

# Measurement in Elderly Populations

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Friday, January 22, 2021, 8:45am – 10:15am

By Zoom

# **GENERAL ISSUES OF MEASUREMENT**

# Methods of Measurement

- Self-report
  - Reliability? e.g. retrospective reports, doctor diagnosis
- Proxy report
  - Availability?
  - Reliability?
- Direct assessment via clinical exam and/or biomarkers
  - Expense / Convenience
  - Selection bias!
- Administrative or medical records
  - Availability
  - Selection bias!

# Measurement Considerations

- Periodicity
- Mode of questionnaire administration
- Instrument and item selection
- Formulation of questions
- Question ordering
- Visual aids
- The role of context

**HOW DO YOU ASSESS HOW  
“GOOD” A MEASUREMENT IS?**

# Sensitivity and Specificity

- Sensitivity:  $\Pr(\text{Test Positive} \mid \text{Condition})$ 
  - Probability of a true positive
  - $1 - \text{sensitivity} = \text{probability of a false negative}$
- Specificity:  $\Pr(\text{Test Negative} \mid \text{No Condition})$ 
  - Probability of a true negative
  - $1 - \text{specificity} = \text{probability of a false positive}$

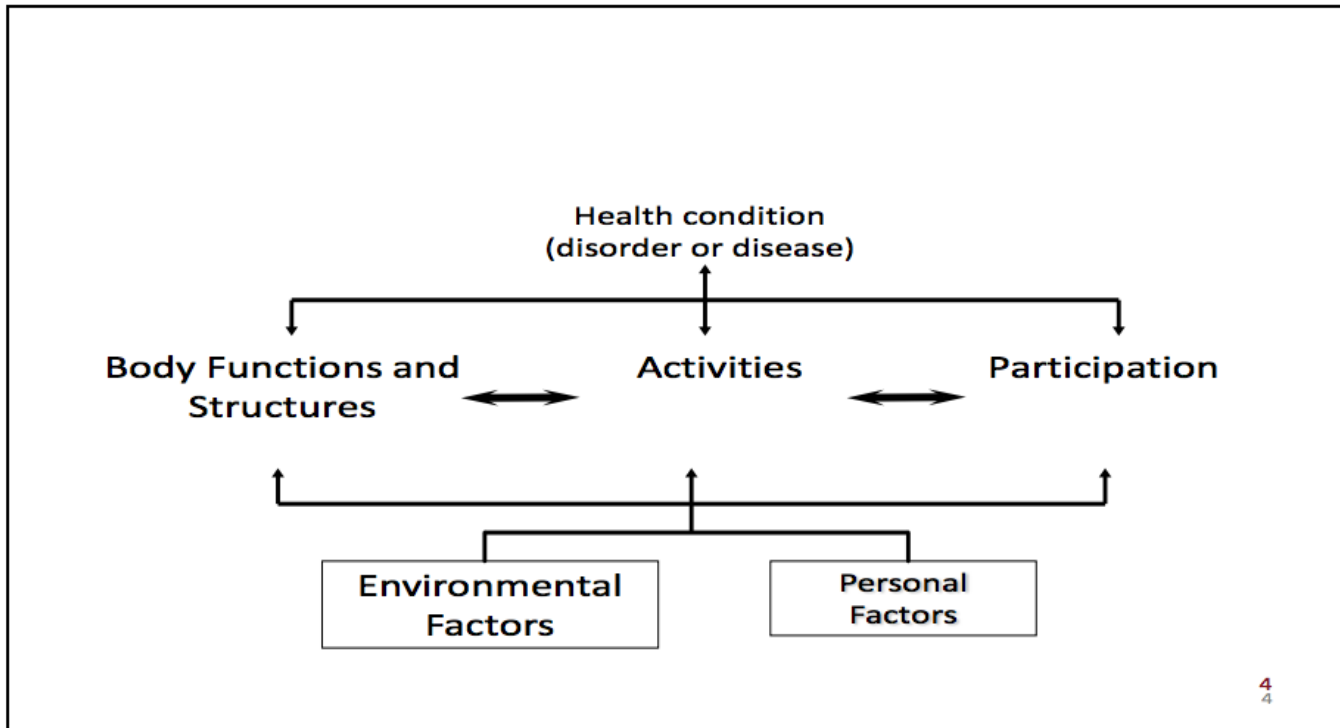
# Validity and Reliability

- Validity: the ability of a measurement to distinguish between who has the condition and who doesn't
- Reliability: the extent to which a measurement is replicated if repeated
  - E.g., inter-rater
  - E.g., test-retest

# Information Bias

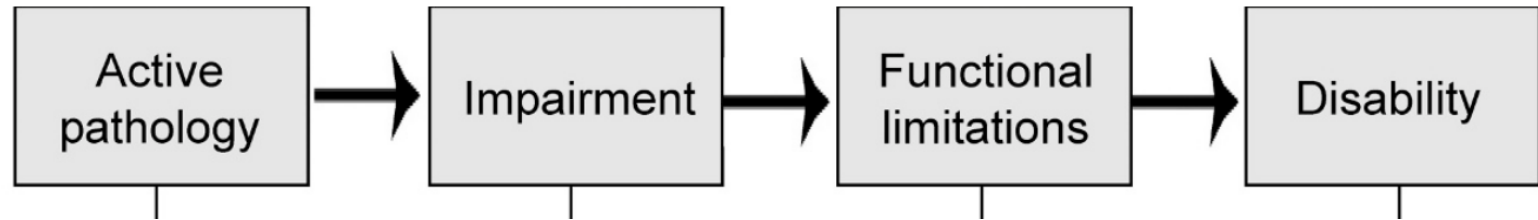
- E.g., Nondifferential misclassification: the degree of misclassification of exposure is independent of outcome (or vice versa)
- E.g., Differential misclassification: the degree of misclassification differs between the groups being compared

**THE ROLE OF CONTEXT:  
THE EXAMPLES OF LATE-LIFE DISABILITY  
AND FUNCTIONAL STATUS**



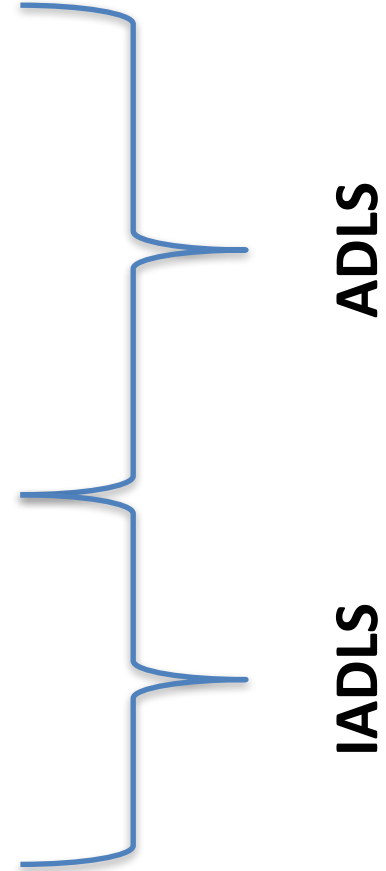
**Figure 1: Interactions between the components of ICF (WHO 2001:18)**

# The Nagi Model



*“Without special help or equipment, how much difficulty do you have with...?”*

- Dressing
- Bathing
- Toileting
- Getting around inside the home
- Getting in and out of bed
- Eating
- Managing money
- Shopping
- Preparing a hot meal
- Managing medications



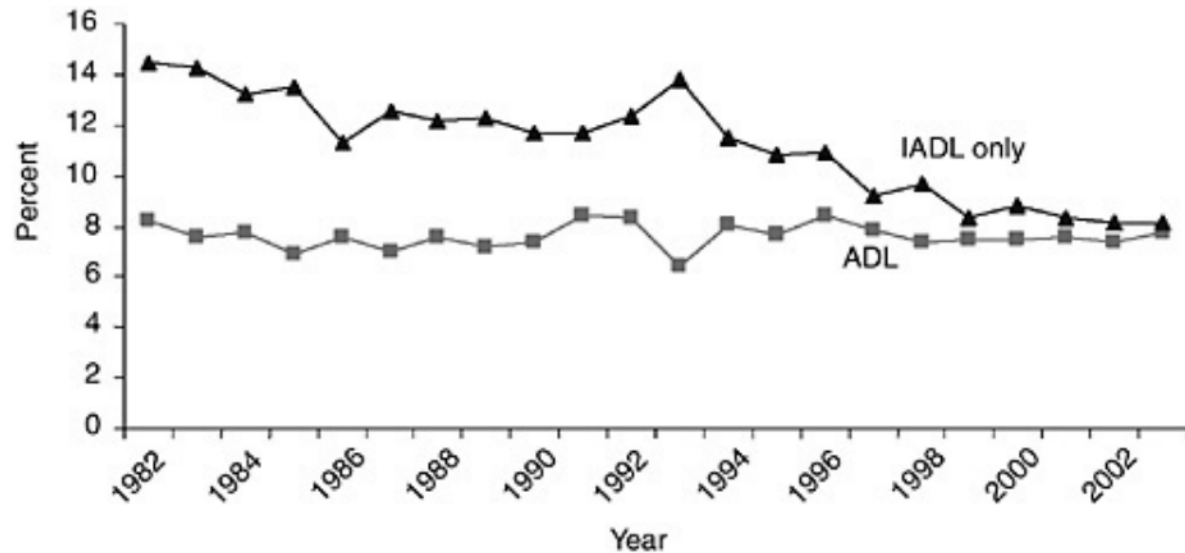
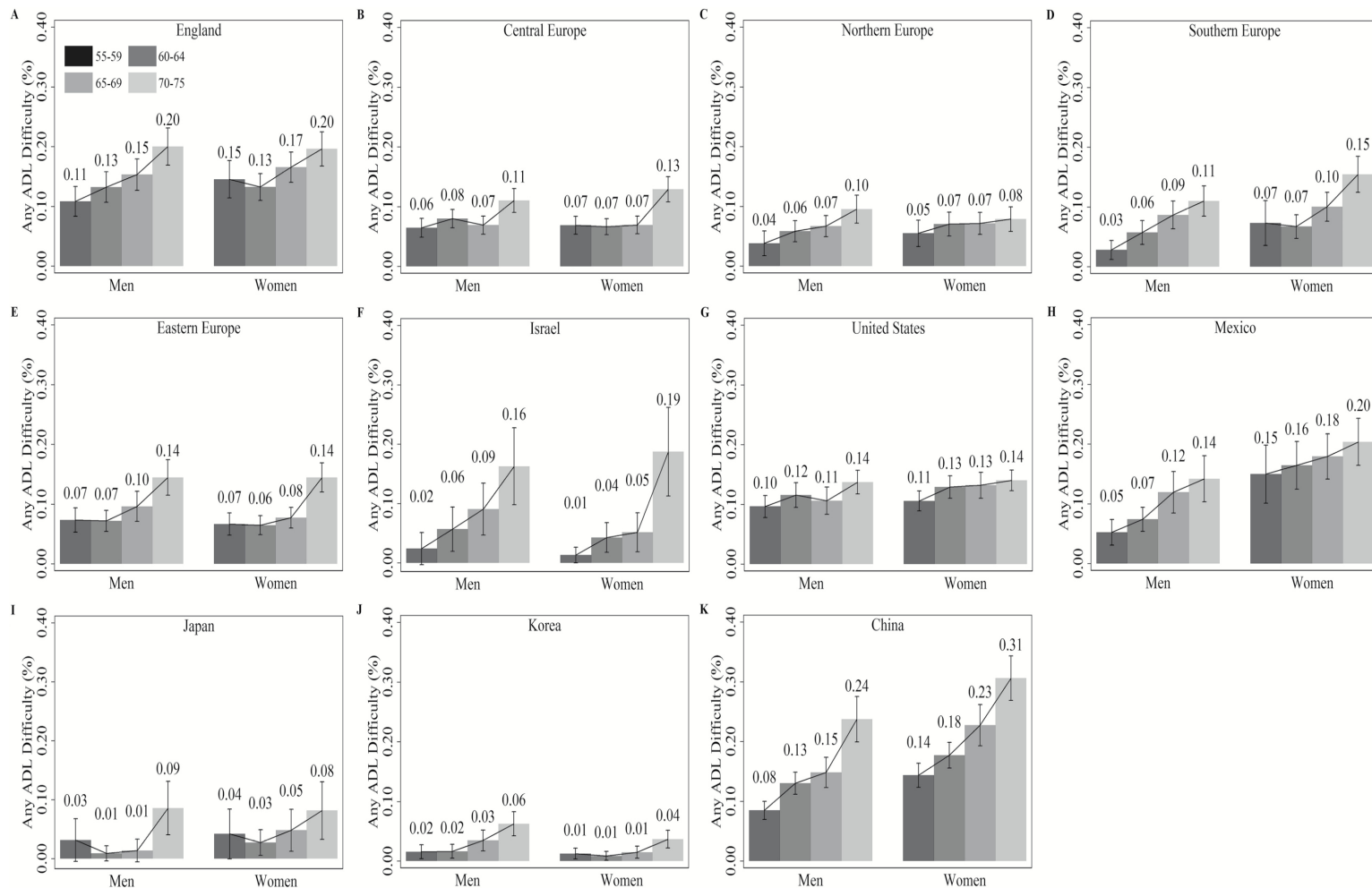


FIGURE E-1 Percentage of the community-based population ages 70 years and older reporting need for help with personal care or only routine care activities, 1982 to 2004.



## **Alternative or additional lead-ins:**

*“Because of a health problem, do you have difficulty with...?”*

*“Because of a health or memory problem, do you have difficulty with..?”*

*“Do you have any difficulty in doing the following activities?”*

*“Exclude any difficulties that you expect to last less than three months.”*

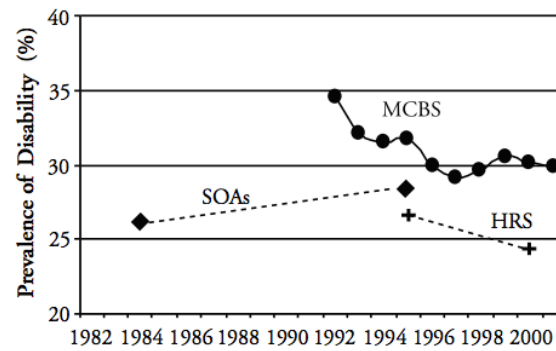
## **Alternative response options:**

- *Yes, No, Can't Do, Doesn't Do*
- *Perform task: independently, with assistance, did not for health reasons, did not perform for non health reasons*

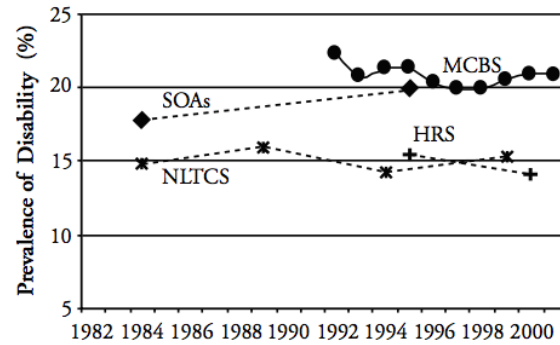
**Table 1. Definitions of Disability for Five National Surveys**

| Definition                                                        | HRS            | MCBS           | NHIS | NLTCS | SOAs           |
|-------------------------------------------------------------------|----------------|----------------|------|-------|----------------|
| 1. Has Difficulty                                                 | √              | √ <sup>a</sup> |      |       | √ <sup>a</sup> |
| 2. Needs Help From Another Person                                 |                |                | √    |       |                |
| 3. Has Difficulty or a Problem and Gets Help                      | √              | √              |      | √     | √ <sup>b</sup> |
| 4. Has Difficulty or a Problem and Gets Help<br>or Uses Equipment | √ <sup>c</sup> | √              |      | √     | √ <sup>b</sup> |

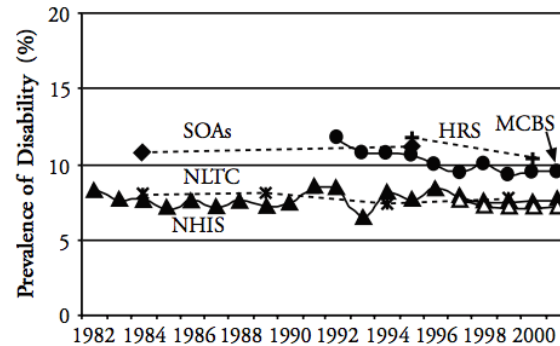
**Freedman et al, 2004,  
Demography**



Panel A. Disability definition: Difficulty with one or more of six ADLs



Panel B. Disability definition: Getting help or using equipment with one or more of six ADLs<sup>a</sup>



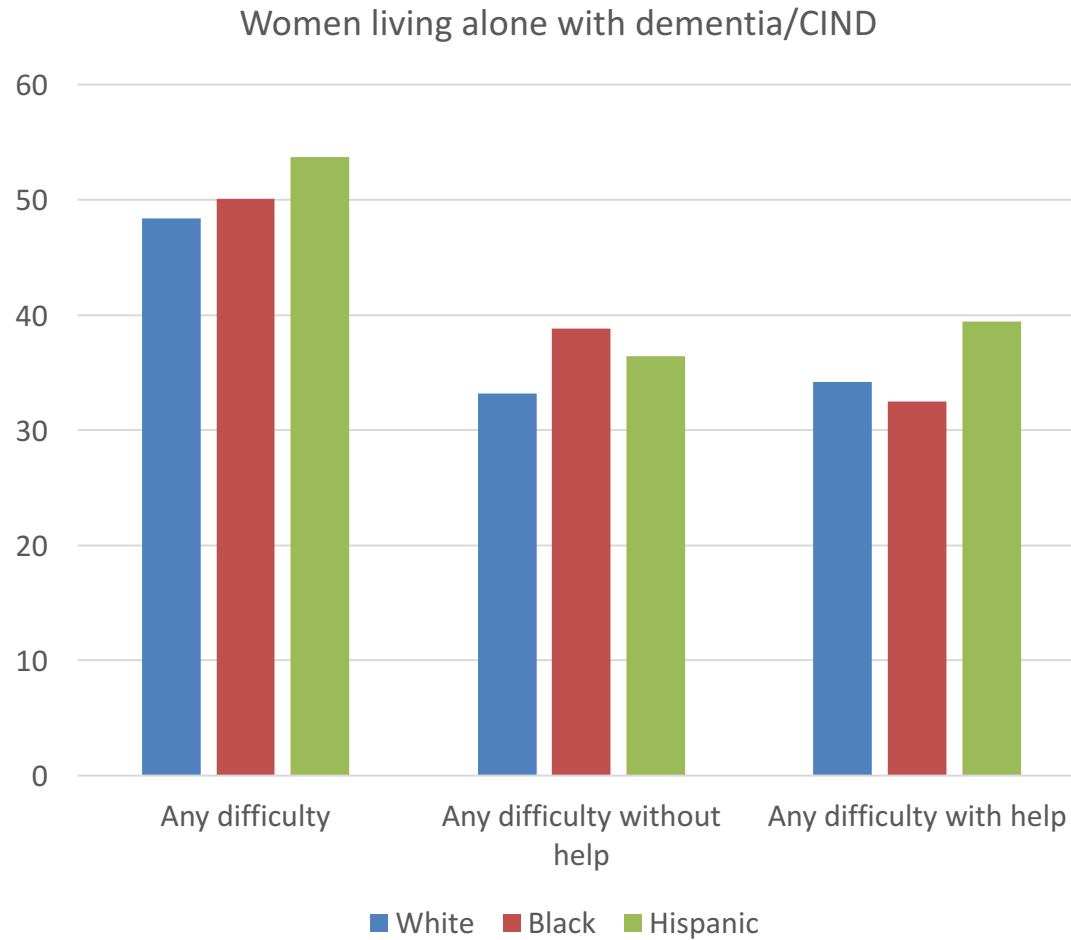
Panel C. Disability definition: Getting help with one or more of six ADLs<sup>b</sup>

Freedman et al,  
2004,  
Demography

# Severity of late-life disability?

## Unmet needs for care?

- Among those who report receiving help with an ADL or IADL:
  - “*Does anyone ever help you with X, Y, Z activity?*”
- Reporting an ADL or IADL with help received is assumed to indicate more severe difficulty (dependency) – those without help assumed to have less severe difficulty



Edwards et al. 2020. Alzheimer's & Dementia

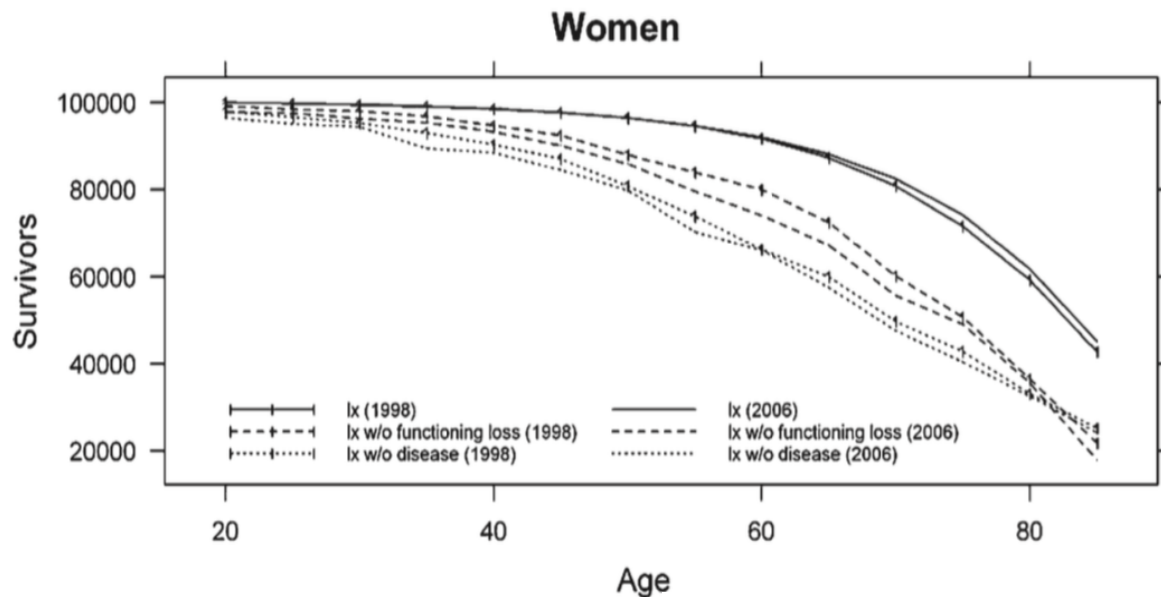
# Physical functioning measures

- Self-report
  - Nagi index
  - Physical Functioning Subscale (PF-10) of the Short Form 36 Health Survey (SF-36)
  - Late-Life Disability Instrument
- Objective performance tests
  - Gait speed
  - Stair climb
  - Chair stand

# Common physical functioning items

- *“Because of a health problem, do you have difficulty with...”*
  - Walking one block, several blocks
  - Sitting for 2 hours
  - Getting up from a chair
  - Climbing one flight of stairs, several flights of stairs
  - Stooping, kneeling, crouching
  - Extending the arms above the head
  - Pushing/pulling large objects
  - Carry a 10-lb weight
  - Picking up a dime

# Crimmins & Beltrán-Sánchez, 2011, JGSS



**Table 2. Trends in Disabled Life Expectancy for 65-Year-Olds: 1992, 1997, and 2002**

|                                         | Both Sexes |      |      | Men  |      |      | Women |      |      |
|-----------------------------------------|------------|------|------|------|------|------|-------|------|------|
| Measure, by Disability Status at Age 65 | 1992       | 1997 | 2002 | 1992 | 1997 | 2002 | 1992  | 1997 | 2002 |
| All Persons                             |            |      |      |      |      |      |       |      |      |
| Total life expectancy                   | 16.8       | 17.1 | 17.3 | 15.0 | 15.5 | 15.8 | 18.3  | 18.5 | 18.6 |
| Active life expectancy                  | 9.5        | 10.0 | 10.3 | 9.9  | 10.4 | 10.8 | 9.2   | 9.7  | 9.9  |
| Disabled life expectancy                | 7.3        | 7.1  | 7.0  | 5.1  | 5.1  | 5.0  | 9.1   | 8.8  | 8.7  |
| IADL disability                         | 2.3        | 2.3  | 2.3  | 1.6  | 1.6  | 1.6  | 2.9   | 2.9  | 3.0  |
| Moderate ADL disability                 | 2.9        | 2.9  | 3.0  | 2.2  | 2.3  | 2.3  | 3.5   | 3.5  | 3.5  |
| Severe ADL disability                   | 2.1        | 1.9  | 1.7  | 1.3  | 1.2  | 1.1  | 2.7   | 2.4  | 2.2  |

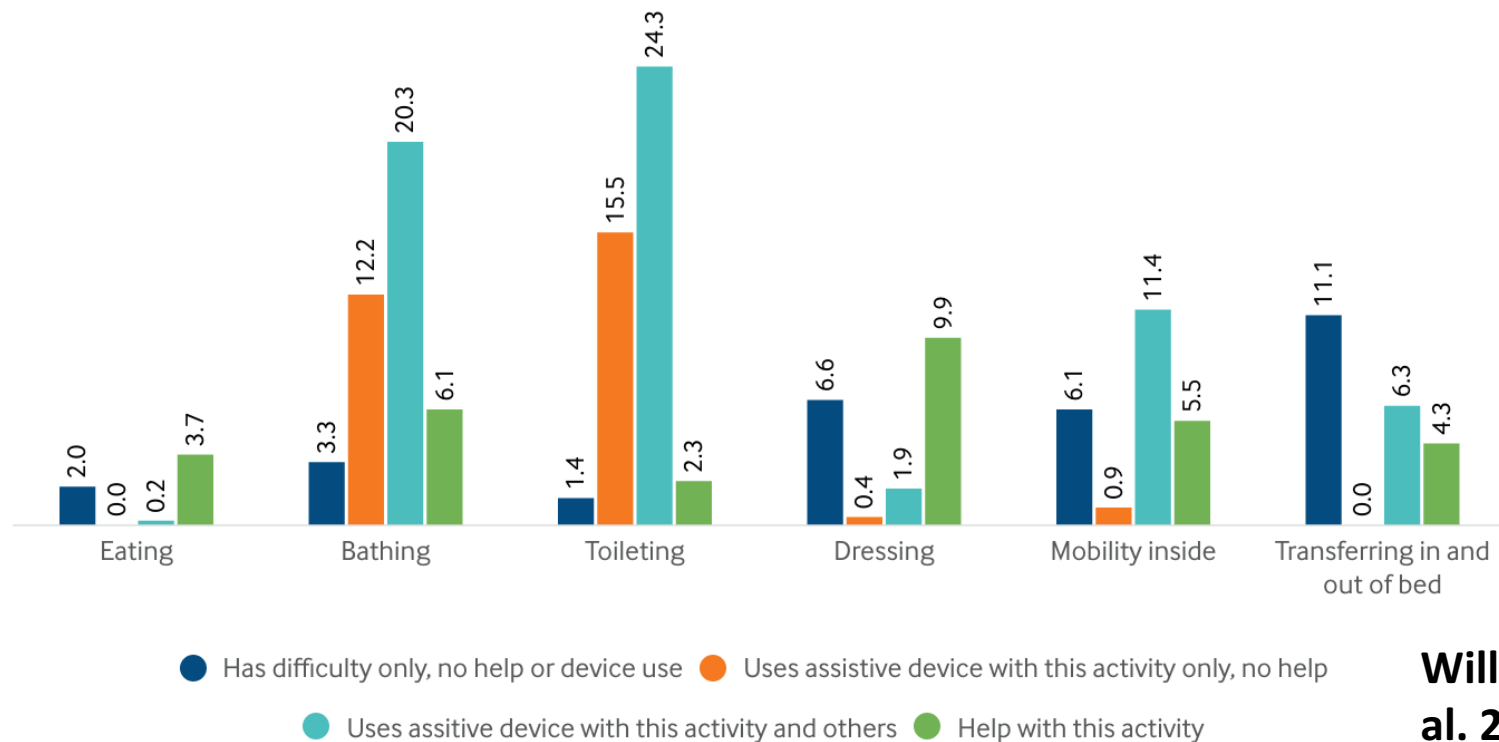
Cai & Lubitz, 2007

# The NHATS alternative

- Distinguishes between capacity, function, and impacts on participation
- Attention to a wide range of accommodations (e.g. built environment, caregiving)
  - Tailored to the assistive equipment used by the respondent
- Incorporates multiple domains of function: social, sensory, cognitive, psychological
- Asks about impact on participation in activities that are meaningful to respondent
- Allows for identifying unmet need for care

# Long-Term Services and Supports by Type of Activity of Daily Living Among Community-Dwelling Medicare Beneficiaries Age 65 and Older

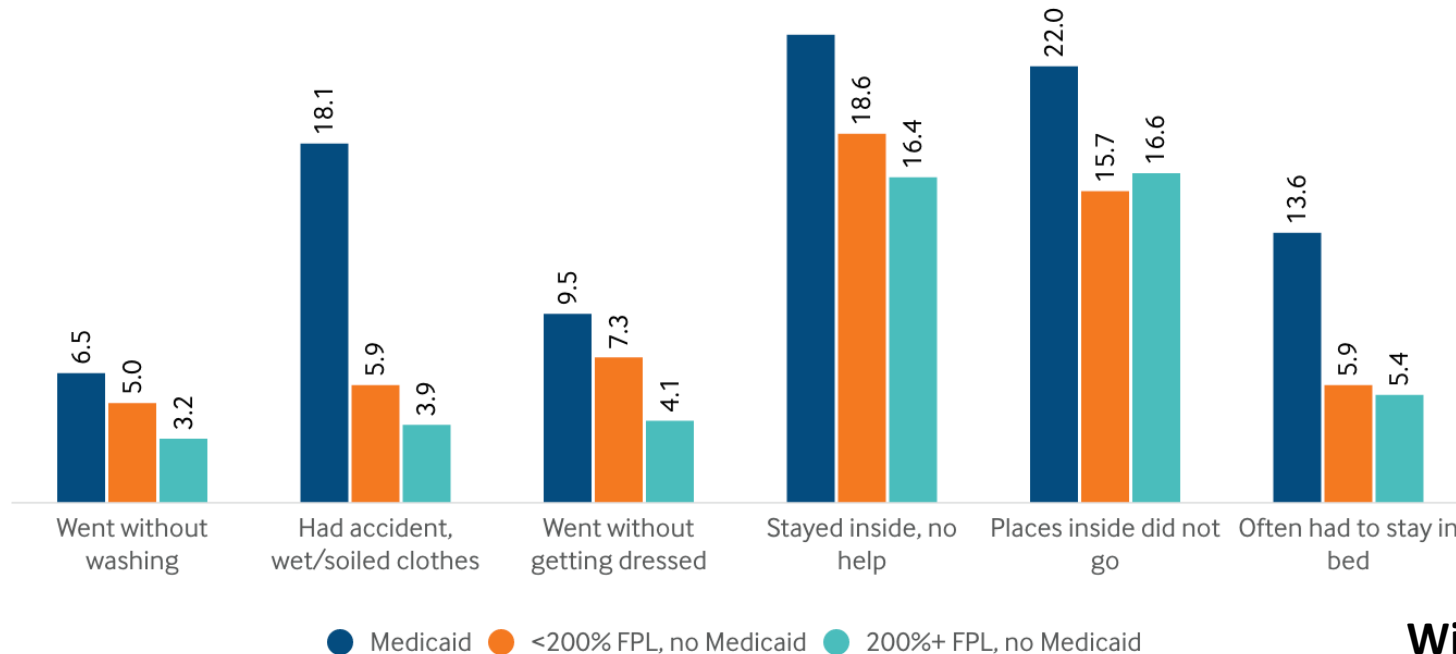
Percent



**Willink et  
al. 2019**

# Adverse Consequences of Unmet Need Among Older, Community-Dwelling Medicare Beneficiaries Receiving Help or Having Difficulty by Activity

Percent



**Willink et  
al. 2019**

# Proxy Informants and Measurement Issues

# General Parameters for Proxy Informants

- Respondents can designate a proxy from the beginning due to physical/cognitive impairment or not wanting to respond
  - Conducted with someone familiar with the financial, health, and family situation of the sampled individual
  - In some studies, thresholds for ‘don’t know’ responses or cognitive tests are set for interviewers can ask to switch to a proxy mid-stream

**TABLE 1. Correspondence between proxy reports and subject self-reports for summary measures in five functional status domains, Baltimore, Maryland, 1991–1992**

|                                                                            | No.<br>of<br>pairs | Mean score      |                            | Intraclass<br>correlation | Standard<br>error | Bias<br>(%) |
|----------------------------------------------------------------------------|--------------------|-----------------|----------------------------|---------------------------|-------------------|-------------|
|                                                                            |                    | Proxy<br>report | Subject<br>self-<br>report |                           |                   |             |
| <b>Physical functioning</b>                                                |                    |                 |                            |                           |                   |             |
| Lower extremity activities (11 items)†                                     | 161                | 5.9             | 5.8                        | 0.68                      | 0.06              | 2.3         |
| Upper extremity activities (4 items)‡                                      | 189                | 0.5             | 0.3                        | 0.56                      | 0.06              | 77.0***     |
| Summary of six activities§                                                 | 178                | 2.5             | 2.4                        | 0.65                      | 0.06              | 4.2         |
| <b>Instrumental functioning</b>                                            |                    |                 |                            |                           |                   |             |
| Summary of seven activities¶                                               | 137                | 3.0             | 2.9                        | 0.85                      | 0.05              | 5.6         |
| <b>Social functioning</b>                                                  |                    |                 |                            |                           |                   |             |
| No. of activities performed in past 2 weeks<br>(12 items)                  | 197                | 4.3             | 4.4                        | 0.61                      | 0.06              | -2.3        |
| No. of minutes per day spent reading and<br>watching television            | 176                | 6.1             | 6.4                        | 0.62                      | 0.06              | -5.3**      |
| Frequency of participation in activities during<br>past 2 weeks (10 items) | 189                | 9.0             | 8.5                        | 0.47                      | 0.06              | 6.0         |
| <b>Cognitive functioning</b>                                               |                    |                 |                            |                           |                   |             |
| Mini-Mental State Examination score                                        |                    |                 |                            |                           |                   |             |
| Continuous scoring                                                         | 212                | 26.3            | 25.3                       | 0.65                      | 0.05              | 4.2***      |
| Dichotomous scoring (% <23)                                                | 212                | 21.2            | 23.1                       | 0.51#                     | 0.06              | -8.2        |
| <b>Affective functioning</b>                                               |                    |                 |                            |                           |                   |             |
| Center for Epidemiological Studies<br>Depression scale                     |                    |                 |                            |                           |                   |             |
| Continuous scoring                                                         | 186                | 13.6            | 11.9                       | 0.45                      | 0.07              | 14.4*       |
| Dichotomous scoring (% ≥16)                                                | 186                | 32.8            | 29.0                       | 0.38#                     | 0.07              | 13.0        |

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  (for a test of zero bias).

† Sum of 11 lower extremity tasks for which dependent status was reported.

‡ Sum of four upper extremity tasks for which dependent status was reported.

§ A summary of dependent status in six areas of physical functioning, incorporating items used by Katz et al.

(38).

¶ Sum of seven instrumental activities for which dependent status was reported.

# Kappa value.

**TABLE 2. Correspondence of independence versus dependence between proxy reports and subject self-reports and performance for individual physical and instrumental activities of daily living, Baltimore, Maryland, 1991–1992**

|                                                 |     | Dependent (%)† |                     |                     | Proxy vs. self-report |      |          | Proxy vs. performance |      |          |
|-------------------------------------------------|-----|----------------|---------------------|---------------------|-----------------------|------|----------|-----------------------|------|----------|
|                                                 | No. | Proxy report   | Subject self-report | Subject performance | Kappa                 | SE‡  | Bias (%) | Kappa                 | SE‡  | Bias (%) |
| Physical activities of daily living             |     |                |                     |                     |                       |      |          |                       |      |          |
| Walking 10 feet                                 | 192 | 57.3           | 44.8                | 40.6                | 0.58                  | 0.06 | 27.9***  | 0.59                  | 0.06 | 41.0***  |
| Getting into and out of bed                     | 152 | 33.6           | 29.6                | 34.2                | 0.39                  | 0.07 | 13.3     | 0.37                  | 0.08 | -1.9     |
| Putting socks and shoes on                      | 169 | 32.0           | 32.0                | 30.8                | 0.51                  | 0.07 | 0.0      | 0.59                  | 0.06 | 3.8      |
| Getting on and off the toilet                   | 168 | 44.0           | 68.5                | 70.8                | 0.40                  | 0.07 | -35.7*** | 0.31                  | 0.07 | -37.8*** |
| Eating§                                         | 199 | 3.0            | 1.5                 | 2.0                 |                       |      |          |                       |      |          |
| Rising from an armless chair                    | 164 | 62.2           | 52.4                | 41.5                | 0.26                  | 0.08 | 18.6*    | 0.38                  | 0.07 | 50.0***  |
| Putting on a shirt/blouse                       | 184 | 17.4           | 10.9                | 9.8                 | 0.56                  | 0.06 | 60.0**   | 0.50                  | 0.06 | 77.8**   |
| Buttoning a shirt/blouse                        | 182 | 17.0           | 7.1                 | 6.6                 | 0.51                  | 0.06 | 138.5*** | 0.31                  | 0.07 | 158.3*** |
| Grooming                                        | 190 | 14.2           | 8.4                 | 2.6                 | 0.35                  | 0.07 | 68.8*    | 0.22                  | 0.07 | 440.0*** |
| Getting into and out of a bath/shower           | 133 | 63.9           | 88.7                | 88.0                | 0.32                  | 0.08 | -28.0*** | 0.17                  | 0.09 | -27.4*** |
| Taking a shower, bath, or sponge bath           | 176 | 59.7           | 43.8                |                     | 0.18                  | 0.07 | 36.4***  |                       |      |          |
| Walking one block                               | 158 | 69.6           | 67.1                |                     | 0.77                  | 0.05 | 3.8      |                       |      |          |
| Climbing five stairs                            | 157 | 82.2           | 93.0                |                     | 0.18                  | 0.08 | -11.6**  |                       |      |          |
| Getting into a car                              | 168 | 66.7           | 46.4                |                     | 0.15                  | 0.08 | 43.6***  |                       |      |          |
| Putting on pants                                | 181 | 23.8           | 15.5                |                     | 0.43                  | 0.07 | 53.6***  |                       |      |          |
| Instrumental activities of daily living         |     |                |                     |                     |                       |      |          |                       |      |          |
| Using the telephone                             | 177 | 16.9           | 17.5                | 38.4                | 0.35                  | 0.07 | -3.2     | 0.38                  | 0.07 | -55.9*   |
| Handling money                                  | 152 | 30.9           | 34.2                | 48.7                | 0.81                  | 0.05 | -9.6     | 0.42                  | 0.07 | -36.5*   |
| Taking medications                              | 166 | 30.1           | 29.5                | 47.0                | 0.81                  | 0.05 | 2.0      | 0.34                  | 0.07 | -35.9*   |
| Getting places that are out of walking distance | 176 | 72.7           | 71.0                |                     | 0.79                  | 0.05 | 2.4      |                       |      |          |
| Shopping                                        | 150 | 66.7           | 60.7                |                     | 0.64                  | 0.06 | 9.9      |                       |      |          |
| Preparing meals                                 | 152 | 35.5           | 31.6                |                     | 0.65                  | 0.06 | 12.5     |                       |      |          |
| Housecleaning                                   | 139 | 80.6           | 74.8                |                     | 0.55                  | 0.07 | 7.7      |                       |      |          |

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  (for a test of zero bias).

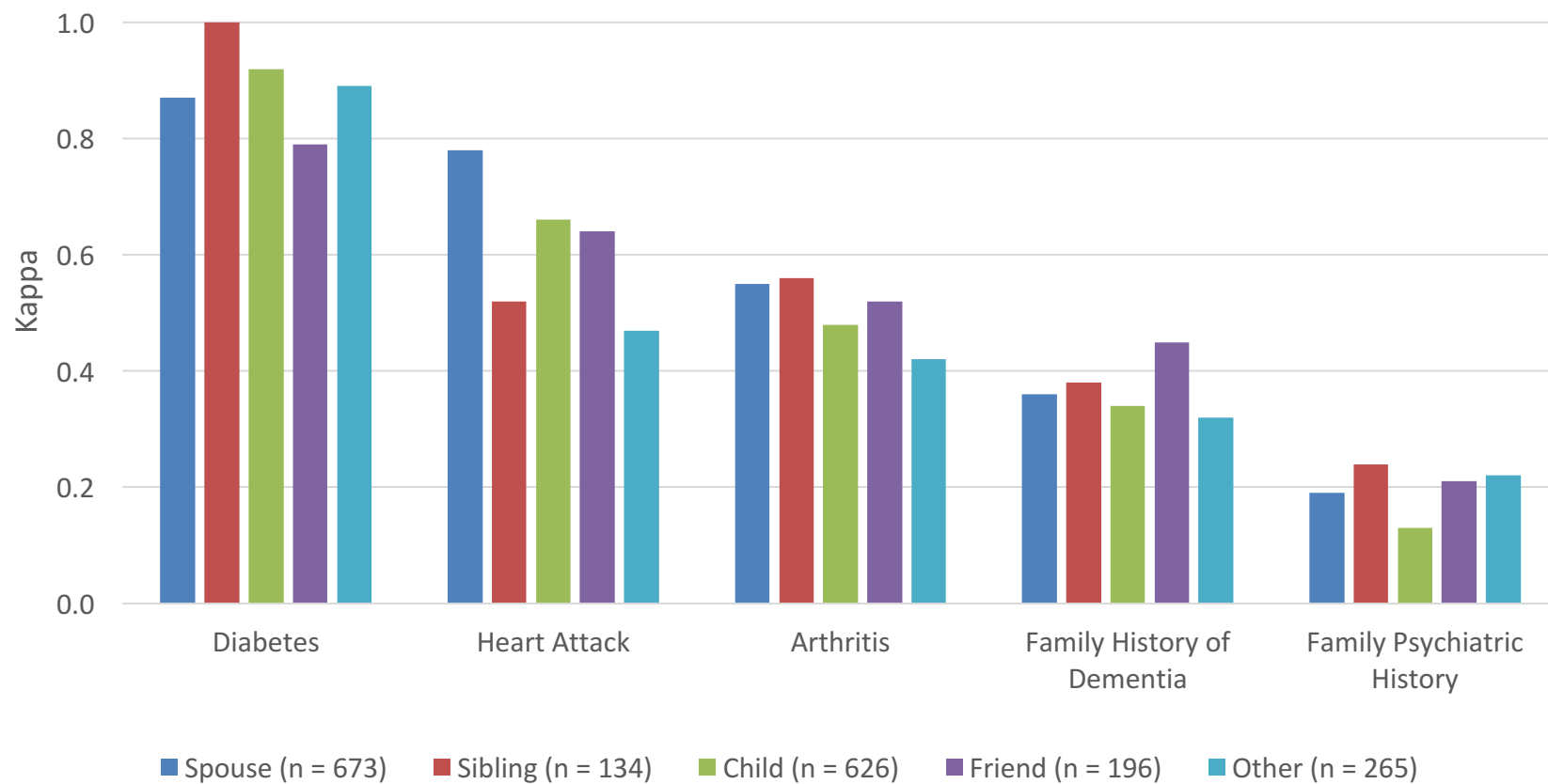
† The dependency category includes needing assistance, not performing a task for health reasons, or being unable to perform the task completely or correctly.

‡ SE, standard error.

§ Kappa and bias were not computed because of a low prevalence of dependency.

Magaziner et al. AJE. 1997

## Proband-Informant Agreement



Next Week:

**LECTURE: GUEST LECTURE ON BIOLOGY  
OF AGING**

**HOMEWORK: MEASUREMENT  
ASSIGNMENT**