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Development of a new self-report assessment for senior drivers in Korea

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Abstract

Background: This study developed a new self-report assessment for Korean elderly driver based on the Rasch model by collecting extant assessment items. Methods: For development, extant approved assessment items were collected, and 44 essential items were selected by the opinions of 33 elderly and driving experts. Using these items, data on a total of 339 elderly drivers were collected, and a Rasch analysis was performed to exclude nonconforming subjects and items, select an optimal scale, and verify reliability and validity. Results: As a result of Rasch analysis, 31 subjects were found to be nonconforming. Based on the data of 308 subjects, 6 items were found to be nonconforming, and a total of 38 items were selected. These items and elderly drivers were arranged in order of difficulty and ability based on the logit values of -2.43 to 1.84. Subject ability was arranged in order from logit values of -2.44 to 2.44, from which a subject ability conversion equation was completed. The 3-point optimal scale and sub-areas of "On-road, Coping, and Health" were established. Conclusions: Through this study, a new self-report assessment for elderly drivers in South Korea was developed; it was named the SAFE-DR (Self-Assessment Forecasting Elder's Driving Risk).

Keywords: *Driving risk, Elderly, Rasch analysis, Self-assessment*

1. Introduction

Age increases in the elderly are often accompanied perceptual, motor, and cognitive dysfunction that impairs normal daily functioning and mobility [1][2]. And securing the mobility of the elderly allows their active participation that can lead to success in later life [3]. But most elderly drivers discontinue driving due to accidents and the high risk [2]. In the elderly, the unexpected discontinuation of driving reduces social participation and causes stress, that can have a negative impact on their life [4][5].

The elderly drivers tend to attribute the accident cause to declined competency instead of other drivers [6][7], those that do, make efforts to prevent dangerous driving related situations through self-reflection, using their capacity for self-regulation [8][9]. Self-report assessments have been designed so that elderly drivers can monitor their driving ability by utilizing their capacity to self-regulate - this has been widely used given the need and the recognition of its efficacy in accident prevention [10].

Self-assessment tools were developed in various countries, such as the United Kingdom (DDW: Driving Decisions Workbook, The Older Driver Risk Index), Australia (RACQ Older Driver's Self-Assessment Questionnaire), and the United States (SAFER: Self-Awareness and

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Feedback for Responsible Driving, Driving Safely While Aging Gracefully, Driver 65 Plus, SDBM: Safe Driving Behavior Measure), in accordance with each country's situation [10]. On the other hand, there are no self-report evaluations that have been developed in accordance with the characteristics of Korean elderly drivers. This assessment tool is difficult to construct because it must capture all the driving-related factors (including health, driving behavior, cognition, and perception) although it is simple for the elderly to identify these issues by themselves [10][11]. Therefore, it is arguably possible to reconstruct a concise self-assessment tool that reflects the essential driving-related factors in the Korean elderly by selecting the core items of essential evaluation areas among the items used in the extant assessments. This test can be effectively used for monitoring and safety education of elderly drivers in Korean society, which is a rapidly aging society.

Rasch analysis allows for an objective comparison of these evaluation results by converting the ordinal scale into an interval scale, and the validity of the assessment tool can be established by analyzing the conformity of the one-dimensional composition and local independence [12][13]. Furthermore, an optimal scale for evaluating a subject can be constructed through the rating scale model of a Rasch analysis [14].

Thus, the purpose of this study was to construct such objective items and a scale for a self-assessment tool for Korean elderly drivers based on the Rasch model by selecting the essential items from existing self-assessment items for elderly drivers, in order to present evidence to objectively compare the evaluation results.

2. Methods

2.1. Procedure

All processes of the study were conducted with the approval of the Konyang University's Institutional Review Board (identification number: 2016-016). All participants were informed about the study and agreed to participate both verbally and in writing. To develop new self-assessment. the 10 most widely used self-report assessment were collected through a online search. Using items of these assessments, a Delphi survey was conducted with occupational therapy professors, occupational therapists, social workers, and road traffic experts with more than 5 years of elderly and driving related experience. As a result, 44 essential items were selected. Using these items, data on elderly drivers were collected through local community elderly welfare centers and elderly societies from September 2016 to November 2016.

2.2. Analysis method

For the elderly driver data analysis, PASW Statistics version 18.0, Winstep version 3.80.1, and AMOS 16 was used. In this study, the logits for item difficulty and subject ability, nonconforming item and subject, optimal scale, separation reliability were analyzed through Rasch analysis. The potential factors for constructing sub-areas of the assessment were identified through an exploratory factor analysis. And the conformity and validity of the factor model were verified through a confirmatory factor analysis.

3. Results

3.1. Determination of nonconforming subjects and items

As a result of the conformity analysis, 31 out of 339 elderly drivers (9.1%) were determined to be nonconforming subjects, and thus, they were excluded, and the analysis was thereafter continued on 308 subjects. The mean squared residual and Z values of the infit index of all excluded subjects were 2.0 or more at the same time Table 1.

Table 1. Goodness-of-fit analysis of subjects

Person number	Logit	S.E.	Infit		Outfit	
			MnSq	Z	MnSq	Z
60	4.2	0.51	4.25	4	7.29	5.3
30	2.56	0.27	2.68	4.4	4.15	6.6
32	1.52	0.2	3.66	7.2	3.5	6.9
330	1.52	0.2	3.66	7.2	3.5	6.9
152	2.88	0.3	3.02	4.7	3.6	5.2
42	3.59	0.4	3.58	4.4	2.76	3.1
244	3.08	0.32	2.62	3.8	3.23	4.4
87	3.31	0.35	3.12	4.3	3.13	3.9
115	2.8	0.29	3.13	5	2.64	3.9
84	3.08	0.32	2.85	4.2	3.11	4.3
137	2.17	0.24	3.1	5.5	3.02	5.3
2	1.44	0.19	2.73	5.4	3.04	6
316	1.44	0.19	2.73	5.4	3.04	6
99	2.71	0.28	2.93	4.7	2.1	3
77	1.91	0.22	2.78	5.1	2.43	4.3
254	1.91	0.22	2.78	5.1	2.43	4.3
89	2.98	0.31	2.77	4.2	1.83	2.2
95	2.23	0.24	2.58	4.5	2.48	4.2
93	2.8	0.29	2.49	3.8	1.78	2.2
214	1.04	0.18	2.36	4.9	2.29	4.6
304	1.04	0.18	2.36	4.9	2.29	4.6
31	2.49	0.26	2.35	3.8	2.02	3
79	2.06	0.23	2.31	4	2.04	3.3
41	-0.94	0.18	2.27	4.5	2.3	4.6
336	-0.94	0.18	2.27	4.5	2.3	4.6
3	2.8	0.29	2.27	3.4	2.02	2.7
29	1.07	0.18	2.22	4.5	2.24	4.5
329	1.07	0.18	2.22	4.5	2.24	4.5
38	1.37	0.19	2.11	3.9	2.2	4.1
334	1.37	0.19	2.11	3.9	2.2	4.1
135	3.19	0.34	2.1	2.7	1.65	1.7

MnSq of infit outside range >+2.0 or <-2.0, and Z-value outside range >+2.0 or <-2.0.
Mnsp: Mean square residual, SE: Standard Error

Conformity analysis for the items was performed on 308 conforming subjects. A total of 6 items were found to be nonconforming, all of which showed a mean squared residual and Z values of the infit index greater than 1.4 and 2.0, respectively Table 2. The final 38 items were selected from the 44 items selected based on expert opinions.

Table 2. Items deleted in the conformity analysis

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Item number	Logit	SE	Infit		Outfit	
			MnSq	Z	MnSq	Z
1	-0.79	0.09	1.89	7.4	1.94	5.5
9	0.35	0.08	1.7	7.2	1.88	7.5
18	-0.4	0.09	1.41	4	1.69	4.9
19	0.46	0.07	1.44	4.9	1.72	6.6
43	-0.7	0.09	1.51	4.7	1.3	2.2

Mnsp: Mean square residual, SE: Standard Error
MnSq of infit outside range >+1.4 or <+0.6, and Z-value outside range >+2.0 or <-2.0.

3.2. Verification of model conformity

In the analysis of the 3-point scale of 1, 1, 1, 2, and 3, the mean measurements showed a vertical sequence, and the mean squared residuals of all scales were analyzed to be less than 2.0, satisfying the criteria. Furthermore, the stepwise calibration interval was 1.96, which satisfied the step calibration interval which is larger than 1.4 and smaller than or equal to 5.0 - the minimum criteria of the 3-point scale. The observation frequency of each scale was evenly distributed Table 3 and the probability curves were evenly distributed among each scale.

Table 3. Rating scale analysis of 3 point category through 1, 2, 3 integration

Category Label	Observed Count	Observed Average	Infit MnSq	Outfit MnSq	Step Calibration
1	2984	-1.18	1.16	1.36	None
2	4341	0.00	0.88	0.80	-0.99
3	4379	2.06	0.93	0.94	0.99

Mnsp: Mean square residual

3.3. Verification of separation reliability

The separation reliability of subject was .95 and separation index was 4.28, while the separation reliability of item was .98 and the separation index was 6.43. Therefore, the separation reliabilities of subject and item were both confirmed to be excellent Table 4.

Table 4. Separation reliability of person and item

	SE of Mean	Separation Index	Separation Reliability
Person	0.46	4.28	0.95
Item	0.13	6.43	0.98

SE: Standard Error

3.4. Constructing sub-areas and verification of factor model

For the classification of the sub-areas of the self-evaluation tool for the elderly drivers, they were classified into a total of 3 factors of exploratory factor analysis results Table 5. A confirmatory factor analysis was performed in order to analyze factor conformity of sub-items for 3 potential factors and 3 potential factors of the factor analysis model. Good levels of GFI and NFI, and values near CFI 0.9 and RMSEA 0.1 were confirmed Table 6.

Table 5. Exploratory factor analysis for sub-areas

Items	Factor 1	Factor 2	Factor 3	h2
2	0.467			0.533
3	0.641			0.657
4	0.429			0.67
5	0.539			0.691

6	0.642			0.711
7	0.809			0.813
8	0.852			0.808
10	0.595			0.747
11	0.377			0.7
13		0.359		0.513
14		0.534		0.625
15		0.563		0.612
16		0.62		0.719
17		0.552		0.724
20		0.666		0.652
21		0.579		0.715
22		0.594		0.512
23		0.611		0.661
24		0.595		0.688
25		0.607		0.717
26		0.638		0.75
27		0.564		0.643
28		0.466		0.73
29			0.618	0.716
30			0.449	0.726
31			0.859	0.79
32			0.75	0.76
33			0.737	0.731
34			0.384	0.538
35			0.509	0.532
36			0.326	0.676
37			0.393	0.669
38			0.438	0.752
39			0.507	0.639
40			0.358	0.603
41			0.476	0.638
42			0.387	0.511
44			0.388	0.526
Command of Factor	On-road	Coping	Health	
Eigen-value	16.293	1.717	1.521	
Variance Explained (%)	42.876	4.518	4.002	
Cumulative Variance (%)	42.876	47.395	51.396	
Kaiser-Meyer-Olkin	0.931			
Bartlett sphericity	Chi-square		8779.762	
	df		703	
	Sig.		0	

Table 6. Confirmatory factor analysis in factor model

Area	$\chi 2$	df	GFI	NFI	CFI
On-road	192.99	27	0.87	0.89	0.91
Coping	368.15	77	0.86	0.85	0.88
Health	569.78	90	0.79	0.79	0.81
Factor model*	2955.03	662	0.66	0.68	0.73

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GFI: Goodness of Fit Index, NFI: Normed Fit Index, CFI: Comparative Fit Index, RMSEA: Root Mean Squared Error of Approximation

*Factor 1: On-road, Factor 2: Coping, Factor 3: Health

4. Conclusion

This study developed the SAFE-DR self-assessment tool for elderly drivers and confirmed the validity and reliability. The results of the SAFE-DR evaluation can provide information to identify driving behaviors of elderly drivers for a wide range of driving abilities.

Acknowledgements

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