ORIGINAL ARTICLE

Explorative Survey on the Usage and Needs of Mobile Health Applications (mHealth) amongst Caregivers in Taking Care of Stroke Survivors

FIRDAUS A[1], NOOR AZAH AA[2], WAN ASYRAF WZ[3], FAIRUZ A[2]

[1]*Precint 9 Putrajaya Health Clinic, Putrajaya, 62250, Malaysia*
[2]*Long Term Stroke Clinic, Department of Family Medicine,* [3]*Department of Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia*

ABSTRAK

Aplikasi kesihatan mudah alih (mHealth) boleh membantu penjaga pesakit strok dalam menangani keperluan maklumat dan sokongan yang tidak mencukupi daripada penjaga kesihatan profesional. Kajian ini bertujuan untuk mengkaji penggunaan dan keperluan aplikasi mHealth di kalangan penjaga pesakit strok dan faktor yang berkaitan dengannya. Kajian keratan rentas ini melibatkan 207 penjaga strok yang menghadiri klinik strok di hospital dan pusat komuniti di Kuala Lumpur antara Disember 2020 hingga Mac 2021. Tinjauan dilakukan melalui soal selidik dwibahasa yang dibangunkan dengan menggunakan temu-bual bersemuka, temu-bual telefon dan borang Google. Majoriti penjaga (77.8%) menggunakan sekurang-kurangnya satu aplikasi mHealth untuk penjagaan diri atau semasa proses penjagaan pesakit strok. Tiga jenis aplikasi mHealth yang paling diperlukan ialah menghubungi penjaga kesihatan profesional (89.9%), pemantauan penyakit (89.4%) dan maklumat kesihatan (89.4%). Tiga ciri aplikasi mHealth yang paling diperlukan adalah percuma untuk dimuat turun/digunakan (94.7%), antara muka yang mudah (93.7%) dan keselamatan/privasi data (93.7%). Ujian Chi Square menunjukkan pengurusan pesakit ($\chi^2(1) = 5.65, p = 0.017$), maklumat kesihatan ($\chi^2(1) = 6.72, p = 0.01$), pemantauan penyakit ($\chi^2(1) = 9.58, p = 0.002$), menghubungi profesional penjagaan kesihatan ($\chi^2(1) = 6.27, p = 0.012$) dan tahap ketidakupayaan pesakit ($\chi^2(1) = 4.29, p = 0.038$) dikaitkan secara signifikan dengan jenis aplikasi mHealth. Kesimpulannya, penggunaan aplikasi mHealth dalam kalangan penjaga pesakit strok adalah tinggi, dan jenis serta ciri khusus yang terdapat dalam aplikasi mHealth adalah diperlukan dalam kalangan penjaga strok.

Kata kunci: aplikasi mudahalih, mHealth, penjaga strok, teleperubatan

Address for correspondence and reprint requests: Prof. Dr. Noor Azah Abd Aziz. Long Term Stroke Clinic, Department of Family Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia. Tel: +603-91459473 Email: azah@ppukm. ukm.edu.my

ABSTRACT

Mobile health (mHealth) applications may assist stroke caregivers in answering the unmet needs of inadequate information and support from healthcare professionals. This study aimed to explore the usage and needs of mHealth applications among stroke caregivers and its associated factors. This cross-sectional study involved 207 stroke caregivers attending hospital and community-based stroke clinics in Kuala Lumpur between December 2020 until March 2021. The survey was done through newly developed self-administered bilingual questionnaires using face to face interviews, telephone interviews and Google form. Most caregivers (77.8%) used at least one mHealth application for self-care or during the caregiving process. The three most types of mHealth applications were contacting healthcare professionals (89.9%), disease monitoring (89.4%) and health information (89.4%). The three most features of mHealth applications were free to download/use (94.7%), simple interface (93.7%) and data security/privacy (93.7%). Chi-square test of association showed managing appointment ($\chi^2(1) = 5.65$, p = 0.017), health information ($\chi^2(1) = 6.72$, p = 0.01), disease monitoring ($\chi^2(1) = 9.58$, p = 0.002), contacting healthcare professional ($\chi^2(1) = 6.27$, p = 0.012) and patient disability level ($\chi^2(1) = 4.29$, p = 0.038) were significantly associated with specific types of mHealth applications. In conclusion, the overall usage of mHealth applications among stroke caregivers was high, with the need of specific types and features in mHealth applications among stroke caregivers.

Keywords: mHealth, mobile applications, stroke caregivers, telemedicine

INTRODUCTION

Smartphone ownership has steadily increased, and it is estimated that at least 3.5 billion were smartphone users worldwide. In addition, there were 29 million internet users in Malaysia, with 98.7% using a smartphone as the primary device to access the internet (Malaysian Communications and Multimedia Commission 2020). A smartphone is a mobile phone with a touchscreen interface, internet connection and an operating system that can execute downloadable applications (Islam et al. 2010). The mobile phone applications are easily accessible via Google Play or App Store, generally inexpensive and provide information to integrate from multiple sources (Wang et al. 2017).

Mobile health, often known as mHealth, is described as "medical and public health practise assisted by mobile technology such as cell phones, patient monitoring devices, personal digital assistants and other wireless devices" (World Health Organisation 2016). It is an emerging branch of medicine that utilises technology to improve health care. Due to the increasing popularity of mHealth

application among the public, it has increased tremendously over the years. It is estimated that over 99,366 mHealth applications are available in the Apple Store and Google Play (Tangari et al. 2021). mHealth may provide a solution to boost early stroke rehabilitation (Mosa et al. 2012) by providing stroke caregivers with access to information, monitoring and tracking, appointments and other recovery needs at anytime (Lobo et al. 2021). Sarfo et al. (2018) suggested that telerehabilitation had superior or equivalent beneficial effects on motor, higher cortical and mood problems compared to traditional face-to-face therapy. Fan and Zhao (2021) also found positive correlations in mHealth interventions for chronic illness management, stating that these technologies would change healthcare delivery, particularly to rural and disadvantaged communities. However, Zhang et al. (2020) discovered that most stroke-related applications were created without the participation of health experts, which should be improved (Zhang et al. 2020). A recent review by Lobo et al. (2021) on the 47 mHealth applications for stroke caregivers found that only a small percentage of applications was evaluated before releasing them in the application store. Furthermore, none of these applications focused on the usability in delivering caregiving support but rather focused on evaluating the accuracy of the applications in improving recovery (Lobo et al. 2021).

Stroke is a leading cause of death and disability in a number of countries. It is an acute condition with long-standing complications which requires continuous care and constant monitoring during the entire recovery continuum (Fearon & Langhorne 2012). It is estimated that over 40,000 acute stroke cases are registered in Malaysia each year, with approximately 23% hospitalised individuals have a history of recurrent stroke (Loo & Gan 2012). Furthermore, the incidence of ischemic stroke has been observed to rise by 29.5% every year, whereas haemorrhagic stroke rises by about 18.7% (Aziz et al. 2015). Stroke impairment may be permanent, leading to the stroke survivors to be fully dependent on the caregiver for daily activities, social interactions, emotional support and financial assistance (Kelly-Hayes et al. 2003). Family involvement, especially the spouses as the primary caregiver, is vital in helping with the daily activities, offering emotional support and rehabilitation (Ali et al. 2013). In comparison to other chronic conditions, stroke strikes unexpectedly yet has a lasting effect, leaving caretakers have little time to prepare and adjust to their new roles (Greenwood et al. 2008). Caregivers reported that they were getting help during hospitalisation, but not beyond discharge. Furthermore, the type of information and assistance required by caregivers may change over the continuum of care and may be necessary for a longer period of time (Zawawi et al. 2020).

Coronavirus disease (COVID-19) has brought significant challenges to health care delivery especially to stroke survivors, due to nationwide lockdown and strict control movement

orders (Aziz et al. 2020). Patients with a history of stroke are 2.5 times more likely to proceed to a severe stage of COVID-19 (Aggarwal et al. 2020). Since COVID-19 is spread via person-to-person contact, stroke patients who conduct outpatient rehabilitation and attend appointments during the COVID-19 pandemic may be at an elevated risk of infection. Physical touch with other people is impossible to avoid, particularly in busy situations. Regular assessment and monitoring after discharge are crucial for stroke recovery and it remain as a challenges in the COVID-19 period (Aziz & Raymond 2008). Stroke patients and their caregivers should share management with the stroke care providers about the various aspects of stroke care (Aziz 2021). The disruptive manner of COVID-19 that leads to the cancellation of appointments and rehabilitation therapy remain as the gap in our traditional conduct with stroke patients. Thus, we believe that mHealth plays an essential role in bridging stroke caregivers' unmet needs especially during the COVID-19 pandemic. This study aimed to explore the usage and need of mHealth applications among stroke caregivers in the community. Further assessment on the association between caregivers characteristics and caregiving-related information with the needs of mHealth applications were explored. This information provided insight to developers and researchers in creating better mHealth applications for stroke caregivers.

MATERIALS AND METHODS

Study Design

This was a cross-sectional study exploring the usage and needs of mHealth applications among stroke caregivers in the community. This study was conducted between December 2020 until March 2021. The study sites were the Neuromedical Clinic and Long-Term Stroke Clinic (LTSC) of Hospital Canselor Tuanku Muhriz (HCTM). The Neuromedical Clinic is a subspecialty clinic under the Medical Department HCTM that treats most of the neurology cases, including stroke cases. The LTSC is a unit in a Primer Clinic that provides long term follow-up care for stroke patients in the community.

Study Population

The study population was the stroke caregivers who accompanying the stroke survivors during the follow-up in Neuromedical Clinic or LTSC. The inclusion criteria for the study were stroke caregivers aged 18 years old and above; owned and used smartphones; and actively involved in taking care of stroke patients at home (at least 1 hour per day or 5 hours per week). The exclusion criteria for this study were caregivers who involved in taking care of stroke patients in the nursing home or patients who was diagnosed with stroke less than three months.

Sample Size Calculation

To our understanding, there was no data available regarding the local prevalence of stroke or mHealth users

among the population in Malaysia. The sample size for this study was estimated based on the stroke survivors attendance at both clinics. The estimated total number of stroke patients attending the Neuromedical Clinic and LTSC were 180 and 90, respectively during the study period. The list of stroke patients was taken from the clinic registry, which had complete details of stroke patients attending the clinic. The sample size calculation was based on Kretcjie and Morgan (1970). Thus, a sample size of 245 was computed with a 5% margin of error, a 95% confidence interval, a population percentage of 0.5, and a 20% non-response rate.

Data Collection

A convenience sampling method was used to recruit the participants. During the initial part of data collection, the caregivers who accompanied the stroke patients for the follow-up appointment were invited to participate in the survey. The purpose and format of the questionnaire were explained to them. A cover letter that explained about the study and a consent form were attached to each questionnaire. Participants who agreed were asked to sign the informed consent before completing the questionnaire. Unbiased assistance was given to patients who required such as elderly patients or patients who unable to comprehend questions fully. The completed questionnaire was returned on the spot. However, due to the COVID-19 pandemic and the restricted movement order imposed by the government,

additional methods via telephone call and google form (https://forms.gle/oNwfGcSq5K79x2xu8) were used. The stroke caregivers were randomly selected from the stroke registry books from both clinics, and the researcher contacted them via telephone. Verbal consent was obtained from the caregivers who agreed to participate. The participants were then given options to answer the questionnaire through telephone interview or via a google form, in which it was collected by the researcher.

Study Instrument

This study used a set of newly developed self-administered bilingual questionnaires, which consisted of four sections. The first section (Section A) was about the demographic characteristics of the stroke caregivers. The second section (Section B) was about the caregiving-related information. Information regarding current degree of disability was assessed in Question 12. Question 12 was about the current degree of disability of the stroke patient using the modified Rankin Scale (mRS). The mRS is an ordinal scale that measures functional outcomes and degree of disability or dependence in everyday life after stroke. It ranges from 0 (no symptoms) to 5 (severe disability). A simplified modified Rankin Scale questionnaire (smRSq) was used during the interview of the stroke caregivers (including telephone interviews). It had excellent reliability and could be administered in less than 1.5 minutes in person and by telephone (Bruno et al.

2011). Question 13 is about the stroke caregiver's usual task. The caregiver tasks were based on American Association of Retired Person (AARP)'s Prepare to Care: A Resource Guide for Families handbook (American Association of Retired Persons 2017). The participants were allowed to choose multiple responses according to their usual caregiving tasks.

In the third section (Section C), the caregivers were asked regarding the current experience of using a smartphone for any healthcare purposes. Participants were asked to rate their level of agreement with each item on a 5-point Likert scale ranging from 1 (never) to 5 (always). The functions of mHealth were grouped into nine categories, based on the WHO's Third Global Survey on eHealth (World Health Organisation 2016). In the last section (Section D), the caregivers were asked which types and features they would like to have in the mHealth application. The participants were asked to indicate the importance of each item using a 5-point Likert scale ranging from 1 (not important) to 5 (very important). The questions in Section D were adapted from a study in Singapore (Hossain et al. 2018) and were adjusted according to the suitability of cultural settings in Malaysia. Permission to use the questionnaires was obtained from the original author.

A linguist who is a native Malay speaker and professionally multilingual (Malay and English) was hired to translate the English version of the questionnaire into Malay (forward translation). Disagreements in the terms

were resolved through discussions and final consensus. Another family medicine specialist then did a backward translation, translating it back into English. Finally, two family medicine specialists who were experts in managing stroke patients at the community level and one neurologist reviewed and performed the content validation. In addition, 20 stroke caregivers were assessed in a pilot study. Modifications were made based on the feedback to improve the clarity and the pilot study responses were omitted from the final analysis. The Cronbach's alpha for the nine items in Section C (usage), nine items in Section D (types) and seven items in Section D (features) were 0.9, 0.89 and 0.78. As this study was the first to look into mHealth applications, we used a consensus method based on WHO's Third Global Survey on eHealth on defining terms for the study (World Health Organisation 2016).

In this study, usage refer to the use of mHealth applications for healthcare purposes (for self-care or during the caregiving process). Needs referred to the important types and features of mHealth application which were needed by the stroke caregivers. In this study, non-user was defined as caregivers who have not used mHealth applications for healthcare purposes (for self-care or during the caregiving process). Stroke caregivers who spent at least 1 hour per day or 5 hours per week of caregiving activities were defined as caregivers. Stroke survivors were those who continued to live after being discharged from the hospital for a stroke treatment, either

in rehabilitation or in the community. This study only included caregivers of stroke survivors who had a stroke for more than three months before enrolment.

Data Analysis

All the data in this study were analysed using IBM SPSS version 25 (IBM, NY, US). For the descriptive analysis, categorical data were reported using frequencies and percentages. The stroke caregivers tasks were divided into low (1-2 tasks), moderate (3-5 tasks) and high (6-8 tasks). In addition, the modified Rankin Scale was dichotomised into stroke survivors with no disability or slight disability (mRS 0 – 2) and moderate or severe disability (mRS 3 – 5) (Weisscher et al. 2008). For the descriptive analysis, the Likert scale response on the usage of the mHealth applications was divided into three categories; non-user (never), less frequent user (rarely, sometimes) and frequent user (often, always). In addition, the response in Section D (types and features) was categorised according to the level of importance; not important (Likert 1-2), non-committal (Likert 3) and important (Likert 4-5).

For the inferential analysis, the Likert scale response on the types and features of mHealth applications were categorised into not important (Likert 1-3) and important (Likert 4-5). Chi-square test of association (non-parametric test) was used to determine the association between social-demographic, caregiving-related characteristics with the level of importance for types and features of the mHealth applications. A p-value of <0.05 was considered statistically significant.

Ethical Approval

Approval to conduct the study was obtained from the Research and Ethics Committee of Universiti Kebangsaan Malaysia (JEP-2020-023). Permission for data collection was then obtained from each clinic involved in this study (Neuromedical Clinic HCTM and Primer Clinic HCTM). Finally, written and verbal informed consent to participate in this study was obtained from all participants.

RESULTS

Characteristic of the Participants

Overall, 245 questionnaires were distributed, but only 207 fulfilled the inclusion and exclusion criteria and were included in the analysis, yielding a response rate of 84%. Table 1 described the socio-demographic characteristics of the caregivers. The majority of the caregivers were females (58.9%), Malay (67.6%) and married (71.5%). The mean age of the caregivers was 48.2 $\pm$ 13.9 years old. Most of them were in full-time employment (44.4%) and had a tertiary level of education (52.2%). More than half of the caregivers had a monthly household income of less than RM4,850.00 (62.8%).

Caregiving Related Characteristics

Table 2 described the caregiving related characteristics. Most caregivers were either son/daughter (42.5%) or spouse (38.6%). The majority of the caregivers lived together with the patient (72%) and had a moderate caregiving task (51.7%). A total of 56.5% of the participants spent more than 6 hours per day, and 83.6% cared for the stroke survivors for more than 12 months. The stroke survivors had almost equal distribution in terms of the disability level.

Table 1: Summary of socio-demographic data (n = 207)

Characteristics	n (%)	Mean ± SD
Age		
Below 40 years	64 (30.9)	
40-59 years	87 (42.0)	48.2 ±
Above 60 years	56 (27.1)	13.9
Gender		
Male	85 (41.1)	
Female	122 (58.9)	-
Race		
Malay	140 (67.6)	
Chinese	55 (26.6)	-
Indian	11 (5.3)	
Others	1 (0.5)	
Marital status		
Single	47 (22.7)	
Married	148 (71.5)	-
Divorced	5 (2.4)	
Widowed	7 (3.4)	
Level of education		
Primary school	3 (1.4)	
Secondary school	82 (38.9)	-
Tertiary level	108 (52.2)	
Others	14 (6.8)	
Employment status		
Full-time	92 (44.4)	
Part-time	11 (5.3)	-
Unemployed	55 (26.6)	
Retired	49 (23.7)	
Household income		
Less than RM4850	130 (62.8)	
RM4850- RM10970	57 (27.5)	-
More than RM10970	20 (9.7)	

Table 2: Summary of caregiving related characteristics (n = 207)

Characteristics	n (%)
Co-residency	
Yes	149 (72)
No	58 (28)
Relationship with the stroke patient	
Son or daughter	88 (42.5)
Spouse	80 (38.6)
Siblings	15 (7.2)
Non-family	15 (7.2)
Grandchildren	6 (2.9)
Parent	3 (1.4)
Duration of care (month)	
Less than 6 months	17 (8.2)
6-12 months	17 (8.2)
More than 12 month	173 (83.6)
Duration of care per day (hour)	
Less than 3 hours	57 (27.5)
3-6 hours	33 (15.9)
More than 6 hours	117 (56.5)
Patient disability level (modified Rankin Scale)	
No or slight disability (mRS 0-2)	103 (49.7)
Moderate to severe disability (mRS 3-5)	104 (50.3)
Caregiver task (number of tasks)	
Low task (1-2)	24 (11.6)
Moderate task (3-5)	107 (51.7)
High task (6-8)	76 (36.7)

mHealth Usage among Caregivers

Figure 1 illustrated the usage of mHealth applications among caregivers. The majority of the caregivers (77.8%) used at least one type of mHealth application for self-care or during the caregiving process. Out of the 207 participants, 46 (22.2%) had not used mHealth applications. The least used types of mHealth application were accessing health records (72.5%), diet tracking (70.5%) and support groups (70.0%). Interestingly, 68.3% of the caregivers had experience in using health information or health education applications, contributing it to be the
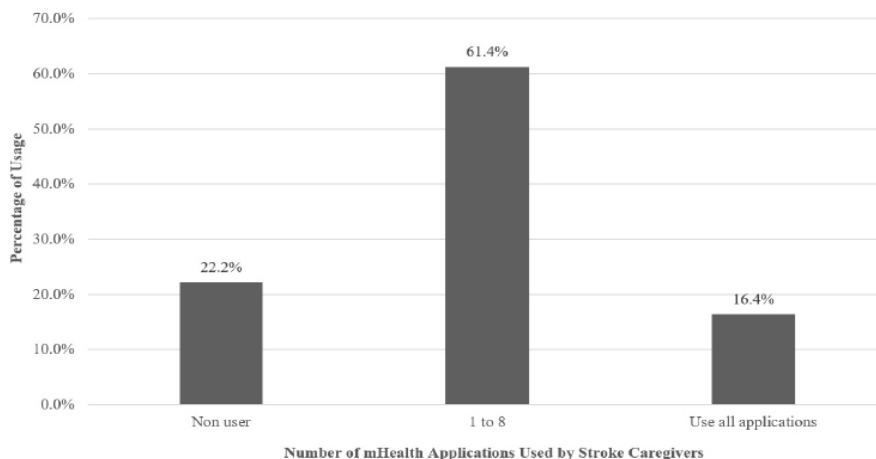
Figure 1: Overall usage of mHealth applications among the stroke caregivers (n=207)

most used mHealth application in this study.

Types and Features of the mHealth Applications Needed by the Stroke Caregivers

Tables 3 and 4 illustrated the types and features of mHealth applications needed by stroke caregivers. The majority of the respondents agreed that these types of mHealth applications were important during the caregiving process; contacting healthcare professionals (89.9%), health information/education (89.4%), disease monitoring (89.4%), managing appointments (87.9%), accessing health records (87.4%), medication management (82.6%), home-based exercise/physiotherapy (83.6%), support groups (77.3%) and diet tracking (74.9%).

In terms of the features of mHealth applications, the majority of the participants agreed that these features were important; free to download and use (94.7%), simple interface (93.7%), data security/privacy (93.7%), multiple language support (91.3%), minimal self-entry of data (87.9%) and automatic login (84.5%). However, only 40.6% of the caregivers felt that paid subscriptions were important for mHealth applications.

The Association between Caregivers Characteristics and Caregiving Related Information with Types and Features mHealth Applications

A Chi-Square test of association was performed to examine the relationship between the caregivers' characteristics and caregiving related information with types and features of mHealth applications (Table 5). There was a statistically significant association between co-residency status and types of mHealth applications; (i) managing appointment [$\chi^2(1) = 5.65$, $p = 0.017$]; (ii) health information [$\chi^2(1) = 6.72$, $p = 0.01$]; (iii) disease monitoring [$\chi^2(1) = 9.58$, $p = 0.002$]; and (iv) contacting healthcare professional [$\chi^2(1) = 6.27$, $p = 0.012$]. There was

Table 3: Types of mHealth applications needed by stroke caregivers (n = 207)

Variables	Not Important, n(%)	Non-Committal, n(%)	Important, n(%)
Managing appointments	16 (7.7)	9 (4.3)	182 (87.9)
Accessing health records	15 (7.2)	11 (5.3)	181 (87.4)
Health information/education	16 (7.7)	6 (2.9)	185 (89.4)
Diet tracking	22 (10.6)	30 (14.5)	155 (74.9)
Disease monitoring	15 (7.2)	7 (3.4)	185 (89.4)
Medication management	22 (10.6)	14 (6.8)	171 (82.6)
Contacting healthcare professionals	10 (4.8)	11 (5.3)	186 (89.9)
Home based exercise/physiotherapy	14 (6.8)	20 (9.7)	173 (83.6)
Support groups	20 (9.7)	27 (13.0)	160 (77.3)

a significant association between the stroke survivors disability level (modified Ranking Scale) and the types of mHealth applications, which was accessing health records [$\chi^2(1)$ = 4.29, p = 0.038]. However, both of the associations were weak. Nonetheless, there was no significant relationship between the other caregivers' characteristics and caregiving related information with the types and features of mHealth applications.

DISCUSSION

The stroke caregivers' socio-demographic characteristics in this study were similar to the previous stroke studies (Hussain et al. 2014; Jawahir et al. 2021; Tan et al. 2020). The majority of the caregivers in this study were females and either of them were children or spouses of the stroke survivors. Our findings on the caregiving-related characteristics were consistent with the previous study by Jawahir et al. (2021), in which majority of the caregivers lived together and spent significant hours taking care of the stroke patients. These findings reflected Malaysian culture, whereby females spouses and daughters were expected to take care of their sick family members, showing respect and gratitude to their husbands and parents (Ahmad Ramli et al. 2021).

In this study, we found that the usage of mHealth applications among

Table 4: Features of mHealth application needed by the stroke caregivers (n = 207)

Variables	Not Important, n(%)	Non-Committal, n(%)	Important,n(%)
Free to download and use	6 (2.9)	5 (2.4)	196 (94.7)
Simple interface	8 (3.9)	5 (2.4)	194 (93.7)
Multiple language support	12 (5.8)	6 (2.9)	189 (91.3)
Data security/privacy	10 (4.8)	3 (1.4)	194 (93.7)
Minimal self-entry of data	13 (6.3)	12 (5.8)	182 (87.9)
Automatic login	19 (9.2)	13 (6.3)	175 (84.5)
Paid subscription	87 (42.0)	36 (17.4)	84 (40.6)

Table 5: Summary of significant chi-square test of association between caregivers characteristics and caregiving related information with the types of mHealth applications (n = 207)

Characteristics	Managing appointment		Accessing health record		Health information		Disease monitoring		Contacting healthcare professional	
	Not important n (%)	Important n (%)	Not important n (%)	Important n (%)	Not important n (%)	Important n (%)	Not important n (%)	Important n (%)	Not important n (%)	Important n (%)
Co-residency										
Yes	23 (92.0)	126 (69.2)			21 (95.5)	128 (69.2)	22 (100.o)	127 (68.6)	20 (95.2)	129 (69.4)
No	2 (8.0)	56 (30.8)			1 (4.5)	57 (30.8)	0	56 (31.4)	1 (4.8)	57 (30.6)
	$p = 0.017$ $\chi^2 = 5.65$ $\Phi = 0.17$				$p = 0.01$ $\chi^2 = 6.72$ $\Phi = 0.18$		$p = 0.002$ $\chi^2 = 9.58$ $\Phi = 0.22$		$p = 0.012$ $\chi^2 = 6.27$ $\Phi = 0.17$	
Patient disability level (modified Rankin Scale)										
mRS 0-2			8 (30.8)	95 (52.5)						
mRS 3-5			18 (69.2)	86 (47.5)						
			$p = 0.04$ $\chi^2 = 4.29$ $\Phi = -0.14$							

Notes: The Likert scale response on the types and features of mHealth applications were categorised into not important (Likert 1-3) and important (Likert 4-5). Chi-square test of association was conducted between caregivers' characteristics and caregiving related information with the types of mHealth applications. All expected cell frequencies were greater than five. p-value statistically significant at < 0.05. Only significant results were reported, df = 1, Φ = phi coefficient.

caregivers was high, with 77.8% of the stroke caregivers used at least one mHealth application. In addition, the most used mHealth applications by the caregivers were for accessing health information (63.8%). However, our results were opposite with the findings from a local study looking into views and perceptions of mHealth among the public (Lee et al. 2020). Lee et al. (2020) found that only 20.4% of respondents were familiar with mHealth or had used a health-related application. The disparity of the result could be due to the current COVID-19 pandemic, whereby MySejahtera had become one of the essential mHealth applications for the Malaysian during the COVID-19 pandemic. Conversely, the least used mHealth applications were for support groups (70%), diet tracking (70.5%) and accessing health records (72.5%). Nonetheless, the lacking usage of other mHealth applications among the caregivers could be due to several reasons, including lack of awareness of mHealth applications (Lee et al. 2020), preference for face-to-face communication with their healthcare providers (Jamal et al. 2015), limited understanding of the various functions of a smartphone (Spann & Stewart 2018) and issues with the cost, security and privacy of embracing such technology (Krebs & Duncan 2015; Zhou et al. 2019). Despite mHealth applications had been regularly used by the primary care physicians (PCPs) in the clinical practice, Lim et al. (2021) found that PCPs rarely promoted mHealth applications to their patients. It could have been related to the difficulty in identifying evidence-based, accurate

and relevant applications for their patient usage. Lack of knowledge about reliable mHealth applications available for patients and lack of confidence in counselling patients on specific mHealth risks, such as data privacy, were among the other factors (Gagnon et al. 2016). With the increased exposure of mHealth applications during this pandemic area, it is interesting to observe whether the pattern of mHealth applications usage will sustain in the post-pandemic era.

The results of this study indicated that contacting healthcare professionals, disease monitoring and health information were among the top three types of mHealth applications needed by stroke caregivers. In contrast to earlier findings by Singer et al. (2018), which reported that doctor/rehabilitation appointments, links to reliable medical information and local stroke support groups were among the important types of mHealth applications needed by the stroke caregivers. It was possible that these results were due to the recent COVID-19 pandemic, which had severely disrupted the continuation of chronic illness care. The disruption of the regular services may cause significant difficulty for the caregivers and patients to find further information, especially on the long-term management of chronic illness, including stroke. The present findings were consistent with other research, which found that doctor consultation and disease monitoring were most affected during the COVID-19 pandemic due to the decrease in physical appointments or routine patient care services (Pati et al. 2021).

Interestingly, the co-residency status of the caregivers and patient disability level were significantly associated with specific types of mHealth applications. However, the association was weak. Nonetheless, we could not find any relevant studies that look into these factors. Therefore, it was suggested that the association of these factors could be investigated in future studies.

In addition, the present study found that free to download/use was the most important feature of mHealth applications needed by stroke caregivers. However, the current study's findings did not support the previous research by Abu Seman & Ramayah (2017). The study observed that most of the consumers in Malaysia were ready and willing to pay for mHealth applications, provided that the price was between RM10.00 to RM25.00 (Abu Seman & Ramayah 2017). This inconsistency might due to the timing of our study, as it was done during the COVID-19 pandemic. It was understandabe that COVID-19 pandemic had caused a significant financial burden to the general population. The cost of developing and implementing mHealth applications varied depending on the type of intervention, the number of technologies used and whether it was supplemented with a non-mHealth component. According to Rinaldi et al. (2020), the cost of mHealth interventions for type 2 diabetes mellitus prevention and control might range from \$1.8 to \$10110.1 per patient per year, depending on the types and amount of technologies employed in the applications. They also suggested

that a simple mHealth intervention used only one type of technology would be the most user-friendly and cost-effective (Rinaldi et al. 2020). However, there were no studies have been conducted in Malaysia to compare the cost and cost-effectiveness of mHealth applications in managing chronic diseases. Thus, we suggested that further exploration into the cost-effectiveness of preventative mHealth interventions for chronic diseases was warranted.

Interestingly, the present study found that the interface of mHealth applications was an important factor that needs to be taken into account when developing an applications for stroke caregivers. In simple terms, "user interface" was how the applications look and interact with the user. In this study, 93.7% of stroke caregivers indicated that a simple interface was important in mHealth applications. These results matched earlier studies, suggesting that ease of use and simplicity were essential to overcome the barrier of using mHealth applications (Peng et al. 2016). However, our findings on the simple interface were too general. Therefore, further research is warranted to look into the technical aspect of the user interface according to stroke caregivers' preferences. Despite the benefits of mHealth, there were some risks for users. For example, there was growing concern about health data security and privacy issues when using mHealth applications. Astonishingly, a recent study conducted by Tangari et al. (2021) discover that 88% of the 20,000 mHealth applications collected

and shared data with other parties, including advertisers and tracking services. Additionally, the study found that mHealth applications were far from transparency in handling user data, with only half adhered to their declared privacy policies (Tangari et al. 2021). The Personal Data Protection Act 2010 (PDPA) is the only legislation related to privacy in Malaysia. The PDPA regulates the use of personal data in commercial transactions and rules that allow data users to collect, process, and use personal data when dealing with their employees, suppliers and customers. However, the PDPA's privacy protection was insufficient to ensure protection in the event of a data breach (Hasan et al. 2020). These issues proved to be a potential barrier for patients or caregivers to maximise the benefit of mHealth applications. Our study findings further emphasised the importance of having data security and privacy as part of the compulsory feature in mHealth application. Future developers need to pay extra attention to this issue and go hand in hand with government policies to ensure the safety of the mHealth users.

The present study was a first attempt to explore the needs of mHealth applications among stroke caregivers in the community. To the best of our knowledge, there is no study carried out in Malaysia specifically looking into the types and features of mHealth applications for stroke caregivers. Therefore, this findings could provide essential information for future studies. In addition, the results of our study can provide insight to the developers to design better mHealth applications

for stroke caregivers. However, this study had several limitations which need to be taken into consideration. First, the convenience sampling was used in this study causing lack of the generalisation. Secondly, this study was conducted in the urban area, which had better access to the internet and more established long-term stroke care. Thus, it might not represent the opinion of caregivers live in rural settings or other regions of the country. Thirdly, this study only explored the types of mHealth applications for stroke caregivers superficially. Therefore, it was suggested to look into the specific domain of types of mHealth applications in future studies.

CONCLUSION

The overall usage of mHealth applications among stroke caregivers was high, with most of the caregivers used mHealth applications to access health information. This study showed a high need for mHealth applications with specific types and features among stroke caregivers in the community. Associated factors such as caregivers' co-residency status and patients' disability level must be considered when developing mHealth applications for stroke caregivers. This study's findings provided a foundation for future researchers and developers despite the limitations. It was suggested that the future research should as well look into the barrier to the usage of mHealth applications among stroke caregivers and involved a multicenter stroke clinics (suburban and rural areas) for better representation of

the stroke community in Malaysia. Due to the complexity of long-term stroke care, we strongly suggested the collaboration of various stakeholders during the development of mHealth applications for stroke caregivers was needed.

REFERENCES

Abu Seman, S.A., Ramayah, T. 2017. Are we ready to app?: a study on mhealth apps, its future, and trends in malaysia context. In *Mobile Platforms, Design, and Apps for Social Commerce.* Edited by Pelet J. Hershey, PA, USA: IGI Global; 69-83.

Aggarwal, G., Lippi, G., Michael Henry, B. 2020. Cerebrovascular disease is associated with an increased disease severity in patients with coronavirus disease 2019 (Covid-19): a pooled analysis of published literature. *Int J Stroke* **15**(4): 385-9.

Ahmad Ramli, F.Z., Tilse, C., Wilson, J. 2021. Embarking to caregiving role: a thematic analysis of malay caregivers of older adults with mental health problems perspectives. *J Gerontol Soc Work* **64**(5): 499-517.

Ali, M.F., Aziz, N.A., Aznida, F.A.A., Rizal, A.M., Azmin, S. 2013. Prospective study of functional recovery of stroke patients at three months post admission: outcomes and implications for post stroke care provision. *Med & Health* **8**(1): 19-27.

American Association of Retired Persons. 2017. *Prepare to Care: A Resource Guide for Families* https://www.aarp.org/content/dam/aarp/caregiving/2018/02/prepare-to-care-guide-english-aarp.pdf?intcmp=AE-CAR-P2CGD-ENG [1 Jan 2019]

Aziz, N.A. 2021. *Penjagaan strok lanjutan dalam komuniti pendekatan berasaskan pelbagai displin.* Bangi: Penerbit Universiti Kebangsaan Malaysia.

Aziz, N.A., Othman, J., Lugova, H., Suleiman, A. 2020. Malaysia's approach in handling Covid-19 onslaught: report on the movement control order (MCO) and targeted screening to reduce community infection rate and impact on public health and economy. *J Infect Public Health* **13**(12): 1823-9.

Aziz, N.A., Raymond, A.A. 2008. Managing further rehabilitation in longer-term stroke patients in the community: a new approach. *Med Health* **3**(1): 1-6.

Aziz, Z.A., Lee, Y.Y., Ngah, B.A., Sidek, N.N., Looi, I., Hanip, M.R., Basri, H.B. 2015. Acute stroke registry malaysia, 2010-2014: results from the National Neurology Registry. *J Stroke Cerebrovasc Dis* **24**(12): 2701-9.

Bruno, A., Akinwuntan, A.E., Lin, C., Close, B., Davis, K., Baute, V., Aryal, T., Brooks, D., Hess, D.C., Switzer, J.A., Nichols, F.T. 2011. Simplified modified rankin scale questionnaire. *Stroke* **42**(8): 2276-9.

Fan, K., Zhao, Y. 2021. Mobile health technology: a novel tool in chronic disease management. *Intell Med* **2**(1): 41-7.

Fearon, P., Langhorne, P., Early Supported Discharge Trialists. 2012. Services for reducing duration of hospital care for acute stroke patients. *Cochrane Database Syst Rev* (9): Cd000443.

Gagnon, M.P., Ngangue, P., Payne-Gagnon, J., Desmartis, M. 2016. m-Health adoption by healthcare professionals: a systematic review. *J Am Med Inform Assoc* **23**(1): 212-20.

Greenwood, N., Mackenzie, A., Cloud, G.C., Wilson, N. 2008. Informal carers of stroke survivors--factors influencing carers: a systematic review of quantitative studies. *Disabil Rehabil* **30**(18): 1329-49.

Hasan, S.S.C., Mohamed, D., Yusoff, Y. 2020. Mysejahtera app and the privacy rights in times of Covid 19: the legal and syariah perspectives. *INSLA E-Proceedings* **3**(1): 575-80.

Hossain, I., Lim, Z.Z., Ng, J.J.L., Koh, W.J., Wong, P.S. 2018. Public attitudes towards mobile health in Singapore: A cross-sectional study. *Mhealth* **4**: 41.

Hussain, N.A, Abdullah, M.R., Esa, A.R., Mustapha, M., Yusoff, N. 2014. Predictors of life satisfaction among family caregivers of hospitalized first-ever stroke patients in Kelantan. *Asean J Psychiatr* **15**(2): 164-75.

Islam, M.R., Islam, M.R., Mazumder, T.A. 2010. Mobile application and its global impact. *Int J Eng Technol* **10**(6): 104-11.

Jamal, A., Khan, S.A., AlHumud, A., Al-Duhyyim, A.,

Alrashed, M., Bin Shabr, F., Alteraif, A., Almuziri, A., Househ, M., Qureshi, R. 2015. Association of online health information-seeking behavior and self-care activities among type 2 diabetic patients in Saudi Arabia. *J Med Internet Res* **17**(8): e196.

Jawahir, S., Tan, E.H., Tan, Y.R., Mohd Noh, S.N., Ab Rahim, I. 2021. The impacts of caregiving intensity on informal caregivers in Malaysia: findings from a national survey. *BMC Health Serv Res* **21**(1): 391.

Kelly-Hayes, M., Beiser, A., Kase, C.S., Scaramucci, A., D'agostino, R.B., Wolf, P.A. 2003. The influence of gender and age on disability following ischemic stroke: the framingham study. *J Stroke Cerebrovasc Dis* **12**(3): 119-26.

Krebs, P., Duncan, D.T. 2015. Health app use among us mobile phone owners: a national survey. *JMIR Mhealth Uhealth* **3**(4): e101.

Krejcie, R.V., Morgan, D.W. 1970. Determining sample size for research activities. *Educ Psychol Meas* **30**: 607-10.

Lee, J.W., Theng, Y.L., Lee, S.W. 2020. Health information seeking behaviour using mobile devices among people with diabetes: a comparison between middle and high income country. *Digit Health* **6**: 2055207620956457.

Lee, J.Y., Wong, C.P. Lee, S.W.H. 2020. M-Health views and perception among Malaysian: findings from a survey among individuals living in Selangor. *Mhealth* **6**: 6.

Lim, H.M., Dunn, A.G., Muhammad Firdaus Ooi, S., Teo, C.H., Abdullah, A., Woo, W.J., Ng, C.J. 2021. mHealth adoption among primary care physicians in malaysia and its associated factors: a cross-sectional study. *Fam Pract* **38**(3): 210-7.

Lobo, E.H., Frølich, A., Kensing, F., Rasmussen, L.J., Livingston, P.M., Grundy, J., Abdelrazek, M. 2021. mHealth applications to support caregiver needs and engagement during stroke recovery: a content review. *Res Nur Health* **44**(1): 213-25.

Loo, K.W., Gan, S.H. 2012. Burden of stroke in Malaysia. *Int J Stroke* **7**(2): 165-7.

Malaysian Communications and Multimedia Commission. 2020. *Internet Users Survey 2020.* Cyberjaya.

Mosa, A.S., Yoo, I., Sheets, L. 2012. A systematic review of healthcare applications for smartphones. *BMC Med Inform Decis Mak* **12**: 67.

Pati, S., Mahapatra, P., Kanungo, S., Uddin, A., Sahoo, K.C. 2021. Managing multimorbidity (multiple chronic diseases) amid Covid-19 Pandemic: a community based study from Odisha, India. *Front Public Health* **8**: 584408.

Peng, W., Kanthawala, S., Yuan, S., Hussain, S.A. 2016. A qualitative study of user perceptions of mobile health apps. *BMC Public Health* **16**(1): 1158.

Rinaldi, G., Hijazi, A., Haghparast-Bidgoli, H. 2020. Cost and cost-effectiveness of mhealth interventions for the prevention and control of type 2 diabetes mellitus: a systematic review. *Diabetes Res Clin Pract* **162**: 108084.

Sarfo, F.S., Ulasavets, U., Opare-Sem, O.K., Ovbiagele, B. 2018. Tele-rehabilitation after stroke: an updated systematic review of the literature. *J Stroke Cerebrovasc Dis* **27**(9): 2306-18.

Singer, J., Weingast, S., Gilles, N., Faysel, M., Stefanov, D.G., Girouard, S., Conigliaro, A., White, M.F., Jensen, A., Burton, D., Levine, S.R. 2018. Developing a user-centered mobile application for stroke caregivers: a pilot national survey. *J Mob Technol Med* **7**(2): 35-45.

Spann, A., Stewart, E. 2018. Barriers and facilitators of older people's mhealth usage: a qualitative review of older people's views. *Hum Technol* **14**(3): 264-96.

Tan, C.E., Hi, M.Y., Azmi, N.S., Ishak, N.K., Mohd Farid, F.A., Abdul Aziz, A.F. 2020. Caregiving self-efficacy and knowledge regarding patient positioning among Malaysian caregivers of stroke patients. *Cureus* **12**(3): e7390.

Tangari, G., Ikram, M., Ijaz, K., Kaafar, M.A., Berkovsky, S. 2021. Mobile health and privacy: cross sectional study. *BMJ* **373**: n1248.

Wang, Y., Xue, H., Huang, Y., Huang, L., Zhang, D. 2017. A systematic review of application and effectiveness of mhealth interventions for obesity and diabetes treatment and self-management. *Adv Nutr* **8**(3): 449-62.

Weisscher, N., Vermeulen, M., Roos, Y.B., De Haan, R.J. 2008. What should be defined as good outcome in stroke trials; a modified rankin score of 0-1 or 0-2? *J Neurol* **255**(6): 867-74.

World Health Organization. 2016. *Global diffusion of ehealth: making universal health coverage achievable: report of the third global survey on ehealth.* Geneva.

Zawawi, N.S.M., Aziz, N.A., Fisher, R., Ahmad, K., Walker, M.F. 2020. The unmet needs of stroke survivors and stroke caregivers: a systematic narrative review. *J Stroke Cerebrovasc Dis* **29**(8): 104875.

Zhang, H., Wang, T., Zhang, Z., Lin, B., Mei, Y., Zhang, Y., Chen, G. 2020. The current status of stroke-related smartphone applications available to adopt in China: A systematic review study. *Medicine* **99**(27): e20656

Zhou, L., Bao, J., Watzlaf, V., Parmanto, B. 2019. Barriers to and facilitators of the use of mobile health apps from a security perspective: mixed-methods study. *JMIR Mhealth UHealth* **7**(4): e11223.