

Promoting health education through mobile apps: a quantitative analysis about the world's best hospitals

La promoción de la educación en salud a través de las mobile apps: un estudio cuantitativo sobre los mejores hospitales del mundo

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Abstract

Introduction: Promoting health education through different platforms (patient portals, social media, websites) has become a common practice in many countries. Recently, many hospitals have prioritized mobile apps as a health education tool. **Objectives:** This paper aims to analyze how hospitals should use mobile apps to promote health education efficiently and this way improve their relations with patients. **Methodology:** To answer this question, we carried out a literature review about health education, mobile apps, patients' empowerment, and noncommunicable diseases; and then, we resorted to 38 indicators to analyze how the top 150 hospitals in the world manage these platforms to promote health education. **Conclusion:** We concluded that the three main criteria that hospitals should consider when using mobile apps for health education purposes are: 1) respecting patients' needs in terms of information and emotional support; 2) evaluating health professionals' and patients' skills in mobile literacy; and 3) considering public health priorities.

Keywords: Hospitals; Health education; Mobile apps; Patients; Noncommunicable diseases.

Resumen

Introducción: Promover la educación en salud a través de diferentes plataformas (portal del paciente, redes sociales, sitios web) se ha convertido en una práctica común en muchos países. Estos últimos años, muchos hospitales se han centrado en las aplicaciones móviles como herramienta de educación sanitaria. **Objetivo:** Este artículo tiene como objetivo analizar cómo deberían utilizar los hospitales las mobile apps para fomentar la educación en salud y así mejorar sus relaciones con los pacientes. **Metodología:** Para responder a esta pregunta, realizamos una revisión de literatura sobre educación en salud, aplicaciones móviles, empoderamiento de los pacientes y enfermedades no transmisibles; y posteriormente, recurrimos a 38 indicadores para analizar cómo los 150 mejores hospitales del mundo gestionan estas plataformas para promover la educación en salud. **Conclusión:** Concluimos que los tres criterios principales que los hospitales deben respetar cuando usan aplicaciones móviles con fines educativos son: 1) respetar las necesidades informativas y emocionales de los pacientes; 2) evaluar las habilidades de los profesionales de la salud y los pacientes en alfabetización móvil; y 3) considerar las prioridades de salud pública.

Palabras clave: Hospitales; Educación en salud; Aplicaciones móviles; Pacientes; Enfermedades no transmisibles.

Introduction

Many hospitals all over the world implement health education initiatives to better satisfy their patients' needs: medical outcomes, information, and emotional support. To do that, these organizations manage different platforms, such as corporate websites, patient portals, social media platforms and mobile apps. Some of them even integrate these tools into the hospital's internal medical protocols. Recently, many hospitals have prioritized mobile apps as main platform to help patients reinforce their skills in health education. However, these organizations face different barriers. First, hospitals need to collaborate with different stakeholders (patients, doctors, external developers) to design appropriate mobile apps that satisfy patients' needs in terms of information and emotional support. Second, they must find synergies among different elements: the hospital's business objectives, patients' medical needs, and public health authorities' priorities. And third, they must manage these apps in a creative way: proposing useful services, using visual tools, explaining scientific information, etc. To efficiently face all these barriers and develop useful mobile apps, many hospitals have recruited experts in corporate communication, artificial intelligence, and public health.

This paper aims to analyze how the best hospitals in the world manage mobile apps to implement health education initiatives addressed to patients. In other words, we tried to answer a main research question: What are the main criteria that hospitals should consider when using mobile apps for health education purposes? To answer this question, we conducted a literature review about health education, patients' empowerment, the interdisciplinary nature of healthcare, the role of mobile apps in health education, and the impact of this technology in patients facing noncommunicable diseases (cancer, heart diseases, diabetes, chronic respiratory diseases). Then, we resorted to 38 quantitative indicators to analyze how the 150 best hospitals in the world managed mobile apps for health education purposes. Finally, based on our quantitative and qualitative results, we answered the main research question, and we proposed three conclusions that hospitals should consider when using mobile apps as a health education tool.

Literature review

Health education and patients' empowerment

Hospitals, Schools of Medicine, and other healthcare institutions collaborate to reinforce patients' empowerment (Pekonen, Eloranta, Stolt, Virolainen & Leino-Kilpi, 2020). When patients actively participate in their processes of care (ask questions, require information), they

improve their medical outcomes and protect their rights (Hammoud, Amer, Lohner & Kocsis, 2020). However, in some hospitals, patients' empowerment is not sufficiently well defined at each level of the care production chain, which constitutes a risk for patients' rights (Tilkin et al., 2019). Hospitals must lead a cultural change that promotes patients' empowerment as a reference for health professionals: behaviours, mentalities, communication preferences, access to information, use of technological tools, etc. (Affinito, Fontanella, Montano & Brucato, 2022).

Health professionals play a key role in hospitals' health education initiatives: they analyze patients' skills in health literacy and propose medical information that satisfies patients' needs in terms of knowledge and emotional support (Navarro, 2020). Thanks to this patient-centered education approach, patients reinforce their empowerment and establish better relationships with health professionals (Vaartio-Rajalin, Nyholm, Fagerström, 2020). On the other hand, health professionals measure their patients' empowerment in different ways: analyzing their behaviours and prejudices, and implementing continuous monitoring systems (Navarro Martínez, Igual García, Traver Salcedo, 2021). Health professionals can use different tools to measure patients' empowerment; however, these tools should always be consistent with the hospitals' requirements in terms of medical quality (Pekonen et al., 2020).

Thanks to health education initiatives focused on patients, the last understand their treatments and diseases, change their behaviors, and protect their rights (Fittipaldi, O'Dwyer, Henriques, 2021). Patients play a key role in health education: they need to accept that, on the one hand, these initiatives are part of their civic education; and, on the other hand, thanks to these initiatives they can protect their rights as patients and citizens (Alanazi, 2021). Health education allows patients to actively participate in health decision-making processes and become true protagonists in the hospital system: ask questions to doctors, share their personal opinions about medical protocols, meet with other patients, and contribute to improve treatments and medical protocols (Navarro, 2020).

When hospitals enable patients to increase control over their health, they contribute to improve the public health system (Van den Broucke, 2020). Empowered patients decide whether to be treated or not, whether to be hospitalized or not, and whether to be active or not: in other words, being empowered does not necessarily imply deciding about health issues related to guidelines imposed by health professionals (Tilkin et al., 2019). Patients' empowerment is directly related to quality, engagement, and behaviors, and not to key performance

indicators (Ardisonne, 2020). Finally, promoting patients' empowerment contributes to enhance patients' wellbeing and medical outcomes (Hammoud et al., 2020).

A multidisciplinary approach for health education

Global health has never been more important: its centrality and intersectional nature have recently been emphasized by the impact of different pandemics, such as Ebola, H1N1 or COVID-19 (Lee & Quinn, 2021). Addressing global health in an efficient way requires different organizations to collaborate: hospitals, schools of medicine, patients' associations, and public authorities (Fittipaldi et al., 2021). Thanks to this integrated approach, healthcare organizations can translate theoretical inputs about global health into practical initiatives allowing patients to improve their medical outcomes and protect their rights (Simonsmeier, Flaig, Simacek & Schneider, 2021). On the other hand, these organizations need to disseminate the social determinants of health, tackle health inequalities and promote social justice (Civitelli, Tarsitani, Rinaldi & Marceca, 2020).

Promoting a multidisciplinary approach of health education means that professionals working in healthcare organizations need to collaborate with experts from other fields (Herzig Van Wees & Holmer, 2020). These organizations must recruit experts from other professional fields beyond the health sector who contribute to efficiently promote health education (Parkes et al., 2020). According to Troiseufs (2020), experts in sociology, anthropology and education sciences should be part of health organizations' education initiatives. Suárez-Argüello et al. (2021) recommended to also include experts in philosophy, history, and digital humanities. Finally, several authors, such as Morsa (2021), insisted on integrating ethics into health education initiatives. The establishment of partnerships among community, hospitals, universities, and public health entities increases the efficiency of health education campaigns (Schulz et al., 2020).

Collaborating with different stakeholders and experts in several professional fields is essential to help health organizations satisfy their patients' needs in terms of information (Team et al., 2020). When health organizations focus on these needs rather than on technical aspects, they contribute to reinforce patients' empowerment (Tomokawa et al., 2021). On the other hand, these needs do not only refer to medical information, but also to emotional aspects: providing patients with emotional and social support is vital to improve their global well-being (Doffoel et al., 2022). An emotional support also includes initiatives addressed to patients' relatives and friends (Troiseufs, 2020). This humanistic approach helps health organizations to switch the focus from diseases

to patients, and this way reinforce these last ones' empowerment (Shi et al., 2021)

Health education and mobile apps

Doctors' and patients' skills in mobile literacy are essential for hospitals: without this knowledge, hospitals cannot implement health education campaigns (Yu et al., 2021). Promoting mobile apps as a health education tool means more than sharing medical information: hospitals need to use these technologies to change their internal processes and improve patients' satisfaction with medical services (Mateus-Coelho & Avila, 2021). On the other hand, healthcare organizations should research on patients' perceptions about mobile apps: performance expectancy, social influence, impact on treatments, etc. (Yu et al., 2021). Based on this information, hospitals can take appropriate decisions to efficiently integrate mobile apps into the organization's medical protocols (Navarro Martínez et al., 2021). Finally, hospitals need to train doctors on how to use mobile apps to interact with patients and, at the same time, respect the organization's legal requirements (Palacios-Gálvez, Andrés-Villas, Vélez-Toral & Merino-Godoy, 2021).

Thanks to mobile apps, hospitals improve their medical services in five different ways. First, doctors and nurses become more independent and reinforce their skills in healthcare management and health education (Ardisonne, 2020). Second, thanks to mobile apps, hospitals provide patients with accurate medical information, which helps these organizations to reinforce their scientific credibility (Palacios-Gálvez et al., 2021). Third, hospitals use mobile apps to implement more democratic decision-making processes among patients and doctors (Rowland, Fitzgerald, Holme, Powell & McGregor, 2020). Fourth, hospitals resort to this technology to renew their medical protocols and make their internal processes more efficient (Mateus-Coelho & Avila, 2021). And fifth, mobile apps allow hospitals to reduce health inequalities by providing different medical services to people living in isolated zones (Tassone et al., 2020).

Health education and noncommunicable diseases

Health education is especially important for patients suffering from noncommunicable diseases, such as cancer, heart diseases or diabetes: these patients need continuous emotional support and updated medical information to improve their well-being. *Cancer patients* face an emotional shock that leads them to ask many questions to health professionals: diagnosis, treatments, tests, personal concerns, social and family impact of this disease, etc. (Tuominen et al., 2021; Lavdaniti, 2020). This support from doctors is especially important when

patients face a radiation therapy (Kumar et al., 2021), or a surgery (Steves & Scafide, 2021): in both cases, they are overwhelmed with information, they experience psychological distress, and they have negative feelings such as anxiety, resistance, fear, and reluctance to cooperate with doctors (Feng, Wang, Wu, & Ma, 2021).

Concerning patients suffering from *heart diseases*, they need to establish empathic interactions with doctors based on nonverbal communication and mutual respect (Mentrup, Harris, Gomersall, Köpke & Astin, 2020). That is why, hospitals' health education initiatives addressed to these patients prioritize their expectations rather than technical aspects related to treatments and diseases (Andelman et al., 2019). To efficiently achieve this objective, these organizations implement two main initiatives: 1) training doctors on linguistic, interpersonal, and sociocultural skills (Mentrup et al., 2020); and 2) helping patients to control their emotions and feelings, such as depression or anxiety (Oudkerk et al., 2021). Focusing health education initiatives on patients' needs allows hospitals to lower the rate of rehospitalizations, reduce costs and improve patients' quality of life (Świątoniowska-Lonc, Sławuta, Dudek, Jankowska & Jankowska-Polańska, 2020).

As to patients facing *diabetes*, they need clear information about this disease as well as the different treatments: this information is vital to avoid medication errors, improve their quality of life, and reinforce their empowerment (Ratri, Hamidah, Puspitasari & Farid, 2020). Thanks to this information, patients can change their behaviors and monitor medical indicators, such as the blood sugar (Soep & Agussalim, 2020). On the other hand, thanks to this information, patients understand and accept their medical treatments (Leemans, Van den Broucke, Philippe, 2021), as well as the social impact of their diseases - changing personal behaviors, establishing new relations with doctors, etc.- (Chen, Wang, Chi, Chen & Park, 2020). Finally, these health education initiatives are especially important for patients living in rural communities because many of them have difficulties to move to hospitals (Yin et al., 2020).

Methodology

Many hospitals worldwide resort to mobile apps to implement health education initiatives; however, every organization follows different logics and objectives. In order to better understand how these organizations promote mobile apps as a health education tool, we analyzed the *World's Best Hospitals 2022*, a global ranking published by *Newsweek* and *Statista*. Both institutions' researchers evaluated 2.200 hospitals from 27 different countries (United States, Spain, United Kingdom, etc.) according

to three main criteria: a) recommendations from 80.000 medical experts working in 27 different countries (doctors, managers, health care professionals); b) patients' satisfaction surveys (organizational services, medical cares, etc.); and c) medical indicators about hospitals (number of patients per doctor, quality of treatments, etc.). Recommendations from medical experts accounted for 55%, patient's experience 15%, and medical indicators about hospitals 30%. Finally, all results were validated by an independent Global Board of Medical Experts from the United States, Switzerland, Israel, and Germany (NewsWeek, 2022).

Thanks to this ranking, we identified the 150 best hospitals in the world (see supplementary material 1). We analyzed each hospital's online presence: website, patient portal, social media platforms, and mobile apps. We focused on these four platforms for several reasons. *First*, corporate websites remain a public health tool that allows hospitals to improve their health education campaigns (Li et al., 2020). *Second*, thanks to social media platforms, hospitals disseminate scientific information in different formats -image, video, text-, which helps patients to better understand their treatments and diseases (Comp, Dyer & Gottlieb, 2020). *Third*, patient portals contribute to reinforce patients' skills in health education, which leads the last to actively participate in collective making-decision processes along with doctors (Driever, Stiggelbout, & Brand, 2019). And *fourth*, thanks to mobile apps, hospitals can make their health education initiatives more dynamic (Palacios-Gálvez et al., 2021). We considered these four platforms, but we focused mainly on mobile apps because these tools are radically changing hospitals' internal and external processes (Yin et al., 2020).

From 3rd November to 6th December 2022, we conducted a quantitative analysis on how the world's best 150 hospitals managed their mobile apps for health education purposes. Based on our literature review, we identified 38 indicators that we grouped in four main categories: a) online integration, b) global app for patients, c) mobile apps for other targets, and d) mobile apps for patients suffering from noncommunicable diseases (see Table 1). These indicators allowed us to understand how hospitals managed online platforms (websites, patient portals, social media, and mobile apps) to improve stakeholders' experience when interacting with the organization. We also analyzed whether these hospitals proposed a global app allowing patients to interact with doctors, and conduct some activities, such as review test results, manage appointments, pay bills, or carry out online consultations. Then, we evaluated how these hospitals used mobile apps to improve their

relations with some stakeholders, such as patients facing particular diseases, employees, suppliers, and media companies. Lastly, we evaluated how hospitals used these applications to take care of patients suffering from non communicable diseases (cancer, cardiovascular diseases, chronic respiratory diseases, and diabetes) and this way enhance their perceptions about the hospital's medical services.

We focused on mobile apps addressed to patients facing noncommunicable diseases (NCDs) because they need a regular follow-up with doctors. NCDs kill 41 million people every year, equivalent to 74% of all deaths globally: on the other hand, four NCDs – cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes- account for over 80% of all premature NCDs deaths (World Health Organization, 2022). On the other

hand, when analyzing each hospital's social media presence, we only considered corporate profiles, and not those of particular departments or events; on the other hand, we only focused on mobile apps addressed to patients, and we only evaluated apps developed by the hospital, or apps developed by external providers that were adapted to the hospital's internal system¹. We evaluated all indicators according to the binary system, except one that was analyzed as an absolute number: online integration (5. Number of mobile apps).

¹ Some hospitals resorted to an external provider (My Chart, Epic) to develop their mobile apps: UCSF Medical Center (United States), University of Wisconsin Hospitals (United States), University of Utah Hospital (United States), University of Kansas Hospital (United States), North York General Hospital (Canada), and Universitair Medisch Centrum Groningen (The Netherlands).

Table 1. Indicators.

Online integration	Global app for patients	Mobile apps for other targets	Mobile apps for patients suffering from noncommunicable diseases
<ol style="list-style-type: none"> 1. Corporate website 2. Patient portal 3. Social media platforms 4. Mobile apps 5. Number of mobile apps 	<ol style="list-style-type: none"> 1. Review test results 2. Upload personal data 3. Access family's health data 4. Communicate with doctors 5. Manage appointments 6. Request prescriptions 7. Conduct video consultations 8. Find physicians 9. Pay bills 	<ol style="list-style-type: none"> 1. Patients facing particular diseases 2. Employees 3. Suppliers 4. Media companies 	<p>Cardiovascular diseases</p> <ol style="list-style-type: none"> 1. Access health education information 2. Track medical metrics 3. Contact doctors 4. Conduct online consultations 5. Request prescriptions <p>Cancer</p> <ol style="list-style-type: none"> 1. Access health education information 2. Track medical metrics 3. Contact doctors 4. Conduct online consultations 5. Request prescriptions <p>Chronic respiratory diseases</p> <ol style="list-style-type: none"> 1. Access health education information 2. Track medical metrics 3. Contact doctors 4. Conduct online consultations 5. Request prescriptions <p>Diabetes</p> <ol style="list-style-type: none"> 1. Access health education information 2. Track medical metrics 3. Contact doctors 4. Conduct online consultations 5. Request prescriptions

Source: Authors.

Results

Using mobile apps for health education purposes has become a main trend in many countries. However, some hospitals are not performant when using these tools: they lack meaningful content, they face usability-related problems, and they do not integrate these apps with other platforms. In order to justify this sentence, we present our quantitative results grouped in four main categories: a) global integration, b) global app for patients, c) apps for other targets, and d) apps for patients suffering from NCDs.

Global integration. According to our results, all hospitals had a corporate website, 91,3% were present on at least one social media platform, 62% showcased a patient portal, and 57,3% used mobile apps. On average, these hospitals managed 3,5 different mobile apps that they used to communicate with patients (treatments, medical information, events, etc.). On the other hand, these results proved that most hospitals integrated the four platforms (website, patient portals, social media platforms and mobile apps). Finally, the best hospital in terms of number of mobile apps was *The John Hopkins Hospital – United States-* (see Table 2).

Table 2. Ten best hospitals by number of mobile apps.

Hospital	Number of mobile apps
The Johns Hopkins Hospital (United States)	29
University of Michigan Hospitals - Michigan Medicine (United States)	17
Cleveland Clinic (United States)	14
Geneva University Hospitals (Switzerland)	13
All India Institute of Medical Sciences - Delhi (India)	12
UCLA Health – Ronald Reagan Medical Center (United States) (1)	11
UCLA Health - Santa Monica Medical Center (United States) (1)	11
Radboud Universitair Medisch Centrum (The Netherlands)	9
Massachusetts General Hospital (United States)	7
Vanderbilt University Medical Center (United States)	7

(1) UCLA Health – Ronald Reagan Medical Center (United States) and UCLA Health - Santa Monica Medical Center (United States) belong to the same group and use the same mobile apps.

Source: Authors.

Global app for patients. Most hospitals had a global app allowing patients to interact with doctors and ask them for different services. More precisely, 69,8% of hospitals using mobile apps proposed a global app for patients. However, many of these organizations did not provide patients with all services considered: review test results and medical records (100%), manage appointments with doctors at the hospital (100%), upload personal health data (98,3%), communicate with doctors (98,3%), find physicians (55%), request prescriptions (48,3%), pay bills (48,3%), conduct video consultations with doctors (31,7%), and access family's health information (23,3%). On the other hand, the only hospital fulfilling the 9 criteria was *UC Health University of Colorado Hospital – United States-* (see *Table 3*). On the other hand, some hospitals from the same country respected 8 criteria (*The Mount*

Sinai Hospital, University of Michigan Hospitals-Michigan Medicine, and University of California-Davis Medical Center) which led us to affirm that many hospitals in this country consider mobile apps as a key element to improve their internal processes. Concerning the remaining hospitals, 85% of them respected between 5 and 7 criteria (see *Table 4*). These results proved that most hospitals resorted to mobile apps to improve their relations with patients; nevertheless, they can still improve in this area, especially those that only respected 4 criteria or less. Using a global mobile app constitutes an opportunity for hospitals to accelerate their digital transformation; however, to efficiently do that, they need to propose services that make patients' experience more unique, such as for example conducting online consultations with doctors.

Table 3. Best apps by number of services proposed to patients.

Mobile app and Hospital	Number services (out of 9)
UC Health App (UCHealth University of Colorado Hospital, United States)	9
Health Buddy App (Singapore General Hospital, Singapore)	8
My Mount Sinai App (The Mount Sinai Hospital, United States)	8
My UofM Health App (University of Michigan Hospitals - Michigan Medicine, United States)	8
My UC Davis Health App (University of California - Davis Medical Center, United States)	8

Source: Authors.

Table 4. Hospitals and criteria.

Number of criteria	Number of hospitals
9	1
8	4
7	16
6	18
5	17
4	4
3	0
2	0
1	0

Source: Authors.

Apps for other targets. Most hospitals using mobile apps resorted to these tools to interact with their patients. Few organizations considered also other targets: patients suffering from particular diseases, such as depression or mental disorders (45,3%), hospital's employees (44,2%), and media companies (2,3%). On the other hand, no hospital proposed an app addressed to suppliers (pharmacies, logistic companies, etc.). Our results proved that most hospitals prioritized their patients as main target, and did not use these apps to interact with other publics, such as suppliers or media companies. Finally, no hospital had at least one app to interact with the four targets at the same time (patients, employees, media companies and suppliers).

Apps for patients suffering from NCDs. According to our quantitative results, most hospitals did not use mobile apps to interact with patients facing cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes.

Only 8.1% of hospitals having mobile apps proposed at least one app for patients suffering from *cardiovascular diseases*. These apps provided patients with different services: access health education information (100%), contact doctors (100%) and track medical metrics (28,6%). However, these apps did not allow patients to conduct online consultations and request prescriptions. The only mobile apps respecting at least 3 out of 5 criteria were Corrie Health App (*The Johns Hopkins Hospital*, United States) and AVC HUG (*Geneva University Hospitals*, Switzerland).

Concerning *cancer*, 6,9% of hospital having mobile apps proposed at least one app addressed to these patients. Nevertheless, most hospitals did not respect the indicators considered: access health education information (100%), contact doctors (83,4%), track medical metrics (50%), conduct online consultations (0%), and request prescriptions (0%). The three online mobile apps fulfilling at least 3 criteria were HUG Cancer du Sein App (*Geneva University Hospitals*, Switzerland), UM Skin Check App (*University of Michigan Hospitals - Michigan Medicine*, United States) and CMyLife App (*Radboud Universitair Medisch Centrum*, The Netherlands).

As to *chronic respiratory diseases*, the only hospital proposing an app for these patients was *Cleveland Clinic* (United States). Thank to the Sleep App, patients could access health education, track medical metrics, contact doctors, and conduct online consultations.

Finally, 3,5% of hospitals had an app for patients facing *diabetes*. Thanks to these apps, patients could access health education information, track medical metrics, and contact doctors; however, no mobile app allowed them to conduct online consultations with doctors

and request prescriptions. The three hospitals proposing these apps were: LDL Cholesterol Calculator App (*The Johns Hopkins Hospital*, United States), Diabetes Emoticons App (*University of Michigan Hospitals - Michigan Medicine*, United States) and Webdia (*Geneva University Hospitals*, Switzerland).

Discussion

The accessibility of smart technologies - mobile apps, social media platforms and websites- has a pronounced influence on the delivery of patients' education (Jamleh, Nassar, Alissa & Alfadley, 2021). Health organizations play a key role in promoting eHealth literacy (Lu & Zhang, 2021), that is why doctors should become experts in directing patients towards appropriate information and facilitating the use of digital health technologies (Kuwabara, Su & Krauss, 2019). However, our quantitative results proved that many hospitals did not use these smart technologies to improve patients' skills in health education. In fact, 38% of hospitals did not showcase a patient portal, and 42.7% did not manage mobile apps addressed to patients. Besides, concerning hospitals using mobile apps, some of them did not develop their own mobile apps: they used the same apps implemented by other hospitals belonging to the same group. This was the case of *Mayo Clinic* (Rochester, Jacksonville, and Phoenix -United States-), *UCLA Health* (Ronald Reagan Medical Center, Santa Monica Medical Center -United States-), or *APHP* (Hôpital Universitaire Pitié Salpêtrière, Hôpital Européen Georges Pompidou -France-).

Improving m-Health education means that hospitals should use mobile technologies to better protect patients' rights (Mateus-Coelho & Avila, 2021). Besides, these organizations should integrate mHealth apps into their medical protocols (Rowland et al., 2020). Hospitals can also use mobile apps to take care of surgical patients: communication between doctors and patients, personal guidance, medical metrics, etc. (Machado, Turrini & Sousa, 2020). Nevertheless, our quantitative results demonstrated that most hospitals proposing a global mobile app to patients used this that as an administration platform rather than a medical tool. That is why most hospitals allowed patients to use these global apps to review test results (100%) or upload personal health data (98,3%), but only some organizations integrated these global apps into their internal processes: request prescriptions (48,3%), conduct video consultations (31,7%).

Hospitals should use mobile apps to interact with different stakeholders (Ardisonne, 2020). For example, they can use these platforms to communicate with media

companies and produce educational material for patients (Bange, Huh, Novin, Hui & Yi, 2019); on the other hand, they can also help journalists to produce more accurate papers, which is consistent with patients' new requirements (Sola Pueyo, 2022). They can also implement different programs to help employees improve their skills and behaviours (Meinert, Rahman, Potter, Lawrence & Van Velthoven, 2020), and this way better serve some patients, such as those living in isolated places and facing chronic diseases (Yin et al., 2020). However, our results proved that most hospitals focused their mobile apps on patients facing general health issues, and not on other targets such as suppliers or media companies. In fact, only 2,3% of hospitals proposed a mobile app addressed to media companies, and no hospital had a mobile app for the organization's suppliers.

Patients suffering from noncommunicable diseases need to interact frequently with their doctors and nurses, that is why developing mobile apps for these patients should constitute a priority for hospitals. In the field of oncology, digital patient education is relatively new and lacks an organized strategy, which is why hospitals and technology providers should work together to develop mobile apps that satisfy patients' needs in terms of information and emotional support (Turkdogan et al., 2021). On the other hand, mobile apps are also essential for people suffering from diabetes because it allows them to improve their cognitive, affective, and psychomotor abilities (Soep & Agussalim, 2020). Finally, patients facing heart diseases also need to use mobile apps to interact more with doctors and reduce risks (Świątoniowska-Lonc et al., 2020). Despite these facts, our quantitative analysis proved that most hospitals did not propose apps for these patients: only 3,5% of hospitals had an app addressed to patients facing diabetes, and only 6,9% of these organizations developed an app for cancer patients.

Our quantitative results demonstrated that the best hospitals in the world can still improve their practices to better integrate mobile apps into their internal protocols, and this way enhance patients' satisfaction. Despite these interesting results, we must highlight three main limitations affecting this paper. *First*, we did not have access to each hospital's corporate communication department, which avoided us to know more about their communication plans, budgets, and policies concerning mobile apps. *Second*, we did not analyze the legal frameworks existing in each country, which determines how hospitals manage these apps. And *third*, we could not find similar papers to compare our results and enhance our conclusions. We recommend researchers interested in developing this

area in the next years to focus on some strategic areas such as how to train doctors on the use of mobile apps, how to integrate these apps into the hospital's medical protocols, and how to evaluate patients' satisfaction with these platforms.

Conclusion

Promoting health education and helping patients reinforce their empowerment has become a common practice. Hospitals focus on this area because it positively impacts their internal functioning, and because it contributes to protect patients' rights. In this framework, mobile apps play a key role. However, hospitals cannot only rely on the technological aspects of these platforms: health professionals' and patients' needs and rights remain more important than technical elements. This paper aimed to analyze how the best hospitals in the world managed mobile apps to promote health education. We tried to answer a main research question: What are the main criteria that hospitals should consider when using mobile apps for health education purposes? After analyzing our quantitative results, as well as the literature review carried out about this area, we can affirm that hospitals should consider three main criteria: 1) respecting patients' needs in terms of information and emotional support, 2) evaluating health professionals' and patients' skills in mobile literacy, and 3) considering public health priorities.

To conclude this paper, we propose three last ideas that can help hospitals manage mobile apps more efficiently. First, hospitals should integrate mobile apps with other platforms (websites, patient portals, social media) and include these apps in some medical protocols so that this technology becomes a medical tool, rather than an administrative platform. According to our results, only 57,3% of hospitals managed mobile apps, and only 62% proposed a patient portal, which means that most of these organizations can still improve in this area. Second, hospitals need to focus on content and services that are meaningful for stakeholders, and not on administrative information about the organization's internal procedures. Thus, only 31,7% of hospitals allowed patients to use their global app to conduct a video consultation with doctors. And third, hospitals should collaborate with public health authorities and develop mobile apps that are consistent with the hospital's business needs, but also with public health authorities' priorities: in other words, hospitals should use mobile apps to reinforce their engagement with public health, and not to promote medical treatments.

Authors' contributions

Each authors equally contributed to this paper and approved the final version sent to the journal.

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Data availability statement

Data presented in this study can be consulted by contacting the corresponding author.

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