ORIGINAL ARTICLE

CONTENTS

Using a chatbot as a digital tool at the primary health care level

Hlib D. Aleksandrenko, Maryna V. Shevchenko
SCHOOL OF PUBLIC HEALTH OF NATIONAL UNIVERSITY «KYIV-MOHYLA ACADEMY», KYIV, UKRAINE

ABSTRACT

Aim: To analyze the feasibility of utilizing a digital tool such as a chatbot at the primary health care level as part of a health program.

Materials and Methods: With the involvement of a general practitioner and the use of a digital tool, a chatbot, a three-month health program was conducted for employees of an IT company. The chatbot was used to collect information, monitor the health status of participants and provide personalized health recommendations. To evaluate the program's effectiveness survey was conducted to compare participants answers before and after using standardized evaluation scales. A questionnaire based on the Evaluation and Management Services Guide was created to collect medical information on the health status of participants before and after the program.

Results: After the program, the average total score of participants' health complaints and symptoms decreased (from 27.1 to 16.1, p=0.019). The average severity of the chief complaint on a scale of 0 to 10 decreased from 5.08 to 2.27, or by 55.3% (p=0.00676). The frequency of individual complaints such as eye pain, decreased concentration, increased fatigue and irritability also dropped.

Conclusions: The chatbot enabled the primary care physician to respond promptly to participants' health complaints. The results demonstrated the potential of chatbots as innovative and accessible digital tools at the primary health care level for providing recommendations, monitoring health, and contacting a primary care physician in a timely manner.

KEY WORDS: primary health care, preventive health services, digital health, mental health, health informatics

Wiad Lek. 2024;77(4):623-628. doi: 10.36740/WLek202404101 DOI

INTRODUCTION

Primary health care (PHC) is the foundation of health systems as it provides citizens with their first point of contact for health services, offering preventive, curative, and rehabilitative care. However, PHC faces challenges that can reduce its effectiveness and accessibility [1]. The introduction of digital technologies presents new opportunities to transform and modernize PHC, improving its quality and accessibility [2].

Digital health is an interdisciplinary field that uses digital technologies and solutions to enhance healthcare quality, improve health outcomes, and promote public health [3]. Digital health interventions have the potential to improve PHC services, increase quality, coverage, and efficiency, and contribute to achieving universal health coverage (UHC) [4]. Recent publications have emphasized the increasing importance of digital tools in PHC and their potential to enhance access to services, healthcare quality, and efficiency [5]. A systematic review of digital health technologies during COVID-19 [6] found that telemedicine and mobile applications played a crucial role in maintaining PHC during the pandemic. It is also noted that the COVID-19 pandemic further accelerated the digital transformation of PHC. The consensus report of the US National Academies of Sciences, Engineering, and Medicine [7] also emphasizes the importance of developing digital tools to support the work of primary care physician (PCP). In particular, it refers to clinical decision support systems, the integration of data from different sources, and the use of analytics, artificial intelligence, and machine learning to identify risks and predict treatment outcomes.

Digital tools are being implemented in PHC to address challenges such as improving mental health, treating chronic diseases, promoting physical activity, and enhancing communication between healthcare professionals and patients [8]. It is important to note that the widespread use of mobile technologies has led to the development of various diabetes-related and health promotion applications [9].

Special attention should be given to the potential of chatbot implementation in healthcare. Precedence Research estimates the global healthcare chatbot market to be worth $196.9 million as of 2022, with projected size of $944.7 million in 2032 (17% annual growth). According to Grand View Research, the healthcare system

is one of the top three verticals for the use of chatbots, following online trading and the financial sector [10].

At the PHC level, chatbots have shown promise for improving service delivery through personalized service, improving diagnosis and prevention of chronic diseases, collecting patient feedback, and managing health during global pandemics. Some chatbots have also proven effective in providing information and engaging in conversations. Users can ask a chatbot for additional information about symptoms, conditions, complications, or methods of treatment and self-help methods. This allows for and leads to wider access to important and verified information [11].

Therefore, it is imperative to identify the most effective methods for integrating digital tools into PHC, such as utilizing chatbots to gather and analyze data, customize communication, and promptly address patient inquiries and concerns.

AIM

To analyze the feasibility of using a digital tool as a chatbot at the primary health care level as part of a health program.

MATERIALS AND METHODS

This study describes the development and implementation of a health program for employees of a Ukrainian IT company.

The study participants were 16 IT specialists from one company with offices in three cities in Ukraine: Kyiv, Zhytomyr, and Chernihiv.

The study was conducted from October 2020 to March 2021.

The program utilized a chatbot as a digital tool to collect, exchange, and interpret health information of participants. Additionally, it provided continuous feedback to the general practitioner (GP) involved in the program. The chatbot was developed using a low-code platform, enabling the programming and transfer of patient care processes through a graphical interface. The chatbot algorithm collected real-time information on the health status of program participants, monitoring their complaints, requests, and questions, which were addressed by the GP.

The health program was created using the author's model [12]. The development process followed the principles of information security and data confidentiality. Additionally, the platform used to create the digital tool complied with the General Data Protection Regulation (GDPR).

To collect medical information about the participants' health status before and after the program implementation, a questionnaire was created based on the Evaluation and management services guide developed by the U.S. Centers for Medicare & Medicaid Services [13]. These guidelines provide a framework for documenting various aspects of patient care. This questionnaire contains 4 main components:

1. Chief complaint: main symptoms, problem, condition, or diagnosis that the participant is concerned about. The severity of the main complaint is rated by the participant from 0 (There is no CC) and 1 (minimum) to 10 (maximum).
2. History of Present Illness: details and chronological description of the development of the existing problem or disease from the first signs and/or symptoms.
3. Review of Systems: an inventory of body systems obtained through a series of questions seeking to identify signs and/or symptoms (health complains) which the patient may be experiencing or has experienced. These types of review have been defined for general multi-system and the following single organ systems: constitutional symptoms (eg, fever, weight loss); eyes; ears, nose, mouth, and throat (ENT); cardiovascular; respiratory; gastrointestinal; genitourinary; musculoskeletal; integumentary (skin and/or breast); neurological; psychiatric; endocrine; hematologic/lymphatic/immunologic (HLI).
4. Past, Family, and/or Social History: experience of diseases, surgeries, injuries, previous treatment regimens; family history (review of medical events, diseases or hereditary conditions), social history (information about professional activities, living conditions, work environment, etc.).

The results of the survey were mainly used to obtain information about the presence of diseases and to assess the health complaints of each participant for further consultation with PCP. The main components of the questionnaire for analysis were the chief complaint and the review of systems. These were used for comparative analysis before and after.

The chatbot collected and analyzed information in real-time regarding complaints and needs from program participants. It provided personalized health recommendations and tracked the health status of program participants. Daily questions and requests were transmitted to the PCP in an anonymous form, with the possibility of further individual consultation. To maintain anonymity throughout the collection and processing of information, each participant was assigned a unique identifier (UID).

The data was analyzed using descriptive statistics, as appropriate for this study's purpose. The statistical significance level was determined using the Wilcoxon test, with a critical level of significance of 0.05 or less. Data

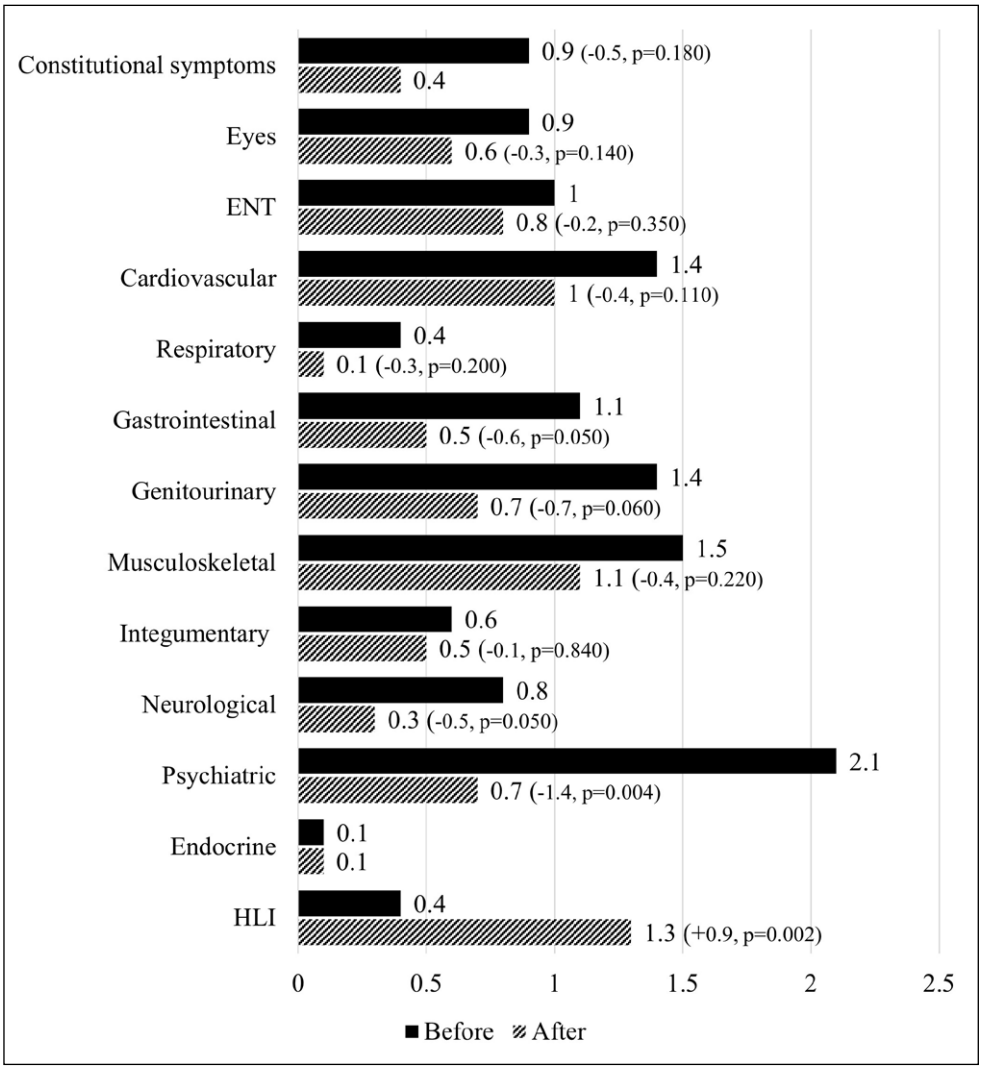

Fig. 1. Comparison of the average number of health complaints in review of systems (n=16).

analysis was performed using the Statistical Package for the Social Sciences (SPSS).

The study was conducted in compliance with ethical principles. Participation in the program was voluntary and based on the potential participants' own motivation. The corporate program developers and participants signed agreements on non-disclosure and confidentiality of information. Information was collected, processed, and visualized anonymously using UIDs to identify information about a particular participant.

RESULTS

After implementation of the health program, there was a significant average decrease in the total score of the chief complaint and health complaints in review of systems among the participants. At the beginning of the project, the average total score was 27.1 points, while at the end, it was 16.1 points, indicating a decrease of -10.9 points (p=0.019).

The average score of chief complaint decreased significantly from 5.08 to 2.27 (p=0.00676), representing a reduction of 55.3%. Furthermore, the number of participants who reported the chief complaints decreased from 12 (75%) to 8 (50%), with a general reduction of 33.3%. The most common chief complaints at the beginning of the program were headaches, weakness, and dizziness (reported by 6 participants), pain in various parts of the back (reported by 4 participants), and symptoms of depression, anxiety, and fatigue (reported by 3 participants). At the end of the program, the types of health complaints shifted. Four participants reported experiencing headaches, three participants reported back and lumbar pain, one participant reported issues with the ENT, and one participant reported fatigue.

The total number of health complaints in review of systems among participants decreased by 57.0% (from 198 to 113, p=0.00776). The average number of complaints in review of systems per individual body system also decreased (Fig. 1). The psychiatric system experienced the largest decrease in the number of health complaints, from an average of 2.1 to 0.7 complaints per person (p=0.004). There was a decrease in the number of health complaints related to diseases or problems with

the genitourinary (from 1.4 to 0.7, p=0.060), gastrointestinal (from 1.1 to 0.5, p=0.05), and neurological (from 0.8 to 0.3, p=0.0505) systems. Simultaneously, there was a decrease in the number of constitutional symptoms (from 0.9 to 0.4, p=0.180), diseases or problems with the cardiovascular system (from 1.4 to 1.0, p=0.110), respiratory system (from 0.4 to 0.1, p=0.200), and eyes (from 0.9 to 0.6, p=0.140), although these decreases were not statistically significant. Additionally, the number of complaints related to the ENT, musculoskeletal, integumentary, and endocrine systems was not statistically significant (p>0.050). However, there was a significant increase in the number of health complaints related to the HLI (from 0.4 to 1.3 complaints, p=0.002).

After implementing the program, the frequency of complaints from participants in many areas decreased. Specifically, there has been a decrease in the number of complaints regarding fatigue (from 8 to 3), eye pain (from 4 to 0), eye redness (from 3 to 0), shortness of breath during nervous exertion (from 2 to 0), moist cough (from 2 to 0), sputum production (from 2 to 0), nausea (from 4 to 2), abdominal pain (from 5 to 2), menstrual irregularities (from 6 to 0), and limb numbness (from 3 to 0). There was a significant decrease in the frequency of complaints related to psycho-emotional symptoms. For example, the number of reported frequent headaches decreased from 6 to 3, unreasonable anxiety - from 4 to 1, decreased concentration - from 5 to 1, problems falling asleep - from 5 to 3, increased irritability - from 6 to 1, and mood swings - from 5 to 3.

DISCUSSION

This study analyzed the feasibility of using a chatbot as a digital tool in PHC to track health complaints or deterioration among participants. The results showed that the GP could track information about health complaints of participants and respond promptly to their needs through online or offline counseling. The results suggest that a chatbot can serve as an efficient digital tool to enhance access to PHC. The combination of a chatbot with the traditional model of PHC provision resulted in a positive impact, as evidenced by the decrease in the number of complaints among program participants.

The study's findings align with the overall trend of increasing reliance on digital tools in PHC. Specifically, the study confirms the efficacy of digital solutions in mental health [1], chronic disease monitoring [8], medical staff-patient communication improvement [9], and timely healthcare service access [11]. Also, the results of this study are consistent with the findings of other researchers, on the potential of using chatbots for screening and remote monitoring of patients. It was demonstrated the effectiveness of a chatbot for COVID-19 screening of healthcare workers, reducing wait times, enabling physical distancing, and providing real-time data for staffing decisions [14]. Similarly, another study developed a preventive care chatbot that offers information, advice, and monitoring to patients undergoing home treatment for COVID-19 and dementia, showcasing the potential of chatbots for personalized care [15].

At the same time, data on the use of chatbots in PHC indicate their potential for managing chronic diseases, supporting diagnostic processes [3], and preventing non-communicable diseases. However, the issue of ensuring the ethical and safe implementation of such technologies, in particular with the use of large language models, remains relevant [6].

The study had limitations, including a small sample size and limited observation period, which prevent further extrapolation of results. To draw more solid conclusions, expanding the study in terms of participants and duration is advisable.

Nevertheless, the preliminary findings indicate that further exploration of the role of chatbots and other digital tools in PHC is necessary. It is important to note the lessons learned, particularly the need to develop the digital literacy of health professionals to effectively use digital tools such as chatbots in clinical practice. Integrating digital health into education and training programs is crucial for developing a digitally literate health workforce [16]. The introduction of digital tools should be accompanied by training for both healthcare providers and users to enhance their digital skills. It is important to address the global issue of the digital divide, which refers to the gap in access to and ability to use digital tools, in order to prevent inequalities in access to digital health. Efforts to implement digital tools at the PHC level should include initiatives to bridge the divide between those who have access to technology and those who do not [17].

In addition, in order to realize the potential of digital tools to improve PHC services delivery and outcomes globally, the development of digital health policies is critical [18].

CONCLUSIONS

The utilization of a digital tool such as a chatbot for health programs involving a general practitioner indicates that the physician can respond promptly to participants' health complaints. For instance, after analyzing the frequency of health complaints related to a particular body system among program participants, the general practitioner involved in the program provided online counseling and recommendations for prevention and treatment.

The study results show that chatbots have potential as innovative and accessible digital tools for primary health care. They can provide individualized health recommendations, monitor, and control health, allow patients to contact a doctor, and provide timely assistance. However, it is important to ensure appropriate levels of cybersecurity and personal data protection when implementing these digital tools - they must be regulated and comply with national or internationally adopted standards.

Future research could focus on digital divide, developing and implementing specialized digital tools tailored to specific user groups, taking into account their psychological, physical, professional, and other characteristics. Combining chatbots with other digital tools may be effective and warrants further investigation. Furthermore, the implementation of chatbot algorithms that utilize artificial intelligence methods shows promise. However, it is important to consider ethical, privacy, regulatory, and other issues when implementing them.

REFERENCES

1. Endalamaw A, Erku D, Khatri RB et al. Successes, weaknesses, and recommendations to strengthen primary health care: a scoping review. Arch of Public Health. 2023;81(1):100. doi: 10.1186/s13690-023-01116-0. DOI
2. Limna P. The Digital Transformation of Healthcare in The Digital Economy: A Systematic Review. IJAHST. 2023;3(2):127–132. doi: 10.35882/ijahst.v3i2.244. DOI
3. WHO. Digital health. https://www.who.int/europe/health-topics/digital-health#tab=tab_1 [Accessed 27 February 2024].
4. Erku D, Khatri R, Endalamaw A et al. Digital Health Interventions to Improve Access to and Quality of Primary Health Care Services: A Scoping Review. Int J Environ Res Public Health. 2023;20(19):6854. doi: 10.3390/ijerph20196854. DOI
5. Kozicki ZA, Baiyasi-Kozicki SJS. The survival of mankind requires WATER centers & Water Quality and Quantity Index (WQQI). European Journal of Public Health. 2020;30(5):574. doi: 10.1093/eurpub/ckaa166.068. DOI
6. Ndayishimiye C, Lopes H, Middleton J. A systematic scoping review of digital health technologies during COVID-19: a new normal in primary health care delivery. Health and Technology. 2023;13:273 –284. doi:10.1007/s12553-023-00725-7. DOI
7. Krist A.H, Phillips R, Leykum L et al. Digital health needs for implementing high-quality primary care: recommendations from the National Academies of Sciences, Engineering, and Medicine. JAMIA. 2021;28(12):2738–2742. doi:10.1093/jamia/ocab190. DOI
8. Chen L. Telemedicine in Chronic Wound Management: Systematic Review And Meta-Analysis. JMIR mHealth and uHealth. 2020;8(6):15574. doi:10.2196/48155. DOI
9. Doyle-Delgado K, Chamberlain JJ. Use of diabetes-related applications and digital health tools by people with diabetes and their health care providers. Clin Diabetes. 2020;38(5):449–461. doi: 10.2337/cd20-0046. DOI
10. Healthcare Chatbots Market. 2023. https://www.precedenceresearch.com/healthcare-chatbots-market. [Accessed 27 February 2024].
11. Kurup G, Shetty SD. AI Conversational Chatbot for Primary Healthcare Diagnosis Using Natural Language Processing and Deep Learning. In: Advances in Intelligent Systems and Computing. Singapore: Springer. 2021, p.500.
12. Aleksandrenko H, Shevchenko M. Digital solutions for the development of corporate health programs. Int Sci J "Internauka". 2023;(8):11–18. doi: 10.25313/2520-2294-2023-8-9126. DOI
13. Centers for Medicare & Medicaid Services. Medicare learning network. 2022. https://www.cms.gov/outreach-and-education/medicare-learning-network-mln/mlnproducts/mln-publications-items/cms1243514 [Accessed 27 February 2024].
14. Giunti G, Isomursu M, Gabarron E et al. Designing Depression Screening Chatbots. Studies in Health Technology and Informatics 2023;284:259–263. doi: 10.3233/SHTI210719. DOI
15. Maia E, Vieira P, Praça I. Empowering Preventive Care with GECA Chatbot. Healthcare. 2023;11(18):2532. doi: 10.3390/healthcare11182532. DOI
16. Ungureanu M, Wong B. Round table: Digitally literate health workforce for a resilient future. Eur J Public Health. 2022;32(3):129. doi: 10.1093/eurpub/ckac129.383. DOI
17. Lopez T, Moreno L, Alacreu M et al. Bridging the Generational Digital Divide in the Healthcare Environment. J Pers Med. 2022;12(8):1214. doi: 10.3390/jpm12081214. DOI
18. Ahmad Z. Why are digital health policies crucial? J Med Econ. 2024;27(1):167–169. doi: 10.1080/13696998.2024.2302254. DOI

The work performed within the framework of the scientific research project "Human resource management in the context of systemic changes in health care in Ukraine" (2021–2023, № state registration 0121U107806).

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Hlib D. Aleksandrenko
National University of Kyiv-Mohyla Academy,
2 Skovorody vul., Kyiv 04070, Ukraine,
e-mail: g.aleksandrenko@ukma.edu.ua

ORCID AND CONTRIBUTIONSHIP
Hlib D. Aleksandrenko: 0009-0007-2980-8213 A B C D
Maryna V. Shevchenko: 0000-0003-1828-8447 E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 17.12.2023
ACCEPTED: 02.04.2024