Journal of Convergence for Information Technology
Vol. 9. No. 6, pp. 175-182, 2019
e-ISSN 2586-4440
DOI : https://doi.org/10.22156/CS4SMB.2019.9.6.175

Validity of the Self-report Assessment Forecasting Elderly Driving Risk (SAFE-DR) Applicable to Community Health Convergence

Seong-Youl Choi
Professor, Department of Occupational Therapy, Kwangju Women's University

지역사회 보건 융합에 활용 가능한 노인 운전자용 자가-보고식평가(SAFE-DR)의 타당도 연구

최성열
광주여자대학교 작업치료학과 교수

Abstract This study was conducted to test the assessment validity and examine the cut-off scores for driving risk as a part of the Self-report Assessment Forecasting Elderly Driving Risk (SAFE-DR) development project. The 132 senior drivers were categorized as either risky of 58 or safe of 74 drivers through the Drivers 65 Plus. Based on this initial assessment, we analyzed the risk prediction cut-offs. Furthermore, we tested the construct, content, and predictive validity. The cut-off score for the prediction of driving risk was found to be 74.5 points. The positive predictive value was 88.6%, and the negative predictive value was 86.3% about the cut-off score, signifying an excellent level of discrimination. Convergent validity, nomological validity, and content validity were found to be appropriate. Therefore, this study confirms that SAFE-DR is an appropriate assessment that can be used to screen dangerous elderly drivers.

Key Words : Senior drivers, Self-report assessment, Driving risk, Cut-off score, SAFE-DR

요 약 본 연구는 노인운전자용 자가 보고식 평가 SAFE-DR 개발 프로젝트의 일환으로 운전위험성 선별을 위한 기준점수를 확인하고 평가의 타당성을 검증하기 위해 수행되었다. Driver 65 Plus평가를 통해 노인운전자 132명을 58명의 위험성 운전자와 74명의 안전성 운전자로 구분하고, 이를 기준으로 SAFE-DR 평가의 위험성 예측 기준을 분석하였다. 또한 SAFE-DR 평가의 구성 타당도, 내용 타당도, 예측 타당도를 검증하였다. SAFE-DR 평가의 운전위험성 예측을 위한 기준점수는 74.5점으로 분석되었으며, 이 기준의 양성 예측도는 88.6%, 음성 예측도는 86.3%로 판별력은 훌륭한(excellent) 수준으로 확인되었다. 또한 집중타당성, 법칙타당성, 내용타당성이 적절한 것으로 판정되었다. 따라서 본 연구를 통해 SAFE-DR은 위험한 노인운전자를 선별하는 용도로 활용할 수 있는 적절한 평가임을 확인하였다.

주제어 : 노인 운전자, 자가 보고식 평가, 운전 위험성, 기준 점수, SAFE-DR

*This paper was supported by National Research Funds of Korea in NRF-2017R1C1B5076770.
*Corresponding Author : Seong-Youl Choi(ckshrj6@hanmail.net)
Received May 3, 2019 Revised May 21, 2019
Accepted June 20, 2019 Published June 28, 2019

1. Introduction

As the population ages due to increase life expectancy, the risk of driving accidents increases gradually for senior drivers[1,2]. While driving simulators or on-road tests can most accurately predict the driving risks of senior drivers, they are inefficient in terms of time, economic costs, and safety[3]. In contrast, a self-report assessment for senior drivers is a tool with which one can check the risk of driving by oneself and is useful in ascertaining the risk of driving and in preventing accidents in a wide range of senior populations[4]. Driver's educational programs that use this assessment help prevent accidents by enhancing senior drivers develop self-awareness about changes in their own driving abilities[5,6].

The primary objective of a self-reported assessment is to predict the risk of an accident while driving by fostering awareness among the senior driver population about their own driving skills. Therefore, the results of this assessment help a senior driver decide how to respond to the detailed evaluation requests of the driving rehabilitation experts[7]. With this advantage, various countries are developing self-report assessments for senior drivers considering their own cultural uniqueness, including the Driving Decisions Workbook which consists of 101 items related to on the road, seeing, thinking, getting around, and health in the United Kingdom[8], the Older Drivers' Self-Assessment Questionnaire (ODSQ) consisting of 31 driving self-assessment items in Australia Automobile Association[9], and the Self-Awareness and FEedback for Responsible Driving tool developed by emphasizing topics related to health[10], the Driving Safely While Aging Gracefully (DSWAG) handbook consisting of 23 items related to visual acuity, physical function, reaction time, and accident risk[11], the Drivers 65 Plus: Check Your Performance tool to provide screening criteria of risk driver[12], and the Safe Driving Behavior Measure (SDBM) to measure safe driving behavior in the United States[13]. These countries make their self-reported assessments available not only in hard copy but also online so that senior drivers can easily access them[7].

In Korea, the K-SDBM (Korean SDBM) and K-Drivers 65 Plus (Korean Drivers 65 Plus) tools have been developed[14,15]. Both assessments were designed in a hard copy format. Reliability and validity were tested through adapting well-known assessments developed by other countries. As part of an initiative to produce an assessment indigenous to Korea, the researchers of this study are developing the SAFE-DR independently within Korea through a project of the National Research Foundation of Korea. The eventual goal of the project is to build application version of the self-report assessment so that senior driver populations in Korea can easily check their driving risks.

The print version of the current SAFE-DR assessment that we aim to develop into an online application was developed. Before distributing the online application version, however, it is necessary to obtain objective data and cut-offs that senior drivers can use to assess their driving risks. Therefore, in this study, we aimed to establish the cut-offs of risk selection that can be provided to drivers when the application is built and test its validity by collecting data from Korean senior drivers.

2. Methods

2.1 Inventory

This study confirmed the validity of an offline tool as a preparation step of the project for the development of the application version of the self-report assessment for senior drivers. In this step, a team of senior driving experts—including professors, occupational therapists, social workers, and road traffic experts—collected 10 well-known

self-report assessments based on a review of previous research. In the second step, we selected the 79 most frequently used items among the items across these assessments. After combining duplicate contents, 52 items remained. In the third step, two native Korean speakers were asked to translate the 52 items from English to Korean. The study's expert research team combined the two translations into one. Two native-English-speaking translators were then asked to back-translate the combined translation. The team of experts combined the resulting five versions into one final translation. In the fourth step, this version of the translated items was used to conduct a Delphi method investigation on 5 senior drivers and 28 experts with more than 5 years of experience of clinical, research, educational, or project-related experience in the field of seniors or driving. Based on results of this investigation, some items were revised, combined, or deleted. A total of 38 final items were thus generated for use in the study[16]. The final offline test was constructed using these items for the collection of senior driver data and was named SAFE-DR.

2.2 Sample selection

All research procedures were approved by Kwangju Women's University's Institutional Review Board (Research approval number: 1041485-201709-HR-001-29). All senior drivers who participated in the study were sufficiently informed of the research process and signed a consent form containing information about the research. Study subjects were selected if they were older than 65 years old, had cognitive and language skills sufficient to read and answer the SAFE-DR test independently, currently had a driver's license, and had more than one year of experience driving.

Subjects were recruited from September 2017 to August 2018. A total of 132 senior drivers completed both the SAFE-DR test that was designed for this study and the Drivers 65 Plus assessment. The Drivers 65 Plus assessment was developed by the American Automobile Association, and its validity and reliability have been confirmed and includes a cut-off capable of selecting risky senior drivers[12]. We selected risky senior drives based on this assessment and used them to test the predictive validity of SAFE-DR.

2.3 Analytical method

All data of the study were analyzed using PASW Statistics version 18.0, Winstep (Chicago, IL, USA) version 3.80.1. First, we assumed that if there was a correlation between the results of Drivers 65 Plus, a previously recognized self-report assessment, and SAFE-DR, it could be concluded that both assessments equally measured driving risk and thus had convergent validity. We also assumed that if there was a relationship between the subscales comprising SAFE-DR and the total score, there was a nomological validity in which the lower-level contents explained the upper-level content of driving risk. We tested construct validity by combining these two validities and performed Pearson's correlations. Second, for content validity, we tested whether the subscales of SAFE-DR had internal consistency and whether they were grouped in representative concepts through exploratory factor and reliability analyses. In the former, factors were extracted with maximum likelihood and the Varimax rotation method. Goodness of fit was judged based on significant Bartlett sphericity, a KMO (Kraiser-Meyer-Olkin) test value greater than 0.5, and Eigen values greater than 1. Given the context of this research within the social sciences, the factor weight of each item was assessed based on cut-off lines greater than 0.3 [17,18]. Reliability of the items in each subscale was measured by Cronbach's alpha. Third, receiver-operating characteristic (ROC) analysis was performed on risky or safe senior drivers as

identified by the Drivers 65 Plus assessment to test the predictive validity of the SAFE-DR assessment. Youden's index, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were analyzed to determine the optimal cut-off for use in an online application of SAFE-DR.

3. Results

3.1 Participants

Of the 132 senior driver participants, 102 were male (77.3%) and 30 were female (22.7%). The average age was 71.26, with 56 subjects in their 60s (42.4%), 67 subjects in their 70s (50.8%), and 9 subjects in their 80s (6.8%). A total of 14 subjects had fewer than 10 years of driving experience (10.6%), 38 subjects had 10 to 20 years (28.8%), and 80 subjects had more than 20 years (60.6%) of experience. There were 15 participants not currently driving (11.3%) and 9 drivers who had experienced an accident within the prior 3 months of the beginning of the study (6.8%). Through the Driver 65 Plus assessment, 58 participants (43.9%) were classified as risky senior drivers and 74 (56.1%) were classified as safe drivers.

3.2 Construct validity

The Drivers 65 Plus and SAFE-DR assessments showed significant correlations of -0.682 for the total score, -0.634 for on-road tests, -0.604 for coping, and -0.635 for health ($p<0.01$). The total score of the SAFE-DR showed significant correlations with the subscales for on-road, coping, and health, which were 0.894, 0.924, and 0.918, respectively ($p<0.01$). The results of the construct validity analysis are shown in Table 1.

Table 1. Correlation between Drivers 65 Plus and SAFE-DR (N=132)

		Drivers 65 Plus	SAFE-DR			
			Total	On-road	Coping	Health
Drivers 65 Plus		1				
SAFE-DR	Total	-0.682**	1			
	On-road	-0.634**	0.894**	1		
	Coping	-0.604**	0.924**	0.770**	1	
	Health	-0.635**	0.918**	0.738**	0.745**	1

SAFE-DR: Self-Assessment Forecasting Elderly Driving Risk
** $p<0.01$

3.3 Content validity

The KMO value of the factor model following the exploratory factor analysis was 0.866; the Eigen values of the factors representing the subscales of the SAFE-DR assessment were all above 1.0; and Bartlett sphericity was statistically significant ($p=0.000$). Thus, the data fit the model well. The factor weights of most items in the factor matrix were above 0.3, but item 37 showed a relatively low factor weight of 0.290. The reliability of each subscale were 0.906, 0.921, and 0.913 for on-road, coping, and health, respectively, confirming the items' internal consistency. The results of this analysis are shown in Table 2.

3.4 Predictive validity

ROC curve analysis returned a total score of 74.50; the on-road testing result was 17.50, coping was 30.50, and health was 24.50. Corresponding cut-off values were selected where sensitivity was 0.853, 0.654, 0.481, and 0.904, specificity was 0.898, 0.800, 0.800, and 0.667, and Youden's index was the highest at 0.752, 0.454, 0.281, and 0.571. The PPVs of each cut-off value were 88.6%, 70.4%, 75.7%, and 42.0%, and the NPVs were 86.3%, 72.2%, 41.7%, and 97.2%. The ROC curve for these cut-off values are presented in Fig. 1, and the areas under the curve (AUC) were 0.922, 0.855, 0.865, and 0.919 ($p<0.000$). The probability curves were statistically significant. Table 3 show the results of ROC analysis.

Table 2. Factor matrix and reliability of SAFE-DR subscales (N=132)

Items	On-road	Coping	Health	Communality summary loading	Cronbach's α
1	0.464			0.608	0.906
2	0.672			0.749	
3	0.551			0.800	
4	0.615			0.861	
5	0.608			0.794	
6	0.653			0.841	
7	0.667			0.812	
8	0.537			0.803	
9	0.358			0.801	
10		0.356		0.715	0.921
11		0.500		0.672	
12		0.522		0.668	
13		0.602		0.790	
14		0.409		0.776	
15		0.730		0.755	
16		0.649		0.782	
17		0.503		0.607	
18		0.656		0.706	
19		0.720		0.745	
20		0.609		0.730	
21		0.574		0.769	
22		0.629		0.706	
23		0.563		0.826	
24			0.689	0.767	0.913
25			0.517	0.804	
26			0.773	0.855	
27			0.696	0.817	
28			0.672	0.767	
29			0.439	0.632	
30			0.504	0.663	
31			0.330	0.722	
32			0.470	0.735	
33			0.363	0.771	
34			0.511	0.716	
35			0.433	0.657	
36			0.469	0.748	
37			0.290	0.690	
38			0.329	0.713	
Eigen-value	15.408	1.727	1.300		
Variance Explained (%)	40.548	4.545	3.422		
Cumulative Variance (%)	40.548	45.093	48.515		
Kaiser-Meyer-Olkin	0.866				
Bartlett sphericity	Chi-square		3957.761		
	df		703		
	Sig.		.000		

Table 3. Predictive validity of SAFE-DR (N=132)

Score		Sensitivity	Specificity	Youden's index	+LR	-LR	PPV	NPV	AUC (95% CI)	SE	p value
Total	73.50	0.853	0.797	0.650	4.20	0.18	0.764	0.883	0.922 (0.876~0.968)	0.023	<0.000
	74.50	0.853	0.864	0.718	6.29	0.17	0.846	0.869			
	75.50*	0.853	0.898	0.752	8.39	0.16	0.886	0.863			
	77.00	0.813	0.932	0.746	12.00	0.20	0.928	0.802			
	79.00	0.787	0.949	0.736	15.47	0.22	0.948	0.758			
On-road	15.00	0.712	0.600	0.312	1.78	0.48	0.459	0.838	0.855 (0.789~0.920)	0.033	<0.000
	16.50	0.712	0.733	0.445	2.67	0.39	0.616	0.804			
	17.50*	0.654	0.800	0.454	3.27	0.43	0.704	0.722			
	18.50	0.423	0.800	0.223	2.12	0.72	0.732	0.362			
	19.50	0.423	0.933	0.356	6.35	0.62	0.908	0.320			
Coping	26.50	0.635	0.533	0.168	1.36	0.69	0.458	0.736	0.865 (0.802~0.927)	0.032	<0.000
	28.50	0.519	0.667	0.186	1.56	0.72	0.605	0.523			
	30.50*	0.481	0.800	0.281	2.40	0.65	0.757	0.417			
	31.50	0.385	0.800	0.185	1.92	0.77	0.744	0.293			
	32.50	0.346	0.867	0.213	2.60	0.75	0.821	0.230			
Health	22.50	0.904	0.467	0.371	1.69	0.21	0.251	0.979	0.919 (0.873~0.964)	0.023	<0.000
	23.50	0.904	0.600	0.504	2.26	0.16	0.343	0.976			
	24.50*	0.904	0.667	0.571	2.71	0.14	0.420	0.972			
	25.50	0.827	0.667	0.494	2.48	0.26	0.450	0.935			
	26.50	0.750	0.800	0.550	3.75	0.31	0.609	0.879			

+LR: Positive likelihood ratio, -LR: Negative likelihood ratio, PPV: Positive Predictive Value, NPV: Negative Predictive Value, AUC: Area Under the Curve, CI: Confidence Interval, SE: Standard Error
* Cut-off score

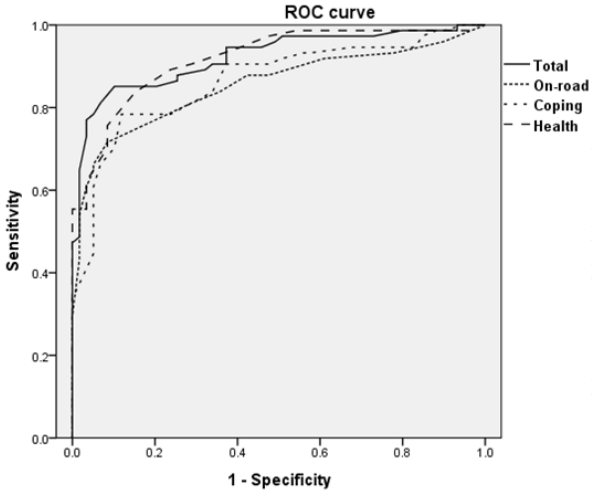

Fig. 1. ROC curve of SAFE-DR

4. Discussion and Conclusion

Self-report assessments for senior drivers can lower the likelihood of automobile accidents among the elderly and can foster self-awareness about declines in driving abilities among the senior population[7]. Thus, the SAFE-DR development project aimed to increase accessibility to the assessment by creating an online version. This study, which comprises part of the project, provided a basis for driving risk assessment in the online application and tested its validity.

Of the extant and widely used self-report assessments for senior drivers, only ODSQ, DSWAG, and Drivers 65 Plus require a short time to complete and are offered online. Only Drivers 65 Plus offers cut-off scores that can predict driving risks[12]. In Korea, there a lack not only of

independently developed self-report assessments but also of driving risk standards and online services. Thus, the SAFE-DR's driving risk cut-off score in our study represents a crucial asset for the traffic safety of Korean senior drivers. The AUCs of these cut-off values are all above 0.9 and have excellent levels of discrimination[19,20]. The total score of 74.50 showed a high predictive capability, with an 88.6% probability of being able to select safe senior drivers and an 86.3% probability of being able to select risky senior drivers. However, the PPV of coping and the NPV of health, among the predictive probabilities of subscales, showed low predictive power at about 40%. Therefore, when presenting driving risks in the online application, total scores should be considered over the results of the subscales.

The higher the SAFE-DR score and the lower the Drivers 65 Plus score, the greater was the driving risk. Thus the two assessments were negatively correlated. The results of the two assessments were strongly correlated at about 0.6[21], confirming the convergent validity of the two assessments. Furthermore, the SAFE-DR total score showed a very strong correlation with subscales at about 0.9[21], confirming that the nomological validity of the lower-level content concepts consistently explain the upper-level content concept of driving risk.

While construct of the scale and subscales were confirmed, the factor weight of item 37, related to drug use, was below 0.3, indicating its insufficiency as a measurement tool[17]. Korean doctors and pharmacists complain about a lack of drug consultation resources, particularly preventive drug use[22,23]. Thus, Korean senior drivers' do not understand how drugs effect their driving. When designing the online SAFE-DR, we decided to collect and analyze more data rather than deleting the item.

This study had two key limitations: First, the sample pool was insufficient to prove validity of one assessment tool. Second, further reliability tests of the assessment, such as the test-retest reliability and internal reliability of each item, were not performed. Still, this research provides a strong starting point for expediently developing an online version of the SAFE-DR assessment, which might help mitigate risk among senior Korean drivers in an increasingly aged population.

REFERENCES

[1] K. L. Anstey, T. D. Windsor, M. A. Luszcz & G. R. Andrews. (2006). Predicting driving cessation over 5 years in older adults: psychological well-being and cognitive competence are stronger predictors than physical health. *Journal of the American Geriatrics Society, 54(1),* 121-126.
DOI : 10.1111/j.1532-5415.2005.00471.x

[2] E. M. Kang & Y. C. Lee. (2018). Analysis of factors affecting the life satisfaction of elderly users of senior citizen centers: focus on senior citizen centers in Seoul. *Journal of Convergence for Information Technology, 8(5),* 173-181.

[3] T. Galski, H. Ehle, M. McDonald & J. Mackevich. (2000). Evaluating fitness to drive after cerebral injury: basic issues and recommendations for medical and legal communities. *The Journal of Head Trauma Rehabilitation, 15(3),* 895-908.

[4] L. J. Molnar, D. W. Eby, P. S. Kartje & R. M. St. Louis. (2010). Increasing self-awareness among older drivers: The role of self-screening. *Journal of Safety Research, 41(4),* 367-373.
DOI : 10.1016/j.jsr.2010.06.003

[5] H. I. Ahmed, E. E. Mohamed & S. M. Aly. (2014). Effect of mobility on the quality of life among older adults in geriatric home at Makkah Al-Mukarramah. *Advances in Life Science and Technology, 17,* 39-50.

[6] C. Owsley, B. T. Stalvey & J. M. Pjillips. (2003). The efficacy of an educational intervention in promoting self-regulation among high-risk older drivers. *Accident Analysis & Prevention, 35(3),* 393-400.
DOI :10.1016/S0001-4575(02)00016-7

[7] B. Lang, A. Parkes & K. Fernandez-Medina. (2013). *Driving choices for the older motorist: The role of*

self-assessment tools. London : RAC Foundation.

[8] D. W. Eby, L. J. Molnar & J. T. Shope. (2000). *Driving decisions workbook. Report No. UMTRI-2000-14.* Ann Arbor : University of Michigan Transportation Research Institute.

[9] Australian Automobile Association. (2010). *Older driver policy framework paper.* https://secure.racq.com.au/ssl/questionnaires/older_drivers self_assessment_questionnaire.cfm _

[10] D. W. Eby, J. M. Molnar & P. Kartje. (2006). *SAFER Driving: The enhanced driving decisions workbook.* Ann Arbor : University of Michigan Transportation Research Institute.

[11] National Highway Traffic Safety Administration. (2003). *Driving safely while aging gracefully.* https://one.nhtsa.gov/people/injury/olddrive/Driving%20Safely%20Aging%20Web/index.html

[12] American Automobile Association. (2010). *Drivers 65 plus: Check your performance.* https://seniordriving.aaa.com/wp-content/uploads/2016/08/Driver65Z.pdf

[13] S. Classen, P. S. Wen, C. A. Velozo, M. Bēdard, S. M. Winter, B. Brumback & D. N. Lanford. (2012). Psychometrics of the self-report safe driving behavior measure for older adults. *American Journal of Occupational Therapy, 66(2),* 233-41. DOI : 10.5014/ajot.2012.001834

[14] S. W. Han, J. S. Lee, S. K. Kim, T. H. Cha, D. H. Yoo & H. Kim. (2018). The standardization of the Korean drivers 65 plus to identify driving fitness of senior drivers. *The Journal of Korean Society of Occupational Therapy, 26(1),* 15-29. DOI : 10.14519/jksot.2018.26.1.02

[15] S. H. Park & J. I. Shin. (2018). A study on the need of revisions and supplementation of Korean safe driving behavior measure (K-SDBM). *The Journal of Humanities and Social Sciences 21, 9(1),* 93-105. DOI : 10.22143/HSS21.9.1.8

[16] D. E. Beaton, C. Bombardier, F. Guillemin & M. B. Ferraz. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25(24),* 3186-91.

[17] H. F. Kaiser. (1974). An index of factorial simplicity. *Psychometrika, 39(1),* 31-36. DOI : 10.1007/BF02291575

[18] A. Field. (2000). *Discovering statistics using SPSS for Windows.* London: Sage.

[19] J. R. Hanley & B. J. McNeil. (1982). The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology, 143(1),* 29-36. DOI : 10.1148/radiology.143.1.7063747

[20] M. P. Muller et al. (2005). Can routine laboratory tests discriminate between severe acute respiratory syndrome and other causes of community-acquired pneumonia? *Clinical infectious diseases, 40(8),* 1079-1086. DOI : 10.1086/428577

[21] J. D. Evans. (1996). *Straightforward statistics for the behavioral sciences.* Pacific Grove : Thomson Brooks/Cole Publishing Co.

[22] K. S. Kim, H. J. Song & U. D. Sohn. (2007). A study of need for medication education and efficient policies for elderly patients in an aging society. *Yakhak Hoeji, 51(5),* 318-326.

[23] Y. H. Lee, E. J. Ji & K. J. Yun. (2019). Health concern, health information orientation, e-health literacy and health behavior in aged women : focused on 60-70s. *Journal of Convergence for Information Technology, 9(4),* 39-47.

최 성 열(Seong-Youl Choi) [정회원]

· 2014년 2월 : 건양대학교 보건복지대학원 작업치료학과(보건학석사)
· 2017년 8월 : 건양대학교 일반대학원 보건학과(보건학박사)
· 2015년 3월 ~ 2017년 2월 : 유원대학교 작업치료학과 교수
· 2017년 3월 ~ 현재 : 광주여자대학교 작업치료학과 교수
· 관심분야 : 보건 융합, 지역사회 재활, 지역사회 작업치료
· E-Mail : ckshrj6@hanmail.net