



Sensor based assessment of mobility and fall risk

*In the lab or in daily life,
does it matter where to measure?*

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Fall risk assessment

Predictive ability of questionnaires and motor performance tests is still insufficient

(Peeters et al, 2011; Hamacher et al, 2011)

Trunk accelerations to complement fall risk assessment

(Hausdorff et al, 1997; vanSwearingen et al, 1998; Lockhart et al, 2008)

- Require long data series
- Exhibit day-to-day variations

Ambulatory assessment over multiple days seems desirable

Fall risk assessment from gait analysis

Estimate characteristics in the lab

- Many relations with fall risk found

Estimate characteristics in daily life

- Very recent studies (2013 –)
- Some relations with fall risk as well

Relation between lab and daily life?

- Which characteristics agree?

Measuring 3D accelerations

In daily life (FARAO)

- One week
- Extract gait episodes
- Analyze in 10s periods



In lab data

- Five minutes at fixed speed
- Extract middle three minutes
- Analyze in 10s periods as well



Gait characteristics from accelerations

- **Estimated Gait quality characteristics**

Stride time

Intensity (Range and standard deviation)

Stride variability / regularity (Autocorrelation, power and width of ground frequency in psd)

Symmetry (Harmonic ratio)

Smoothness (Index of harmonicity)

Sample entropy

Local divergence exponent (Lyapunov exponent)

Which will agree?

Test relation lab – daily life

Relative agreement

- Pearson's correlation

Systematic difference between settings

- Paired t-test

Relative agreement

	R	(<i>p</i>)
Stride Time	0.53	(0.02)
Stride Time Variability	0.01	(0.98)
Stride Regularity VT	0.55	(0.02)
Stride Regularity ML	0.54	(0.02)
Stride Regularity AP	0.49	(0.04)
Harmonic Ratio VT	-0.09	(0.74)
Harmonic Ratio ML	0.55	(0.02)
Harmonic Ratio AP	0.18	(0.46)
Lyapunov Exponent (VT)	0.55	(0.02)
Lyapunov Exponent/stride	0.65	(0.003)

Condition bias, all significant

	Lab		Home	
	Mean	Std	Mean	Std
Stride Time	1.09	0.07	1.19	0.12
Stride Time Variability	1.55	0.31	7.65	4.10
Stride Regularity VT	0.85	0.06	0.53	0.18
Stride Regularity ML	0.69	0.09	0.40	0.14
Stride Regularity AP	0.79	0.07	0.47	0.15
Harmonic Ratio VT	3.80	0.92	2.36	0.56
Harmonic Ratio ML	2.59	0.60	1.91	0.33
Harmonic Ratio AP	3.41	0.77	2.01	0.50
Lyapunov Exponent	0.83	0.25	1.46	0.31
Lyapunov Exponent/stride	0.90	0.29	1.68	0.42

Between-condition correlation of gait characteristics

Why are some correlated?

- The same 'human system' will show the same characteristics (i.e., the individual's physical and cognitive capacities)

Why are some not correlated?

- Conditions in daily life vary within subjects
- Characteristics depend heavily on conditions (i.e., situational factors)

What's better?

Why choose lab?

- Similar conditions for all participants
- Measure someone's ability
- Allowing direct targets for intervention?

Why daily life?

- See someone's natural behavior
- Measure stability as shown in daily life
- Characteristics obtained at low risk situations ("extreme values") indicate someone's ability?

Future evaluation

- Fall prediction models on characteristics obtained from either or both conditions

Relative agreement

- Relative agreement differs between characteristics.
- Factors deciding agreement are not fully understood.

Systematic differences between settings

- Most characteristics show a systematic difference between lab and daily life settings, partly explained by velocity.

Thank you

www.fbw.vu.nl/fallrisk

Discussion

