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Digital Health Solutions for Chronic Illnesses: A Systematic Review of Mobile Health Apps and Quality Analysis with Mobile App Rating Scale

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Abstract: Currently, more than half of the adults worldwide have at least one chronic condition; however, poor medication adherence and self-management are observed. Tools, such as mHealth apps, may play a crucial role for millions of people in increasing the patients' involvement in the treatment process. The purpose of this study is to evaluate the characteristics and quality of the existing mHealth apps for patients with various chronic conditions. The study was conducted from February 1 to March 31, 2022. The mHealth applications' search was performed on the iOS platform, and 29 apps were included in the final analysis. The quality of apps was evaluated using Mobile App Rating Scale. The majority of the apps had symptom and medication tracking functionality. The mean score of apps' overall quality was 3.45 (SD = 0.61) out of five, ranging from 2.04 to 4.50. The highest-rated category was the functionality of the app—3.75 (0.61); followed by aesthetics—3.67 (0.62); subjective quality—3.47 (0.88); engagement—3.33 (0.78); and information—3.04 (0.61). The study revealed that only a few high-quality apps for chronic condition management exist, and there is still some space for improvements.

Keywords: digital health; mHealth; apps; mobile apps; smartphone apps; chronic disease; chronic condition; symptom tracker; medication tracker

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1. Introduction

Healthcare systems around the world are facing significant challenges, predominantly caused by the huge burden of chronic diseases [1–6]. Even though people's lifespan continues to increase, especially in the higher mid-income and high-income countries, the global prevalence of diseases increases accordingly, raising questions about whether the health span is growing as well [7–9]. As a result of an aging population, it is currently estimated that more than half of the adults worldwide have at least one chronic condition, while up to one-third are suffering from multiple chronic conditions (MCCs) [1,10–12]. The fast-growing health burden is indisputable, with non-communicable diseases (NCDs) accounting for nearly three-fourths of yearly deaths globally [13]. Moreover, around 15 million people each year experience premature death from an NCD between the age of 30 to 69 years [13]. Chronic cardiovascular diseases, cancer, respiratory diseases, and diabetes are being identified as the most common NCDs, having the greatest influence in increasing the disability-adjusted life years (DALYs) and accounting for the majority of deaths globally every year [1,6,13]. In addition to that, the prevalence of chronic mental health conditions, such as depression and anxiety, has also increased significantly, especially since the beginning of the COVID-19 pandemic, thus, moving mental health up the list of global health burdens [14,15]. Therefore, despite the rise in overall life expectancy, years of life lost due to premature death or years lived with a disability will continue to grow.

Even though the number of chronic morbidities is growing, poor adherence to treatment plans and lack of self-involvement in health management is being observed. Two-thirds of adults have at least one prescription drug used every month, while around two out of ten use at least five [16]. However, roughly 50 percent of the patients fail to stick to their medication schedule, which in turn substantially increases the DALYs [17,18]. Thus, a huge demand for new patient-centered solutions to reach better patient-reported outcomes has emerged. In order to assist and augment healthcare quality and accessibility, there is room for innovation; therefore, digital healthcare solutions could be of particular importance. COVID-19 pandemic was yet another setback that helped digital health gain momentum and accelerated its integration into clinical practice, which is believed to have just unveiled itself and will continue to grow successfully [19–21]. With around five billion smartphone users globally, the possibility of tackling healthcare issues with mobile health (mHealth) applications are proven to be possible [22]. Simple tools, such as mHealth apps for symptom and medication tracking, may play a crucial role for millions of people globally in keeping track of an individual's health between visits and increasing patients' involvement, active and timely participation in the treatment process, improving self-management, and expanding the reach of certain health care services, therefore, enhancing patients' outcomes and reducing DALYs. Germany was probably one of the first countries to understand the benefits of smartphone app use in healthcare; thus, in 2019, they ratified the Digital Healthcare Act, successfully introducing prescription mHealth apps for patients to clinical practice with over 30 accepted prescribable digital healthcare applications for different chronic health conditions existing up to date [23–26].

Currently, many different mHealth apps already exist, and new ones are being developed: from simple health tracking, wellbeing, and fitness apps, to chronic condition-specific apps designed for mental health issues, substance abuse problems, chronic obstructive pulmonary disease, and other respiratory problems, diabetes, chronic pain syndromes, cardiovascular diseases, migraine, and other headache disorders, sleeping disorders, cancer, or medication adherence and management tools [27–43]. While the assortment of mHealth apps is high, studies evaluating the quality of these apps are insufficient. In addition to that, none of the studies addressed the possible effect of universal all-in-one mHealth apps that are developed to manage and track not one specific but many different chronic conditions on the patient-reported outcomes, nor evaluated the quality and characteristics of such applications. Therefore, in this study, we aim (1) to evaluate the characteristics and quality of the existing mHealth apps with symptom and medication tracking functionality, designed for patients to track and manage various chronic conditions, (2) to assess the current involvement of healthcare organization in the mHealth applications' development process, (3) to evaluate the main symptom and medication tracking functionality of such applications, and (4) to analyze the differences between existing mHealth applications. Finally, we will discuss the possible health-related advantages of mHealth applications.

2. Methods and Materials

2.1. Study Design

An observational, descriptive study of smartphone apps was conducted during the period of 1 February to 31 March 2022. The search was performed for patients with different chronic conditions for apps available on the iOS platform. The quality of mobile apps was evaluated using Mobile App Rating Scale (MARS) [44].

2.2. Eligibility Criteria

The search was performed in the Apple App Store (Table S1) by three independent reviewers (i.e., health professionals) with expertise in healthcare (specifically, in nursing, physiotherapy, and rehabilitation). The following search terms were used: *symptom tracker, chronic illness, chronic condition*. Only apps in the English language with symptoms' tracking functions for MCCs, designed specifically for patients or their caregivers, were included.

All apps, regardless of their cost (free, free with premium features, or paid), were equally eligible. Apps that were last updated five years ago or more were not included in the study.

Apps created for health care personnel, specific and limited to one certain chronic condition, or with diagnostic, informative, or educational purposes were not included in the study. The systematic apps review process flow chart was based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis PRISMA guidelines [45,46].

2.3. Data Extraction and Quality Evaluation

Apps were analyzed by three independent health professionals. Prior to the research and evaluation process, the reviewers have carefully read and analyzed the research studies on MARS and then participated in the MARS scale training course held by Vilnius University of Applied Sciences Electronics and Computer Engineering department specialists. All of the reviewers independently performed smartphone apps search in the Apple App Store. First, the reviewers screened the title and description pages of the apps, and then the potentially eligible apps that met the selection criteria were downloaded, installed, and tested on iPhone 11 pro mobile phone. For applications that required payment to obtain access to all of the application's premium features, the reviewers have bought the subscriptions. Basic information such as app category, cost, and time of last app update was collected. After installing the app, symptom and medication tracking functions were further evaluated.

Lastly, the smartphone app analysis was conducted using the MARS—a multidimensional and reliable tool to evaluate the quality of mHealth apps [44]. Overall, the MARS scale covers five main app quality criteria with 23 subcategories assessed in total: engagement (entertainment, interest, customization, interactivity, target group), functionality (performance, ease of use, navigation, gestural design), aesthetics (layout, graphics, visual appeal), information (accuracy of app description, goals, quality and quantity of information, visual information, credibility, evidence base), and subjective quality (app recommendation, frequency of use, willingness to use, overall app rating). Each of the subcategories is evaluated on a 5-point scale, with 1-point meaning inadequate quality and 5-points—excellent quality. After assessing every item, the mean score for each of the separate categories and the overall app quality score from all five categories are calculated. Finally, mean scores from independent reviewers for every mHealth app were derived.

2.4. Statistical Analysis

Continuous variables were presented with mean score and standard deviation (SD) or median and interquartile range (IQR), as appropriate, and categorical variables—with frequencies and percentages. The Student's *t*-test or Mann–Whitney U test was used to compare the quantitative variables, as appropriate. $p < 0.05$ (two-sided) was considered to be statistically significant. Statistical analysis was performed with IBM SPSS Statistics 23.0 software (IBM Corp, Armonk, NY, USA).

3. Results

3.1. Eligibility

In total, 366 potentially eligible mHealth apps were identified in the Apple App Store (Figure 1). After evaluating the name, category, description, and visuals of the app available on the Apple App Store, 320 apps were excluded from the study. The remaining 46 apps were selected for further screening and downloaded to assess eligibility. After evaluating the downloaded apps, 17 did not match the inclusion criteria, and 29 mHealth apps were finally included in the descriptive analysis.

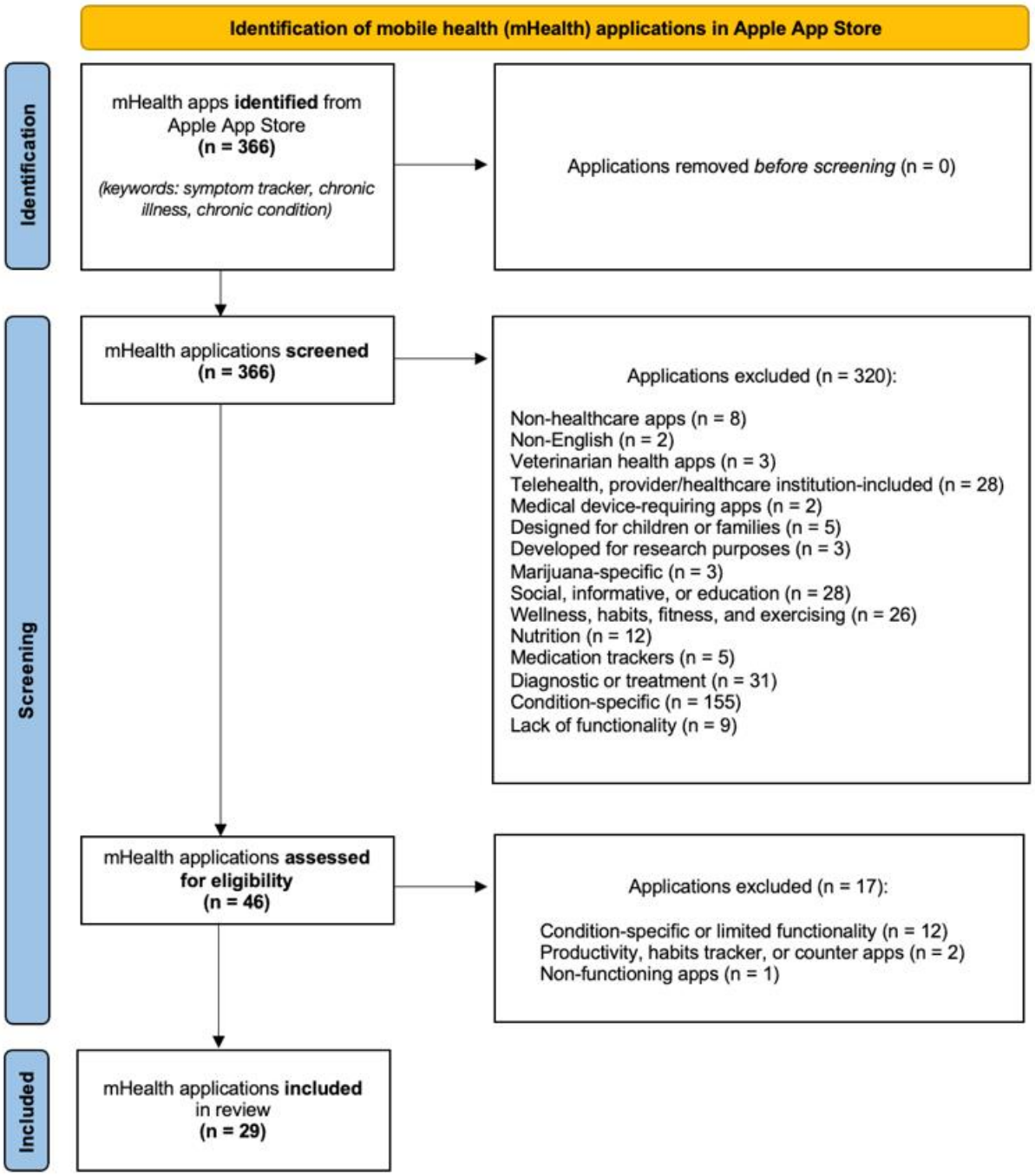

Figure 1. PRISMA flow diagram for systematic mobile health (mHealth) applications search conducted in Apple App Store.

3.2. Overview of the mHealth Apps

The majority of eligible mHealth apps were described under the "Health & Fitness" category (19/29, 65.2%), while the remaining were described as "Medical" apps (10/29, 34.5%). None of them were developed by a healthcare organization. Twenty-one apps (72.4%) were last updated by the developer from one week up to one year ago, another seven apps (24.1%) were last updated one-to-four years ago, and one app (3.4%) was never updated since the release of the app. The average App Store rating was 4.17 out of 5. Twenty-two mHealth apps (75.9%) were only available to use after registration. Out of all the apps, 11 (37.9%) were completely free to use, and two (6.9%) required a one-time payment for premium app features, with a median price of USD 6.99. The other 10 (34.5%)

apps provided premium features with monthly or annual subscriptions, with the average price of USD 4.99 (IQR [4.24–6.99]) per month. The remaining six (20.7%) were paid-only apps—one (3.4%) app required a one-time payment of USD 4.99, and the other five (17.2%) were based on a subscription model (monthly or annually) with a median price of USD 4.99 [2.99–8.49] per month. Free mHealth apps with available premium features offered a median of three [0–7] days of a free trial, while paid-only apps—seven [0–18.5] trial days. The general app characteristics are described in Table 1.

Table 1. Overview of mHealth apps included in the study.

Characteristics (*n* = 29)		
Apple App Store category, *n* (%)		
Health and Fitness	19 (65.2)	
Medical	10 (34.5)	
Time of the last update, *n* (%)		
1 week—9 months ago	21 (72.4)	
2 years—4 years ago	7 (24.1)	
Never updated since the release	1 (3.4)	
Average App Store rating (max. 5)	4.17	
Registration, *n* (%)		
Required	22 (75.9)	
Not required	7 (24.1)	
Cost, *n* (%)		
Free, no premium features	11 (37.9)	
Free, one-time payment for premium features	2 (6.9)	
Free, subscription for premium features (monthly or annual)	10 (34.5)	
Paid, one-time payment	1 (3.4)	
Paid, subscription required (monthly or annual)	5 (17.2)	
Price, median (IQR)		
One-time payment for premium	USD 6.99	-
Monthly premium subscription	USD 4.99	[4.24–6.99]
One-time payment	USD 4.99	-
Monthly subscription required	USD 4.99	[2.99–8.49]
Duration of the trial version, days median (IQR)		
Free, with premium features	3 (0–7)	
Paid	7 (0–18.5)	

3.3. Symptom and Medication Tracking Functionality

Further, we evaluated the mHealth apps' symptom and medication tracking functionality (Table 2). All of the apps were assessed for eight main symptom and medication tracking functions. App-provided symptoms list was available in 22 out of 29 (75.9%) apps, and the possibility to manually add new symptoms—in 27 (93.1%) apps. The possibility to indicate symptom severity or add additional notes was observed, respectively, in 28 (96.6%) apps and 26 (89.7%) apps. A graphical summary of the symptoms was available in 27 (93.1%) apps, while a possibility to export the data—in 26 (89.7%). Additionally, medication and supplement tracking possibilities were observed in 19 (65.5%) apps; of those, 13 (44.8%) offered reminders for medications. Overall, every mHealth app included in the study was able to track many different symptoms at a time.

Table 2. mHealth apps symptom and medication tracking functionality.

mHealth App Name	Symptom Tracking Function							
	Symptoms Listed	Possibility to Add New Symptoms	Symptoms Severity	Possibility to Add Notes	Graphical Summary	Data Export	Medication Tracking	Medication Reminders
Effecto Symptom Tracker	•	•	•	•	•	•	•	•
Wave: health and symptom tracker	•	•	•	•	•	•	•	•
CareClinic—Tracker, Reminder	•	•	•	•	•	•	•	•
Healthily: Self-care and Tracker	•	•	•	•	•	•	-	-
Moodflow	-	•	•	•	•	•	•	-
Symptom and Mood Tracker	•	•	•	•	•	•	•	•
Avanti	•	•	•	•	-	•	•	-
Journal My Health	•	•	•	•	•	•	•	-
itFeels	•	•	•	•	•	•	-	-
Crystal™	•	•	•	•	•	•	•	•
Folia Health	•	-	•	•	•	•	•	-
Wanngi Health tracker	•	•	•	•	•	•	•	•
Medication Reminder—Care	•	•	-	•	•	•	•	•
Health Storylines	•	•	•	•	•	•	•	•
Opencare—Track symptoms	-	•	•	•	•	•	•	•
#trackit: Track Health and Pain	-	•	•	•	•	-	-	-
Chronic insights	•	•	•	•	•	•	-	-
MDHealthTrak—Symptom Tracker	•	•	•	•	•	•	-	-
Symptomator	-	•	•	•	•	-	-	-
CoVstat	•	•	•	•	•	•	-	-
Chronic illness Monitor	•	•	•	•	•	•	•	•
Metriport—Tracker and Lifelog	•	•	•	•	•	•	•	•
Symple Symptom Tracker	•	•	•	-	-	•	-	-
Flaredown for Chronic Illness	•	•	•	•	•	•	-	-
Symptom Tracker	-	•	•	•	•	•	•	-
Wellth Health Tracker	•	•	•	-	•	•	•	•
TracknShare LITE	-	•	•	-	•	•	•	-
PeopleWith—Symptoms and Health	•	-	•	•	•	-	•	•
Healthmatica	-	•	•	•	•	•	-	-

3.4. Mhealth Apps MARS Quality Score

The quality scores of the included apps are shown in Table 3. The mean score of apps' overall quality is 3.45 (SD = 0.61) out of five, ranging from 2.04 (lowest score) to 4.50 (highest score). Across the five main categories, the highest-rated was the functionality of the app—3.75 (0.61); followed by esthetics—3.67 (0.62); subjective quality—3.47 (0.88); engagement—3.33 (0.78); and, lastly, information—3.04 (0.61). The mean subjective app quality score, which was calculated from the subjective reviewer's opinion, coincided with the mean overall app quality score (3.45, SD = 0.57), with the latter category excluded from the calculations. The highest score diversities between the reviewers were observed in the

"Engagement" and "Subjective quality" categories as expected, as both of the categories include subjective questions.

Table 3. Mobile App Rating Scale (MARS) mean scores of the included mHealth apps. Rating out of 5.

APP NAME	Engagement	Functionality	Esthetics	Information	Subjective Quality	Overall †	Overall-Excluded ‡
Effecto Symptom Tracker	4.60	4.50	4.67	4.00	4.75	4.50	4.44
Wave: health and symptom tracker	4.20	4.75	4.33	4.14	4.75	4.44	4.36
CareClinic—Tracker, Reminder	4.60	3.75	4.33	4.29	4.50	4.29	4.24
Healthily: Self-care and Tracker	4.60	3.75	4.33	3.57	5.00	4.25	4.06
Moodflow	4.80	3.75	4.33	3.71	4.50	4.22	4.15
Symptom and Mood Tracker	4.40	4.50	4.00	3.57	4.25	4.14	4.12
Avanti	3.40	4.00	4.00	3.71	4.25	3.87	3.78
Journal My Health	3.40	4.50	4.00	3.57	3.25	3.74	3.87
itFeels	3.20	4.75	3.67	3.14	3.75	3.70	3.69
Crystal™	3.20	4.50	4.00	2.86	3.75	3.66	3.64
Folia Health	3.80	3.50	4.00	3.14	3.75	3.64	3.61
Wanngi Health tracker	3.40	3.75	4.00	2.86	4.00	3.60	3.50
Medication Reminder—Care	3.20	3.50	4.33	3.00	3.75	3.56	3.51
Health Storylines	3.40	3.25	4.00	3.14	3.75	3.51	3.45
Opencare—Track symptoms	3.60	3.75	3.33	3.00	3.75	3.49	3.42
#trackit: Track Health and Pain	2.80	4.50	4.00	3.14	2.50	3.39	3.61
Chronic insights	3.20	3.25	3.67	3.00	3.75	3.37	3.28
MDHealthTrak—Symptom Tracker	3.20	3.75	3.67	3.14	2.75	3.30	3.44
Symptomator	2.20	4.50	3.67	2.57	3.50	3.29	3.23
CoVstat	3.20	3.50	3.33	3.00	3.25	3.26	3.26
Chronic iIllness Monitor	3.20	3.50	3.33	2.86	2.75	3.13	3.22
Metriport—Tracker and Lifelog	3.20	3.50	3.33	2.43	3.00	3.09	3.12
Symple Symptom Tracker	3.20	3.25	3.00	2.43	3.25	3.03	2.97
Below average #							
Flaredown for Chronic Illness	3.00	2.75	3.33	2.86	3.00	2.99	2.99
Symptom Tracker	2.60	4.00	2.67	2.00	3.00	2.85	2.82
Wellth Health Tracker	2.60	3.25	3.33	2.71	2.00	2.78	2.97
TracknShare LITE	2.40	3.00	2.67	2.14	2.50	2.54	2.55
PeopleWith—Symptoms and Health	2.40	3.00	2.67	2.14	1.75	2.39	2.55
Healthmatica	1.60	2.50	2.33	2.00	1.75	2.04	2.11
Mean quality score	**3.33**	**3.75**	**3.67**	**3.04**	**3.47**	**3.45**	**3.45**

† This score is calculated from the arithmetical mean of five MARS categories. ‡ Subjective quality score is excluded from the arithmetic mean score. # Apps with an overall score of 3.00 or lower were considered to be below the average quality score.

3.5. Quality Comparison by Different Characteristics

While comparing the apps by registration criteria, mean MARS scores in engagement and information categories were found to be statistically significantly higher in the apps that require registration before starting using the app—3.40 [3.2–4.25] vs. 2.80 [2.4–3.2], $p = 0.013$ and 3.07 [2.86–3.61] vs. 2.57 [2.13–3.14], $p = 0.048$, respectively (Table 4). Even

though no statistically significant overall score results were observed, the mean overall score was higher in the apps group with registration—3.54 [3.12–4.16] vs. 3.29 [2.85–3.66], $p = 0.237$.

Table 4. Quality comparison by different characteristics.

Category	Registration, *Median (IQR)*			Cost, *Median (IQR)*		
	Required (*n* = 22)	**Not Required (*n* = 7)**	***p* Value**	**Free (*n* = 23) †**	**Paid (*n* = 6) ‡**	***p* Value**
Engagement	3.40 (3.2–4.25)	2.80 (2.4–3.2)	0.013	3.20 (2.60–3.60)	3.30 (3.20–4.60)	0.232
Functionality	3.63 (3.25–3.81)	4.5 (3.25–4.5)	0.165	3.75 (3.25–4.50)	3.75 (3.50–4.50)	0.477
Aesthetics	4.00 (3.33–4.33)	3.67 (2.67–4.00)	0.165	3.67 (3.30–4.00)	4.00 (3.33–4.42)	0.254
Information	3.07 (2.86–3.61)	2.57 (2.13–3.14)	0.048	3.00 (2.43–3.57)	2.93 (2.86–3.68)	0.773
Subjective quality	3.75 (2.94–4.31)	3.25 (2.5–3.75)	0.217	3.50 (2.75–3.75)	3.88 (3.13–4.81)	0.192
Overall	3.54 (3.12–4.16)	3.29 (2.85–3.66)	0.237	3.39 (2.99–3.74)	3.63 (3.23–4.31)	0.254

† Apps that are: free with no premium features, free with a one-time payment for premium, and free with a monthly or annual subscription are included. ‡ Apps that require one-time payment and monthly or annual subscription to use the app are included.

Finally, we compared the free apps, including those with premium features ($n = 22$) and paid apps ($n = 7$). The comparison revealed no statistically significant differences, however, a trend of paid apps having better mean aesthetics, subjective quality, and overall app scores was observed, respectively, 3.67 [3.30–4.00] vs. 4.00 [3.33–4.50], $p = 0.254$, 3.50 [2.75–3.75] vs. 3.88 [3.13–4.81], $p = 0.192$, and 3.39 [2.99–3.74] vs. 3.63 [3.23–4.33], $p = 0.254$.

4. Discussion

The study on mHealth apps for chronic conditions provided us with several main findings. First, we found that currently, there are only a few high-quality apps designed for patients with different chronic diseases. Second, healthcare institutions still lack innovation and patient-centered digital solutions, therefore, non-medical institutions have currently occupied the market. Third, the majority of mHealth apps have the essential symptom and medication tracking functions. Fourth, we observed significant differences and insufficient quality of the existing mHealth apps. Finally, we found a tendency that apps requiring registration and payment before using the app have higher quality. We will discuss the possible implications below.

While people's lifespan is increasing, global morbidity is rising accordingly. Given that the medical personnel is more overwhelmed than ever, delays in reaching out to a physician are of significant importance. Therefore, to reach better patient-reported outcomes, increase patient engagement in their health tracking and management, and enhance patient-provider communications, modern solutions could be employed. Initially, we identified 366 mHealth apps under our three main search keywords—*symptom tracker*, *chronic condition*, and *chronic illness* (Figure 1). After a careful review and analysis, only 29 health apps were selected as being appropriate to use for patients with different chronic conditions; of those, $\frac{1}{4}$ had a quality lower than average. This could potentially be related to the lack of focus and resources devoted by healthcare institutions to innovation; thus, digital healthcare solutions that could tackle the increasing global morbidity levels and improve DALYs of patients with chronic conditions are insufficient. Nevertheless, some high-quality health and chronic condition management apps do exist.

With only a few governments and healthcare institutions introducing health and chronic conditions monitoring smartphone apps into clinical practice [47], patient knowledge and engagement in self-health management are insufficient. Therefore, to overcome this problem, independent developers and non-medical institutions are creating digital health tools. However, the existing real needs of patients and providers, the disease-specific clinical features, and their monitoring peculiarities are not being met. In addition to that,

there are no specific mandatory standards (except the Android or iOS App Store regulations acting as a barrier) for developing and releasing mHealth apps. As a result, only a few high-quality apps exist. Therefore, to increase the apps' quality and patients' engagement in self-monitoring, governmental and healthcare institutions must join the smartphone health apps' development process, introduce them into clinical practice, and assist developers with healthcare subtleties, thus, improving outcomes and decreasing the burden of chronic conditions on everyday life.

According to reimbursement criteria for digital health apps in Germany, health apps must fulfill two criteria, one of which is to have positive care effects by improving the health of the user [47]. To reach the best patient-reported outcomes and reduce the highly-possible disability level due to chronic conditions, symptoms tracking functionality is of immense value. In addition, medication scheduling and reminders can also play an important role in chronic disease management in outpatient settings, as around two-thirds of adults have at least one drug prescribed for constant use, and around half of them still fail to stick with their medications' schedule [16]. Therefore, our study addressed this issue and found that the majority of apps included in the study successfully integrated symptom tracking functions. However, a few chronic condition management apps still lack some of the basic features, such as the possibility to add symptoms from a list (7 apps out of 29, 24.1%) or manually (2 apps out of 29, 6.9%), add additional symptom-specific notes (1 app out of 29, 3.4%), mark the severity of the symptoms (3 apps out of 29, 10.3%), provide a visual symptoms' summary (2 apps out of 29, 6.9%), and export the collected data (3 apps out of 29, 10.3%). These features are of high importance in disease management, as they help physicians to gather the anamnesis and are constantly used in clinical practice when deciding on further diagnostic, treatment, and management plans [48,49]. Secondly, we observed a higher percentage of apps without medication tracking (10 apps out of 29, 34,5%) and reminder (16 apps out of 29, 55.2%) functions. However, adherence to the treatment plan and medication schedule is a key to successful treatment, and, on the contrary, failure to adhere to the treatment plan leads to substantial worsening of the disease course and an increase in health care costs [50]. Even though mHealth apps with complete functionality exist (Table 2), developers must pay more attention to implementing fully-functioning symptom and medication trackers to reduce the subjectivity levels of medical history (as the disease is being tracked continuously), increase earlier diagnostic and treatment possibilities, and improve patients' outcomes.

The mHealth apps' quality analysis revealed a lack of high-quality apps. (Table 3). While the mean overall quality score was slightly higher than the scale's average, six apps (20.7%) did not reach the average quality score of three points. The highest scores were noted in the app functionality (3.75) and esthetics (3.67) categories, which demonstrates that developers are more than capable of building high-quality tools from technical functionality and design perspective. On the other hand, a lack of cooperation between healthcare institutions or providers and software developers is observed. Given that the engagement and information categories obtained the lowest scores (3.33 and 3.04, respectively), cooperation is indispensable, as engagement is identified as the key factor for patients to employ the routine use of mHealth apps for daily health check-ups. Physicians are considered highly professional; therefore, they are trusted by the community, and as a result, patients turn to them regarding their health issues. Likewise, the mHealth apps should provide patients with the same feeling of safety. Bridging the informational gaps with simple, clear, and scientifically proven material that patients could empower for their daily condition-specific purposes is of immense value. To improve the overall quality, healthcare institutions and providers' should actively contribute to the development of mHealth apps.

When considering which mHealth app to choose, data protection and regulation, price, and the quality of the app are important. Additional development solutions, such as the registration process before starting to use the app, address the privacy concern by increasing users' data safety and overall quality of the app. Our study results concur with this statement, as statistically higher mean quality scores in engagement and information

categories were observed in the apps group that requires registration (Table 4). When comparing the free and paid apps, higher-quality trends were observed in the paid apps group. For patients, this simple pay-wall solution means that more funds will be allocated to the further app development process, which means that higher quality and more personalized apps will be built. Paid app model means that more capital is available for the developer to increase the quality of the app.

5. Strengths and Limitations

The main strength of our study was that it is the first study that provides an in-depth analysis of mHealth apps, designed specifically for patients with various single or multiple chronic conditions, available in the Apple App Store, and applying MARS as a golden standard for quality assessment and validation. In addition to that, this is the first study addressing the issue of the lack of decent quality mHealth applications that could able to cover patients with multiple chronic conditions and the lack of healthcare and medical professionals' involvement in the development process.

The main limitation of our study is that it was performed in the U.S. Apple App Store only, with just English apps considered eligible. However, the iOS platform covers nearly 60% of the market share in the U.S [51] and one-third worldwide [52], and currently, the U.S. mHealth applications market size accounts for the majority of the whole world's total market [53]; therefore, it proves the generalizability of our findings. Another important limitation was MARS and investigators' subjectivity in the mHealth apps assessment and validation process. However, to minimize the subjectivity of the evaluation process, the reviewers analyzed the newest literature on the MARS scale and were trained by specialists on how to use the MARS scale properly. In addition, this issue was minimized by calculating the average score of each of the criteria derived from three independent reviewers involved in the evaluation process. Given that the *Overall* and *Overall-excluded* scores are practically identical (Table 3), the issue of subjectivity has been reduced to a minimum.

6. Conclusions

The study on mHealth apps for chronic conditions revealed that up-to-date, high-quality apps designed for patients with chronic diseases do exist; however, some space for improvements in symptom and medication tracking functionality is still available, and a solution for a one-in-all mHealth application to track and manage various multiple physical and mental health conditions is still required. To increase the usage of the mHealth apps in everyday lives and improve the quality of health care in outpatient settings, developers should focus not only on the technological functionality and aesthetics but also on creating a highly user-engaging and informative app. In addition to that, healthcare institutions and providers should join the innovation process, more actively install patient-centered digital solutions into the clinical practice, and contribute to the mHealth apps development process with their clinical knowledge to create more personalized and higher quality tools for patients to improve the patient-reported outcomes and overall outpatient healthcare quality. Further studies on mHealth apps should be executed to evaluate the real effect of mHealth applications on patients' overall health and patient-reported outcomes.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/jal2030016/s1, Table S1: References of the mHealth applications (n = 29) included in the study.

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