree of CP, there is no association between the degree of CP and the variation of gait represented by the SDCOM. In both groups, the error of the calculated walking distance was negligible.

Further research will be performed to validate the DynaPort MiniMod for other groups (e.g. children with walking impairments, various adult patient populations) and to enhance the outcome of the device in order to monitor daily activities (e.g. the percentage of standing, sitting, walking).

### REFERENCES

1. Zijlstra, Eur J Appl Physiol., **92**, 39-44, 2004.
2. Zijlstra et al., Gait & Posture, **18**, 1-10, 2003.