mHealth Apps: Potentials for the Patient – Physician Relationship

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***Abstract*—Digitalization is revolutionizing our healthcare system. New ways of communication and new options of information gathering are among the reasons why the healthcare is constantly changing. An upsurge can be observed in the development of health-related applications (mhealth apps). There are hundreds of new apps added to the app store every day. This makes it extremely difficult to keep an overview of all of these mhealth apps. This paper aims at providing such an overview. In this work we classify mhealth apps according to the target group patient, patient-physicians and physicians and considered also what functions the app is providing for its user. For each defined segment we have examined the potential on the market.**

***Index Terms*—mhealth app, healthcare, segmentation, medical app, potential**

I. Introduction

The number of smartphone users is growing every year and is forecasted to approx. 2.5 billion in 2019 [1]. At the same time, the demand for new apps is increasing. This trend can also be observed in healthcare. In November 2017 more than 318.000 health apps have been available in app stores and every day more than 200 health apps are being added [2]. The fast expand of health apps on the market shows evidence of digital health being an accelerating innovation. With a market growth of 32.5% CAGR (Compound Annual Growth Rate) in 2016 the mobile app development industry is the fastest growing market [3]. The mhealth market is expected to reach over $102 billion by 2022 [3].

The healthcare market is an extremely complex system and facing various challenges such as the population getting older; growing world population; increasing number of chronically diseased people [4]; increasing healthcare related costs [5]; growing prosperity and therefore a better access to medication and finally higher requirements to the healthcare system [6]. These issues can be addressed and potentially be solved with smartphone based health applications – mhealth apps [5]. However, in order to successfully manage these issues, the industry needs to become more innovative [6]. mhealth technologies might fundamentally change the healthcare market and make it accessible anywhere, anytime in a cost-effective manner [7]. Not only is it possible to video chat with your doctor or store your fitness data, but you can also control your allergy, track your heart rate, monitor your baby's heart, keep track of your medication, share medical information with your doctor and many more [4]. It becomes apparent that there exist tons of health and medical apps for many health conditions and situations. However, this high number of apps on the market makes it difficult for the user to find the right one. The customer/patient today wants to understand his condition, be involved in the treatment and wants to determine what he wants. Apps are used to create a "health selfie" [8].

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II. Problem Statement and Objective

To cope with the growing costs in the healthcare sector [5], [9], mhealth apps have proven to have a positive long-term effect in many areas of application [7], [10]. Due to the high number of different apps, it is beneficial for the related person to understand what kind of mhealth apps are on the market. It proves to be a challenge to find the right app under the variety of different fields of application and orientations – this is the starting point of the preliminary work. The current market situation is not transparent nor do the app store categories provide a reliable information about the content of an app [11]. Therefore, the scope of this paper is to look into different mhealth apps to unravel this chaos by classifying them into different segments. The proposed segmentation will give an overview, while the subdivisions of these apps intend to form homogeneous groups in such a way that the differences between them are as low as possible. In this way app users, such as patients and physicians can benefit of individually tailored product packages according to their needs. Further, the potentials (i.e. not yet exhausted possibilities) for each segment are determined to give an idea, which segments are considered to have an even bigger impact into the future. Therefore, this work aims to answer the following research questions:

RQ1: "How can mhealth apps be classified?"
RQ2: "What are the potentials on the market for each defined segment?"

In order to answer these research questions, a literature research has been conducted aiming at a solid

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segmentation approach for apps. Afterwards, we classify apps that were found on the app store. In a third step we have evaluated the potential for patients and physicians of each segment using an extended literature review.

During our research we have found rough mhealth app segmentation [3]:

- Chronic care management apps;
- Medical apps;
- Healthcare and fitness apps;
- Women's health apps;
- Medications management apps and
- Personal health record apps.

It is a good basis and gives a first understanding how mhealth apps can be differentiated, however, we found it not satisfying, since they do not include all mhealth related apps and are described very vaguely. Therefore, we are going to suggest a deeper and more detail-oriented segmentation table for three different target groups.

III. Methodology

We used a mixed-methods approach [12] involving both qualitative and quantitative methods. Between March 2018 and May 2018, we searched for literature and mHealth related apps in the app store. An extensive literature search has been carried out using academic research databases, such as shown in Table I:

TABLE I. Research Databases

Name	URL
IEEE	https://www.ieee.org/
SpringerLink	https://link.springer.com/
Google Scholar	https://scholar.google.ch/
PubMed Central®	https://www.ncbi.nlm.nih.gov/pmc

We have looked for recent articles related to the following search terms: 'mHealth apps', 'smartphone healthcare', 'artificial intelligence mHealth', 'potential mHealth' and 'medical apps'. We selected papers from 2013 to 2018. During the literature search, we selected papers related to one of the following topics: the potential of mHealth; studies providing evidence and studies that will help us to make a segmentation. The relevant parts of the papers were then marked with the coding system MAXQDA 2018 [13]. Our coding system counted 7 different codes (Table II).

TABLE II. Code List

Code	Number of marked texts
Requirements on mHealth	37
App related	45
Chances and potential for mHealth	68
Weaknesses of mHealth	74
State of the art	16
Possible segmentation	26
New possibilities with mHealth	52

TABLE III. A Segmentation Framework for mHealth App

Target Group	Segment	Description	Scope	Example of mhealth Apps
Patient	Wellness and Fitness Apps [2], [14]	Different apps, which track health and wellbeing, such as fitness and weight loss and nutrition.	The user can track his fitness and save health information on an app and check improvements. It eventually motivates the user to live a healthy lifestyle.	Lifesum, Nike + Run Club, FizzUp, Fitbit Coach, Mind Journey, Freeletics, MyFitnessPal, YAZIO, Pacer, BMI Calculater
	Medication Management Apps [14], [15]	Apps that help to keep track of taking medication.	The user gets reminders of when taking the medication. Improve its adherence among patients.	MyPill, Pill-in-time, Mediteo, Pill Reminder Alarm, Take Me, RX2, Vaccines Log Pro
Patient and Physician	Personal Health Record Apps [3]	Apps that store medical condition data such as allergies and sleeping habits	Patients have access to their medical records at all time. These data can be shared with the physician in order to get instant treatment.	Sleep Watcher by Bodymatter, iHealth MyVitals, medicus.ai, AlliApp, Qardio, myZio, myTherapy
	Self-Diagnostics and Awareness Apps [3], [16], [17]	Apps that provide diagnostics and generate awareness among patients. They create alerts and serve as medical reference or patients and physicians. Can lead to an online consultation with the doctor.	To generate early stage diagnosis and bring awareness among patient. Has an effect on reducing cost and increases the efficiency.	Ada, Thermia, Bright.md, eeDoctors, Babylon, Doctor mole, Symptify, Your.MD, myZio
	Chronic Care Management Apps [3], [8], [11]	These apps help users to manage their chronic diseases such as bloods pressure, diabetes, cancer, mental health. The patient is under medical supervision.	The patient can manage its disease on his own – no necessity for a doctor consultation.	Curelator Headache & Migraine, Glooko+diasend®Blood Pressure Assistent, Diabetes Assistant, Flaredown, Symple
Physicians	Diagnosis (and identifying treatment plan) Apps [18]	These apps support physicians to diagnose and additionally may suggest a treatment plan.	Provide more accurate diagnosis in a faster rate Increases efficiency, lower costs, increasing capacity of patient.	Viz.ai Alpha, PEPID, MDCalc, Xebra
	Information Tool [19]	Apps that enable physicians to look up drug information. Check the disease reference tool or gives the newest medical update.	Physicians know the latest developments are up to date. They can look up for information and deepen their knowledge.	Epocrates, UpToDate, Medscape, Case, Read by QxMD

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68 posts of the potential mhealth apps have been tagged, 26 posts were tagged to help building a more detailed segment matrix of the different mHealth apps. To segregate the segments more in detail, a scope for each target group was defined. We have set the focus on physicians and patients. While our research we have realized that we should not only focus on these two stakeholders, but also on the patient-physician-relationship. Therefore, three different target groups (patient, patient and physician & physicians) have been identified. Once we had identified our target group, we have looked for apps that are aiming at these target groups. Altogether we went over 40 mHealth apps. We made the segmentation based on what the app was providing to its user. Finally, for every segment the potential was analyzed with extended literature review. We have found 68 text passages that were able to help us to identify the potential on the market of each segment. (Table III)

IV. Findings

During our text analysis we found that we should not only look for apps that were designed only for patient or only for physicians, but foremost for the shared use. Meaning, there are many existing apps that aim to improve the communication between patient and physician. We came to the conclusion that a segmentation according to the target group is more appropriate, because the app user can directly realize which segmentation might be relevant for him. Another reason for this conclusion is that depending on the target group, the requirements of a mHealth app varies. Sorting it this way will help to eliminate irrelevant apps.

A. App Segmentation

The highest segmentation-level is the target group. The second level distinguishes the segments by what an app is providing to its target group.

In addition to the already existing segmentation we have found apps providing "chronic care management" or "self-diagnostics" that do not fit in any proposed segmentation. For instance, for apps giving you an advice on what medication you should take (e.g. for a self-diagnostics and awareness app [3] or apps tracking your blood pressure and sending the data to the physician e.g. for a chronic care management app [3]) – these apps did not fit into the already existing segmentation.

Our research led us to expand the existing mHealth app segmentation as follows:

B. Target Group: Patient

All apps belonging to this segment are designed for the user for personal purposes. Meaning, the reason to use the app and to generate personal fitness or medical data is on behalf of personal interest.

These data are not intentionally shared with professionals. Nevertheless, the recorded data might be collected by the app provider, which raises the question, what happens with this data?

We have distinguished this target group in two segments: wellness/fitness apps and medication management apps.

Currently, *wellness apps* represent the majority of the mHealth apps available on the market [20]. Applications to analyze the fitness level, health and training success – tracking apps – are clearly ahead with 70 percent [21]. To this segment we count various nutrition apps, health tracking, fitness and weight loss apps. An example of this category is the app *Lifesume*. *Lifesume* creates a personalized nutrition plan, counts calories, saves body measurements and provides healthy recipes [22]. With the apps *Fizz Up* and *Freeletics* a personal online fitness plan is fitted and the fitness progress can be tracked [23] [24]. A very common business model in this segment is the freemium model, where the user gets basic features for free and for additional features the user has to pay [25].

Medication management apps or health condition management apps are increasing at a fast rate and represent 40 percent of all mHealth apps [20]. These apps help the user not to forget to take its medication. They do not share any information with the physicians. One example is the app myPill [26].

C. Target Group: Patient and Physician

The idea behind this segment is on the one hand that the patient gets an insight into his health information. On the other hand, the patient can share the collected medical information with his doctor to either get a remote diagnosis or recommendation concerning his further situation. In this segment it is all about the constant connection between patient and physicians enabling remote feedback. We found three groups which can be segmented differently: personal health record apps, self-diagnostics and awareness apps and chronic care management apps.

Personal health record apps store medical data of users and access to these data can be given to physicians. This segment typically only records data but does not give you any advice to the user based on the data. An interesting and by physicians developed app in this segment is Medicus [27].

Medicus is an artificial intelligence supported app that converts health-related data and medical information into a digital experience with visual elements, personalized health information and easy-to-understand health insights and recommendations. Algorithms simulate the logic decision process of physicians and allow real-time reasoning and interpretation. Furthermore, users can anonymously share their data analytics for research purposes [27].

The segment of *self-diagnostics and awareness app* is a very promising segmentation app nowadays and for the future. As the name already tells, this segmentation provides self-diagnostics and awareness among the users. The number of apps promising to give you an accurate diagnosis is increasing. In 2015 a study has been published in the British Medical Journal evaluating self-diagnostics apps. The study found out that 34% of the

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time the apps provided a correct diagnosis and the care advice provided was correct in two-third of the time [28]. The study concluded that "in many cases symptom checkers can give the user a sense of possible diagnoses but also provide a note of caution, as the tools are frequently wrong and the triage advice overly cautious" [29].

The German start-up *Ada* introduced an artificial intelligence healthcare app and telemedicine service, empowering patients to make better decisions concerning their health [30]. According to the study, *Ada* is evaluated as the best app in this segment [29]. It provides a first medical assessment of diseases and symptoms. The app asks the patient for its symptoms and then creates a personalized analysis based on the information. Depending on the complaints the app recommends a follow up remote consultation with a real doctor over text. "Through machine learning and multiple closed feedback loops, *Ada* continues to grow more intelligent, putting *Ada* ahead of anyone else in the market," the company says [30]. Therefore, *Ada* learns more about a patient's health and it can ask smarter and more effective questions.

Chronic care management apps are used more and more by doctors for monitoring their patients' health. Simultaneously patients become more aware of the possibility to use mhealth apps for their chronic disease management [31]. The scope of those apps is to reduce the consultation time, which leads to a win-win situation for the patient as well as for the physicians [32]. The patients spend less money and less time on consultation and the physicians can work more efficiently. However, according to an American study one-third of patient with a chronic health disease are not using mhealth apps, either because they do not know about the apps or because they do not think that it helps[33].

According to another study 28.5%, 28.1% and 27% of all chronic care management apps monitor blood pressure, blood glucose and weight, respectively [32]. A successful example in this category regarding blood glucose is the FDA cleared [34] App *Glooko*, which is used by over 7'000 provider sites [35]. This diabetes management app enables a link between mobile phone and blood glucose meter. The newly added artificial intelligence driven features support the doctors to detect and understand glucose pattern and to provide a better treatment plan [35].

D. Target Group: Physician

The number of mhealth apps focusing on physicians is increasing. Simultaneously physicians become more comfortable using the help of these apps [36]. Some use cases show that mhealth apps for clinical decision support have improved physicians' test ordering and diagnosis decisions [36]. We have distinguished between diagnosis apps and information apps.

Some successful *diagnosis apps* exist on the market. One of them is the app *Contact* by Viz.ai. Viz.ai introduced the application Viz LVO Stroke Platform that uses artificial intelligence and deep learning algorithms to analyze computed tomography (CT) images of the brain [37]. The application aids in diagnosing and identifying treatment plans and was the first-ever computer-aided triage and notification platform to identify LVO that has been permitted by the U.S. Food and Drug Administration [38]. Nevertheless, according to our research today this segment provides the fewest apps on the market. Many of them are still in research are pilots or not available in public.

Information apps for physicians are widespread and are designed to look up medical information; give newest medical updates or exchange with other physicians [19]. They keep doctors up to date. However, it may be that information leads the physicians to make a diagnosis. The app QxMD promises to keep up the professionals with the latest research. Additionally, this app provides various decision support tools to be used in practice [39].

E. Potential

Potential generally refers to a currently unrealized ability. Almost 90% of the world's population could benefit from the opportunities mobile technologies offers at relatively low cost [40, p. 75]. By performing a wide variety of functions, mobile technology has the potential to increase both the efficiency and the spread of healthcare services. Maximizing a healthcare professionals' time while also reducing costs of maintaining quality healthcare services improves the complete value chain.

mhealth itself has the potential to reduce healthcare cost per person while maintaining or increasing care quality. And as governments around the world start to explore different measures of human progress, wellbeing is increasingly being treated as an indicator. A lot of "city rankings" for example the Mercer Quality of Living Survey [41] include the available healthcare quality as an indicator. In this sense, mhealth has a role to play in improving new "gross national happiness" indicators by producing a happier, healthier populace, and has the potential to transform health service delivery [42, p. 9].

Change the system, from to prevent, instead of threatening the patient, is the new moto of many insurance companies and governments. Mhealth apps can support developments where the political point of view is meaningful and wanted. This includes, for example, shifting the classical treatment to coordinated care or shifting the center of gravity from healing to predecease. An area that has the potential to transform the health system as well as to increase quality and efficiency. More and more its being attempted to care the patient, whenever possible, at home [43, p. 8].

Demographic Shift: Unless major changes take place in the way healthcare is delivered, the demographic shift presents serious challenges for the governments all over the world, as the number of citizens needing medical care will increase rapidly. For these countries, mhealth has the potential to deliver affordable care to the elderly and allow people to remain independent longer [44]. The price difference of care at home with a care service instead of staying at a hospital is immense especially in light and medium cases [45, p. 27].

What inhibits the potential? One big problem all mhealth apps are facing that they all want to enter into the very complex healthcare market. The healthcare systems

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are very complex and timewise different actors are following self-interested targets. The health industry is normally cautious regarding new technology mainly because new diagnostics and therapies have to prove their effectiveness and patient's safety. As an example, the mobile industry has innovation cycles of months as the average development time for a new drug is between 10 to 15 years [46, p. 16].

Law and Regulations: mhealth apps have the potential to make big improvements in the delivery of quality health care to patients wherever they are and whatever their circumstances. First, however, mhealth apps have to prove that it actually improves the health status of patients and consumers, and second, the legal community needs to demonstrate that laws and practice can catch up with the rapid developments in health technology [47].

Wellness Apps can enable lifestyle improvements by equipping patients with relevant information on their mobile devices, thereby helping them make improvements, keep them motivated and inform them with lifestyle choices.

mHealth solutions that focus on wellness and prevention can help them make better decisions about simple aspects of their lifestyle such as the nutrition, ways to counter the urge to smoke, and the number of steps to walk. A key reason for the reluctance to manage one's lifestyle better is the lack of self-motivation and adherence. Interactive, self-directed mhealth solutions can motivate patients to improve their lifestyle by developing game-like attaining everyday fitness goals and compare themselves with friends in different rankings [48].

The great potential of fitness apps is certainly the effect that people who have little to no desire for sports can be motivated, at least in the short term to become active in sports. The app can be a boost, but in principle only the people keep doing sports, which would probably have made it also without the app [49].

Medication Management Apps: The potential of this segment is very high, especially for people who need to take a lot of medication at a specific time. These include many older people. However, especially for this target group, the applications do not meet the needs of the customer group. A recent study published in the Journal of Medical Internet Research found that users may not see value from many of these apps due to shortcomings in features advertised by developers and a broad range of applications that are not designed to meet many common consumer needs [50].

Despite those shortcomings and being untested, medication apps represent a possible strategy that pharmacists can recommend to non-adherent patients and incorporate into their practice [51]. In sum, families and doctors should be careful when recommending health management apps, such as these medication management apps to older adults. Studies show that such apps do not accommodate the will of older adults' capabilities and limitations. However, there is potential for these apps to benefit older adults. If the usability issues are identified those apps have the potential to contribute added value [52].

Personal Health Record App (PHR)s: Studies indicate that the benefits of PHR apps are improving clinical outcomes and that they are correlating with age, because younger patients are more likely to use PHRs more frequently. Ethnic and racial minorities have also been reported to adopt PHRs less frequently than others do, and patients from lower income groups are less likely to use PHRs as compared to those with higher incomes shows a study from the US [53]**.** Mobile PHRs have the potential to help patients and providers identify medical conditions and prescriptions from numerous locations, which may minimize medical errors and identify improvements to health behaviors during emergencies, or when patients change the physician. Despite their benefits, numerous challenges inhibit the adoption and further development of PHRs apps, including integration into the overall health technology infrastructure and legal and security concerns are to solve [54]. The outcome of a study which has reviewed more than 5000 scientific studies published in the last 10 years, selected the most significant approaches, and thoroughly surveyed the health care field related to PHRs was: With respect to PHRs, this might refer to reducing the cost of collecting data, improving health information quality, anticipating potential problems and allowing the patients to interact with their health data. The patient is in a more active role [55].

Another potential could be carrying out evidence of clinical tests. With the support of existing technologies and Internet of Things (IoT) hardware, such applications were already used as clinical systems for decision support or to support the diagnostic process and enable a faster response to possible health problems [56, p. 1]. Combined with the data of the PHRs clinical studies could link data to get more precise results and sort out not ideal candidates.

Self-Diagnostics and Awareness Apps: The main potential of this segment is to strengthen one's own consciousness, to be able to recognize for oneself that something is wrong and that a specialist should be consulted. Large randomized controlled trials have shown that stable mobile applications have contributed towards the improvement of quality of life, especially using self-monitoring mobile applications, electronic health records and automated alert/reminder based applications [5, p. 25]. Furthermore, specific target groups can be sensitized via targeted alerts. As an example, a study shows that it is not about creating a 100 percent correct diagnosis, but also improves the communication between doctor and patient. Researchers of the study assessed the SkinVision app, for example, said: "By the way, the patient-doctor communication is made known through the use of the concept of skin cancer screening and by giving a basis of interaction [52]. In developing countries with high levels of infectious diseases, people can be sensitized to awareness apps and news. Focus on improving the efficiency of healthcare workforce and systems. India, South Africa and Kenya include prevention and

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awareness messages on the spread of infectious diseases [57, p. 6].

Chronic Care Management Apps: The greatest potential of all segments could be the more efficient treatment of chronic diseases. Surprisingly, there are only a few studies in this segment that can prove a higher level of efficiency. There is potential for mhealth tools to better facilitate adherence to chronic disease management, but the evidence supporting its current effectiveness is mixed [58]. Further research should focus on understanding and improving how mhealth tools can overcome specific barriers to adherence [59]. Chronic diseases account for 70% of U.S. deaths and 75% of U.S. healthcare spending [58]. Especially people with chronic diseases are less active, so they also need less mhealth apps from other segments and those people are more skeptical [53].

"One challenge facing CDM (Chronic disease management) apps is that they are difficult to sell directly to patients – making this group an unlikely source of paying customers, they say. Given that individuals are not used to pay for chronic disease treatment beyond standard co-pays for physician visits and prescription drugs, the costs of acquiring individual patients as customers are likely to be quite high" [33]. CDM apps can raise citizens' awareness of health issues through easy-to-understand information about their health condition and how to live with it, thus helping them take more informed decisions on their health [58]. Diagnosis apps can also help to ensure that alternative diagnoses are not overlooked [60].

Diagnosis Apps: Apps in this segment have the potential to create faster diagnostics through artificial intelligence using databases and big data. Furthermore, studies have reported an increase in the appropriateness of diagnoses and treatment decisions when mobile devices were used for clinical decision support, particularly when a CDSS (Clinical decision support system) app was used [61]. Different apps can provide graphical flowcharts to provide help to physicians identify diagnostic possibilities [62]. Another diagnostic mobile app applies clinical algorithms to aid physicians in determining a disease diagnosis. Mobile devices can also be used to access CDSSs installed on desktop computers in clinical settings to aid in diagnosis and treatment decisions [63]. Data also have shown that when electronic references were consulted, there were twice as many adjustments in patient management decisions compared to cases in which only paper resources were available [64]. Mobile devices have been proven to improve contact between HCPs and their colleagues which can help in difficult cases to get other opinions [65]. Improve Accuracy: Mobile devices have repeatedly been found to improve the completeness and accuracy of patient documentation, an effect that has often been attributed to ease of use [66]. More accurate diagnostic coding, more frequent documentation of side effects, and increased medication safety through reduced medical errors have been reported [66].

Increased Efficiency: The use of mobile devices has been shown to provide HCP (health care professionals) with numerous enhanced efficiencies, including increased quality of patient documentation through fewer errors and more complete records, more rapid access to new information, and improved workflow patterns. Physicians have reported that the use of a mobile device for retrieving information from a drug database led to more efficient decision-making and patient care [64].

Enhanced Productivity: Research has shown that the use of mobile devices at the point of care has helped streamline workflow and increase the productivity of HCPs [64].

Information Apps: Information applications have demonstrated effectiveness for supporting health care professionals' information seeking needs. Where PDAs were used for self-directed learning, medical students perceived time savings of around 1 min/encounter; 83% reported being better able to inform patients about medication use when looking at drug reference data [67].

Physicians accessed electronic resources via a PDA more often than paper resources (181 vs 131 episodes), but average time spent in accessing them was similar (9.3 and 9.4 seconds) [68]. The authors of Epocrates, the most commonly used drug reference app, found that 90% of physicians use mobile device apps to access drug information [69]. When health care professionals were provided with a PDA with headlines about new books, guidelines, reviews, and medical literature, they reported learning about new developments sooner than without it [70]. Summarized the potentials of information-apps for health care professionals are as followed: Have access to the most recent knowledge, as get informed about new studies, new drugs or other important information. Another big advantage is the comfortable search of drug references or to do literature research or review on the spot more effective as without an app.

V. Discussion

A strict segmentation is not applicable. First because the mhealth market is a fast moving and fast-growing market which changes every day. Daily, new apps with new technologies and new possibilities come to the market what might lead to a modification of our suggested segmentation. Second there are some apps that cannot be put into a segment we suggested because they have character properties of multiple segments. An example for this case is the app called *Medisafe* a "complete continuum-of-care solution" app [71]. The app is a patient's virtual pillbox, personal nudge and health coach. Further health measurements can be tracked and made available to the doctor [71]. According to our segmentation this app could be divided into various segments. We have decided to focus and only include the three chosen target group for our work. The segmentation table could be extended in multiple ways. Further target groups such as insurance companies, research establishments or tech companies could have been included. A further possibility to extend the segmentation for example is to dig deeper and distinguish between provider of the apps; whether the app is certified or not; the technology behind the app; a patients live situation or

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the step of the patients health journey [72]. Nevertheless, this segmentation is meaningful first for the creation of homogeneous groups (as good as possible) and specially to identify the development potential and difficulties for each segment. Another challenge with physician mhealth device use is the lack of interoperability between information stored in EHRs and the data aggregated from a patient's mobile health device [73].

Our review shows also that all segments have potential. However, we see the biggest potential in the chronic care management apps segment as chronical diseases account for 70% of U.S. deaths and 75% of U.S. healthcare spending [58]. Especially due the upcoming demographic changes and the older getting population with more and more chronical diseases a more efficient and economic healthcare system is required [43].

There are many projects regarding mhealth apps that include artificial intelligence. These technologies are already in use in different segments but for some segments such as chronical care management apps, self-diagnostics and diagnosis apps for physicians it might make a huge impact in the future. Some more evidence-based studies to prove the advantage of mhealth apps over current systems and processes are still rare today [46]. Further, in order to embrace mhealth, the governments have to enact laws and regulations to support the mhealth initiatives [74]. Therefor we conclude that we are just at the beginning of the mhealth area and we predict that a lot will happen and change in the upcoming years.

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