How to measure disability, the disablement process and early signs of disability?

- Kirsten Avlund
- Professor, Dr.Med., Ph.D.
- Department of Social Medicine
- Institute of Public Health
- University of Copenhagen

- REVES
- Copenhagen 28 May 2009
The disablement process

Pathology → Impairments → Functional limitations → Disability

External factors (Social)

Genes → Life Style

Internal Factors

The disablement process

• Pathology
  – Disease, injury, developmental conditions

• Impairment
  – Dysfunction and structural abnormalities in specific body systems

• Functional limitations
  – Restrictions in basic physical and mental actions

• Disability
  – Difficulties doing activities of daily life
## Impairments, functional limitations and disability

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Func limitations</th>
<th>Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomical, physiological, mental abnormality or loss</td>
<td>Limitation in performance at the level of the whole person</td>
<td>Difficulty in doing socially defined roles and tasks within a socio-cultural and physical environment</td>
</tr>
<tr>
<td>e.g. Gait assessment</td>
<td>Walking speed</td>
<td>Trouble walking on stairs</td>
</tr>
</tbody>
</table>
Pathology ➔ Impairment ➔ Functional Limitation ➔ Disability

Denervated muscle in arm due to trauma ➔ Atrophy of muscle ➔ Cannot pull with arm ➔ Change of job; can no longer swim recreationally
**Differentiating Functional Limitation and Disability**
Nagi, IOM Report, 1991

<table>
<thead>
<tr>
<th>Functional Limitation</th>
<th>Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limitation in performance at the level of the whole organism or person</td>
<td>Limitation in performance of socially defined roles and tasks within a sociocultural and physical environment</td>
</tr>
</tbody>
</table>

*Functional limitation* refers to organismic performance; *disability* refers to social performance.
Measuring Functional Limitations and Disability

- Functional limitations and physical disability refer to different behaviors not to different ways of measuring the same behavior.

- Thus, you can measure functional limitations and physical disabilities using either subjective or objective measures.
Examples of Objective Performance Tests Used to Evaluate Functional Limitations

- Pegboard test
- Picking up object
- Lifting 10 pounds
- Gait speed
- Chair rise – single and repeated
- Stair climb
Most measures of disability include

Mobility e.g. walk on stairs, take long walks

ADL Activities of Daily Living e.g. bathing, dressing

IADL Instrumental Activities of Daily Living e.g. housework, shopping
Most measures of disability are based on questions about ability to perform on activity with or without

- need of help
- difficulties
- pain
- technical aids
- tiredness
- reduced speed
## What do the 70-year-olds do? Examples in %

<table>
<thead>
<tr>
<th></th>
<th>Men (n=366)</th>
<th>Women (n=368)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk outside in nice weather</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Walk on stairs</td>
<td>99</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td><strong>ADL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wash upper body</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Shoes /Stockings on/off</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>IADL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook for guests</td>
<td>18</td>
<td>89</td>
<td>***</td>
</tr>
<tr>
<td>Garden work</td>
<td>71</td>
<td>54</td>
<td>***</td>
</tr>
</tbody>
</table>

P describes gender differences by Chi-Square test. *** p<0.001

Source: Avlund & Schultz-Larsen 1991
Reasons for not performing an IADL-activity

1) Irrelevant
2) No need, another person does it
3) Doesn´t know how to to it
4) Not motivated
5) Physical problems
6) Health problems
7) Fear of falling
8) Problems in the physical environment

Recommendations for measures of disablement process

• Be cautious about
  – Combining measures of different concepts in the disablement process
  – Combining measures of ADL and IADL
The disablement process

Early signs of disability

Pathology → Impairments → Functional limitations → Disability
Indicators of later disability

- Inflammation (Ferrucci et al. 1999; Penninx et al. 2004)
- Inflammation in the periodontium (Holm-Pedersen 2006; Avlund et al. 2009)
- Hand grip strength (Rantanen et al. 1999)
- Physical performance (Guralnik et al. 1995; Gill et al. 1996; Ostir et al. 1998)
- Difficulty with ADL (Sonn et al. 1996; Gill et al. 1998)
- Task modification (Fried et al. 2001; Mänty et al. 2006)
- Perceived security (Dahlin Ivanoff 2006)
- Fatigue in daily activities (Avlund et al. 1995-2008)
Risk of incident disability in mobility after 18 months*

Task modification but no difficulty in tasks

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>walking ½ mile</td>
<td>climbing up</td>
</tr>
<tr>
<td>3.77 (1.91-7.47)</td>
<td>3.86 (1.83-8.17)</td>
</tr>
</tbody>
</table>

*Adjusted by walking speed, stair climb speed, age, education, living alone, chronic diseases, depression, knee strength, balance

**Task modification as indicator of early decline in performance and early disease**

<table>
<thead>
<tr>
<th>Walking speed (sec)</th>
<th>Exercise tolerance (sec on tread mill)</th>
<th>Muske strength</th>
<th>Balance (sec)</th>
</tr>
</thead>
</table>

**Walking ½ mile**

<table>
<thead>
<tr>
<th>High function</th>
<th>Higher speed</th>
<th>Higher speed</th>
<th>Stronger</th>
<th>Higher speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task modification</td>
<td>Slower speed</td>
<td>Slower speed</td>
<td>Weaker</td>
<td>Slower speed</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Fatigue measured as Tiredness in daily activities

**Mob-T**
Transfer
Get outdoors
Walk indoors
Walk outdoors in nice weather
Walk outdoors in poor weather
Walk on stairs

**Lower Limb-T**
Use toilet
Wash lower body
Dress lower body
Take shoes/stockings on/off*
Cut toenails

Odds ratios (95% CI) for onset of disability at five year follow-up by fatigue at age 75

<table>
<thead>
<tr>
<th></th>
<th>Mobility disability (n = 510)</th>
<th>Disability in ADL (n = 429)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tired in 2-4 activities</td>
<td>3.2 (1.4-7.6)</td>
<td>2.1 (1.0-4.2)</td>
</tr>
<tr>
<td>Tired in 1 activity</td>
<td>1.7 (0.8-3.8)</td>
<td>2.0 (1.0-3.9)</td>
</tr>
<tr>
<td>Not tired</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Adjusted by sex, chronic diseases, cognitive function, self-rated health, depressive symptoms, housing tenure, social relations, physical activity

Source: Avlund et al. J Clin Epidemiol 2002
### Odds ratios (95%) onset of disability and mortality at 5-, 10- and 15-year follow-up by fatigue at age 70

<table>
<thead>
<tr>
<th></th>
<th>5-year follow-up</th>
<th>10-year follow-up</th>
<th>15-year follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onset of disability</strong>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 564)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.09 (4.71-17.54)</td>
<td>1.87 (1.17-2.99)</td>
<td>1.84 (0.93-3.64)</td>
<td></td>
</tr>
<tr>
<td><strong>Mortality</strong>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 705)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.83 (1.17-2.85)</td>
<td>2.16 (1.52-3.05)</td>
<td>2.31 (1.64-3.24)</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted by sex, number of diseases, VO\(^2\) max

Survival curves among 70-year-olds with and without fatigue during 21 year follow-up
Onset of walking limitation at 5-year follow-up

- Measured by a 10 meter laboratory test using a stop watch

- Onset of walking limitations was defined as onset into the slowest quartile of maximal walking speed: > 1.33 m/sec.
# Odds ratios (95% CI) for onset of walking limitations at 5-year follow-up by fatigue (n = 319)

<table>
<thead>
<tr>
<th></th>
<th>Crude</th>
<th>Adjusted*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tired</td>
<td>3.97(2.16-7.29)</td>
<td>2.78(1.43-5.41)</td>
</tr>
<tr>
<td>Not tired</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* Adjusted by sex, walking speed and chronic diseases at baseline

Source: Avlund, Sakari-Rantala, Rantanen et al. J Am Geriatr Soc. 2004
Fatigue measured as tiredness in daily activities is predictive of

- Onset of disability after
- 1 year (Avlund et al. 2008)
- 1½ years (Avlund et al. 2003)
- 5 years (Avlund et al. 2002; 2003; Schultz-Larsen et al. 2007)
- 10 years (Avlund et al. 2003; Schultz-Larsen et al. 2007)
- 15 years (Schultz-Larsen et al. 2007)
Fatigue measured as tiredness in daily activities is predictive of:

- Onset of disability
- Both in young, young-old, and old-old populations
- In different geographic localities
Fatigue measured as tiredness in daily activities is predictive of:

- Onset of walking limitations
  - (Avlund et al. 2004)
- Use of health and social services
  - (Avlund et al. 2001)
- Decline in physical activity
  - (Elkjær et al. 2006)
- Mortality
  - (Avlund et al. 1998; Avlund et al. 2003; Schultz-Larsen et al. 2007)
Factors related to fatigue in non-disabled older adults

Social position
- Pathology
- Comorbidity
- Specific diseases
- Use of medication

Impairments
- Muscle strength
- Pain
- Cognitive performance
- VO2 Max

Walking limitations

Psychological factors
- Depressive mood

Fatigue in daily activities

Conclusions

• Fatigue is influenced by multiple potential modifiable factors

• None of these factors explain the associations between fatigue and the various outcomes

• Fatigue may be thus be regarded as a subjective measure of frailty

• Fatigue may be used to identify non-disabled individuals at high risk of functional decline
New research questions about early signs of disability will be followed during the next years at

- The Research Group in Gerontology at Department of Social Medicine
- In collaboration with
- Copenhagen Aging and Midlife Biobank (CAMB) - supported by the VELUX FOUNDATION

- Danish Research Center for Ageing (DARC) - Odense, Aarhus, København – supported by the VELUX FOUNDATION

- Center for Healthy Aging (CESA) – The Faculty of Health Sciences, University of Copenhagen, Supported by the Nordea-Denmark Foundation