P24 Comparing linking approaches for patient-reported outcomes under non-normal distribution: A Monte Carlo simulation study

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Objective: In the field of patient reported outcomes, linking refers to the psychometric process used to establish a relationship between scores from different instruments. Empirical data in this field often exhibit zero-inflated distributions, with a large proportion of individuals clustered at the lower end of the distribution, reporting little to no symptoms. Despite this common pattern, there is limited research on how different linking methods perform under such data. This study aims to compare the performance of three linking approaches (unidimensional IRT, equipercentile, calibrated projection linking) when the underlying theta distribution deviates from normality, using item parameters from Patient-Reported Outcomes Measurement Information System® (PROMIS®) Anxiety bank and Generalized Anxiety Disorder 7-item scale.

Methods: Monte Carlo simulation study was conducted to evaluate the performance of the three linking methods under varying degrees of non-normality and latent correlations. Theta distributions for both instruments were generated using a mixture of two normal distributions: one centered at 0, and another centered at -1.5, to simulate the zero-inflated peak at the lower end. Mixing proportions ranged from 0% (normal) to 40% in 10% increments, and latent correlations from 0.6 to 1 in 0.05 increments. For each of the resulting 45 conditions (5 mixing proportions x 9 latent correlations), 20 datasets (N = 1,000) were simulated and linked using the three methods. Performance was evaluated using the Root Mean Square Error (RMSE) values of the difference between the linked and the true PROMIS theta.

Results: Across all mixing proportions, RMSE increased as latent correlation decreased, reflecting greater linking error. The calibrated projection method consistently demonstrated the lowest RMSE, indicating strong robustness under non-normal conditions. The equipercentile and unidimensional IRT methods performed similarly across most conditions, with equipercentile method slightly outperforming the unidimensional IRT method at correlations above 0.9 with higher zero inflation (30-40%).

Conclusions: Calibrated projection emerged as the most reliable linking method for patient reported outcomes with non-normal, zero-inflated distribution. While equipercentile method provides a viable alternative for high correlation scenarios, researchers should exercise caution under severely non-normal conditions. These findings provide practical guidelines for selecting linking approaches for patient-reported outcome measures under a more realistic distributional assumption.