Research Article

Investigating the Inter-Rater Reliability and Usability of Telehealth for Home Hazard Falls-Risk Assessment After Stroke

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ABSTRACT

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

Materials and 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. Stroke survivors and their caregivers answered the telehealth usability questionnaire.

Results: A total of 36 stroke survivors and 31 caregivers participated in the study. Gwet's AC1 was used for agreement analysis. The overall AC1 value for the inter-rater reliability was 0.93 (95% confidence interval [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%, 4.39%). The overall mean score of the telehealth usability questionnaire was 5.62 out of 7.

Conclusion: 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.

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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, more dependent on others, and have an increased fear of falling [3]. These factors create challenges to social and community participation and negatively impact quality of life [4]. Multiple interventions are available for fall prevention, and one of these is home hazard management [5]. However, fall prevention and intervention in stroke survivors have received less attention as physical rehabilitation was the main focus for stroke recovery, and, consequently, home hazard 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]. In addition, 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 utilizes information and communication technology to deliver health-related services when the client and practitioner are in separate 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]. Various technologies have been employed to enhance home safety, yet the application of technology for real-time, synchronous home hazard assessments remains under-explored [19]. Sadasivam et al. [20] utilized robots for home safety level viewpoint, poor video quality, and the robot's inability to climb stairs or navigate tight spaces. Photography has also been examined [21-23], but its static, two-dimensional nature has proven to be insufficient. Renda et al. [18] used smartphones and other portable devices for home safety interventions, but the live video quality was poor, necessitating recorded videos for clearer home details. Similarly, Romero et al. [24] developed a protocol for clients to record videos of their homes for clinical review. These studies focused on asynchronous methods for assessing home hazards. Despite the challenges in implementing real-time home safety evaluations, delivery by an occupational therapist has been found to be the most effective approach [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, this study examines the reliability and usability of using telehealth for an occupational therapy home hazard assessment to address home hazard fall risk.

Materials and Methods

Study 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.

Study instruments

Home hazard assessment

The HOME FAST is a 25-item screening tool designed to identify home hazards and assess how individuals interact with their home environment during activities that could lead to falls [27]. It evaluates potential hazards across seven domains: flooring, furniture, lighting, bathroom, storage, stairways or steps, and mobility. Each item is rated as 'yes' (no hazard), 'no' (hazardous), or 'na' (not applicable). the total score is the sum of the 'no' responses, with each 'no' contributing one point. Scores range from 0 to 25, with higher scores indicating more hazards and a greater risk of falls [27]. The HOME

FAST is administered through observation and interviews about the individual's functioning in their home environment [28]. Although developed in Australia, it has been internationally adopted and cross-culturally tested in Malaysia [29]. The HOME FAST has been validated for use with older adults [29, 30].

Telehealth usability questionnaire

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 7-point Likert scale ranging from 1 (disagree) to 7 (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].

Study participants

The inclusion criteria for participants in this study were as follows: 1) Stroke survivors who were 21 to 80 years old with a diagnosis of 6 months and above; 2) Subjects who were discharged from an inpatient ward and living in the community; 3) Individuals who had slight to moderately severe disability according to the modified Rankin scale; 4) Subjects who could speak and understand Malay or English; and 5) Subjects who were able to cognitively capable of giving informed consent.

The participants were excluded if they were clinically diagnosed with dementia, psychiatric illnesses, or aphasia. As for caregivers, the inclusion criteria comprised 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 the participants. Stroke survivors were recruited at selected National Stroke Association of Malaysia (NASAM) centers in Selangor and Kuala Lumpur, Malaysia. The screening was conducted using the modified Rankin scale via a face-to-face interview at the center. The study was also advertised in the stroke survivors Malaysia online support group with an invitation to participate in this study. Any interested group member 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 the 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 falls and accident screening tool via telehealth

The online assessment is similar to an on-site assessment except that it was conducted remotely using a telehealth platform. The chosen telehealth platform was Coviu, 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. Before 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 caregivers broadcast with their phones. For stroke survivors whose caregivers did not participate, the stroke survivors conducted the telehealth sessions alone by placing the devices near 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 (including 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 min. The participants were free to choose the 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, and simultaneously rated participants' home environment using the HOME FAST.

Administration of the telehealth usability questionnaire

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 the inter-rater reliability, Gwet's AC1 [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 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 [9, 38]. The Pearson/Spearmen Rho correlation was applied to measure the association between the two variables and ranges from -1 and 1, with 1 (-1), indicating a 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, the standard error of measurement (SEM) was calculated to measure the range of errors in 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 (Equation 1):

1. $SEM=SD\times\sqrt{(1-ICC)}$,

with "ICC" as the intraclass correlation coefficient and "SD" representing the standard deviation of the measure [42, 43].

Results

A total of 36 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. Meanwhile, 15 of the caregivers were children to the stroke survivor participants, 14 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 caregivers used their smartphones to access the telehealth system. The duration of the online assessments was 15-20 min. Two occupational therapists (one aged 23 years, the other 36 years; mean age = 29.5±9.19 years) 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.

Inter-rater reliability

A total of 72 ratings from 36 stroke survivor participants and two raters were obtained. The overall AC1 value for inter-rater reliability was 0.93, indicating excellent inter-rater reliability (95% confidence interval [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±2.68 and 10.81±2.94, respectively.

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

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±1.18 for usefulness, 5.71±1.24 for ease of use, 5.61±1.35 for interface, 5.59±1.31 for interaction, 5.36±1.26 for reliability, and 5.61±1.32 for satisfaction. The t-test indicated no significant difference between the caregiver's and stroke survivor's rating on any of the domains (usefulness: $P=0.27$; ease: $P=0.34$; interface:

Table 1. Demographics of stroke occupants (n=36)

Home Characteristics		No. (%)
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	≤24	6(16.7)
	>24	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)

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Table 2. Inter-rater reliability of the HOME FAST telehealth administration

HOME FAST Item	Inter-rater (n=36)	
	AC1	Agreement (%)
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

HOME FAST Item	Inter-rater (n=36)	
	AC1	Agreement (%)
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 the bathroom	0.97	83.3
15. The toilet is not close to the bedroom	0.93	69.4
16. Difficulty reaching items in the 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
Mean	0.93	78.0

AC1: Gwet's AC1 analysis; HOME FAST: Home falls, and accident screening tool.

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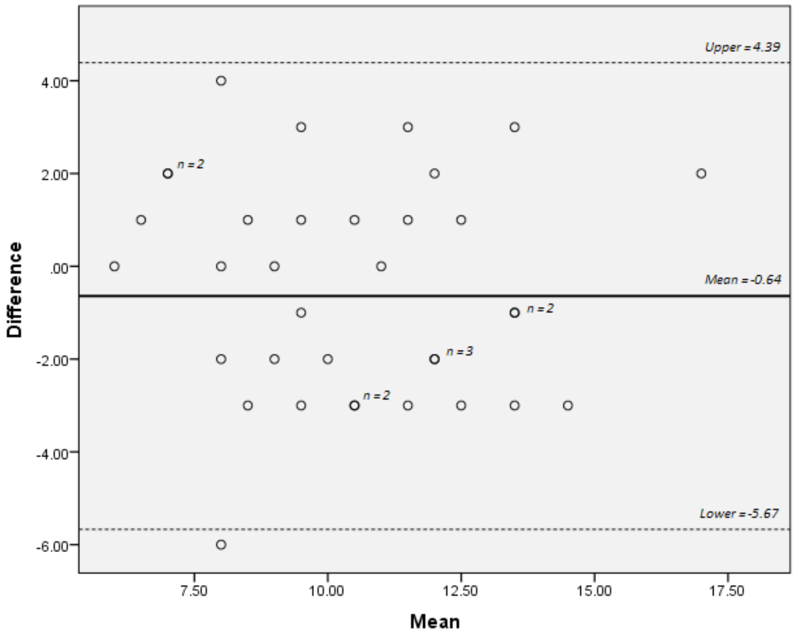

Figure 1. Bland-Altman analysis for inter-rater reliability

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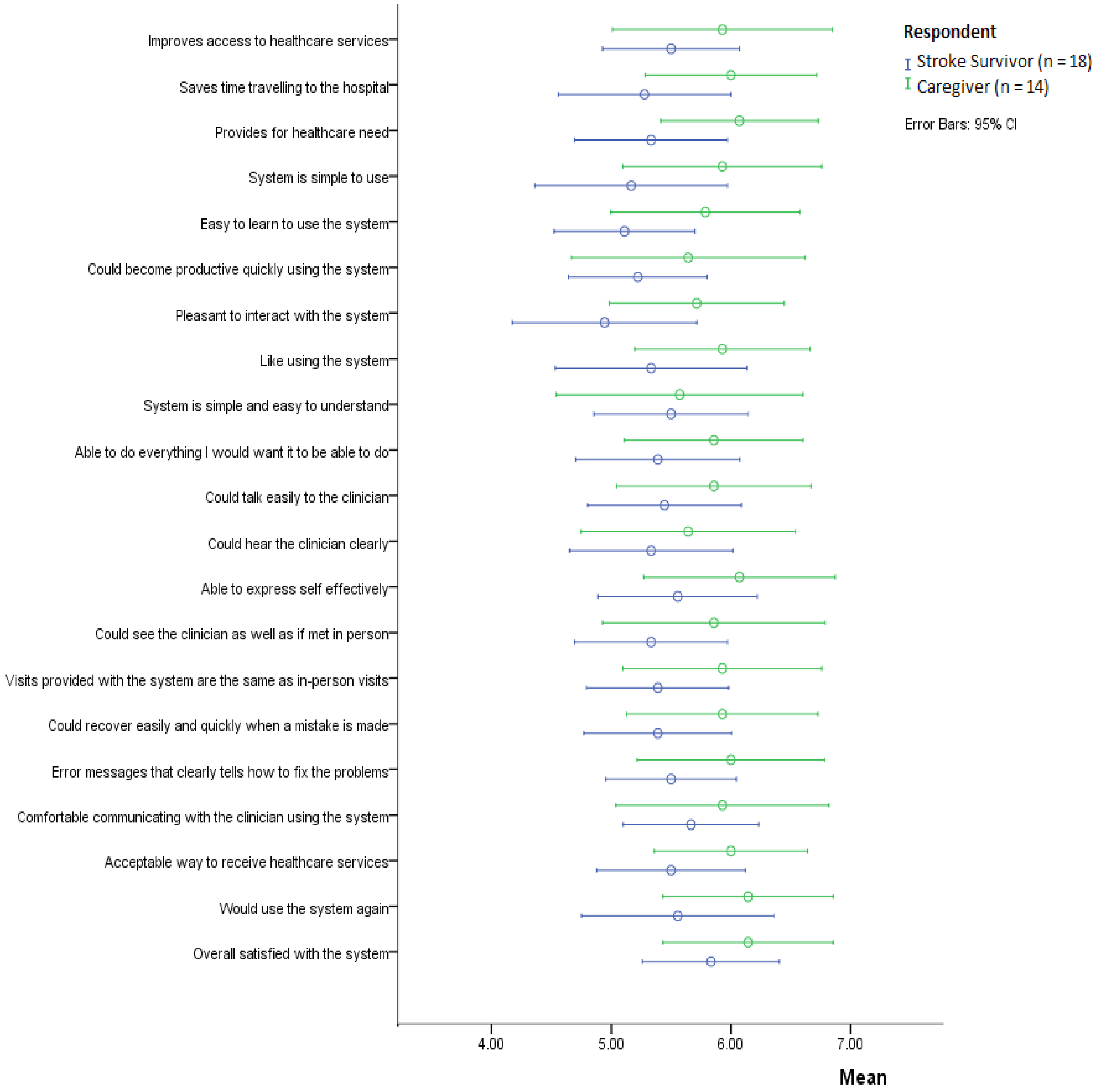

Figure 2. Usability of the telehealth system

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.

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 caregivers were given a pamphlet before 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 confirms 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 with 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 Wi-Fi 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 alternative 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 assistance from therapists. Stroke patients and their caregivers will be able to identify home hazards specific to them and prevent future falls from happening.

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 before the telehealth session is beneficial to ensure effective and smooth navigation of the system.

Study limitations and recommendations

The respondents were self-selecting and knew that the study involved using technology. Consequently, our participants (stroke survivors and their caregivers) might possess a higher level of digital literacy related to health applications compared to 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.

Ethical Considerations

Compliance with ethical guidelines

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

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Authors' contributions

Conceptualization and methodology: Husna Ahmad Ainuddin and Muhammad Hibatullah Romli; Funding acquisition: Muhammad Hibatullah Romli; Investigation and writing the original draft:: Husna Ahmad Ainuddin; Formal analysis: Husna Ahmad Ainuddin; Resources: Mazatulfazura SF Salim, Tengku Aizan Hamid and Lynette Mackenzie; Review, and editing: Muhammad Hibatullah Romli, Mazatulfazura SF Salim, Tengku Aizan Hamid, and Lynette Mackenzie; Supervision: Muhammad Hibatullah Romli.

Conflict of interest

The authors declared no conflict of interest.

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