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# A STUDY OF QUALITY CRITERIA OF MOBILE HEALTH APPLICATION FOR MEDICATION ADHERENCE: USER VIEWPOINTS

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**ABSTRACT**

Mobile health (mHealth) applications (apps) have been growing rapidly in the commercial market aligned with the increase in ownership of smartphones. The mHealth apps provide diverse functions from various areas including assisting individuals with complex and long-term treatments to adhere to their prescribed medications. However, several literatures reported a low number of mHealth apps that were considered good or high-quality medication adherence apps. Besides, there was a lack of user involvement in the current quality assessment tool of mHealth apps for medication adherence. This paper aimed to determine quality criteria for mHealth apps used for medication adherence based on the potential users of the apps. A survey was created based on Medication Adherence Application Quality (MedAd-AppQ) items and several criteria from relevant literature. The survey was distributed to patients and caregivers of chronic diseases through physical and online platforms. In total, 207 participants had completed the survey for this study, with 40% of the participants were chronic disease patients and 53% of the participants were the caregivers. Based on the findings, content reliability, feature usefulness, and feature convenience had positive correlation values, and feature convenience had the highest value with 3.40 (p-value <0.001). This paper revealed diverse quality criteria and categories that can be integrated into the current quality assessment tool or the design for mobile health apps. By providing new insights for app developers and health practitioners, this study hoped to enhance the advancement of current mHealth apps and eventually improve the health conditions of individuals with long-term diseases.
**Keywords:** *Medication Adherence, Mobile Health App, Quality Criteria.*

## 1. INTRODUCTION

A mobile application or mobile app refers to a software program that is operated in a mini wireless device that can be carried around easily such as tablet and smartphone [1]. It has been utilized by consumers in multiple fields including banking, gaming, financing, health centers, documentation, and communication. It is very convenient to use, and it assists a lot of individuals' daily tasks such as reading and replying to an email at any time without the need to stay in one place. Mobile health apps, also known as mHealth app refers to software programs that can be performed on mobile devices to assist users in health management and improve their well-being [2].

Mhealth app is designed and developed for various functionalities, including disease identification, disease management, medical information, and gathering and tracking of medical records [3]. Several mHealth apps were specifically created and utilized for symptom observation and contact tracking to manage infectious disease during the sudden coronavirus outbreak in early 2020 [4]. Aligned with the rapid increase of ownership of smartphones, the number of mHealth apps extensively increased in the commercial app market. According to 2022 data by the Statista.com website, there are about 41,517 mHealth apps on the Apple App Store [5] and 54,546 mHealth apps on Google Play Store [6]. Yet, current quality studies of these mHealth apps revealed concerning results.

It is crucial to ensure the quality of mHealth apps as the apps are not controlled by any organization's policy. A study by Cheng et al. found that more than 50% of the apps had provided faulty or missing information regarding infant feeding out of 47 apps [7]. Also, 21% of mHealth apps

developed for bipolar disorder provided incorrect information, in which one of the apps suggested alcohol intake to aid in sleep management during a manic episode [8]. These unreliable features in the apps may worsen users' condition and cause major concerns. Tremendous misinformation and harmful apps were prevented with the help of the World Health Organization (WHO), Google, Apple, and other major companies [4], leading to better and more effective responses in controlling the disease globally.

Therefore, this paper aimed to determine the criteria of the mHealth app for medication adherence from chronic disease patients' views. A survey derived from Medication Adherence App Quality (MedAd-AppQ) [9] with additional items from literature such as password features and rewards features was distributed to the potential users of the medication adherence app. These items were scored based on their importance level in the quality evaluation of the medication adherence app. This journal is an extension study from a published paper "*Users' Perception on Quality Medication Adherence Applications*" in *Advances on Intelligent Computing and Data Science*. Furthermore, this study emphasized potential users with chronic diseases experience, but not specific to certain conditions as different diseases require different measures and medication specifications.

## 2. LITERATURE REVIEW

### 2.1 Noncommunicable Diseases (NCDs)

Noncommunicable diseases (NCDs) or chronic diseases are diseases developed due to genetic, behavioral, and environmental factors of the individuals, and are not contagious from one person to another [10]. NCDs are responsible for 74% of worldwide deaths and have been a major health concern, especially in low- and middle-income countries [11]. Examples of NCDs include cancers, diabetes, chronic respiratory conditions, and cardiovascular diseases. The disease is also known as the "lifestyle" illness as it is developed by risky practices such as unhealthy diet, uncontrollable alcohol intake, and lack of physical workouts [12]. Thus, it is important to improve individuals' behavior such as in nutritional intake to minimize the risk of diagnosis with NCDs, which can be assisted through mobile app intervention [13].

### 2.2 Medication Adherence

Adherence to medication and prescribed dietary is important to ensure the effectiveness of the medication in enhancing health conditions and controlling the disease, especially for NCD patients. Despite medication aid to reduce health complications, it is reported that only 30% of patients in Malaysia adhere to their prescriptions [14]. The adherence rates for undeveloped countries are usually even lower [15] due to challenges including facilities, costs, and public awareness regarding the medications. Low adherence rates not only promote hospital readmission [16] and premature deaths [17], but generate huge medication wastage in the countries. An estimated US$ 375 billion can be saved per year with a high medication adherence rate [18]. Besides, RM 10 million worth of medication has been thrown away every year in Malaysia [19].

World Health Organization (WHO) defined medication adherence as the degree of a person's behavior regarding the intake of medication alongside the suggested diet and way of life as prescribed by the healthcare [15]. 80% or higher medication intake based on the healthcare provider's recommendations are considered good or high medication adherence rates [20]. A good medication adherence rate needs to be achieved to ensure the efficacy of medication intake, yet it is a complex issue which affected by numerous factors [15]. Medication adherence is influenced by factors including socio-economic factors, treatment factors, and healthcare system-related factors (as shown in Figure 1) [15]. Patients who did not take medication based on the healthcare suggestion and did not fulfill their scheduled appointments regularly, are likely to non-adherence [21].

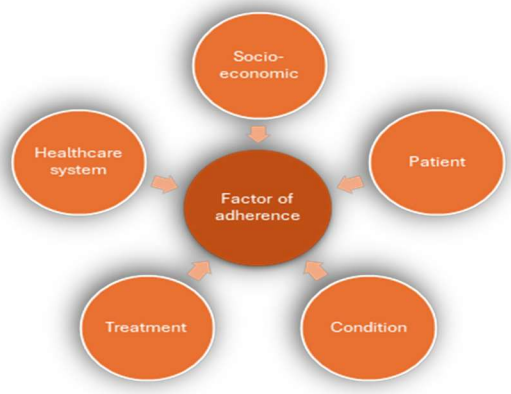


*Figure 1: The factors of medication adherence*

Therefore, multiple interventions were thoroughly designed and produced to enhance adherence rates by tackling the concerns in the medication adherence factors. Interventions conducted by pharmacists assist in increasing medication adherence by determining the patients' challenges in adherence [22]. Besides, intervention through technological advancements such as message services, digital pillboxes, and mobile apps have also shown effective outcomes in increasing medication adherence rates by aiding patients' medication management [23]. This study focused on functions and features that were deemed important in medication adherence apps targeting patients with long-term conditions.

### 2.3 MHealth App for Medication Adherence

There are more than 165,00 mHealth apps available to 8 billion mobile users [23], which can be utilized to improve their health condition through diverse approaches. In addition, there are around 24% of the mHealth apps have been developed for medication and disease management [24]. The mHealth app is one of the most cost-effective interventions for medication adherence compared to other technological interventions and the app supports users' convenience of use through personalization [25]. Besides, the apps provide security protections for users' information and data, which are exclusively accessible to the users.

MHealth apps provide features including medication intake reminders, health parameters records, medical information availability, and a medium for supporting the community to promote adherence rates for various health conditions [26]. Besides, features based on persuasive techniques were incorporated in the development of a mobile app for medication adherence. Apps with features tailored to persuasive techniques such as self-monitoring, rewards, and goal setting enhance medication adherence by emphasizing behavioral changes [27]. Besides, frameworks such as Orem's theory on self-care and Kolb's experiential learning theory were utilized in developing medication adherence apps [23].

Previous literature reported significant increments in adherence rates especially for patients with chronic diseases through the utilization of mHealth apps [26]. However, most of the medication adherence apps were considered low-quality, and the current app store was poorly regulated [28]. Previous research has mentioned potential safety risks and negative health outcomes due to faulty features in mHealth apps. For example, mHealth apps provided incorrect alcohol information to users causing an increased amount of alcohol consumption and increased anxiety [29].

Therefore, it is important to thoroughly evaluate medication adherence apps that are available in the marketplace before recommending them to the users. Currently, there are various methods and tools available to evaluate the quality of mHealth apps, however, most of the tools were designed specifically for experts [30]. Thus, this study aimed to provide quality criteria based on potential users' viewpoints of medication adherence apps, as it is essential to incorporate users' perspectives during the development process to enhance the mHealth app's quality [29]. Besides, this study is conducted to assist developers and researchers in understanding users' expectations when designing medication adherence apps.

### 2.4 Existing Quality Criteria of MHealth Apps

The quality criteria in this study were explored based on the current assessment methods and tools developed for medication adherence apps. During the reviews, it was found that most of the criteria were similar between the tools, however, the criteria were structured or organized in the different domains based on the authors' perspectives (see Table 1). Some are divided based on the intervention strategies and others are divided based on the functional features available in the app.

Santo et al. evaluated mHealth apps for medication alerts through 17 desirable features and via an assessment tool, which was Mobile Apps Rating Scale (MARS) [28]. MARS is one of the widely utilized tools in evaluating the quality of mobile apps and mHealth apps. Through the classification process, more than 50% of medication reminder apps were considered advanced apps with a higher number of features compared to the remaining basic apps. Examples of the features were flexible scheduling, medication intake records, personalized notifications, refill alerts, and adherence statistics.

Next, adherence apps were evaluated based on five domains including health literacy, general features, connectivity, adherence attributes, and medication management [31]. The Health Insurance Portability and Accountability Act (HIPPA) statement was also included as one of the quality

criteria in the general features. Besides, Ahmad et al. designed a quality evaluation tool for medication adherence apps based on the intervention strategies [32]. The Medication Adherence Application Quality (MedAd-AppQ) tool included various criteria, which were divided into three categories including content reliability, feature usefulness, and feature convenience to tackle multifactorial non-adherence behaviors.

*Table 1. Existing quality evaluation tools*

| Author | Summary | Assessment Tool and Domain |
|---|---|---|
| Santo et al. (2016) | The authors evaluated the quality and features of medication reminder apps through classification and existing evaluation tool. | 1. Apps classification:<br>- apps with basic features<br>- apps with advanced features<br>2. Mobile App Rating Scale (MARS)<br>- engagement<br>- functionality<br>- aesthetics<br>- information quality<br>- subjective quality |
| Dayer et al. (2017) | Dayer et al. assessed the highest ranking of medication adherence apps and correlated the results with the consumer ratings of the apps. | - adherence attributes<br>- medication management<br>- connectivity<br>- general features<br>- health literacy |
| Ahmed et al. (2018) | The authors designed an assessment tool to evaluate the quality of medication adherence apps by integrating various intervention features and reliability criteria of the app. | Medication Adherence Application Quality (MedAd-AppQ tool<br>- content reliability<br>- feature usefulness<br>- feature convenience |
| Park et al. (2019) | Park et al. categorized and evaluated medication adherence apps based on the behavioral and educational interventions' frameworks. | - availability of quality features<br>- user-friendliness |

Lastly, Park et al. assessed mHealth apps developed to enhance medication adherence through user friendliness evaluation and availability of adherence features in the apps [33]. 12 adherence features from educational and behavioral interventions were utilized in evaluating the quality of medication adherence apps. Based on the existing evaluation methods and tools explored through literature reviews, the author adopted the MedAd-AppQ tool for this study as the tool contained criteria from various intervention strategies to enhance medication adherence.

## 3. METHODOLOGY

### 3.1 Research Phases

This research consisted of three phases to determine the quality criteria of medication adherence apps from users' views, which include criteria identification, survey development, and survey distribution (as shown in Figure 2). The first phase was the identification of the appropriate quality criteria for the medication adherence app. The criteria were studied through the literature on the existing techniques and instruments of evaluating mobile apps and mHealth apps for enhancing medication management. Based on the literature reviews, criteria and items in the Medication Adherence Application Quality (MedAd-AppQ) tool were selected for this study, as the tool development focused on medication adherence [9].

Next, a survey was created based on the MedAd-AppQ tool and several additional criteria using Microsoft Forms. Then, six experts from the healthcare and information technology field reviewed and provided feedback to improve the developed survey. A pilot study was also conducted with 39 participants, which revealed good reliability results with Cronbach's Alpha (CA) values higher than 0.70 for all three categories. The survey was finalized and items from the Subject Quality of MARS were added as the quality indicator. The items in the survey will be elaborated on in the next subsection.

Lastly, the finalized survey was distributed to convenient sampling for three months via online mediums such as Facebook and WhatsApp. The criteria of the participants were adults with chronic disease experience as the patients or the caregivers. In addition, physical version of the form was also distributed to increase the number of participants. The results were analyzed using Spearman

correlation to investigate the relationship between criteria and the quality of the app.

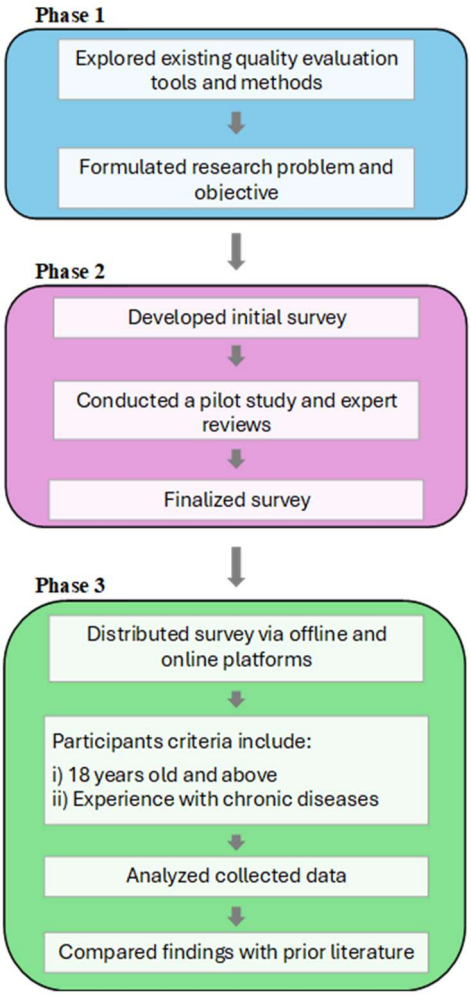


*Figure 2: Flow of research phases*

### 3.2 Quality Criteria of Medication Adherence App

Existing studies were reviewed to find suitable quality criteria for evaluating the mHealth app in assisting medication adherence. The items were derived from the MedAd-AppQ tool as mentioned in the previous section. The items in MedAd-AppQ tools were divided into three categories, which were content reliability, feature usefulness, and feature convenience (see Figure 3). Each statement was modified to suit the sentences for the survey, which led to differences in the number of items between the original tool and the survey developed.

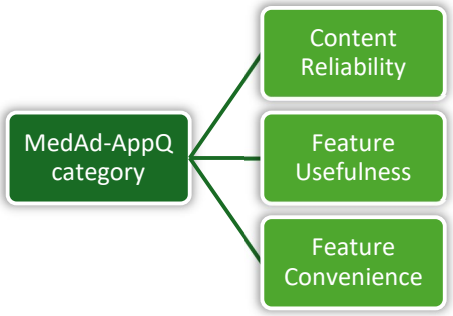


*Figure 3: Criteria categories of MedAd-AppQ tool*

One subcategory, named adherence rates was added to feature usefulness, with 2 new criteria derived from other literature [34][28]. Furthermore, 5 new criteria were added to feature convenience, which were language features, password features, flexibility of alarm sounds, customizable time zones, and compatibility of wearable device ([28], [32]. In total, content reliability consisted of 7 criteria, measured by 14 statements, feature usefulness consisted of 17 criteria, measured by 28 statements, and feature convenience had 7 criteria with 9 statements. Lastly, 4 statements were adapted from the subjective quality of the user version of the MARS as the indicator of medication adherence apps' quality.

A 5-point Likert scale was utilized to assess each statement in the survey. The scale started with point 1 as strongly disagree, point 2 as disagree, point 3 as neutral, point 4 as agree, and point 5 as strongly agree. Besides, participants were allowed to recommend new criteria in the provided box at the end of each category. In addition, the survey was made available in two languages, which were English and Bahasa Melayu (BM). The survey was distributed through both online platforms (using Microsoft Forms) and offline platforms (physical version).

## 4. RESULTS

### 4.1 Demographic Analysis

This survey was distributed for three months, and 211 respondents met the participant's criteria. This section explains the results and analysis of the current data, which was executed using IBM SPSS Statistics version 29. Missing data in the demographic section were ignored and missing data in the criteria section were imputed with median values as the data is in ordinal form. During the cleaning process, 4 outliers were removed, and the

remaining 207 results were analyzed. The detailed demographic can be seen in Table 2.

The survey was filled by 63.8% (132) females, followed by 35.8% (74) males, and one gender of the respondents was unable to be identified due to missing value in the survey. Around 32.9% (68) of the respondents were between the ages of 18 years old to 24 years old, 25.1% (52) respondents were in the range of 45 years old to 54 years old, and 17.9% (37) respondents were between 25 years old to 34 years old. Only one respondent was in the category of 75 years old and above.

*Table 2: Demographic percentage*

| Demographic | Category | *f* | Percentage (%) |
|---|---|---|---|
| Gender | Male | 74 | 35.75 |
| | Female | 132 | 63.77 |
| Age | 18 - 24 years old | 68 | 32.85 |
| | 25 - 34 years old | 37 | 17.87 |
| | 35 - 44 years old | 25 | 12.08 |
| | 45 - 54 years old | 52 | 25.12 |
| | 55 - 64 years old | 19 | 9.18 |
| | 65 - 74 years old | 5 | 2.42 |
| | 75 years old and above | 1 | 0.48 |
| Education level | SPM or equivalent level | 23 | 11.11 |
| | Certificate | 5 | 2.42 |
| | Diploma | 32 | 15.46 |
| | Bachelor's Degree | 110 | 53.14 |
| | Master's Degree | 18 | 8.70 |
| | Doctorate Degree | 6 | 2.90 |
| | Others | 13 | 6.28 |
| Income group | Low-income | 123 | 59.42 |
| | Middle-income | 80 | 38.65 |
| Nationality | Malaysia | 199 | 96.14 |
| | Others | 8 | 3.86 |

*Table 3: Demographic background on chronic disease*

| Demographic | Category | *f* | Percentage (%) |
|---|---|---|---|
| Experience in chronic condition | Yes, currently still experience the chronic condition | 59 | 28.50 |
| | Yes, but not anymore | 23 | 11.11 |
| | I am answering this survey as a caregiver | 110 | 53.14 |
| | No | 15 | 7.25 |
| Type of chronic condition(s) | Asthma | 39 | 18.84 |
| | Chronic obstructive pulmonary disease | 2 | 0.97 |
| | Diabetes | 77 | 37.20 |
| | Hyperlipidemia (High cholesterol) | 29 | 14.01 |
| | Hypertension (High blood pressure) | 84 | 40.58 |
| | Ischemic heartdisease | 18 | 8.70 |
| | Stroke | 15 | 7.25 |
| | Others | 30 | 14.49 |
| Period of experiencing the chronic condition(s) | Less than 6 months | 20 | 9.66 |
| | 6 to 12 months | 19 | 9.18 |
| | 1 to 2 years | 43 | 20.77 |
| | 3 to 5 years | 54 | 26.09 |
| | More than 5 years | 69 | 33.33 |
| Type of medication(s) prescribed | None | 4 | 1.93 |
| | 1 type of medication only | 28 | 13.53 |
| | 2 - 3 types ofmedications | 94 | 45.41 |
| | More than 3 types of medication | 79 | 38.16 |

Around 65% of the respondents were in tertiary education with 53.1% (110) respondents having bachelor's degrees, 8.7% (18) respondents with master's degrees, and nearly 3% (6) respondents with doctorate. The remaining respondents had secondary and post-secondary education, including Malaysian Education Certificate and relevant certificate with 11.1% (23), Malaysian Higher School Certificate with 4.8% (10),

and diploma with 15.5% (32). 59.4% (123) of the respondents were in the low-income class and 38.7% (80) respondents were in the middle-income class.

Less than 12% (24) of respondents were reported to have experience in utilizing mobile apps for medication adherence (see Figure 4). Examples of the mobile apps listed by the respondents were MyFitness, MyUBAT, Dosecast, Naluri, HealthifyMe, Health, and Samsung Health. The respondents downloaded the apps to manage their medication (13) and their family members' medication (10), especially for their parents and grandparents. More than 53% (110) of respondents were caregivers and around 40% (82) of the respondents were patients with chronic conditions (as shown in Table 3). About 7.3% (15) of the participants ticked "No" for experience with chronic illness but were included in the analysis as they provided the illness information in the next questionnaires of the survey.

The top three of the most common chronic conditions experienced by the respondents were hypertension (40.6%), diabetes (37.2%), and asthma (18.8%). Nearly 30% (60) of the respondents answered more than one type of chronic condition. Furthermore, 14.5% (30) of respondents mentioned other types of conditions including kidney failure, cancer, and Alzheimer's. The conditions were mostly experienced for more than 5 years (33.3%), then between 3 to 5 years (26.1%) and between 1 to 2 years (20.8%). Below 2% (4) of the respondents were not prescribed medication for their condition, while 45.4% (94) of the respondents were prescribed 2 to 3 types of medication.

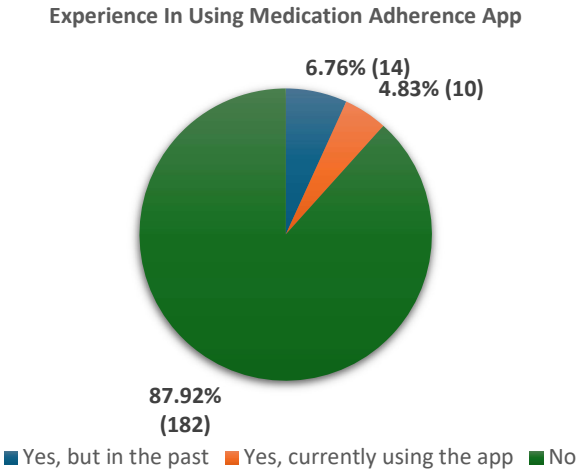


*Figure 4: Percentage of medication adherence app utilization*

### 4.2 Statistical Analysis

Each statement in the survey was measured by a 5-point Likert scale, where a high point refers to agreeing with the importance of the item as a quality criterion for medication adherence and a low point refers to disagreeing with the item as a quality criterion for medication adherence app. Table 4 below displays the value of three categories in this study, which was between 3.93 to 4.38. This indicated that respondents highly agreed that content reliability, feature usefulness, and feature convenience are important quality criteria for medication adherence apps. The standard deviation value was also low among the respondents as all values were below 1.0.

*Table 4: Mean and standard deviation values*

| Category | N | Mean | Std. Deviation |
|---|---|---|---|
| Content Reliability (CR) | 207 | 3.93 | 0.77 |
| Feature Usefulness (FU) | 207 | 4.38 | 0.67 |
| Feature Convenience (FC) | 207 | 4.22 | 0.72 |

The sampling of this study was adequate as the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy Test was more than 0.6, with 0.939 and Bartlett's Test of Sphericity was significant, with *p* value less than 0.001. Based on the factor analysis test, 5 statements of Content Reliability and 4 statements of Feature Usefulness were deleted due to the low value of factor loading (below 0.5). The total Variance Explained for this study was 63.81%, by factor 1 with 31.83%, factor 2 with 19.04%, and factor 3 with 12.92%. Furthermore, Cronbach's Alpha (CA) was used to measure the reliability calculated to measure the validity of the survey. The CA values in Table 5 below indicated that the survey was reliable as the CA values for all categories.

*Table 5: Cronbach's Alpha values of the categories*

| Category | CA | N of Items |
|---|---|---|
| Content Reliability (CR) | 0.880 | 9 |
| Feature Usefulness (FU) | 0.975 | 24 |
| Feature Convenience (FC) | 0.933 | 9 |

Lastly, correlation analysis was conducted using Pearson Correlation to measure the relationship between the criteria and quality. Table 6 revealed a positive correlation for all criteria in CR, FU, and FC except for the second criterion for CR, which was privacy regulations and disclaimers. The same criterion was the only criterion that did not achieve significant correlation as its p-value of 0.100 is bigger than the 0.01 significant level. CR consisted of two criteria with a total of 9 items, FU consisted of four criteria with a total of 24 items and FC is directly measured with a total of 9 items.

Based on the correlation values, FC had the highest correlation with 0.340, p-value <.001, and CR had the smallest correlation with 0.270, p-value <.001. Although all the categories and criteria except the privacy regulations and disclaimers had a positive correlation, the correlation values were considered small in determining the quality of medication adherence apps.

*Table 6: Correlation values of the criteria*

| Criteria | N of Items | Pearson Correlation | p-value |
|---|---|---|---|
| **Content Reliability (CR)** | **9** | **0.270**** | **0.000** |
| 1. Details of the app's developer and intended user | 8 | 0.275** | 0.000 |
| 2. Privacy regulations and disclaimers | 1 | 0.115 | 0.100 |
| **Feature Usefulness (FU)** | **24** | **0.317**** | **0.000** |
| 1. Ability to schedule medication | 3 | 0.260** | 0.000 |
| 2. Ability to monitor and backup | 10 | 0.297** | 0.000 |
| 3. Ability to provide information | 5 | 0.322** | 0.000 |
| 4. Ability to notify | 6 | 0.282** | 0.000 |
| **Feature Convenience (FC)** | **9** | **0.340**** | **0.000** |

** Correlation is significant at the 0.01 level (2-tailed).

## 5. DISCUSSION

The objective of this paper is to identify the quality criteria of medication adherence apps based on the user's perceptions. Based on the findings, all three categories had a positive correlation with the quality of medication adherence apps, indicating that participants in this study believed the criteria in this research would increase the quality of the mHealth apps. This study revealed the importance of including details of developers and healthcare professionals in the app's information to enhance the app's quality. In addition, previous literature has reported that apps with good credibility have been associated with better user engagement [35]. Privacy statement criteria were crucial in defining good quality apps, as safety concerns such as unauthorized access to the user's personal data might reduce app utilization by the user [36].

Next, most of the criteria in FU showed positive correlation values, indicating that these criteria were positively valued to be included in medication adherence apps. It is essential to include scheduling and saving features in these apps as it is the main features for medication management apps [28]. Besides, the apps should include information features to provide the right medical data, and reminder features to alerts for medication refills and intakes. These criteria were also emphasized as the desired features for coronary heart disease patients [37]. Furthermore, FC had the highest correlation value, indicating the respondents appreciated features that ease the use of the medication adherence app, including password features, language options, and compatibility with wearable devices, which supported by similar studies [28]-[32].

The end-users of the medication adherence app in this study refer to the patients or caregivers with the need for medication management assistance. This research emphasized on chronic disease patients as they are more likely to monitor their health compared to the people with no health issues [38]. All respondents in this study had experienced with chronic disease, where 110 respondents were the caregivers, and the rest were chronic disease patients. The exposure to the chronic disease was important to ensure valid results in rating the quality criteria as user perceived quality based on the addressed concern [39], which was enhancing medication adherence or assisting the medication management.

During the factor analysis computation, 9 items were removed from CR and FU, which led to the remaining 43 items being analyzed. In the CR category, 3 items from details of the developer and intended user criteria and 2 items from privacy regulations and disclaimers were deleted, causing the last criterion, privacy regulations and disclaimers to be measured with only one item. Meanwhile, 4 items from the FU category were all under adherence rates criteria, which caused the entire criteria to be deleted. This research achieved a strong reliability value, which is common in quality assessment studies [40]-[41]. However, the results of this study revealed weak and moderate correlation values between criteria and the quality of medication adherence apps, compared to strong correlation values in the original work [9].

This might have been caused by different perspectives on the quality criteria as the original tool was evaluated by the experts, meanwhile, this study was rated by the potential users. A similar study by Kuttal et al. showed that developers and users had different views on the quality criteria and feedback for mobile apps, where most of the high ratings apps on the user platform had relatively low ratings in the developer platform [42]. In this study, details of the developers and intended users had a higher correlation compared to the privacy regulations as new items regarding healthcare representative information were added to the criterion. The results aligned with previous literature, where patients and users were more likely to download and utilize mHealth apps with healthcare or organization credentials [43].

Besides, the weak correlation values might be affected due to the low number of respondents with the experience of using the mHealth apps for medication adherence. Research conducted by Kheirinejad et al. in 2022 reported that there was a significant difference in perspectives regarding mHealth apps between users and non-users [44]. There were only 24 respondents (11.6%) had downloaded and used the medication adherence app. This might be due to a large number of respondents being caregivers (53.15%) who had good health conditions, and thus did not need to utilize the mHealth app for medication management. This result aligned with a study by Lee et al. which mentioned that only 20% out of 4,504 Malaysians were familiar with the mHealth app, while more than 60% of them had no awareness regarding healthcare-related mobile apps [45].

In addition, the small sample size of participants might cause weak and moderate correlation values. This study faced difficulty in achieving an adequate number of potential users with experience of chronic conditions, despite one in five Malaysian adults living with diabetes [46]. This might be due to misconceptions of the chronic diseases by the participants. This can be seen when 15 respondents had chosen no experience of chronic disease, however, they reported on diseases such as asthma or hypertension when being asked about the disease details in the next section of the survey, including their medication prescriptions.

Although the correlation values in this study were weak and moderate, it is hoped that the results can be beneficial to the practitioners, researchers, and developers in creating and enhancing features of current mHealth apps. The criteria can be integrated into the current framework and guidelines for assessing mobile apps in related fields. However, further investigation is required to determine the deeper impact of each criterion on the quality of mHealth apps. Moreover, apps targeting specific chronic conditions such as diabetes may require tailored functions and features to increase the effectiveness of the mobile intervention in enhancing medication adherence. This study was conducted to determine the quality criteria for mHealth apps targeting general chronic condition patients and did not depict the usability or efficacy of the mHealth apps.

## 6. PRIOR WORK

Compared to other studies, this research emphasized obtaining direct user feedback and expectations on quality criteria of mHealth apps designed to improve adherence rates among general chronic disease patients. Previously, researchers have been evaluating the quality of mHealth apps from users' perspectives through analysis of apps' ratings [47]. Besides, there were various studies in gaining users' feedback highlighting the effectiveness of mHealth apps [48], yet lack of studies involving direct user perspectives in assessing the quality of mHealth apps targeting general chronic disease. Besides, this study emphasized the quality of mHealth apps developed for enhancing medication adherence, in which certain criteria were not included in the established assessment tools such as the user version of the Mobile Apps Rating Scale (uMARS) [49].

The main findings of this study are to provide researchers and developers with insightful perspectives and expectations of potential users among chronic disease patients on their desired mHealth apps. This study found that the respondents highly prioritize the criteria that can ease them in utilizing the apps such as providing autocomplete text, text recognition, and a barcode scanner for data entry. Therefore, developers should include various convenience features to increase apps' usability, especially for the elderly and patients with difficulties, to improve the overall quality of the mHealth apps.

## 7. CONCLUSION

In conclusion, mHealth apps have been widely available in the commercial marketplace for various functionalities including health monitoring, weight management, and medication adherence. As there are minimal regulations and restrictions in developing these apps, users should ensure to choose credible and high-quality apps to assist their lives. Faulty features might cause negative effects on users' health for a long duration. Therefore, this study is conducted to explore new insights into the quality criteria perceived by chronic disease patients and caregivers. Further research on the effect of high-quality apps on the usability of the app should be explored to ensure the effectiveness of mHealth apps in achieving their intended purpose.

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