The Role of Mobile Applications in the Doctor's Working Time Management System

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Abstract: *Background*: Information technologies have become a mandatory component for health care institutions, as well as for doctors. Doctors' use of medical mobile applications to access medical information has the potential to improve the use of their working time. Primary care physicians can use mobile applications to communicate with their patients, thereby improving the health of individual patients and the population as a whole.

Objectives: The study aims to determine the effectiveness of the use of medical reference mobile applications by general practitioners in their medical practice.

Methods: The research was conducted through a sociological survey and a questionnaire survey. Descriptive statistics were used for the analysis.

Results and Conclusions: The study found that in Ukraine, medical mobile applications are mainly reference, and their use allows doctors to improve decision-making and has a positive effect on the level of health of the population and the doctor's working time management. The assessment of the duration of the appointment using applications showed that in most cases, the time of the consultation was reduced to 15 minutes, which testifies to the improvement of this type of assistance to the population. Besides, the use of applications provides a significant reduction of the time for making a clinical decision by 5 minutes. We found a relationship between the average duration of the appointment, as well as the time for making a clinical decision and the frequency of using the mobile application during the working day. The hypothesis of a direct effect of an innovative approach (use of a mobile application) on the time of outpatient appointments by family doctors with a significance level of 0.05 was tested using statistical data analysis according to the Student's test. The presented results of the analysis of a medical experiment with general practitioners allowed concluding the positive impact of the use of mobile applications on the working time savings of general practitioners when providing medical services.

Keywords: Applications, Appointment Duration, Electronic Medical Records, M-Health (Mobile Health), Patient Monitoring, Time Management.

INTRODUCTION

Working time management is a constant personal and professional challenge for doctors. The duty towards patients is a unique professional responsibility that regularly urges the doctor's time planning. Patient care responsibilities and unpredictability in work caused by interruptions, unpredictable changes in patient care, emotional and physical fatigue, erratic schedules, or work responsibilities may not be fully controllable or variable. The time management resources available in other areas, mainly business, often cannot fully meet the time management needs that result from duty towards the patients. Mobile applications are one of the modern solutions for managing doctors' working time.

The ability to download medical apps to mobile devices has made a lot of mobile resources available to doctors. Mobile health apps are available for many purposes, including e-prescribing, diagnosis and treatment, practice management, coding and billing, e-record entries, and e-learning. There is a wide variety of applications that help to run the clinical practice and deal with other issues during healthcare services delivery, such as drug guides, medical calculators, clinical guidelines and other decision support tools, textbooks, and information and data retrieval portals. There are even mobile apps that simulate surgical procedures or can perform simple medical examinations such as hearing or vision tests.

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One of the main motivations that prompted doctors to widely use mobile applications was the need for better communication and information resources at the point of care. Ideally, physicians need access to many types of resources in the clinical setting, including:

– communication capabilities — voice calls, video conferences, text messages and e-mail;

– hospital information systems (HIS) — electronic health records (EHR), electronic medical records (EMR), clinical decision support systems (CDSS), picture archiving and communication systems (PACS) and laboratory information systems (LIS);

– information resources — textbooks, recommendations, medical literature, drug guides;

– clinical software products — disease diagnostics tools, medical calculators.

The research aims is to study the use of medical reference mobile applications and their effectiveness for general practitioners in their medical practice.

Research Objectives

1. Determine the factors of mHealth in the context of mobile applications that improve the doctor's working time management and identify the types of medical mobile applications used in Ukraine;

2. Evaluate the intensity and motivation of the use of reference mobile applications in the physicians' practice;

3. Determine the effectiveness of the use of Ukrainian-language mobile applications by doctors in patient care.

LITERATURE REVIEW

Research on the use of mobile applications in medicine and medical education is limited and closely related to the mobile health concept (mHealth). Maintaining a work-life balance for physicians requires learning to increase efficiency and effectively manage the limited resource of available time [1]. The physicians serve increasingly complex patients in less time, deal with more administrative paperwork, and are more easily accessible through e-mail, pagers, cell phones, and other technological tools, which contributes to high burnout rates [2]. As a result, doctors increasingly report severe time management problems [3]. However, few medical publications directly address the issue of improving physicians' time management skills, this can contribute to the sustainability of a physician's career [4]. The number of patients with more than one chronic disease is constantly increasing. About 67.3% of the years of life lost will be caused by chronic non-communicable diseases by 2040 [5].

mHealth focuses on accessing medical data and enabling communication between doctors and patients through electronic access. Therefore, the role of mobile phone and mobile applications in the health care sector is increasing. Mobile medical applications can save a lot of time and effort for physicians because of constant direct contact with patients. As a result, their use optimizes the work of physicians, increases their productivity and supports agility in communication with patients [6].

Classification of mobile medical applications is a complex issue because of the large number of products in this field. There were no articles containing a comprehensive review of mobile health applications until 2012. Mosa, Yoo, and Sheets [7] were the first authors to systematize them by function and specialization. Scientists [8] state that the three main advantages of using medical applications are a higher quality of health care delivery regardless of location, access to health services, and higher efficiency in the health care resource allocation.

All research on the impact of medical mobile applications in the health care sector can be divided into the study of the effectiveness of their use by patients and those engaged in the medical profession. At the same time, most medical mobile applications remain a novelty for doctors. These studies are inconsistent and incomprehensive, their results are outdated. In particular, better ways to assess app quality and effectiveness are required to use the potential of mobile health apps to change behaviour and improve health [9]. Scientists [10] studied the impact of mobile apps, mostly related to diabetes, mental health, and obesity, on patient health.

The use of smartphones and the installation of medical applications in medical facilities by medical workers may also depend on the mentality of the population of a certain country [11]. For example, in Saudi Arabia, their use rates are low because of the lack of acceptance. There are several comprehensive

reviews on the effectiveness of mobile health applications in enhancing physical activity, improving diet and nutrition [12], and improving health-related behaviours [13] among the population as a whole.

Only a few studies outlined the prospects for the use of mobile health technologies by physicians. For example, authors [14] state that in a series of interviews with general practitioners in Australia, physicians reported the benefits of mobile applications, including patient education and medical record-keeping, but the technology was not integrated into their workflow.

Mobile medical technologies are a proven means of doctor-patient communication and have contributed to significant improvements in patient health outcomes [15]. Scientists note that medical consultation through mobile applications is convenient for doctors and their patients, as it saves both time and money [16].

Medical mobile applications are designed to facilitate point-of-care decisions, such as medication dosing, by presenting relevant concise, and easily accessible information. Scientists [17] state that these applications help to provide patient-centred, evidence-based care while reducing error rates and are increasingly popular among healthcare professionals worldwide. Authors [18] found in their study on Iran that medical students used the following mobile applications the most frequently: medical dictionaries, drug ordering applications, medical calculators, and anatomical atlases, while nursing students used medical dictionaries, anatomical atlases, and patient care manuals.

There's little data on how many doctors recommend applications to their patients and which applications they use/recommend, if any, while mobile applications for Android and iOS keep ratings and downloads. In general, physicians' views on mHealth technologies are poorly studied despite several bibliometric studies on this issue [19, 20].

The aim of the above studies on determining the impact of medical mobile applications on the medical practice of physicians was a general assessment of their use of mobile applications. They contain data on their development, content, application in particular situations, quality, etc., but their impact on doctors' working time has not been studied. Therefore, studying the importance of mobile applications in doctors' time management with a view to the active development of the market of health-related mobile applications as the main technology of mHealth is relevant.

MATERIALS AND METHODS

Following the research objectives, we formalize the procedure, methodological and information background of the analysis of the role of mobile applications in the physicians' working time management system.

The work presents the development of the market of mobile medical applications as one of the main elements and key factors influencing physicians' working time management system. Accordingly, the study is based on the assumption that mobile medical applications increase the efficiency of physicians' working time. Therefore, it was determined at the initial stage of the research that physicians in Ukraine mainly use free mobile medical reference applications.

The next stage involved a sociological survey to assess the impact of the use of reference mobile applications on physicians' working time. The data was obtained based on empirical data collection, namely a study of public opinion regarding the use of mobile applications in Ukraine. A survey using a specially developed questionnaire was chosen as the method. An invitation to participate in the study was sent to 100 general practitioners. A total of 76 physicians returned completed questionnaires, so a response rate was 76%.

The questionnaire consisted of several parts. Part 1 determined participant demographics, including age, gender, whether a mobile device was used, or whether medical applications were installed on a smartphone. Part 2 assessed participants' perceptions of medical smartphone applications. Part 3 evaluated the use of medical reference mobile applications. Part 4 examined the direct impact of mobile application use on physicians' working time efficiency. The questionnaire was pre-tested with 8 primary care physicians (PCPs) regarding the understanding of the questionnaire items. Partially completed questionnaires were not included in the analysis.

Ukraine has introduced a three-level system of providing medical care, and primary care (PC) is the first one that patients recourse to. The state guarantees free PC based on family medicine in state and communal health care institutions with which the chief budget administrator has agreed with medical care for the population. PC can be provided by a general

practitioner — a family physician, a pediatrist, or a therapist. According to the Center of Medical Statistics of the Ministry of Health of Ukraine, there were 23,755 PCPs in 2021 working under a contract with the National Health Service, of which 15,559 (65.5%) are family physicians, as well as 3,446 therapists and 4,859 pediatrists. Therefore, only general practitioners were interviewed to achieve the aim. It can also be noted that the vast majority of the specialists surveyed had 5 to 10 years of professional experience. The critical level of significance of the statistical hypotheses in this study was taken as 0.05 since the possibility of difference was more than 95%.

Participants were asked whether they owned smartphones and whether they used mobile applications on their smartphones to support their educational and practical activities. The frequency of use of mobile applications was also studied. Analysis of responses to open-ended questions allowed exploring participants' views on mobile applications.

At the same time, the time of having a mobile device (smartphone/tablet) was first assessed. It was established that 9 physicians (11.8%) used these devices for less than 1 year, 13 physicians (17.1%) — for 1–3 years, 17 physicians (22.4%) – for 3–6 years, 37 physicians (48.7%) – more than 6 years (Figure **1**).

At the same time, all physicians were assessed for their level of knowing how to use a mobile device. It was established that the majority of respondents (46 physicians — 60.5%) rated their level of knowing how to use as high, 27 (35.5%) — as a medium, and 3 physicians (4.0%) – as low (Figure **2**).

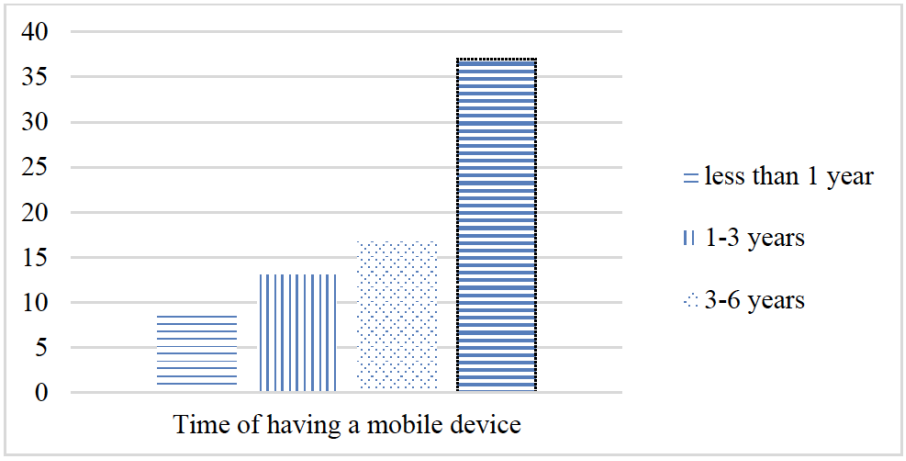

Figure 1: Distribution of respondents by the time of having a mobile device (units).

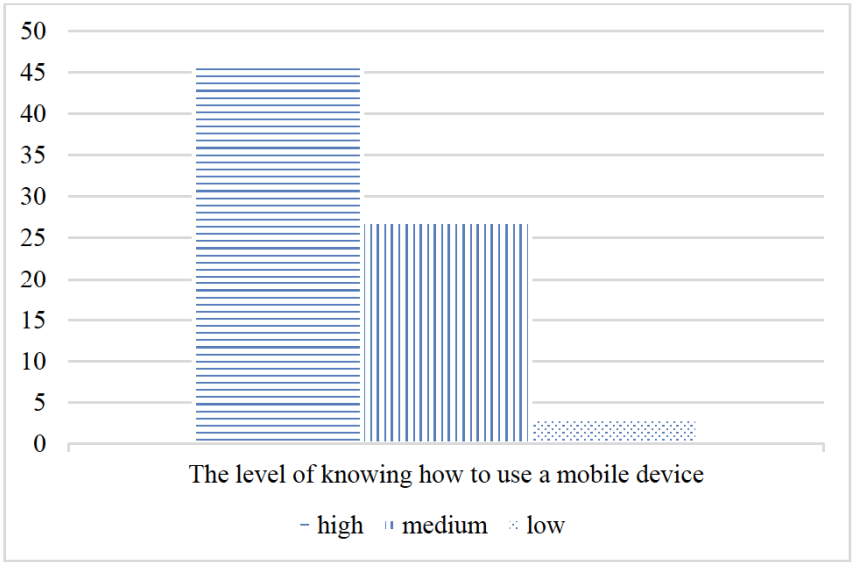

Figure 2: Distribution of respondents in terms of their level of knowing how to use a mobile device (units).

Outpatient appointments take the largest proportion of the working time of general practitioners, this is why we will evaluate the direct impact of reference mobile applications on their duration. For this purpose, we divided all 76 doctors into two groups of 38 people each. The first group used the traditional method in their medical practice, the second group used a mobile application. The analysis and processing of the obtained experimental data by timekeeping were carried out using the Student's t-test. The efficiency indicator E is determined by Formula (1):

$$E = \left(\frac{M_2 * 100}{M_1} \right) - 100, \quad (1)$$

where: M_1, M_2 – calculated mathematical expectation for Groups 1, 2.

The research involved content analysis, review of electronic resources, system and logical analysis. A system of general scientific research methods and research methods at the empirical and theoretical levels was also used, namely: a sociological survey with the use of a questionnaire to determine the spread of the use of medical mobile applications. The method of comparison was used to study the frequency of their use; methods of analysis and synthesis — to identify the impact of the use of mobile applications on the physicians' working time. An abstraction method was applied for identifying the result of using medical mobile applications. Statistical analysis methods were involved to evaluate survey results.

The study used statistical data analysis according to the Student's test, with a significance level of 0.05, to determine the impact of an innovative approach (use of a mobile application) on the time of outpatient appointments of patients by family doctors. Statistical processing of the data obtained was carried out using open versions of the Excel package.

RESULTS

Our review identified mobile applications that are capable of fulfilling the tasks of family physicians. It was found that mHealth applications can replace physicians in collecting medical history and diagnosing; carrying out some inspections; clinical decision support and management; providing assistance in emergency, long-term and specific medical care; and promoting health improvement. However, mHealth applications will not be able to perform medical procedures, properly involve other professionals, and coordinate a team-based approach.

mHealth applications serve a variety of purposes and perform many functions for both patients and healthcare professionals. This review focuses on mHealth applications used by patients for health purposes. The results suggest that mHealth applications have the potential to perform several specific clinical tasks typically performed by a physician. mHealth applications allow patients to address specific clinical issues, such as self-management of pain and weight management. Such mobile application features can replace several functions of a family physician, for example, a diagnostic application can help users make decisions about further treatment options, thereby potentially replacing a physician for this purpose. However, most programmes, especially for collecting medical history and diagnosing, cannot replace a consultation with the physician. The applications were found to be suitable for providing basic health information and recommendations only.

Tt can be concluded based on the results of the analysis of the use of mobile applications in Ukraine (Table **1**) that quite a few Ukrainian-language mHealth applications are mostly reference applications.

Table 1: The Most Popular Free Medical Applications in Ukraine in Apple App Store (in Ukrainian)

Apple App Store	Score
1 Tabletki.ua: searching and ordering medicines in pharmacies Tabletki.ua	4.9
2 Helsi Helsi. me	4.7
3 Liki24 - delivery from pharmacies Liki24 Ltd	4.8
4 Vahitnist' — pregnancy calendar Wachanga LTD	4.9
5. Labour counter. Pregnancy Alek Neiman	4.9

Source: generalized by the author.

Some functions of a general practitioner cannot be performed with mHealth. For example, mHealth apps cannot perform medical procedures. However, mHealth applications, along with other assistive technologies, have the potential to support clinical functions. Other competencies of physicians include personal qualities such as attitude, practical skills, and soft skills that mHealth applications cannot currently replace. However, mHealth applications can support physicians in terms of training and recommendations. Therefore, mobile applications can perform some of the functions

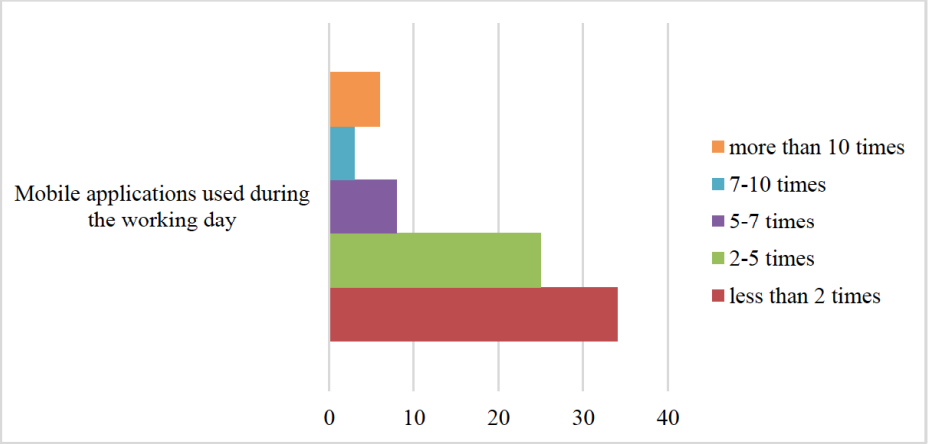

Figure 3: Distribution of respondents by the number of mobile applications used during the working day (units).

of physicians regarding health care, but cannot replace them.

We will conduct a study of the use of reference medical applications in the practice of general practitioners. It was established in the course of the study that most physicians used mobile applications from 2 to 5 times during the working day (Figure **3**).

When analysing the reasons for using mobile applications, it was established that more than a third of doctors mainly used electronic versions of directories to quickly find the necessary information and available tools (calculators, scales), read current news, and study clinical cases from the experience of colleagues, read medical literature (Lancet, PubMed) (Figure **4**).

When evaluating the duration of an outpatient appointment, it was established that 3 (3.9%) more than half of the physicians estimated the average duration of their appointment at 15-20 minutes (Figure **5**).

During the evaluation of the appointment time using mobile applications, 26 physicians (34.2%) testified about reduced appointment duration by 5 minutes, and 31 physicians (40.8%) did not note any change in the duration of the consultation appointment (Figure **6**).

The comparison of the average appointment duration before and after the introduction of reference mobile applications revealed a reliable reduction in the duration of the outpatient appointment. In particular, the average appointment duration was 18.6 minutes before the introduction of the mobile application, while it became 14.2 after the introduction.

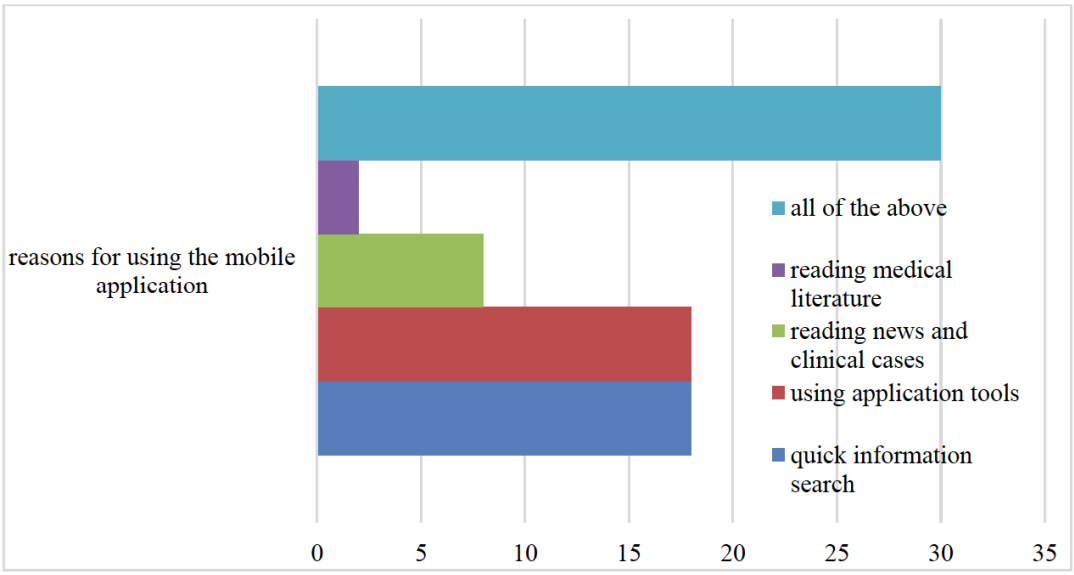

Figure 4: Frequency of reasons for using mobile applications (units).

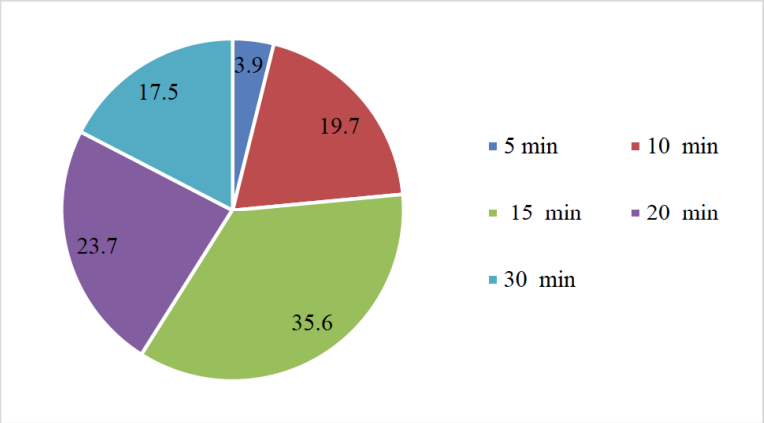

Figure 5: The ratio of the average duration of the consultation appointment (%).

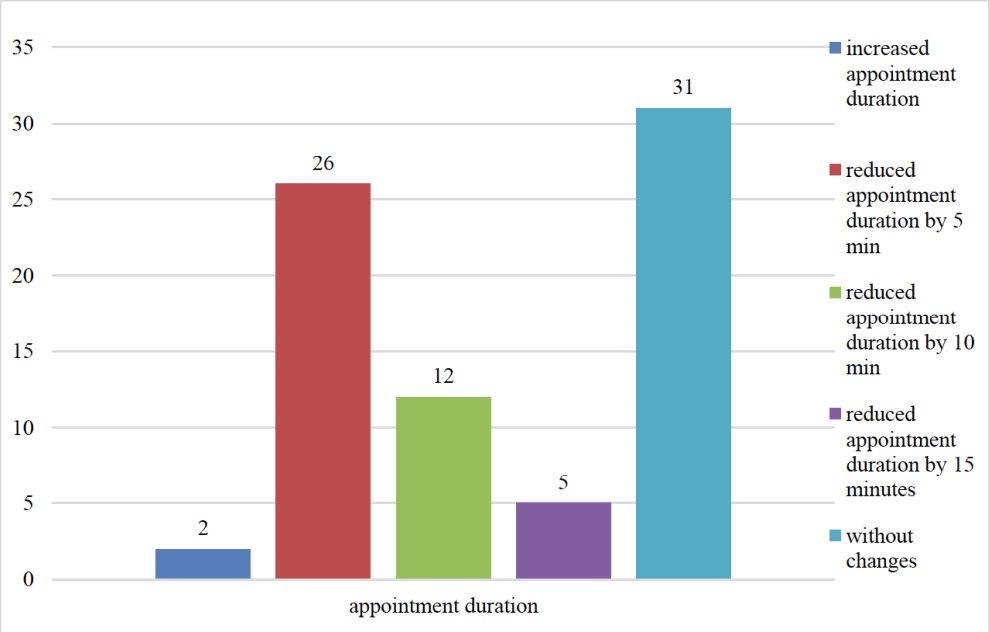

Figure 6: Distribution of the impact of using mobile applications on the duration of outpatient appointments (units).

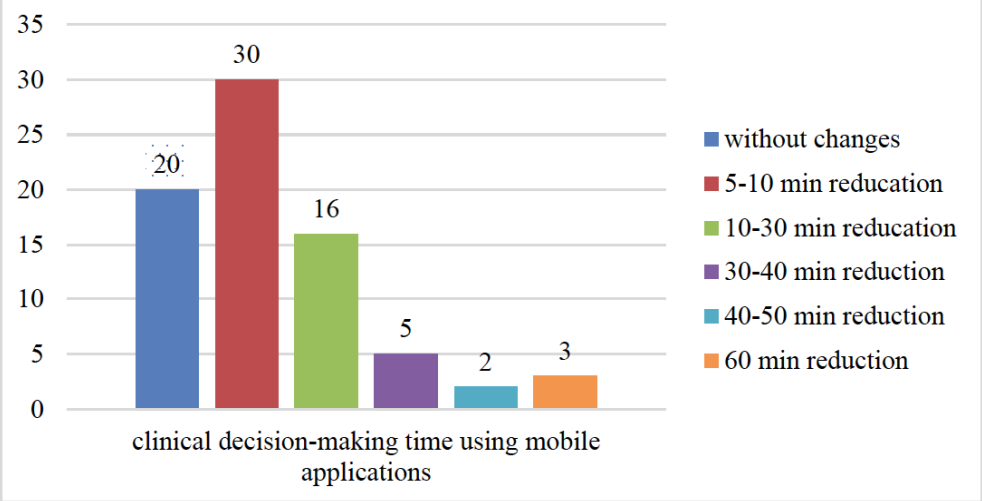

Figure 7: Distribution of respondents by clinical decision-making time using a mobile application (units).

Table 2: Comparative Results of Traditional Outpatient Appointments and those with the use of Reference Mobile Applications

Family physicians	Time spent on the traditional appointment, min	An appointment using medical mobile applications, min	Difference	Difference squared
1	20	14	-6	36
2	18	15	-3	9
3	17	16	-1	1
4	21	13	-8	64
5	15	14	-1	1
6	19	16	-3	9
7	19	13	-6	36
8	20	14	-6	36
9	18	15	-3	9
10	18	15	-3	9
11	18	13	-5	25
12	17	14	-3	9
13	16	15	-1	1
14	18	15	-3	9
15	20	15	-5	25
16	19	13	-6	36
17	21	13	-8	64
18	18	14	-4	16
19	19	14	-5	25
20	17	15	-2	4
21	19	13	-6	36
22	18	14	-4	16
23	19	13	-6	36
24	20	14	-6	36
25	20	13	-7	49
26	18	14	-4	16
27	17	16	-1	1
28	18	13	-5	25
29	20	14	-6	36
30	19	15	-4	16
31	19	15	-4	16
32	18	13	-5	25
33	19	14	-5	25
34	19	15	-4	16
35	18	15	-3	9
36	17	15	-2	4
37	18	13	-5	25
38	22	13	-9	81

Evaluating the time to make a clinical decision using mobile applications, 20 physicians (26.3%) noted that applications do not affect this indicator. At the same time, the majority of respondents testified to a significant reduction in clinical decision-making time through the use of mobile applications. In particular, 30 physicians (39.5%) indicated a decrease in time spent by 5–10 minutes, 16 physicians (21.1%) – by 10–30 minutes, 5 physicians (6.6%) – by 30-40 minutes, 2 physicians (2.6%) – by 40–50 minutes, 3 physicians (3.9%) – by more than an hour (Figure **7**).

Table 3: Results of the Analysis Comparing the duration of Outpatient Appointments of Two Groups by Traditional and Innovative Methods

Group 1 – Traditional method of outpatient treatment		Group 2 – Appointment using medical mobile applications
M = 18.57895	Calculation of a mathematical expectation	M = 14.15789
S=1.407155	Calculation of root-mean-square deviation	S=0.973329
We calculate the value of the Student's t-test and compare it with the table value to accept or reject the hypothesis being tested		
t_c=0.46252	<	$t_{c(table)}$=2.036

A significant decrease in clinical decision-making time before and after the implementation of reference mobile applications was established when evaluating this indicator. At the same time, the average indicator was 23.8 minutes before the introduction of the mobile application, and 19.4 after.

Therefore, the use of mobile applications during the working day reduces the overall average appointment duration, as well as the time is taken by the physician to make a clinical decision.

The results of research in the above-mentioned groups are shown in Table **2**. The hypothesis of a direct effect of an innovative approach (use of a mobile application) on the duration of outpatient appointments with family physicians with a significance level of 0.05 was tested. Paired samples are presented in this case.

Further calculations (results) were obtained after statistical analysis of data using the Student's t-test (Table **3**). It can be concluded based on the results of the analysis that the tested hypothesis has the right to exist, as evidenced by the comparison of the obtained value of the Student's t-test with the tabular value.

The obtained value of the Student's t-test t_c is less than the table value, which, in turn, confirms the proposed hypothesis. It can be concluded based on the results of the hypothesis test that the outpatient appointments of Group 2, which involved medical mobile applications, are more efficient, more successful, has a higher quality indicator of time consumption than Group 1 with traditional appointments. The calculated efficiency indicator of Group 2 allows seeing how much more efficient outpatient appointments are with the use of medical mobile applications.

Calculations of formula (1) showed that the efficiency of Group 2 compared to Group 1 is 23.80% higher, which in turn confirms the appropriateness of implementing and using medical mobile applications by physicians in outpatient appointments.

DISCUSSION

Medical mobile applications have a positive impact on physicians' education, efficiency, and patient care [21]. The data that we obtained indicate a decrease in time spent by general practitioners on the medical care of patients at an average level of intensity of the use of medical mobile applications. At the same time, existing studies do not so much determine the impact of the use of medical mobile applications on the work of physicians as describe their general characteristics. In particular, Bhanot and Sharma [22] studied the Epocrates mobile application. Authors [23] studied the popularity of mobile application use among groups of medical students and doctors in the UK. They found that most students and doctors knew how to use 1–5 medical-related applications, with only a few knowing how to use more than 10, while iPhone owners were significantly more likely to use the applications. Both groups showed similar trends in using applications several times a day. At the same time, students used applications for disease diagnosis/management and drug information, while physicians preferred clinical assessment/calculator applications. It should be noted that doctors in Ukraine currently use only reference and informational mobile applications, unlike in developed countries, which makes cross-country comparative analysis impossible. It should be noted that doctors in Ukraine currently use only reference mobile applications, unlike doctors in developed countries, which makes cross-country comparative analysis impossible.

At the same time, scientists [24] also note the weak involvement of clinicians in the development and support of the use of mobile solutions, which can negatively affect their further use. In the current digital transformation of healthcare, physicians can play a key role in determining the most appropriate mobile applications to be recommended to patients [25, 26].

When studying the issues of medical mobile applications, researchers also evaluate their effect on the structure of doctors' working time. An examination of medication sub-tasks showed that increased time spent, for example, looking up medication in a mobile application was offset by decreased time spent in other areas [27]. As mHealth in Ukraine is currently a system of non-interrelated mobile applications, doctors sometimes have to spend additional time, and therefore personalization is necessary for applications that will interact, in particular, with the patient's electronic medical records and between themselves, taking into account the characteristics of patients.

Reasons for using mobile applications are also different in our research. While in the USA the three main reasons were diagnosis and examination, drug dosage, and self-education on the example of the work of dermatologists [28-30], in Ukraine those were reading the news and medical literature, using the tools of medical mobile applications, and quick search for information.

Although the spread of mobile applications is constantly increasing due to lower costs and shorter waiting times, the phenomenon has not yet reached maturity [31]. However, the use of medical mobile applications currently falls into a legislative grey area because of a lack of funding and guidelines [32, 33].

This study focused on general practitioners, who are the study groups, but their level of digital literacy is unknown. The increased likelihood that smartphone users would respond to a survey related to the use of mobile applications is a source of non-response bias, and the use of a questionnaire may have contributed to the research design limitation. However, the spread of smartphones was only one of the objectives of the survey, and it reflected data at the time of the survey, which is a useful reference for future research.

This study has some limitations. One of these limitations is that the causal relationship between the use of medical mobile applications and other variables affecting physicians' use of work time has not been examined. A second limitation is single-country results that cannot be generalized to all.

CONCLUSION

The use of mobile medical applications is a need that meets modern conditions and ensures the rationalization and productivity of the use of physicians' working time, as well as optimizes the time spent on doctor-patient communication, and the number of patients requiring primary medical care. The latter is connected with the development of gadgets and mobile applications for health monitoring. It is more appropriate to involve a team of experts in the relevant medical field when developing mobile applications to prepare a high-quality knowledge base. This will lead to active use of the developed applications by doctors and their patients, and entail the optimization of the working time.

The use of medical mobile applications rationalizes the structure of the doctor's working time, in particular, reducing the appointment and clinical decision-making time. When assessing the appointment duration using the applications, in most cases, the consultation appointment time is reduced to 15 minutes, which can testify to the improvement of the qualifications of this type of assistance to the population. In addition, using applications significantly reduces the time of making a clinical decision by 5 minutes. In the course of our study, we found a relationship between the average duration of the appointment, as well as the time of making a clinical decision, and the frequency of using the mobile application during the working day.

A statistically reliable relationship was found in the course of our study between the average duration of an outpatient appointment and the use of medical mobile applications during the working day, which allows concluding the appropriateness of their introduction into the practice of doctors.

Further research will be aimed at studying the impact of the use of medical mobile applications on the provision of secondary and tertiary medical care and the health status of patients, as well as on the competence of doctors.

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