

## **Relationship of Cognitive Ability and Self-Confidence in Driving Activities among Post-Stroke Survivors**

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### **Abstract**

Evidence on cognitive abilities and driving activity's self-confidence associated with difficulty in performing driving among post-stroke patients is still insufficient. Therefore, the cross-sectional study was conducted to investigate the association between post-stroke survivors' cognitive abilities and driving activity's self-confidence among post-stroke patients. The findings indicated a significant association ( $p < 0.05$ ) between cognitive ability with age and driving status. Moreover, driving status shows a significant association ( $p < 0.05$ ) with self-confidence. Therefore, an occupational therapist must conduct an off-road evaluation identifying an individual's cognitive capacity and self-confidence associated with the post-stroke patient's driving performance.

**Keywords:** : Cognitive ability; self-confidence; driving; post-stroke

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DOI: <https://doi.org/10.21834/ebpj.v8i24.4678>

### **1.0 Introduction**

Malaysia is home to 32.78 million people as of 2022. Most are Malays, Chinese, Indians, and other ethnic groups (Department of Statistics Malaysia, 2022). Cerebrovascular disease, also known as stroke, was Malaysia's third most prevalent cause of death. There is a marginal increase in incidence from 8% to 8.3% in 2021 (Department of Statistics Malaysia, 2021). The latest World Health Organization (WHO) figures show that 21,592 stroke fatalities, or 12.85% of all deaths, occurred in Malaysia in 2020. Malaysia is ranked 92 in the world by the age-adjusted death rate of 81.65 per 100,000 people (WHO, 2020). According to the data, more patients live with stroke-related disabilities (Nor Azlin et al., 2016). According to several acute stroke hospital admissions studies, 36.2% of stroke survivors were discharged independently, while 53.1% had functional dependency (Chen XW et al., 2019). According to a study by Fisk et al. (1997), 30% of stroke survivors who had previously driven reported never driving again. As a result, around one-third of stroke survivors who were frequent drivers before their stroke started driving again after their stroke. The loss of driving privileges can result in depression, reduced access to healthcare, and increased medical expenses. According to earlier research, 33% of people can restart driving with little to no retraining, and 35% need rehabilitation for driving-related issues before they can resume safe driving (Akinwuntan et al., 2012).

#### **1.1 Background of Study**

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DOI: <https://doi.org/10.21834/ebpj.v8i24.4678>

Getting back behind the wheel after a stroke is a crucial rehabilitation objective since it promotes independence and quality of life, preserving access to the community (McNamara et al., 2014). Cognitive estimating skills, especially those linked to self-awareness of deficiency, are typically impaired by stroke. However, few studies have been conducted that specifically state that cognitive capacity significantly influences driving performance after brain injury (Hartman- Maeir, Soroker, Oman, & Katz, 2003; Scott et al., 2009). Stroke survivors frequently experience cognitive impairments and other restrictions that may impair their ability to operate a vehicle. Several studies have revealed an association between lower driving exposure, avoiding stressful driving circumstances, and poorer cognitive performance (McNamara, Radcliff & George, 2014). Driving difficulties may result from a lack of confidence behind the wheel, caused by post-stroke limitations that affect driving performance, such as distractibility, inadequate scanning of the environment, poor lane positioning, judgement problems, and a slow response to emergencies. There was a limited study on the association between drivers' cognitive ability on the off-road exam and their confidence levels, particularly in the community of stroke survivors. Research by Motta et al. (2014) found that the participants (37%) thought their stroke had damaged their driving, including poor judgement and lack of confidence. Also, a study by McNamara et al. (2013) that looked at the early detection of driving confidence concerns may aid stroke survivors in making decisions about resuming driving after their stroke and preventing premature driving cessation. Moreover, driving calls for both mental and performance skills. However, there was limited research on the connection between cognitive function and self-confidence in stroke survivors was studied. As a result, this study aims to determine whether there is a connection between cognitive skills and self-confidence among post-stroke survivors based on the off-road evaluation.

### *1.2 Objective of Study*

This study investigated the relationship between cognitive ability based on off-road assessment and self-confidence in driving activities among post-stroke survivors. Furthermore, to examine any demographic characteristics (age, gender, time after stroke, side of weakness, driving status, service received) associated with post-stroke survivors' cognitive ability and self-confidence in driving performance.

### *1.3 Significant of Study*

The findings of this study could provide essential information on factors associated with the assessment and treatment strategies in driving activity among post-stroke survivors. The patient's confidence level and cognitive abilities required in driving (attention, spatial abilities and non-verbal reasoning) could be the additional factors to be highlighted by the occupational therapist during off-road assessment and rehabilitation programs in improving post-stroke patients' driving performance instead of just focusing on physical aspects only.

## **2.0 Literature Review**

In the early phase of post-stroke, driving and community mobility should be discussed among the patient and family members to reinforce the process of the patient's regaining independent driving. In addition, it may help reduce the psychological distress of the patient and the family members regarding the driving issue. Although alternative transportation, such as rides from family or friends, public transportation, and taxis, may be available, more options may be needed to fully replace independent driving (Finestone et al., 2010). In addition, some stroke patients may be unable to depend on family members and friends all the time as they may become overburdened. Therefore, the risk and potential to return to driving must be discussed among therapists and post-stroke patients to reintegrate into their community mobility (Gillen, 2011).

### *2.1 Cognitive ability in driving activity*

Resumption of driving is an essential goal in rehabilitation as people after stroke drive less and experience difficulty in demanding driving environments (George, Clark and Crotty, 2007). As driving involves the simultaneous performance of multiple activities, paying adequate attention and appropriately executing sequences of actions in response to the traffic demand is required (Akinwuntan et al., 2006). According to Gillen (2011), driving an automobile is a complex task involving hierarchy skills. Adequate motor response and physical control of the vehicle are essential skills but secondary to accurate perception and understanding of ever-changing traffic environments and unpredictable situations. A driver processes information and makes conscious or unconscious decisions using environmental information (such as traffic lights, road markings, road signs and other road users), attention and perceptual mechanisms using visual search, spatial relations and time and space management; reasoning, problem-solving and planning to analyze each situation and understand cause and effect and response by physical control, adjustment and compromise (Lodha et al., 2021; Zhou et al., 2021).

### *2.2 Self-confident in driving activity*

One step towards independence after a stroke is returning to driving, and confidence is related to performance in on-road assessment on return to driving following a stroke (McNamara et al., 2014). A screening process such as an off-road assessment is essential in identifying the indicators of post-stroke readiness so that they will be evaluated when they have recovered to a level that offers them a realistic opportunity towards passing the driving assessment later; hence a person who is not ready to undergo an on-road driving evaluation can be recognized for a further evaluation (Mazer et al., 1998). Full functions of essential systems in the complexity of the action of driving, such as visual function, motor function and cognitive ability that include executive function, response time, praxis and knowledge, decision-making, attention and planning, may be impaired in stroke patients. Hence, a neurological or neuropsychological assessment is the first step in determining whether the patient is ready for the road test, which is the final step in evaluating their driving ability (Fernandez et al., 2014).

### 3.0 Methodology

#### 3.1 Scope of the Study

This study focused on stroke survivors who received treatment from the occupational therapy department at the general hospital in Taiping, Perak, 1 to 6 months after their stroke.

#### 3.2 Data Collection

The cross-sectional study design was conducted where 33 patients (n=33) who had experienced a stroke from General Hospital Taiping, Perak, were recruited. The inclusion criteria have been set for this study, where the participants who participated ranged in age from 18 to 65 and had experienced a stroke 1 to 6 months prior. The post-stroke survivors had to be licensed to drive and had been doing so before the stroke. In addition, the post-stroke survivors must be free of epilepsy and not have any visual impairments, such as hemianopia, disregard of visual neglect, or low visual acuity. The Research Ethics Committee, Faculty of Health Sciences, University Teknologi MARA, [600-IRMI (5/1/6)] and General Hospital Taiping approval was obtained before conducting this study. Participants were required to sign a consent form to acknowledge that they understood the procedures and agreed to participate in the study. The assessment procedures were explained to each participant before the study was conducted. Once consent from participants had been gained, they were required to fill in the demographic data for additional information, including; age, gender, race, time since stroke, side of stroke and any services they received after a stroke. Next, the Stroke Drivers' Screening Assessment (SDSA) was conducted to identify the subjects' cognitive abilities, which contained three tests; Dot Cancellation, Square Matrices (Directions and Compass) and Road Sign Recognition. The scores obtained were recorded on the summary score sheet, and the 'pass' and 'fail' equations were performed separately. Finally, the participants were required to answer the Adelaide Driving Self-Efficacy Scale (ADSES) questionnaire that contains 12 questions that scale from 0 (not confident) and 10 (completely confident) to evaluate their confidence level in driving activity.

#### 3.3 Data Analysis

The participants' demographic data were analyzed descriptively. An Independent T-test was used to analyze the relationship between cognitive ability recorded in Stroke Drivers' Screening Assessment (SDSA) and total self-confidence in driving activities as recorded on the Adelaide Driving Self-Efficacy Scale (ADSES). In addition, Pearson Chi-Square was used to measure the correlations between cognitive ability and self-confidence in driving activities among post-stroke survivors. Furthermore, this test was used to examine any demographic characteristics associated with post-stroke survivors' cognitive ability and self-confidence in driving performance.

### 4.0 Findings

#### 4.1 Demographics Data

As indicated in Table 1, most participants were aged 35 – 40 years old, male and Malay. In addition, most participants were post-stroke survivors 4- 6 months ago, having left-side weakness and receiving rehabilitation treatment from occupational therapy and physiotherapy.

Table 1: Demographic data

| Variables                              | n  | Percentage (%) |
|----------------------------------------|----|----------------|
| Age (years old)                        |    |                |
| 18 – 20                                | 0  | 0              |
| 25 - 29                                | 0  | 0              |
| 30 - 34                                | 0  | 0              |
| 35 – 40                                | 18 | 54.5           |
| 50 and above                           | 15 | 45.5           |
| Gender                                 |    |                |
| Male                                   | 26 | 78.8           |
| Female                                 | 7  | 21.2           |
| Race                                   |    |                |
| Malay                                  | 26 | 78.8           |
| Chinese                                | 4  | 12.1           |
| Indian                                 | 3  | 9.1            |
| Period of Stroke                       |    |                |
| 1 to 3 months                          | 14 | 42.4           |
| 4 to 6 months                          | 19 | 57.6           |
| Side of Weakness                       |    |                |
| Right                                  | 15 | 45.5           |
| Left                                   | 18 | 54.5           |
| Services Received                      |    |                |
| Occupational Therapy Only              | 13 | 39.4           |
| Occupational Therapy and Physiotherapy | 20 | 60.6           |

#### 4.2 Cognitive ability and confidence level in driving activity

Fig. 1 illustrates the percentage of a pass and fails group of Stroke Drivers' Screening Assessment (SDSA). 51.1% (n=17) of participants' scores

pass with a mean predictive score of 10.35 (SD = 5.32), and 48.5% (n=16) scores fail with a mean predictive score of 10.67 (SD = 3.05).

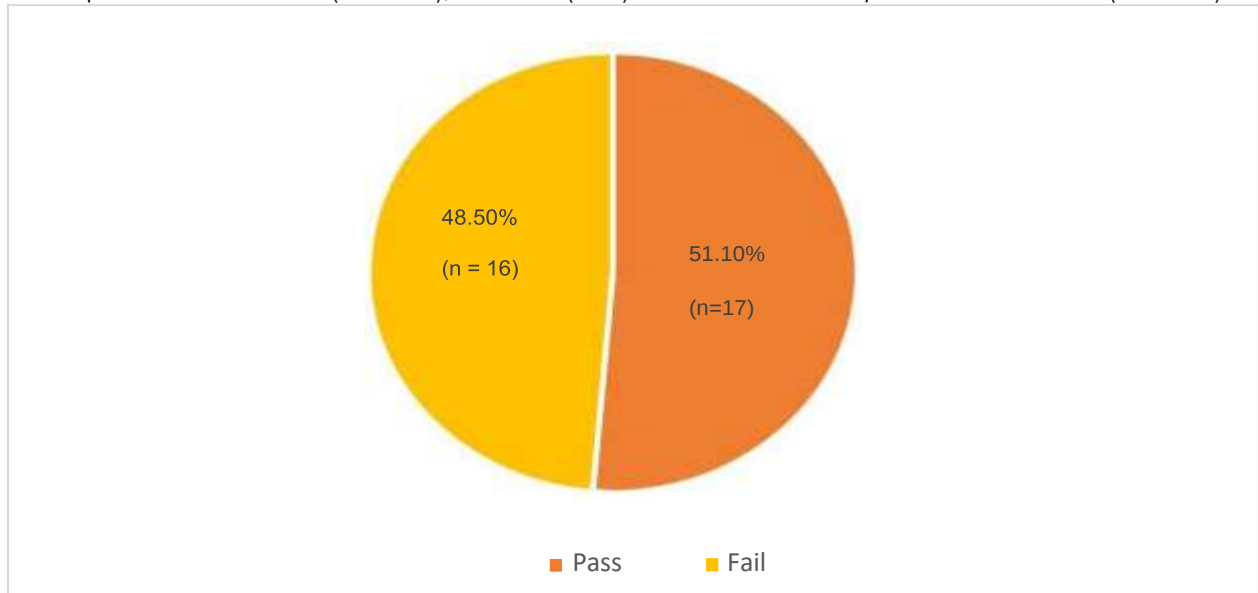


Fig.1: Percentage of pass and fail group of SDSA

Fig. 2 summarizes the percentage of those not confident and confident in the Adelaide Driving Self-Efficacy Scale (ADSES) based on their total score. The total ADSES mean score is 78.82 (SD = 32.64), and the maximum score is 120. 66.7% (n=22) participants score a range of 0 to 106, which indicates not confident in performing driving activities, and 33.3% (n=11) achieves a range above 107, which shows confidence in performing driving activities.

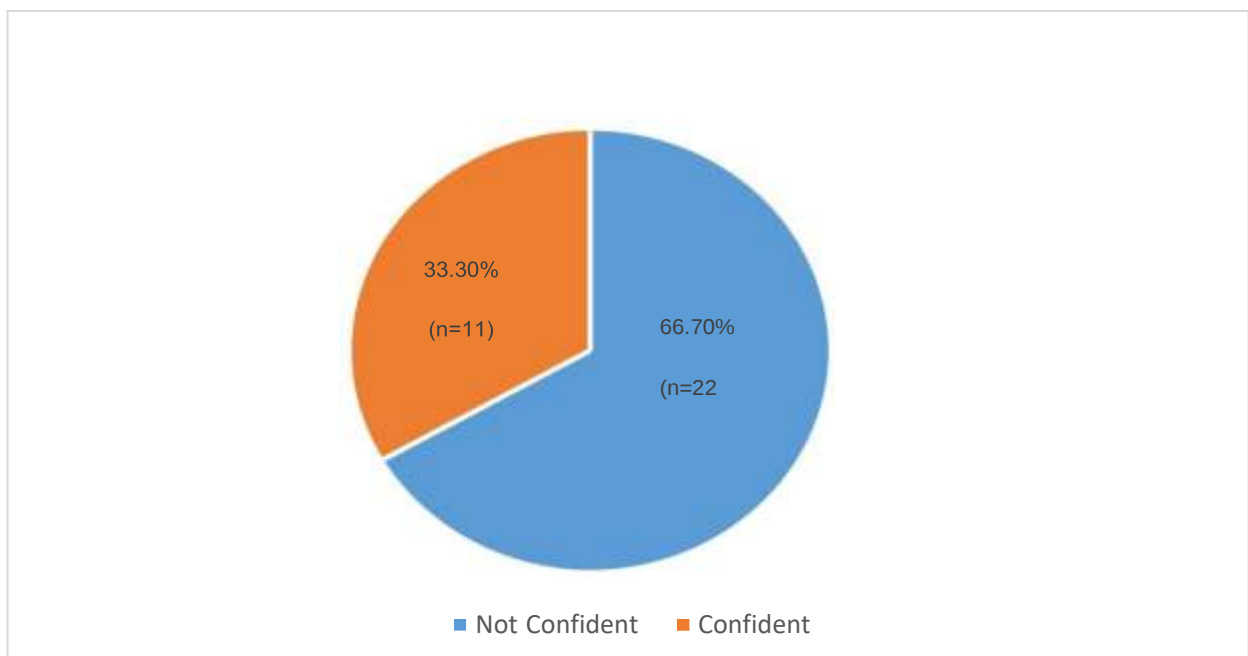


Fig.2: Percentage of not confident and confident level based on ADSES score

#### 4.3 Relationship between post-stroke cognitive ability based on off-road assessment and self-confidence in driving activities

Table 2 shows the differences between the pass and fail group of post-stroke survivors using the Stroke Drivers' Screening Assessment (SDSA) and the total score of the Adelaide Driving Self-Efficacy Scale (ADSES). The participants who scored pass had a higher mean of self-confidence ( $\bar{x}=108.12$ , SD = 9.71) than those who scored fail ( $\bar{x}=47.69$ , SD = 12.86). The mean difference (60.43) between the pass and fail group was statistically significant ( $t = 15.29$  (31);  $p = .000$ ). The 95% confidence interval showed that the mean group difference is likely to fall between 52.37 and 68.49. Therefore, there are significant differences between the pass and fail groups with their self-confidence score ( $p < 0.05$ , 95% CI = 52.57, 68.79).

Table 2: Differences between post-stroke SDSA score with ADSES score

| Variables         | SDSA                        |                               | Mean difference (95% CI) | t-stats (df) | p-value |
|-------------------|-----------------------------|-------------------------------|--------------------------|--------------|---------|
|                   | Pass<br>(n=17)<br>Mean (SD) | Failed<br>(n=16)<br>Mean (SD) |                          |              |         |
| Total ADSES Score | 108.12 (9.71)               | 47.69 (12.86)                 | 60.43 (52.37,68.49)      | 15.29 (31)   | .000    |

Table 3 shows the results of the relationship between the post-stroke survivors' cognitive ability (SDSA) and their self-confidence in driving (ADSES). The two variables show a good, positive relationship ( $r = 0.579$ ) which is statistically significant ( $p = 0.000$ ). Hence, a significant correlation exists between cognitive ability and self-confidence in driving activities among post-stroke survivors. ( $r = 0.579$ ,  $p < 0.05$ ). Therefore, the total SDSA predictive value and total ADSES score showed a good, statistically significant positive relationship.

Table 3: Relationship between the post-stroke cognitive ability (SDSA) with the self-confidence (ADSES) in driving

| Variables               | Cognitive ability (SDSA) |             |
|-------------------------|--------------------------|-------------|
|                         | r value (r)              | p-value (p) |
| Self-confidence (ADSES) | 0.58                     | 0.00        |

#### 4.4 Relationship between demographic characteristics with post-stroke survivors' cognitive ability and self-confidence in driving performance.

Table 4 shows summary results of the relationship between the post-stroke survivors' demographic characteristics and their cognitive ability using SDSA. First, there was a significant relationship between post-stroke survivors' age range and their cognitive ability ( $X^2 (1, N = 33) = 6.798$ ,  $p = 0.009$ ). Those above 50 years old were significant to score failed (73.3%) compared to those who scored pass (68.4%) between the age of 35 to 49 years old. The Cramer's V measure of effect size was 0.454. In age above 50, there was a lower mean (SD) score of fail, 9.579 (1.842), compared to a mean (SD) score of the pass, 12.051 (4.246). Next, a significant relationship was found between driving status with cognitive ability ( $X^2 (1, N = 33) = 14.29$ ,  $p = 0.000$ ). Those who stopped driving after the stroke were significantly more likely to obtain fail (75%) than those who resumed driving that scored pass (92.3%) on the SDSA test. The Cramer's V measure of effect size was 0.658. For those who stopped driving after the stroke, there was a lower mean (SD) score of fail, 9.410 (1.596), compared to a mean (SD) score of the pass, 11.085 (3.367).

Table 4: Relationship between the post-stroke demographic characteristics with the SDSA score

| Demographic characteristics    |                                           | SDSA              |              |                   |              | X2<br>Statistic (df) | P-<br>value |
|--------------------------------|-------------------------------------------|-------------------|--------------|-------------------|--------------|----------------------|-------------|
|                                |                                           | Pass              |              | Fail              |              |                      |             |
|                                |                                           | Mean<br>(SD)      | n<br>(%)     | Mean<br>(SD)      | n<br>(%)     |                      |             |
| Age (years old)                | 35 – 49                                   | 14.582<br>(4.676) | 13<br>(68.4) | 8.534<br>(0.992)  | 5<br>(27.8)  | 6.798 (1)            | 0.009       |
|                                | Above 50                                  | 12.051<br>(4.246) | 4<br>(28.6)  | 9.579<br>(1.842)  | 11<br>(73.3) |                      |             |
| Gender                         | Male                                      | 13.085<br>(4.665) | 13<br>(50)   | 9.277<br>(1.743)  | 13<br>(50)   | 0.113 (1)            | 1.000       |
|                                | Female                                    | 16.920<br>(3.156) | 4<br>(57.1)  | 9.143<br>(1.603)  | 3 (42.9)     |                      |             |
| Time after stroke<br>(months)  | 1 to 3 months                             | 14.001<br>(4.647) | 8<br>(53.3)  | 10.445<br>(0.450) | 6<br>(42.9)  | 0.308 (1)            | 0.579       |
|                                | 4 to 6 months                             | 13.971<br>(4.807) | 9<br>(50)    | 8.536<br>(1.730)  | 10<br>(52.6) |                      |             |
| Side of weakness               | Left                                      | 14.066<br>(4.689) | 11<br>(61.1) | 9.099<br>(1.789)  | 7<br>(38.9)  | 1.46 (1)             | 0.227       |
|                                | Right                                     | 13.842<br>(4.815) | 6<br>(40)    | 9.371<br>(1.663)  | 9<br>(60)    |                      |             |
| Driving status after<br>stroke | Resume<br>driving                         | 15.196<br>(4.583) | 12<br>(92.3) | 6.888<br>(7.7)    | 1<br>(7.7)   | 14.29 (1)            | 0.000       |
|                                | Not Driving                               | 11.085<br>(3.367) | 5<br>(25)    | 9.410<br>(1.596)  | 15<br>(75)   |                      |             |
| Services Received              | Occupational<br>Therapy only              | 14.667<br>(5.985) | 6<br>(46.2)  | 9.110<br>(1.367)  | 7<br>(53.8)  | 0.113 (1)            | 0.737       |
|                                | Occupational Therapy and<br>Physiotherapy | 13.616<br>(3.907) | 11<br>(55)   | 9.362<br>(1.942)  | 9<br>(45)    |                      |             |

Table 5 shows summary results of the relationship between the post-stroke survivors' demographic characteristics and their self-confidence in driving using ADSES. Only driving status shows a significant relationship with self-confidence after post-stroke ( $X^2 (1, N = 33) = 12.438$ ,  $p = 0.000$ ). Those who resumed driving after the stroke were significantly more self-confident (69.2%) than those who did not continue driving (10%). The Cramer's V measure of effect size was 0.614. It shows that those who continue driving have a higher mean (SD) score in confidence, 114.44 (3.877), compared to those who did not drive after their stroke, with a lower mean (SD) score in confidence, 54.778 (22.512).

Table 5: Relationship between the post-stroke demographic characteristics with the ADSES score

| Demographic profiles          |                                         | ADSES                 |              |                       |             | X2<br>Statistic (df) | P-<br>value |
|-------------------------------|-----------------------------------------|-----------------------|--------------|-----------------------|-------------|----------------------|-------------|
|                               |                                         | Not confident (0-106) |              | Confident (above 107) |             |                      |             |
|                               |                                         | Mean (SD)             | n (%)        | Mean (SD)             | n (%)       |                      |             |
| Age (years old)               | 35 – 49                                 | 77.30<br>(24.671)     | 10<br>(55.6) | 114.625<br>(3.114)    | 8<br>(44.4) | 2.20<br>(1)          | 0.138       |
|                               | Above 50                                | 47.667<br>(16.691)    | 12<br>(80.0) | 113.000<br>(5.00)     | 3<br>(20.0) |                      |             |
| Gender                        | Male                                    | 62.579<br>(26.403)    | 19<br>(73.1) | 114.143<br>(3.805)    | 7<br>(26.9) | 2.266<br>(1)         | 0.132       |
|                               | Female                                  | 52.00<br>(15.716)     | 3<br>(42.9)  | 114.25<br>(3.50)      | 4<br>(57.1) |                      |             |
| Time after stroke<br>(months) | 1 to 3 months                           | 57.375<br>(25.690)    | 8<br>(57.1)  | 114.333<br>(3.502)    | 6<br>(42.9) | 0.992<br>(1)         | 0.319       |
|                               | 4 to 6 months                           | 63.286<br>(25.623)    | 14<br>(73.7) | 114.0<br>(3.937)      | 5<br>(26.3) |                      |             |
| Side of weakness              | Left                                    | 64.909<br>(27.278)    | 11<br>(61.1) | 114.714<br>(3.352)    | 7<br>(38.9) | 0.550<br>(1)         | 0.458       |
|                               | Right                                   | 57.363<br>(23.619)    | 11<br>(73.3) | 113.25<br>(4.113)     | 4<br>(26.7) |                      |             |
| Driving status after stroke   | Resume driving                          | 89.75<br>(15.435)     | 4<br>(30.8)  | 114.44<br>(3.877)     | 9<br>(69.2) | 12.438<br>(1)        | 0.000       |
|                               | Not driving                             | 54.778<br>(22.512)    | 18<br>(90.0) | 113.00<br>(0.00)      | 2<br>(10.0) |                      |             |
| Services Received             | Occupational<br>Therapy only            | 53.00<br>(20.021)     | 8<br>(61.5)  | 114.60<br>(4.219)     | 5<br>(38.5) | 0.254<br>(1)         | 0.614       |
|                               | Occupational Therapy &<br>Physiotherapy | 65.786<br>(27.308)    | 14<br>(70.0) | 113.83<br>(3.189)     | 6<br>(30.0) |                      |             |
|                               |                                         |                       |              |                       |             |                      |             |

## 5.0 Discussion

The majority of the participants that passed the screening driving stroke assessment had a higher self-confidence score than those who failed. This result was proven by a previous study by Nouri and Lincoln (1993) that the stroke drivers screening assessment correctly predicted 81% of patients on the road performance, which required reasoning, concentration and visual perception, and correctly identified most of those who failed the road test. Hence, it is recommended that those who fell into the pass category be safe to drive, and above all, they were highly self-confident and more likely to be able to perform the driving activity without harm. Age range and driving status are significantly associated with post-stroke survivors' cognitive ability based on their pass or fail group on SDSA. There is a higher proportion of whose age above 50 years old whose scores fail compared to those within the age range of 35 to 49 years old. This result was supported by a study done by Mathias and Lucas (2009) showed that due to age-related changes in cognitive functioning, the rate of motor vehicle crashes per kilometre increase with age. The age at which they learnt to drive as it reflects their driving ability and attitude towards driving (Finestone et al., 2010). Only driving status shows a significant relationship with self-confidence in doing driving activities among post-stroke survivors. It is observed that those who stop driving score low on self-confidence compared to those who resume driving after a stroke. Stroke survivors who return to driving maybe those who have driving confidence, and that lack of driving confidence might be the reason for not returning to driving post-stroke (McNamara, Ratcliffe and George, 2014). Lack of confidence and fear of failure, stroke survivors chose to stop driving and did not pursue a driving assessment (Barnsley et al., 2012). Regardless, White et al. (2012) also suggested that lack of driving confidence over a while will remain an issue which might lead to restrictions on return to driving and community access even though they had obtained their license back. This study illustrates that the high scores on self-confidence in ADSES tend to be associated with high scores on cognitive ability in SDSA. Patients had a realistic awareness regarding their capabilities in driving. They may better adjust their performance and feedback in driving rehabilitation, and more possibly be able to perform in further on-road-assessment (Lundqvist & Alinder, 2007). Consequently, patients with impaired judgments regarding their difficulties may affect their driving performance. Hence, awareness about problems in cognitive tests and self-confidence when wishing to return to driving should be a concern among post-stroke survivors.

## 6.0 Conclusion & Recommendations

Cognitive ability can be detected through an off-road assessment, and self-confidence could be the factor in performing driving ability. However, considerations need to be made based on post-stroke survivors' age and driving status; the older the age, the less chance of driving and self-confidence. An occupational therapist can primarily provide advice and early assessment regarding driving issues, such as cognitive abilities and self-confidence among post-stroke survivors. Further study is needed to explore whether increasing self-confidence can improve driving ability among post-stroke survivors. Another recommendation is to involve further on-road evaluations or driving stimulators to identify post-stroke cognitive changes, driving confidence over a period hence identifying whether they are fit to drive again.

## Acknowledgements

The researchers would like to extend our gratitude to all participants willing to participate in this study. Furthermore, the authors of this

publication would like to declare that there is no conflict of interest in the publication of this research.

## Paper Contribution to Related Field of Study

This paper contributes to the occupational therapy and post-stroke driving rehabilitation programme.

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