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LONG PAPER

Significance of the conceptual utility model for pain management mobile apps: clinicians' and older adults' perspectives

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Abstract

Pain management mobile apps can be an effective tool for treating chronic pain. We had proposed a conceptual utility model to evaluate the comprehensiveness of pain management mobile applications with respect to their functional requirements. This research aims to identify clinicians' and older adults' perspectives in relevance to the proposed conceptual utility model of pain self-management mobile applications. Two rounds of focus group discussions with 16 medical doctors, and a questionnaire survey among 40 older adults were conducted to gather the relevant information. The study resulted in the older adults' specific guidelines, recommendations, and suggestions for implementing pain self-management mobile applications at the component or sub-component level of the conceptual utility model. The proposed conceptual utility model was well-accepted by both clinicians and older adults, which further validated and affirmed the significance of the proposed conceptual utility model.

Keywords Pain management · MHealth · Geriatrics · Human and health · Focus group discussion · Questionnaire survey

1 Introduction

The increasingly aging population has several concerns about maintaining their quality of life, including health monitoring, information seeking, social engagement, leisure activities, security, and protection [1, 2]. A significant worldwide public health burden is posed by the accompanying chronic health comorbidities of older adults [3]. A prevalent comorbidity of older adults is chronic pain, which lowers quality of life [4–6]. At least 50% of the older adult population is suffering from chronic pain [7, 8]. Mobile Health applications (mHealth) may improve the provision of healthcare for older adults suffering from chronic pain, through facilitating measuring daily pain levels, tracking symptoms' frequency, and recording adverse effects from treatments. mHealth applications that provide social support, prompt and easy access to medical personnel, and learning resources for older adults suffering with chronic pain, might also be useful [9].

Evidence from research studies [10, 11] suggests that pain management mobile applications can be an effective tool for treating chronic pain. For people suffering from chronic pain, mobile applications for pain management could be a valuable resource besides clinical visits and following a specified treatment plan. These mobile applications offer a range of functionalities such as pain tracking, medication reminders, relaxation techniques, education, and social support. These interventions aid in substantially decreasing pain, enhancing the quality of life, and improving self-management abilities. However, it was identified in a systematic literature review [12] that pain management mobile applications are not comprehensive with respect to the functional requirements of pain management mobile

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The research work presented in this document was primarily conducted during the author's tenure as a Ph.D. student at Universiti Malaya, Malaysia.

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applications, i.e. the features required to fulfil the users' needs. To address this research gap, a conceptual model was proposed to evaluate the comprehensiveness of pain management mobile applications [12]. The proposed conceptual model for pain self-management mobile apps aims to empower patients to manage their pain through a self-care approach. At its core is self-management, supported by two interlinked sub-components: motivation and awareness. Motivation is driven by self-monitoring activities such as self-reporting, pain assessment, result generation, and feedback. Awareness is fostered through education on pain symptoms, coping strategies, and social support. The model integrates these elements with features like goal setting, personalized feedback, and psychological interventions such as cognitive behavioural therapy (CBT). It is also adaptable to other chronic conditions that require shared self-management strategies, including lifestyle changes, symptom tracking, and social support.

The conceptual model was also verified by the clinicians [12]. Nevertheless, there is a need to further evaluate the significance of the proposed conceptual utility model in the purview of older adults' pain management. Thus, this research aims to identify clinicians and older adults' perspectives in relevance to the proposed conceptual utility model, via focus group discussions and questionnaire-based survey. Through this research, various insights are identified to guide the development and verify the suitability and comprehensiveness of pain self-management mobile applications for the older adults.

2 Methodology

A mixed technique approach was used, considering numerous study parameters. It involved a blend of quantitative and qualitative techniques which integrate the facts based on both approaches [13, 14]. Focus group discussion (qualitative) and questionnaire survey (quantitative) are the two main approaches that were adopted to gather information on the clinicians and patient's perspectives, respectively. A focus group approach was used to explore clinicians' perceptions, enabling collaborative discussion and deeper insights not easily captured through individual interviews or surveys. To complement this, a questionnaire survey was conducted to quantitatively capture older adults' perspectives. The questionnaire was based on the proposed conceptual utility model to better understand their views on pain management mobile applications. It was carefully designed with clear and simple language to ensure it was easy for older adults to understand and complete. Together, these methods offered a comprehensive understanding aligned with the study's objectives.

2.1 Participants and study protocol

Ethical approval for the study was obtained from the Medical Research Ethics Committee of UMMC (see Appendix A). Convenience sampling was employed to recruit participants. Clinicians from relevant departments at UMMC, including medical doctors from the Department of Primary Care Medicine, a rehabilitation physician from the APCR Centre, and a consultant neurosurgeon from the Paediatric Neurosurgery and Interventional Pain Management Division, were contacted via email to assist in identifying eligible patients. Additionally, recruitment posters were placed in the Primary Care Department, APCR Centre, and a nearby residential area.

To broaden reach and enhance diversity, snowball sampling was also applied, whereby participants were encouraged to share the study invitation with other eligible individuals. Inclusion criteria for older adult participants were: age 65 and above, a diagnosis of chronic pain, basic smartphone literacy, and the ability to understand English. Individuals with mental health conditions (e.g., depression or anxiety), cognitive impairment, or visual impairment were excluded to ensure the ability to meaningfully engage with a mobile application.

Although the study employed non-probability sampling and involved a relatively small number of older adult respondents, deliberate efforts were made to recruit participants from varied clinical and community settings to enhance the heterogeneity and relevance of the sample. The study's exploratory nature justified the sample size, with the aim of identifying key trends and informing future, larger-scale investigations.

The study was conducted from February to April 2021. It was a one-to-one guided session with each participant, either in UMMC or at the participant's home as per their ease and availability. The session lasted from 30 to 45 min with each participant. The study participants were briefed on the study's background and goal. Only participants who gave consent proceeded with the study.

2.2 Survey instrument

A questionnaire had been developed as the instrument. A senior medical expert from UMCC and an expert in the field of HCI reviewed the questionnaire to assess its understandability. As a result, some of the questions were rearranged and organized into sections for enhanced clarity. The final questionnaire was comprised of five parts (Parts A–E). Part A gathers the socio-demographic details, health characteristic, and awareness regarding pain management apps of the older adults. Part B gathers the older adults' preferences for self-reporting of pain in terms of the necessity for daily assessment, inclination and choice to document/report pain, and the frequency of recording pain. Part C gathers the utility preferences of older adults in terms of attributes of pain assessment, the necessity for the visualization of recorded pain data, preferences of result visualization, summary or report of the recorded pain, alert or reminder feature, the necessity of feedback from a healthcare provider, social support and pain information and pain coping strategies.

As stated in [15] education and example can promote awareness and acceptance. Functionalities of mobile applications would be impractical without end-users' relevant knowledge. Thus, two commercially available smartphone applications for pain management were demonstrated to the participants before the survey, and they were given hands-on training on how to use them. Apps were searched and screened from Google Play Store and App Store based on specific keywords and inclusion-exclusion criteria. The screening and selection criteria is explained in detail in [16].

Part D of the survey questionnaire was based on the training evaluation. As the purpose of the training was to spread awareness among the older adults regarding pain management applications so that they would be able to use the applications and discuss about functionalities of the applications. The purpose of the training evaluation is to find out whether the training goals have been accomplished or not. Moreover, the training evaluation also helped in the face validity of the Utility Survey's questionnaire. For the training evaluation, there were six closed-ended questions based on five-point Likert scale. One open-ended question was asked for the older adults to share their rationale in case of disagreement to any training evaluation questions (see Appendix B).

Part E obtains the participants' overall perception towards pain management mobile applications after getting oriented with the purpose and functionalities of the pain management mobile applications. Moreover, the participants' intention for the future use of pain management mobile applications was recorded. Participants were also asked to suggest anything they would like to add to the pain management mobile applications.

All questions were closed-ended, formulated either as a three-point or five-point Likert scale, or multiple-choice questions with an option for the participants to provide the rationale of their opinion in support of their answers. The questionnaire is attached in Appendix B. The structure of the questionnaire is illustrated in Fig. 1.

2.3 Focus group

The purpose of the focus group in this research study was to gain insight into the clinicians' perspective of pain management mobile applications, as well as reinforce the value of the proposed conceptual utility model.

2.4 Participants and procedure

The UMMC healthcare providers (HCPs), who were pain management specialists, were invited through email to take part in the focus group discussion. Two separate focus group discussions were held in the UMMC's Department of Primary Care Medicine. The number of sessions were determined by the data saturation, i.e. when a new insight or new theme could not be identified during the data analysis, another round of focus group is not required [17].

There were 9 participants in the first focus group discussion and 7 participants in the second focus group discussion. The sessions were audio recorded and lasted for 45 to 60 min. At the beginning of each session, participants were introduced to the study's background and objectives. Both sessions conformed to a planned focus group protocol where the discussion questions were related to the SOCRATES in terms of older adults' pain assessment and their opinion on the visualization of results. It was also discussed when should the HCPs be involved and how should the HCPs be alerted to potentially serious pain reports logged by the older adults, or situations when the older adults may need assistance in managing their pain. The session further discussed how do HCPs see responding to alerts and reviewing data fitting into their daily workflow, and how to help the older adults to comply with pain self-management mobile applications. The audio-recorded sessions were transcribed manually and double checked for its accuracy. The participants were assigned a code while transcribing to remove personal identification. Thematic coding was used to analyse the data manually [14]. The identified themes from the data analysis are given in the subsequent section.

3 Results of the focus group discussion with the clinicians

Seven themes were identified from the analysis of the two focus group discussions (FG1 and FG2) with 16 HCPs specialized in pain management and the exemplary quotes are reported verbatim in the following sections.

3.1 Theme 1: suitability of SOCRATES for pain assessment

The HCPs felt that assessment guided by SOCRATES in relation to the older adults' pain assessment using pain management app is suitable in their initial visit to the hospital/clinic to establish the diagnosis and proceed with the pain

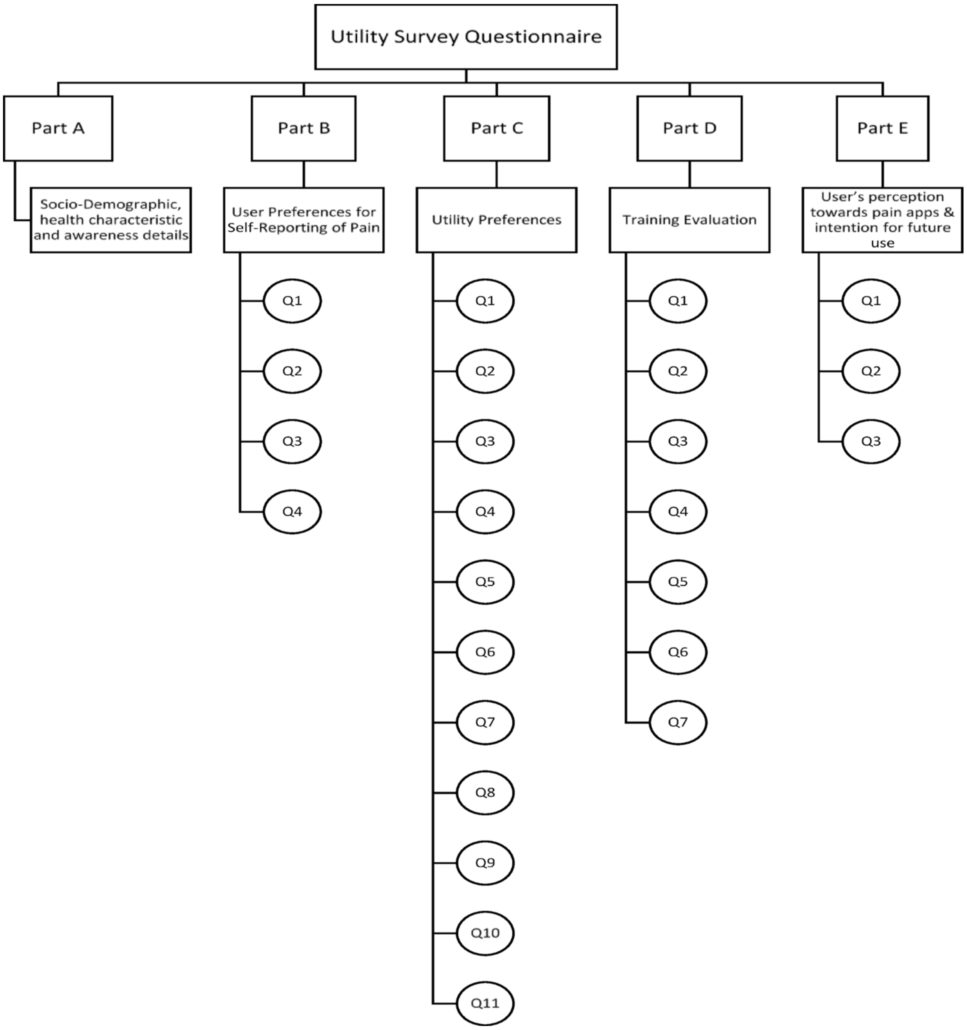


Fig. 1 Structure of the utility survey questionnaire

management. Nevertheless, it could be cumbersome for the patients to record every data in relation to SOCRATES for each assessment:

> We can take the Site and all other things in the first interview of the patient, no need to enter it every time [FG1].

> Some of the elements in SOCRATES are, for example, Radiation and then Onset of pain. If you want to ask day to day, all answers will be the same from the 1st day of treatment. It's a bit tedious if they have to repeat again and again; I think it will be (too) much to answer three times a day for all SOCRATES (items), only certain parts of the SOCRATES (are essential) if you like to use that [FG2].

Some of the HCPs were of the view that severity is adequate for day-to-day assessment:

> From SOCRATES, last S i.e., Severity is important to identify or classify the pain intensity on day to day basis; Only Severity is enough to measure every day [FG1].

> May be for day-to-day assessment only to give them a slider for severity [FG2].

Two of the HCPs also suggested to record the exacerbating and relieving factors on routine basis:

> Exacerbating and relieving factors are also important because when they come maybe they are not having analgesics but after the consultation and initiated certain medication, they feel some creams are beneficial. Or maybe after one week they feel analgesics is comfier, so maybe I think that one would be reported as well; Cause, yes cause. Like the patient walked and got knee pain, the patient jog and got leg pain [FG1].

Another two HCPs proposed to make it optional to input either the complete SOCRATES or partially as per desired in the routine assessment. For example, if the patient faces new kind of symptoms, recording complete data for SOCRATES will be helpful for the pain management then.

> I think that should be optional if they want to record. I see apps like Clue, it's for menstruation. It can be really complex if you want to get into it. You have to put into your symptoms, you have to put in how many pads have you used. There are people who don't want all these and just want to record their pain, we must give them an option of really simple or record anything they like, but shouldn't be mandatory to record all [FG1].

> Yes, for patients first you have to establish the diagnosis based on all the questions. We have to establish other possible diagnosis, and for the second (assessment), you just want to know in terms of pain management to see the severity after prescribing pain killers and kind of effect. Yes, I agree not every day but I think when they have a new kind of symptom, it will be a clue to us for management, so its important (to enter all data of SOCRATES) [FG2].

Other than SOCRATES, the HCPs also discussed to record about the quality of life of the older adults in terms of their daily activities:

> But is it to know what their level of activity was that time when they were having severe pain. I am not sure if it is difficult for them to input that data. Because it can be troublesome for them at the time of pain to record such type of thing [FG1].

> And I think how the pain affects the quality of life, is the most important. How it affects the daily activities that is quite important. Some people score the pain very high but we ask if it is affecting their daily activities or not; I suggest to add on daily activities. Only the pain Onset or Severity is too objective. I mean the daily activity is another part to focus on [FG2].

The HCPs also highlighted the Importance of recording patient's history along with the list of their prescribed medications.

> Patients' history is important and the list of medication they are taking at least the pain killers if not all; As for the elderlies they have so many other comorbidities, we want to know about their other diseases as well [FG1].

> Let's say, if a child says he has tooth ache, it is not going to be that serious. We don't need to know much about that child. But for the case of older adults, yes other diseases, they have other medications they are taking. It will be quite difficult without knowing the patient and looking at their past history; Maybe for some conditions very strict criteria of the disease; and for some cases with complex diseases, it could be dangerous for patients to manage their own pain medication [FG2].

3.2 Theme 2: accessibility of recorded pain data to healthcare providers

In terms of accessibility of the recorded pain data, the HCPs suggested integrating the pain management app with the electronic medical records (EMR) system:

> I will find it more useful when I see the patient in 3 months or 6 months' time and can retrieve the data from the database in the sense that I don't need to see the patient's mobile. I can see the data on my laptop or my portfolio. So, the ability to actually retrieve it in the laptop instead of seeing in the patient's mobile. They can say it is low battery give me your number. I cannot give my number to a large population [FG1].

> To incorporate the app with the EMR system, that's kind of help that you just click to get the patients' recorded pain data [FG2].

Regarding the representation of patients' report, various opinions were floated during the discussion. Mostly, the HCPs showed interest to see the overall result of the days with severity of bad pain, i.e., the pain score either represented as numbers or faces/smileys or colours; and the trend of pain with time.

> Suppose a patient is coming to see the doctor after 3 months, patient cannot recall which day was pain and which day was not pain. So, the app must show how many days was bad pain and how many days patient cannot work; You can show patient a graph but for us a trend chart or something like a menstrual calendar, something like having different colours to code which one is severe pain which one is less pain [FG1].

> Numbers and colours, as sometimes you are busy, if you know it is red it means something urgent, otherwise maybe we can move to other patients; If the patient comes with their 6 monthly hbA1c that is their blood test; it is for the people with pain to come with their 6 months' pain trend [FG2].

3.3 Theme 3: involvement of Doctors for feedback or medical advice

The HCPs elaborated on when to involve them for the medical advice. Most of them suggested an alert notification to be sent in case of increased pain severity.

> If the pain is getting higher, I mean the severity is increasing, we must be alerted [FG1].

> Meaning it is pain right, so anything at the label line, anything above average I think the doctors should help to ease the pain [FG2].

One of them also discussed for the increased pulse rate that could also indicate the pain severity. Nevertheless, a complementary device will be required to measure the pulse rate.

> But for me all according the pulse rate. If pulse rate is more than 100, patient should come for the check-up because the basal pulse rate must not reach 100; So using the wearable they just click and assessed by the app and read the heart rate; But again we have to think for the cost as well; So instead of something being friendly and widely used you have to get the wearable as well [FG1].

Another HCP suggested to refer to the WHO's analgesic ladder. For the cases at or above stage 2, HCPs should be frequently involved for the medical advice.

> And also, you ask at what level doctor should intervene right. I think patient who are taking like more than stage 2 as per WHO ladder of the pain killer and that type of medicines, I think doctors should intervene more often [FG1].

Whether to seek medical advice from HCPs also varies from case to case, as suggested by a few HCPs. It depends on the situation whether a patient has to visit the clinic for a medical advice, or whether there is an emergency need, or whether advice could be sought over the phone:

> It depends on case-to-case basis, I guess. If the starting point of pain is already 10, so maybe patient has to see more frequent(ly) but if the pain is 5, maybe assigned longer interval of visit. I cannot give you the direct answer; If an app notifies us of pain, we should have time to go back, and see what kind of problem; and if necessary call the patient and give some direction to the patient, should they go to the emergency (department) or come the next morning or need to immediately take something [FG1].

> We can ask the patient to go to the emergency (department) or something like that. Yes, I agree, if we feel they need medical attention we can advise (them) to go to the emergency (department) or come to the clinic next morning, or advise (them) to take Panadol or something like this [FG2].

Regarding the alert notification to the HCPs, two scenarios were discussed: (1) To send the notifications directly to the central or main system in the hospital or clinic; (2) There must be an emergency contact number, on the app, of the relatives or caregivers or the HCP. In case of a central system, a person in charge or a doctor on duty needs to be identified to monitor and review the patients' data.

> Healthcare provider number should be there, for a direct call-in life-threatening situation; There must be a main system or someone at the back doing this, reviewing analysis and then alert us when they think this patient would have problem by seeing the trend of the pain or something like that. They might alert healthcare providers. And also, the healthcare provider who is on call must be responsible to review all these charts. Suppose if I am not on call, I am not sure whether I will look at my phone to see charts for patients. I don't think I will do that. I think must be assigned a healthcare provider to certain patients or something like that [FG1].

> If the patient will be having pain at mid night when I switch off my phone or in deep sleep, I couldn't really notice the alert until the next day I realize. But let's say a doctor is on call, they know they are on night duty they can (take) note (of) the alert [FG2].

For the emergency contact, some HCPs were of the view that relatives or caregivers of the patient must be contacted first at the time of need by the patients. The relatives or caregivers can contact the HCPs if it would be necessary.

> Must it be the healthcare provider? It (would be) better if they have contact of their own relative or a caregiver. If they need help, they click that and the caregiver must attend to them. Then they listen whether to call (the healthcare provider) or not. Because on someday, maybe the patient has severe pain in a jungle, it would be better to call 999 instead of the healthcare provider [FG1].

> I think it must be the responsibility of the relative to call us because it's a better communication (that) we can further ask as what is happening. I mean we can further assess (through the relative) as I am afraid that the patient will misuse the notification. Contacting is better from the relative [FG2].

With respect to the monitoring from the central system, one HCP suggested to set expiry dates for the online observations, subject to the improvement in patients' condition.

> I think they should have limit like once you are OK, so no need to have pain monitor. Maybe after three months it should expire. Then if the patient needs more, he has to see the doctor again and decide whether they want to continue this monitoring or not [FG2].

3.4 Theme 4: difficulty in interpretation and communication about pain by the older adults

HCPs felt that older adults are mostly unable to express their pain properly or misinterpret the pain:

> You ask them how much is the pain? "It's painful" just their answer. They can't even tell you how bad the pain is or what are the exacerbating factors, they can't tell you; Then for example there might be some vague answers for example character of pain, some will say it is pressing, some will say it is heavy. How to get the correct word so that they can use the correct word when they are entering the data [FG1].

> Some people underestimate or overestimate the pain. Some patient will say that pain severity is 10 over 10 but when we see the face and the way patient appears, it seems different [FG2].

Explanation of the terminologies to choose the suitable word for answering a question could be helpful in one way and overburdening as well:

> But if you put info like pressing pain, what is that? But it will be a bit tedious for older adults to read what term is what (understand each term) [FG2].

In addition, because of their age, older adults may have problems with vision, hearing or memory. They may take long time to respond for a particular answer. Hence, the HCPs suggested to also involve their caregivers.

> I think if we have to ask them to practice one by one, they might not be able to give the specific answer. It could easily get from someone who is younger. Probably even asking them some of the questions we might not be able to ask all in one setting. And usually, elderly patients in their clinical sessions are accompanied by their family members who help them answer instead. But if it is in the app, probably only for some sections which are easier for them to answer according to what is available because they might take long time to think of one answer [FG1].

> Because from our clinical experience we see that their communication is difficult and very time consuming. We have to repeat many times because their vision, their hearing, their memory and understanding are weak; Even the direct communication is also difficult at times [FG2].

To address hearing-related challenges faced by older adults, an alternative to involving caregivers is to ensure that the pain management app supports multiple synchronized modalities—such as sign-language video, spoken audio, and accurate subtitles [18]. The emergence of generative AI also offers new opportunities for designing more accessible user interfaces for older adults.

Language could also be the barrier to use the pain management app:

> Another thing is the language of the app, either it is in Chinese or English or Malay. If it will be only in English, there will be further limitation for certain patients [FG1].

3.5 Theme 5: Concerns about input procedures and various features of the applications from the older adults' perspective

Regarding the data input procedures, the HCPs suggested to provide easy input solutions and the option to mention multiple pain locations:

> It will be good if it would be easy to understand and as simple as possible, having one click for them to indicate. VAS scale (visual analogue scale) will be the best because it is very easy to use; And for the sites, if they say pain for many sites, here pain, there pain, everywhere pain, the app must give (an) option to choose multiple sites and to mention which one is severe pain [FG1].

For the older adults who are non-tech savvy, it was recommended to provide a one-click solution or wearable devices and voice recognition methods:

> Solution should be simple. Like one button, the more they feel pain the more they press the button; Perhaps there can be two versions, one for the tech savvy and other for the non-tech savvy. Instead of using smartphone, something like Fitbit they can wear and click. Because if they don't know how to use smartphone, they cannot use the app; Something like google voice service, they scream pain and their voice can be recognized [FG1].

> One reason I observed in older adults not to use smartphone is that they don't want to invest time in learning smartphone use. They think learning curve is too steep. So, simplicity is the key. So, give range to such patients. Those who are tech savvy they can input everything. Like if they want to enter new pain, they will enter anything they like; but for some they don't want to bother. So, there must be one click or something like this to record, that's all [FG2].

With respect to pain information, both pain coping strategies and seeking information about disease and symptoms were discussed. The HCPs highlighted that the age factor or low literacy could be an obstacle in understanding the strategies, but simple techniques could be adopted. Moreover, it will be good to seek information about the disease and better understand the self-management of pain.

> Yes, simple maybe. But it will come back to the same issue as we initially said– visual problem, hearing problem or even tech savviness whether they understand or not [FG1].

> It's better for them to look for themselves; Maybe non-pharmacological treatments relating to the pain coping strategies. Yes, I mean I am explaining what is the non-pharmacological treatment. I think the one that you mentioned cognitive behavioural therapy, relaxation techniques, those things that are not related to medicines. I mean medications [FG2].

For the social support, HCPs supported the idea, subject to the reliability of the resource:

> Yes, definitely, especially for those who are single or alone or family is overseas, social support is important. Those who have chronic pain, have symptoms of depression, they need somebody to talk to; Yes, if it is linked to a properly established foundation or NGO, then it will be better. Not like Facebook support [FG1].

> I think still need a medical person to supervise; some person may give wrong information [FG2].

The sub-goals setting feature is not really necessary for the older adults as it may have negative impact when the subgoal couldn't be fulfilled:

> I think it's feasible but I am just worried if they don't achieve the goal what negative affects it could have towards the older adults. But yes, I think it could be an option that can be added to the app [FG1].

> Because if someone who has arthritis, it goes on and off, they can't really achieve goal every time; Probably they can achieve on some days and can't on other days [FG2].

3.6 Theme 6: older adults' compliance to use pain self-management mobile applications

HCPs suggested to incorporate a reward system to make older adults compliant in using the pain self-management mobile applications. Daily bonus points and extra bonus points on achieving a milestone could be helpful. With the bonus points, for example, older adults will be eligible for a fast-track check-up and medicine collection at pharmacy without queuing up.

> To keep them compliant, they can exchange vouchers; It means you login, you achieve something, then you can get daily bonus and if you complete seven days, you will get extra bonus [FG1].

> Maybe you can put in like every day they key in the data they get points, because honestly, I will not be compliant to key in the data every day. Simple example is the menstrual cycle; I do really key in once in a month. So, let's say you key in everyday you get 10

Table 1 Demographic data of the patients

		N[a]	Percentage
Age	65–70 years	13	32.5%
	71–76 years	9	22.5%
	77–82 years	11	27.5%
	83 years and above	7	17.5%
Gender	Male	14	35.0%
	Female	26	65.0%
Ethnicity/Nationality	Malaysian	6	15.0%
	Malaysian (Indian)	12	30.0%
	Malaysian (Chinese)	12	30.0%
	Malaysian (Sri Lankan)	3	7.5%
	Malaysian (Yemen)	1	2.5%
	Malaysia (Eurasian)	1	2.5%
	British	1	2.5%
	Pakistani	3	7.5%
	Burmese	1	2.5%
Education	Tertiary	12	30.0%
	Post-secondary	8	20.0%
	Secondary	13	32.5%
	Primary	5	12.5%
	None	2	5.0%

[a] Where N stands for number of patients

> points. After you key in for 10 days, it does not really have to be the bad days (only), maybe good days in a month (too). For 100 points, as you said, they can get a voucher or if you reach 500 points, then the reward will be different; I don't know if the voucher could be costly or not. We can also set up a system as those who are compliant to medication, we can give them a card. Whenever they come to the clinic they don't have to wait, (but) they get fast track and can go to (the) pharmacy without lining up [FG2].
>
> Reminders or alarm system could also be helpful to keep the older adults compliant.
>
> Probably can put some reminder in the app; SMS reminder, yes, or alarm things [FG1].

3.7 Theme 7: trustworthiness of pain data provided by the older adults

Some of the HCPs also showed concern towards the reliability of data for efficient pain management. They were of the view that older adults might not be able to key in data on time and could not recall well later, or they may misuse the concept of reward system:

> Suppose they have severe pain but they were not in mood to enter data that time. After that they might forget and then when the doctor sees the chart it will look normal but actually there was severe pain that time. So, I don't know how reliable it will be for the management [FG1].
>
> I hope older adults shall not misuse it like young person who want MC and mark all red; Suppose they don't have pain but to collect points, they enter pain, pain, and pain [FG2].

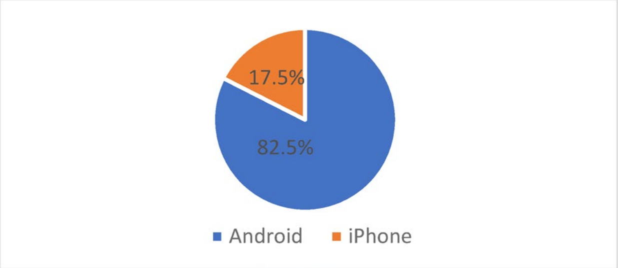


Fig. 2 Type of smartphone owned by the older adults

4 Results of the utility survey with older adults

A sample of 40 older adults was obtained for the survey. The instrument of the survey is given in Appendix B.

4.1 Socio-demographic details, health characteristics, and awareness details

The socio-demographic details of the participants are presented in Table 1. The participants were from multi-cultural background where the mean age of the participants was 75. 65% of the participants were female and 35% of them were male. The education level of the participants varies from secondary (32.5%) to post-secondary (20%) to tertiary (30%): 12.5% of the participants were having primary level education and 5% were illiterate.

Mostly, the participants were having Android smartphones (82.5%) and only a few of them own an iPhone (see Fig. 2). Irrespective of gender, the prominent pain among the participants was back pain (6 males and 7 female patients). The second prominent pain type was knee pain, but most of the patients were female (8 females and 2 males).

Osteoarthritis/rheumatoid arthritis was the third noticeable pain type, observed among the female participants (6 cases) followed by shoulder pain (2 cases), arm pain (1 case), pelvic pain (1 case) and abdomen pain (1 case), all were only recorded among the female participants in this study. The other common pain types among both male and female participants were neck pain (3 females and 1 male),

Fig. 3 Pain types among male and female patients

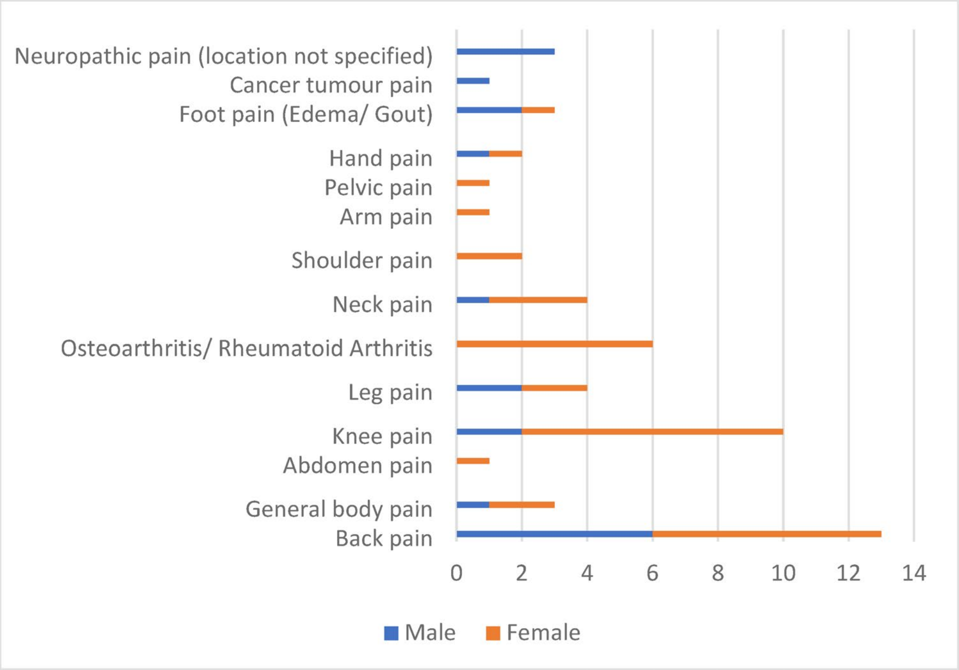


Table 2 Older adults patients' awareness level of pain management mobile applications

		Frequency	Percent
Are you aware of the availability of pain management apps for smartphone?	No	40	100.0
Have you ever used a pain management mobile application before?	No	40	100.0

leg pain (2 females and 2 males), general body pain (2 females and 1 male), foot pain (1 female and 2 males) and hand pain (1 female and 1 male). Whereas, neuropathic pain (3 cases) and cancer tumor pain (1 case) was only recorded among the male participants (see Fig. 3).

As all the participants were unaware of the pain management mobile applications, none of them had ever used such mobile applications (see Table 2).

4.2 User preferences for self-reporting of pain

In response to the statement *I think a daily assessment of pain data is necessary*, 5 (12.5%) participants strongly agreed, 14 (35%) of them agreed and 7 (17.5%) participants remained neutral; whereas, 13 (32.5%) participants disagreed for this and only 1 (2.5%) participant showed strong disagreement (see Table 3). Similarly, of the 40 participants, 23 (57.5%) participants preferred to record pain data by themselves, 14 (35%) participants would prefer the support of a caregiver/doctor/nurse/HCP in recording their pain data and only 3 (7.5%) participants selected both ways. With respect to the choice of recording pain data, most of the participants, i.e., 28 (70%) of them were interested to use the mobile application. However, 7 (17.5%) participants also desired for a wearable device connected with a mobile app and only 5 (12.5%) were willing to record on a piece of paper/booklet.

In response to the question *How many times in a day would you like to record your pain*, the majority of participants were of the view to either record once in a day (18 participants– 45%) or as per needed in a day (14 participants– 35%); 4 (10%) participants needed to record twice a day, 3 (7.5%) participants needed to record thrice a day and only 1 (2.5%) participant wished to record pain in short intervals or on hourly basis.

4.3 Utility preferences

In Part C of the survey questionnaire, several questions were raised concerning the utility preferences of the older adults towards the pain management mobile applications. In response to the question: *Would you like to get reminded by the app?* the majority of participants, i.e., 27 (67.5%) responded Yes, while 10 (25%) of them responded No. Only 3 (7.5%) of the participants were Not Sure about this feature and 5% of the participants were of the view that "*Reminder is not a good idea as it will remind of pain*". The results are summarized in Table 4.

Regarding the multiple choice question, most choices of SOCRATES were chosen to be necessary but in various frequencies. The most selected option was pain site (80%) followed by pain severity (65%), timing (62.5%), pain characteristic (62.5%), associated symptoms (45%), exacerbating and relieving factors (42.5%), pain onset (35%) and pain

Table 3 User preferences for self-reporting of pain

		Frequency	Percent	Valid Percent	Cumulative Percent
I think a daily assessment of pain data is necessary.	Strongly agree	5	12.5	12.5	12.5
	Agree	14	35.0	35.0	47.5
	Neutral	7	17.5	17.5	65.0
	Disagree	13	32.5	32.5	97.5
	Strongly disagree	1	2.5	2.5	100.0
What is your preference to record pain data?	By yourself	23	57.5	57.5	57.5
	With help of caregiver/doctor/nurse/healthcare provider	14	35.0	35.0	92.5
	Both	3	7.5	7.5	100.0
How many times in a day would you like to record your pain?	Once a day	18	45.0	45.0	45.0
	Twice a day	4	10.0	10.0	55.0
	Three times a day	3	7.5	7.5	62.5
	Short intervals/hourly basis	1	2.5	2.5	65.0
	As per needed in a day	14	35.0	35.0	100.0
What is your choice to record the pain data?	Via mobile app only	28	70.0	70.0	70.0
	Via a wearable device connected with a mobile app	7	17.5	17.5	87.5
	On a piece of paper/booklet	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

Table 4 Utility preferences: reminder feature

		Frequency	Percent	Valid Percent	Cumulative Percent
Would you like to get reminded by the app?	Yes	27	67.5	67.5	67.5
	No	10	25.0	25.0	92.5
	Not sure	3	7.5	7.5	100.0
	Total	40	100.0	100.0	

radiation (22.5%) (see Fig. 4). Only 8 participants (20%) selected all of the options as necessary to record on daily basis.

The outcome of participants' preferences for result visualization is presented in Table 5. It was observed that the majority of participants were interested to visualize the recorded pain data, i.e., 25% strongly agreed and 60% agreed. Only 15% remained neutral upon this feature. A few patients expressed that "*visualization of recorded pain data is necessary as I would like to figure out to get more in control*" and "*I can see clearer and remember better*, *I can see progress over time*".

Some 45% of the participants required textual representation and 35% of them needed graphical representation of the recorded pain data. Only 20% of the participants required both textual and graphical visualization; 15% of the participants expressed their inconvenience to understand the graph: "*Graph may not be easily understandable. We are not educated*, *sometimes to learn or understand graph (is difficult). So*, *text will help to comprehend the results*"; 7.5% of the participants explain that textual results will be more understandable than graphical: "*Textual will be more in detail and more descriptive*, *graph will only show up and down*, *it will be easier to understand text as graph could be interpreted wrongly*".

In response to the question: *What summary/report would you like to see from the recorded pain data?* most participants (42.5%) wanted monthly summary or report followed by summary or report for a specified time frame (32.5%). Only a few participants were interested in a daily (7.5%) or weekly (12.5%) summary or report; 2 (5%) participants wanted all kinds of report. One participant elaborated: "*Would like to see daily summary if serious and monthly summary in case of non-serious. App must facilitate for all possibilities*". The preferences are shown in Table 5.

As for the feedback from the HCP, the majority of participants agreed for this feature, i.e., 27.5% strongly agreed while 57.5% agreed. As per the participants, "*It will be hassle free to get expert opinion" or "It will be good if getting feedback from experienced person*". Only 2.5% of the participants remained neutral while, 12.5% of the participants disagreed with the feature. They were of the view that "*instead of healthcare provider's feedback via mobile*, *I would like to visit (the) doctor myself*" or "*I see my doctor regularly so no need to contact via app or automatically*, *I can go and see the doctor*". Preferences for getting feedback from HCPs are shown in Table 6.

In response to the question: *Would you like to share your health concerns with people having same or similar issues?* More than half of the participants (62.5%) responded Yes while 35% participants responded No. Only 1 participant was unsure about this feature. 35% participants realized

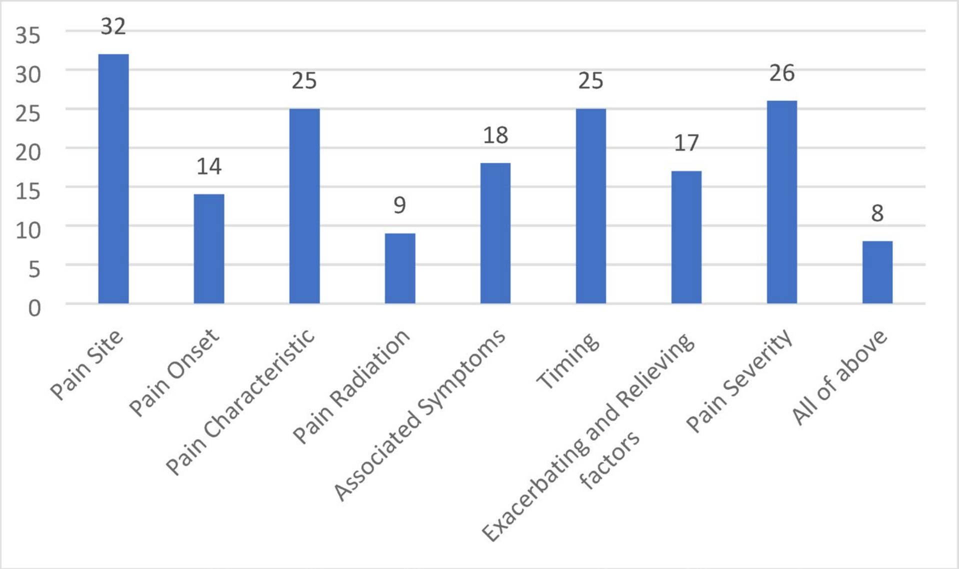


Fig. 4 Pain assessment attributes for self-reporting

and agreed to the importance of social support while 30% strongly agreed, 17.5% disagreed and 15% remained neutral. Only 1 participant strongly disagreed with the importance of social support. Table 7 summarizes the preferences for social support.

The reasons of disagreement were highlighted by a few participants:

> “Other than friend or family not okay. I am a bit private person. Even not keen to see doctor now”.
>
> “I agree that it helps but I would like to keep my things private”.
>
> “Pain is personal and don’t want everyone to know. Close friends are okay. You talk with them and feel better as all are in same age and same problems”.
>
> *“Once you are in pain you are the one who is suffering no need to support then”.*

Most of the participants were interested to learn about pain (92.5%) and to learn the pain coping strategies (95%). 87.5% of the participants also realized the importance of information resources. 5% of the participants further added: “*Would love to learn strategies to try to take less medicines*” and “*My ultimate intention is to overcome this pain and bend down so why not*, *would like to learn about pain*”. Nevertheless, a few of them (5%) were not sure to learn about pain and the significance of information resources (12.5%). Only 1 participant was not willing to learn about pain and 2 participants were not interested to learn the strategies to overcome pain. One of them mentioned: “*Not interested to learn strategies*, *I will do whatever doctor prescribed. Also, not sure about information resources due to lack of time*”. Table 8 summarizes the participants’ preferences for pain coping strategies and disease information.

5 Training evaluation

Part D of the survey was aimed at the training evaluation and face validity of the survey questionnaire. Table 9 presents the summary of responses in terms of frequency and percentage. Most of the participants either strongly agreed or agreed upon the clearly defined training objectives (27.5% strongly agreed and 72.5% agreed), presentation of material (30% strongly agreed and 67.5% agreed), knowledge acquisition via training (30% strongly agreed and 60% agreed) and the fulfilment of the training objectives (22.5% strongly agreed and 67.5% agreed). Less than 15% of the participants remained neutral in their opinion. In response to the queries: *the questions of the survey were sufficient to gather utility preferences from a patient perspective* and *the content of the survey was organized and easy to understand*, 60% of the participants *agreed* for both questions, whereas 22.5% and 40% of the participants *strongly agreed* on the questions, respectively. Only 7 (17.5%) of the participants remained *neutral* in response to the first query.

6 Participants’ perception towards pain management mobile applications and intention for future use after training

Part E of the survey records the participants’ insight about pain management mobile applications after the training session and hands on experience with the selected applications.

Table 5 Utility preferences: result visualization

		Frequency	Percent	Valid Percent	Cumulative Percent
It is necessary to visualize recorded pain data, e.g., presented as a chart or using different colour to indicate the severity of pain.	Strongly agree	10	25.0	25.0	25.0
	Agree	24	60.0	60.0	85.0
	Neutral	6	15.0	15.0	100.0
What is your preference of result visualization?	Textual	18	45.0	45.0	45.0
	Graphical	14	35.0	35.0	80.0
	Both	8	20.0	20.0	100.0
What summary/report would you like to see from the recorded pain data?	Daily summary/report	3	7.5	7.5	7.5
	Weekly summary/report	5	12.5	12.5	20.0
	Monthly summary/report	17	42.5	42.5	62.5
	Summary for a specified time frame	13	32.5	32.5	95.0
	All of the above	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

Table 6 Utility preferences: feedback from healthcare provider

		Frequency	Percent	Valid Percent	Cumulative Percent
I think feedback from healthcare provider on the summary/report of the recorded pain data is necessary	Strongly agree	11	27.5	27.5	27.5
	Agree	23	57.5	57.5	85.0
	Neutral	1	2.5	2.5	87.5
	Disagree	5	12.5	12.5	100.0leP-ara>
	Total	40	100.0	100.0	

Table 7 Utility preferences: social support

		Frequency	Percent	Valid Percent	Cumulative Percent
Would you like to share your health concerns with people having same or similar issues?	Yes	25	62.5	62.5	62.5
	No	14	35.0	35.0	97.5
	Not sure	1	2.5	2.5	100.0
Would you agree that social support is important to understand and deal with your pain?	Strongly agree	12	30.0	30.0	30.0
	Agree	14	35.0	35.0	65.0
	Neutral	6	15.0	15.0	80.0
	Disagree	7	17.5	17.5	97.5
	Strongly disagree	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Table 8 Utility preferences: pain coping strategies and disease information

		Frequency	Percent	Valid Percent	Cumulative Percent
Would you like to learn about or understand your pain?	Yes	37	92.5	92.5	92.5
	No	1	2.5	2.5	95.0
	Not sure	2	5.0	5.0	100.0
Would you like to learn the strategies to overcome your pain?	Yes	38	95.0	95.0	95.0
	No	2	5.0	5.0	100.0
Would you agree that the information resources are important to understand and deal with your pain?	Yes	35	87.5	87.5	87.5
	Not sure	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

It has a multiple-choice question: *which of the following statements best applied to the pain management mobile applications that are comprised of all the necessary features?* Almost all choices were chosen to be applicable but with various frequencies. Figure 5 represents the frequencies of selection of various options by the participants. The statement with the highest frequency helps to record pain data, which was selected by 24 participants, followed by the statement it helps to visualize progress over time selected

Table 9 Training evaluation and face validity of the survey questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
The training objectives were clearly defined	Strongly agree	11	27.5	27.5	27.5
	Agree	29	72.5	72.5	100.0
The material presented was helpful	Strongly agree	12	30.0	30.0	30.0
	Agree	27	67.5	67.5	97.5
	Neutral	1	2.5	2.5	100.0
The training session adds to my knowledge	Strongly agree	12	30.0	30.0	30.0
	Agree	24	60.0	60.0	90.0
	Neutral	4	10.0	10.0	100.0
The training objectives were met	Strongly agree	9	22.5	22.5	22.5
	Agree	27	67.5	67.5	90.0
	Neutral	4	10.0	10.0	100.0
The questions of the survey were sufficient to gather utility preferences from a patient perspective	Strongly agree	9	22.5	22.5	22.5
	Agree	24	60.0	60.0	82.5
	Neutral	7	17.5	17.5	100.0
The content of the survey was organised and easy to understand	Strongly agree	16	40.0	40.0	40.0
	Agree	24	60.0	60.0	100.0
	Total	40	100.0	100.0	

by 23 participants. Three of the statements were equally selected by 20 participants i.e., *it helps to self-monitor pain and the associated symptoms*, *it helps in the follow-up visit with the healthcare provider* and *it helps to understand the pain*. The statements with frequencies between 30 and 40% include: *it helps to deal with the pain (40%)*, *it motivates to take charge of pain (37.5/5)*, *it provides feedback over the period of time (35%)* and *it helps to provide awareness (35%)*. The selection frequency of the remaining two statements were less than 25%: *it is helpful in the emergency situation to connect with the healthcare provider (22.5%)* and *it helps to connect with the people of similar problem (17.5%)*. Only 25% of the participants had selected all statements to be suitable for the pain management mobile applications.

Upon inquiring from the participants about their willingness to use a pain management mobile application in future, 65% of the participants revealed positive intension while 23% of them were not sure about the future use. 12% of the participants were not interested to use a mobile application for managing their pain. The distribution is shown in Fig. 6.

7 Discussion

Focus groups are commonly used to analyse perceptions, thoughts, experiences and responses that would not be much promising with one or more interviews, observational findings or surveys [19]. The conceptual utility model was discussed in two focus groups with the experts to get an insight about the clinicians' prospects of the pain management mobile applications. It was further discussed with the older adults via a questionnaire survey to gather their feedback on the components or sub-components of the conceptual utility model.

7.1 Self-monitoring: self-reporting

With respect to *self-reporting* of pain (sub-component of *self-monitoring* in the conceptual utility model), the suitability of SOCRATES was deliberated with the HCPs. SOCRATES is a mnemonic that is generally used to measure pain [20]. To establish clinical viability of pain management mobile apps, essential pain facts should be input into the apps based on SOCRATES. In the focus groups with the HCPs, it was highlighted that SOCRATES is only suitable to record in the patient's initial visit as to input SOCRATES on regular basis could be cumbersome for the older adults. Unnecessary input procedures may cause older adults' dissatisfaction and frustration. As per the HCPs, *severity and exacerbating and relieving factors* are important to record more frequently for the clinical observation. However, it should be optional to input complete SOCRATES to track new symptoms upon occurrence. On the other hand, in the survey with the older adults, almost all choices of SOCRATES were chosen to be necessary, but in various frequencies. Almost all older adults suggested for the optional choices of SOCRATES as necessary. With respect to *site*, the HCPs also suggested to provide option for the selection of multiple pain locations.

Older adults being the largest age group suffering from pain, are deemed to be late smartphone adopters [21] and slower than young adults in the first-time use [21, 22]. Thinking capacity and task performance could be impacted by the reduced cognition, less flexibility, vision problems and loss of muscle mass [23]. As per the HCPs, older adults may not be able to express their pain properly or they may have difficulty in interpretation of pain. They could also take long time to respond to a question so the involvement of caregivers will be helpful. In addition, as per the results of the survey with the older adults, more than half of the participants wanted to record pain data by themselves, although

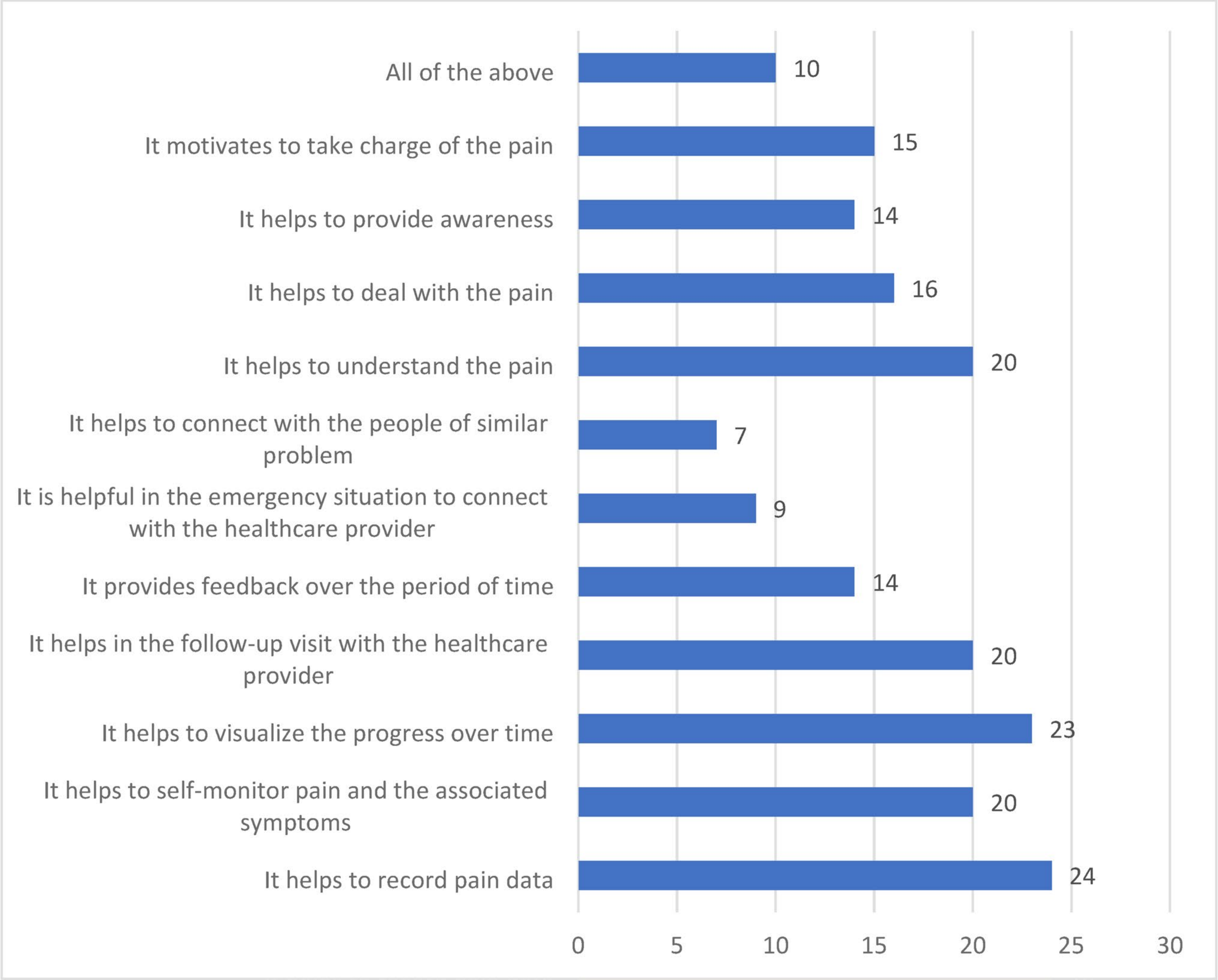
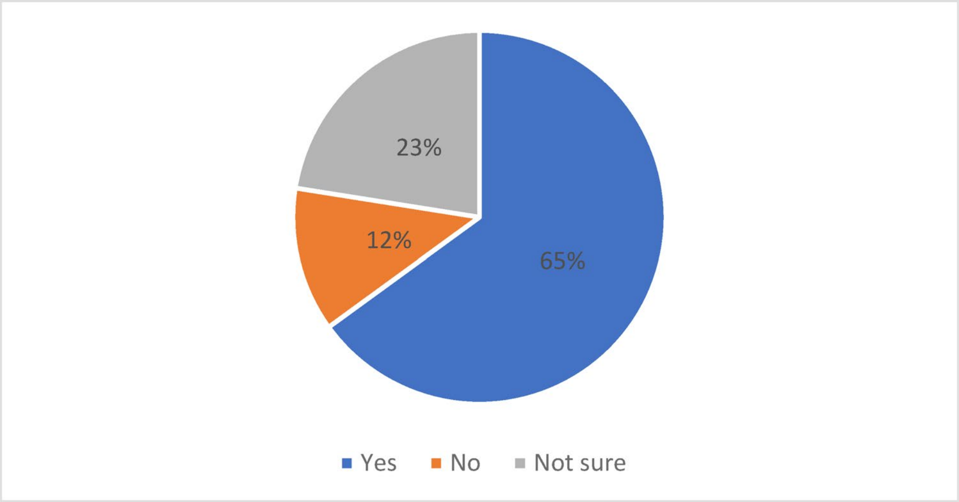


Fig. 5 Patients' perception towards usefulness of pain management mobile applications

Fig. 6 Patients' intension for future use of pain management mobile application



a few participants preferred support of the caregivers. Moreover, a multilingual mobile application will be helpful to overcome the language barrier. Provision of explanation of the terminologies will also be helpful. Nevertheless, it could be overwhelming to the older adults as well.

The pain self-reporting methods include active mode, passive mode and hybrid mode. Older adults must use the application to record pain and related symptoms in active mode. In passive mode, either the mobile device's embedded feature is available to capture and record data automatically without the intervention of patients. The hybrid mode incorporates the features of both active and passive modes [24]. The effective assessment of pain to generate results and provide feedback is based upon the proper self-reporting of pain. Easy and reliable reporting methods must therefore be used to simplify older adults' data input and increase usability [25]. Ease of use also affects self-efficacy directly [26].

Privacy is another issue in addition to convenience and effectiveness with passive or hybrid input modes. The HCPs also expressed their concern to provide easy input solutions and the data input mode must be tailored to the older adults' limitations. For instance, the older adults who are non-tech savvy must be provided with one click solution, voice recognition methods, or some wearable device as per suggestion of the HCPs. The wearable device will also be helpful to measure the vital signs like blood pressure or pulse rate. In case of an increased pulse rate, relating to the increased pain intensity, it could be helpful to seek medical advice. The older adults are reported to prefer wearable appliances over mobile [27, 28] for their support of active data entry mode in a simplified way [28]. Nonetheless, it can only be useful for recording pain severity, while other pain data attributes are also required to report for proper assessment, as discussed earlier. On the other hand, in the survey it was observed that less than 20% of the older adults preferred wearable devices along with the mobile applications. This is contrary to the previous researches [27, 28].

Another concern highlighted by the HCPs was the reliability of data provided by the older adults. For instance, in case older adults fail to key-in their pain data on time. The older adults may not properly recall the actual situation later leading to inaccurate data provision. The reminder or alarm system could prove to be helpful to keep the older adults compliant for the app usage. It was revealed in the survey that the majority of older adults also agreed with this feature. The reward systems having bonus points and vouchers will also be suitable for the older adults' compliance to use the pain self-management mobile application. Nevertheless, it could be misused (e.g., over-reporting) as well and affect the trustworthiness of the pain data provided by the older adults. Self-reporting could be influenced by the patients' behaviour of over-reporting or under-reporting of the pain symptoms [29].

Moreover, HCPs also recommended to record the impact of pain on daily activities as pain usually causes disability [30], as it will help to analyse the quality of life of a pain sufferer. Therefore, it is important to track the daily activities for an appropriate solution to alleviate the suffering and avoid decreased mobility. Pain management offers strategies to efficiently measure and manage pain, therefore improve the quality of life [31]. Recording older adults' history with medications intake is also essential as older adults may have some other comorbidities. It will aid the doctor to choose a suitable pain management regime that may not interfere with the treatment regime of co-occurring diseases.

7.2 Self-monitoring: assessment and reassessment

Managing pain depends on pain assessment, i.e., based on the interpretation of self-reported pain data. Based on the older adults' reports, the HCP will be able to offer a clinical decision required for the advancement or adjustment of the treatment regime. Regarding the assessment and reassessment (the second component of the proposed conceptual utility model) of pain via the pain management mobile application, the HCPs were of the view to have regular assessment for the older adults who are having serious condition or refer to the WHO's analgesic ladder. For the cases at or above stage 2 of pain level, HCPs should be frequently involved for the medical advice. Thus, frequent assessment is required for these patients. The HCPs who took part in the focus group discussion also suggested to set expiry dates for the online observations, subject to the improvement in older adults' condition. In the older adults' perspective, nearly half of the participants (47.5%) supported the notion of daily assessment of pain. Those who disagreed did not provide any concrete reason for the disagreement. From literature, no clear guidance on the frequency of pain data input could be identified. Many researchers aimed to follow the pain assessment scenario once in a day so that the mobile application users are not overwhelmed. Some researchers aim to collect pain data more often than to rely on the recall approach in support of the principle of ecologic momentary assessment (involves repeated sampling of subjects' current behaviours and experiences in real time, in subjects' natural environments). This aspect was investigated in the survey among the older adults suffering from pain. Corresponding to the minimal and optimal frequency of data input, majority of the participants were of the view to record the data once in a day or as per needed in a day.

7.3 Self-monitoring: result generation

The third sub-component of self-monitoring is *result generation*. The HCPs were interested to have a graphical overview of the good days (having no pain) and the bad days (having severe pain) of the older adults with colour code and pain intensity score. Result of the recorded pain data will be helpful to observe the pain trend over time. The HCPs suggested to integrate the pain management mobile application with the EMR to make the recorded pain data easily accessible to them. This sub-component is also supported by 80% of the older adults. Most older adults prefer textual representation over graphical for a better understanding and some prefer to visualize the results in both ways. Older adults were of the view that mobile applications must facilitate all possibilities to generate report, i.e., daily, weekly or monthly pain reports, or pain report for a specified period of time. Monthly pain report and summary and report for a specified period of time were chosen by most of the participants.

7.4 Self-monitoring: feedback

The fourth and last sub-component of *self-monitoring* is *feedback*. Feedback in the form of encouragement or advice from an HCP is necessary for the older adult to continue with the treatment regime. As pain management is a bidirectional process, the treatment plan will be adjusted by the HCP based on the results [32, 33]. Therefore, it is recommended to establish an initial correspondence between the HCP and the older adult prior to the pain self-management via mobile application [34]. It will help to build confidence in the older adult. Based on the results, feedback could be automated as well, to overcome the burden of HCPs or a human expert monitoring the central system. In this case, rigorous inspection for precision by the health care governing bodies is obligatory in the mechanism of automated feedback, or otherwise automated feedback can lead to serious harm [35]. Defining a threshold level is necessary in case of automated systems, so that HCPs could be alerted and involved in time for giving a suitable clinical advice. The active contribution of a clinical expert could improve system efficiency and safety [36, 37]. The system should also have a time-out feature to connect with its caregivers or other medical assistance while seeking advice from medical professionals [36]. The HCPs in the focus group highlighted to involve the caregivers for the feedback or medical advice in case of an alert notification has been sent to the EMR or a central system because of the HCPs increased pain severity. The increased pain severity could be the input to the pain management mobile applications or it could be triggered by the increased pulse rate of the patient (measured by a wearable device). HCPs should also be involved frequently for the feedback/medical advice in cases at or above stage 2 of the WHO's analgesic ladder. The feedback could be provided either by the clinical visit or over the phone as well. HCPs advised for the involvement of caregivers/relatives in the emergency and to be contacted by the caregivers/relatives if necessary.

The need for a person in charge or a physician on duty has been identified to track and examine the alert notifications or the progress of serious cases. It is suggested to set the expiry dates for the online monitoring of serious cases, due to positive progress in the health status of such older adults. The majority of participants in the utility survey were also interested to get feedback from HCPs. Feedback might discourage the older adults in some cases, if the feedback is not much informative or clear to them [38], or same feedback over a period of time due to lack of or very low progress. A clear and informative feedback and motivation for older adults to stay in the self-management program, is therefore important.

7.5 Education/knowledge: social support

With reference to the sub-components of *education/knowledge*, i.e., *social support* and *pain information*, the HCPs endorsed the concept of social support subject to the reliability of resource; 75% of the older adults in the survey supported the idea. They were interested to share their health concerns with people having same issues. Those who disagreed would like to keep their pain conditions private and were only comfortable to share their conditions with family and close friends.

7.6 Education/knowledge: pain information

In relevance to the pain information, HCPs supported seeking information about the disease for the better understanding of self-management. However, they mentioned that age factor or low literacy could be an obstacle in understanding the pain coping strategies. Also assigning the sub-goals to the older adults may have negative impact when the sub-goals are not achieved. On the other hand, more than 90% of the older adults of the survey were interested to learn about pain and techniques to overcome pain. Those who were not sure were unaware of the significance of the education/knowledge in pain self-management.

7.7 Awareness of pain management mobile applications among the older adults

In the survey with the older adults, it was revealed that all participants were unaware of the pain management mobile applications. Thus, they had never used such apps before. The training session and hands on experience of the participants (with the selected pain management mobile applications for the demonstration) results in awareness amongst them regarding pain self-management using a mobile application. The participants realized its significance and the evaluation of their perception reflects patients' understanding towards the pain management mobile applications. The participants comprehended that a pain management mobile application helps to record pain data by self-monitoring of pain and the associated symptoms. The mobile application visualizes the progress or trend overtime that would be helpful in the follow up visit with the HCP. The mobile application also motivates patients taking charge of their pain and regularly provides relevant feedback, as well as being helpful in the emergency. Moreover, a pain management mobile application may help the older adults to connect with people of similar problems.

7.8 Other concerns of the older adults

Upon inquiring the participants' intension for the future use of pain management mobile applications, more than half of the participants were interested to use such mobile applications in future. However, some of them were either not sure or not interested to use the pain management mobile application. They might be afraid of technology use. Although they had smartphones, they used their phone for messaging via *WhatsApp* or for browsing a video sharing app, i.e., *YouTube*. The terminology "healthcare mobile application" gave them impression of a difficult to adopt thing. Some of the participants had careless attitude towards pain management as long as pain does not hinder their daily activities. In some cases, due to prolonged chronic pain, like more than 10 years, some participants were accustomed to pain and did not want to struggle for it. Some participants mentioned that pain is constant the whole day, so it is difficult to record pain all the times. Therefore, they were interested in following the doctor's advice only. In some cases, the pain sufferers were accompanied by the caregivers and in the caregivers' perspective, the pain sufferers have to ultimately take medicine. Recording pain is thus an additional or time taking task. Some participants showed concern for the usage, i.e. whether their pain goes away by using the pain management mobile applications or they had to live their whole life with pain. Moreover, if a patient was about to undergo some procedure by the specialist to overcome pain, he was curious whether pain management mobile applications will still be required after the procedure.

8 Conclusion

This research seeks to investigate clinicians and older adults' insights in relevance with a utility model of pain self-management mobile applications. The insights guide the development and verify suitability and comprehensiveness of pain self-management mobile applications with respect to the older adults' perspectives and preferences, taking into consideration needs and professional opinions of HCPs. Two rounds of focus group discussions were held with 16 HCPs. Thematic areas were identified from the analysis of the focus group discussion with the HCPs. The focus group discussions helped to identify the HCPs data accessibility needs, mechanism to get their involvement, acceptability of the system in their daily workflow and some other concerns about the older adults' practice of pain self-management via mobile application. This was followed by a questionnaire-based survey among 40 older adults to understand their preferences of the pain management applications. The questions raised in the focus group discussion and the survey questionnaire were based on the studied conceptual utility model. The proposed conceptual utility model was well-accepted by both clinicians and older adults, that further affirmed the significance of the conceptual utility model. The utility model is proven to be helpful in providing guidelines to assess or modify the existing pain management mobile applications, or to develop new pain management mobile applications for the older adults.

9 Limitations and future recommendations

Despite efforts to maintain the rigor of the study, several limitations should be acknowledged. The qualitative data were derived from only two rounds of focus group discussions involving sixteen healthcare professionals (HCPs), all Malaysian nationals from UMMC with expertise in pain management. As such, the generalizability of the findings across different countries and cultural contexts remains limited. Future research could expand the number of focus group sessions and include clinicians from diverse healthcare institutions and nationalities to enhance the breadth and applicability of the findings.

Recruiting older adults for the utility study also posed challenges, particularly in gaining their cooperation, which contributed to the limited sample size of 40 participants. Nevertheless, the survey yielded valuable insights into the perceived usefulness of the proposed conceptual utility model. Future studies may replicate the protocol with a larger and more diverse sample, particularly including older adults with lower education levels or those who are illiterate. Such efforts would help assess the broader applicability, usability, and practicality of the model and its associated evaluation guidelines.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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