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**Original Article**

# Mechanography in children: pediatric references in postural control

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### Abstract

**Objective**: To establish pediatric age- and sex-specific references for measuring postural control with a mechanography plate in a single centre, prospective, normative data study. **Methods**: 739 children and adolescents (396 male/343 female) aged 4 to 17 years were studied. Each participant completed the following test sequence three times: Romberg, semi-tandem, tandem, each with eyes open and closed, and a one-leg stand with eyes open, and a single two-legged jump. Normal ranges were determined based on percentile calculations using the LMS method. Results from the two-legged jump were compared to a reference population the single two-legged jump (s2LJ) assessment in 2013. **Results**: 38 different equilibrium parameters calculated were analysed. Of all parameters Path Length, vCoFmean, Equilibrium Score and Sway Angle showed a low variation within the same age group but high dependency on age and were thus chosen for automated balance assessment. **Conclusion**: Standard values of postural control in healthy children derived from automated balance testing using a mechanography plate were successfully acquired and a subset of parameters for automated balance assessment identified.

**Keywords:** Balance, Mechanography, Outcome Measures, Postural, Reference Values

Katharina Vill has received speaker fees from Biogen and RG Ärztefortbildung Gesellschaft für Information und Organisation and received travel expenses from Biogen and Santhera. Rainer Rawer is an employee of Novotec Medical GmbH. Michaela Bonfert has received a Leonardo mechanograph as a loan to set up a study protocol to investigate postural control in children who sustained traumatic brain injury (Novotec Medical). Wolfgang Müller-Felber has served as a member of a scientific advisory board for Biogen, Avexis, PTC, Sanofi-Aventis, Roche, Sarepta and Cytokinetics and received travel expenses and speaker fees from Biogen, Avexis, PTC, Sarepta and Sanofi-Aventis. Astrid Blaschek received speaker fees from Roche, Avexis, Sanofi Genzyme, Admedicum and RG Ärztefortbildung Gesellschaft for Information und Organisation. Astrid Blasch also received honoraria for advisory board (Novartis) outside the submitted work. Franziska Pilz and Moritz Tacke have nothing to disclose.

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## Introduction

Neurological and neuromuscular disorders can affect muscular strength and coordination. Quantification of both entities has been largely based on assessing motor performance with standardized evaluator-based clinical tests.

With increasing availability of targeted therapies, methods to quantify the trajectory of disorders and changes during therapy are essential. Aspects such as balance can currently only be measured using semi-quantitative scales as in the Balance Error Scoring System (BESS) or the pediatric balance scale in children with cerebral palsy[1,2]. Mechanography allows the automatic assessment of physical performance as well as postural control. A ground reaction force plate (GRFP) is used to record variation of ground reaction forces enabling quantification of function and movements relevant to everyday life. Mechanography is an easy, safe and reliable tool to measure lower limb muscle function[3-6].

Paediatric reference values regarding force measurements have been assessed in several cohorts

**Table 1.** Age and sex distribution of the study population.

| Age (years) | Males | Females |
|---|---|---|
| 4 | 16 | 21 |
| 5 | 25 | 24 |
| 6 | 22 | 23 |
| 7 | 23 | 37 |
| 8 | 29 | 28 |
| 9 | 27 | 32 |
| 10 | 53 | 44 |
| 11 | 55 | 22 |
| 12 | 32 | 26 |
| 13 | 36 | 28 |
| 14 | 22 | 25 |
| 15 | 24 | 19 |
| 16 | 19 | 8 |
| 17 | 13 | 6 |
| Sum | 396 | 343 |

of more than 300 children and adolescents for grip force, one-leg whole body stiffness and multiple one-leg hopping and for counter movement jumps and chair rising tests[7,8]. The use of force measurements in sports medicine is well established, the same parameters have been used for children with neuromuscular disorders[9,10]. Mechanography is also capable of assessing balance by measuring variation of ground reaction forces to calculate a variation in the Centre of Force (CoF). In adult neurology and sports medicine, instrumental assessment of postural control using a force plate is already a widely used diagnostic approach to provide a more precise analysis of body sway than clinical examination[11]. Preliminary studies in children with mild traumatic brain injury show a correlation with conventional scales such as the BESS[1], Bonfert et al., submitted. However, no reference values to examine balance have been published to date in the paediatric population, for whom motor performance is highly age-dependent.

The purpose of this study was to generate reference values for postural control in children and adolescents.

## Methods

### *Study Population*

A total cohort of 739 children (396 male, 343 female) took part in the study (Table 1).

The children were pre-schoolers, students from kindergarten and regular schools in the city of Munich with its surrounding area. In total six kindergarten sites, three elementary schools and three high schools participated. Only children with attendance in regular (school-) sports activities with written informed parental consent were included.

The over-all physical performance of this cohort was compared to the cohort from 2013 used as normative data built-into in the Leonardo Mechanography v4.4 software. Jumping Mechanography assessments, the SD-Scores (SDS) of the Esslinger Fitness Index (EFI, power output per body mass in relation to age and gender, a performance parameter) as well as the Force Efficiency (FE, force invested for the generated power output, a movement quality parameter) were compared between these two cohorts.

### *Testing Protocol*

The test series were conducted in the setting of regular school sports classes. Precise instruction was given to perform each test, but no training was done before. Each child first performed a single two-leg jump (s2LJ, countermovement jump without restrictions) for comparison to already published reference data, and then the balance test battery with specific test in the following order:

Romberg test eyes open (Rom EO), Romberg test eyes closed (Rom EC), Semi-Tandem test eyes open (SemTan EO), Semi-Tandem test eyes closed (SemTan EC), Tandem test eyes open (Tan EO), Tandem test eyes closed (Tan EC) and One-Leg stand test eyes open (1LS EO). For all tests arms were hanging extended along the body. The dominant foot was determined as the foot that is used preferentially to climb stairs and the one that is more stable in a one-leg stand.

The duration of each test was ten seconds, the total duration of measurements was about five to ten minutes, depending on age and comprehension of the task.

For the Romberg test, the children were asked to stand on the plate with closed, parallel feet for a maximum of ten seconds, with the knees extended. For the Semi-tandem test, the dominant foot was placed forward by half a foot length, with feet closed. For the tandem test, the two feet (the dominant one in front) were placed one behind the other in a straight line. For the one-leg standing test, children were asked to stand on their dominant foot for as long as possible. For jumping, the patients were advised to jump as high as possible trying to land on their forefeet. Every patient performed the test items three times in a row, in exceptional cases with difficult understanding or technical difficulties more often. Individual measurements in which a foot was set down or the position was left were excluded from the statistical calculation. The result, included in the reference data calculation, is the mean of all valid measurements of the test person (occasionally one (1.6%) and four (15.1%) measurements, usually three (77.0%) measurements).

### *Instrumentation*

Mechanography was assessed using the Leonardo Mechanograph® GRFP (Novotec Medical GmbH, Pforzheim, Germany). This device measures ground reaction forces, allowing evaluation of dynamic forces over time as well as calculation of the variation of the Centre of Force (CoF, in literature also referenced as centre of pressure, CoP). The sampling rate of the system is 800 measurements per

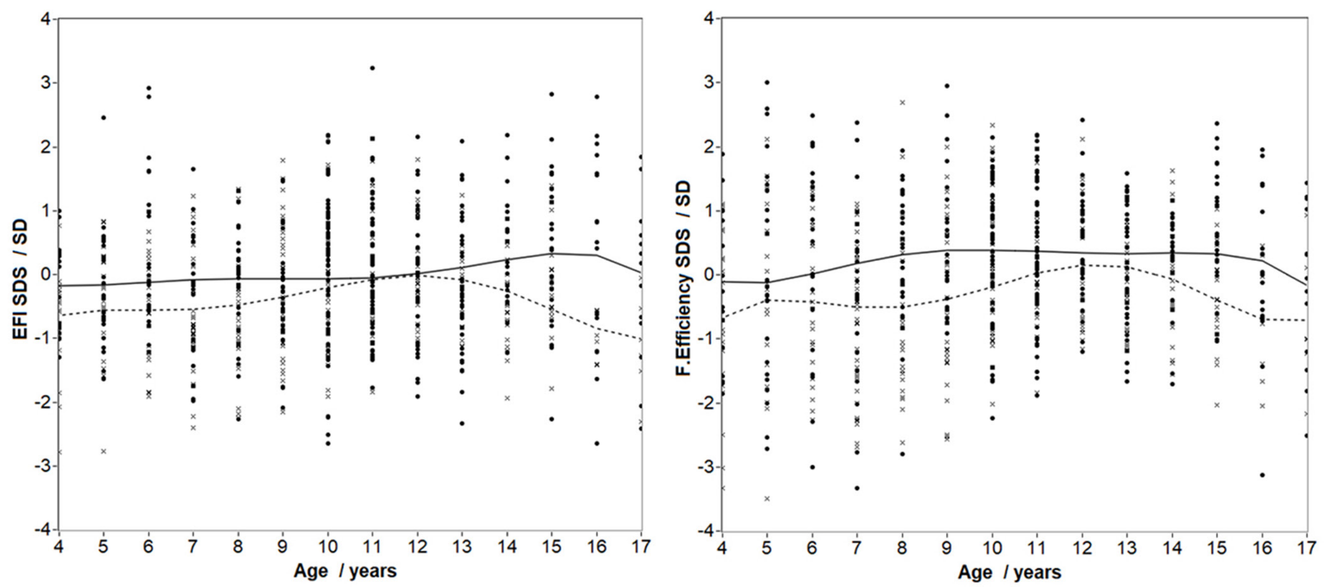



**Figure 1.** EFI and FE scores compared to 2013 reference data. Comparison of SD values in relation to 2013 reference data, a value of 0 SD depicts identical values. Left: EFI SD-Scores (EFI: power output per body mass in relation to age and gender, a performance parameter) Right: Force Efficiency SD-Scores (FE, force invested for the generated power output, a movement quality parameter). Male: solid lines; female: dashed line.

second per force sensor. The software for data acquisition, storage, calculation, basic statistics, and automated data transfer to the statistics package R was Leonardo Mechanography v4.4, also provided by Novotec Medical GmbH. The principle of Mechanography measurements was published in detail in 2013[7].

*Mechanography CoF Calculation*

Like standard stabilography and posturography, mechanography measures the displacement of the Centre for Force (CoF) to estimate variation of the Centre of Gravity (CoG). The CoF is defined as the vertical reaction vector on the surface of a force platform. Due to the inverted Definition of the Equilibrium Score for this parameter larger values (in terms of variation) are considered better.

The Leonardo Mechanograph™ uses one vertical force sensor in each of the four corners of each force plate. Based on the force distribution between those four sensors the effective CoF is calculated for each sample point. In general, Leonardo Mechanography down-samples measurement data to 100 Hz before calculating CoF analysis data, as described in[12-14].

*Parameter Selection*

The variation (trajectory) of the CoF is then analysed and 38 different characteristic parameters (See supplement Table S1 for a complete list) are extracted which encompass mean velocity, mean distance/path length, mean frequency, sway area, anterior-posterior (AP) and medio-lateral (ML) displacement of the CoF.

For clinical application, it is important to identify parameters that show a low variation within a given age and sex group but shows a great variation with increasing age. The coefficient of variation (cv, variation expressed as percentage of the mean value) was estimated using the 2*CV the parameter *2CVe*=100*(C75-C25)/C50. It was proposed that a high effect of age on the C50 value and at the same time a low *2CVe* of the parameters would be most promising for future differentiation between healthy controls and different patient populations.

To identify the most promising parameters four simple quality parameters were defined:

- QP1: Average over all test variants of C75-C25 range divided by average C50 value. This parameter is an estimate of the variability of the specific parameter over all age groups; a small value is preferrable.
- QP2: Variation of the average C50 value of each test variant over all test variants.
  This parameter is an estimation of the dependency of the parameter on the task difficulty; a large value is preferrable.
- QP3: Average of the difference of the C50 data of age groups 4 and 5 compared to age groups 16 and 17 over all test variants in relation to the mean value.
  This parameter is an estimation for the age dependency of the individual parameter; a large value is preferrable.
- QP4: Identical to OP3 but instead of analysing the mean values the difference between the Min and the Max is analysed.

This parameter is an estimation for the age dependency of the individual parameter; a large value is preferrable.

Six parameters discriminating age-dependant changes most reliable were selected for the final reference database.

## Statistical analysis

Percentiles for age groups in 0.5-year steps between 4 and 17 years (percentile lines for 3% (C3), 10% (C10), 25% (C25), 50% (C50), 75% (C75), 90% (C90) and 97% (C97)) where calculated using R v4.1.0 with the GAMLSS package. A detailed description of the methods used can be found elsewhere[11].

To eliminate outliers, a two-step iteration approach was used. In a first step percentile data were calculated and then all measurements below the 0.5% and above the 99,5% threshold were eliminated and the percentile data was recalculated identically. For the parameter *Std. Ellipse* Area this automatic approach did not converge therefore, manual elimination of outliers was needed. This was done by analysing standard deviations per age group assuming a Gausian distribution per age group.

We were able to use the GAMLSS BCPE method in all analyses with the following parameters: Mu=2.0, Sigma=1.0 or 0.5, Nu=0.5. For all calculations 9 subgroups for z-score statistics error estimation were used.

For each gender and age group LMS parameters were calculated, allowing to calculate an accurate z-score based on the reference data for a given combination of gender, age, and individual measurement result (y) according to the following formulas[11]:

$((y/M)^L-1)/S*L$ for L≠0

$1/S*\ln(y/M)$ for L=0

*Formula 1*

When applying this formula, one should notice that the supplied reference data is per age group data. However, most data shows a significant change per year. Especially for (more frequent) longitudinal measurements exact age (including fraction of years) should be used instead. In this case, a factor of 0.5 years needs to be added to the reference values, since mathematically rounding to 5 includes values from 4.5 to 5.5 but age groups include values from 5 to 6 years.

For quality estimation two additional plots generated by the GAMLSS package were used: curve fitting errors for each of the age groups and deviation vs. unit normal quantile plot giving a more detailed view of curve-fitting errors.

## Results

### *Testing protocol and comparison to normative data from 2013*

The tests were performed over all ages without problems. No participant dropped out of the study due to difficulties performing the tests. Results of the single two-leg jump (s2LJ), were within +/- 0.5 SD of the reference cohort, with only females above 15 years of age showing a slight decrease at greater than -1 SD. The male subjects showed a mean of 0.002 SD for the Esslinger Fitness Index (EFI) and 0.25 for Force Efficiency (FE); female subjects showed a mean -0.375 SD for EFI and -0.29 for FE (Figure 1). For both parameters, the cohort showed similar distribution of 0.87 SD for EFI and 1.14 SD (in the SDS plot, a mean of 0 SD means that the mean is identical to our reference cohort, and a standard deviation of 1 SD means that the group has an identical distribution to our reference cohort.

### *Parameters identified by the quality criteria*

According to the prespecified quality criteria 6/38 criteria were selected (Figure 2). In general, velocity histogram parameters were superior to frequency parameters, which showed a moderate variability but very low influence of task difficulty and age. CoF variation data showed high variability and small to moderate influence of task difficulty and age. Subsequently they were not chosen as reference parameters to measure balance.

According to this analysis fs10 parameters (analysis based on data down-sampled to 10Hz) was not considered to be superior to the equivalent data without down-sampling[14].

All parameters selected are shown in figures 3- 6. Reference values and LMS parameter tables to calculate z-scores can be found in the supplemental material (Tables S2-S7):

- *Av. Velocity*: Pathlength (total length of the CoF trajectory in mm) divided by test duration in s.
- $vCoF_{mean}$: Velocity histogram parameter, the distance of the CoF position between two sample points can be used to calculate the velocity of the movement between two consecutive sample points. The velocity histogram shows how often each velocity value was present during the measurement. V mean is the mean value of all velocities in the velocity histogram.
- *EQ ML and AP*: Equilibrium Score Anterior-Posterior in % (AP or y-axis in the area plot) and Medial Lateral in % (ML or x-axis in the area plot) separately, calculated from the AP or ML projection of the 90% Standard Ellipse and estimated height of CoG (see[15] for detailed description).
- *Sway Angle ML and AP*: calculated from the average of the last 0.7s of the CoF variation and the height of the CoG estimated to be at 0.5527 * Body Height (see[15] for detailed description).

Females and males show a linear decrease in mean velocity and vCoFrange, 95% score until age 9, where the curve significantly flattens, with a lower velocity indicating a superior balance (Figures 3 and 4 left), This effect is most pronounced for the One-Leg stand (1LS) as the most difficult one of the test battery. In all test variants females show on average slightly smaller and therefore a superior balance performance as compared to males, particularly pronounced in the 1LS.

| Parameter Name | Parameter Group | QP1 | QP2 | QP3 | QP4 | Selection |
|---|---|---|---|---|---|---|
| | | aveage of Variability of Parameter smaller values better | dependency on task difficulty larger values better | dependency on Age larger values better | dependency on Age larger values better | included in software v4.4b06.xx |
| BT: fs10 av. Freq | FS10 data | 5,3 | 70,1 | 15,8 | 40,5 | |
| BT: fs10 Area / s | (Downsampled to 10 Hz) | 47 | 269 | 97,8 | 99,2 | |
| BT: fs10 Ampl. AP | | 23,4 | 111 | 45,8 | 45,7 | |
| BT: fs10 Ampl. ML | | 31,9 | 92,2 | 49,1 | 73,4 | |
| BT: fs10 av. r | | 18,8 | 94 | 42,2 | 39,7 | |
| BT: fs10 rel.Plen | | 12,9 | 170,4 | 59,1 | 40,3 | |
| Bt: Freq. dispersion | Frequency Spectrum | 2,1 | 7,5 | 4 | 8,4 | |
| Bt: max. Freq. (95%) | | 16,2 | 71,4 | 16,4 | 26,5 | |
| Bt: median Freq. | | 20,3 | 87,5 | 11,6 | 48,7 | |
| Bt: dominant frequency | | 26 | 26,7 | 8,3 | 21,2 | |
| Bt: v CoF median | Velocity Histogram | 17,2 | 152,8 | 58,2 | 33,5 | |
| Bt: v CoF range | | 19,1 | 177,4 | 67,5 | 37,2 | X |
| Bt: EQ ML | Equilibrium Score | 5,6 | 13,1 | 11,5 | 14,2 | X |
| Bt: EQ AP | | 3,8 | 11,3 | 11,3 | 9,8 | X |
| Bt: Std. Elllipse dimension ML | St.-Ellipse | 33,5 | 89,2 | 47,6 | 73,6 | |
| Bt: Std. Elllipse dimension AP | | 24,2 | 104,9 | 41,1 | 40,2 | |
| Bt: std. Ellipse num.Excent. | | 7,2 | 16,1 | 9,5 | 16,6 | |
| Bt: std. Ellipse Area /cm² | | 41,7 | 197,4 | 89,7 | 88,7 | X |
| Bt: Sw. Angle Peak to Peak ML | Sway Angle | 33,3 | 88,8 | 95,3 | 62 | |
| Bt: Sw. Angle Peak to Peak AP | | 23,2 | 102,4 | 90,3 | 33,4 | |
| Bt: Sw. Angle ML Std.Dev. | | 36,2 | 84,4 | 92,7 | 90,5 | X |
| Bt: Sw. Angle AP Std.Dev. | | 26,5 | 88,9 | 86 | 41,3 | X |
| Bt: max.Sway Angle ML /° | | 34,1 | 86,8 | 92,3 | 80,4 | |
| Bt: max.Sway Angle AP /° | | 25 | 92,8 | 87,8 | 33,6 | |
| Bt: CoF x SD /cm | Variation of CoF | 32,8 | 89,6 | 47,2 | 73,9 | |
| Bt: CoF y SD /cm | | 22,8 | 104,7 | 41,8 | 36,5 | |
| Bt: CoF Dist. SD /cm | | 27,9 | 98,2 | 48,6 | 43,9 | |
| Bt: F.tot SD /N | Force Variation | 25,6 | 342,6 | 58,2 | 137,8 | |
| Bt: F.tot rel SD /N/kg | | 30,4 | 350,9 | 75 | 122,3 | X |
| Bt: Path Len. / mm | Path length | 14,2 | 166,3 | 62,5 | 42,4 | |
| Bt: Plen Y (ML) | | 16,9 | 161,4 | 64,5 | 46,6 | |
| Bt: Plen X (ML) | | 15,2 | 169,2 | 60,6 | 40,1 | |
| Bt: v mean / cm/s | | 14,2 | 166,4 | 62,5 | 42,4 | X |
| Bt: v mean Y (ML) | | 17,1 | 161,3 | 64,7 | 46,4 | |
| Bt: v mean X (ML) | | 15,2 | 169,1 | 60,7 | 40 | |
| Bt: v mean Std.Dev. | | 12,3 | 42,1 | 17,2 | 40,9 | |
| Bt: Plen/Area | | 33,4 | 54 | 34,8 | 58,7 | |

**Figure 2.** Quality parameters QP1 to QP 4 for each of the 38 analysis parameters. Parameters are grouped according to the primary outcome, selected parameters marked. Note that std. ellipse area (well-established parameter in posturography) and one-legged Stance (SD) have been selected as well. Parameter details can be found in supplemental table S1. *Mean velocity ($v_{mean}$, Path length/time); vCoF$_{range}$, 95% (derived from velocity histogram).*

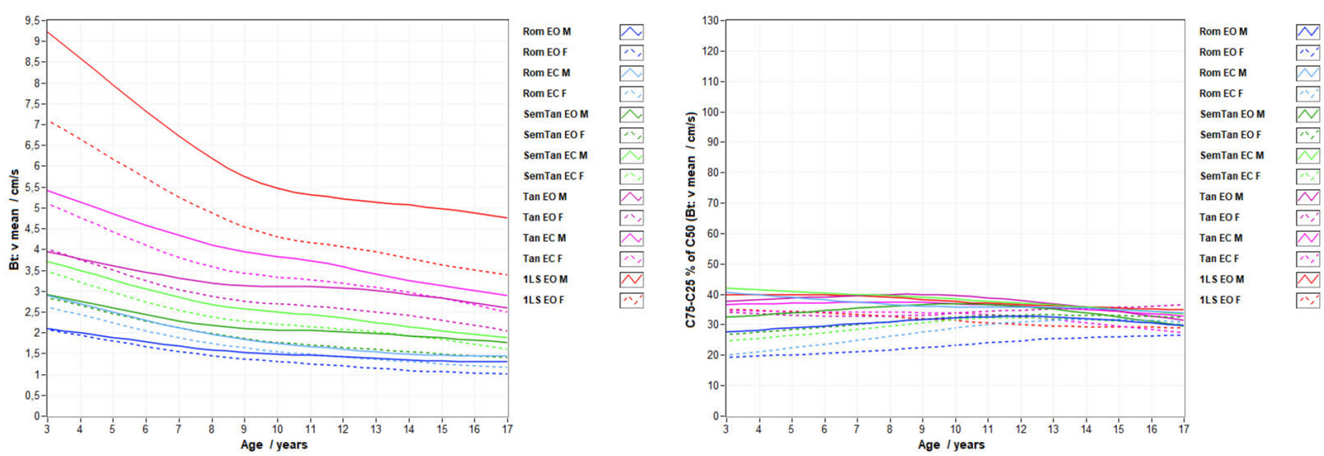



**Figure 3.** Mean velocity ($v_{mean}$, Path length/time). Listed are all tests that were performed, in each case the mean value from all valid tests per person. Left: C50 lines of $v_{mean}$ [cm/s] vs. age for all measurement variants: from bottom plots to top: Rom EO, Rom EC, SemTan EO, SemTan EC, Tan EO, Tan EC, 1LS EO) Right: *2CVe* plots: C75-C25 in percent of C50 value vs. age. male: solid lines, female: dashed lines.

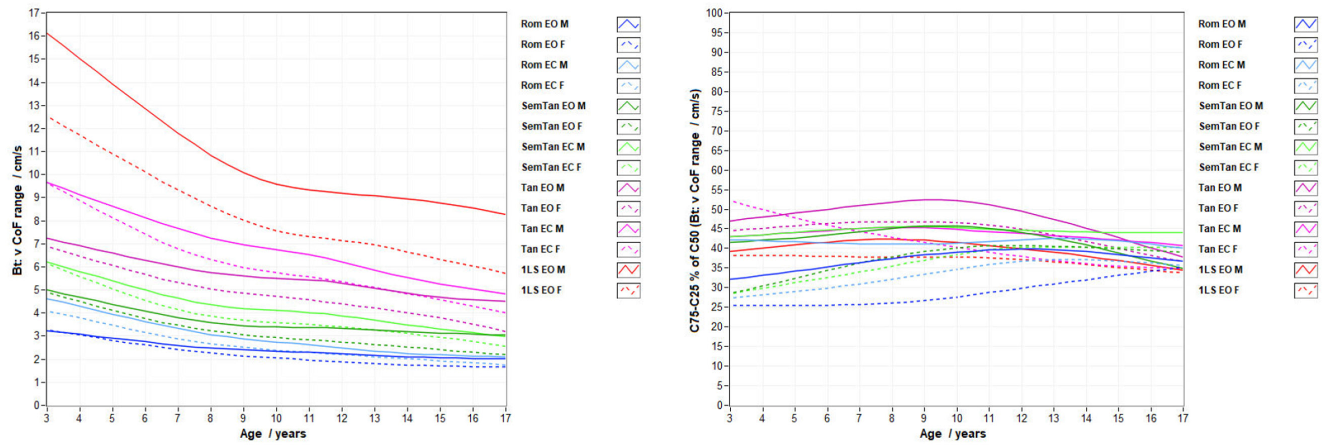
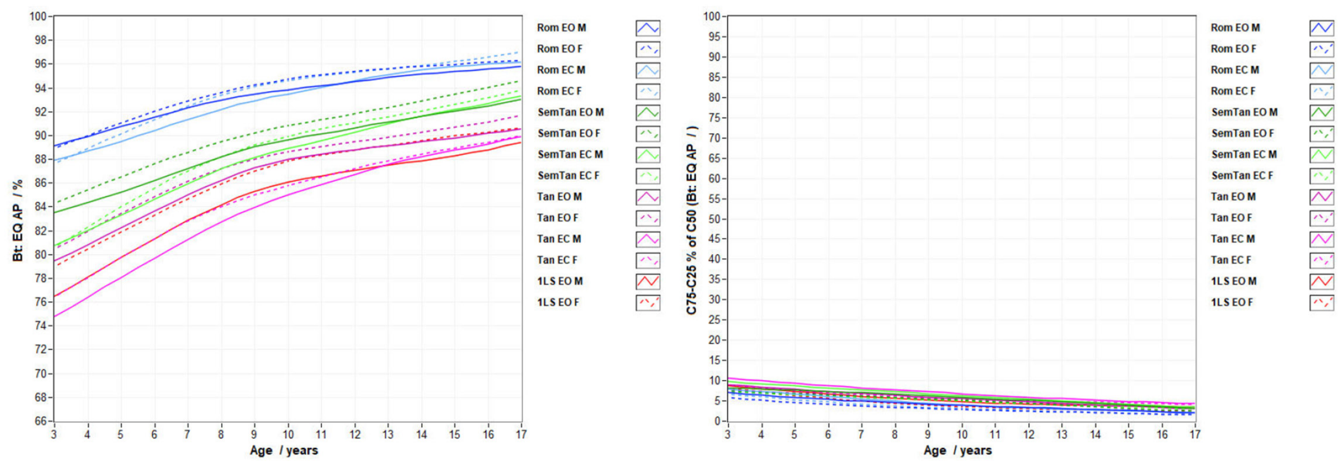



**Figure 4.** vCoF$_{range\ 95\%}$. Listed are all tests that were performed, in each case the mean value from all valid tests per person. Left: C50 lines of vCoFrange 95 [cm/s] vs. age for all measurement variants: from bottom plots to top: Rom EO, Rom EC, SemTan EO, SemTan EC, Tan EO, Tan EC, 1LS EO). Right: 2CVe plots: C75-C25 in percent of C50 value vs. age. male: solid lines, female: dashed lines.

(a) *EQ-Score AP*:




(b) *EQ-Score ML*:

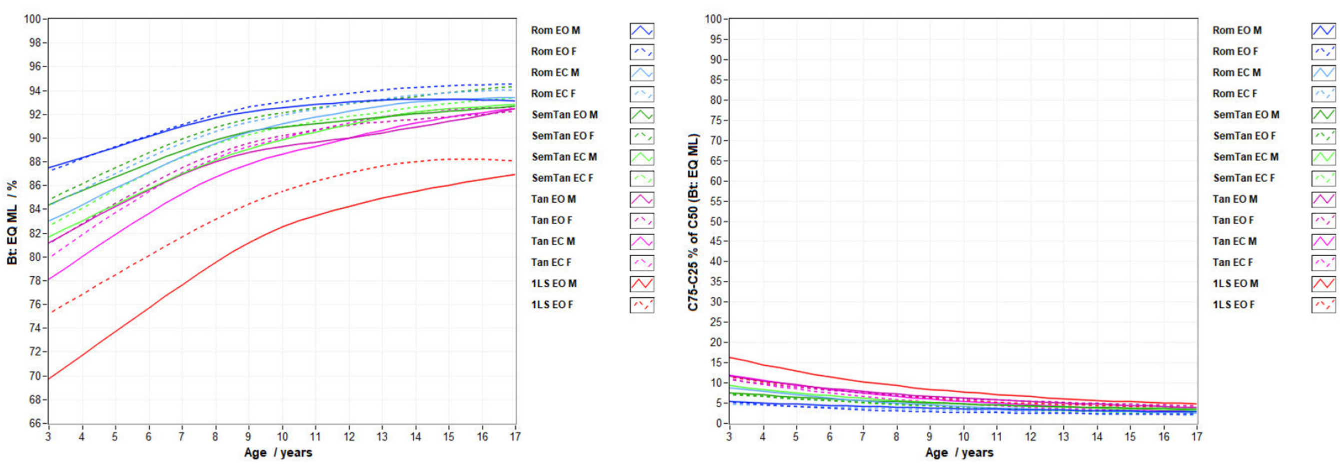



**Figure 5.** EQ-Score. Listed are all tests that were performed, in each case the mean value from all valid tests per person. (a)EQsScore AP: Left: C50 lines of EQ-Score AP [%] vs. age for all measurement variants: from bottom plots to top: Rom EO, Rom EC, SemTan EO, SemTan EC, Tan EO, Tan EC, 1LS EO). Right: 2CVe plots: C75-C25 in percent of C50 value vs. age. (b) EQ-Score ML : Left: C50 lines of EQ-Score ML [%] vs. age for all measurement variants: from bottom plots to top: Rom EO, Rom EC, SemTan EO, SemTan EC, Tan EO, Tan EC, 1LS EO). Right: 2CVe plots: C75-C25 in percent of C50 value vs. age. male: solid lines, female: dashed lines

**(a) *Sway Angle* AP**

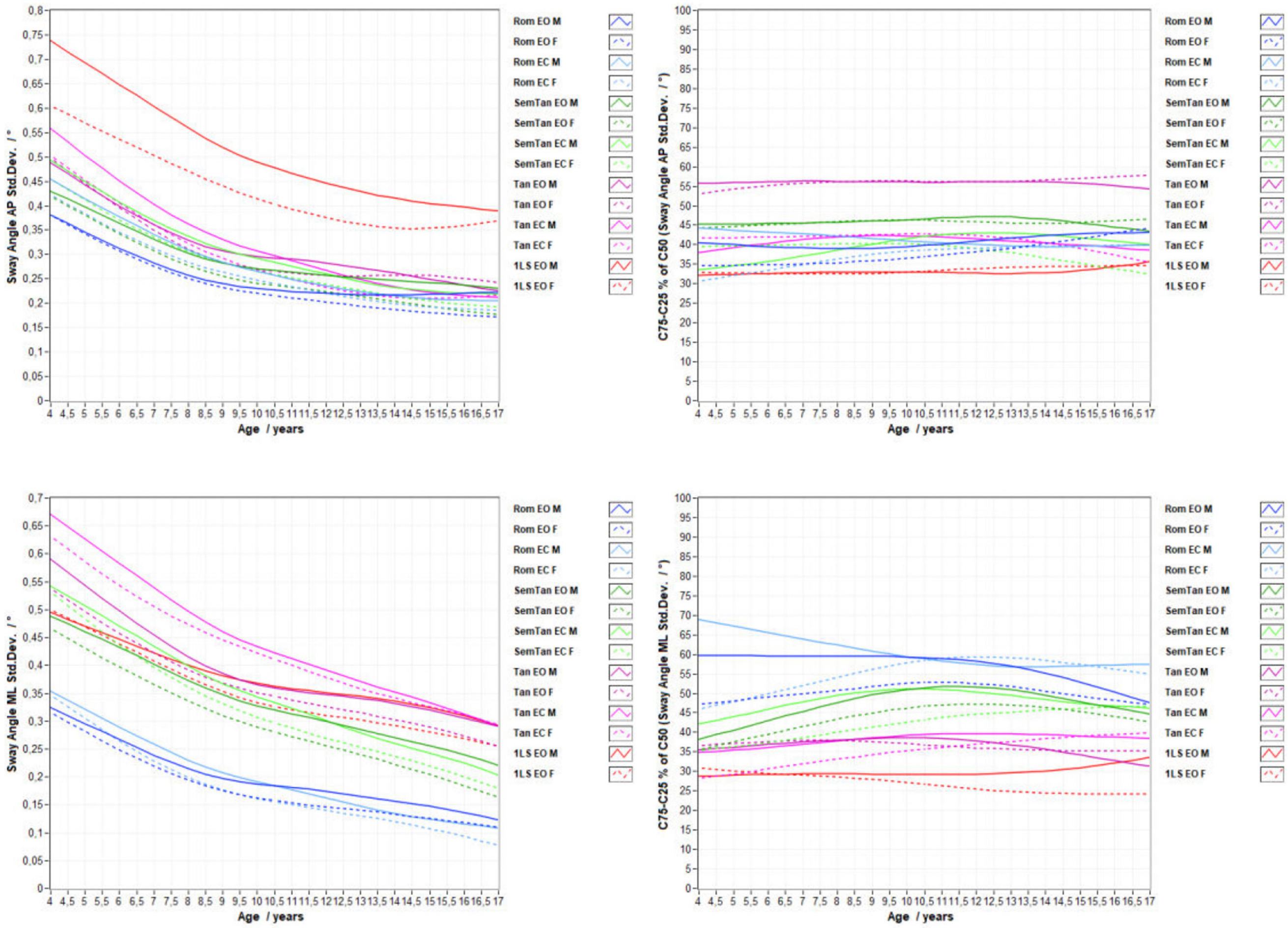



**Figure 6.** Standard deviation of the variation of the sway angle, calculated according to 15 based on an estimated height of the CoG at 0.5527*body height. (a) Sway angle AP SD [°] Left: C50 lines Right: 2CVe plots: C75-C25 in percent of C50 value vs. age (b) Sway Angle ML SD [°] Left: C50 lines of vs. age Right: 2CVe plots: C75-C25 in percent of C50 value vs. age. male: solid lines, female: dashed lines.

*Equilibrium Score*

Again, girls and boys show a linear increase until the age of 9 years, at which time the curve flattens (Figure 5). In the anterior-posterior movement, the compensatory movements in the tandem test are more pronounced in younger children than in the single-leg stand. Interestingly, the *EQ-Score* has an extremely low variance in its raw values with, large age variability, which also makes it a promising parameter for quantifying balance.

*Sway Angle*

The lower the sway angle, the more stable the patient stands. Girls and boys show a linear decrease until the age of 9 years, at which time the curve flattens (Figure 6). In the medial-lateral movement, the compensatory movements in the Tandem and Semi-Tandem test are more pronounced in younger children than in the Single-Leg stand. The *Sway Angle SD* parameter has an average variance, but the least age variability of all analysed analysis parameters, which nevertheless qualifies it as a parameter for measuring balance.

## Discussion

With this study, we provide normative values that incorporate balance performance from a large cohort of 739 healthy children attending public schools in Munich, Germany.

To ensure that the present study cohort does not differ from normative data established in 2013[7,8], physical performance measurements were compared using EFI and FE resulting in similar results(+/-0.5 SD) . The current cohort reflects an average pediatric population, as children visiting all regular school types took part. Since overall physical performance has an impact on balance skills, we propose to include *EFI* as well as *FE* data for future mechanography studies to characterize the study population[16].

*Balance Parameters*

We have identified four variables $V_{mean}$ (path length/time), a parameter of the velocity histogram ($vCoF_{mean}$), the *Equilibrium Score* (ML and AP) and the *Sway Angle SD* (ML and AP) with a high potential to quantify balance. Since we assume that balance improves significantly during maturation in childhood, we selected parameters that show a low variation within a given age and sex group along with a great variation with increasing age.

The distinct bend in the curve reaching adult abilities around age 9 has been seen in other studies on the development of balance skills[17-19]. Interestingly, balance control in antero-posterior (AP) direction was observed earlier than in the medio-lateral direction (ML) as seen in the equilibrium score or sway angle datasets. In developmental studies postural control of AP is reached earlier than in ML plane. Blanchet et al. evaluated the centre of pressure displacement during maximum leaning in four directions showing that postural mechanisms in the anteroposterior axis reach maturity before the mechanisms involved in controlling the mediolateral axis[20]. Clear differences in postural sway have been documented even between children with minimal developmental difficulties (e.g. developmental coordination disorder) and healthy controls[21]. Control of posture in the medio-lateral direction is seen as a good parameter to describe the overall extent of postural control in healthy volunteers and patients. Patients with Multiple sclerosis compared to healthy persons exhibited greater ML motion compared to sway in the AP direction associated to a significantly greater risk of falls in daily life[22].

In our study males consistently showed poorer balance than girls, clearly justifying differentiation for reference data, although the differences are certainly not as pronounced as in the over-all physical performance measurements, especially at the adolescent age[7,8]. Sex differences have been found in other studies, among sportive and non-sportive children. These become apparent from scholar age[17-19,23]. It has been suggested that females might have a better use of vestibular information and males lag behind with their physical growth as well as the development of their neuromuscular system[24]. It should be noted that another factor for this effect might be the observation of the test operator who noticed that females during the test tended to be more focussed (less time and repetition of instructions) compared to males.

*Parameter Scalability between Test Variants*

For a standardized clinical application, the relation of analysis parameters between the different test variants is of interest. The more demanding a balance test becomes for an individual, the better it distinguishes balance abilities compared to a reference database. However, if the individual test is too difficult for one subject that it has to be ended before time or there is an incident with a high impact on the analysis parameters is recorded (e.g. the second foot touched the force plate during the actual test duration of a One-Leg stand). In both cases the test result is therefore not reliable.

However, it would be favourable if the tests variants of a battery best suited are used on an individual basis (as difficult as possible but still achievable) then results would still be comparable to other individuals using different test difficulties.

Although not in the focus of the current analysis, the results of the comparison of C50 plots vs. age show that for some analysis parameters (especially the *mean velocity*) a strict hierarchy within the test battery can be observed even when combining the EO/EC option with each test. The resulting hierarchy order with increasing difficulty is: *Rom EO, Rom EC, SemTan EO, SemTand EC, Tan EO, Tan EO, 1L EO* (*1L EC*, which was not part of the test battery but would be the next difficult test).

For $v_{mean}$ in females there is a quite constant delta between C50 curves which indicate that even independent of age a scaling factor for each test variant can be calculated. This would allow a scalable comparison of a test results. For male subjects an adjustment curve per age group would be needed to make test results of the different test variants comparable.

Other analysis parameters like the *Sway Angle* show a less distinct hierarchy where for example the EO/EC option seem to make much less differences (Figure 6a, *Sway Angle SD AP*) and a separation between tests variants is not as clear (Figure 6b, *Sway Angle SD ML*).

*Clinical relevance of this dataset*

This reference dataset provides normative values to test postural control using automated analysis with the Leonardo Mechanograph force plate. Instrumented posturography is ubiquitously applicable in healthy children within the context of sports medicine, as well as in child neurology. Balance control is not only influenced by functioning cerebellar circuits, but sensory processes such as visual, vestibular and proprioceptive input. In addition, there is now a wealth of evidence indicating that balance involves higher-order brain systems for the integration of not only somatosensory, visual, and vestibular information, but for memory needed for anticipatory movements[25]. Thus, postural control can be hindered by many childhood onset disorders from peripheral neuromuscular disorders or neuropathies to global developmental disorders and cerebral palsy. Since potential new drugs are currently being developed for many neurological diseases, suitable clinical test instruments to quantify physical performance and coordination to evaluate the effects of new therapeutic targets are mandatory.

*Limitations and future work*

Ethics approval was only obtained for balance and strength measurements. As a result, we were not able to acquire information on lifestyle habits, nor did we document ethnic background. In a minority of participants (7,9%) less than three repetitions of tests are available. In principle, an increasing number of measurements to average decreases variability, hence it is favourable to use the average of more than one measurement.

However, given the limitations in time it was not possible to achieve four measurements of all participants. Using a cut-off of a minimum of three measurements would have resulted in 7.9% (one repetitions: 1.6%, two repetitions 6.3%) less data points but most likely representing the low performance percentiles of the study population with significant effects on the spread of the calculated percentiles for lower performance levels. Including the groups of 1 and 2 repetitions thus results in a considerable increase in variability in this group (resulting in an increased spread for the lower performance percentiles) but it also allows to represent this important sub-group. Not representing this sub-group would therefore increase the thresholds for the lower performance levels significantly. The authors therefore considered the negative effect of an increased variability for this subgroup to be acceptable compared to not representing them in the reference data at all.

## Conclusion

The data from healthy participants provide a reference dataset for the assessment of postural control in childhood by mechanography. This study identified four parameters that show a low variation within a given age and sex group but a greater variation with increasing age.

In addition to sports medicine, mechanography may supplement clinical tools to assess the trajectory and effect of interventions in normal development and pediatric neurology.

*Ethics approval*

*The local ethics committee of the Ludwig Maximillian's University of Munich approved the study (internal No: 18-775).*

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## Supplemental Tables

**Table S1.** Parameters measured by Mechanography. List of names, units and description of all balance parameters currently analyzed by the Leonardo Mechanograpy Software. According to the method described in the selections section the six most promising (highlighted in bold letters) parameters have been selected for detailed discussion.

| Name | Unit | Description |
|---|---|---|
| **Path Length** | **mm** | **Total Length CoF trajectory, resulting from variation of position of the force vector entering the platform (CoF aka. CoP); Sum of the position distance between each to consecutive sample points of CoF** |
| **v mean** | **cm/s** | **Mean velocity of CoF, equivalent to pathlength divided by measurement time** |
| Plen X (ML) | mm | Path Length, only analysing the projection in the ML plane |
| V mean X (ML) | cm/s | Mean velocity of CoF ML component (projection in the ML plane) |
| Plen Y (AP) | mm | Path Length, only analysing the projection in the AP plane |
| V mean Y (AP) | cm/s | Mean velocity of CoF AP component (projection in the AP plane) |
| Plen / Area | 1/mm | Path Length / Standard Ellipse area |
| v mean SD | % | |
| Std.Ellipse Area | $cm^2$ | Standard Ellipse (90% confidence ellipse) area covering 90% of all CoF points |
| Std.Ellipse num. Excent. | | Standard Ellipse numerical eccentricity, (a value of 0.5 is equivalent to a circle, larger values is more elliptic) |
| Std.Ellipse Angle | ° | Angle of the main axis of the standard ellipse |
| F tot SD | N | Std. Dev. of vertical Force variation over complete analysis section equivalent to RMS difference to average Force during analysed section |
| **F tot rel SD** | **N/kg** | **Std. Dev. of vertical Force variation in relation to body mass over complete analysis section** |
| CoF Dist. SD | cm | Std. Dev. of CoF Distance variation (direction independent distance to average position) over complete analysis section, equivalent to RMS distance from mean position |
| CoF X x (ML) | cm | Std. Dev. of CoF variation x component (ML), equivalent to RMS distance from mean position (ML) for projection in ML plane |
| CoF Y x (AP) | cm | Std. Dev. of CoF variation x component (AP), equivalent to RMS distance from mean position (AP) for projection in ML plane |
| max. Sway Angle ML | ° | Max Sway Angle ML, Downsampled to 100Hz, calculated over the last 0.7 sec., assuming height of CoG is 0.5527 * Body Height according to[12] |
| max. Sway Angle AP | ° | Max Sway Angle AP, Downsampled to 100Hz, calculated over the last 0.7 sec., assuming height of CoG is 0.5527 * Body Height according to (12) |
| **Sw. Angle** | **°** | **Std.Dev. Sway Angle ML component (see above)** |
| **ML Std. Dev.** | | |
| **Sw. Angle AP Std. Dev.** | **°** | **Std.Dev. Sway Angle AP component (see above)** |
| Bt: Sw. Angle Peak to Peak ML | ° | Peak to Peak angular displacement of Sway Angle in ML direction |
| Bt: Sw. Angle Peak to Peak AP | ° | Peak to Peak angular displacement of Sway Angle in AP direction |
| Std. Elllipse dimension ML | cm | 90% Standard Ellipse dimension in ML direction |
| Std. Elllipse dimension AP | cm | 90% Standard Ellipse dimension in AP direction |
| **EQ ML** | **%** | **Equilibrium Score in ML direction. Calculated from the ML projection of the 90% Std.Ellipse and estimated height of CoG according to[12]** |
| **EQ AP** | **%** | **Equilibrium Score in AP direction. Calculated from the AP projection of the 90% Std.Ellipse and estimated height of CoG according to[12]** |
| v CoF mean | cm/s | Velocity histogram: Mean of al values |
| V CoF median | cm/s | Velocity histogram: Median of al values |
| V CoF range | cm/s | Velocity histogram: 95% cut-of frequency (95% percentile) |
| Dominant frequency | Hz | Dominant frequency of CoF power spectral density (PSD), analysed frequency Band: 0.15Hz..10Hz, according to[15] |
| Median frequency | Hz | Median frequency of CoF power spectral density (PSD), analysed frequency Band: 0.15Hz..10Hz, according to[15] |
| Max. Freq. (95%) | Hz | Frequency range covering 95% of energy (95% percentile), analysed frequency Band: 0.15Hz..10Hz, according to[15] |

**Table S1.** *(Cont. from previous page).*

| Name | Unit | Description |
|---|---|---|
| Freq. Dispersion | | Unitless measure of the variability of the power spectral density (PSD) frequency content (zero for pure sinusoid; increases with spectral bandwidth to one) analysed frequency Band: 0.15Hz..10Hz, according to[15] |
| fs10 rel. PLeng | mm/s | Path length / duration, data down-sampled to 10Hz according to[16] |
| fs10 av. R | mm | Average radial displacement (ARD), data down-sampled to 10Hz according to[16] |
| fs10 Ampl. ML | mm | Amplitude x-component (ML), data down-sampled to 10Hz according to[16] |
| fs10 Ampl. AP | mm | Amplitude y-component (AP), data down-sampled to 10Hz according to[16] |
| fs 10 Area/s | $mm^2/s$ | Area (90° std. Ellipse) / duration, data down-sampled to 10Hz according to[16] |
| fs 10 av. Freq. | Hz | Average frequency, data down-sampled to 10Hz according to[16] |

**Supplemental Tables S2-S7.** The following tables show the LMS parameters needed to calculate ager- and gender specific z-scores according to *Formula 1* (where M = C50, L = Lambda, S = Sigma) for the listed parameters and test variants.
*1* (where M = C50, L = Lambda, S = Sigma) for the listed parameters and test variants.

**Table S2.** Parameter: mean velocity ($v_{mean}$).

**Table S2a.** LMS parameters per age group and gender, Romberg Tests, $v_{mean}$ [m/s].

| | RomEO - $v_{mean}$ [m/s] | | | | | | RomEC - $v_{mean}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 210,5631 | -1,5059 | 0,1999 | 208,3057 | -0,2005 | 0,1425 | 290,5039 | -0,7244 | 0,2929 | 262,5420 | -0,5259 | 0,1476 |
| 4 | 199,8784 | -1,3643 | 0,2045 | 194,5369 | -0,1829 | 0,1456 | 270,4257 | -0,6302 | 0,2882 | 243,1005 | -0,5212 | 0,1561 |
| 5 | 189,1676 | -1,2231 | 0,2094 | 180,8554 | -0,1667 | 0,1487 | 250,3754 | -0,5360 | 0,2835 | 223,7688 | -0,5164 | 0,1650 |
| 6 | 178,4202 | -1,0843 | 0,2144 | 167,6730 | -0,1591 | 0,1522 | 230,6207 | -0,4428 | 0,2785 | 205,1791 | -0,5119 | 0,1740 |
| 7 | 168,1133 | -0,9503 | 0,2194 | 155,5371 | -0,1669 | 0,1560 | 212,0934 | -0,3556 | 0,2736 | 188,4430 | -0,5114 | 0,1835 |
| 8 | 159,5112 | -0,8232 | 0,2245 | 145,3911 | -0,1925 | 0,1604 | 196,2458 | -0,2786 | 0,2693 | 174,6545 | -0,5159 | 0,1933 |
| 9 | 153,3483 | -0,7038 | 0,2293 | 137,4276 | -0,2357 | 0,1657 | 183,9815 | -0,2147 | 0,2659 | 163,8331 | -0,5245 | 0,2038 |
| 10 | 149,1456 | -0,5919 | 0,2332 | 131,0420 | -0,2898 | 0,1722 | 174,8893 | -0,1671 | 0,2636 | 155,4624 | -0,5373 | 0,2138 |
| 11 | 145,6831 | -0,4872 | 0,2364 | 125,4964 | -0,3482 | 0,1797 | 167,5373 | -0,1337 | 0,2629 | 148,7157 | -0,5535 | 0,2228 |
| 12 | 141,9226 | -0,3881 | 0,2381 | 120,0695 | -0,4097 | 0,1875 | 160,3425 | -0,1072 | 0,2631 | 142,4607 | -0,5738 | 0,2296 |
| 13 | 138,2640 | -0,2956 | 0,2378 | 114,8877 | -0,4754 | 0,1951 | 153,8364 | -0,0834 | 0,2629 | 136,5609 | -0,5999 | 0,2333 |
| 14 | 135,2121 | -0,2091 | 0,2351 | 110,5001 | -0,5425 | 0,2023 | 149,2411 | -0,0629 | 0,2615 | 131,1627 | -0,6336 | 0,2340 |
| 15 | 132,6976 | -0,1280 | 0,2308 | 107,0367 | -0,6063 | 0,2095 | 146,3666 | -0,0451 | 0,2586 | 126,0989 | -0,6735 | 0,2327 |
| 16 | 131,0683 | -0,0515 | 0,2258 | 104,3571 | -0,6645 | 0,2160 | 144,9874 | -0,0291 | 0,2546 | 121,0734 | -0,7172 | 0,2303 |
| 17 | 130,0730 | 0,0234 | 0,2210 | 101,9647 | -0,7203 | 0,2223 | 144,2521 | -0,0130 | 0,2500 | 116,0014 | -0,7621 | 0,2273 |

**Table S2b.** LMS parameters per age group and gender, Semi-Tandem Tests, $v_{mean}$ [m/s].

| | SemTnEO - $v_{mean}$ [m/s] | | | | | | SemTanEC - $v_{mean}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 292,4163 | -1,0956 | 0,2354 | 284,6394 | -0,8282 | 0,1962 | 371,5929 | -0,8345 | 0,3014 | 347,8633 | -0,5943 | 0,1813 |
| 4 | 275,7711 | -1,0260 | 0,2399 | 265,6641 | -0,7639 | 0,2018 | 349,3509 | -0,7722 | 0,2984 | 322,8271 | -0,4574 | 0,1881 |
| 5 | 259,2450 | -0,9568 | 0,2445 | 246,7650 | -0,6998 | 0,2076 | 327,1306 | -0,7104 | 0,2955 | 297,8943 | -0,3207 | 0,1950 |
| 6 | 243,3580 | -0,8897 | 0,2496 | 228,5091 | -0,6374 | 0,2138 | 305,2094 | -0,6507 | 0,2927 | 273,9788 | -0,1864 | 0,2019 |
| 7 | 228,7380 | -0,8273 | 0,2551 | 212,0727 | -0,5819 | 0,2204 | 284,7888 | -0,5943 | 0,2903 | 253,4775 | -0,0631 | 0,2096 |
| 8 | 217,1738 | -0,7693 | 0,2603 | 197,9043 | -0,5404 | 0,2267 | 268,2387 | -0,5404 | 0,2877 | 238,0251 | 0,0397 | 0,2181 |
| 9 | 210,0914 | -0,7126 | 0,2639 | 186,1155 | -0,5162 | 0,2328 | 256,9918 | -0,4866 | 0,2844 | 227,3991 | 0,1178 | 0,2269 |
| 10 | 206,8103 | -0,6542 | 0,2650 | 177,2012 | -0,5074 | 0,2380 | 249,7886 | -0,4320 | 0,2804 | 219,9852 | 0,1714 | 0,2347 |
| 11 | 205,2192 | -0,5934 | 0,2637 | 170,8176 | -0,5107 | 0,2417 | 243,4924 | -0,3763 | 0,2762 | 214,4307 | 0,2043 | 0,2401 |
| 12 | 202,6073 | -0,5323 | 0,2605 | 165,3417 | -0,5221 | 0,2433 | 235,1584 | -0,3171 | 0,2722 | 208,5946 | 0,2217 | 0,2431 |
| 13 | 198,1510 | -0,4724 | 0,2550 | 159,9967 | -0,5394 | 0,2435 | 224,7283 | -0,2538 | 0,2682 | 201,4543 | 0,2277 | 0,2437 |
| 14 | 193,0131 | -0,4137 | 0,2475 | 154,7734 | -0,5593 | 0,2427 | 214,5277 | -0,1881 | 0,2637 | 193,4666 | 0,2268 | 0,2432 |
| 15 | 187,9791 | -0,3547 | 0,2386 | 149,4179 | -0,5784 | 0,2415 | 205,1716 | -0,1199 | 0,2587 | 184,4134 | 0,2203 | 0,2423 |
| 16 | 182,7638 | -0,2929 | 0,2288 | 144,5310 | -0,5968 | 0,2398 | 196,5274 | -0,0493 | 0,2535 | 173,8003 | 0,2114 | 0,2408 |
| 17 | 177,3148 | -0,2302 | 0,2188 | 139,9914 | -0,6155 | 0,2377 | 187,7818 | 0,0228 | 0,2483 | 162,0881 | 0,2011 | 0,2387 |

**Table S2c.** LMS parameters per age group and gender, Tandem Tests, $v_{mean}$ [m/s].

| | TanEO - $v_{mean}$ [m/s] | | | | | | TanEC - $v_{mean}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 393,9302 | -0,8282 | 0,2737 | 401,3895 | -0,9459 | 0,2460 | 540,6653 | -0,8097 | 0,2641 | 505,4153 | -0,4480 | 0,2441 |
| 4 | 377,7004 | -0,7654 | 0,2771 | 375,8632 | -0,9099 | 0,2433 | 512,8263 | -0,7198 | 0,2667 | 472,9714 | -0,4389 | 0,2447 |
| 5 | 361,5912 | -0,7023 | 0,2805 | 350,4055 | -0,8740 | 0,2407 | 485,1718 | -0,6299 | 0,2694 | 440,5595 | -0,4289 | 0,2453 |
| 6 | 346,0424 | -0,6379 | 0,2841 | 325,7036 | -0,8386 | 0,2390 | 458,4612 | -0,5405 | 0,2723 | 408,7619 | -0,4140 | 0,2464 |
| 7 | 331,3893 | -0,5732 | 0,2875 | 303,9024 | -0,8034 | 0,2386 | 433,3058 | -0,4534 | 0,2750 | 380,2120 | -0,3917 | 0,2480 |
| 8 | 319,6445 | -0,5104 | 0,2897 | 287,2408 | -0,7689 | 0,2392 | 411,6381 | -0,3721 | 0,2765 | 358,4225 | -0,3590 | 0,2492 |
| 9 | 312,9876 | -0,4544 | 0,2897 | 276,3362 | -0,7384 | 0,2417 | 395,6283 | -0,3008 | 0,2761 | 343,6336 | -0,3155 | 0,2497 |
| 10 | 311,0790 | -0,4099 | 0,2866 | 269,8120 | -0,7176 | 0,2457 | 384,3800 | -0,2404 | 0,2743 | 334,2688 | -0,2639 | 0,2487 |
| 11 | 310,6400 | -0,3764 | 0,2810 | 264,3268 | -0,7083 | 0,2498 | 373,6339 | -0,1899 | 0,2717 | 327,2838 | -0,2029 | 0,2459 |
| 12 | 307,2216 | -0,3514 | 0,2747 | 257,3755 | -0,7076 | 0,2532 | 358,7177 | -0,1462 | 0,2685 | 318,9284 | -0,1336 | 0,2411 |
| 13 | 300,2890 | -0,3322 | 0,2677 | 249,5213 | -0,7117 | 0,2553 | 341,3804 | -0,1066 | 0,2648 | 308,6109 | -0,0607 | 0,2348 |
| 14 | 292,0166 | -0,3169 | 0,2597 | 241,0725 | -0,7167 | 0,2569 | 326,0986 | -0,0704 | 0,2602 | 296,5667 | 0,0142 | 0,2275 |
| 15 | 282,7948 | -0,3018 | 0,2506 | 230,9741 | -0,7194 | 0,2591 | 313,4119 | -0,0363 | 0,2548 | 283,0344 | 0,0896 | 0,2197 |
| 16 | 272,4543 | -0,2855 | 0,2408 | 218,4634 | -0,7201 | 0,2620 | 301,4853 | -0,0032 | 0,2488 | 266,9870 | 0,1666 | 0,2118 |
| 17 | 261,1039 | -0,2685 | 0,2309 | 204,2578 | -0,7197 | 0,2655 | 289,0205 | 0,0293 | 0,2424 | 248,9475 | 0,2446 | 0,2040 |

**Table S2d.** LMS parameters per age group and gender, One Leg Stance, $v_{mean}$ [m/s].

| | 1L EO - $v_{mean}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 922,5746 | 0,3351 | 0,2949 | 711,1495 | -0,5722 | 0,2559 |
| 4 | 858,7285 | 0,2835 | 0,2948 | 664,4194 | -0,5210 | 0,2538 |
| 5 | 795,0391 | 0,2321 | 0,2946 | 617,6474 | -0,4699 | 0,2517 |
| 6 | 732,4480 | 0,1815 | 0,2940 | 570,9651 | -0,4186 | 0,2491 |
| 7 | 672,7598 | 0,1325 | 0,2920 | 526,4385 | -0,3700 | 0,2454 |
| 8 | 618,7642 | 0,0846 | 0,2881 | 487,7524 | -0,3314 | 0,2406 |
| 9 | 575,5103 | 0,0384 | 0,2828 | 455,2329 | -0,3088 | 0,2354 |
| 10 | 547,4494 | -0,0051 | 0,2772 | 431,1204 | -0,3046 | 0,2306 |
| 11 | 532,0197 | -0,0478 | 0,2729 | 417,1009 | -0,3175 | 0,2258 |
| 12 | 522,4338 | -0,0931 | 0,2695 | 406,4656 | -0,3406 | 0,2213 |
| 13 | 514,4264 | -0,1396 | 0,2665 | 394,2852 | -0,3685 | 0,2179 |
| 14 | 507,0164 | -0,1880 | 0,2638 | 378,5650 | -0,3939 | 0,2159 |
| 15 | 498,3354 | -0,2387 | 0,2610 | 362,7413 | -0,4138 | 0,2150 |
| 16 | 488,0953 | -0,2925 | 0,2586 | 350,3517 | -0,4315 | 0,2143 |
| 17 | 475,3389 | -0,3488 | 0,2565 | 340,1125 | -0,4488 | 0,2139 |

**Table S3.**Parameter: $vCoF_{range,95\%}$.

**Table S3a.** LMS parameters per age group and gender, Romberg Tests, $vCoF_{range,95\%}$ [m/s].

| | RomEO - $vCoF_{range,95\%}$ [m/s] | | | | | | RomEC - $vCoF_{range,95\%}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 3,2340 | -1,4984 | 0,2289 | 3,2673 | -0,4535 | 0,1873 | 4,6268 | -0,9182 | 0,3016 | 4,0960 | -0,2557 | 0,2020 |
| 4 | 3,0737 | -1,3580 | 0,2368 | 3,0434 | -0,4094 | 0,1875 | 4,2893 | -0,8052 | 0,3010 | 3,7818 | -0,2625 | 0,2078 |
| 5 | 2,9130 | -1,2180 | 0,2449 | 2,8213 | -0,3661 | 0,1877 | 3,9525 | -0,6924 | 0,3003 | 3,4687 | -0,2693 | 0,2138 |
| 6 | 2,7526 | -1,0803 | 0,2533 | 2,6091 | -0,3274 | 0,1880 | 3,6235 | -0,5810 | 0,2996 | 3,1643 | -0,2772 | 0,2201 |
| 7 | 2,6011 | -0,9472 | 0,2619 | 2,4174 | -0,2992 | 0,1894 | 3,3209 | -0,4747 | 0,2992 | 2,8900 | -0,2887 | 0,2275 |
| 8 | 2,4790 | -0,8202 | 0,2702 | 2,2632 | -0,2829 | 0,1924 | 3,0691 | -0,3774 | 0,2996 | 2,6712 | -0,3050 | 0,2360 |
| 9 | 2,3966 | -0,6996 | 0,2775 | 2,1451 | -0,2753 | 0,1972 | 2,8821 | -0,2902 | 0,3007 | 2,5090 | -0,3285 | 0,2454 |
| 10 | 2,3452 | -0,5855 | 0,2833 | 2,0496 | -0,2709 | 0,2038 | 2,7458 | -0,2135 | 0,3027 | 2,3890 | -0,3607 | 0,2546 |
| 11 | 2,2965 | -0,4765 | 0,2881 | 1,9644 | -0,2639 | 0,2115 | 2,6226 | -0,1433 | 0,3062 | 2,2931 | -0,4004 | 0,2626 |
| 12 | 2,2297 | -0,3680 | 0,2909 | 1,8839 | -0,2555 | 0,2199 | 2,4874 | -0,0730 | 0,3102 | 2,1998 | -0,4483 | 0,2682 |
| 13 | 2,1596 | -0,2593 | 0,2909 | 1,8096 | -0,2474 | 0,2280 | 2,3537 | 0,0008 | 0,3127 | 2,1074 | -0,5049 | 0,2705 |
| 14 | 2,1044 | -0,1509 | 0,2881 | 1,7507 | -0,2369 | 0,2357 | 2,2536 | 0,0766 | 0,3125 | 2,0192 | -0,5681 | 0,2698 |
| 15 | 2,0635 | -0,0428 | 0,2833 | 1,7074 | -0,2237 | 0,2435 | 2,1842 | 0,1533 | 0,3092 | 1,9327 | -0,6374 | 0,2671 |
| 16 | 2,0343 | 0,0660 | 0,2773 | 1,6786 | -0,2106 | 0,2512 | 2,1347 | 0,2302 | 0,3035 | 1,8421 | -0,7099 | 0,2629 |
| 17 | 2,0114 | 0,1757 | 0,2711 | 1,6557 | -0,1992 | 0,2590 | 2,0922 | 0,3071 | 0,2968 | 1,7491 | -0,7833 | 0,2580 |

**Table S3b.** LMS parameters per age group and gender, Semi-Tandem Tests, $vCoF_{range,95\%}$ [m/s].

| | SemTnEO - $vCoF_{range,95\%}$ [m/s] | | | | | | SemTanEC - $vCoF_{range,95\%}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 5,0003 | -1,0078 | 0,2956 | 4,8845 | -1,1304 | 0,2065 | 6,2047 | -0,8634 | 0,3070 | 6,1262 | -0,9273 | 0,2074 |
| 4 | 4,6883 | -0,9627 | 0,2998 | 4,4980 | -1,0221 | 0,2201 | 5,7957 | -0,7729 | 0,3120 | 5,5876 | -0,7603 | 0,2176 |
| 5 | 4,3778 | -0,9180 | 0,3043 | 4,1150 | -0,9144 | 0,2345 | 5,3876 | -0,6827 | 0,3170 | 5,0527 | -0,5938 | 0,2282 |
| 6 | 4,0772 | -0,8755 | 0,3096 | 3,7576 | -0,8116 | 0,2491 | 4,9900 | -0,5939 | 0,3220 | 4,5497 | -0,4304 | 0,2388 |
| 7 | 3,7997 | -0,8361 | 0,3159 | 3,4618 | -0,7221 | 0,2628 | 4,6337 | -0,5084 | 0,3266 | 4,1403 | -0,2753 | 0,2497 |
| 8 | 3,5790 | -0,7987 | 0,3222 | 3,2350 | -0,6500 | 0,2745 | 4,3653 | -0,4259 | 0,3300 | 3,8596 | -0,1333 | 0,2609 |
| 9 | 3,4457 | -0,7606 | 0,3266 | 3,0610 | -0,5942 | 0,2842 | 4,2028 | -0,3467 | 0,3312 | 3,6919 | -0,0038 | 0,2728 |
| 10 | 3,3948 | -0,7179 | 0,3270 | 2,9350 | -0,5503 | 0,2911 | 4,1117 | -0,2720 | 0,3302 | 3,5878 | 0,1139 | 0,2842 |
| 11 | 3,3776 | -0,6678 | 0,3238 | 2,8438 | -0,5179 | 0,2951 | 4,0216 | -0,2041 | 0,3283 | 3,5038 | 0,2218 | 0,2928 |
| 12 | 3,3393 | -0,6096 | 0,3176 | 2,7490 | -0,4950 | 0,2961 | 3,8778 | -0,1438 | 0,3266 | 3,4003 | 0,3196 | 0,2976 |
| 13 | 3,2705 | -0,5425 | 0,3085 | 2,6396 | -0,4826 | 0,2950 | 3,6817 | -0,0916 | 0,3256 | 3,2644 | 0,4075 | 0,2988 |
| 14 | 3,1973 | -0,4667 | 0,2969 | 2,5262 | -0,4787 | 0,2927 | 3,4875 | -0,0471 | 0,3247 | 3,1102 | 0,4867 | 0,2986 |
| 15 | 3,1371 | -0,3833 | 0,2838 | 2,4121 | -0,4785 | 0,2899 | 3,3102 | -0,0052 | 0,3242 | 2,9465 | 0,5585 | 0,2988 |
| 16 | 3,0893 | -0,2952 | 0,2699 | 2,3039 | -0,4789 | 0,2869 | 3,1450 | 0,0371 | 0,3244 | 2,7674 | 0,6248 | 0,2991 |
| 17 | 3,0447 | -0,2063 | 0,2560 | 2,1942 | -0,4793 | 0,2841 | 2,9725 | 0,0805 | 0,3247 | 2,5713 | 0,6896 | 0,2994 |

**Table S3c.** LMS parameters per age group and gender, Tandem Tests, $vCoF_{range,95\%}$ [m/s].

| | TanEO - $vCoF_{range,95\%}$ [m/s] | | | | | | TanEC - $vCoF_{range,95\%}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 7,2312 | -0,6253 | 0,3378 | 6,8852 | -0,9910 | 0,3159 | 9,6609 | -0,8533 | 0,3075 | 9,6350 | -0,0723 | 0,3816 |
| 4 | 6,9080 | -0,6079 | 0,3445 | 6,4668 | -0,9714 | 0,3201 | 9,1372 | -0,7703 | 0,3119 | 8,8778 | -0,0758 | 0,3653 |
| 5 | 6,5874 | -0,5902 | 0,3514 | 6,0523 | -0,9522 | 0,3243 | 8,6175 | -0,6875 | 0,3165 | 8,1255 | -0,0794 | 0,3499 |
| 6 | 6,2809 | -0,5711 | 0,3584 | 5,6616 | -0,9356 | 0,3282 | 8,1195 | -0,6068 | 0,3211 | 7,4073 | -0,0841 | 0,3367 |
| 7 | 5,9962 | -0,5502 | 0,3656 | 5,3214 | -0,9239 | 0,3309 | 7,6575 | -0,5303 | 0,3255 | 6,7805 | -0,0909 | 0,3252 |
| 8 | 5,7557 | -0,5277 | 0,3720 | 5,0555 | -0,9170 | 0,3317 | 7,2570 | -0,4590 | 0,3282 | 6,3082 | -0,0982 | 0,3149 |
| 9 | 5,5945 | -0,5054 | 0,3758 | 4,8550 | -0,9150 | 0,3315 | 6,9591 | -0,3955 | 0,3283 | 5,9770 | -0,1047 | 0,3052 |
| 10 | 5,5116 | -0,4855 | 0,3747 | 4,7060 | -0,9187 | 0,3300 | 6,7470 | -0,3411 | 0,3260 | 5,7470 | -0,1112 | 0,2960 |
| 11 | 5,4448 | -0,4685 | 0,3676 | 4,5681 | -0,9246 | 0,3260 | 6,5288 | -0,2955 | 0,3228 | 5,5610 | -0,1149 | 0,2872 |
| 12 | 5,2991 | -0,4546 | 0,3568 | 4,4030 | -0,9304 | 0,3191 | 6,2163 | -0,2552 | 0,3199 | 5,3453 | -0,1139 | 0,2787 |
| 13 | 5,0783 | -0,4430 | 0,3435 | 4,2159 | -0,9341 | 0,3094 | 5,8454 | -0,2179 | 0,3168 | 5,1006 | -0,1109 | 0,2713 |
| 14 | 4,8587 | -0,4329 | 0,3277 | 4,0177 | -0,9335 | 0,2981 | 5,5193 | -0,1834 | 0,3133 | 4,8435 | -0,1074 | 0,2656 |
| 15 | 4,6883 | -0,4235 | 0,3105 | 3,7961 | -0,9297 | 0,2863 | 5,2632 | -0,1512 | 0,3090 | 4,5859 | -0,1042 | 0,2618 |
| 16 | 4,5861 | -0,4147 | 0,2928 | 3,5241 | -0,9241 | 0,2747 | 5,0412 | -0,1203 | 0,3045 | 4,3087 | -0,1014 | 0,2590 |
| 17 | 4,5109 | -0,4065 | 0,2759 | 3,2094 | -0,9177 | 0,2638 | 4,8164 | -0,0896 | 0,2999 | 4,0064 | -0,0980 | 0,2566 |

**Table S3d.** LMS parameters per age group and gender, One Leg Stance, $vCoF_{range,95\%}$ [m/s].

| | 1L EO - $vCoF_{range,95\%}$ [m/s] | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 16,1151 | 0,7189 | 0,2906 | 12,5119 | -0,0975 | 0,2813 |
| 4 | 15,0204 | 0,6334 | 0,2968 | 11,7064 | -0,1017 | 0,2808 |
| 5 | 13,9267 | 0,5480 | 0,3030 | 10,9010 | -0,1059 | 0,2803 |
| 6 | 12,8438 | 0,4637 | 0,3086 | 10,0988 | -0,1094 | 0,2795 |
| 7 | 11,8004 | 0,3818 | 0,3123 | 9,3228 | -0,1082 | 0,2784 |
| 8 | 10,8413 | 0,3022 | 0,3132 | 8,6218 | -0,1035 | 0,2777 |
| 9 | 10,0704 | 0,2248 | 0,3110 | 8,0170 | -0,1017 | 0,2777 |
| 10 | 9,5839 | 0,1498 | 0,3063 | 7,5702 | -0,1085 | 0,2778 |
| 11 | 9,3285 | 0,0784 | 0,3004 | 7,3242 | -0,1270 | 0,2765 |
| 12 | 9,1866 | 0,0107 | 0,2939 | 7,1490 | -0,1571 | 0,2734 |
| 13 | 9,0746 | -0,0524 | 0,2871 | 6,9450 | -0,1975 | 0,2688 |
| 14 | 8,9489 | -0,1114 | 0,2796 | 6,6540 | -0,2423 | 0,2634 |
| 15 | 8,7743 | -0,1693 | 0,2710 | 6,3285 | -0,2882 | 0,2578 |
| 16 | 8,5520 | -0,2292 | 0,2618 | 6,0229 | -0,3356 | 0,2523 |
| 17 | 8,2724 | -0,2904 | 0,2526 | 5,7296 | -0,3835 | 0,2473 |

**Table S4.** Parameter: *Equilibrium Score ML*.

**Table S4a.** LMS parameters per age group and gender, Romberg Tests, *Equilibrium Score ML* [%].

| | RomEO - *Eqilibrium Score ML* [%] | | | | | | RomEC - *Equilibirum Score ML* [%] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 87,3252 | 17,7018 | 0,0520 | 87,2360 | 7,5575 | 0,0385 | 82,9529 | 7,3979 | 0,0653 | 84,3454 | 4,4830 | 0,0355 |
| 4 | 88,2540 | 19,3798 | 0,0500 | 88,2496 | 8,6836 | 0,0341 | 84,4813 | 10,0275 | 0,0633 | 85,7071 | 5,2988 | 0,0335 |
| 5 | 89,1724 | 21,0533 | 0,0481 | 89,2578 | 9,7984 | 0,0304 | 86,0052 | 12,6569 | 0,0613 | 87,0628 | 6,1213 | 0,0316 |
| 6 | 90,0812 | 22,6984 | 0,0464 | 90,2358 | 10,8636 | 0,0271 | 87,4515 | 15,2841 | 0,0593 | 88,3781 | 6,9887 | 0,0298 |
| 7 | 90,9409 | 24,2792 | 0,0447 | 91,1520 | 11,9109 | 0,0246 | 88,7649 | 17,9018 | 0,0572 | 89,5869 | 7,9674 | 0,0282 |
| 8 | 91,6822 | 25,7601 | 0,0432 | 91,9506 | 13,0092 | 0,0226 | 89,8728 | 20,5027 | 0,0547 | 90,5940 | 9,1303 | 0,0266 |
| 9 | 92,2300 | 27,1260 | 0,0415 | 92,5857 | 14,2006 | 0,0211 | 90,7281 | 23,0771 | 0,0519 | 91,3679 | 10,4688 | 0,0251 |
| 10 | 92,6013 | 28,3647 | 0,0398 | 93,0750 | 15,4930 | 0,0201 | 91,3651 | 25,6101 | 0,0489 | 91,9598 | 11,9440 | 0,0236 |
| 11 | 92,8605 | 29,4952 | 0,0382 | 93,4608 | 16,8758 | 0,0193 | 91,8680 | 28,0965 | 0,0459 | 92,4542 | 13,5445 | 0,0222 |
| 12 | 93,0718 | 30,5425 | 0,0368 | 93,7851 | 18,3378 | 0,0186 | 92,3140 | 30,5324 | 0,0430 | 92,9067 | 15,2643 | 0,0208 |
| 13 | 93,2506 | 31,5193 | 0,0355 | 94,0471 | 19,8833 | 0,0181 | 92,7082 | 32,9277 | 0,0404 | 93,2944 | 17,0888 | 0,0195 |
| 14 | 93,3421 | 32,4480 | 0,0342 | 94,2419 | 21,5101 | 0,0175 | 93,0242 | 35,2936 | 0,0379 | 93,5919 | 18,9843 | 0,0183 |
| 15 | 93,3431 | 33,3474 | 0,0328 | 94,3899 | 23,1858 | 0,0170 | 93,2623 | 37,6381 | 0,0355 | 93,8027 | 20,9089 | 0,0173 |
| 16 | 93,2943 | 34,2246 | 0,0315 | 94,5009 | 24,8829 | 0,0166 | 93,4498 | 39,9668 | 0,0333 | 93,9586 | 22,8342 | 0,0163 |
| 17 | 93,2340 | 35,0877 | 0,0303 | 94,5817 | 26,5796 | 0,0162 | 93,6360 | 42,2847 | 0,0312 | 94,0759 | 24,7556 | 0,0154 |

**Table S4b.** LMS parameters per age group and gender, Semi-Tandem Tests, *Equilibrium Score ML* [%].

| | SemTnEO - *Eqilibrium Score ML* [%] | | | | | | SemTanEC - *Eqilibrium Score ML* [%] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 84,4425 | 12,7219 | 0,0733 | 84,7461 | 11,2071 | 0,0570 | 81,6211 | 8,1007 | 0,0732 | 82,6319 | 7,2114 | 0,0541 |
| 4 | 85,5991 | 14,1373 | 0,0711 | 86,1226 | 13,4207 | 0,0568 | 83,0268 | 10,0261 | 0,0695 | 84,1317 | 7,4385 | 0,0492 |
| 5 | 86,7350 | 15,5517 | 0,0689 | 87,4793 | 15,6360 | 0,0566 | 84,3975 | 11,9487 | 0,0661 | 85,6292 | 7,6661 | 0,0448 |
| 6 | 87,8558 | 16,9618 | 0,0669 | 88,7714 | 17,8582 | 0,0563 | 85,7445 | 13,8545 | 0,0629 | 87,0788 | 7,9074 | 0,0409 |
| 7 | 88,9210 | 18,3657 | 0,0648 | 89,9272 | 20,0839 | 0,0556 | 87,0341 | 15,7287 | 0,0600 | 88,3900 | 8,2191 | 0,0374 |
| 8 | 89,8366 | 19,7419 | 0,0627 | 90,8828 | 22,3122 | 0,0545 | 88,1847 | 17,5560 | 0,0572 | 89,4678 | 8,6615 | 0,0343 |
| 9 | 90,5115 | 21,0643 | 0,0602 | 91,6080 | 24,5336 | 0,0527 | 89,1350 | 19,3301 | 0,0542 | 90,2849 | 9,2704 | 0,0316 |
| 10 | 90,9511 | 22,3214 | 0,0575 | 92,1286 | 26,7384 | 0,0506 | 89,8891 | 21,0509 | 0,0512 | 90,8947 | 10,0681 | 0,0291 |
| 11 | 91,2564 | 23,5165 | 0,0548 | 92,5275 | 28,9310 | 0,0483 | 90,5417 | 22,7102 | 0,0484 | 91,3818 | 11,0141 | 0,0268 |
| 12 | 91,5552 | 24,6594 | 0,0524 | 92,8738 | 31,1207 | 0,0459 | 91,1701 | 24,3184 | 0,0458 | 91,8128 | 12,0384 | 0,0246 |
| 13 | 91,8541 | 25,7701 | 0,0501 | 93,1814 | 33,3110 | 0,0436 | 91,7595 | 25,9001 | 0,0433 | 92,2069 | 13,1002 | 0,0226 |
| 14 | 92,0987 | 26,8636 | 0,0479 | 93,4954 | 35,4907 | 0,0414 | 92,1944 | 27,4721 | 0,0408 | 92,5846 | 14,1849 | 0,0207 |
| 15 | 92,2893 | 27,9478 | 0,0457 | 93,8085 | 37,6564 | 0,0394 | 92,4756 | 29,0409 | 0,0383 | 92,9016 | 15,2754 | 0,0190 |
| 16 | 92,4809 | 29,0282 | 0,0436 | 94,0805 | 39,8147 | 0,0374 | 92,6619 | 30,6093 | 0,0359 | 93,1692 | 16,3508 | 0,0173 |
| 17 | 92,7084 | 30,1066 | 0,0417 | 94,3129 | 41,9699 | 0,0354 | 92,8257 | 32,1771 | 0,0336 | 93,3900 | 17,4200 | 0,0158 |

**Table S4c.** LMS parameters per age group and gender, Tandem Tests, *Equilibrium Score ML* [%].

| | TanEO - *Eqilibrium Score ML* [%] | | | | | | TanEC - *Equilibirum Score ML* [%] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 80,8008 | 7,2002 | 0,0968 | 81,0855 | 7,9114 | 0,0902 | 78,0702 | 5,6636 | 0,0909 | 79,7420 | 6,5050 | 0,0840 |
| 4 | 82,4259 | 8,5683 | 0,0927 | 82,8240 | 9,2958 | 0,0874 | 80,0023 | 7,4765 | 0,0859 | 81,7356 | 8,6805 | 0,0802 |
| 5 | 83,9922 | 9,9346 | 0,0888 | 84,5119 | 10,6797 | 0,0847 | 81,8909 | 9,2878 | 0,0811 | 83,6705 | 10,8561 | 0,0765 |
| 6 | 85,4757 | 11,2916 | 0,0850 | 86,1008 | 12,0590 | 0,0819 | 83,6753 | 11,0942 | 0,0766 | 85,4837 | 13,0334 | 0,0728 |
| 7 | 86,8210 | 12,6356 | 0,0811 | 87,5072 | 13,4205 | 0,0790 | 85,3079 | 12,9075 | 0,0720 | 87,0810 | 15,2178 | 0,0687 |
| 8 | 87,9499 | 13,9548 | 0,0770 | 88,6800 | 14,7456 | 0,0759 | 86,7066 | 14,7386 | 0,0672 | 88,3608 | 17,3982 | 0,0641 |
| 9 | 88,8042 | 15,2335 | 0,0725 | 89,5784 | 15,9970 | 0,0727 | 87,8046 | 16,5882 | 0,0620 | 89,3340 | 19,5566 | 0,0591 |
| 10 | 89,3780 | 16,4752 | 0,0678 | 90,1920 | 17,1674 | 0,0696 | 88,6317 | 18,4577 | 0,0566 | 90,0782 | 21,6890 | 0,0540 |
| 11 | 89,7864 | 17,6977 | 0,0630 | 90,6602 | 18,2656 | 0,0666 | 89,3026 | 20,3563 | 0,0512 | 90,7107 | 23,8024 | 0,0490 |
| 12 | 90,1993 | 18,9203 | 0,0584 | 91,0664 | 19,3063 | 0,0640 | 89,9631 | 22,2789 | 0,0463 | 91,2964 | 25,9060 | 0,0445 |
| 13 | 90,6488 | 20,1573 | 0,0541 | 91,3607 | 20,3043 | 0,0615 | 90,6317 | 24,2132 | 0,0419 | 91,8049 | 28,0020 | 0,0402 |
| 14 | 91,0576 | 21,4156 | 0,0498 | 91,5654 | 21,2777 | 0,0590 | 91,2262 | 26,1526 | 0,0378 | 92,1917 | 30,0990 | 0,0363 |
| 15 | 91,4169 | 22,6921 | 0,0458 | 91,7458 | 22,2479 | 0,0567 | 91,7204 | 28,0966 | 0,0341 | 92,4103 | 32,2050 | 0,0325 |
| 16 | 91,7468 | 23,9802 | 0,0419 | 91,9857 | 23,2219 | 0,0544 | 92,1283 | 30,0419 | 0,0306 | 92,5214 | 34,3206 | 0,0289 |
| 17 | 92,0820 | 25,2736 | 0,0384 | 92,2632 | 24,1990 | 0,0523 | 92,4841 | 31,9881 | 0,0275 | 92,5748 | 36,4416 | 0,0257 |

**Table S4d.** LMS parameters per age group and gender, One Leg Stance, *Equilibrium Score ML* [%].

| | 1L EO - *Eqilibrium Score ML* [%] | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 69,0002 | 2,6623 | 0,1199 | 75,2085 | 3,1123 | 0,0842 |
| 4 | 71,1974 | 2,9837 | 0,1067 | 76,8488 | 3,5904 | 0,0760 |
| 5 | 73,3856 | 3,3057 | 0,0949 | 78,4876 | 4,0668 | 0,0686 |
| 6 | 75,5260 | 3,6325 | 0,0846 | 80,1158 | 4,5394 | 0,0619 |
| 7 | 77,5854 | 3,9764 | 0,0758 | 81,6971 | 5,0289 | 0,0557 |
| 8 | 79,5388 | 4,3462 | 0,0683 | 83,1517 | 5,5611 | 0,0502 |
| 9 | 81,2592 | 4,7361 | 0,0620 | 84,4565 | 6,1294 | 0,0455 |
| 10 | 82,5846 | 5,1363 | 0,0568 | 85,5367 | 6,7017 | 0,0418 |
| 11 | 83,5454 | 5,5374 | 0,0524 | 86,3727 | 7,2461 | 0,0387 |
| 12 | 84,3375 | 5,9140 | 0,0485 | 87,0673 | 7,7337 | 0,0362 |
| 13 | 85,0400 | 6,2414 | 0,0449 | 87,6042 | 8,1559 | 0,0342 |
| 14 | 85,5940 | 6,5270 | 0,0418 | 87,9767 | 8,5184 | 0,0326 |
| 15 | 86,0082 | 6,7792 | 0,0393 | 88,1462 | 8,8474 | 0,0312 |
| 16 | 86,3182 | 7,0118 | 0,0373 | 88,0979 | 9,1637 | 0,0301 |
| 17 | 86,5967 | 7,2366 | 0,0356 | 87,9575 | 9,4758 | 0,0290 |

**Table S5.** Parameter: *Equilibrium Score AP*.

**Table S5a.** LMS parameters per age group and gender, Romberg Tests, *Equilibrium Score AP* [%].

| | RomEO - *Eqilibrium Score AP* [%] | | | | | | RomEC - *Equilibirum Score AP* [%] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 89,0331 | 15,1182 | 0,0836 | 89,0622 | 15,0342 | 0,0503 | 87,6851 | 11,0585 | 0,0664 | 87,7126 | 2,0198 | 0,0498 |
| 4 | 89,8798 | 16,7119 | 0,0764 | 90,1270 | 18,0579 | 0,0472 | 88,5599 | 11,0271 | 0,0587 | 88,9593 | 3,4568 | 0,0442 |
| 5 | 90,7211 | 18,3128 | 0,0697 | 91,1430 | 21,0835 | 0,0444 | 89,4883 | 11,0001 | 0,0520 | 90,1986 | 4,8937 | 0,0392 |
| 6 | 91,5470 | 19,9442 | 0,0636 | 92,0872 | 24,1057 | 0,0415 | 90,4462 | 10,9965 | 0,0459 | 91,3902 | 6,3329 | 0,0347 |
| 7 | 92,3314 | 21,5810 | 0,0578 | 92,9362 | 27,0582 | 0,0387 | 91,3974 | 11,0267 | 0,0406 | 92,4681 | 7,8057 | 0,0308 |
| 8 | 93,0104 | 23,1704 | 0,0522 | 93,6615 | 29,8635 | 0,0358 | 92,2715 | 11,0865 | 0,0360 | 93,3620 | 9,4112 | 0,0275 |
| 9 | 93,5276 | 24,6706 | 0,0468 | 94,2646 | 32,4913 | 0,0330 | 92,9816 | 11,1762 | 0,0321 | 94,0620 | 11,2298 | 0,0249 |
| 10 | 93,8918 | 26,0582 | 0,0416 | 94,7532 | 34,9666 | 0,0302 | 93,5329 | 11,3258 | 0,0288 | 94,5826 | 13,2938 | 0,0227 |
| 11 | 94,2054 | 27,3220 | 0,0368 | 95,1317 | 37,3620 | 0,0274 | 94,0365 | 11,5645 | 0,0262 | 94,9767 | 15,5837 | 0,0208 |
| 12 | 94,5574 | 28,4901 | 0,0324 | 95,4336 | 39,7308 | 0,0247 | 94,5753 | 11,9039 | 0,0239 | 95,3181 | 18,0584 | 0,0190 |
| 13 | 94,9103 | 29,6078 | 0,0284 | 95,6671 | 42,1254 | 0,0220 | 95,0964 | 12,3354 | 0,0220 | 95,6166 | 20,6919 | 0,0173 |
| 14 | 95,1931 | 30,7115 | 0,0247 | 95,8557 | 44,5673 | 0,0195 | 95,5022 | 12,8570 | 0,0202 | 95,9075 | 23,4450 | 0,0157 |
| 15 | 95,4163 | 31,8226 | 0,0212 | 96,0369 | 47,0431 | 0,0171 | 95,7917 | 13,4444 | 0,0186 | 96,2357 | 26,2697 | 0,0142 |
| 16 | 95,6213 | 32,9468 | 0,0181 | 96,2175 | 49,5392 | 0,0150 | 96,0023 | 14,0715 | 0,0171 | 96,6216 | 29,1259 | 0,0128 |
| 17 | 95,8395 | 34,0773 | 0,0155 | 96,4176 | 52,0432 | 0,0132 | 96,1966 | 14,7147 | 0,0158 | 97,0379 | 31,9877 | 0,0116 |

**Table S5b.** LMS parameters per age group and gender, Semi-Tandem Tests, *Equilibrium Score AP* [%].

| | SemTnEO - *Eqilibrium Score AP* [%] | | | | | | SemTanEC - *Equilibirum Score AP* [%] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 83,4103 | 11,7389 | 0,0795 | 83,2378 | 10,5117 | 0,0600 | 80,1095 | 6,8562 | 0,0736 | 80,6399 | 2,8571 | 0,0531 |
| 4 | 84,2909 | 11,7110 | 0,0729 | 84,5742 | 11,0147 | 0,0568 | 81,5067 | 7,1972 | 0,0691 | 82,3276 | 3,2301 | 0,0505 |
| 5 | 85,2040 | 11,6830 | 0,0669 | 85,9052 | 11,5108 | 0,0538 | 82,9076 | 7,5363 | 0,0649 | 84,0044 | 3,6049 | 0,0481 |
| 6 | 86,1814 | 11,6515 | 0,0615 | 87,1969 | 11,9698 | 0,0510 | 84,3212 | 7,8633 | 0,0610 | 85,6062 | 3,9919 | 0,0457 |
| 7 | 87,2129 | 11,6015 | 0,0567 | 88,3726 | 12,3808 | 0,0481 | 85,7140 | 8,1634 | 0,0572 | 87,0353 | 4,4061 | 0,0435 |
| 8 | 88,2102 | 11,5085 | 0,0523 | 89,3879 | 12,7640 | 0,0453 | 86,9877 | 8,4213 | 0,0536 | 88,2372 | 4,8539 | 0,0412 |
| 9 | 89,0562 | 11,3465 | 0,0482 | 90,2370 | 13,1328 | 0,0423 | 88,0203 | 8,6273 | 0,0500 | 89,2024 | 5,3554 | 0,0389 |
| 10 | 89,6960 | 11,1074 | 0,0444 | 90,9278 | 13,4797 | 0,0392 | 88,8056 | 8,7745 | 0,0464 | 89,9492 | 5,9052 | 0,0366 |
| 11 | 90,2034 | 10,7904 | 0,0408 | 91,4967 | 13,7992 | 0,0359 | 89,5054 | 8,8557 | 0,0430 | 90,5551 | 6,4971 | 0,0342 |
| 12 | 90,6987 | 10,4069 | 0,0375 | 92,0107 | 14,0938 | 0,0326 | 90,2411 | 8,8678 | 0,0397 | 91,0895 | 7,1355 | 0,0319 |
| 13 | 91,1994 | 9,9852 | 0,0344 | 92,5025 | 14,3782 | 0,0294 | 90,9917 | 8,8205 | 0,0366 | 91,5749 | 7,8253 | 0,0298 |
| 14 | 91,6389 | 9,5473 | 0,0314 | 93,0053 | 14,6490 | 0,0262 | 91,6133 | 8,7348 | 0,0336 | 92,0390 | 8,5641 | 0,0278 |
| 15 | 92,0458 | 9,0937 | 0,0286 | 93,5194 | 14,8975 | 0,0232 | 92,1339 | 8,6281 | 0,0307 | 92,5143 | 9,3328 | 0,0260 |
| 16 | 92,4915 | 8,6209 | 0,0260 | 94,0261 | 15,1318 | 0,0204 | 92,6565 | 8,5122 | 0,0281 | 93,0481 | 10,1125 | 0,0242 |
| 17 | 92,9949 | 8,1353 | 0,0237 | 94,5324 | 15,3649 | 0,0180 | 93,2423 | 8,3886 | 0,0257 | 93,6339 | 10,8960 | 0,0224 |

**Table S5c.** LMS parameters per age group and gender, Tandem Tests, *Equilibrium Score AP* [%].

| | TanEO - *Eqilibrium Score AP* [%] | | | | | | TanEC - *Equilibirum Score AP* [%] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 79,6861 | 3,4937 | 0,0663 | 80,5680 | 10,4310 | 0,0607 | 74,7870 | 3,4128 | 0,0784 | 76,3443 | 4,1376 | 0,0655 |
| 4 | 81,0497 | 4,5082 | 0,0617 | 82,0347 | 10,3785 | 0,0569 | 76,4305 | 3,7779 | 0,0734 | 78,0167 | 3,9275 | 0,0606 |
| 5 | 82,4128 | 5,5171 | 0,0575 | 83,5026 | 10,3235 | 0,0534 | 78,0692 | 4,1435 | 0,0687 | 79,6861 | 3,7172 | 0,0561 |
| 6 | 83,7565 | 6,4978 | 0,0536 | 84,9059 | 10,2585 | 0,0500 | 79,6829 | 4,5145 | 0,0644 | 81,3195 | 3,5103 | 0,0522 |
| 7 | 85,0443 | 7,4467 | 0,0500 | 86,1589 | 10,1912 | 0,0467 | 81,2519 | 4,9012 | 0,0605 | 82,8154 | 3,3275 | 0,0487 |
| 8 | 86,2125 | 8,3695 | 0,0467 | 87,2025 | 10,1309 | 0,0434 | 82,7170 | 5,3063 | 0,0567 | 84,0664 | 3,1956 | 0,0457 |
| 9 | 87,1599 | 9,2755 | 0,0437 | 88,0182 | 10,0916 | 0,0403 | 83,9786 | 5,7346 | 0,0531 | 85,0795 | 3,1279 | 0,0431 |
| 10 | 87,8418 | 10,1600 | 0,0407 | 88,6042 | 10,0838 | 0,0375 | 84,9960 | 6,1885 | 0,0497 | 85,8954 | 3,1136 | 0,0410 |
| 11 | 88,3114 | 11,0118 | 0,0377 | 89,0536 | 10,0941 | 0,0350 | 85,8662 | 6,6648 | 0,0464 | 86,6075 | 3,1231 | 0,0391 |
| 12 | 88,6729 | 11,8363 | 0,0349 | 89,4668 | 10,1122 | 0,0327 | 86,7252 | 7,1649 | 0,0434 | 87,2846 | 3,1619 | 0,0375 |
| 13 | 89,0141 | 12,6314 | 0,0321 | 89,8631 | 10,1451 | 0,0306 | 87,5459 | 7,6976 | 0,0407 | 87,9058 | 3,2353 | 0,0361 |
| 14 | 89,3613 | 13,4025 | 0,0294 | 90,2599 | 10,2045 | 0,0287 | 88,2059 | 8,2706 | 0,0382 | 88,4621 | 3,3359 | 0,0348 |
| 15 | 89,7195 | 14,1574 | 0,0268 | 90,6804 | 10,2825 | 0,0269 | 88,7561 | 8,8822 | 0,0358 | 88,9474 | 3,4580 | 0,0335 |
| 16 | 90,1011 | 14,9053 | 0,0244 | 91,1659 | 10,3703 | 0,0251 | 89,3121 | 9,5220 | 0,0337 | 89,4316 | 3,5889 | 0,0322 |
| 17 | 90,5254 | 15,6537 | 0,0222 | 91,7015 | 10,4589 | 0,0235 | 89,9044 | 10,1746 | 0,0317 | 89,9432 | 3,7229 | 0,0308 |

**Table S5d.** LMS parameters per age group and gender, One Leg Stance, *Equilibrium Score AP* [%].

| | 1L EO - *Eqilibrium Score AP* [%] | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 76,6441 | 2,4528 | 0,0642 | 79,2552 | 1,3270 | 0,0605 |
| 4 | 78,2453 | 2,7602 | 0,0590 | 80,6352 | 2,5994 | 0,0533 |
| 5 | 79,8430 | 3,0657 | 0,0541 | 82,0131 | 3,8788 | 0,0470 |
| 6 | 81,4125 | 3,3712 | 0,0496 | 83,3773 | 5,1901 | 0,0414 |
| 7 | 82,8958 | 3,7204 | 0,0454 | 84,6982 | 6,5394 | 0,0366 |
| 8 | 84,2183 | 4,1679 | 0,0416 | 85,9096 | 7,9838 | 0,0326 |
| 9 | 85,2925 | 4,7430 | 0,0382 | 86,9630 | 9,5566 | 0,0293 |
| 10 | 86,0718 | 5,4517 | 0,0353 | 87,7821 | 11,2395 | 0,0265 |
| 11 | 86,6298 | 6,2780 | 0,0330 | 88,3489 | 13,0095 | 0,0244 |
| 12 | 87,0918 | 7,1870 | 0,0311 | 88,7859 | 14,8245 | 0,0226 |
| 13 | 87,5159 | 8,1619 | 0,0297 | 89,1704 | 16,6511 | 0,0213 |
| 14 | 87,8862 | 9,1878 | 0,0285 | 89,5793 | 18,4840 | 0,0203 |
| 15 | 88,2207 | 10,2623 | 0,0275 | 89,9814 | 20,3146 | 0,0195 |
| 16 | 88,5943 | 11,3753 | 0,0268 | 90,3341 | 22,1439 | 0,0187 |
| 17 | 89,0187 | 12,5067 | 0,0263 | 90,6766 | 23,9739 | 0,0181 |

**Table S6.** Parameter: *Sway Angle SD ML* [°].

**Table S6a.** LMS parameters per age group and gender, Romberg Tests, *Sway Angle SD ML* [°].

| | RomEO - *Sway Angle SD ML* [°] | | | | | | RomEC - *Sway Angle SD ML* [°] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,3518 | -0,3082 | 0,4789 | 0,3572 | -0,0957 | 0,3628 | 0,3903 | -0,1339 | 0,5214 | 0,3770 | 0,6685 | 0,3907 |
| 4 | 0,3237 | -0,2512 | 0,4780 | 0,3213 | -0,0908 | 0,3688 | 0,3567 | -0,0778 | 0,5134 | 0,3375 | 0,6003 | 0,4044 |
| 5 | 0,2954 | -0,1942 | 0,4768 | 0,2856 | -0,0858 | 0,3747 | 0,3230 | -0,0215 | 0,5054 | 0,2981 | 0,5320 | 0,4183 |
| 6 | 0,2667 | -0,1374 | 0,4745 | 0,2512 | -0,0811 | 0,3798 | 0,2893 | 0,0349 | 0,4965 | 0,2601 | 0,4637 | 0,4313 |
| 7 | 0,2390 | -0,0805 | 0,4716 | 0,2201 | -0,0764 | 0,3844 | 0,2565 | 0,0905 | 0,4880 | 0,2257 | 0,3959 | 0,4438 |
| 8 | 0,2150 | -0,0212 | 0,4690 | 0,1948 | -0,0733 | 0,3903 | 0,2273 | 0,1449 | 0,4808 | 0,1978 | 0,3272 | 0,4560 |
| 9 | 0,1976 | 0,0426 | 0,4661 | 0,1758 | -0,0731 | 0,3980 | 0,2046 | 0,1977 | 0,4753 | 0,1763 | 0,2562 | 0,4663 |
| 10 | 0,1871 | 0,1102 | 0,4634 | 0,1624 | -0,0741 | 0,4061 | 0,1885 | 0,2475 | 0,4725 | 0,1610 | 0,1807 | 0,4727 |
| 11 | 0,1804 | 0,1810 | 0,4617 | 0,1529 | -0,0740 | 0,4113 | 0,1748 | 0,2926 | 0,4734 | 0,1497 | 0,0996 | 0,4729 |
| 12 | 0,1733 | 0,2536 | 0,4603 | 0,1451 | -0,0731 | 0,4118 | 0,1599 | 0,3311 | 0,4769 | 0,1394 | 0,0116 | 0,4669 |
| 13 | 0,1650 | 0,3262 | 0,4561 | 0,1379 | -0,0733 | 0,4064 | 0,1449 | 0,3611 | 0,4808 | 0,1297 | -0,0846 | 0,4558 |
| 14 | 0,1566 | 0,3974 | 0,4463 | 0,1305 | -0,0763 | 0,3957 | 0,1337 | 0,3817 | 0,4835 | 0,1195 | -0,1882 | 0,4415 |
| 15 | 0,1464 | 0,4682 | 0,4316 | 0,1224 | -0,0806 | 0,3817 | 0,1252 | 0,3955 | 0,4842 | 0,1076 | -0,2967 | 0,4258 |
| 16 | 0,1332 | 0,5397 | 0,4143 | 0,1141 | -0,0862 | 0,3665 | 0,1179 | 0,4058 | 0,4831 | 0,0936 | -0,4075 | 0,4103 |
| 17 | 0,1179 | 0,6116 | 0,3965 | 0,1054 | -0,0924 | 0,3514 | 0,1106 | 0,4149 | 0,4811 | 0,0785 | -0,5187 | 0,3952 |

**Table S6b.** LMS parameters per age group and gender, Semi-Tandem Tests, *Sway Angle SD ML* [°].

| | SemTnEO - *Sway Angle SD ML* [°] | | | | | | SemTanEC - *Sway Angle SD ML* [°] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,5245 | -0,1783 | 0,3205 | 0,5092 | -0,7621 | 0,2716 | 0,5949 | -0,1577 | 0,3113 | 0,5803 | 0,5266 | 0,2614 |
| 4 | 0,4955 | -0,1340 | 0,3323 | 0,4716 | -0,6316 | 0,2867 | 0,5553 | -0,1255 | 0,3258 | 0,5302 | 0,4953 | 0,2713 |
| 5 | 0,4661 | -0,0895 | 0,3446 | 0,4340 | -0,5018 | 0,3027 | 0,5155 | -0,0930 | 0,3410 | 0,4804 | 0,4637 | 0,2814 |
| 6 | 0,4347 | -0,0442 | 0,3573 | 0,3973 | -0,3758 | 0,3195 | 0,4744 | -0,0596 | 0,3565 | 0,4334 | 0,4308 | 0,2920 |
| 7 | 0,4011 | 0,0008 | 0,3702 | 0,3634 | -0,2571 | 0,3362 | 0,4329 | -0,0250 | 0,3722 | 0,3922 | 0,3957 | 0,3033 |
| 8 | 0,3683 | 0,0441 | 0,3828 | 0,3332 | -0,1509 | 0,3521 | 0,3942 | 0,0100 | 0,3868 | 0,3578 | 0,3590 | 0,3148 |
| 9 | 0,3409 | 0,0849 | 0,3937 | 0,3074 | -0,0614 | 0,3663 | 0,3631 | 0,0443 | 0,3990 | 0,3292 | 0,3225 | 0,3257 |
| 10 | 0,3217 | 0,1234 | 0,4014 | 0,2868 | 0,0112 | 0,3773 | 0,3408 | 0,0783 | 0,4088 | 0,3057 | 0,2880 | 0,3353 |
| 11 | 0,3082 | 0,1615 | 0,4062 | 0,2700 | 0,0708 | 0,3838 | 0,3219 | 0,1145 | 0,4170 | 0,2856 | 0,2558 | 0,3440 |
| 12 | 0,2952 | 0,2009 | 0,4081 | 0,2544 | 0,1239 | 0,3854 | 0,3007 | 0,1557 | 0,4228 | 0,2677 | 0,2252 | 0,3523 |
| 13 | 0,2809 | 0,2401 | 0,4068 | 0,2379 | 0,1735 | 0,3825 | 0,2782 | 0,2009 | 0,4259 | 0,2515 | 0,1945 | 0,3607 |
| 14 | 0,2669 | 0,2780 | 0,4020 | 0,2199 | 0,2216 | 0,3757 | 0,2588 | 0,2481 | 0,4253 | 0,2363 | 0,1618 | 0,3698 |
| 15 | 0,2526 | 0,3163 | 0,3951 | 0,2004 | 0,2705 | 0,3661 | 0,2412 | 0,2964 | 0,4218 | 0,2200 | 0,1281 | 0,3791 |
| 16 | 0,2354 | 0,3572 | 0,3870 | 0,1798 | 0,3205 | 0,3547 | 0,2229 | 0,3453 | 0,4174 | 0,2007 | 0,0944 | 0,3877 |
| 17 | 0,2155 | 0,4002 | 0,3787 | 0,1583 | 0,3705 | 0,3428 | 0,2020 | 0,3949 | 0,4129 | 0,1796 | 0,0603 | 0,3957 |

**Table S6c.** LMS parameters per age group and gender, Tandem Tests, *Sway Angle SD ML* [°].

| | TanEO - *Sway Angle SD ML* [°] | | | | | | TanEC - *Sway Angle SD ML* [°] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,6150 | 0,1072 | 0,2911 | 0,5900 | -0,3493 | 0,2864 | 0,7153 | -0,2742 | 0,2608 | 0,6787 | 0,3134 | 0,2315 |
| 4 | 0,5736 | 0,0773 | 0,2978 | 0,5446 | -0,2855 | 0,2945 | 0,6713 | -0,2423 | 0,2667 | 0,6318 | 0,3477 | 0,2371 |
| 5 | 0,5323 | 0,0478 | 0,3046 | 0,4996 | -0,2219 | 0,3028 | 0,6272 | -0,2105 | 0,2729 | 0,5851 | 0,3823 | 0,2431 |
| 6 | 0,4914 | 0,0203 | 0,3115 | 0,4573 | -0,1594 | 0,3108 | 0,5833 | -0,1794 | 0,2795 | 0,5401 | 0,4176 | 0,2497 |
| 7 | 0,4520 | -0,0047 | 0,3181 | 0,4195 | -0,0985 | 0,3162 | 0,5398 | -0,1506 | 0,2864 | 0,4993 | 0,4512 | 0,2570 |
| 8 | 0,4162 | -0,0272 | 0,3239 | 0,3870 | -0,0379 | 0,3172 | 0,4984 | -0,1247 | 0,2930 | 0,4650 | 0,4799 | 0,2640 |
| 9 | 0,3880 | -0,0481 | 0,3276 | 0,3617 | 0,0163 | 0,3152 | 0,4626 | -0,1033 | 0,2992 | 0,4373 | 0,5005 | 0,2711 |
| 10 | 0,3690 | -0,0666 | 0,3273 | 0,3447 | 0,0590 | 0,3114 | 0,4346 | -0,0883 | 0,3043 | 0,4153 | 0,5132 | 0,2781 |
| 11 | 0,3569 | -0,0804 | 0,3222 | 0,3327 | 0,0917 | 0,3069 | 0,4116 | -0,0802 | 0,3079 | 0,3961 | 0,5212 | 0,2851 |
| 12 | 0,3483 | -0,0902 | 0,3128 | 0,3223 | 0,1167 | 0,3025 | 0,3891 | -0,0795 | 0,3108 | 0,3772 | 0,5248 | 0,2917 |
| 13 | 0,3402 | -0,0967 | 0,3002 | 0,3126 | 0,1322 | 0,2986 | 0,3675 | -0,0893 | 0,3133 | 0,3597 | 0,5225 | 0,2978 |
| 14 | 0,3313 | -0,1015 | 0,2851 | 0,3021 | 0,1390 | 0,2946 | 0,3502 | -0,1122 | 0,3148 | 0,3439 | 0,5148 | 0,3034 |
| 15 | 0,3202 | -0,1049 | 0,2687 | 0,2893 | 0,1413 | 0,2899 | 0,3355 | -0,1472 | 0,3158 | 0,3293 | 0,5029 | 0,3079 |
| 16 | 0,3062 | -0,1074 | 0,2517 | 0,2731 | 0,1417 | 0,2848 | 0,3202 | -0,1904 | 0,3171 | 0,3137 | 0,4899 | 0,3107 |
| 17 | 0,2904 | -0,1102 | 0,2355 | 0,2545 | 0,1415 | 0,2794 | 0,3038 | -0,2372 | 0,3185 | 0,2964 | 0,4764 | 0,3125 |

**Table S6d.** LMS parameters per age group and gender, One Leg Stance, *Sway Angle SD ML* [°].

| | 1L EO - *Sway Angle SD ML* [°] | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,5202 | -0,6183 | 0,2476 | 0,5204 | 0,7423 | 0,2614 |
| 4 | 0,4954 | -0,5093 | 0,2458 | 0,4915 | 0,6107 | 0,2525 |
| 5 | 0,4705 | -0,4003 | 0,2439 | 0,4627 | 0,4785 | 0,2441 |
| 6 | 0,4459 | -0,2925 | 0,2418 | 0,4340 | 0,3445 | 0,2367 |
| 7 | 0,4222 | -0,1912 | 0,2396 | 0,4053 | 0,2117 | 0,2306 |
| 8 | 0,4001 | -0,1023 | 0,2372 | 0,3771 | 0,0813 | 0,2260 |
| 9 | 0,3814 | -0,0307 | 0,2351 | 0,3514 | -0,0507 | 0,2220 |
| 10 | 0,3679 | 0,0191 | 0,2335 | 0,3319 | -0,1892 | 0,2178 |
| 11 | 0,3587 | 0,0465 | 0,2326 | 0,3200 | -0,3354 | 0,2133 |
| 12 | 0,3510 | 0,0558 | 0,2330 | 0,3116 | -0,4816 | 0,2090 |
| 13 | 0,3431 | 0,0475 | 0,2350 | 0,3044 | -0,6219 | 0,2058 |
| 14 | 0,3346 | 0,0232 | 0,2386 | 0,2955 | -0,7556 | 0,2041 |
| 15 | 0,3244 | -0,0135 | 0,2445 | 0,2851 | -0,8817 | 0,2040 |
| 16 | 0,3124 | -0,0579 | 0,2535 | 0,2743 | -1,0007 | 0,2053 |
| 17 | 0,2992 | -0,1057 | 0,2650 | 0,2623 | -1,1149 | 0,2071 |

**Table S7.** Parameter: *Sway Angle SD AP* [°].

**Table S7a.** LMS parameters per age group and gender, Romberg Tests, *Sway Angle SD AP* [°].

| | RomEO - *Sway Angle SD AP* [°] | | | | | | RomEC - *Sway Angle SD AP* [°] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,4145 | -0,4027 | 0,3196 | 0,4065 | -0,0503 | 0,3032 | 0,5015 | 0,1224 | 0,3684 | 0,4623 | 0,4101 | 0,2237 |
| 4 | 0,3802 | -0,4026 | 0,3186 | 0,3720 | -0,0477 | 0,2970 | 0,4606 | 0,0802 | 0,3619 | 0,4226 | 0,3598 | 0,2364 |
| 5 | 0,3460 | -0,4021 | 0,3177 | 0,3378 | -0,0443 | 0,2912 | 0,4196 | 0,0382 | 0,3556 | 0,3832 | 0,3093 | 0,2497 |
| 6 | 0,3125 | -0,3996 | 0,3174 | 0,3050 | -0,0376 | 0,2866 | 0,3792 | -0,0033 | 0,3494 | 0,3451 | 0,2573 | 0,2637 |
| 7 | 0,2816 | -0,3942 | 0,3179 | 0,2753 | -0,0290 | 0,2842 | 0,3413 | -0,0471 | 0,3438 | 0,3105 | 0,2017 | 0,2779 |
| 8 | 0,2564 | -0,3879 | 0,3195 | 0,2506 | -0,0207 | 0,2849 | 0,3085 | -0,0944 | 0,3390 | 0,2828 | 0,1411 | 0,2919 |
| 9 | 0,2397 | -0,3829 | 0,3217 | 0,2322 | -0,0136 | 0,2886 | 0,2831 | -0,1448 | 0,3352 | 0,2628 | 0,0784 | 0,3043 |
| 10 | 0,2306 | -0,3771 | 0,3248 | 0,2192 | -0,0076 | 0,2945 | 0,2647 | -0,1956 | 0,3324 | 0,2476 | 0,0183 | 0,3136 |
| 11 | 0,2249 | -0,3680 | 0,3280 | 0,2090 | -0,0019 | 0,3003 | 0,2501 | -0,2430 | 0,3304 | 0,2328 | -0,0380 | 0,3180 |
| 12 | 0,2200 | -0,3538 | 0,3301 | 0,1998 | 0,0041 | 0,3047 | 0,2368 | -0,2815 | 0,3287 | 0,2176 | -0,0940 | 0,3181 |
| 13 | 0,2161 | -0,3361 | 0,3313 | 0,1917 | 0,0089 | 0,3067 | 0,2248 | -0,3116 | 0,3266 | 0,2046 | -0,1563 | 0,3152 |
| 14 | 0,2150 | -0,3173 | 0,3306 | 0,1852 | 0,0110 | 0,3064 | 0,2162 | -0,3361 | 0,3237 | 0,1960 | -0,2262 | 0,3104 |
| 15 | 0,2163 | -0,2983 | 0,3276 | 0,1796 | 0,0126 | 0,3045 | 0,2111 | -0,3563 | 0,3200 | 0,1913 | -0,3000 | 0,3050 |
| 16 | 0,2188 | -0,2782 | 0,3232 | 0,1749 | 0,0146 | 0,3017 | 0,2087 | -0,3728 | 0,3161 | 0,1887 | -0,3744 | 0,2989 |
| 17 | 0,2214 | -0,2567 | 0,3182 | 0,1712 | 0,0171 | 0,2986 | 0,2074 | -0,3876 | 0,3126 | 0,1871 | -0,4482 | 0,2926 |

**Table S7b.** LMS parameters per age group and gender, Semi-Tandem Tests, *Sway Angle SD AP* [°].

| | SemTnEO - *Sway Angle SD AP* [°] | | | | | | SemTanEC - *Sway Angle SD AP* [°] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,4666 | -0,4855 | 0,3353 | 0,4616 | -0,7714 | 0,3343 | 0,5226 | -0,0974 | 0,3231 | 0,5105 | -0,0778 | 0,2999 |
| 4 | 0,4334 | -0,4736 | 0,3419 | 0,4209 | -0,7165 | 0,3409 | 0,4860 | -0,1460 | 0,3245 | 0,4627 | -0,0644 | 0,3039 |
| 5 | 0,3999 | -0,4614 | 0,3486 | 0,3804 | -0,6622 | 0,3477 | 0,4492 | -0,1938 | 0,3262 | 0,4152 | -0,0511 | 0,3080 |
| 6 | 0,3657 | -0,4473 | 0,3556 | 0,3414 | -0,6111 | 0,3547 | 0,4118 | -0,2375 | 0,3288 | 0,3697 | -0,0390 | 0,3122 |
| 7 | 0,3318 | -0,4300 | 0,3622 | 0,3064 | -0,5665 | 0,3621 | 0,3754 | -0,2731 | 0,3327 | 0,3293 | -0,0316 | 0,3163 |
| 8 | 0,3025 | -0,4096 | 0,3685 | 0,2778 | -0,5301 | 0,3696 | 0,3424 | -0,2978 | 0,3372 | 0,2973 | -0,0331 | 0,3198 |
| 9 | 0,2827 | -0,3854 | 0,3745 | 0,2573 | -0,5017 | 0,3762 | 0,3148 | -0,3112 | 0,3415 | 0,2747 | -0,0463 | 0,3218 |
| 10 | 0,2726 | -0,3564 | 0,3802 | 0,2439 | -0,4777 | 0,3808 | 0,2924 | -0,3151 | 0,3452 | 0,2588 | -0,0732 | 0,3212 |
| 11 | 0,2669 | -0,3200 | 0,3858 | 0,2334 | -0,4537 | 0,3818 | 0,2734 | -0,3125 | 0,3485 | 0,2461 | -0,1111 | 0,3178 |
| 12 | 0,2603 | -0,2733 | 0,3908 | 0,2231 | -0,4294 | 0,3794 | 0,2556 | -0,3068 | 0,3505 | 0,2350 | -0,1558 | 0,3127 |
| 13 | 0,2522 | -0,2172 | 0,3941 | 0,2129 | -0,4060 | 0,3747 | 0,2397 | -0,3028 | 0,3500 | 0,2249 | -0,2035 | 0,3063 |
| 14 | 0,2448 | -0,1553 | 0,3948 | 0,2024 | -0,3846 | 0,3704 | 0,2300 | -0,3022 | 0,3463 | 0,2152 | -0,2526 | 0,2996 |
| 15 | 0,2382 | -0,0900 | 0,3938 | 0,1925 | -0,3654 | 0,3678 | 0,2256 | -0,3033 | 0,3398 | 0,2074 | -0,3018 | 0,2920 |
| 16 | 0,2310 | -0,0227 | 0,3920 | 0,1845 | -0,3476 | 0,3660 | 0,2239 | -0,3041 | 0,3319 | 0,2011 | -0,3493 | 0,2834 |
| 17 | 0,2229 | 0,0455 | 0,3896 | 0,1783 | -0,3302 | 0,3646 | 0,2229 | -0,3042 | 0,3235 | 0,1962 | -0,3960 | 0,2744 |

**Table S7c.** LMS parameters per age group and gender, Tandem Tests, *Sway Angle SD AP* [°].

| | TanEO - *Sway Angle SD AP* [°] | | | | | | TanEC - *Sway Angle SD AP* [°] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | | Female | | | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,5387 | -0,5904 | 0,4001 | 0,5591 | -0,5392 | 0,4025 | 0,5996 | -0,4694 | 0,3603 | 0,5573 | 0,0308 | 0,3475 |
| 4 | 0,4926 | -0,5758 | 0,4029 | 0,5040 | -0,5205 | 0,4112 | 0,5488 | -0,4970 | 0,3613 | 0,5047 | -0,0078 | 0,3517 |
| 5 | 0,4466 | -0,5610 | 0,4058 | 0,4491 | -0,5020 | 0,4201 | 0,4983 | -0,5244 | 0,3622 | 0,4522 | -0,0462 | 0,3558 |
| 6 | 0,4018 | -0,5452 | 0,4089 | 0,3960 | -0,4837 | 0,4287 | 0,4491 | -0,5509 | 0,3626 | 0,4011 | -0,0840 | 0,3593 |
| 7 | 0,3607 | -0,5287 | 0,4118 | 0,3483 | -0,4643 | 0,4359 | 0,4030 | -0,5771 | 0,3615 | 0,3543 | -0,1227 | 0,3606 |
| 8 | 0,3270 | -0,5120 | 0,4148 | 0,3090 | -0,4414 | 0,4411 | 0,3631 | -0,6053 | 0,3581 | 0,3160 | -0,1650 | 0,3592 |
| 9 | 0,3041 | -0,4967 | 0,4183 | 0,2825 | -0,4158 | 0,4463 | 0,3324 | -0,6391 | 0,3525 | 0,2876 | -0,2125 | 0,3559 |
| 10 | 0,2931 | -0,4846 | 0,4224 | 0,2692 | -0,3884 | 0,4522 | 0,3097 | -0,6803 | 0,3458 | 0,2669 | -0,2647 | 0,3512 |
| 11 | 0,2889 | -0,4767 | 0,4269 | 0,2618 | -0,3584 | 0,4591 | 0,2909 | -0,7273 | 0,3390 | 0,2496 | -0,3192 | 0,3458 |
| 12 | 0,2839 | -0,4726 | 0,4326 | 0,2565 | -0,3245 | 0,4664 | 0,2713 | -0,7762 | 0,3328 | 0,2342 | -0,3741 | 0,3400 |
| 13 | 0,2755 | -0,4715 | 0,4394 | 0,2554 | -0,2875 | 0,4732 | 0,2518 | -0,8237 | 0,3264 | 0,2222 | -0,4288 | 0,3333 |
| 14 | 0,2650 | -0,4724 | 0,4463 | 0,2564 | -0,2487 | 0,4789 | 0,2363 | -0,8696 | 0,3192 | 0,2142 | -0,4825 | 0,3249 |
| 15 | 0,2525 | -0,4735 | 0,4519 | 0,2557 | -0,2094 | 0,4831 | 0,2251 | -0,9144 | 0,3105 | 0,2113 | -0,5334 | 0,3142 |
| 16 | 0,2383 | -0,4733 | 0,4558 | 0,2506 | -0,1702 | 0,4861 | 0,2182 | -0,9595 | 0,3006 | 0,2115 | -0,5816 | 0,3016 |
| 17 | 0,2227 | -0,4723 | 0,4587 | 0,2429 | -0,1310 | 0,4885 | 0,2137 | -1,0046 | 0,2904 | 0,2134 | -0,6287 | 0,2884 |

**Table S7d.** LMS parameters per age group and gender, One Leg Stance, *Sway Angle SD AP* [°].

| | 1L EO - *Sway Angle SD AP* [°] | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| Age | C50 | Lambda | Sigma | C50 | Lambda | Sigma |
| 3 | 0,8103 | 0,2492 | 0,2567 | 0,6459 | -0,0025 | 0,2854 |
| 4 | 0,7578 | 0,2204 | 0,2585 | 0,6102 | -0,0158 | 0,2825 |
| 5 | 0,7055 | 0,1912 | 0,2604 | 0,5746 | -0,0293 | 0,2797 |
| 6 | 0,6549 | 0,1597 | 0,2628 | 0,5390 | -0,0438 | 0,2767 |
| 7 | 0,6060 | 0,1247 | 0,2659 | 0,5032 | -0,0603 | 0,2738 |
| 8 | 0,5593 | 0,0857 | 0,2696 | 0,4693 | -0,0797 | 0,2712 |
| 9 | 0,5189 | 0,0449 | 0,2736 | 0,4390 | -0,1025 | 0,2693 |
| 10 | 0,4895 | 0,0048 | 0,2767 | 0,4145 | -0,1247 | 0,2680 |
| 11 | 0,4696 | -0,0324 | 0,2783 | 0,3951 | -0,1389 | 0,2671 |
| 12 | 0,4528 | -0,0594 | 0,2777 | 0,3774 | -0,1400 | 0,2659 |
| 13 | 0,4366 | -0,0664 | 0,2758 | 0,3629 | -0,1278 | 0,2648 |
| 14 | 0,4222 | -0,0516 | 0,2748 | 0,3527 | -0,1065 | 0,2640 |
| 15 | 0,4092 | -0,0174 | 0,2762 | 0,3480 | -0,0818 | 0,2634 |
| 16 | 0,3984 | 0,0296 | 0,2807 | 0,3495 | -0,0568 | 0,2626 |
| 17 | 0,3888 | 0,0826 | 0,2876 | 0,3526 | -0,0314 | 0,2614 |