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Rasch Rating Scale Model (RSM) Analysis of the EQ-5D Using the 2003 Medical Expenditure Panel Survey (MEPS)

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Introduction

- The EQ-5D is a widely used generic preference-based instrument quantifying health-related quality-of-life (HRQoL) in health outcome assessments, clinical trials, cost-effectiveness analysis (CEA) and burden of disease studies
- EQ-5D
 - 5 items (domains)
 - mobility (MO), self-care (SC), usual activities (UA), pain/discomfort (PD) and anxiety/depression (AD)
 - Each item has 3 responses
 - No problem (=1), some problem (=2), extreme problem (=3)
 - $3^5 = 243$ health states
 - Visual Analogue Scale (VAS)
 - Single index score
- The validity and the item properties, in a U.S. sample have yet to be explored



Fundamental Assumptions

- EQ-5D describes and quantifies HRQoL
- Fewer problems endorsed indicates better HRQoL
- Lower severity of problems also indicates better HRQoL

By these assumptions...

- Item endorsement should be a function of respondent HRQoL, the difficulty of endorsing the item and the severity level of the response category



The Rasch Model (RM)

$$P(X_{ni} = x) = f(\beta_n - \delta_{ix}) \quad (1)$$

- The probability of endorsing an item is a function of the persons HRQoL β and the severity of the EQ-5D item δ at category x



The Rasch Rating Scale Model (RSM)

$$P(X_{ni} = x) = \frac{\exp \sum_{j=0}^x [\beta_n - (\delta_i + \tau_j)]}{\sum_{k=0}^m \exp \sum_{j=0}^k [\beta_n - (\delta_i + \tau_j)]}, x = 0, 1, \dots, m \quad (2)$$

- Where $P(X_{ni} = x)$ is the probability that a person n is assigned to rating scale category x on item i , each item has $m + 1$ rating scale categories
- And

$$\sum_{j=0}^0 [\beta_n - (\delta_i + \tau_j)] = 0 \quad (3)$$



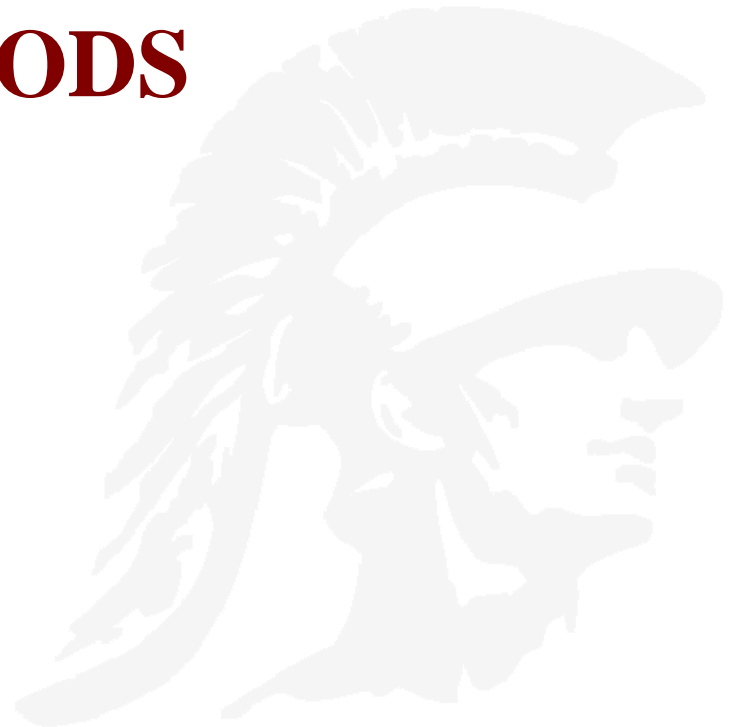
Hypotheses Tested

- *H1*: All EQ-5D items contribute to a single underlying construct of HRQoL in all populations
- *H2*: Departure from *H1* occurs in one or more sub-populations (gender or disease groups)



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METHODS





Data Source

- The 2003 Household Component Full-Year Files from the Medical Expenditure Panel Survey (MEPS), conducted by the US Agency for Healthcare Research and Quality (AHRQ)
- **Inclusion criteria**
 - positive person weights
 - 18 years or older
 - complete EQ-5D responses
 - no extreme scores demonstrating ceiling or floor effect
 - Primary ICD-9-CM codes for the top 10 most prevalent chronic diseases in MEPS

Participants

Chronic Disease	ICD-9	n (%)
Hypertension	401	797 (19.4)
Diabetes	250	484 (11.8)
Depression	311	468 (11.4)
Back Disorder	724	417 (10.2)
Arthropathy	716	383 (9.3)
Cholesterol	272	182 (4.4)
Asthma	493	172 (4.2)
Sinusitis	473	133 (3.2)
Anxiety	300	191 (4.7)
Joint Disorder	719	164 (4.0)
Healthy	No ICD-9	716 (17.4)
TOTAL		4107 (100%)



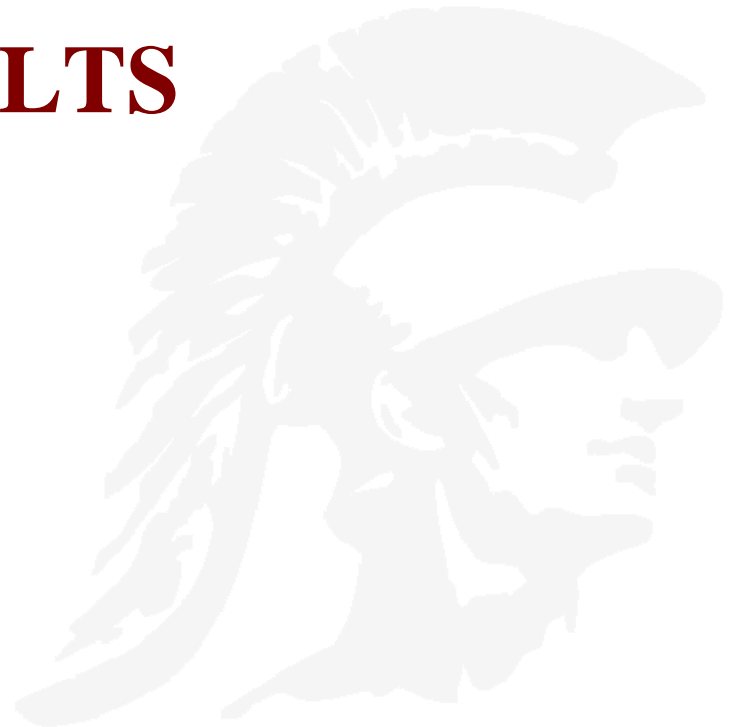
Analysis Plan

- Create linear measures using RSM
- Item infit/outfit standardized z score (Z)
 - Underfit if $Z > +2 \rightarrow$ noisy/erratic
 - Overfit if $Z < -2 \rightarrow$ muted/Guttman
- Principal component analysis (PCA) of Rasch residuals
 - Amount of variance explained after the Rasch measure is accounted for
- Differential Item Functioning (DIF)
 - DIF if individuals with the same level of HRQoL respond systematically different to the EQ-5D items
- Report using log-odd units (logits)
- *A priori* significance level 0.05
 - Bonferroni adjustment to control for Type I error



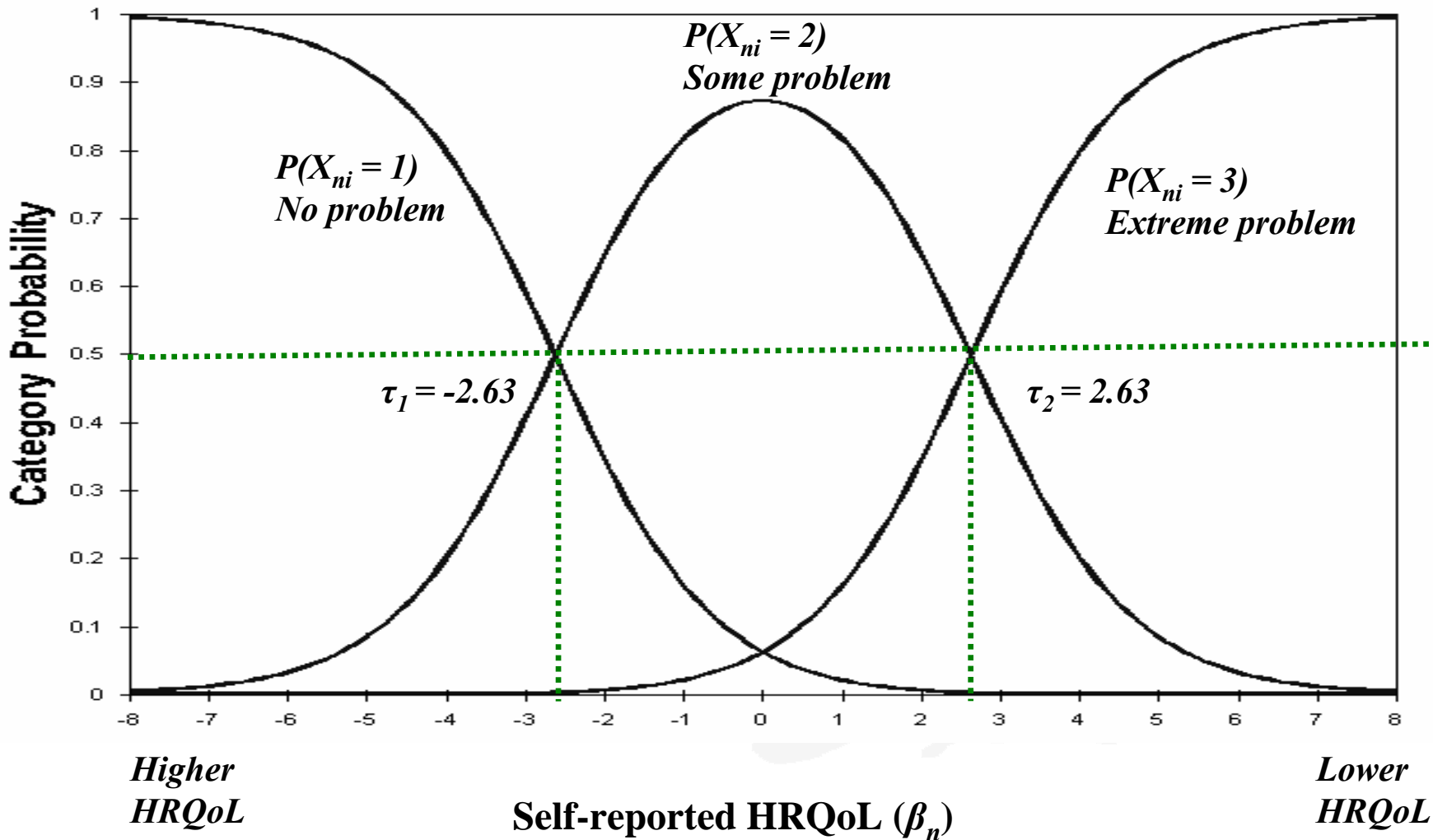
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RESULTS





Category Probability Curves





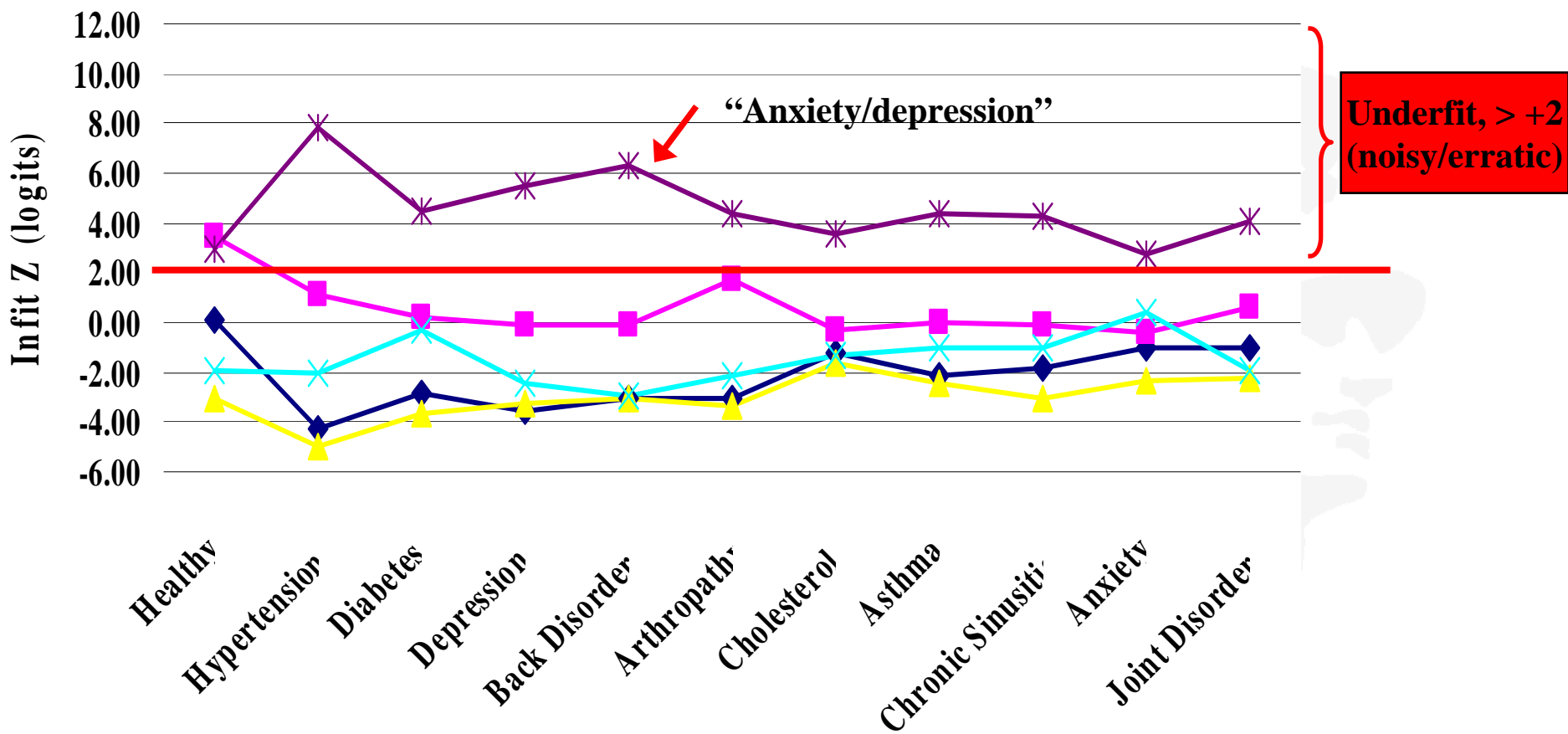
Principal Component Analysis of Rasch Residuals

- About 75% ~ 94% of the variance explained by the EQ-5D items within different disease groups, after the Rasch measure was accounted for
- Small amount of variance unexplained



Infit Z

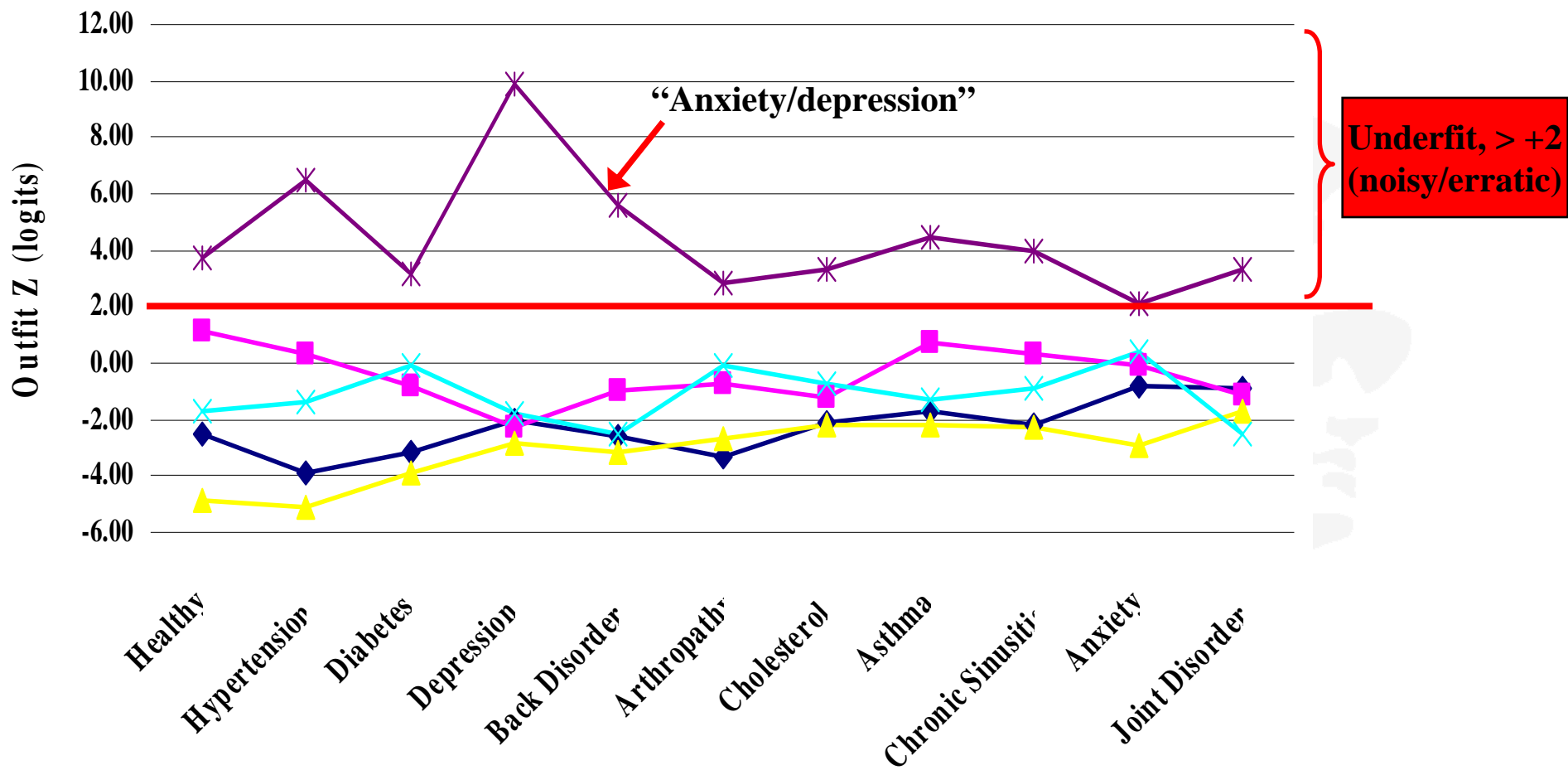
◆ Mobility ■ Self-Care ▲ Usual Activities ✕ Pain/Discomfort * Anxiety/Depression





Outfit Z

◆ Mobility ■ Self-Care ▲ Usual Activities ✧ Pain/Discomfort ✧ Anxiety/Depression





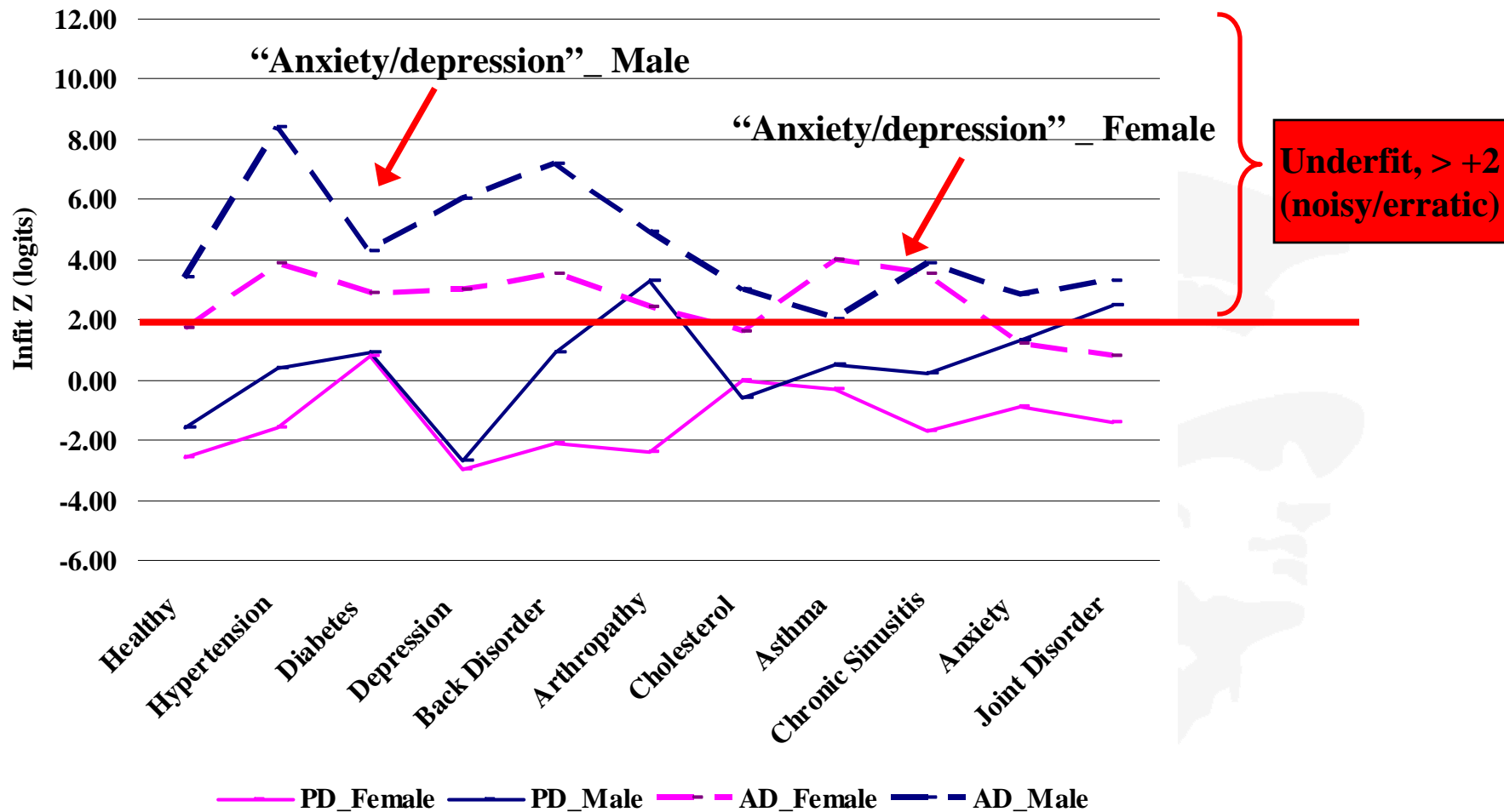
Gender-Related Differential Item Function (DIF)

Item	Female		Male		DIF Contrast
	DIF Measure	DIF S.E.	DIF Measure	DIF S.E.	
Mobility	0.36	0.05	0.21	0.06	0.15
Self-Care	3.00	0.08	3.00	0.10	0.00
Usual Activities	-0.05	0.05	0.13	0.08	-0.18
Pain/Discomfort	-2.22	0.05	-2.50	0.05	0.28*
Anxiety/Depression	-1.06	0.05	-0.80	0.06	-0.26*

* Significant after Bonferroni adjustment of Type I error



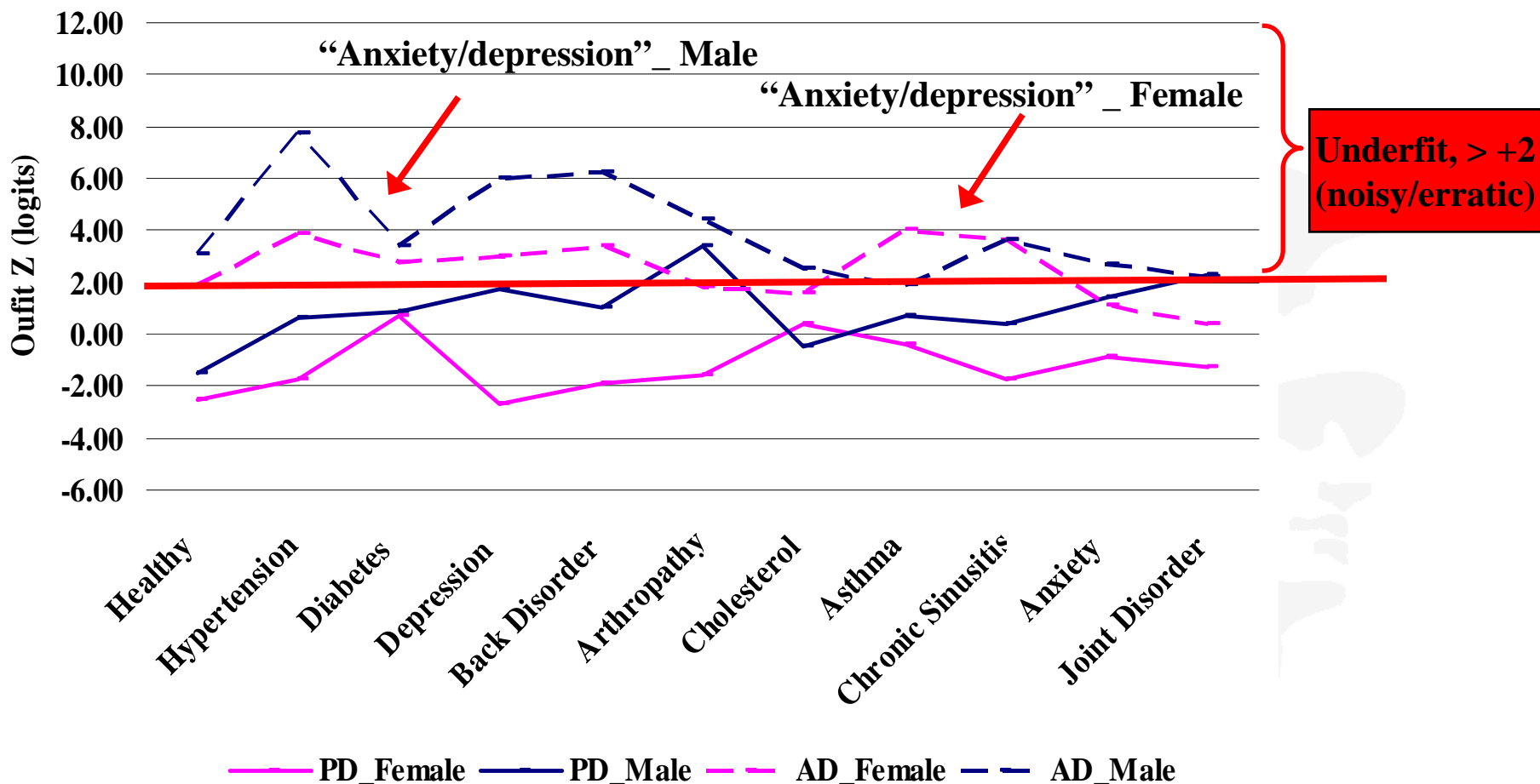
Infit Z on PD & AD with Gender-Split



Abbreviation: PD = Pain/Discomfort; AD = Anxiety/Depression



Outfit Z on PD & AD with Gender-Split



Abbreviation: PD = Pain/Discomfort; AD = Anxiety/Depression



Limitations and Future Studies

- In this study, we did not investigate:
 - ethnicity or socioeconomic status (SES) related DIF
 - interactions between disease and item within subgroups
 - the inclusion of the EQ-5D VAS into the Rasch model analysis
 - the validity of the findings by using different Rasch models



Conclusions

- We reject our null hypothesis
- EQ-5D items function similarly in different disease groups
- Unidimensionality is not achieved across all disease groups
- Item “*anxiety/depression*” consistently showed misfit irrespective of gender in most cases
- DIF found on the items “*anxiety/depression*” & “*pain/discomfort*” attributes, perhaps, to potential statistical artifacts
- It’s important to diagnose the potential causes of the misfit using the Rasch models by taking the confounding factors into consideration



Acknowledgments

- Sincere thanks to **Dr. Trevor G. Bond** for his valuable input, time, effort and patience
- Special thanks to **Dr. Richard Smith, Dr. Everett Smith** and **Joanne Wu** for their help and generous offerings of the resources
- Thanks to **Merck Fellowship** that makes Ning Yan Gu's study at USC possible
- Also thank Agency for Healthcare Research and Quality (**AHRQ**) for the availability of the MEPS data and swift responses



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Thank You !

