Research Article

Inter-Rater Reliability and Usability of Telehealth for Home Hazard Falls-Risk Assessment after Stroke

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Running Title: Reliability of Telehealth for Home Falls Assessment

Abstract

Objective: Stroke survivors are more likely to fall at home. A home hazard assessment may be beneficial to reduce the risk of falling, but it is resource and time intensive. This study examined the inter-rater reliability and usability of telehealth for a hazard assessment to address risk of falls.

Methods: Two occupational therapists accessed the telehealth platform from different locations and simultaneously rated participants' home environment using the Home Falls and Accident

Screening Tool (HOME FAST). Stroke survivors and their caregivers answered the Telehealth Usability Questionnaire (TUQ).
Results: Thirty-six stroke survivors and 31 caregivers participated in the study. Gwet's AC_1 was used for agreement analysis. The overall AC_1 value for the inter-rater reliability was 0.93 (95% CI: 0.66-1.00). There was a moderate correlation between the raters (r=0.57, p=0.000). Bland and Altman graph plot showed a mean difference of -0.61 and 97.2% of the difference score fell within the limits of agreement (95% CI, −5.67 to 4.39). The overall mean score of the TUQ was 5.62 out of 7.
Conclusions: Telehealth technology is a potential medium that provides an opportunity for synchronous practitioner-client interaction in evaluating home hazards. Some challenges were noted during the telehealth sessions, thus requiring a brief protocol to navigate the system.
Keywords: Telehealth; usability; home hazard; falls; stroke

Introduction

Strokes are one of the most common causes of disability worldwide [1] and one of the pertinent issues in stroke is falls [2]. In addition to injuries, persons who fall may, as a result, become limited in their activities, become more dependent on others, and have an increased fear of falling [3]. These factors create challenges to social and community participation and negatively impact on quality of life [4]. Multiple interventions are available for falls prevention, and one of these is home hazards management [5]. However, falls prevention and intervention in stroke survivors have received less attention as physical rehabilitation was the main focus for stroke recovery and, consequently, home hazards management for this population has been neglected [6].

Stroke survivors are more likely to fall at home [7]. A home visit for an in-person evaluation is considered the gold standard practice for home hazards management, especially when carried out by an occupational therapist [8, 9]. However, home visits are decreasing due to time constraints, resource limits, geographical barriers, non-compliance with rehabilitation, and a lack of understanding from stroke survivors and caregivers [10-12]. Worse, stroke survivors and healthcare practitioners frequently consider falls prevention and intervention to be secondary concerns, and home visits unnecessary [13]. Furthermore, the COVID-19 pandemic has made patients unable to access post-stroke rehabilitation services (14), with postponed or limited appointments, cancellation of therapy sessions, and limited physical contact. Communication technology such as telehealth is an alternative identified to overcome these challenges [14].

Telehealth is the use of information and communication technology to provide health-related services while the client and practitioner are in different locations [15]. It may offer a way to administer occupational therapy assessment and interventions, especially to rural clients located far from practitioners. The telehealth medium has previously been used in occupational therapy practice [16], including home hazards management [17, 18]. Numerous technologies have been utilized to address home safety; however, little is known about how technology may be used to provide a real-time, synchronous home safety evaluation, which is the 'gold standard' of care in this area [19]. Sadasivam et al. [20] used robots to assess home safety, but the floor-level viewpoint was limited, video quality was poor, and the robot could not climb stairs and navigate small areas of the home. The use of photography has also been explored [21-23] but this two-dimensional and static view is by its nature demonstrated to be inadequate. In a recent study, Renda et al. [18] employed smartphone and other portable technology for a home safety intervention, but the 'live' video used had poor video quality that required recorded videos to

clarify home details. Similarly, Romero et al. [24] developed a protocol for clients to video-record areas of their home to be sent for clinical review. These studies investigated asynchronous techniques for home hazard assessment. While there are barriers to a real-time home safety evaluation, its delivery by an occupational therapist has been found most effective [9, 25].

While an in-person perspective is vital, in-home telemedicine's technological needs and characteristics and the demands it places on clients are not well understood [26]. This knowledge gap is exacerbated for stroke patients, who may have sensory and mobility issues that make using technology challenging, especially for video telemedicine that involves clients moving around the home, such as during a home safety review. Thus, the purpose of this study was to examine the reliability and usability of using telehealth for an occupational therapy home hazard assessment to address home hazards falls-risk.

Materials and Methods

Research design

A cross-sectional study design was conducted to examine the inter-rater reliability and the usability of the telehealth system for falls-risk home hazard assessment. This study was conducted from May 2021 to February 2022. Inter-rater reliability measures the consistency between two raters rating the home hazard assessment by using the telehealth system. The instrument applied to measure falls-risk home hazard was the Home Falls and Accident Screening Tool (HOME FAST), and the Telehealth Usability Questionnaire (TUQ) was used to evaluate the usability of the telehealth system navigation.

Instrumentation

Home Hazard Assessment

The HOME FAST is a 25-item screening instrument that examines home hazards and the interaction of individuals and their home environment when performing activities that could put them at risk of falling [27]. The HOME FAST assesses potentially hazardous items belonging to seven domains: flooring, furniture, lighting, bathroom, storage, stairways or steps, and mobility. Each item in the HOME FAST is rated either 'YES' (no hazards), 'NO' (hazardous), or 'NA' (not applicable). The score is calculated by counting and totalling the NO responses, whereby each response contributes 1 mark. The score range is from 0 to 25, and higher scores indicate more hazards at home and, therefore, a higher risk of falls [27]. HOME FAST is administered via observation of and interview about how the individual functions in their home environment [28]. It was designed in Australia but has been internationally adopted and had undergone cross-cultural tests in Malaysia [29]. HOME FAST has been validated [29, 30] among older adults.

Telehealth Usability Questionnaire (TUQ)

The TUQ uses a broader definition of usability that includes the technology's utility as well as its usability [31]. Utility here refers to whether the functionality of the technology does what users need [32], while usability is the extent to which users can use a system to achieve specified goals with effectiveness, efficiency, and satisfaction [33]. The TUQ usability factors include usefulness, ease of use, effectiveness, reliability, and satisfaction [31]. TUQ items are rated using a seven-point Likert scale ranging from one (disagree) to seven (agree), where higher ratings indicate better system usability [31]. The total score ranges from 21 to 147. It has been translated into Malaysia's three main spoken languages [34].

Participants

The inclusion criteria for participants in this study were: i) stroke survivors who are 21 to 80 years old with a diagnosis of 6 months and above, ii) are discharged from an inpatient ward and living in the community, iii) have slight to moderately severe disability according to the Modified Rankin Scale, iv) are able to speak and understand Malay or English and v) able to cognitively capable of giving informed consent. Participants were excluded if they were clinically diagnosed with dementia, psychiatric illnesses, or aphasia. As for caregivers, the inclusion criteria included family members who cared for the stroke survivor for at least 6 months post-stroke.

Informed consent was obtained for all stroke survivors and their caregivers before conducting the home assessments. Convenience sampling was conducted to recruit participants. Stroke survivors were recruited at selected National Stroke Association of Malaysia (NASAM) centres in Selangor and Kuala Lumpur. The screening was conducted using the Modified Rankin Scale via a face-to-face interview at the centre. The study was also advertised in the Stroke Survivors Malaysia online support group with an invitation to participate in this study, and any group member who was interested was given instructions to contact the researchers. Once a group member had contacted the researcher, the researcher explained the study, asked for personal information and established their functional status according to the Modified Rankin Scale via online video conferencing, call, text, or WhatsApp.

Data sources and collection procedure

For inter-rater reliability, two raters who were part of the research team with an occupational therapy background concurrently rated the participant's living environment according to HOME FAST assessment via online video conferencing (telehealth). For a fair quality reliability study, the suggested sample size is 30 to 50 home visits (one visit per home) and HOME FAST scores [35].

Administration of the HOME FAST via telehealth

The online assessment is similar to an on-site assessment except that it was conducted remotely using a telehealth platform. The telehealth platform chosen was Coviu (https://www.coviu.com/en-au/?hsLang=en-au&gredir=0), which was developed for telehealth use, has teleconference functions, and can be used either with a computer or mobile devices (e.g., smartphone, tablet). An appointment was made with the participants to conduct the home hazard assessment via telehealth. Prior to the assessment day, via a telephone call and simple e-guidebook the researcher briefed both the end users (the stroke survivor participant and caregiver) on how to navigate the online system and what to expect on the assessment day. This included stroke survivors walking around the home while the caregiver broadcast with their phones. For stroke survivors whose caregivers did not participate, they (stroke survivors) conducted the telehealth sessions alone by placing the devices near to the location of the assessment, for example on cupboards in the kitchen, on a table in the bedroom or by holding the device while they maneuver around the house. Instructions were given by the primary rater to the participants on what to do during the home hazard assessment. During the assessment day, an exercise navigating the system (includes the link, instructions on how to open the system and introduction of the features of the system) was done before the assessment to make the participants comfortable and familiar with the system. The exercise took approximately 5 to 10 minutes. The participants were free to choose their own type of device (mobile phone or laptop)

used to access the telehealth platform. Two occupational therapists accessed the telehealth platform using their own devices but from different locations, simultaneously rated participants' home environment using the HOME FAST.

Administration of the TUQ

Both the stroke survivor participants and caregivers who used the telehealth system were given an online TUQ form to answer after the online home hazard assessment. The TUQ was given in a Google form link via WhatsApp to the participants. Directions on how to answer the form were detailed in the Google form.

Data analysis

The data analysis for this study was performed using the Real Statistics Resource Pack software (Release 7.2) (Copyright 2013-2020) [36]. Descriptive statistics were used to summarize rater and stroke survivor characteristics, range, and distribution of the scores on the outcome measures. For inter-rater reliability, Gwet's AC_1 [37] is the statistic of choice for the case of two or more raters. Gwet's agreement coefficient can be used in more contexts than Kappa because it does not depend upon the assumption of independence between raters was shown to provide a more stable inter-rater reliability coefficient than Cohen's Kappa [38]. The values are classified as a poor agreement for a score of 0 and below, slight agreement for a score between 0.01 and 0.20, fair for 0.21 to 0.40, moderate for 0.41 to 0.60, substantial for 0.61 to 0.80, and almost perfect agreement for a score from 0.81 to 1.00, based on the suggestion of Landis and Koch [38 9]. The Pearson/Spearmen's Rho correlation was applied for measuring the association between the two variables and ranges from -1 and 1, with 1(-1) indicating perfect positive (negative) correlation and 0 indicating no association between the variables [39 40].

The Bland-Altman plot method was used to examine the agreement between the inter-rater in scoring the hazards for two parallel measurements [40 41]. In addition, Standard Error of Measurement (SEM) was calculated to measure the range of error of the home hazard assessment. SEM is the determination of the amount of variation or spread in the measurement errors for a test [41 42]. SEM is calculated as follows: $SEM = SD \times \sqrt{(1 - ICC)}$, with ICC as the Intraclass Correlation Coefficient and SD representing the Standard Deviation of the measure [42 43].

Results

A total of thirty-six stroke survivors participated in this study. Their characteristics and those of their homes are presented in Table 1. A total of 31 caregivers participated in the study. Fifteen of the caregivers were children to the stroke survivor participants, fourteen were spouses, one was a relative and one caregiver was a housekeeper. Five stroke survivors did not have caregivers participating in the study. All stroke survivor participants or the caregivers used their smartphones to access the telehealth system. The duration of the online assessments was 15-20 minutes. Two occupational therapists (one aged 23, the other 36; mean age 29.5 (SD=9.19)) participated as raters. Both raters had approximately 3 years of experience in conducting home hazard assessments. The highest education level of one of the raters was a master's degree and of the other a diploma. Both raters completed the home hazard assessment for all participants, and no missing data were recorded.

Table 1-Demographic of Stroke Occupants

Home Characteristic	N=36	%
Type of Home		
Apartment / Condominium	11	30.6
One storey landed	9	25.0
Double / Multi-storey landed	16	44.4
Home Modification		
Yes	4	11.1
No	32	88.9
Months Post-Stroke Occupant		
>6-24 months	6	16.7
More than 24 months	30	83.3
Walking Aids		
Yes	19	52.8
No	17	47.2
Falls after Stroke		
No	19	52.8
Yes	17	47.2
Location of falls		
Indoor	13	76.5
Outdoor	4	23.5
Activity when falling		
Walking	6	35.3
Showering/Toileting	4	23.5
Standing	7	41.2

Inter-rater Reliability

A total of 72 ratings from 36 stroke survivor participants and two raters were obtained. The overall AC_1 value for inter-rater reliability was 0.93, indicating excellent inter-rater reliability (95% CI: 0.66-1.00) (Table 2). There was a moderate correlation between the first and second rater (r=0.57, p=0.000). The mean of the HOME FAST score for the first and second raters were 10.17 (SD=2.68) and 10.81 (SD=2.94) respectively.

Table 2-Inter-Rater Reliability of the HOME FAST Telehealth Administration

HOME FAST item	Inter-rater (n=36)	
	AC_1	%
1.Walkway cluttered	0.92	63.9
2. Poor condition of floor coverings	0.91	52.8
3. Slippery floor surfaces	0.98	86.1
4. Loose mats	0.97	83.3
5. Difficulty with bed transfers	0.98	86.1
6. Difficulty with lounge transfers	0.96	77.8
7. Poor lighting	0.98	91.7
8. No access to bedside light	0.99	94.4
9. Poor lighting on outdoor paths	0.82	69.4
10. Difficulty with toilet transfers	0.89	52.8
11. Difficulty with bath mobility	0.98	88.9
12. Difficulty with shower mobility	0.90	63.9
13. No access to grab rails in bath	0.98	91.7
14. No slip-resistant mats in bathroom	0.97	83.3
15. Toilet is not close to bedroom	0.93	69.4
16. Difficulty reaching items in kitchen	0.95	80.6
17. Difficulty carrying meals	0.93	77.8
18. Inadequate/absent rails indoor	1.00	100.0
19. Inadequate/absent stair rails outdoor	0.98	94.4
20. Using stairs	0.97	91.7
21. Undefined stair edges	0.94	77.8
22. Entrance doors	0.95	69.4
23. Outdoor paths	0.66	44.4
24. Improper footwear	0.99	94.4
25. Hazardous pets	0.86	63.9
Average	0.93	78.0

** Note. AC_1 = Gwet's AC_1 analysis; % = Agreement percentage*

The mean difference of -0.64 in the Bland and Altman graph plot in Figure 1 indicated small discrepancy showing a relatively fairly similar home hazards identification between the two raters, and 97.2% of the difference score fell within the limits of agreement (95% CI, −5.67 to 4.39) which indicated consistency of the scoring between the two raters. The overall SEM for inter-rater reliability was 0.74.

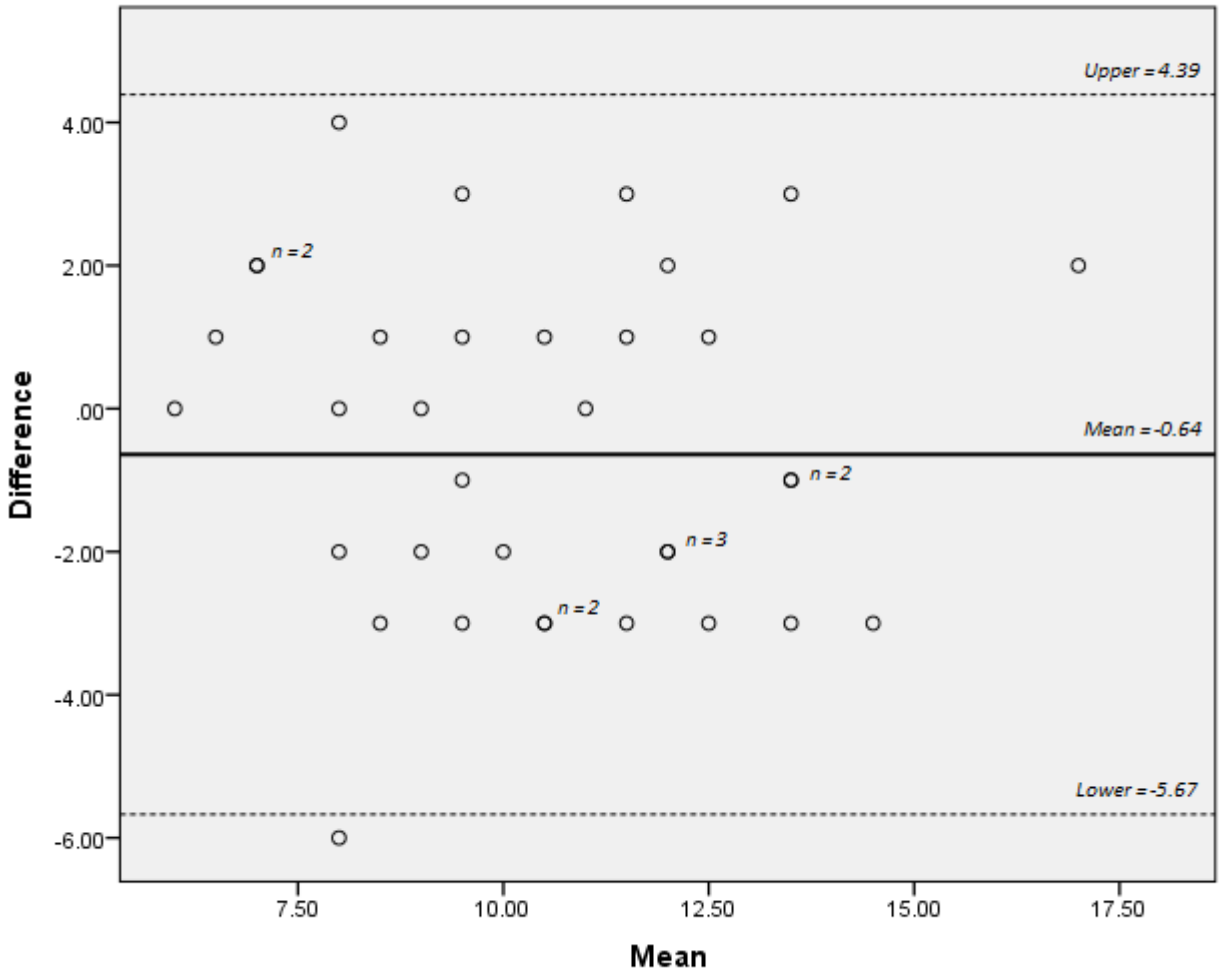

Figure 1- Bland Altman analysis for inter-rater reliability

Usability

A total of 32 (18 stroke survivors and 14 caregivers) participants answered the TUQ. The overall mean score of the TUQ was 5.62 out of 7. The mean score for each domain was 5.83 (SD=1.18) for Usefulness, 5.71 (SD=1.24) for Ease of Use, 5.61 (SD= 1.35) for Interface, 5.59 (SD=1.31) for Interaction, 5.36 (SD=1.26) for Reliability, and 5.61 (SD=1.32) for Satisfaction. T-test indicated no significant difference between caregiver's and stroke survivor's rating on any of the domains (usefulness: p=0.27, ease: p=0.34, interface: p=0.34, interaction: p=0.42, reliability: p=0.17, satisfaction: p=0.16 and total score: p=0.26). The mean score for each item is illustrated in Figure 2.

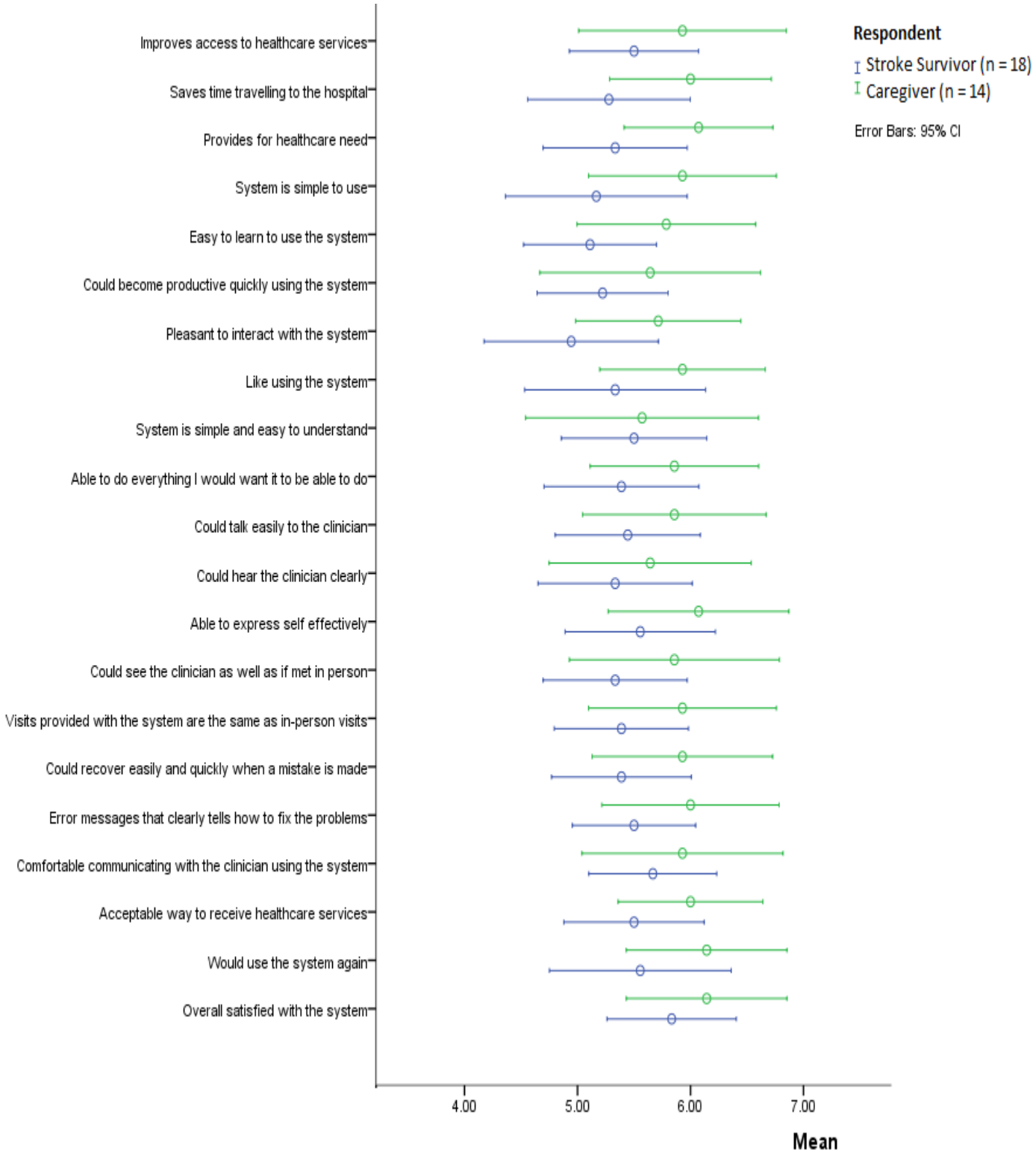

Figure 2- Usability of the Telehealth System

Discussion

A total of 36 stroke survivors' houses were evaluated by two occupational therapists via the telehealth system. This study has demonstrated that a simple on-site home hazard assessment can safely be performed or augmented using technology, in line with other studies investigating technological applications for on-site home visits [26, 44]. Stroke survivors and their caregiver were given a pamphlet prior to the telehealth session. This includes information on navigating the system as well as the assessment that will be used during the home hazard assessment. A briefing at the start of the telehealth session was also included to address safety issues and to troubleshoot any technical problems such as the absence of audio or video during the session. All participants used a smartphone to access and navigate through the telehealth system. Technology is changing rapidly, making it easily accessible for smartphones and apps to permit video streaming, thus allowing this type of home visiting to become routine practice for occupational therapists [44].

Reliability

Overall, in terms of consistencies between raters, telehealth had higher inter-rater reliability when compared with photographs [21, 22] or video [45]. This could be because videoconferencing enables a real-time, synchronous encounter [46] similar to a typical home visit. Any issues arising during the home hazard assessment could be rectified during the session, something not possible when using only videos or photographs. This proves that telehealth is more reliable when compared with other available technologies for assessing home hazards.

Usability

In terms of usability, stroke survivors and caregivers were satisfied with the telehealth system's usefulness, ease, effectiveness, reliability, and satisfaction for home hazard assessment. However, the need for caregiver assistance was apparent during a home hazard assessment as stroke survivor participants needed to move around the house while the researchers assessed the home environment. Furthermore, poor internet connectivity challenged the telehealth session as the videos lagged and hung occasionally, similar in occurrence to a study by Gately et al. [47]. However, steps were taken to resolve this issue in this study, which included informing participants to use WiFi if available, choosing the bandwidth-restricted mode for video and audio on the telehealth system and recording the live streaming as a backup.

Implications for Practice

The use of a telehealth system can be an alternate or complement the conventional home hazards assessments conducted by occupational therapists. As the system is simple and user-friendly, stroke patients and their caregivers have the opportunity to conduct the assessment at home with the assistance from therapists. Stroke patients and their caregivers will be able to identify home hazards specific to them and prevent future falls from happening.

Limitations and Recommendations

The respondents were self-selecting and aware that the study required the use of technology; therefore, our respondents (stroke survivors and their carers) may have a higher level of digital literacy with respect to health applications than is found in the general population. As the results of the study are promising, a large-scale study is recommended for future research. In addition, investigating the feasibility of the telehealth system, which includes time, cost-effectiveness, and

participants' experiences, would further enhance the contribution to technology usage in telehealth.

Conclusion

Telehealth provides an opportunity for synchronous practitioner-client interaction in evaluating home hazards and is a potential medium to substitute on-site home visits. Administrating the HOME FAST for home hazard assessment via telehealth is recommended. However, some challenges were noted during the telehealth sessions, such as difficulties using the online system, no available assistance from caregivers, and poor internet connection. A brief protocol regarding the procedure and troubleshooting prior to the telehealth session are beneficial to ensure effective and smooth navigation of the system.

Author Contributions

Conceptualization: Husna Ahmad Ainuddin and Muhammad Hibatullah Romli
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Writing—review and editing: Muhammad Hibatullah Romli, Mazatulfazura SF Salim, Tengku Aizan Hamid and Lynette Mackenzie

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. The study was approved by the Universiti Putra Malaysia Ethics Committee (JKEUPM-2019-320).

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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