The gait pattern of healthy old people for fast walking condition

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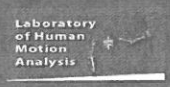

The 10th WORLD CONFERENCE of GERONTECHNOLOGY

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To assess gait pattern of healthy old people for dual task walking condition

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Disclosure of interest

- No disclosure of interest

The background

Accelerometric and kinematic methods have been described as reliable tools for human gait analysis

Gait performances in dual task could be considered as a reflect of the cerebral burden linked to the age

But reference data for healthy old people still lacking

The goal

To provide references values concerning the gait pattern of healthy old people for dual task condition

The method

After local press call and personal phone contact

127 volunteers benefit from a functional assessment

According the functional assessment

66 volunteers older than 65 years were included as « healthy old »

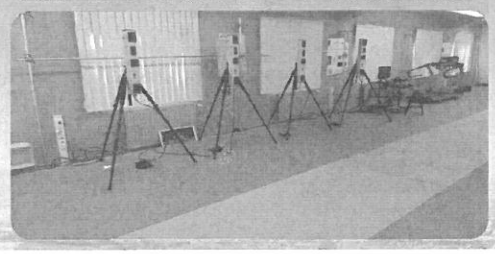
Inclusion criteria
To be older than 65 years
Understanding french
Living independantly at home

Exclusion criteria
Acute cardiac or respiratory illness
Alcoholism, cognitive or mood disorders
Gait complain, cautious gait or walking aids
Knee or hip prothesis earlier than 6 month
Neurologic or osteo-articular disorders
Fall in the previous year
Frailty
Neoplasm

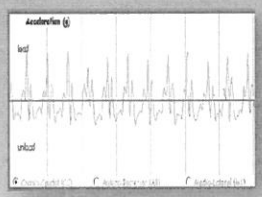
The method

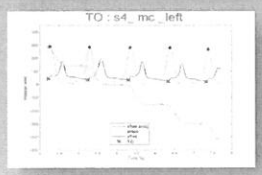
Data acquisition

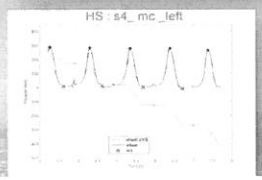
Cognitive task: Serial sevens counting down



Gait parameters extraction







From the accelerometer:
Gait speed, Stride length and frequency, Regularity and Symmetry, from C-C accelerations and after Fourier transformation
Auvinet et al. Gait and Posture, 2002.

From the kinematic method:
Swing time and ratio (proportion of gait cycle),
Stance time and ratio,
Double support time and ratio,
Minimum toe clearance,
using a validated software automatically detecting gait events (HS and TO).
Boutaayamou et al. Medical Engineering and Physics, 2015.

The results

Gait parameters obtained during dual task from the accelerometer

The correlation between gait parameters both extracted by the two methods show ICC 0.97(GS), 0.82(SL), 0.83(SF)

Post-hoc analyses confirm the difference in **normalized SL** according to the **gender** (p=0.0093) and to the **age category** (p=0.041).

Gait parameters (unit)	Men (Mean ± SD)		Women (Mean ± SD)		P-values	CI 95%
	< 70, N=9	≥ 70, N=20	< 70, N=26	≥ 70, N=11		
Gait speed (m/s)	**1.36 ± 0.25**	**1.22 ± 0.21**	**1.16 ± 0.24**	**1.09 ± 0.16**	**0.042**	1.14 - 1.25
Normalized gait speed	1.55 ± 0.27	1.42 ± 0.24	1.14 ± 0.30	1.35 ± 0.19	0.41	1.36 - 1.48
Stride length (m)	**1.30 ± 0.28**	**1.60 ± 0.53**	**1.33 ± 0.21**	**1.23 ± 0.15**	**0.0009**	1.23 - 1.37
Normalized stride length	**1.83 ± 0.62**	**1.54 ± 0.22**	**1.49 ± 0.19**	**1.46 ± 0.15**	**0.021**	1.47 - 1.62
Cadence (stride/s)	0.87 ± 0.10	0.92 ± 0.07	0.93 ± 0.11	0.92 ± 0.09	0.47	0.89 - 0.94
Stride Regularity (dimensionless)	307 ± 58	240 ± 48	262 ± 70	248 ± 78	0.074	243 - 275
Symmetry (dimensionless)	208 ± 49	210 ± 61	231 ± 75	244 ± 64	0.45	207 - 240

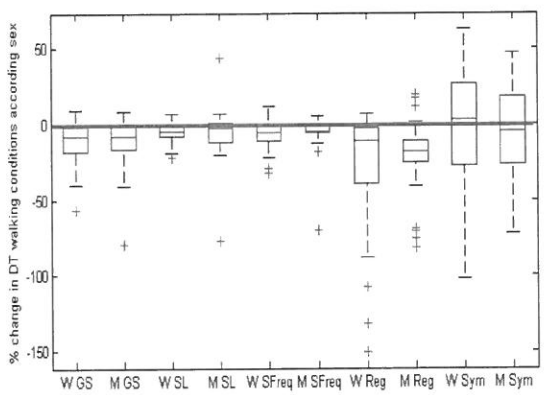
The results

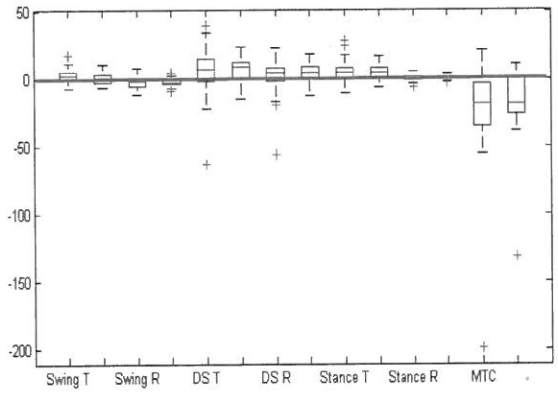
Gait parameters obtained during dual task from the opto-electronic method

Gait parameters (unit)	Men (Mean ± SD)		Women (Mean ± SD)		P-values	CI 95%
	< 70, N=9	≥ 70, N=20	< 70, N=26	≥ 70, N=11		
Swing Time (s)	0.38 ± 0.03	0.39 ± 0.03	0.38 ± 0.03	0.37 ± 0.03	0.63	0.38 - 0.39
Swing Ratio (% of the stride time)	35.50 ± 1.66	35.75 ± 1.27	35.19 ± 2.63	34.68 ± 2.46	0.62	34.80 - 35.88
Double Support Time (s)	0.16 ± 0.03	0.15 ± 0.02	0.16 ± 0.05	0.17 ± 0.04	0.74	0.15 - 0.17
Double Support Ratio (% of the stride time)	14.43 ± 1.64	14.14 ± 1.24	14.71 ± 2.58	15.21 ± 2.54	0.61	14.03 - 15.10
Stance Time (s)	0.69 ± 0.07	0.70 ± 0.05	0.71 ± 0.11	0.71 ± 0.08	0.94	0.68 - 0.73
Stance Ratio (% of the stride time)	64.50 ± 1.66	64.25 ± 1.27	64.81 ± 2.63	65.32 ± 2.46	0.62	64.12 - 65.20
Min Toe Clearance (mm)	**19 ± 6**	**17 ± 4**	**13± 5**	**15 ± 5**	**0.0016**	14.01 - 16.62

Post-hoc analyses confirm the difference in **MTC** according to the **gender** (p=0.0010)

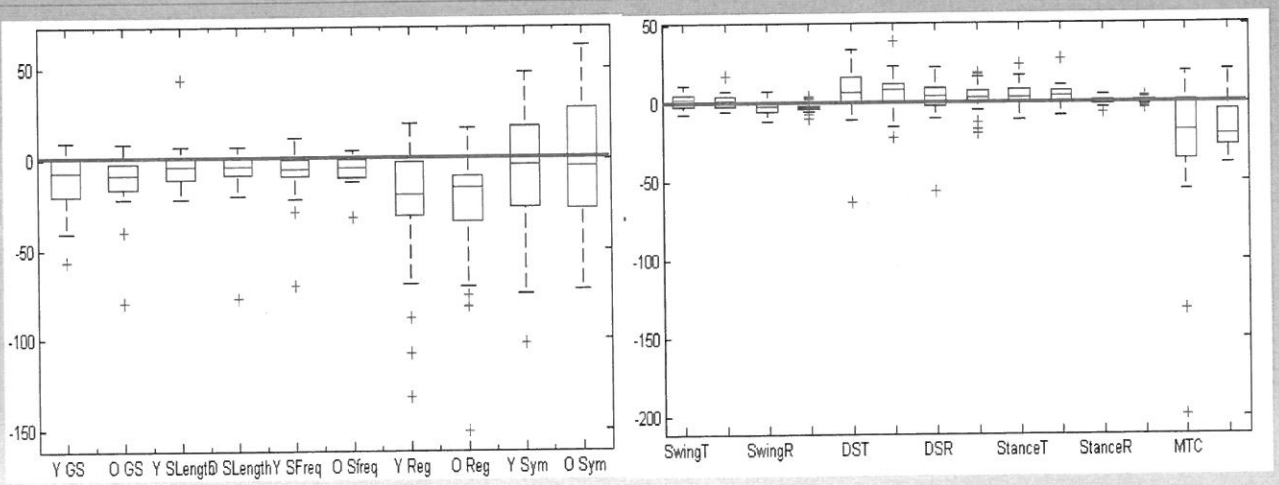
Gait parameters changes between comfortable and DT walking conditions (DT cost) according to the gender





One-way ANOVA analysis confirm that the « DT cost » of gait parameters are not different according to the gender

Gait parameters changes between comfortable and DT walking (DT cost) conditions according to the age category (<70 or ≥70 years)



One-way ANOVA analysis confirm that the « DT cost » of gait parameters are not different according to the age category

Take Home Messages

This work provides **reference values** for **14 gait parameters** assessed in **healthy old people** for dual task walking condition

After normalization to the leg length

- The **SL and the MTC** show a difference according to the **gender** (as for comfortable condition)
- The **SL** shows a difference according to the **age** category

In healthy old people, gait parameters changes observed (between comfortable and dual task walking conditions) are not different considering the age category or the gender

The strongs of this work were

- The strict selection of healthy old people
- The extraction of 14 gait parameters using two complementary validated methods

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Thank you for your attention

Special thanks to the other members of the team:

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C. Schwartz for the **Laboratory of Human Motion Analysis** - LAMH, University of Liège

M. Boutaayamou for the **INTELSIG Laboratory**, University of Liège

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127 volunteers benefit from a functional assessment

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Inclusion criteria

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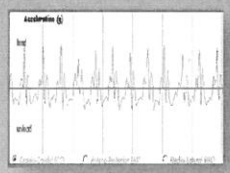
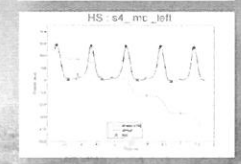
Gait parameters extraction





From the accelerometer (and stopwatch):
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Boutaayamou et al. Medical Engineering and Physics, 2015.

The results: Gait parameters from the accelerometer

Normalization:
to the right leg length.

The correlation between gait parameters both extracted by the two methods was calculated and show excellent ICC : 0.95 for GS, 0.96 for SL and 0.93 for SF.

Post-hoc analyses confirm the difference in **GS** (p=0.0019), **SL** (p<0.001) and **Normalized SL** (p=0.0019) according to the **gender**

AND a difference in **SL** according to the **age category** (p=0.026).

Gait parameters (unit)	Men (Mean ± SD)		Women (Mean ± SD)		P-values	CI 95%
	< 70, N=9	≥ 70, N=20	< 70, N=26	≥ 70, N=11		
Gait speed (m/s)	1.43 ± 0.17	1.35 ± 0.17	1.27 ± 0.22	1.18 ± 0.16	0.017	1.25 - 1.35
Normalized gait speed (1/s)	1.63 ± 0.21	1.57 ± 0.19	1.54 ± 0.27	1.47 ± 0.21	0.44	1.50 - 1.60
Stride length (m)	1.50 ± 0.15	1.41 ± 0.15	1.30 ± 0.15	1.20 ± 0.11	<0.0001	1.30 - 1.39
Normalized stride length (dimensionless)	1.71 ± 0.15	1.64 ± 0.14	1.57 ± 0.17	1.50 ± 0.16	0.019	1.56 - 1.64
Stride Frequency (stride/s)	0.95 ± 0.07	0.95 ± 0.06	0.98 ± 0.09	0.97 ± 0.06	0.69	0.95 - 0.98
Stride Regularity (dimensionless)	337 ± 27	297 ± 56	314 ± 37	291 ± 50	0.085	297 - 319
Symmetry (dimensionless)	206 ± 37	214 ± 63	231± 61	200 ± 60	0.42	203 - 232

The results: Gait parameters from kinematic method

Post-hoc analyses confirm the difference in **MTC** (p=0.0003) according to the **gender**.

Gait parameters (unit)	Men (Mean ± SD)		Women (Mean ± SD)		P-values	CI 95%
	< 70, N=9	≥ 70, N=20	< 70, N=26	≥ 70, N=11		
Swing Time (s)	0.38 ± 0.03	0.38 ± 0.03	0.37 ± 0.02	0.36 ± 0.02	0.12	0.37 - 0.38
Swing Ratio (% of the stride time)	36.27 ± 1.38	36.45 ± 1.52	35.88 ± 1.97	35.21 ± 1.43	0.31	35.6 - 36.4
Double Support Time (s)	0.14 ± 0.01	0.14 ± 0.02	0.15 ± 0.03	0.15 ± 0.02	0.71	0.14 - 0.15
Double Support Ratio (% of the stride time)	13.65 ± 1.36	13.46 ± 1.60	14.07 ± 1.98	14.72 ± 1.52	0.30	13.47 - 14.35
Stance Time (s)	0.67 ± 0.04	0.66 ± 0.04	0.66 ± 0.07	0.67 ± 0.05	0.99	0.65 - 0.68
Stance Ratio (% of the stride time)	63.73 ± 1.38	63.55 ± 1.52	64.12 ± 1.97	64.79 ± 1.43	0.31	63.54 - 64.41
Min Toe Clearance (mm)	21 ± 2	20 ± 4	15 ± 5	16 ± 5	0.0007	16 – 19

The Take Home Messages

This work provides **reference values** for **14 gait parameters** assessed in **healthy old people** for comfortable walking condition

After normalization to the leg length

- The normalized **SL and the MTC** show a difference according to the **gender**
- Any gait parameter shows a difference according to the age category

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