36-Item Short Form Survey (SF-36) Versus Gait Speed as a Predictor of Preclinical Mobility Disability in Older Women

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Background: The Disablement Process

- Mobility independence = important goal for both clinical medicine as well as public health
- Declining mobility → poorer quality of life, higher morbidity and mortality
- Loss of mobility is progressive, transitory, and dynamic → disablement process
- Dynamic nature of the disablement process

Gill et al. 2006
Mobility Disability: Understanding the Pathway to Progression

- “Pre-clinical disability” (PCMD)-- a time of increasing impairment or disability in the absence of any recognition of loss of performance by the individual (Fried et al 1991, 2000)

Fried et al. 2000
Understanding the Pathway to Progression to Mobility Disability

- Pre-clinical mobility disability (PCMD)
  - Insight to a critical point of transition to risk of disability
  - Natural trajectory to mobility disability in vulnerable populations
  - Informs opportunities for prevention
Methods of assessment

• Physical Performance: Gait Speed
  • PROs:
    • Well-established interrater and test–retest reliability
    • High sensitivity to change
    • High predictive validity
      • Slower gait speeds (<1.0m/s) ≈ higher risk for functional decline, morbidity
      • Faster gait speeds (≥1.0m/s) is related to a lower risk of adverse health events and better survival
  • CONs:
    • Sensitivity to change in higher-functioning populations may be limited
    • Costly (equipment, training/administration space)
    • Time-consuming, patient burden

• Self-Reported: Short-Form (RAND 36) Physical Function Index (SF-36 PF)
  • PROs:
    • Validated questionnaire
    • High sensitivity to detect differences in health-related quality of life (HrQoL)
    • Easier administration
    • Less expensive
    • Practicality to a population level.
  • CONs:
    • Reliance on self-perception of mobility status and performance of daily activities
    • Sensitivity to change in mobility status is limited
    • Prospective data for prediction of mobility disability remain limited
Current Gaps…

1. How does gait speed and SF-36 (or self-reported) physical functioning compare when predicting future PCMD risk?

2. Do small, clinically meaningful declines in mobility predict PCMD in well-functioning adults?

3. When is the ideal time to intervene for prevention efforts to be maximized?
Objectives…

• To compare the predictive value of clinically measured gait speed versus SF-36 Physical Function Index (self-reported) in relation to future PCMD in older women

  • **Baseline** gait speed vs. **Baseline** SF-36

  • **One-year** change in gait speed vs. **One-year** change in SF-36

  • PCMD @ 3yr F/U

  • PCMD @ 6yr F/U
Hormone Therapy Trials

Calcium/Vitamin D Dietary Modification Trial

3 Controlled Trials

CT + OS: 161,808 women total (1993-2005)

WHI Components

SF-36 All enrolled women N=68,132

GAIT SPEED 25% CT COHORT ≥65yrs N=5962
Study Design & Methods

Study population

n = 5739 women with complete baseline data for both gait speed and SF-36

- 1046 women excluded for having gait speed <1.0 m/s at baseline,
- 182 women excluded for missing both gait speed and SF-36 data at year 1
- 648 women excluded for missing either gait speed or SF-36 at year 1

Total n= 3587 women
Assessment Methods & Outcome Measures

Assessments
- 6 meter timed gait speed (m/s) at usual pace
  - Assessed at baseline and years 1, 3, and 6
- 10-item SF-36 PF subscale of the RAND 36-item health survey
  - 0 to 100; higher scores = better physical functioning
  - Calculated as year 1 minus baseline
  - Gait speed: change in usual-pace 0.1 m/s (0.2 mph)---Perera 2005a, Studenski 2004
  - SF-36- change in score by 10 points --Perera 2005b
  - Women dichotomized as “decliners” or “non-decliners”

Meaningful decreases in PF

Outcome: Pre-clinical Mobility Disability (PCMD)
- Defined as usual-pace gait speed <1.0 m/s at year 3 and 6 follow-ups
Statistical Methods

• Logistic regression- odds ratios (OR) and 95% confidence intervals (CI)
  • Baseline Models
    • Evaluate associations between baseline measures of gait speed or SF-36 scores and incident PCMD at year 3 or 6 F/U
  • Change Models: “Decliners vs. Non-Decliners”
    • Evaluate change ($\Delta Y_{1-B}$) in gait speed or SF-36 as predictors of incident PCMD
      • Incident PCMD between baseline and year 3
      • Incident PCMD between baseline and year 6

• Three levels of covariate adjustment:
  • Model 1: age, clinical trial arm(s), and baseline gait speed;
  • Model 2: Model 1+ age at menopause, race/ethnicity, BMI, physical activity, alcohol use, and smoking;
  • Model 3: Model 2 + self-reported general health and history of hypertension, diabetes, CVD, and arthritis
Statistical Methods

- Receiver-operator characteristic (ROC) curve analyses at year 3 and 6 F/U time points
  - Baseline gait speed vs. SF-36 scores
  - One-year declines in gait speed vs. SF-36 scores
  - Baseline-only vs baseline + one-year

- Differences in Area under the ROC curve (AUC)

- Sensitivity analyses
  - likelihood ratio tests- test for interactions between baseline gait speed or SF-36 score and decliner status on incident PCMD
## Results: Table 1 - Gait speed Groups

<table>
<thead>
<tr>
<th>Mean ± SD or n (%)</th>
<th>Gait speed</th>
<th>Physical Activity; MET-hr/wk</th>
<th>Self-reported general health</th>
<th>History of arthritis</th>
<th>Hypertension status</th>
<th>History of diabetes</th>
<th>History of CVD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Characteristics</strong></td>
<td><strong>Non-decliner n = 2056</strong></td>
<td><strong>Decliner n = 1531</strong></td>
<td><strong>11.8 ± 12.9</strong></td>
<td><strong>12.3 ± 13.7</strong></td>
<td><strong>1050 (51%)</strong></td>
<td><strong>812 (54%)</strong></td>
<td><strong>368 (18%)</strong></td>
</tr>
<tr>
<td>Gait speed (m/s)</td>
<td>1.19 ± 0.2</td>
<td>1.34 ± 0.2</td>
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<tr>
<td>SF-36 score</td>
<td>81.3 ± 17.2</td>
<td>80.2 ± 18.0</td>
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<td></td>
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<td></td>
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<tr>
<td>Age (y)</td>
<td>69.4 ± 3.5</td>
<td>69.9 ± 3.7</td>
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<tr>
<td>Race/ethnicity: Non-Hispanic White</td>
<td>1859 (90%)</td>
<td>1342 (88%)</td>
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<tr>
<td>Other race/ethnicity</td>
<td>200 (10%)</td>
<td>189 (12%)</td>
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<tr>
<td>Smoking status: Never</td>
<td>1130 (56%)</td>
<td>843 (56%)</td>
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</tr>
<tr>
<td>Former</td>
<td>812 (40%)</td>
<td>602 (40%)</td>
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</tr>
<tr>
<td>Current</td>
<td>94 (5%)</td>
<td>67 (4%)</td>
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</tr>
<tr>
<td>Alcohol use: Never</td>
<td>217 (11%)</td>
<td>197 (13%)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Former</td>
<td>373 (18%)</td>
<td>275 (18%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>1453 (71%)</td>
<td>1053 (69%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>27.9 ± 5.5</td>
<td>27.9 ± 5.1</td>
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</tr>
</tbody>
</table>
## Results: Table 1 - SF-36 Groups

| Mean ± SD or n (%) | SF-36 | SF-36 score | Age (y) | Race/ethnicity: | Smoking status: | Alcohol use: | Body Mass Index | Physical Activity; MET-hr/wk) | Self-reported general health | History of arthritis |
|--------------------|-------|-------------|---------|----------------|----------------|--------------|----------------|-------------------|---------------------|---------------------|---------------------|
| Baseline Characteristics | Non-decliner n = 2802 | Decliner n = 785 | Non-decliner n = 2802 | Decliner n = 785 | Non-decliner n = 2802 | Decliner n = 785 | Non-decliner n = 2802 | Decliner n = 785 | Non-decliner n = 2802 | Decliner n = 785 | Non-decliner n = 2802 | Decliner n = 785 |
| Gait speed (m/s) | 1.26 ± 0.2 | 1.24 ± 0.2 | | | | | | | | | | |
| SF-36 score | 81.1 ± 18.0 | 79.9 ± 15.6 | | | | | | | | | | |
| Age (y) | 69.5 ± 3.5 | 69.9 ± 3.8 | | | | | | | | | | |
| Race/ethnicity: | | | | | | | | | | | | |
| Non-Hispanic White | 2503 (89%) | 695 (89%) | | | | | | | | | | |
| Other race/ethnicity | 299 (11%) | 90 (11%) | | | | | | | | | | |
| Smoking status: | | | | | | | | | | | | |
| Never | 1561 (56%) | 412 (53%) | | | | | | | | | | |
| Former | 1096 (40%) | 318 (41%) | | | | | | | | | | |
| Current | 118 (4%) | 43 (6%) | | | | | | | | | | |
| Alcohol use: | | | | | | | | | | | | |
| Never | 320 (12%) | 94 (12%) | | | | | | | | | | |
| Former | 474 (17%) | 174 (22%) | | | | | | | | | | |
| Current | 1994 (71%) | 512 (66%) | | | | | | | | | | |
| Body Mass Index | 27.6 ± 5.2 | 29.0 ± 5.7 | | | | | | | | | | |
| Physical Activity; MET-hr/wk) | | | | | | | | | | | | |
| Self-reported general health | | | | | | | | | | | | |
| Excellent | 505 (18%) | 96 (12%) | | | | | | | | | | |
| Very Good | 1285 (46%) | 309 (39%) | | | | | | | | | | |
| Good | 867 (31%) | 317 (40%) | | | | | | | | | | |
| Poor | 141 (5%) | 63 (8%) | | | | | | | | | | |
| History of arthritis | 1411 (51%) | 451 (58%) | | | | | | | | | | |
| Hypertension status: | | | | | | | | | | | | |
| Never | 1788 (65%) | 443 (57.2) | | | | | | | | | | |
| Hypertensive (UnTX and TX) | 982 (36%) | 332 (43%) | | | | | | | | | | |
| History of diabetes | 124 (4%) | 49 (6%) | | | | | | | | | | |
| History of CVD | 470 (17%) | 165 (22%) | | | | | | | | | | |
## Results: Table 2

### Associations between baseline gait speed or SF-36 and incident pre-clinical mobility disability (< 1 m/s) at year 3 or 6*

<table>
<thead>
<tr>
<th>Physical function measure</th>
<th>Follow-up year</th>
<th>Model 1(^a) OR (95% CI)</th>
<th>Model 2(^b) OR (95% CI)</th>
<th>Model 3(^c) OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait speed (m/s)</td>
<td>3</td>
<td>0.45 (0.40–0.51)</td>
<td>0.50 (0.44–0.57)</td>
<td>0.53 (0.47–0.60)</td>
</tr>
<tr>
<td>SF-36</td>
<td>3</td>
<td>0.62 (0.58–0.68)</td>
<td>0.70 (0.64–0.76)</td>
<td>0.76 (0.69–0.85)</td>
</tr>
<tr>
<td>Gait speed (m/s)</td>
<td>6</td>
<td>0.58 (0.53–0.64)</td>
<td>0.63 (0.57–0.70)</td>
<td>0.65 (0.59–0.72)</td>
</tr>
<tr>
<td>SF-36</td>
<td>6</td>
<td>0.59 (0.54–0.64)</td>
<td>0.65 (0.59–0.72)</td>
<td>0.69 (0.62–0.77)</td>
</tr>
</tbody>
</table>

*Odds ratios represent the effect for a 1-SD change in gait speed (0.21 m/s) or SF-36 score (17.5 points)

\(^a\) Model 1 adjusted for age and clinical trial arms

\(^b\) Model 2 further adjusted for age at menopause, race/ethnicity, BMI, physical activity, alcohol use, and smoking

\(^c\) Model 3 further adjusted for self-reported general health and history of hypertension, diabetes, CVD, and arthritis

All estimates are strongly significant (\(P < .001\))
### Associations between decline in gait speed or SF-36 and pre-clinical mobility disability (<1 m/s) at year 3 or 6

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Year</th>
<th>n (%)</th>
<th>Model 1 OR (95% CI)</th>
<th>Model 2 OR (95% CI)</th>
<th>Model 3 OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gait speed (m/s)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-decliner</td>
<td>3</td>
<td>389 (21.4)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Decliner (≥ 0.1 m/s)</td>
<td>3</td>
<td>394 (29.5)</td>
<td>2.70 (2.24–3.26)</td>
<td>2.61 (2.14–3.19)</td>
<td>2.59 (2.11–3.17)</td>
</tr>
<tr>
<td>Non-decliner</td>
<td>6</td>
<td>484 (29.0)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Decliner (≥ 0.1 m/s)</td>
<td>6</td>
<td>471 (39.3)</td>
<td>2.52 (2.10–3.02)</td>
<td>2.36 (1.95–2.85)</td>
<td>2.35 (1.94–2.86)</td>
</tr>
</tbody>
</table>

**Note:** n (%) represents mobility disability prevalence at follow up year;

a Area under ROC curve (AUC) is based on Model 3. Differences in ROC between gait speed decliners and SF-36 decliners and incident mobility disability at year 3 ($P<0.001$), and at year 6 ($P=0.002$)

b All estimates are strongly significant ($P<0.001$) except SF-36 at year 3, model 3 ($P=0.002$)
Comparing discriminatory power of baseline-only to baseline-plus-year-1 models of gait speed and SF-36 scores and pre-clinical mobility disability (<1 m/s) at year 3 or 6

<table>
<thead>
<tr>
<th>Physical function measure</th>
<th>Follow-up year</th>
<th>Baseline AUC(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait speed (m/s)</td>
<td>3</td>
<td>0.734 (0.71–0.76)</td>
</tr>
<tr>
<td>SF-36</td>
<td>3</td>
<td>0.699 (0.68–0.72)</td>
</tr>
<tr>
<td>Gait speed (m/s)</td>
<td>6</td>
<td>0.713 (0.69–0.73)</td>
</tr>
<tr>
<td>SF-36</td>
<td>6</td>
<td>0.705 (0.68–0.73)</td>
</tr>
</tbody>
</table>

\(^a\) Differences in AUC between baseline measures of gait speed alone versus SF-36 alone at year 3 (\(P<.001\)), and at year 6 (\(P=.21\))

AUC based on fully adjusted Model 3
Comparing discriminatory power of baseline-only to baseline-plus-year-1 models of gait speed and SF-36 scores and pre-clinical mobility disability (≤1 m/s) at year 3 or 6

<table>
<thead>
<tr>
<th>Follow-up year</th>
<th>Baseline AUCb</th>
<th>Baseline + Y1 AUCc</th>
<th>Pa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait speed (m/s) 3</td>
<td>0.734 (0.71–0.76)</td>
<td>0.763 (0.742–0.783)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SF-36 3</td>
<td>0.699 (0.68–0.72)</td>
<td>0.707 (0.685–0.729)</td>
<td>.005</td>
</tr>
<tr>
<td>Gait speed (m/s) 6</td>
<td>0.713 (0.69–0.73)</td>
<td>0.739 (0.719–0.759)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SF-36 6</td>
<td>0.705 (0.68–0.73)</td>
<td>0.712 (0.692–0.733)</td>
<td>.004</td>
</tr>
</tbody>
</table>

*P*-values represent the difference in AUC of fully adjusted models between baseline alone versus baseline plus year 1 measures

- Differences in AUC between baseline measures of gait speed alone versus SF-36 alone at year 3 (*P*<.001), and at year 6 (*P*=.21)

- Differences in ROC between baseline plus year 1 measures of gait speed versus SF-36 at year 3 (*P*<.001), and at year 6 (*P*<.001)

Year 3 PCMD  
Gait speed, test for difference in ROC curves, *P*< .001  
SF-36, test for difference in ROC curves, *P*= .005  

Year 6 PCMD  
Gait speed, test for difference in ROC curves, *P*< .001  
SF-36, test for difference in ROC curves, *P*= .004
Comparing discriminatory power of baseline-only to baseline-plus-year-1 models of gait speed and SF-36 scores and pre-clinical mobility disability (<1 m/s) at year 3 or 6

<table>
<thead>
<tr>
<th>Physical function measure</th>
<th>Follow-up year</th>
<th>Baseline AUC&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Baseline + Y1 AUC&lt;sup&gt;c&lt;/sup&gt;</th>
<th>P&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
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<tr>
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<td>.004</td>
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</table>

<sup>a</sup> P-values represent the difference in AUC of fully adjusted models between baseline alone versus baseline plus year 1 measures

<sup>b</sup> Differences in AUC between baseline measures of gait speed alone versus SF-36 alone at year 3 (P<.001), and at year 6 (P=.21)

<sup>c</sup> Differences in ROC between baseline plus year 1 measures of gait speed versus SF-36 at year 3 (P<.001), and at year 6 (P<.001)
Conclusions

- Gait speed or SF-36 decliners (versus non-decliners) showed substantial likelihood of developing PCMD at follow-up years 3 and 6.
- Gait speed (either at baseline only or one-year change) demonstrated better predictive performance at predicting incident PCMD 3 and 6 years later, than SF-36.
- *Baseline* SF-36 showed comparable performance to gait speed when discriminating future PMCD cases in older women.
  - (i.e., 1–3% difference) over the 6-year follow-up.
- Prediction of future PCMD in the present study was significantly stronger when considering measures from two time points instead of only one.
  - One-year declines in clinically measured gait speed showed greater sensitivity to change in mobility than SF-36.
Clinical & Research Implications

- Gait speed and SF-36 do not measure the same construct of functional status and disability
  - In *non-disabled* populations, routine **gait speed** assessments
    - Develop risk profiles that identify individual’s trajectory from functional independence to disability over time
    - Distinguish presence and severity of subtle functional changes in individuals who do not report functional problems
Clinical & Research Implications

- SF-36
  - Primary question is to determine likelihood of future PCMD
  - Describes disability risk
  - Screen older women for declining PF based on self-reported survey responses.
  - More feasible in epidemiological studies
    - less costly (i.e., staff time), less burden, or participant fatigue
Limitations

• Gait speed served as a *predictor* and used to define PCMD (*outcome*)
  • Alternative measures not available in this cohort

• Selection bias
  • ~648 women excluded if missing *either* one-year SF-36 or gait speed data (19% of analytic cohort) 
    • Reported significantly slower gait speeds than those who were not missing year-1 measures

• SF-36 limitations
  • influenced by individual mood, expectations, or past experiences
Take home message

- Performance vs. self-reported measures?
  - Study population
  - Feasibility
  - Research objectives/ question

- Opportune time to intervene in well-functioning women is between baseline and the first year following initial functioning assessment.
  - Prevention!
  - Promoting recovery is high
  - Guide initiation and intensity of intervention strategies
Special thanks to:

- WHI sponsor: Dr. Marcia Stefanick, Phd
- All co-authors
- Statistical Support, Betsy C. Wertheim MS
- WHI investigators and staff for their dedication, and the study participants for making the program possible
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References


EXTRA
Retention and Loss-to follow-up (LTFU)

- At years 3 and 6, LTFU is associated with lower baseline gait speed (year 3, 1.23 vs. 1.26 m/s; P=0.01; year 6, 1.23 vs. 1.26 m/s; P=0.001)

- Women with gait speed data at year 3 (vs. LTFU):
  - Younger
  - lower BMI
  - reported better health
  - lower prevalence of co-morbidities (diabetes, CVD)

- Women with gait speed data at year 6 (vs. LTFU):
  - Younger
  - more physical active (self-report)
  - reported better health
  - consumed more alcohol,
  - were not current smokers,
  - less CVD