# Normal distribution of standing balance for healthy Danish children – Reproducibility of parameters of balance.

Line Kjeldgaard Pedersen MD; Habib Ghasemi; Ole Rahbek MD, Ph.D; Bjarne Møller-Madsen MD, DMSc

Department of Children's Orthopedics, Aarhus University Hospital, Nørrebrogade 44, 8000 Aarhus, Denmark

**www.dpor.dk**

## Background:
Pedobarographic measurements are increasingly used in children with orthopedic disabilities undergoing surgical procedures. Recent technology provides usable sway analysis of balance parameters but a normal distribution for the standing balance of healthy children is not available.

## Purpose/Aim of study:
Firstly, to assess the validity and reproducibility of 5 parameters of standing balance in order to establish a method for examining standing balance in children. Furthermore to assess standing balance in healthy Danish children using pedobarographic sway analysis establishing a reference for comparison of balance in children with orthopedic disorders.

## Materials and methods:
Sixty-six children aged 7-14 years from the 1th, 3th, 5th and 7th grades were included at a Danish primary school after informed consent was obtained. The Tekscan F-scan Research was used and the pedobarographic measurements were analyzed with original Sway Analysis Module software. Three consecutive measurements on standing pedobarograms was used to calculate the average result with eyes open and eyes closed for each of the 5 parameters of balance. A Coefficient of Variation (CV) was calculated for each triple measurement and an average for each grade were averaged in order to visualize the overall reproducibility of the balance parameters. Statistical analysis with STATA 11 was used, and Spearman correlation and students t-test was calculated.

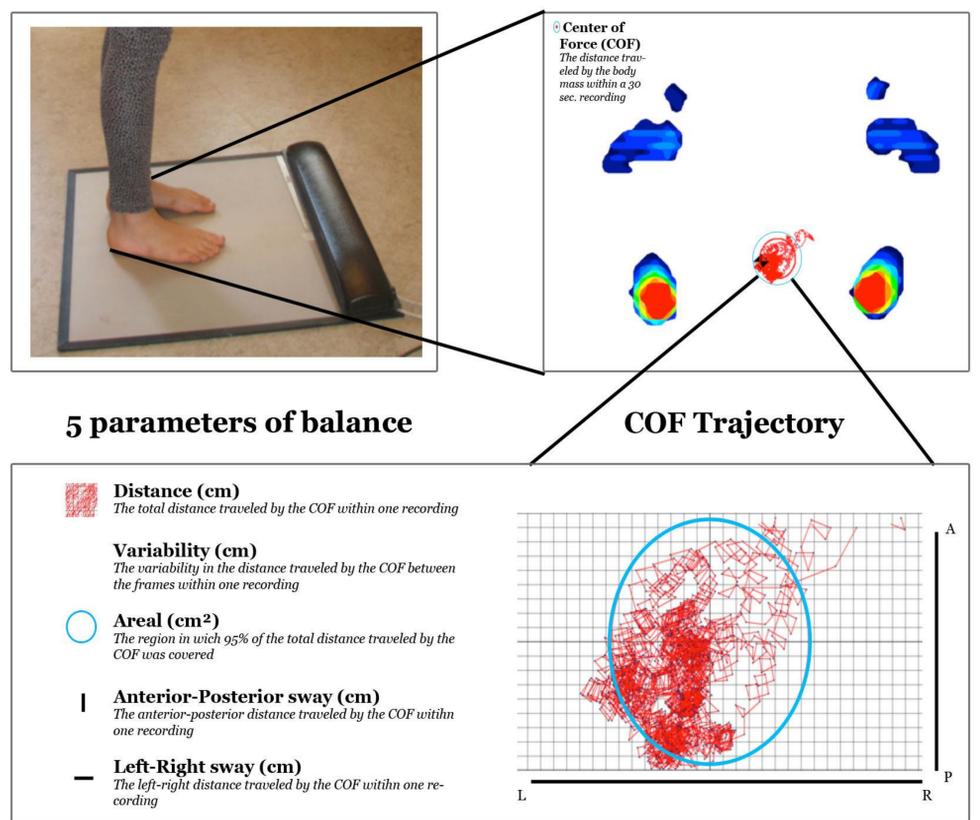### Measurement of standing balance - Sway Analysis Module (SAM)



**5 parameters of balance**

**Distance (cm)**
The total distance traveled by the COF within one recording

**Variability (cm)**
The variability in the distance traveled by the COF between the frames within one recording

**Areal (cm²)**
The region in wich 95% of the total distance traveled by the COF was covered

**Anterior-Posterior sway (cm)**
The anterior-posterior distance traveled by the COF witihn one recording

**Left-Right sway (cm)**
The left-right distance traveled by the COF witihn one recording

**COF Trajectory**



### Table 1: Coefficients of Variation for the 5 parameters of balance

| | | Area CV / % | Distance CV / % | Variability CV / % | A-P Excursion CV / % | L-R Excursion CV / % |
|---|---|---|---|---|---|---|
| Eyes Open | 1. grade | 33,1 ● | 19,2 ● | 14,7 ● | 23,6 ● | 13,8 ● |
| | 3. grade | 25,8 ● | 8,5 ● | 12,6 ● | 14,9 ● | 15,1 ● |
| | 5. grade | 27,2 ● | 12,3 ● | 12,7 ● | 19,1 ● | 13,3 ● |
| | 7. grade | 35,2 ● | 12,7 ● | 10,5 ● | 24,9 ● | 15,9 ● |
| Eyes Closed | 1. grade | 33,2 ● | 12,8 ● | 14,2 ● | 23 ● | 22,3 ● |
| | 3. grade | 20,4 ● | 9,7 ● | 10,3 ● | 13,9 ● | 10,8 ● |
| | 5. grade | 25,2 ● | 7,3 ● | 9,2 ● | 18,1 ● | 14,2 ● |
| | 7. grade | 26,9 ● | 9,4 ● | 11,9 ● | 15,5 ● | 16,6 ● |

| Excellent CV (<10%) | Acceptable CV (10%-20%) | Poor CV (>20%) |
|---|---|---|

### Table 2:

| | Total | 1. grade | 3. grade | 5.grade | 7.grade |
|---|---|---|---|---|---|
| Number of children - n | 65 | 15 | 14 | 18 | 18 |
| Age/yrs (SD) | 10,38 (2,32) | 7,2 (0,4) | 9,1 (0,4) | 11,1 (0,5) | 13,3 (0,5) |
| Body Mass Index (SD) | 16,7 (2,2) | 15,5 (1,5) | 15,7 (1,1) | 17,1 (2,2) | 18,1 (2,4) |
| Distance – open eyes /cm (SD) | 1188,6 (339,2) | 1161,7 (316,9) | 1410,1 (391,2) | 1130,4 (294,2) | 1097,5 (305,6) |
| Distance – closed eyes /cm (SD) | 1223,7 (374,5) | 1327,6 (503,9) | 1439,9 (381,7) | 1081,1 (247,5) | 1111,6 (251,7) |
| Variability – open eyes /cm (SD) | 0,2479 (0,0846) | 0,3055 (0,09329) | 0,2891 (0,0718) | 0,2101 (0,05999) | 0,2055 (0,067) |
| Variability – closed eyes /cm (SD) | 0,2605 (0,115) | 0,3633 (0,1507) | 0,29796 (0,091) | 0,1987 (0,0604) | 0,2073 (0,059) |

## Findings/ Results:
CV showed excellent to acceptable levels for the 2 balance parameters distance and variability and acceptable to poor levels for the remaining 3 balance parameters (area, A-P and L-R excursion) indicating that only distance and variability is a reproducible outcome measure for balance (Table 1). Data were stratified according to age, weight and height.

No significant difference between the validated balance parameters with both open and closed eyes could be found (p<0,21 p<0,11). When tested by gender we found that girls have a significant better balance than boys with both open (p<0,05 p<0,02) and closed eyes (p<0,01 p<0,01). A positive correlation was found between Body Mass Index (BMI) and both balance with open eyes (p<0,07 p<0,00) and closed eyes (p<0,01 p<0,00) for the two validated balance parameters, indicating that children with a high BMI have the best postural standing balance (Table 2).

## Conclusion:
We have found that only 2 of the 5 parameters have acceptable reproducibility from which we conclude these 2 parameters to be validated for use as outcome measure for the postural standing balance in children. We measured the effect of BMI, age, gender and visual information on standing balance and have established a normal distribution for standing balance in healthy Danish children. This normal distribution can be used as reference data for comparison with children with orthopedic disorders.

*Aarhus University Hospital*
ÅRHUS SYGEHUS