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Original Research

The attitudes of pharmacists, students and the general public on mHealth applications for medication adherence

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ABSTRACT[*]

Background: During recent years mobile technology has developed tremendously and has infiltrated the healthcare field. Mobile healthcare (mHealth) applications, or apps, may be used to support patient adherence to medication thus promoting optimal treatment outcomes and reducing medication wastage.

Objective: This study shall consider the opinions of United Kingdom (UK) based pharmacists, pharmacy undergraduates and members of the general public towards the use of mHealth apps to promote adherence to prescribed medication regimens.

Methods: On Liverpool John Moores University (LJMU) ethical approval, the 25 item questionnaire was distributed to UK registered pharmacists within inner city Liverpool and Manchester (n=500), pharmacy undergraduates studying at LJMU (n=420) and members of the general public within Liverpool City Centre (n=400). The questions were formatted as multiple choice, Likert scales or the open answer type. The data were analysed using simple frequencies, cross tabulations and non-parametric techniques in the SPSS v22 program.

Results: The number of completed questionnaires from the pharmacist, student and general public cohorts were 245, 333 and 400; respectively. The data indicated that the general public rely heavily upon daily routine to take medication as prescribed (54.1%) with mHealth app use being extremely low (1.5%); a similar trend was noted for the pharmacist / student cohorts. The age of the individual is an important consideration, with the younger generation likely to engage with mHealth apps and the older generation less so. Here, education and training are important. Pharmacists (82.3%) would be happy to deliver training packages to the public who would in turn happily receive such training (84%). Key barriers precluding mHealth app use include data reliability, security and technical difficulties.

Conclusion: Adherence apps hold great promise to support the patient and their healthcare needs. In order to increase acceptance and uptake simple, user-friendly designs must be considered and constructed. In addition, such technology requires effective promotion and end user training in order to reach its full potential. Furthermore, the regulation of mobile adherence apps will be essential in order to overcome underlying patient concerns.

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INTRODUCTION

Mobile technology has advanced significantly over the course of the previous decade. Within recent years this form of technology has undergone major improvements in terms of processor speed, memory and storage capacity along with battery life. Furthermore, operating systems have become more efficient thus enabling the execution of multiple tasks including Internet access.[1] Mobile telephones that meet such specifications are now referred to as 'smartphones'.[2] In a similar manner, tablet devices (i.e. larger versions of smartphones with a similar feature set) have also become exceedingly popular. Software applications (i.e. 'apps') are essential drivers for all mobile devices.[3] Mobile apps have infiltrated into society through services including gaming, social networking, news, education and healthcare. As previously reported[3], the rapid evolution of software platforms on advanced mobile devices over the past decade has paved the way for mobile healthcare (mHealth) apps, which have seamlessly infiltrated healthcare systems in the developed world.[1] At present, thousands of mHealth apps are available[4,5] and include for example 'Dario' and 'MyMeds'.[6,7] Naturally, the scope of mHealth apps in patient care is huge. For instance, the software packages can aid the diagnosis process, enable effective patient monitoring, provide medical information and even serve as a communication tool between patients and healthcare professionals.[1] More recently, remote diagnosis has become a popular trend within the field of mHealth. A prime example involves the development of a mobile healthcare app which allows the general public to take photographs of their skin conditions, with the image being sent to a dermatologist for analysis. In 2012, Borve and co-workers reviewed the viability of this concept in which 40 patients sent photographs of their skin conditions (e.g. cancer) to dermatologists for diagnosis and treatment advice.[5] It was noted that the dermatologists assessing the photographs had an accuracy concordance of 68%. Clearly, mHealth apps provide the opportunity to support the patient (e.g. their adherence to medication regimens) and ultimately improve quality of life.

Patient adherence to medication regimens

The term 'adherence' refers to the extent to which a patient takes their medication as agreed with their prescriber.[8-10] Aspects that might impact upon this include the dose, timing, frequency and duration of the treatment.[4] Medication non-adherence is prevalent within developed countries (i.e. the United Kingdom (UK) and the United States of America (USA)).[11] This particular issue within healthcare is becoming increasingly significant, with recent UK estimates suggesting that a third to a half of prescribed medication is not used as intended.[12] Net effects include poor therapeutic outcomes, increased hospital admissions along with medication wastage.[13] Clearly, such negative aspects can place huge financial burdens on healthcare providers. For example, in 2010 the UK-based National Health Service (NHS) estimated that non-adherence to prescribed medication resulted in the loss of GBP 500 million from their system.[14]

Patient non-adherence to prescribed medication regimens may be broadly described as either intentional or unintentional.[8] The former involves the patient deciding that they do not wish to use their medication in the way that was agreed between themselves and the prescriber. This may be ascribed to the individual experiencing adverse drug reactions, holding a poor perception of health benefits and confusion due to regimen complexity.[4] Unintentional non-adherence differs slightly in that the patient is willing to take their medication as agreed but fails to do so, possibly due to forgetfulness and complexities of daily life.[8,15-18]

The ability to communicate with healthcare professionals via mHealth platforms could offer an effective means by which to resolve issues with medication that can lead to unintentional non-adherence. For example, the technology could be applied to track a patient's health status on a daily basis such that the extent of their symptoms or side effects (i.e. blood pressure, heart-rate or blood glucose levels) may be monitored. Related documentation and educational approaches could make health benefits clearer to patients and better support their needs. Indeed, mHealth can be helpful in making complex drug regimens seem straightforward and easier to manage thus making the patient feel less overwhelmed and more likely to take their medication as prescribed thus overcoming elements relating to unintentional non-adherence.

To date, positive steps have been taken within the UK to remedy this pressing situation. However, true adherence is challenging to both monitor and measure.[4] All methods to aid adherence to medication (i.e. the use of traditional pill boxes) have limitations. For example, patient feedback is likely to be inaccurate due to bias and memory defects[8], the direct observation of medicine administration is often impractical and in terms of blister packs, supply counts and repeat prescription rates do not confirm that the patient has actually taken the medication prescribed.[8]

The most common type of behavioural intervention is through reminder systems, which can involve various prompts through notes, diaries, alarms or advanced pill boxes.[19] Text messages and text messages requiring a response have been utilised in order to improve adherence and results have shown positive short-term outcomes after six months.[20] Nevertheless, the effect of long-term use is less clear and it may be that text-message reminders are only suitable for short-courses of drug treatment as opposed to managing chronic conditions.

Service driven initiatives are now firmly established within the community pharmacy setting with the aim of educating and empowering the patient; hence offering potential to overcome the drawbacks associated with the more traditional routes of adherence support. Here, the pharmacist is able to conduct medicines use reviews (MURs) and deliver the new medicines service (NMS) in order to underscore the importance / use of prescribed medication and why it is imperative to take medication as prescribed.[3] Notwithstanding the success of such advanced services, scope now exists to exploit mobile technology platforms along with app-based software to support the patient in following daily treatment plans to optimise treatment outcomes.

At present mHealth is an emerging concept within developed countries and is not positioned directly at the forefront of healthcare service provision.[3] Typically, workplace activities within a community pharmacy premises in the UK involve prescription dispensing, over-the-counter sales and the provision of related advice plus services such as blood pressure monitoring. There is great potential, however, for mHealth apps to support the pharmacist in daily activities, as mentioned herein, and offer support to the patient to derive the maximum benefit from prescribed / purchased medication regimens. Over time there is real potential for the integration of the more traditional mechanisms of healthcare delivery supported with mHealth apps and related advanced technologies in the delivery of healthcare to the public.

Mobile healthcare apps to support patient adherence to medication regimens

Mobile healthcare applications offer an innovative means by which to improve patient adherence to medication, thus negating the problems associated with non-adherence. This form of technology is particularly valuable to patients with complex medication regimens and those with cognitive impairment along with carers.[8] Such mHealth apps may be utilised to remind patients when to take their medication. Here, the more straightforward mHealth apps (i.e. RxmindMe[21]) are able to provide individuals with reminder notices as to when the dose is due and additionally have the capacity to record when the dose is taken. Such apps can provide information about medicinal products, including special instructions from healthcare providers and can also monitor physiological parameters.[8] Although there is great potential for mHealth apps to serve as reminder points for dosing regimens, the software does fail to address aspects such as educational barriers and health

literacy amongst a population. Aspects such as these may be overcome with service driven support mechanisms within the community pharmacy setting, as noted above, such that the patient is clear on why their medication is prescribed and the associated dosing schedules.

An excellent example of a more advanced system is that of SmartTrack, a novel device that aims to improve patient adherence to inhaler devices. This platform works by clipping onto inhaler devices, such that when a patient inserts the inhaler to take a dose, the unit records the date and time and uploads the data onto a website which can also be accessed via an app. The product can also send reminder messages if a dose is missed. The potential of this particular adherence app was investigated by Foster and co-workers in 2014.[22] Here, a randomised controlled trial was conducted in a primary care setting and involved 143 patients with inadequate asthma control, who were prescribed a control inhaler for twice daily use. The data indicated that after a period of six months had elapsed the SmartTrack users showed significantly higher levels of medication adherence (i.e. 73% vs 46%).

In relation to this point, Propeller Health has recently devised a sensor technology called Propeller Sensor that is capable of recording the time and location of inhaler use.[23] The sensor is able to connect to a mobile device and capture data that can be applied to monitor both usage and inhaler technique. The information acquired may be applied to educate the patient on how best to use the inhaled dosage form. An important feature with the mHealth app-based approach involves the capacity to monitor the frequency of drug administration with global position in mind. Here, scope exists to link the onset of an asthma attack directly with the immediate environment. The information gained may be used as an avoidance strategy for further asthma attacks.

The development of smartphone / tablet devices has inevitably led to the integration of healthcare apps with external physical biosensors, which may allow for the monitoring of patient adherence to prescribed regimens.[14,24] Such biosensors may take the form of solid oral dosage forms or 'smart patches', for example. In any case, the units have embedded technology to 'read' vital signs associated with administration and bodily function. A good example of this approach is the 'Helius' platform that provides opportunity to track medication usage (i.e. via oral administration) using a sensor-enabled inactive tablet.[25] Here, the technology relies upon a biosensor that is embedded into a mock oral dosage form. The sensor is able to transmit two signals, one to a wearable patch once in contact with electrolytes in gastric fluid and another to the mobile device displaying the time and date that medicine was ingested.[26] In this way, the feedback system can monitor when a particular dose has been taken and the information can be relayed to the prescriber for monitoring purposes. In addition, scope exists to obtain physiologically relevant information (i.e. heart rate and blood pressure) via an accompanying smart patch worn by the patient. Clearly, this form of novel technology can assist patients who cannot remember if they have taken their medication (i.e. via reminder messages) and can also be used by family members to monitor the patient. In principle, this approach does show promise as demonstrated by Belknap and colleagues in 2013.[27] Here, the group conducted a small scale study that involved 30 tuberculosis patients in the age range of 22 and 79 years. The data indicated that 83% of the patients showed high levels of comfort with the Helius technology and indeed 75% would be content with using it permanently.

Concerns with healthcare apps

Although mobile apps demonstrate promise to support healthcare many concerns have been aired.[28] For example, limited regulation may lead to apprehension over accuracy, reliability and the evidence-base for information provided.[3] In addition, concerns surrounding the extent of medical training of the app developers have been highlighted.[28] An important concern revolves around usability, particularly with the older generation who may be unfamiliar using such programmes.[29] However, in terms of this latter point, recent research indicates that the older generation may be slowly embracing developments in the mHealth field[30]; which will be an emerging trend as the younger generation ages.[3] To illustrate this point, Parker and co-workers have recently considered the opinions of 41 patients aged 60 and over with chronic pain in the USA towards the use of mHealth apps; with only a small proportion of the study group had previously used a mHealth app.[30] The data suggested that the majority of participants (i.e. 85%) were enthusiastic about the use of mHealth apps to assist with pain management. Furthermore, participants discussed important barriers to preclude the use of mHealth apps (i.e. concerns about privacy) and methods by which to enhance uptake (i.e. training).

With respect to healthcare provision, a key area for consideration would be the balance between the time taken for mHealth app use and the direct benefit to the unfolding clinical scenario. This point was alluded to by Kamel Boulos and colleagues in 2014, who suggested that in a time critical situation mHealth apps may play an important role should speed and accessibility be required.[31] The examples provided by the group were those of stroke or acute trauma. However, in a similar way the pharmacist located within the community setting, or indeed the hospital setting, may at some stage require fast and ready access to medical information to manage an unfolding situation within their practice.

Research purpose

Over the course of recent years mobile apps have significantly influenced the way in which people go about their daily lives; including how they manage their health. A number of current studies within the field consider the variety of adherence apps that are available for use to support healthcare within more developed countries. However, to date, there is

limited research that considers the thoughts of pharmacy undergraduate students, qualified pharmacists and members of the general public regarding the use of such apps in aiding medication adherence. These groups are of particular interest as they are, in their own particular way, ultimately involved with medication supply and usage. The perceptions of pharmacy students, pharmacists and the general public towards the use of mHealth apps for medication adherence are important so as to note whether the technology platforms can be of real value within the sphere of healthcare delivery in the (near) future. We suggest that it is indeed timely to investigate whether mobile apps may be applied to support medication adherence from both a professional and end-user perspective.

METHODS

Questionnaire preparation and ethical approval

At the outset, a comprehensive literature review was conducted in order to fully understand current opinion surrounding the field of mHealth. This process involved an intensive period of investigation of peer-reviewed journal articles and Internet-based assets that closely aligned with mHealth app use in the field of healthcare. Overall, our assessment indicated that themes of importance were the use of technology in healthcare, the increased popularity of self-care among the public, various forms of adherence interventions and the suitability of using mobile apps over more traditional options and obstructions that could counteract the use of mobile apps. These topics were listed and subsequently a number of questions were formulated linking to the recurrent themes. To this end, the understanding gained was utilised to inform the questions posed during the study; example questions included:

1. To what extent do you feel confident in managing your own medication?
2. How likely would you be to use mobile healthcare apps over consulting a healthcare professional?
3. To what extent would you use a mobile app to help with your adherence to medication?
4. To what extent would feel confident in using a mobile app to help aid adherence if promoted by a healthcare professional?
5. To what extent is it important for you that mobile healthcare apps are regulated by a professional body?
6. How happy would you be to receive training on how to use a mobile health application from your healthcare professional?

The questions were formulated appropriately to target the pharmacist, pharmacy students and the general public cohorts. To achieve this consideration was given to the roles of healthcare provider and end-user:

1. Pharmacist opinion on the usefulness / barriers of mHealth apps to support patient adherence / healthcare
2. The opinions of students as to how useful mHealth apps might be to support patient adherence / healthcare
3. The way in which the general public (i.e. patients) view mHealth apps to support medication adherence

The questionnaire featured Likert statements (i.e. strongly agree, agree, neither agree nor disagree, disagree, strongly disagree) and 'free-text' boxes to develop a deeper understanding of participant views. The questionnaire contained five sections: (1) Background information, (2) Self-care, (3) Medication adherence, (4) Usability and (5) Demographics. Further to completion of the questionnaire and support materials (i.e. cover letter and participant information sheet), ethical approval was sought and obtained by the Liverpool John Moores University Research Ethics Committee (LJMU REC).

Questionnaire distribution

During January and February 2015, the questionnaire packs were distributed to 420 MPharm undergraduate students enrolled at LJMU, 500 community pharmacies located within inner city Liverpool and Manchester along with 400 members of the general public within Liverpool City Centre. The sample size of each cohort was chosen due to time and resource restrictions. As the study period totalled 6 weeks, an appropriate number of participants were chosen for each cohort. In addition, the size of the study was limited with the budget available for printing and distributing the questionnaires. In the case of the general public cohort, the questionnaire was completed at the initial point of contact and remained anonymous throughout. The inclusion criteria involved the following: any individual who was willing to participate; but did not include pharmacists, pharmacy staff, healthcare students, anyone under the age of 18 or vulnerable adults who were unable to give consent. Here, participants were approached at different times in the day in an attempt to target various people and to achieve an accurate representation of the local population.

The pack consisted of a 25 item questionnaire, a covering letter, a participant information leaflet as well as an A5 freepost response envelope for document return and confirmation of consent (i.e. in the case of the pharmacist cohort). At all times the information remained confidential. The questionnaires were coded for tracking purposes and all codes were held securely. In an attempt to improve the response rate, follow up telephone calls were made to those pharmacies who did not respond after two weeks of receiving the questionnaire; if necessary, the questionnaire completed over the telephone or another questionnaire pack dispatched if requested. The data were not analysed with the codes as references. The codes were used solely to track the position of the response rate over time and for subsequent follow up.

Statistical analysis

The data obtained were processed and analysed via the Statistical Package for the Social Sciences (SPSS) v22 software package. All data were validated via double inspection. To provide an overview of trends within the data, the analysis included descriptive procedures such as frequencies on each variable. Bivariate procedures such as cross tabulations, Mann-Whitney tests and Kruskal-Wallis tests were used to observe associations between different groups. P-values were calculated with statistical significance only if the p-value was less than or equal to 0.05 which implies that there was a 95% confidence in the analysis.

RESULTS

Demographics

Overall, 420 questionnaires were distributed to MPharm undergraduate students who were present during their scheduled lecture sessions at LJMU. In total, 333 completed documents were received from this cohort, presenting a response rate of 79.2%. Participants included 204 females (61%) and 129 males (39%). Here, the group included a reasonably even spread of students across Level 4 (24.6%), Level 5 (23.4%), Level 6 (27.6%) and Level 7 (24.4%); the system that refers to student progression across the four years from entry (i.e. Level 4) to exit (i.e. Level 7). In terms of age, 95.2% of all questionnaires distributed were completed by students in the 18-29 years old bracket with 3.9% in the 30-39 age bracket and 0.9% in the 40-49 year old range.

A total of 245 completed questionnaires were received from the community pharmacy cohort based in Manchester and Liverpool, thus providing a response rate of 49%. Participants included 125 females (49%) and 120 males (51%). The respondents were categorised into 6 age groups; namely between 18 to 29 years (29.4%), between 30 to 39 years (38%), between 40 to 49 years (16.7%), between 50 to 59 years (11.8%), between 60 to 69 years (2.4%), and over 70 years (1.6%). The participants possessed a wide ranging level of experience, with 173 having practised for 10 years or less (70.7%) and followed by 72 participants having practised for 10 years or more (29.3%).

In total, 400 completed questionnaires were received from the general public cohort. Approximately half of those invited to complete the research tool returned it. Of those who took a form, all returned it. Participants included 214 females (53.5%) and 186 males (46.5%). Individuals were between 18 and 40 years old (45.5%) and over 40 years old (54.5%). For the purposes of this study, the former grouping shall be classed as the 'young cohort' and the latter grouping classed as the 'old cohort'; with no offence intended. The younger group was classified as participants between 18 and 40 years old since individuals in this group living in developed countries would have grown up with mobile technology and therefore more likely to be familiar with it. The participants were categorised depending on the highest level of education achieved; trade or vocational qualification (5%), GCSE (13.8%), A-Level (23.5%), undergraduate degree (35.5%) or post graduate degree (17.3%), the remaining 5% did not have any qualifications.

Table 1. Approaches taken by the general public to adhere to prescribed medication regimens (n=400)

Strategy	% respondents
Written reminders	4.8%
Daily routine	54.1%
Alarm	10.0%
Family / Carer	19.6%
Mobile apps	1.5%
None	10.0%

Adherence strategies

A number of well documented strategies exist to support patients with medication adherence. Accordingly, the participants from each cohort were asked what strategies they used / would recommend in supporting medication adherence. The data obtained from the general public in Liverpool City Centre are presented in Table 1.

The data indicate that daily routine serves as the principal way in which those individuals surveyed remember to use their medication (54.1%). It is also apparent that within this particular cohort the reliance upon mobile apps is extremely low (1.5%). In a similar manner, the pharmacist cohort surveyed indicated that daily routine would be the most likely route to support adherence to medication regimens (51.4%), with written reminders in second place at 17.6%. Again, the use of mobile apps to promote medication adherence was low within the pharmacist cohort, with only 2.4% of respondents agreeing that this would be a viable support mechanism. With respect to the student cohort a similar trend was noted.

In this case, taking medicine as part of the daily routine was cited as the most common method to support adherence to prescribed medication regimens (47.4%). Whilst it was apparent that a relatively large proportion of students did not utilise a particular strategy to aid medication adherence (23.7%). Interestingly, only 3% of those surveyed used mobile apps as a current strategy to support adherence.

Mobile app use to support medication adherence

Within recent years, smartphone usage across the generations has increased significantly. In an attempt to establish whether there was a difference between older and younger generations and mobile app usage, participants were asked to consider how willing they would be to use / promote mobile apps to aid medication adherence. The data from the general public cohort is presented in Figure 1.

The data presented in Figure 1 indicate that the young cohort would be more willing to use mobile apps to support medication adherence, a trend contrasting with the older respondents. In relation to this point, the pharmacist cohort was asked to consider whether patients might use mobile healthcare apps to help with adherence to medication. Here, those individuals surveyed suggested that they either agree (36.7%), neither

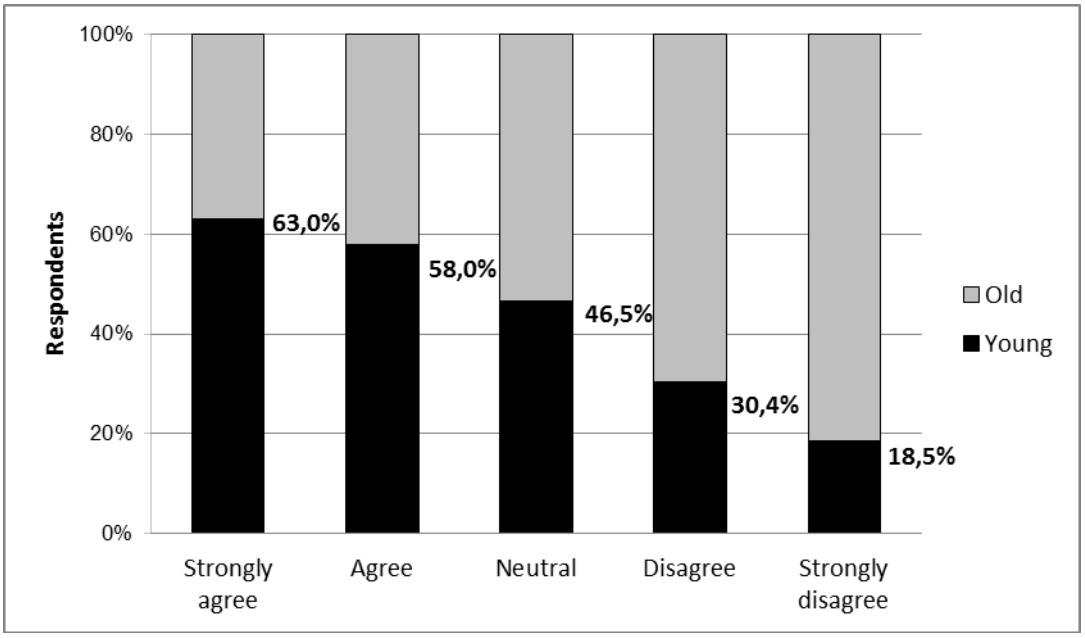

Figure 1. Willingness of the general public to use mobile apps to aid adherence as a function of age (n=400)

agree or disagree (30.6%) or disagree (23.7%). The data is suggestive of a divide between the old and young cohorts to the acceptance / ability to use mobile healthcare apps to support healthcare. With reference to the student cohort, a total of 51.1% of those surveyed agreed (i.e. strongly agree or agree) to using mobile apps to support adherence to medication regimens with only 17.8% being opposed to the idea (i.e. strongly disagree and disagree).

Monitoring health profiles with adherence apps / external devices

As previously outlined, scope now exists to fuse mobile healthcare apps with external devices (i.e. smart patches) in order to monitor patient adherence to medication regimens. Innovations such as this hold the potential to support patients and health providers in monitoring medicines usage and related treatment outcomes. Consequently, participants were asked to consider their level of comfort in using / recommending external devices to aid the adherence process. The data obtained from the general public cohort is presented in Figure 2.

The data presented in Figure 2 indicate that the younger participants within the general public cohort were comfortable in using an external device linked to a smartphone / table device when compared to the older participants. There is a clear divide in the data set which may be ascribed to the function of age. With respect to the pharmacist cohort, 86.2% of respondents indicated that they would be comfortable in recommending the use of an external device to monitor the level of patient adherence to prescribed medication.

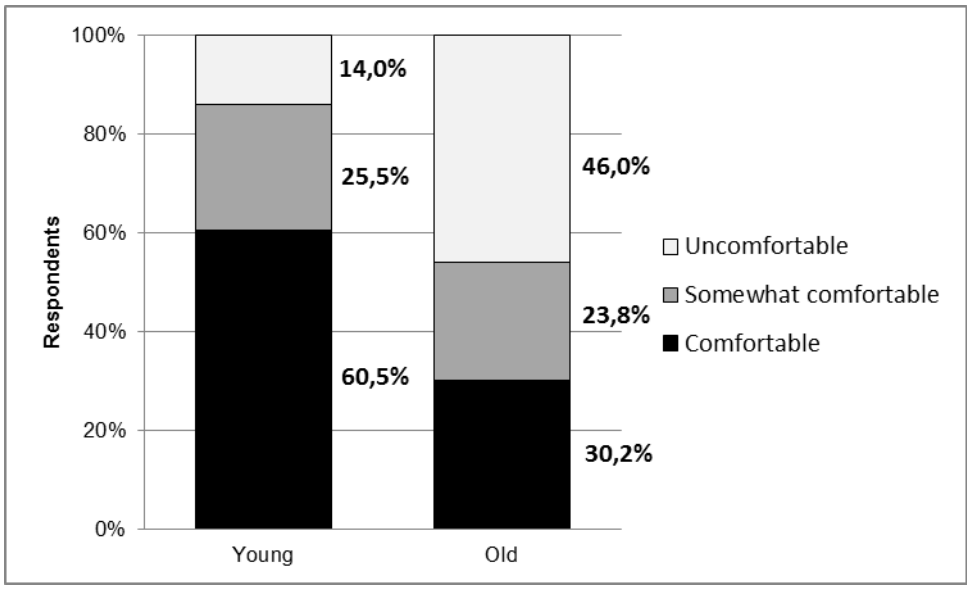

Figure 2. Level of comfort expressed by the general public towards the use of an external device with an adherence app (n=400),

Table 2. Aspects of an adherence app considered important by the pharmacist cohort (n=245)

Factor	% respondents
Ease of use	50.7%
Reliability / Security	13.1%
Regulated information	6.6%
Cost	19.6%
Fun	3.4%
Impact on battery life	6.6%

In terms of the student cohort, consideration was given to the prospect of both using an external device located on their body to monitor adherence and a healthcare professional monitoring medicines usage with a mobile app. Here, 48.7% of Level 7 students were comfortable in wearing an external device to monitor adherence, with 58.7% of students at Level 6 stating the same.

Furthermore, of those students studying at Level 5 a total of 50% were comfortable in using an extra device and this number reduced to 30.4% in Level 4. Those students who suggested that they would use a mobile app to aid adherence were statistically more likely to be comfortable in using an external device on part of their body to support the monitoring process (p=0.000) compared to those who would not. The majority of student participants (64.1%) were comfortable in such monitoring taking place by a healthcare professional. Overall, the data clearly demonstrate that there is a divide between the young and old age brackets towards the use and application of mobile healthcare apps to support medication adherence.

Desirable traits of an adherence app

The ideal characteristics of a mobile healthcare app to support medication adherence were determined by ranking six features in order of importance. Aspects for consideration included: ease of use, reliability and security, regulated information, cost, fun and impact on battery life. The data presented in Table 2 provide an overview of the pharmacists' perceptions on these themes.

The data presented in Table 2 demonstrate that the pharmacist cohort believed that the ease of use of a mobile app is the most important point to consider when using the platforms to promote / support medication adherence, followed by the cost of the app and reliability / security aspects. In a similar fashion, the results from the student cohort indicated that the most popular traits for a mobile healthcare app to support adherence were ease of use (34.6%) along with reliability and security (25.9%). It was also evident that the availability of regulated information was important (19.8%) and the cost of a mobile app was a key consideration (18.5%). In a similar manner to the general public cohort, the aspect of fun and the impact on battery life were given the lowest level of importance by the students. The data suggest that these trends were apparent through each of the Levels surveyed (i.e. from the more basic (Level 4) to the more advanced (Level 7)).

Table 3. Aspects of mobile app design considered important by the pharmacist cohort (n=254)

Element	% respondents
Technical difficulties	26.1%
The usage of data	4.5%
Security of mobile apps	20.8%
Regulation of mobile apps	13.5%
Reliability of information	35.1%

Barriers to adherence app use

In order to ascertain the barriers that might hinder the uptake and use of mobile healthcare apps to support medication adherence, each cohort was asked to highlight key concerns based on: technical difficulties, data usage, app security, app regulation and the reliability of information. The data obtained from the pharmacist cohort is presented in Table 3.

Upon inspection of the data is it clear that the reliability of information, app security and technical difficulties are chief concerns amongst this cohort. In a similar manner, members of the general public suggested that both the reliability of information is a key concern (i.e. young cohort: 29.8% / old cohort: 21.7%) as well as app security (i.e. young cohort: 34.3% / old cohort: 27.6%). Interestingly, the older cohort within this group suggested that technical difficulties may present as a barrier to mobile app use (27.2%), whereas this was not important in the young cohort (3.9%). The student unit mirrored these concerns with app reliability (39.2%) and app security (27.8%) being of significance. Those concerns aired from this group included the fact that battery life may be affected and time is required for mHealth app use.

Support mechanisms to enhance adherence app uptake

In order to promote the uptake and use of mobile healthcare apps in the sphere of adherence to medication regimens, there may be a need to educate and train individuals on the use of healthcare apps. Here, the pharmacist cohort was asked to consider if they would be happy to help with the support of the patient in this field and the results are presented in Figure 3.

The data demonstrate that the pharmacist cohort responded positively with 82.3% stating that they would be happy to train individuals on how to use mobile apps to support adherence. This figure reflects that expressed by those members of the general public surveyed in this study, where 84% indicated that they would be happy to receive training on the use of mobile health applications to support adherence to prescribed medication regimens. In addition, the student cohort was invited to consider whether they would be content to use a mobile healthcare app to aid adherence to medication regimens further to training from healthcare professionals. Here, a total of 70.4% of Level 7 students appeared happy to do so (i.e. very or quite happy). However, those students in Levels 4, 5 and 6 demonstrated slight reservations in that 52.5%, 58.7% and 57.6%, respectively, reported that they would be happy to receive such training. In general terms, it appears that there is a level of acceptance and satisfaction in using mobile apps to

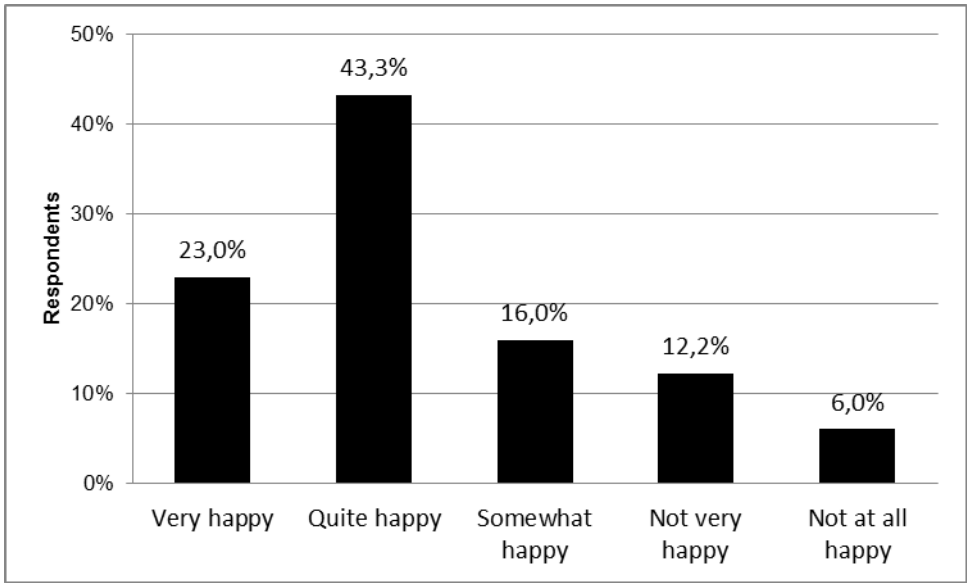

Figure 3. Degree to which the pharmacist cohort would be happy to educate the patient in mobile app use (n=254)

aid medication adherence should sufficient training and support be provided by a healthcare professionals.

DISCUSSION

Recent developments in the field of mobile technology have led to a notable upsurge in software applications to support patient healthcare.[3] Potential now exists for mHealth apps to promote medication usage (i.e. adherence) thus leading to improved treatment outcomes and reduced medicines wastage. To date, a significant amount of work has been conducted within the sphere of mHealth in order to develop and appraise software apps plus the hardware to run them. However, so far, limited consideration has been given to the attitudes of those individuals who would either promote (i.e. qualified pharmacists / pharmacy undergraduates) or use (i.e. members of the general public) mobile apps to support healthcare needs and in particular the adherence to medication regimens. Therefore, this timely study has considered the potential for using mobile apps to support patient adherence to medication within the community setting.

Strategies to support medication adherence

The number of prescribed drugs, timing of administration, frequency of dosing along with the cost and duration of treatment can influence adherence to medication regimens.[32] Further to these points, the data presented within this study indicates that daily routine is an important consideration. We would indeed expect this factor to be significant as the patient would be familiar in following a set routine, which would involve taking their medication during regular day-to-day activities. However, in reality, issues may arise to affect such regularity (i.e. ill health of a family member). On occasions such as this, mHealth apps may be recommended and used to support the patient with adherence to prescribed medication regimens (i.e. via reminder functionalities). However, it would appear that mHealth apps are seldom used to support medication adherence. It is likely that this tendency is associated with two key points; namely, patient awareness and education concerning mHealth apps. To address these pressing issues scope exists within the community pharmacy sector to promote mHealth apps and thus stimulate uptake and end use. Opportunity undoubtedly presents for the pharmacist to engage with patients and educate as to the function of mHealth apps. Here, several aspects would be important for consideration; namely, device type and appropriate training.

We perceive no reason as to why mobile apps cannot contribute to supporting adherence to medication regimens on a daily basis in the future. A wide range of software applications (i.e. 160 or more) have been developed within recent years; prime examples include MyMeds and RxmindMe. These software packages employ reminder and alarm modalities to provide daily alerts based on individual requirements (i.e. for those who are forgetful, on complex medication regimens plus those who have cognitive impairment along with patient carers.[8,33]

Willingness to use / promote mHealth apps to support medication adherence

With the general public in mind, the younger respondents of those surveyed (i.e. individuals aged 40 years or less) were positive towards the use of mHealth adherence apps when compared to the older cohort. Understandably, this finding may be related to the fact that younger individuals are accustomed to using mobile technology and are somewhat reliant on it for conducting daily activities. Therefore, it is expected that this group would be comfortable with incorporating mHealth apps to manage their medication (i.e. supporting adherence) on a daily basis. Indeed, it is important to highlight that several of the younger participants questioned currently utilise mHealth apps such as My Pill and Medisafe with a high degree of enthusiasm.

As noted, the older participants within this study (i.e. individuals aged 40 years or over) were significantly less receptive to using adherence apps. In fact, those individuals questioned cited that the platforms would not be helpful. If we consider the 'Technology Acceptance Model', the incentive to use mHealth apps stems from both the perceived specific benefits to the user and also the ease of use.[34] It is highly probable that the older participants are too familiar with more traditional techniques for taking their medication and subsequently they do not recognise the usefulness of mHealth apps. This observation was similarly noted in the small scale study conducted by Lee and colleagues in 2014.[29] Here, interviews concerning mHealth technologies were conducted with 11 patients aged over 65 years taking anticoagulation medication. The group reported that participants believed mHealth apps to manage medication may be of value to other patients but not themselves because the majority of participants had been prescribed warfarin therapy for many years and therefore had developed suitable adherence strategies during that time. The older participants also stated that they found the concept of mHealth apps to be complicated. Although there are a large number of mHealth apps currently available to support the patient, such platforms may not be designed to account for age-specific requirements. This population subgroup have needs that vary substantially from a younger population due to impaired vision, cognitive function and manual dexterity, for example.[35] The perceived complex nature of adherence apps may have arisen due to the older subgroup presuming that the app would be too time-consuming, difficult to initiate and require a lot of data entry and management.

Notwithstanding this notable trend, potential does exist for older individuals to utilise mobile technology to support their healthcare needs. For instance, in 2014 Mira and co-workers conducted a study involving 51 participants and analysed a medicine management app called 'ALICE'.[36] The data suggested that older patients with complex medication regimens, as well as limited experience in using smart devices or even computers, were still able to effectively use the adherence app. Here, it is important to note that the participants were provided with a relatively simple to use 7-inch platform device, attended a two hour app training session and had convenient access to a technical support number; thus a positive outcome was anticipated. We believe approaches such as these could be readily implemented within the community pharmacy sector and thus afford great benefit to the general public as a whole, regardless of age. Well-designed and supported adherence apps would allow for ease of use by all age groups.

Pharmacists within the community setting are well-placed to provide such training and the data presented herein indicate that those surveyed would be happy to help the patient in using mHealth adherence apps. Clearly, a well-informed supporting framework is required going forward in order to enhance uptake of the technology platforms. Here, pharmacists may have the opportunity to reverse erroneous misperceptions as well as increase awareness of adherence apps among their patients by providing patient education through seminars, leaflets and individual consultations on available apps, how they are used, how to access technical support and information on the relative benefits the technology brings. With regard to pharmacist remuneration for mHealth service provision in the UK, providers could be locally commissioned to offer an enhanced service to members of the general public. Within the UK, the clinical commissioning group (CCG) model may be applied to provide a mHealth service to the local community for a financial reward.[37] Additional routes for reimbursement in the UK may involve accessing local authority or local NHS England team funds. For instance, these approaches could be applied in the case of the Helius platform as detailed previously. Payment to the pharmacy could be claimed after a follow-up consultation once the app and equipment have been set up. In a similar manner to existing enhanced services (i.e. Inhaler Technique Review and Training), implementation of an adherence app service is likely to be a practical approach to improving public health and reducing medicine wastage.

Monitoring and use of external devices to aid adherence to prescribed medication

In terms of the general public surveyed within this study, there was once again a clear divide in age when consideration was given to the level of comfort in medication use being monitored by a healthcare professional via a mobile app. We believe that the same rationale as previously provided regarding age-related patient uptake of mHealth may be applied here. Interestingly, in 2013 Dayer and co-workers determined that data sharing between patients and healthcare providers was indeed valued.[8] It is reasonable to propose, therefore, that patients assign a level of importance in having open and effective communication with their healthcare provider. There is a perceived level of benefit of treatment monitoring as useful for general wellbeing, with an added benefit of the reassurance available to answer queries. In order to secure effective mHealth app uptake within the community setting it is this point that needs to be built on and developed. Perhaps the personalisation this approach brings could augment adherence to prescribed regimens by providing motivation and enhanced support.

Increasing demands on healthcare provider time within developed countries (i.e. the UK and USA) often make it challenging to sustain frequent face-to-face communication with those patients who require regular monitoring or those who find adherence difficult.[38] Consequently, patients may experience negative health effects, thereby increasing pressure on related healthcare services. Innovative technology platforms offer a means by which to solve these issues by enabling patient information to be readily accessible by healthcare professionals to review and then respond in a more streamlined manner.[38] On the other hand, frequent communication with healthcare professionals via mHealth strategies may exert additional workload

pressures (i.e. due to the combination of dealing with patients remotely as well as those in person within the same timeframe of a working day). For instance, DiDonato and co-workers noted apprehension with this arrangement as communication via mobile apps was perceived to increase the workload of pharmacists.[39] Over the course of recent years within the UK, time pressures within community pharmacy have steadily increased due to increased prescription volume and the growing number of advanced (i.e. appliance use review) and enhanced (i.e. supervised medication consumption) services offered. Thus, pharmacists may find incorporating adherence app management into their practice particularly challenging.

In terms of the student cohort, a mixed reception to the use of an external device to monitor medication adherence patterns was apparent. Overall, there was a general acceptance of the concept. However, the data suggest that the Level 4 students were rather unimpressed with the approach with this viewpoint changing as the years developed. We are of the view that those students positioned towards the end of their studies would have a cumulative knowledge and a great deal of experience of medication usage plus the benefit of patients to adhering to prescribed regimens effectively, thus would be more likely to consider the associated practicalities in a more positive and pro-active manner. Naturally, this approach would feed into professional life upon qualification and as practising pharmacists the individuals would strive towards high standards and accordingly support patients in the management of disease (i.e. to monitor and track adherence). Leading on from this, the vast majority of pharmacists surveyed within this study were comfortable in recommending a mHealth app and an external monitoring device to promote medication adherence. We suggest that those respondents feel monitoring patient adherence and treatment outcomes are very important routes to assure and sustain an optimal quality of life. Remarkably, workload pressures were not stated as a barrier to monitoring patient adherence by the pharmacist cohort. Here, we suggest that the benefits associated with such monitoring would outweigh the perceived increase in pressure.

Perceived barriers to mobile app uptake and methods to circumvent

Healthcare apps are evidently becoming increasingly popular amongst the healthcare community and public, alike. Nevertheless, several concerns appear to exist that might hinder future uptake. To ensure mHealth apps are successful such concerns need to be addressed in a pro-active manner. Amongst all cohorts key concerns surrounding mHealth app use included data reliability and regulation, app security plus ease of use.

The ability of a mHealth app to provide reliable information was regarded as essential by the general public surveyed within this study. We attribute this finding to the fact that such software platforms may be the basis on which critical decisions concerning their healthcare are made.[28] Clearly, in order for reliable information to be provided there needs to be strict regulation within the field. Such regulation would overcome safety issues that may arise as a result of the lack of medical training of some app developers and thereby increase the confidence that reliable information is present.[28] Furthermore, as previously alluded to, there is currently a large number of mHealth apps on the market which can lead to confusion amongst patients leading to the issue of which one(s) to trust.[40] Here, the endorsement of a number of regulated mHealth apps would be a suitable route to follow to stimulate public acceptance and thus promote the uptake of these technologies. In terms of mHealth app uptake and acceptability within the general population, we suggest that those individuals who are generally adherent to their medication will be more accepting of the technology platforms because they have the understanding and behaviour engrained within them to derive the maximum benefit from the range of support mechanisms available. Whereas those individuals who do not routinely adhere to prescribed medication regimens are likely not to be adherent or open to mHealth app software for support. In the case of this latter population subgroup, patient education is key and assistance to establish mHealth apps on their chosen device would be extremely important. Once a mHealth app is established on a portable device, in general there would be no requirements for further interventions and thus regular prompts / advice may be received by the patient to encourage medication adherence.

Interestingly, in 2014 The Food and Drug Administration (FDA) released a guidance document in relation to the regulation of medical apps.[31] The organisation highlighted that some apps may be classified as 'high-risk', including those that transform the mobile platform (i.e. smartphone / tablet device) into a medical device.[40] To date, within the UK and USA markets a risk assessment framework does not exist and it is not always clear if a particular app is classed as a 'medical device'. Naturally, these points can lend confusion to the scene over which apps actually need to be regulated.[28] In relation to these points, attempts have taken place to regulate mHealth apps. For example, within the UK the NHS has established an online 'Health Apps Library' which provides recommendations for specific apps and many are anticipating the NHS creating a 'vetted app store' to ensure the quality of mHealth apps.[31]

As per other groups within this study, the student cohort considered that mHealth apps should be regulated by a professional body. With this, any changes or updates to information and guidance should be regular and quick to access. A model example of this is the National Institute for Health and Care Excellence (NICE) mobile app platform. Here, published NICE guidelines are regularly updated and the app automatically receives updates when new guidelines are released.[41]

In a similar manner to the general public, those pharmacists surveyed indicated that the major issue with mHealth apps is the concern over data

reliability. To overcome this issue and improve acceptance of the technology platforms amongst the healthcare community, we suggest that medical professionals should be involved during all stages of app development as detailed by Visser and co-workers in 2012.[42] Moreover, peer review of mHealth apps would offer an effective means to ensure data accuracy and thus applicability within the medical community and general public, alike. It is interesting to note that the pharmacist cohort believed that the general public would indeed be comfortable in using mHealth apps if they were promoted by healthcare professionals. In point of fact, the finding links well with previous research, with those mHealth apps developed by healthcare organizations being rated higher on the patient comfort score.[43]

Naturally, such healthcare apps could be designed and developed in-house by independent / large chain retailers. Here, healthcare organisations would have the flexibility to drive software development and introduce their own views as to what is important for mHealth app usage. This is a clear area for further investigation. Within such work, a key question would be whether the mHealth apps should be standard and follow a prescriptive approach or if they should be tailored directly to the business requirements of the individual outlet.

A key attribute of mHealth apps is the ability to collect and transmit personal information (i.e. daily activities and health status).[31] Whilst this is advantageous in certain circumstances (i.e. during the monitoring of adherence to medication regimens), concern exists with regard to the security of the app and who might have access to this data. To circumvent such unease, technological advances have been made. For instance, there has been a recent introduction of biometric fingerprint identification in some mobile devices which may be able to offer reassurance with this regard by being able to confirm identity without the hassle of entering a manual passcode.[40] Furthermore, the patient's account could automatically be configured to log out after a few minutes of inactivity to prevent fraudulent use. Moreover, several individuals surveyed here were particularly concerned about app developers selling personal data to third parties (i.e. insurance companies) and consequentially being subjected to increased premium rates. Positive steps may be taken to counter this concern, for instance certain app stores (i.e. Apple) have tightened their privacy policies to prohibit the sale of data.[44]

Both age groups within the general public cohort indicated that technical aspects surrounding mobile platforms stood as a barrier to end use, albeit for different reasons. With regard to the younger participants questioned, concerns were aired over volume of data the app would use, which would ultimately impact upon costings and the network plan. However, arguably more important, the older cohort was anxious with regard to experiencing technical difficulties with mHealth apps and the physical technology platform itself.

The latter point is significant because should medically accurate and highly-regulated apps be released onto the marketplace, limited benefit would be derived should technical / use difficulties arise and not overcome. The respondents were also anxious about app / device set up, troubleshooting should malfunctions arise and the possibility of not understanding the content presented. In order to circumvent these issues, targeted training (i.e. background overview plus use and maintenance of the technology) could be executed within community pharmacy premises as detailed previously.

Furthermore, in a similar fashion as the other cohorts studied herein, the student body believed that training is essential for mHealth apps to really have an impact on patient healthcare. Here, it is appropriate to consider the inclusion of mHealth app training within the MPharm degree in order to equip the pharmacists of the future with the skills necessary to promote and train members of the general public on the use of mHealth apps. In this case, provision within the undergraduate timetable could be made for both theoretical and practical aspects surrounding mHealth (i.e. the technology platforms and how they may best serve healthcare needs) in order to familiarise students progressing through the MPharm degree.

Limitations

The data generated within this study provide an insight into the opinions held by UK registered pharmacists, pharmacy undergraduates and the general public in the Liverpool region towards the use of mHealth technology to aid medication adherence. Whilst clear trends are evident within the results, caution must be exercised in terms of generalisability for more developed populations (i.e. the UK and USA) as a whole. As the sample size was relatively small and from the North West of England the applicability to other parts of the country, and indeed overseas, may be questioned. Therefore, we highlight the fact that only general predictions may be allocated to the themes presented within this piece. As mHealth platforms are becoming ever more popular and clearly infiltrating into society there is a pressure to view the platforms in a positive manner during discussion. The data presented within this cross-sectional survey may involve an element of social desire bias that will ultimately influence patterns within the presented data. An additional factor for consideration involves the possibility of respondent fatigue and as such a general non-commitment to some of the questions posed during the interview process. Such responses can result in a degree of impartiality on a specific theme, which can skew the data set acquired and hence related description.

CONCLUSIONS

The evolution of smartphone and tablet device technology has impacted all areas of society, including the sphere of healthcare. Potential now exists to download and install mHealth apps which may connect to monitoring platforms and ultimately

support patient adherence to prescribed regimens. The acceptance and uptake of such technologies will be dependent upon aspects such as individual preparedness to use a mHealth app as a function of age, suitable promotion and education strategies plus appropriate regulation. The latter point is pivotal to initiate a paradigm shift. This is so as effective regulatory control and the standardisation of mHealth apps will eliminate the reluctance of pharmacists in promoting the technology and likewise stimulate patient-end use. Further work to compare the more traditional methods to support medication adherence and advanced strategies will be of great value within this field of healthcare. With more detailed investigation and development plus related management and assistance, we envisage a point in time where mHealth strategies (i.e. the promotion of medication adherence) will hold a prominent position within the field of healthcare and naturally bring benefit to the wider public health as a whole.

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CONFLICT OF INTEREST

None declared.

ACTITUDES DE LOS FARMACÉUTICOS, ESTUDIANTES Y PUBLICO EN GENERAL SOBRE APLICACIONES DE mHEALTH PARA ADHERENCIA A LA MEDICACIÓN

RESUMEN

Antecedentes: Durante los últimos años, la tecnología móvil se ha desarrollado enormemente y se ha infiltrado en el campo de la salud. Las aplicaciones, o apps, de sanidad móvil (mHealth) pueden usarse para apoyar la adherencia del paciente a la medicación y así promover los resultados óptimos del tratamiento y reducir el desperdicio de medicamentos.
Objetivo: Este estudio considerará las opiniones de los farmacéuticos, estudiantes de farmacia, y público en general del Reino Unido (UK) sobre el uso de apps de mHealth para promover la adherencia a los regímenes de medicación prescritos.
Métodos: Después de aprobación ética por la Liverpool John Moores University (LJMU), se distribuyó el cuestionario de 25 ítems entre los farmacéuticos registrados en las ciudades de Liverpool y Manchester (n=500), estudiantes de farmacia de la LJMU (n=420), y miembros del público en general en el centro de la ciudad de Liverpool (n=400). Las preguntas estaban formateadas en una escala Likert de selección múltiple o en respuestas abiertas. Se analizaron los datos utilizando frecuencias simples, tablas cruzadas, y pruebas no paramétricas en el programa SPSS v22.
Resultados: El número de cuestionarios completados por los farmacéuticos, estudiantes de farmacia y público en general fue de 245, 333 y 400; respectivamente. Los datos indicaron que el público general confiaba fuertemente en la rutina diaria de tomar la medicación como fue prescrita (54,1%), con un uso de apps de mHealth extremamente bajo (1,5%); tendencias similares se encontraron en las cohortes de farmacéuticos / estudiantes de farmacia. La edad de los individuos es un elemento importante a considerar, con la generación más joven proclive a envolverse con apps de mHealth y una generación mayor menos proclive. Aquí, la educación y la formación son importantes. Los farmacéuticos (82,3%) estarían de a favor de proporcionar paquetes de formación al público que a cambio está de acuerdo en recibir esa formación (84%). Las principales barreras que impiden el uso de apps de mHealth incluyen la fiabilidad de los datos, la seguridad y las dificultades técnicas.
Conclusión: Las apps de adherencia son una gran promesa para apoyar al paciente y sus necesidades de salud. Para aumentar la aceptación y la adopción, deben considerarse y construirse diseños simples y amigables. Además, esta tecnología requiere promoción efectiva y formación del usuario final para alcanzar su potencial completo. Por último, será esencial la regulación de las apps de adherencia para sobrepasar las preocupaciones subyacentes de los pacientes.

Palabras clave: Teléfonos Celulares; Computadores de Bolsillo; Cumplimiento de la Medicación; Preferencias del Paciente; Farmacéuticos; Cuestionarios; Reino Unido

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