Choice consistency in discrete choice experiment: Does numeracy skill matter?

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Background/Objective

- Bias in responses due to low numeracy skills can be a big problem in discrete choice experiments (DCEs) (Katz et al., 2018; Lusardi, 2012; Schwartz et al., 1997).
- **Objective**: To investigate the effects of numeracy skills on choice consistency in DCE.

Methods

Study design:

- A paper-based DCE that explored patients' preferences for kidney transplantation in Italy (Genie et al., 2020).

DCE survey development:

- Attributes and levels were defined in consultation with kidney surgeons at the University of Padova (Italy).
- A D-efficient design was used to generate 16 choice tasks using '*AlgDesign Package*' in R (Aizaki & Nishimura, 2008). Each choice task contained two kidney transplant alternatives.
- After the DCE, respondents completed a numeracy skill quiz. The numeracy questions were adapted from the Survey of Health, Ageing and Retirement in Europe (SHARE), including the following questions:
  - The probability of contracting an illness is 10%, how many people out of one thousand would be expected to get the disease?
  - In a sale, a shop is selling all items at half price. Before the sale, the sofa costs €300. How much will it cost in the sale?
  - A second-hand car dealer is selling a car for €6,000. This is two-thirds of what it costs new. How much did the car cost new?

Data collection:

- The DCE survey was administered to all 250 patients on the waiting list for a kidney transplant at the Kidney and Pancreas Transplantation Unit (University of Padova).

Data analysis:

- A heteroskedastic mixed logit (HMXL) model was used to estimate the effect of numeracy on error variance/scale (Jonker et al., 2019).
- Willingness to wait (WTW) was calculated by patients' numeracy score.
- **Hypothesis**: Higher numeracy is expected to increase choice consistency in DCE.

Results

Patient characteristics:

- Average age was 49.9 years old (SD = 11.3). Average duration of dialysis was 3.38 years (SD = 3.76).
- Majority completed high school (47.6%), female (35%), married (66.5%), and employed (62.5%).
- The maximum attainable score was three correct answers.

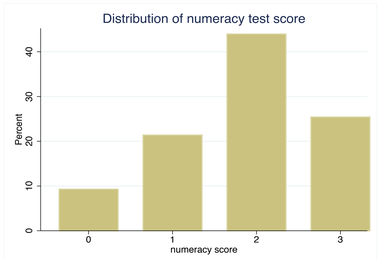

Figure 1: The distribution of numeracy test score

Heteroskedastic mixed logit model results:

- All attribute coefficients were statistically significant and had expected signs.
- The coefficient of numeracy score was positive and significant, indicating that choices were more consistent among patients with a higher numeracy score (Table 1).

Table 1: HMXL results: the effect of numeracy test score on error variance

	1 (Mean)	2 (SD)
Waiting time	-0.067 (0.006) ***	0.071 (0.012) ***
Graft survival	0.355 (0.028) ***	0.076 (0.034) ***
Infectious risk (reference: augmented)		
Standard infectious risk	1.743 (0.125) ***	1.418 (0.192) ***
Neoplastic risk (reference: augmented)		
Standard neoplastic risk	1.871 (0.143) ***	1.454 (0.199) ***
ASC	0.162 (0.044) ***	-
Covariates of scale		
Numeracy score	0.113 (0.043) ***	-
Model diagnostics		
LL at convergence	-1999.598	
McFadden's pseudo-R2	0.244	
BIC/n	1.091	
n (observations)	3818	
r (respondents)	248	

Standard errors in parenthesis, *** p<0.01. ASC: alternative specific constant; SD: standard deviations, BIC: Bayesian information criteria.

- **Willingness to wait**: Patients, on average, were willing to wait about seven months for a kidney that will offer an extra year of graft survival and 31-35 months longer for a kidney of standard risk compared to augmented risk.

Implications of accounting choice consistency for WTW estimates:

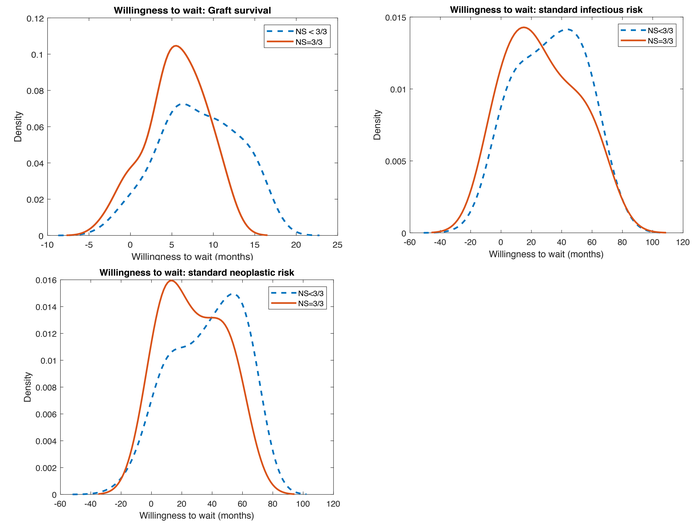

Figure 2: Kernel density plots of the distribution of patient-level WTW by numeracy score (NS, 3/3 versus NS, <3/3)

- Considering only patients who answered all three numeracy questions correctly lowered the estimated WTW. For instance, for graft survival, the mean WTW was three months shorter; for standard infectious risk, it was six months shorter; for standard neoplastic risk, it was ten months shorter than those who answered less than three questions correctly.
- Pooling of the two groups (NS =3 versus NS < 3) led to inflated WTW values.

Robustness to design, survey format, and disease context:

- We also used a web-based dual-response DCE that explored patients' preferences for disease modifying drugs in the treatment of Rheumatoid Arthritis in the USA.
- Most patients (43.86%) scored 3/3, while around 39.47% scored 2/3. The remaining 14.91% and 1.75% scored 1/3 and 0/3, respectively.
- The coefficient for numeracy score was positive and significant, indicating that patients who had higher numeracy scores were more likely to make consistent choices.

Conclusions

- In two separate DCEs, patients with higher numeracy scores demonstrated less variability in their choices compared to those with lower scores.
- Combining patients with different levels of numerical ability may introduce bias in the WTW/WTP estimates.
- Further research is needed to understand whether the effects of numeracy skills on WTW estimates is due to inadequate comprehension of the choice tasks or if patients with higher numeric ability prefer lower WTW.

Implication:

- Incorporating short numeracy questions in DCEs may be crucial. However, more research is required to determine whether any interventions could be adopted to improve patients' numeracy skills.

Limitation:

- A potential confounding effect between numeracy skill and commitment, as well as capability.
  - E.g., a patient may have high numeracy skill but may not be interested in answering the numeracy questions carefully due to a lack of commitment.

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