



Original Article

# Validity and reliability of the safe driving behavior measure in community-dwelling self-drivers with stroke

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**Abstract.** [Purpose] Driving is a vital component of recovery for stroke survivors facilitating restoration of their family roles and reintegration back into their communities and associations. The purpose of this study was to evaluate the validity and reliability of the Safe Driving Behavior Measure (SDBM) in community-dwelling self-drivers post-stroke. [Subjects and Methods] Participants were sixty-seven community-dwelling self-drivers who had received a diagnosis of first stroke in the past twelve months. To investigate the validity and reliability of the SDBM, this study evaluated two sessions, held three days apart in a quiet and well-organized assessment room. Cronbach's alpha and the Intraclass Correlation Coefficient [ICC (2.1)] were used to evaluate statistically concurrent validity and reliability of the overall and three domain scores. Pearson's correlations were used to quantify the bivariate associations among the three domains. [Results] The Cronbach's alpha coefficients for the three domains of person-vehicle (0.989), person-environment (0.997), and person-vehicle-environment (0.968) of the SDBM indicated high internal consistency in community-dwelling self-drivers with stroke, in addition to excellent rest-retest reliability. [Conclusion] The results of this study suggest that the SDBM could be a reliable measure to evaluate automobile driving in community-dwelling self-drivers with stroke.

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

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## INTRODUCTION

Stroke is a major cause of disability in the adult population, affecting participation in daily activities and integration into the community. Stroke survivors have significant complications, such as visuoperceptual impairment, muscle weakness, spasticity, cognitive impairment, depression, neglect, reduced information-processing speed, visuospatial impairment, and apraxia, all of which that may influence self-driving abilities along with family and social roles<sup>1</sup>). As the number of stroke survivors and their longevity increases, more of them wish to return to driving. Fisk and colleagues reported that up to 30% of stroke survivors return to driving, although they are left with persistent impairments following stroke<sup>2</sup>). Therefore, the need for well-planned clinical measures in conjunction with well-designed driving assessments is increasing. Fisk and colleagues also reported that 87% of stroke survivors return to driving without receiving any formal evaluation of their driving performance<sup>3</sup>). Akinwuntan and colleagues estimated that approximately 35% of stroke survivors will require driving-related rehabilitation before they can resume safe driving behaviors<sup>4, 5</sup>). Driving rehabilitation for stroke should

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involve driving simulators, which range from replica vehicles to driving-specific computerized programs, cognitive skills assessment with context-specific driving situations, and contextual approaches to retraining driving skill<sup>5-7</sup>). Therefore, it is essential to include a simple and concise assessment of driving situations and contextual approaches with good predictive precision in a rehabilitation setting before stroke patients return to driving. It is also necessary to repetitively examine the therapeutic effects on driving abilities due to the progressive declines in physical and cognitive functions following stroke despite non-progressive brain damage. The Safe Driving Behavior Measure (SDBM) is a self-report measurement tool to assess safe driving behaviors in an elderly population<sup>8</sup>). The purpose of this study was to examine the feasibility and test-retest reliability of the SDBM in community-dwelling self-drivers following stroke.

## SUBJECTS AND METHODS

A total of 66 community-dwelling persons with a diagnosis of first stroke were enrolled in this study through convenience sampling by means of leaflet, and they willingly provided written informed consent. The 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: (1) a diagnosis of first stroke, (2) a valid driver's license, driving three months prior to and at the time of recruitment, (3) no orthopedic diseases or neurological disorders except stroke that could affect driving, (4) having the cognitive and physical ability to complete the SDBM, (5) no uncontrolled seizures, and (6) no serious visual impairment. Participants were excluded if they had visuoperceptual impairment, neglect, or apraxia. [Table 1](#) depicts the clinical and demographic characteristics of the participants, including respondent type, gender, age, height, weight, purpose of driving, crash events, duration of driving, Brunnstrom stage, duration post-disease, affected side, etiology, visual deficit, and Mini-mental State Examination (MMSE) score. This study was a correlational research design in which two measurements were taken, spaced three days apart to minimize fatigue or poor concentration with a self-report clinical measurement of driving performance using the SDBM. The measurement was followed by a standardized administration of the SDBM in a clear and well-organized assessment room with the participant seated at a table. The first session included collection of demographic data, driving history, and administration of the SDBM, while the second session consisted of a re-administration of the SDBM to analyze intrarater reliability. The testing times in the first and second sessions were 20 and 15 minutes respectively.

The SDBM is a self-report measurement tool to assess safe driving behaviors developed by Classen and colleagues, and measures the physical and cognitive aspects of driving such as car controls or features, responses to physical and social factors, and responses to environmental factors<sup>8</sup>). The 68 items are divided into three domains: person-vehicle (11 items), person-environment (42 items), and person-vehicle-environment (15 items). The SDBM employs a 5-point rating scale ranging from 1 (cannot do) to 5 (not difficult), resulting in a total possible score of 340 points. The score represents the level of impairment of the safe-driving behaviors given the participant's performance. The SDBM has demonstrated good validity and reliability<sup>8,9</sup>).

Descriptive statistics were used to analyze data on demographic characteristics and driving history such as respondent types, gender, age, height, weight, purpose of driving, crash events, duration of driving, Brunnstrom stage, duration post-disease, affected side, etiology, visual deficits, and Mini-mental State Examination score. Cronbach's alpha and Intraclass Correlations Coefficients (ICC) were used in order to assess the concurrent validity and test-retest reliability of the SDBM. Pearson correlations were used to analyze the interactions between SDBM subitems, including the three domains. Analysis was performed with the aid of PASW version 18.0 for Windows (SPSS Inc., Chicago, IL, USA), with a statistical significant level of 0.05.

## RESULTS

This study examined 61 licensed drivers (58 males and 8 females) with a mean age of 59.4 years, a mean height of 166.7 cm, and a mean body weight of 63.3 kg. Fewer participants (24) were affected on the right side than the left (42), while 42 persons had ischemic etiology and 24 persons suffered hemorrhage. Mean post-stroke duration of participants was 38.5 months, and the average amount of medication was 4.4 tablets. A total of 63 participants had a visual deficit. Most (54) drove for personal reasons, although 12 drove to commute to work. The mean number of collisions was 1.3, the mean duration of driving was 167.6 months, and the mean MMSE score was 28.1 ([Table 1](#)).

This study evaluated the safety of self-driving by using the three domains of person-vehicle, person-environment, and person-vehicle-environment of the SDBM in community-dwelling self-drivers with stroke. The Cronbach's alpha coefficients for person-vehicle domain (0.989), person-environment domain (0.997), person-vehicle-environment domain (0.968), and total score of the SDBM (0.995) indicated excellent internal consistency ([Table 2](#)).

[Table 3](#) shows the relationships of these three domains. The person-vehicle domain demonstrated a significant correlation with person-environment (0.972), person-vehicle-environment (0.819), and total score of the SDBM (0.964). Person-environment also showed a significant correlation with person-vehicle (0.972), person-vehicle-environment (0.863), and total score of the SDBM (0.992). Likewise, person-vehicle-environment was significantly correlated with person-vehicle, person-environment, and total score of the SDBM (0.920; [Table 3](#)).

**Table 1.** Demographic profile and driving history of the participants (N=66)

| Variables                                     | Participants          |
|---|-----------------------|
| Respondents (older adults/family assistance)  | 30 (45.5%)/36 (54.5%) |
| Gender (male/female)                          | 58 (87.9%)/8 (12.1%)  |
| Age (years)                                   | 59.4 ± 20.1           |
| Height (cm)                                   | 166.7 ± 7.2           |
| Weight (kg)                                   | 63.3 ± 11.8           |
| Affected side (right/left)                    | 24 (36.4%)/42 (63.6%) |
| Etiology (ischemic/hemorrhage)                | 42 (63.6%)/24 (36.4%) |
| Duration of post-stroke (months)              | 38.5 ± 24.8           |
| Amount of medication                          | 4.4 ± 1.9             |
| Visual deficit (yes/no)                       | 63 (95.5%)/3 (4.5%)   |
| Purpose of driving (personal/commute to work) | 54 (81.8%)/12 (18.2%) |
| Collisions (times)                            | 1.3 ± 0.4             |
| Duration of driving (months)                  | 167.6 ± 153.5         |
| Mini-mental State Examination (scores)        | 28.1 ± 2.2            |

**Table 2.** Test-retest reliability for the Safe Driving Behavior Measure (N=66)

| Variables                         | First test   | Second test  | Cronbach's $\alpha$ | 95% of CI      |
|-----------------------------------|--------------|--------------|---------------------|----------------|
|                                   | Mean±SD      |              |                     |                |
| Person-vehicle domain             | 52.2 ± 4.7   | 52.2 ± 4.9   | 0.989               | 0.983–0.994*** |
| Persons-environment domain        | 188.9 ± 34.5 | 188.7 ± 34.3 | 0.997               | 0.996–0.998*** |
| Person-vehicle-environment domain | 55.8 ± 13.1  | 55.6 ± 14.0  | 0.968               | 0.948–0.981*** |
| Total score of SDBM               | 296.9 ± 50.8 | 296.5 ± 51.1 | 0.995               | 0.992–0.997*** |

\*\*\*p<0.001. SDBM: Safe Driving Behavior Measure

**Table 3.** Correlations among three domains of Safe Driving Behavior Measurement (N=66)

|             | PV      | PE      | PVE     | Total Score |
|-------------|---------|---------|---------|-------------|
| PV          |         | 0.972** | 0.819** | 0.964**     |
| PE          | 0.972** |         | 0.863** | 0.992**     |
| PVE         | 0.819** | 0.863** |         | 0.920**     |
| Total Score | 0.964** | 0.992** | 0.920** |             |

\*\*p<0.01.

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

## DISCUSSION

This study examined the concurrent validity and reliability of the SDBM and the correlations among person, vehicle, and environment for community-dwelling self-drivers with stroke. The main results of this study were as follows: (1) The SDBM showed excellent reliability (ICC, 0.995) for community-dwelling self-drivers with stroke; and (2) The Cronbach's alpha coefficients for the three domains of person-vehicle (0.989), person-environment (0.997), and person-vehicle-environment (0.968) indicated excellent internal consistency in community-dwelling self-drivers with stroke. Stroke survivors and their families fervently desire recovery from their disease, and ultimate reintegration into their social roles<sup>1)</sup>. Returning to driving is a major concern for stroke survivors because driving is often necessary in maintaining an active social life<sup>2)</sup>. In particular, stroke survivors generally have an abnormal gait pattern affected by a persistent implication such as hemiparesis, muscle weakness, or joint contractures in the extremities. The abnormal gait pattern demands higher energy expenditure than a normal gait over a short distance and leads to difficulty in using public transportation<sup>10)</sup>. Therefore, returning to driving is a vital issue for stroke survivors in overcoming a restricted lifestyle and improving the quality of life. There are prerequisites for returning to driving including various functional abilities such as motor, visual-perceptual, and

cognitive function<sup>3, 5</sup>). Driving performance consists of the complex processing of turning the wheel, operating the foot pedals, recognizing traffic signs, being aware of the directions to the destination, and switching lanes<sup>4, 6</sup>). Stroke survivors will need clinical assessment from driving rehabilitation specialists in order to resume driving, as well as regular monitoring of their driving performance after a stroke.

The SDBM is a self-reported measurement tool of driving behaviors including instructions, demographic profile, driving history profile, and 68 items assessing driving abilities<sup>8, 9</sup>). This study evaluated the 68 items with regard to the concurrent validity and the test-retest reliability of the three domains of the SDBM in order to analyze the interaction among person, vehicle, and environment for community-dwelling self-drivers with stroke. This study also determined the feasibility of using these measures for evaluating self-driving behaviors in community-dwelling self-drivers with stroke. The SDBM is a safe driving self-report measurement allowing older drivers and family to examine driving self-reports<sup>8, 9</sup>). The results of this study show that the SDBM has excellent validity and reliability and suggest that the SDBM is a solid and reliable measure of self-reported, safe driving behavior in community-dwelling self-drivers with stroke. The results of this study also suggest the feasibility of the SDBM for assessing driving behavior in this population. This study provides evidence in a driving rehabilitation setting to assess driving ability post-stroke. Further studies are needed to test the therapeutic effects of assessing driving abilities by using the SDBM in community-dwelling self-drivers with stroke.

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