



Original Article

## Test-retest reliability of the safe driving behavior measure for community-dwelling elderly drivers

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**Abstract.** [Purpose] The Safe Driving Behavior Measure (SDBM) is a self-report measurement tools that assesses the safe-driving behaviors of the elderly. The purpose of this study was to evaluate the test-retest reliability of the SDBM among community-dwelling elderly drivers. [Subjects and Methods] A total of sixty-one community-dwelling elderly were enrolled to investigate the reliability of the SDBM. The SDBM was assessed in two sessions that were conducted three days apart in a quiet and well-organized assessment room. That test-retest reliability of overall scores and three domain scores of the SDBM were statistically evaluated using intraclass correlation coefficients [ICC (2.1)]. Pearson correlation coefficients were used to quantify bivariate associations among the three domains of the SDBM. [Results] The SDBM demonstrated excellent rest-retest reliability for community-dwelling elderly drivers. The Cronbach alpha coefficients of the three domains of person-vehicle (0.979), person-environment (0.944), and person-vehicle-environment (0.971) of the SDBM indicate high internal consistency. [Conclusion] The results of this study suggest that the SDBM is a reliable measure for evaluating the safe-driving of automobiles by community-dwelling elderly, and is adequate for detecting changes in scores in clinical settings.

**Key words:** Automobile driving, Community-dwelling, Elderly

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### INTRODUCTION

Declines in driving performance are associated with a reduction in functional activities, visuoperceptual abilities, and physiological function in older adults, and the number of deaths caused by traffic accidents increases with age<sup>1)</sup>. Even though the overall number of traffic accidents has continued to decrease, the accident risk of elderly drivers has been increasing, becoming a serious social problem<sup>2)</sup>. The driving population in industrial countries is aging<sup>3)</sup>. Therefore, elderly drivers should be made fully aware of the importance of precise and proper evaluation of their driving performance and the risk factors inherent in driving a car on public roads during their daily and social activities.

Driving is a complex task that requires various underlying elements, such as motor and sensory functions, attention, consciousness, cognitive activities, decision making and vehicle control<sup>1, 4)</sup>. Older adults display deteriorations in underlying elements such as strength, coordination, flexibility, attention, memory, decision making, and judgment due to normal aging processes which result in unsafe driving. Safe driving behaviors require a complex sequence of interactions among persons, vehicles, and environment levels, while avoiding near misses, errors, violations, crashes, and crash-related injuries<sup>4)</sup>. A driving assessment is a comprehensive driving evaluation administered by driving rehabilitation specialists that assesses these behaviors. Safe driving by older adults has traditionally been measured by evaluating driving history, including citations or violation history, crash rates, and crash-related morbidity and mortality rates, but they have not captured specific driving

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characteristics, including patterns of driving behavior and driving errors<sup>5</sup>).

Previous studies have reported various clinical measures for the assessment of safe driving by older adults<sup>5, 6</sup>). However, one concern regarding the use of self-reports to assess driving is the issue of selection bias, as older adults highly confident about their driving may be more likely to complete a driving self-report, and may also tend to overrate their driving ability. Therefore, a self-report assessment for older adults must possess test-retest reliability. The Safe Driving Behavior Measure (SDBM) is a self-report measurement tool that assesses the safe-driving behaviors of the elderly<sup>7</sup>). The purpose of this study was to evaluate the test-retest reliability of the SDBM for community-dwelling elderly drivers.

## SUBJECTS AND METHODS

A total of sixty-one community-dwelling elderly were recruited by leaflet from senior complex community centers using convenience sampling, and they voluntarily signed written consent forms. This study was carried out in accordance with the International Ethical Guidelines and the Declaration of Helsinki and was approved by the Chosun University Institutional Review Board. The inclusion criteria were as follows: age between 65 and 80 years, a valid driver's license, driving for three months prior to and at the time of recruitment, and the cognitive and physical ability to complete the SDBM. Those with missing limbs or a major psychiatric diagnosis were excluded, as were those having neurological deficits or severe orthopedic diseases that affected driving. Participants were also excluded if they had been medically advised not to drive, had experienced uncontrolled seizures in the past year, were taking medications that caused central nervous system impairment, or had serious visual impairment. Table 1 displays the clinical and demographic characteristics of the participants, including respondent type, gender, age, height, weight, purpose of driving, crash accidents, duration of driving, and Mini-mental State Examination scores. This study employed a correlational research design in which measurements were taken twice, three days apart, along with a self-report clinical measurement of driving performance using the SDBM. The SDBM was administered by a standardized method in a clear and well-organized rehabilitation room. The first session consisted of surveys to establish the subjects' demographic profiles and driving history, and administration of the SDBM, of the second session was a re-administration of the SDBM for analysis of the intra-rater reliability. The testing times of the first and second sessions were 20 and 15 minutes respectively.

The SDBM is a self-report measure of safe driving behaviors developed by Classen and colleagues. It contains a total of 68 items organized into three domains: person-vehicle (11 items), person-environment (42 items), and person-vehicle-environment (15 items). The tool assesses physical and cognitive components such as car controls or features, responses to physical and social factors, and responses to environmental factors. The SDBM items are rated on a 5-point adjectival scale from 1 (cannot do) to 5 (not difficult) with maximum possible scores on the person-vehicle, person-environment, and person-vehicle-environment domains of 55 points, 210 points, and 75 points, respectively. The maximum score of the SDBM is 340 points. The score indicates the level of difficulty with safe-driving behaviors. The SDBM has been reported as having good validity and reliability<sup>4, 7</sup>).

Descriptive statistics were used to present demographic characteristics and driving history [respondent type, gender, age, height, weight, purpose of driving, crash accidents, duration of driving, and Mini-mental State Examination (MMSE) scores]. Cronbach's alpha and Intraclass Correlation Coefficients (ICC) were used to examine the test-retest reliability of the three domains of the SDBM (person-vehicle, person-environment, and person-vehicle-environment). To evaluate the relationships among the three domains, Pearson correlation coefficients were used in this study. All analyses were performed using PASW version 18.0 for Windows (SPSS Inc., Chicago, IL, USA) and a significance level of 0.05.

**Table 1.** Demographic profile and driving history of the participants (N=61)

Variables	Participants
Respondents (older adults/family assistance)	51 (83.6%)/10 (16.4%)
Gender (male/female)	46 (75.4%)/15 (24.6%)
Age (years)	68.6 ± 3.3
Height (cm)	166.5 ± 6.7
Weight (kg)	66.4 ± 8.7
Purpose of driving (private driving/commute to work)	54 (88.5%)/7 (11.4%)
Crash accidents (times)	1.7 ± 0.5
Duration of driving (months)	270.1 ± 113.0
Mini-mental State Examination (scores)	28.8 ± 1.3

## RESULTS

This study examined 61 licensed drivers (46 males and 15 females) with a mean age of 68.6 years, a mean height of 166.5 cm, and mean body weight of 66.4 kg. Most (54 persons) drove for personal purposes, and 7 drove to work. The mean number of accidents was 1.7, the mean duration of driving was 270.1 months, and the mean MMSE score was 28.8 (Table 1). This study also evaluated the safety of driving using the three domains of the SDBM. The Cronbach alpha coefficients for person-vehicle domain (0.979), person-environment domain (0.944), person-vehicle-environment domain (0.971), and total score of the SDBM (0.916) indicated excellent internal consistency (Table 2). Table 3 shows the relationships of these three domains. Person-vehicle showed significant correlations with person-environment ( $r=0.762$ ,  $p<0.01$ ), person-vehicle-environment ( $r=0.417$ ,  $p<0.01$ ), and total score of the SDBM ( $r=0.725$ ,  $p<0.01$ ). Person-environment also showed significant correlations with person-vehicle ( $r=0.762$ ,  $p<0.01$ ), person-vehicle-environment ( $r=0.804$ ,  $p<0.01$ ), and total score ( $r=0.986$ ,  $p<0.01$ ). The person-vehicle-environment domain score also showed significant correlations with person-vehicle ( $r=0.417$ ,  $p<0.01$ ), person-environment ( $r=0.804$ ,  $p<0.01$ ), and total score ( $r=0.888$ ,  $p<0.01$ ) (Table 3).

## DISCUSSION

This study examined the test-retest reliability of SDBM and correlations among person, vehicle, and environment for community-dwelling elderly drivers. The main findings of this study were that the SDBM showed excellent reliability (ICC, 0.916) for community-dwelling elderly drivers, and that the Cronbach alpha coefficients of the three domains of the person-vehicle (0.979), person-environment (0.944), and person-vehicle-environment (0.971) of the SDBM indicate high internal consistency. The subjects reporting more interactions with persons, vehicles, and the environment showed safer driving abilities.

Driving behavior can be affected by many internal and external cognitive and physical factors such as depression, psychological distress, occupational impairment, functional disability, and driving anxiety. Previous studies have developed specific methods to enable older adults to describe their physical and cognitive abilities of driving<sup>5</sup>). Although driving a car is a major mode of transportation for older adults, there is still insufficient information to evaluate and document their on-road driving performance. As the elderly population of grows, the number of older drivers is also increasing in modern industrialized societies worldwide<sup>5, 8</sup>). Older drivers tend to experience deficits in the necessary components of driving, including blurred vision, cataracts, glaucoma, and cognitive decline. They also suffer declines in processing speed, memory, problem solving ability, and executive functioning. The elderly tend to reduce weekly driving distances, do not maintain the speed limit, and have more crashes or citations compared to most other age groups<sup>8</sup>). Therefore, proper assessment and re-education of driving behavior and habits are needed for older drivers.

The SDBM is a self-report tool for assessing the driving behaviors of the elderly. It includes instructions, demographic profile, driving history profile, and 68 items measuring driving abilities<sup>4, 7</sup>). This study used the 68 items of driving abilities to evaluate the test-retest reliability of the three domains of the SDBM in order to analyze the interactions among

**Table 2.** Test-retest reliability for the Safe Driving Behavior Measure (N=61)

Variables	First test mean ± SD	Second test mean ± SD	Cronbach's α	95% of CI
Person-vehicle domain	53.2 ± 2.8	53.2 ± 3.1	0.979	0.965–0.987
Persons-environment domain	181.9 ± 22.0	182.6 ± 20.4	0.944	0.906–0.966
Person-vehicle-environment domain	51.8 ± 10.5	52.0 ± 9.8	0.971	0.952–0.983
Total SDBM score	286.8 ± 33.1	287.8 ± 30.6	0.916	0.880–0.945

CI: confidence interval

**Table 3.** Correlations among three domains of Safe Driving Behavior Measurement (N=61)

	PV	PE	PVE	Total score
PV		0.762**	0.417**	0.725**
PE	0.762**		0.804**	0.986**
PVE	0.417**	0.804**		0.888**
Total Score	0.725**	0.986**	0.888**	

\*\* $p<0.01$

PV: person-vehicle domain; PE: person-environment domain, PVE: person-vehicle-environment domain

person, vehicle, and environment, to determine its reliability in evaluating safe-driving behaviors of older adults. Classen and colleagues reported that the SDBM is unique among self-report and proxy measures in its combined measurement approach, using both traditional measurement strategies addressing validity and item response theory strategies to increase the precision of items. Winter and colleagues conducted focus groups to contribute to item development for the SDBM, a safe driving self-report or proxy-report measure for older drivers, family, caregivers, and professionals, adding to the body of research on driving self-report by older adults. They reported that the SDBM study expands on existing older driver self-report research using client participation to develop and refine an item set capturing person-vehicle, person-environment, and person-vehicle-environment behaviors<sup>9</sup>). The results of the present study also indicate that the SDBM is a good and reliable measure of self-reported interview-based safe-driving behavior of Korean community-dwelling older adults.

The results of this study encourage further evaluation of the use of the SDBM as a precise and accurate measure for detecting the interaction among person, vehicle, and environment in safe-driving for community-dwelling older adults. Further studies will be needed to test comprehensive test protocols with additional instruments such as on-road tests.

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