Chapter 31
Item Response Modeling Instead of Classical Linear Analysis of Questionnaires

1 General Purpose

Item response modeling is used for analyzing psychometric data, quality of life data, and can even be used analyzing diagnostic tests. It may provide better precision than does the classical linear analysis. This chapter assesses how it works.

2 Schematic Overview of Type of Data File

Outcome (answer pattern)
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3   Primary Scientific Question

Are item response models more sensitive than classical linear methods for making predictions from psychological/QOL questionnaires, and diagnostic tests.

4   Example

One of the estimators of quality of life (QOL) is "feeling happy". Five yes/no questions indicate increasing levels of daily happiness: (1) 0 hours happy, (2) 6 hours happy, (3) 12 hours happy, (4) 18 hours happy, (5) 24 hours happy. Usually, with five yes/no questions in a domain the individual result is given in the form of a score, here, e.g., a score from 0 to 5 dependent on the number of positive answers given per person. However, with many questionnaires different questions represent different levels of difficulty or different levels of benefit etc. This can be included in the analysis using item response modeling.

A summary of a 5-item quality of life data of 1000 anginal patients is given below.

No. response pattern	Response pattern (1 = yes, 2 = no) to items 1 to 5	Observed Frequencies
1.	11111	0
2.	11112	0
3.	11121	0
4.	11122	1
5.	11211	2
6.	11212	3
7.	11221	5
8.	11222	8
9.	12111	12
10.	12112	15
11.	12121	18
12.	12122	19
13.	12211	20
14.	12212	21
15.	12221	21
16.	12222	21
17.	21111	20
18.	21112	19
19.	21121	18
20.	21122	15
21.	21211	12
22.	21212	9

23.	21221	5
24.	21222	3
25.	22111	4
26.	22112	0
27.	22121	0
28.	22122	0
29.	22211	0
30.	22212	0
31.	22221	0
32.	22222	0_____+

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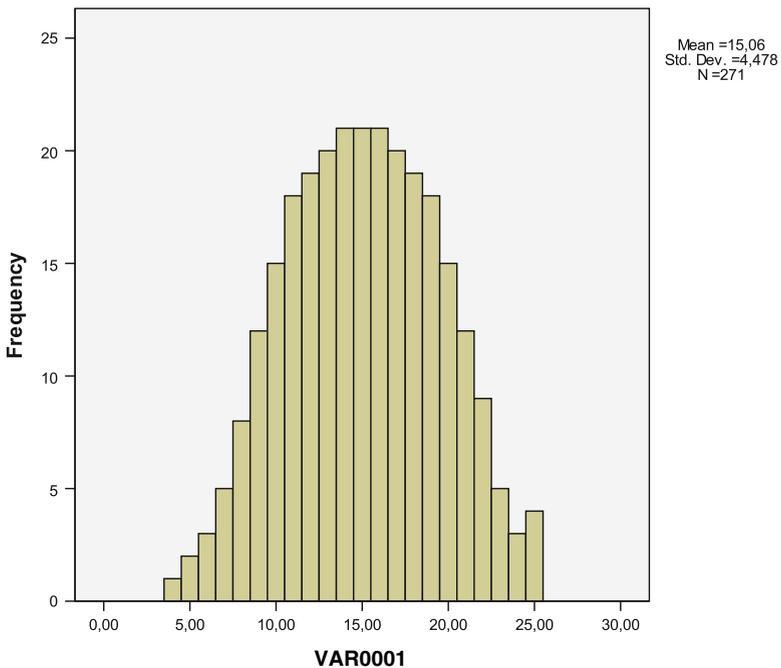
The above table shows how 5 questions can be used to produce 32 different answer patterns. The above graph figure shows a histogram of the answer patterns with the type of pattern on the x-axis and "how often" n the y-axis. A Gaussian like distribution frequency is observed. A score around 15 is observed most frequently, and can be interpreted as the mean score of the study. Low scores indicate little QOL. High scores indicate high QOL. Underneath the areas under the curve (AUCs) of the histogram is also given. The larger the AUCs, which run from 0.004 to 1.000 (0.4–100 %), the better the QOL.

Response pattern	AUC (area under the curve)	
4	1/271	=0.004 (=4 %)
5	3	=0.011
6	6	=0.022
7	11	=0.041
8	19	=0.070
9	31	=0.114
10	46	=0.170
11	64	=0.236
12	83	=0.306
13	103	=0.380
14	124	=0.458
15	145	=0.535
16	166	=0.613
17	186	=0.686
18	205	=0.756
19	223	=0.823
20	238	=0.878
21	250	=0.923
22	259	=0.956
23	264	=0.974
24	267	=0.985
25	271	=1.000 (=100 %)

Item response models are more sensitive than classical linear methods for making predictions from psychological/QOL questionnaires, and diagnostic tests. The above example shows that instead of a 6 point score running from 0 to 5 in the classical score, the item response model enabled to provide 32 scores, running from a QOL of 0.4 % to one of 100 %. A condition for item response modeling to be successfully applied is, of course, that the data should somewhat fit the Gaussian distribution.

5   Conclusion

Item response models are more sensitive than classical linear methods for making predictions from psychological/QOL questionnaires, and diagnostic tests.

Item response modeling is not in SPSS, but the LTA-2 software program of Uebersax is a free software program for the purpose. It works with the areas under the curve of statistically modeled best fit Gaussian curves of the data rather than a histogram of the data, but, otherwise, it is similar to the pocket calculator method.

6 Note

More background, theoretical and mathematical information of item response modeling is given in Statistics applied to clinical studies 5th edition, Chap. 39, Springer Heidelberg Germany, 2012, from the same authors.