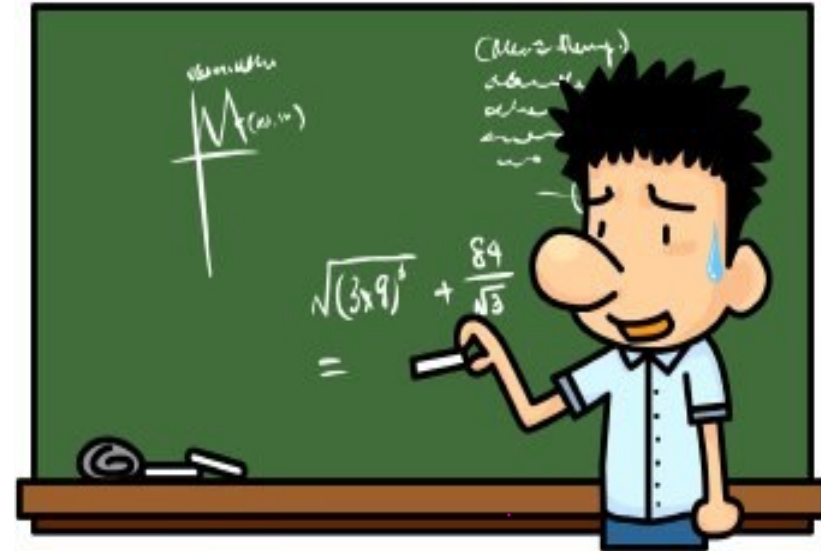


Psychometric evaluation of Measures

Ron D. Hays, Ph.D.



November 8, 2023 (2:30-4:00 pm)

Questionnaire Design and Testing Workshop

9th Floor Conference Room, 1100 Glendon Ave, Los Angeles, CA 90024

Medicare Health Outcomes Survey 2020 Cohort 23 Baseline File

- 8 Physical Functioning Activities of Daily Living (PFADL) items.
- CMS scores items with 0-2 points each.
 - Physical limitation or inability to perform an ADL = 0 points
 - Some limitation or difficulty = 1 point
 - No limitation or difficulty = 2 points.
- The unadjusted PFADL scale score sum ranges from 0 to 16 and a higher score is better.
 - Change from baseline to follow-up is scored on a 0-100 possible range, with 100 equivalent to retaining 100% of baseline function over two years and 0 corresponding to maximum decline.

Physical Functioning Activities of Daily Living items

2. The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?

a. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf (*B23vrmact*)

Yes, limited a lot

Yes, limited a little

No, not limited at all

b. Climbing several flights of stairs (*B23vrstair*)

Yes, limited a lot

Yes, limited a little

No, not limited at all

SF-36 Physical Function Items

21. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If yes, how much? **(Mark One Number on Each Line)**

<u>Activities</u>	Yes, Limited <u>A Lot</u>	Yes, Limited <u>A Little</u>	No, Not Limited <u>At All</u>
a. <u>Vigorous activities</u> , such as running, lifting heavy objects, participating in strenuous sports.....	1	2	3
b. <u>Moderate activities</u> , such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.....	1	2	3
c. Lifting or carrying groceries.....	1	2	3
d. <u>Climbing several flights of stairs</u>	1	2	3
e. Climbing <u>one</u> flight of stairs.....	1	2	3
f. Bending, kneeling, or stooping	1	2	3
g. Walking <u>more than a mile</u>	1	2	3
h. Walking <u>several blocks</u>	1	2	3
i. Walking <u>one block</u>	1	2	3
j. Bathing or dressing yourself.....	1	2	3

Physical Functioning Activities of Daily Living items

10. Because of a health or physical problem, do you have any difficulty doing the following activities without special equipment or help from another person?

a. Bathing (*B23adlbth*)

No, I do not have difficulty

Yes, I have difficulty

I am unable to do this activity

b. Dressing (*B23adldrs*)

No, I do not have difficulty

Yes, I have difficulty

I am unable to do this activity

c. Eating (*B23adleat*)

No, I do not have difficulty

Yes, I have difficulty

I am unable to do this activity

Physical Functioning Activities of Daily Living items

10. Because of a health or physical problem, do you have any difficulty doing the following activities without special equipment or help from another person?

d. Getting in or out of chairs (*B23adlchr*)

No, I do not have difficulty

Yes, I have difficulty

I am unable to do this activity

e. Walking (*B23adlwlk*)

No, I do not have difficulty

Yes, I have difficulty

I am unable to do this activity

f. Using the toilet (*B23adlflt*)

No, I do not have difficulty

Yes, I have difficulty

I am unable to do this activity

Cohort 23 Dataset

- 287,476 observations (13,219 have missing data for > half the items).
- “The 2020 Cohort 23 Baseline Medicare HOS included a random sample of 783,389 beneficiaries, including both the aged and disabled, from 510 managed care plans. Of the 783,389 individuals sampled, 287,476 (36.7%) completed the baseline survey and were included in the C23B_PUF.CSV data file. For the purposes of this data file, a completed survey was defined as a survey with at least one question item completed and a survey disposition code equal to M10, M11, M31, T10, T11, or T31 (please refer to Field 81 in the Survey Administration Table for a description of the codes)” (2020 Cohort 23 Baseline Public Use File Data Users Guide).
- <https://www.hosonline.org/en/data-dissemination/research-data-files/>

Sample Characteristics

- 58% female
- 16% less than 65 years old, 50% 65-74, and 34% 75 or older
- 77% White, 14% Black, and 8% another race
- 19% less than high school education, 32% high school or GED, and 48% more than a high school education.
- 44% married

95% completed the survey in English and 5% in Spanish.

Table 1: Characteristics of the Sample (n = 287476)

Variable	N (Percent)	Medicare Population²⁵
Female	156296 (58%)	55%
Age		
< 65 years	46005 (16%)	14%
65-74	142812 (50%)	50%
75 or older	98659 (34%)	37%
Race		
White	197788 (77%)	77%
Black	36753 (14%)	11%
Another race	21670 (8%)	12%
Education		
Did not graduate high school	51462 (19%)	14%
High school graduate/general education diploma	86034 (32%)	33%
More than high school	128452 (48%)	53%
Marital Status		
Married	118771 (44%)	51%
Survey Language		
English	273109 (95%)	
Spanish	14003 (5%)	
Chinese	364 (<1%)	

Psychometrics

- Item frequencies
- Inter-item correlations
- Item-scale correlations and scale reliability
- Scale means, medians, SD, % floor/ceiling
- Factor analysis
- Associations with other (similar and other) measures
- Item response theory parameters

Item Frequencies

	Most Limitation	Intermediate Limitation	No Limitation
Several flights of stairs	32% limited a lot	35% limited a little	32% not limited at all
Moderate activities	25% limited a lot	35% limited a little	40% not limited at all
Walking	3% unable to do	34% have difficulty	62% do not have difficulty
Getting in or out of chairs	2% unable to do	24% have difficulty	75% do not have difficulty
Bathing	4% unable to do	15% have difficulty	81% do not have difficulty
Dressing	2% unable to do	23% have difficulty	85% do not have difficulty
Using the toilet	2% unable to do	9% have difficulty	89% do not have difficulty
Eating	1% unable to do	5% have difficulty	94% do not have difficulty

Table 3: Percentage Able to Do 6 Physical Function Activities Without Difficulty in Three Datasets

	2010 Medicare CAHPS* (n =366,701)	2019 Medicare CAHPS† (n = 79,725)	2020 Health Outcomes Survey (HOS) Baseline Cohort 23
Walking	253024 (69%)	58120 (73%)	168686 (62%)
Getting in or out of chairs	286027 (78%)	64737 (81%)	201882 (75%)
Bathing	311696 (85%)	69600 (87%)	221099 (81%)
Dressing	322697 (88%)	71194 (89%)	231088 (85%)
Using the toilet	333698 (91%)	73347 (92%)	240899 (89%)
Eating	344699 (94%)	75420 (95%)	254111 (94%)

*Consumer Assessment of Healthcare Providers and Systems (CAHPS®) Medicare managed care and fee-for-service respondents including those less than 65 years old.²¹

†Medicare fee-for-service 65 years of age and older (unpublished).

Pearson Correlation Coefficients
 Prob > |r| under H0: Rho=0
 Number of Observations

	B23vrstair	B23vrract	B23adlwlk	B23adlchr	B23adlbth	B23adldrs	B23adltit	B23adleat
B23vrstair	1.00000 <.0001 273867	0.72393 <.0001 270405	0.55204 <.0001 262015	0.44904 <.0001 262869	0.37641 <.0001 263209	0.33146 <.0001 263158	0.28357 <.0001 261373	0.18781 <.0001 263386
B23vrract	0.72393 <.0001 270405	1.00000 <.0001 276706	0.56402 <.0001 264248	0.47197 <.0001 265132	0.43764 <.0001 265488	0.39118 <.0001 265412	0.32677 <.0001 263544	0.22680 <.0001 265626
B23adlwlk	0.55204 <.0001 262015	0.56402 <.0001 264248	1.00000 <.0001 270018	0.63733 <.0001 268593	0.53575 <.0001 268121	0.49914 <.0001 268153	0.48020 <.0001 267021	0.32181 <.0001 268421
B23adlchr	0.44904 <.0001 262869	0.47197 <.0001 265132	0.63733 <.0001 268593	1.00000 <.0001 270984	0.55901 <.0001 269054	0.57294 <.0001 269113	0.56309 <.0001 267792	0.38542 <.0001 269359
B23adlbth	0.37641 <.0001 263209	0.43764 <.0001 265488	0.53575 <.0001 268121	0.55901 <.0001 269054	1.00000 <.0001 271321	0.73132 <.0001 269898	0.59691 <.0001 267391	0.46039 <.0001 270004
B23adldrs	0.33146 <.0001 263158	0.39118 <.0001 265412	0.49914 <.0001 268153	0.57294 <.0001 269113	0.73132 <.0001 269898	1.00000 <.0001 271268	0.63161 <.0001 267519	0.51319 <.0001 270254
B23adltit	0.28357 <.0001 261373	0.32677 <.0001 263544	0.48020 <.0001 267021	0.56309 <.0001 267792	0.59691 <.0001 267391	0.63161 <.0001 267519	1.00000 <.0001 269372	0.48800 <.0001 267797
B23adleat	0.18781 <.0001 263386	0.22680 <.0001 265626	0.32181 <.0001 268421	0.38542 <.0001 269359	0.46039 <.0001 270004	0.51319 <.0001 270254	0.48800 <.0001 267797	1.00000 <.0001 271530

Types of Reliability

- Inter-rater (rater)
 - Need 2 or more raters of the thing being measured
- Test-retest (administrations)
 - Need 2 or more time points
- Internal consistency (items)
 - Need 2 or more items



Test-retest Reliability of MMPI 317-362 ($r = 0.75$)

$0.9 \leq \alpha$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

		MMPI 317		
		True	False	
MMPI 362	True	169	<u>15</u> (14%)	184
	False	<u>21</u> (11%)	95	116
		190	110	

I am more sensitive than most other people.

Hays, R. D., & Revetto, J. P. (1992). Old and new MMPI-derived scales and the Short-MAST as screening tools for alcohol disorder. *Alcohol and Alcoholism*, 27, 685-695.

Alpha

Reliability Formulas

Model	Reliability	Intraclass Correlation
Two-way random	$\frac{N(MS_{BMS} - MS_{EMS})}{NMS_{BMS} + MS_{JMS} - MS_{EMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS} + k(MS_{JMS} - MS_{EMS}) / N}$
Two-way mixed	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS}}$
One-way	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS} + (k-1)MS_{WMS}}$

BMS = Between Ratee Mean Square

N = n of ratees

WMS = Within Mean Square

k = n of items or raters

JMS = Item or Rater Mean Square

EMS = Ratee x Item (Rater) Mean Square

Cronbach Coefficient Alpha	
Variables	Alpha
Raw	0.856839
Standardized	0.878594

Cronbach's alpha	Internal consistency
$0.9 \leq \alpha$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Cronbach Coefficient Alpha with Deleted Variable				
Deleted Variable	Raw Variables		Standardized Variables	
	Correlation with Total	Alpha	Correlation with Total	Alpha
B23vrstair	0.611752	0.847986	0.550937	0.872785
B23vrmact	0.661205	0.838821	0.601265	0.867662
B23adlwlk	0.715431	0.825866	0.698535	0.857521
B23adlchr	0.692120	0.830891	0.709276	0.856382
B23adlbth	0.675571	0.832094	0.722315	0.854993
B23adldrs	0.658332	0.836310	0.716397	0.855624
B23adlftt	0.595802	0.844644	0.650304	0.862590
B23adleat	0.440349	0.857865	0.484508	0.879418

Physical Function Scale Distribution

Medicare Health Outcomes Survey 2020 Cohort 23 Baseline

The MEANS Procedure

Variable	N	Mean	Std Dev	Minimum	Maximum
PHYFUN8	252577	1.6162477	0.3920813	0	2.0000000
PHYFUN8SUM	252577	12.9299817	3.1366508	0	16.0000000

Median = 14

Mode = 16

Floor: 0.3%

Ceiling: 26%

Exploratory Factor Analysis

08:14 Saturday, January 28, 2023 2

Medicare Health Outcomes Survey 2020 Cohort 23 Baseline
PRINCIPAL COMPONENTS ANALYSIS
GUTTMAN'S WEAKEST LOWER BOUND
LOOKING FOR EIGENVALUES ≥ 1

The FACTOR Procedure
Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

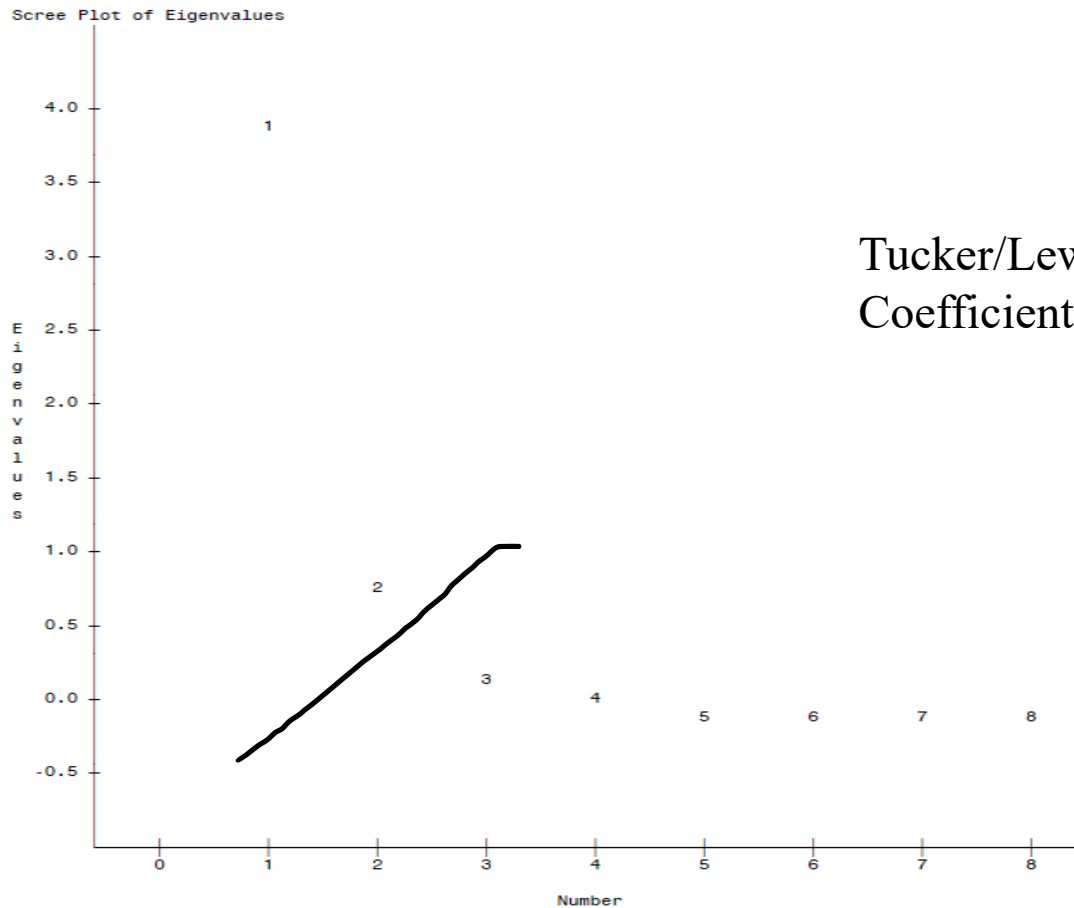
Eigenvalues of the Correlation Matrix: Total = 8 Average = 1				
	Eigenvalue	Difference	Proportion	Cumulative
1	4.37789943	3.12737856	0.5472	0.5472
2	1.25052086	0.65423351	0.1563	0.7036
3	0.59628735	0.09249348	0.0745	0.7781
4	0.50379388	0.10300752	0.0630	0.8411
5	0.40078636	0.05803916	0.0501	0.8912
6	0.34274720	0.07251832	0.0428	0.9340
7	0.27022888	0.01249284	0.0338	0.9678
8	0.25773604		0.0322	1.0000

Note: 5.99 and 0.85 for polychoric correlations.

Scree Plot

Medicare Health Outcomes Survey 2020 Cohort 23 Baseline
SQUARED MULTIPLE R COMMUNALITIES
GUTTMAN'S STRONGEST LOWER BOUND
SCREE PLOT FOR CATTEL'S SCREE TEST

The FACTOR Procedure
Initial Factor Method: Principal Factors



Tucker/Lewis reliability
Coefficient for 2 factors = 0.95

Number of Variables in Your Dataset to be Factor Analyzed (Please change)

Sample Size of Your Dataset (Please change)

Type of Analysis

Number of Random Correlation Matrices to Generate (default of 100 currently set)

Percentile of Eigenvalues (default of 95th percentile currently set)

Seed

About this Application

Patil et al. (2008) presented a web-based parallel analysis engine (Patil et al. 2007) that used SAS. This

Citing this Application:

Patil Vivek H, Surendra N. Singh, Sanjay Mishra, and D. Todd Donovan (2017). Parallel Analysis Engine to Aid in Determining Number of Factors to Retain using R [Computer software], available from <https://analytics.gonzaga.edu/parallelengine/>.

Using this Application

Based on parameters provided by the researcher, this engine calculates eigenvalues from randomly generated correlation matrices. These can be then compared with eigenvalues extracted from the researcher's dataset. The number of factors to retain will be the number of eigenvalues (generated from the researcher's dataset) that are larger than the corresponding random eigenvalues (Horn 1965).

The default (and recommended) values for number of random correlation matrices and percentile of eigenvalues are 100 and 95 respectively (see Cota et al. 1993; Glorfeld 1995; Turner 1998; Velicer et al. 2000). Based on the nature of their particular dataset, researchers, can override these default options. Higher (lower) values of number of correlation matrices generated increase (decrease) computation time but provide more (fewer) data points in the distribution of different eigenvalues. The percentile determines the desired eigenvalue from this distribution, which is then used for comparison purposes. Lower values of the percentile tend to lead to over extraction (extraction of more factors than necessary).

Component or Factor	Mean Eigenvalue	Percentile Eigenvalue
1	0.007911	0.010570
2	0.005288	0.006889
3	0.003121	0.004931
4	0.001077	0.002401
5	-0.000916	0.000618
6	-0.002992	-0.001436
7	-0.005197	-0.003523
8	-0.008079	-0.005921

Factor Loadings for Rotated Factors

	Factor 1: BADL	Factor 2: Advanced
Several flights of stairs	-0.09	0.85
Moderate activities	-0.02	0.82
Walking	0.32	0.54
Getting in our out of chairs	0.51	0.33
Bathing	0.74	0.11
Dressing	0.83	0.01
Using the toilet	0.76	-0.01
Eating	0.65	-0.09

Inter-factor correlations = 0.57

Multi-trait Scaling (n = 252,577; SE = 0.002)

Item	BADL	Advanced
Several flights of stairs	0.43	0.74*
Moderate activities	0.46	0.75*
Walking	0.63	0.60*
Getting in or out of chairs	0.64*	0.59
Bathing	0.74*	0.51
Dressing	0.78*	0.46
Using the toilet	0.71*	0.40
Eating	0.55*	0.27

Multi-trait Scaling (n = 252,577, SE = 0.002)

Item	BADL	Advanced
Several flights of stairs	0.49	0.73*
Moderate activities	0.54	0.73*
Walking	0.63*	0.60
Getting in or out of chairs	0.70*	0.50
Bathing	0.74*	0.44
Dressing	0.75*	0.39
Using the toilet	0.70*	0.33
Eating	0.52*	0.23

Inter-scale correlation = 0.55

Confirmatory Factor Analysis Fit Indices

- Normed fit index: $\frac{\chi_{null}^2 - \chi_{model}^2}{\chi_{null}^2}$
 - Non-normed fit index: $\frac{\frac{\chi_{null}^2}{df_{null}} - \frac{\chi_{model}^2}{df_{model}}}{\left[\frac{\chi_{null}^2}{df_{null}} - 1 \right]}$
 - Comparative fit index: $1 - \left[\frac{\chi_{model}^2 - df_{model}}{\chi_{null}^2 - df_{null}} \right]$
- RMSEA = SQRT $(\lambda^2 - df)/SQRT (df (N - 1))$

CFI ≥ 0.95 and RMSEA ≤ 0.06

Correlations with Other Measures

	Easier 2-PF (BADL)	Harder PF (Advanced)
Difficulty doing errands due to health condition	-.55	-.45
Memory problems interference with daily activities	-.45	-.38
Difficulty concentrating, remembering, decisions	-.39	-.33
Blind or serious difficulty seeing even with glasses	-.24	-.21
Depression	-.28	-.29
Arthritis of hip or knee	-.25	-.33
Arthritis of hand or wrist	-.21	-.26
Emphysema, asthma, or COPD	-.16	-.24
BMI	-.13	-.21
Congestive heart failure	-.18	-.20

IRT Parameters

Item	%	Threshold	Slope (item-rest correlation)
B23vrstair (mean = 2.00) Climbing stairs			2.60 (0.61)
Yes, limited a lot	32		
		-0.56 ^a	
Yes, limited a little	35		
		0.56 ^b	
No, not limited at all	32		
B23vrnact (mean = 2.15) Moderate activities			2.75 (0.66)
Yes, limited a lot	25		
		-0.81 ^c	
Yes, limited a little	35		
		0.28 ^d	
No, not limited at all	40		
B23adlwlk (mean = 2.59) Walking			3.49 (0.72)
I am unable to do this activity	3		
		-1.97	
Yes, I have difficulty	34		
		-0.38	
No, I do not have difficulty	63		
B23adlchr (mean = 2.73) Getting in/out of chairs			3.58 (0.69)
I am unable to do this activity	2		
		-2.25	
Yes, I have difficulty	24		
		-0.75	
No, I do not have difficulty	74		
B23adlbth (mean = 2.78) Bathing			4.22 (0.68)
I am unable to do this activity	4		
		-1.84	
Yes, I have difficulty	15		
		-0.98	
No, I do not have difficulty	81		
B23adldrs (mean = 2.83) Dressing			4.76 (0.66)
I am unable to do this activity	2		
		-2.01	
Yes, I have difficulty	12		
		-1.10	
No, I do not have difficulty	85		

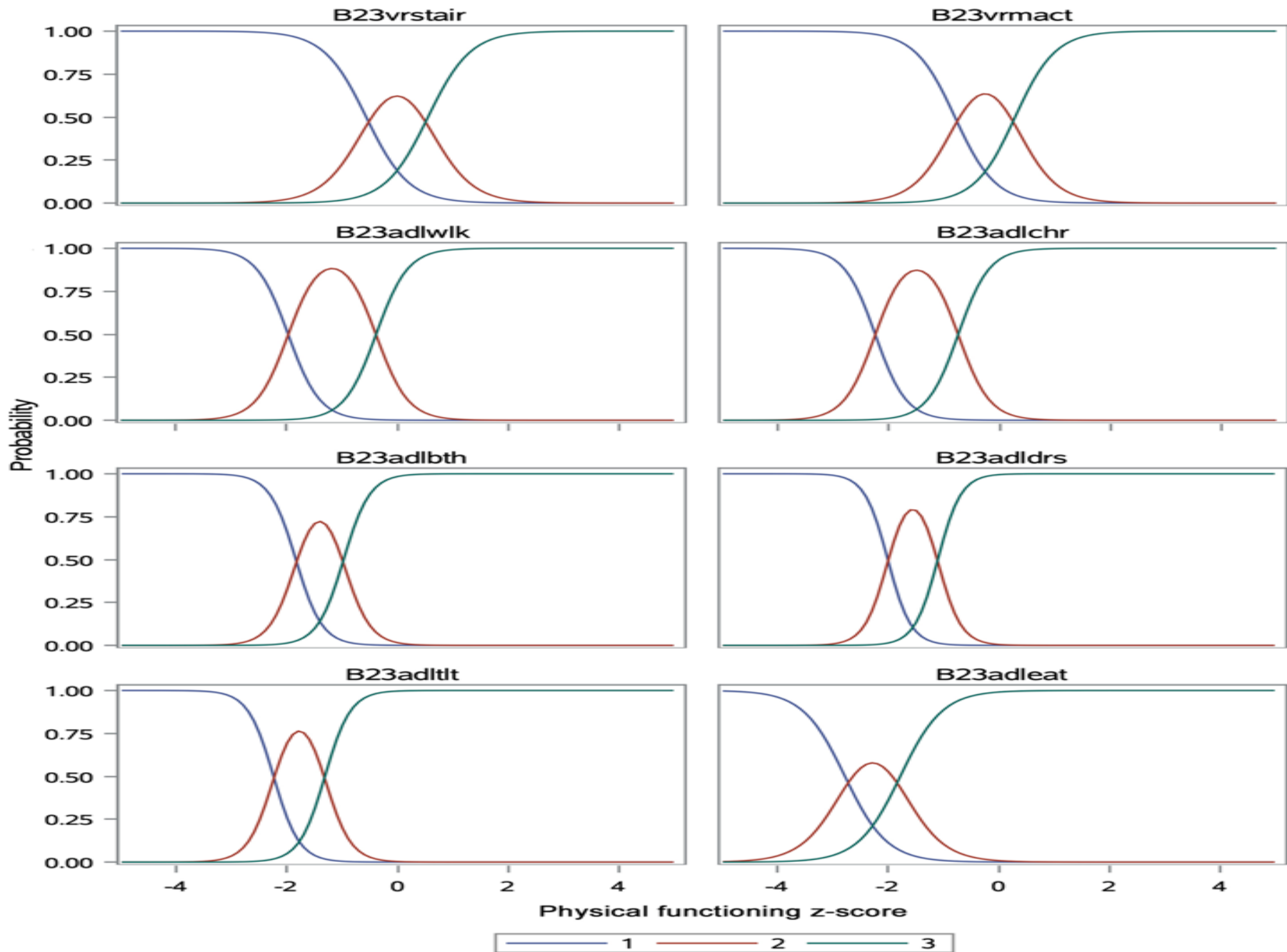
^a -1.82 in PROMIS® general population. ^b -0.09 in PROMIS® general population.

^c -2.20 in PROMIS® general population. ^d -0.49 in PROMIS® general population.

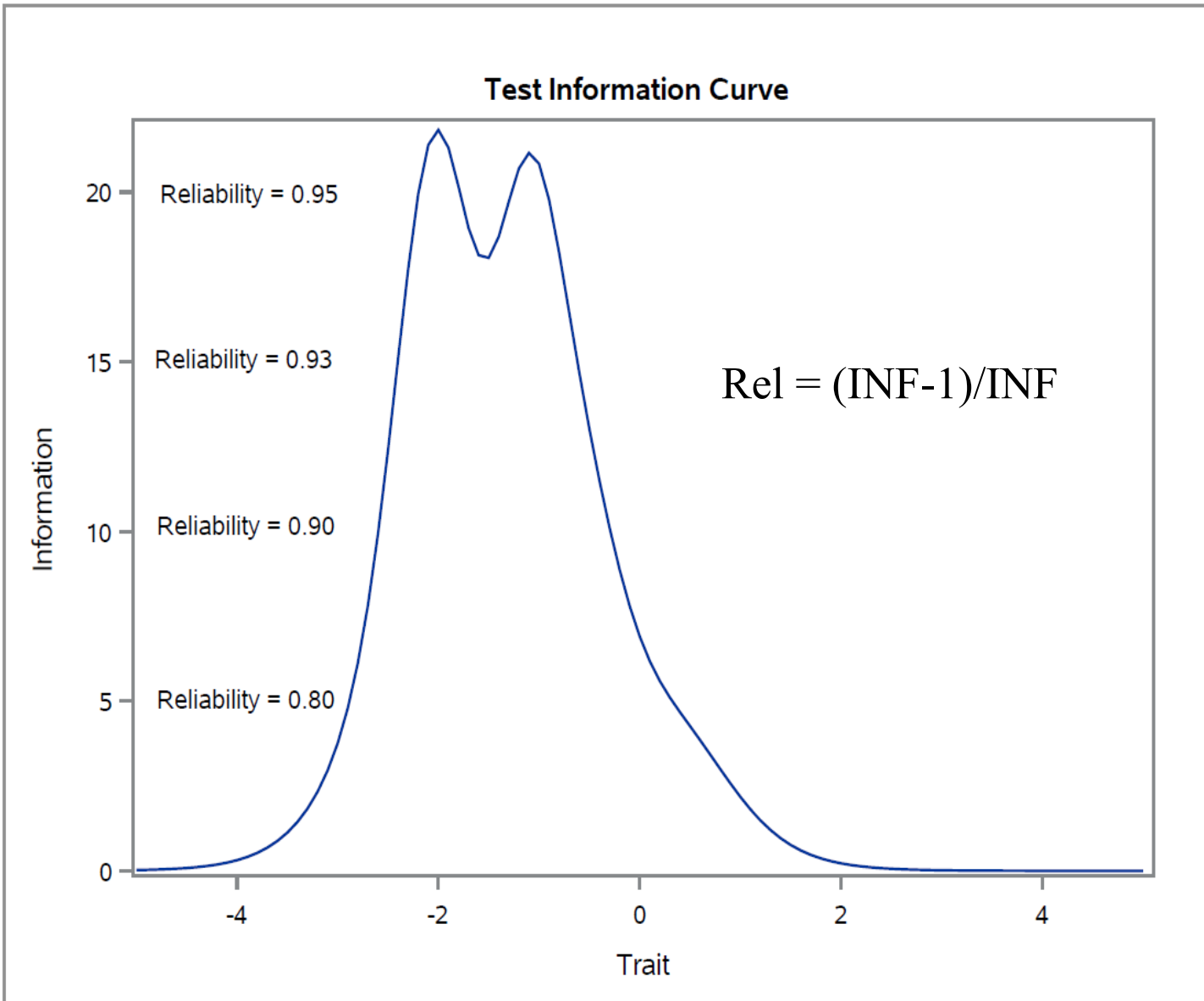
IRT Parameters (Continued)

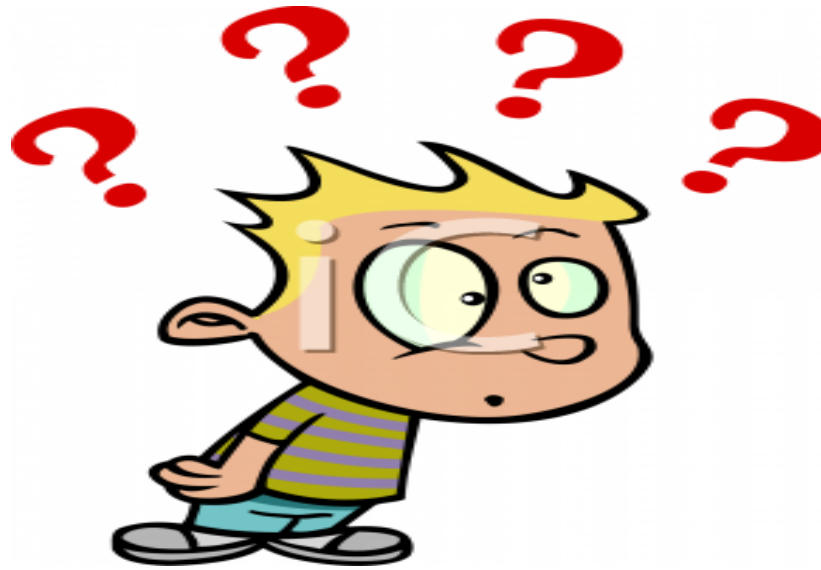
Item	%	Threshold	Slope (item-rest correlation)
B23adldtlt (mean = 2.88) Using the toilet			4.32 (0.60)
I am unable to do this activity	2		
		-2.25	
Yes, I have difficulty	9		
		-1.32	
No, I do not have difficulty	89		
B23adleat (mean = 2.93) Eating			2.63 (0.44)
I am unable to do this activity	1		
		-2.79	
Yes, I have difficulty	5		
		-1.78	
No, I do not have difficulty	94		

Item Characteristic Curves



The IRT Procedure





Email: drhays@ucla.edu

Resources

<https://labs.dgsom.ucla.edu/hays/pages/>

Hays, R. D., & Elliott, M. N. (submitted May 14, 2023; revised and resubmitted, September 6, 2023). Performance of the physical functioning activities of daily living scale in the 2020 Medicare Health Outcomes Survey. Arch Phys Med Rehabil.