Original Article

The effectiveness of a mobile application in enhancing community pharmacists' knowledge of natural herbs and drug interactions

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Abstract

Background & Objective: The use of natural herbs is steadily increasing worldwide. This increase has led to a growing number of individuals seeking advice and guidance from community pharmacists on natural herbs. Unfortunately, community pharmacists often lack sufficient knowledge concerning the uses, side effects, and drug interactions of these natural herbs. This study aims to develop and evaluate the quality and effectiveness of a mobile application that focuses on common natural herbs and their interactions with medications, enhancing the knowledge of Syrian community pharmacists.

Materials & Methods: The smartphone application (Herbal Guide) was created and installed on the participants' phones. A quasi-experimental study with a pretest-posttest design was conducted involving twenty-three participants. They completed both tests to evaluate the application's impact on enhancing the knowledge of Syrian community pharmacists. Statistical analysis involved using the paired- t-test to compare pre-test and post-test results, while Cronbach's Alpha was employed to measure the internal consistency of the evaluation questionnaire statements.

Results: Ninety-six pharmacists participated in this study, with only twenty-three completing both the pre-test and post-test and meeting the criteria. The application significantly improved the knowledge of Syrian community pharmacists regarding common natural herbs and their interactions with medications. The mean and standard deviation of the participants' results before using the application was 17.56 ± 1.22, compared to 22.04 ± 1.47 after using the application. There was a significant difference in average scores before and after using the application ($p < 0.01$). There were no statistically significant differences between the average grades of participants and their gender ($p > 0.05$) or their years of experience ($p > 0.05$). Most participants found the application easy to use, effective, and characterized by high-quality content and design.

Conclusion: The introduction of the new mobile application, "Herbal Guide," resulted in an enhancement of knowledge among Syrian community pharmacists regarding common natural herbs and their interactions with medications, as evidenced by positive feedback from the study participants.

Keywords: mobile application, natural common herbs, medical education, community pharmacists, drug interactions

Introduction

Before the widespread use of modern medicine, natural herbs were commonly used to treat various diseases throughout history. The earliest records of using natural herbs for medicinal purposes can be traced back approximately 5,000 years in historical texts from India, Greece, China, Syria, and Egypt. This highlights the rich legacy of traditional herbal therapy across ancient civilizations [1]. Recent studies have shown a growing global interest in natural herbs, with around 70-80% of the world population turning to traditional herbal medicines for their primary healthcare needs [2, 3]. Many people believe in the effectiveness of natural herbs in treating a wide range of diseases, comparing them to chemical medicines. The popularity of traditional herbal remedies can be attributed to their widespread use among patients and their accessibility. Most people view natural

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herbs as safer alternatives to chemical medicines due to their natural origins [4]. However, some use these natural herbs as supplements without consulting healthcare professionals [5], which can pose risks, including interactions with pharmaceutical preparations [6].
Additionally, it is important to note that the Food and Drug Administration (FDA) does not classify natural herbs and herbal preparations as drugs. Under the Education and Health Act for Dietary Supplements of 1994, dietary supplements like vitamins, minerals, herbs, or plants (excluding tobacco) are considered distinct from food and are intended for human consumption only. As a result, the safety and efficacy of natural herbs and herbal preparations remain unclear. Community pharmacists play a crucial role as healthcare providers and in delivering top-quality pharmaceutical care services [7]. They are involved in various areas, such as ensuring patients adhere to their prescribed medications, offering counselling, educating patients on the uses of natural herbs, and informing them about possible interactions [8]. Research involving several studies [9, 10, 11] indicated that certain community pharmacists lack sufficient information regarding the side effects, precautions, and interactions of herbal products. They require reliable resources and knowledge to provide evidence-based advice to their customers [12]. Syria is distinctive for the richness of its vegetation and its species diversity; the urban and rural populations still rely on traditional herbal remedies for the treatment of various diseases [13, 14]. Additionally, the use of common herbs for treatment has become more widespread due to their affordability, accessibility, and cost-effectiveness. Unlike physician consultations, which may involve costs and long waiting times, Syrian community pharmacists typically offer free and immediate advice. Consequently, Syrian pharmacists are increasingly fielding inquiries about natural herbs. The pharmacy curricula in Syrian universities include pharmacognosy and phytochemistry courses, which are taught in depth starting from the third academic year. These courses aim to provide graduated pharmacists with essential competencies related to the origin, active ingredients, and physiological effects of medical plants rather than focusing solely on their side effects and interactions with medications. Furthermore, many Syrian community pharmacists have been internally displaced or relocated due to the Syrian crisis. This has interrupted their access to continuous education programs, resulting in a knowledge gap among community pharmacists. Several studies conducted in Syria across various medical fields have provided evidence that integrating information technology into medical education can result in greater educational opportunities for medical students and healthcare professionals. The integration of knowledge facilitates acquisition, improves decision-making, enhances psychomotor skills, and promotes the development of new ideas and concepts [15-18]. Additionally, information technology can be considered an effective adjunct tool that can offer high-quality medical education in conflict zones [19]. Furthermore, online medical education can yield positive outcomes even in resource-limited communities, provided that the educational materials are tailored to the needs, language, and culture of the healthcare providers. Additionally, developing and evaluating the scientific content by local medical educators who are familiar with these factors can lead to improving the effectiveness and usefulness of online medical education [20]. In this regard, smartphone applications have a positive impact on enhancing knowledge and skills among healthcare professionals across various health topics and contexts. Mobile applications are effective adjunct tools in medical education due to their low cost and high versatility [21, 22]. In this context, educational mobile applications on pharmaceutical topics would be crucial for pharmacists, providing them with sufficient information and assisting them in bridging the knowledge gap. However, the literature remains limited regarding the effectiveness of smartphone educational applications in enhancing the knowledge of community pharmacists in Syria. Therefore, this study aimed to develop and evaluate the impact of a mobile application designed to enhance the knowledge of Syrian community pharmacists regarding natural herbs and their interactions with medications. This assessment was conducted through pre- and post-intervention tests, as well as a questionnaire to evaluate the application's quality, efficiency, and ease of use.

Materials & Methods

Design and setting(s)

This study employed a quasi-experimental design with a pre-test and post-test conducted on a randomized group of Syrian community pharmacists enrolled in the Syrian Pharmacists' Association in Syrian cities in December 2022.

Participants and sampling

The sample size consisted of 96 community pharmacists from various locations in Syria, selected using a convenience sampling method. Eligible participants were pharmacists working in community pharmacies in Syria who met the inclusion criteria for participation in this study. The sample size was calculated using Formula A, with a 95% confidence level and an 80% statistical power. The mean and standard deviation parameters were also determined.

Formula A: $n = \frac{Z^2 p(1-p)}{d^2}$

To recruit a large sample, pharmacists were informed about the developed application and its unique features, as well as the study's purpose and procedure through advertisement on social media platforms with significant pharmacist membership. Additionally, to further increase the sample size, extra community pharmacists

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were contacted at their pharmacies in different Syrian cities. The responses from Pharmacists who expressed interest in the application, accepted participation in the study, and met the inclusion criteria were analyzed by the main researcher to confirm their eligibility. The inclusion criteria required pharmacists to be licensed in the Syrian Arab Republic, employed in community pharmacies, hold at least a bachelor's degree or a higher qualification, and be willing to voluntarily participate in this study. The exclusion criteria included pharmacy personnel working in other sectors, such as hospitals, industry, and academia (**Figure 1**). The study involved 23 eligible pharmacists (16 female, seven male). Information collected from the participating pharmacists includes age, gender, years of experience, and the university from which they graduated. The personal information was compiled and sent to the program coordinator, who then provided an electronic link to download the application, along with an instructional video explaining registration steps and how to use the application.

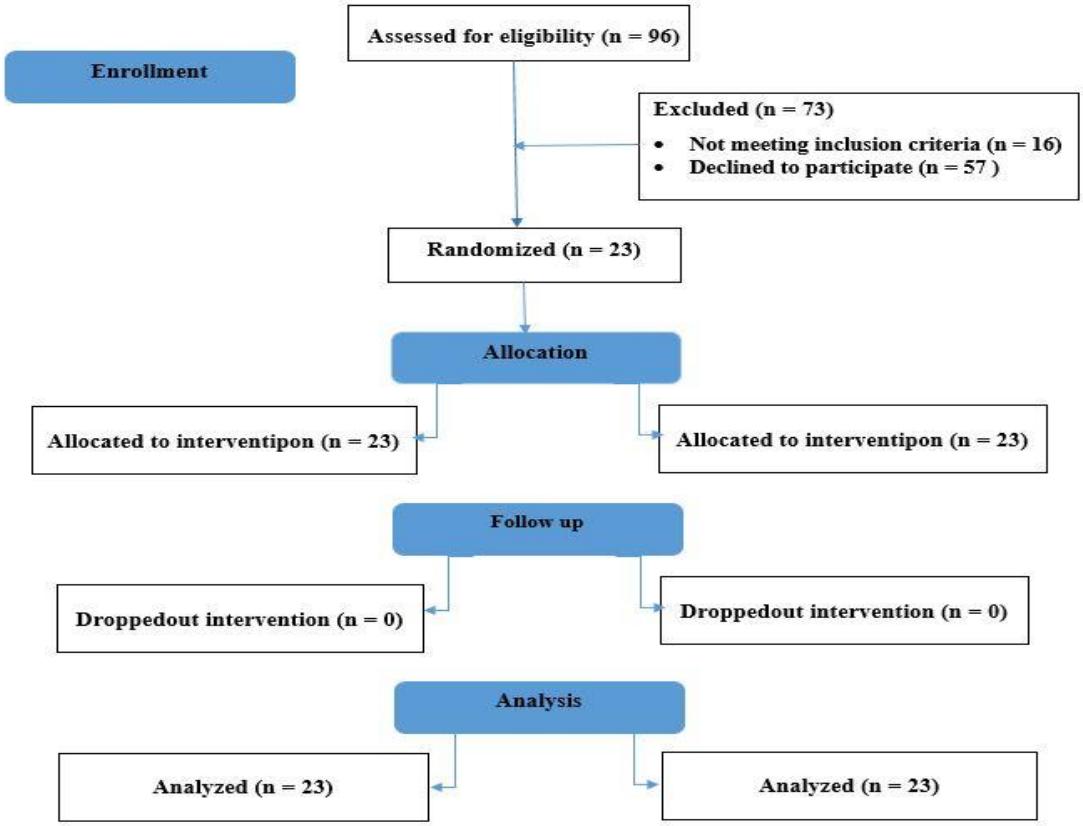

Figure 1. CONSORT diagram of participants eligible, dropped out, numbers followed up and included in analysis

Tools/Instruments

The study comprised two phases: the initial phase involved the creation and development of the application. In contrast, the subsequent phase focused on evaluating the application's effectiveness in enhancing pharmacists' knowledge of common herbal remedies and their interactions with medications. Additionally, the study involved evaluating the quality of the application's content, design, and usability. The first phase of this study took place before the intervention, during which the scientific content of the application was developed by the primary researcher. This development drew on the Physicians' Desk Reference (PDR) - Fourth Edition for Medicinal Herbs, as well as relevant international articles and publications available on PubMed. The selection of common natural herbs included in the application was based on their popularity and demand in pharmacies in the Syrian Arab Republic. The content was refined through focused discussions with supervising professors who acted as arbitrators to determine the sessional content to be included in the application. The scientific content was validated by MD, a faculty member and an expert in medical education, and CK, a faculty member at the Syrian Pharmacy College and an expert in pharmacognosy and phytochemistry. They ensured the content was aligned with critical information from the Syrian pharmacy curricula and their practical experiences. (additional details can be found in **Appendix 1**). After receiving the approval, the smartphone application "Herbal Guide" was specifically

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developed for smartphones operating on the Android or iOS systems. The design, programming, and testing phases lasted approximately two months, during which the development team provided the researcher with a trial version of the application on a weekly basis to ensure that there were no technical or scientific errors. The pre-and post-tests were designed in Arabic to assess the knowledge level of participants and pharmacists before engaging with the application and to determine whether it had improved after use. The pre-test was designed in alignment with the purpose for which the application was developed. Additionally, the test consisted of a series of questions covering the uses of commonly found natural herbs, potential contraindications, side effects, and interactions with drugs to assess the participants' knowledge before engaging with the application. The assessment contained twenty-five questions. Fifteen questions were in a multiple-choice format, and ten questions followed a true or false template (**Appendix 2**). The pre-test was administered immediately after registration to the application and before the content was displayed. Upon completion of the pre-test questions, participants were asked to submit their responses via e-mail to the researcher. Subsequently, the second phase of this research involved implementing the intervention. In this phase, the application's content features a collection of familiar natural herbs. Each herb was accompanied by an illustrative image, its scientific name in Arabic and English, and a search tool at the top of the screen. Each herb is presented on a separate screen, including information such as the scientific name, medicinal part, therapeutic properties, contraindications, side effects, prominent drug interactions, and references. The application was used for three weeks, during which the researcher actively encouraged and reminded participants to use it through a WhatsApp group. The researcher provided guidance on completing the post-test. The application featured an evaluation icon next to each herb; when clicked, it directed users to the post-test, which replicated the questions from the pre-test. This post-test was administrated immediately after twenty-one days of using the application, and participants submitted their responses via e-mail to the researcher. The maximum possible score for each test was twenty-five. Additionally, a feedback questionnaire was included in the post-test to evaluate the content quality, design effectiveness, and user-friendliness of the application. This questionnaire was structured in three sections, each containing ten statements rated on a five-point Likert scale, where one indicated "strongly disagree," two represented "disagree," 3 was "unsure," 4 stood for "agree" and five denoted "strongly agree" (**Appendix3**). To assess internal consistency, Cronbach's alpha coefficient was applied to the questionnaire items. The first section scored 0.81, the second section 0.69, and the third section 0.78. Values range from 0 to 1, with an acceptable threshold in social studies being 0.60. These results indicate that the questionnaire is reliable, valid, and honest. Content and face validity were checked and examined by the supervisor, MD, who is an expert in the medical education field. Additionally, the mean and standard deviation were used to analyze the distribution of responses for each item, providing insights into participants' satisfaction.

Data collection methods

Before their participation, informed consent was obtained from all participants. The consent form, written in Arabic, provided a clear description of the study objectives and procedures. Participants were assured that their personal information would be securely stored and solely used in this study. A basic instructional video was prepared and distributed to 96 participants, explaining registration steps and how to use the application as the first step of this study. A total of 23 participants who met the inclusion criteria agreed to take part in the study.

Data analysis

Only the results from participants who completed all study procedures were included. Data from the pre-and post-tests were organized in Excel 2019. A one-tailed paired t-test was performed to assess differences between the pre-and post-test results with a significance level set at $p < 0.05$. Descriptive statistics, including mean and SD, were utilized to analyze the study outcomes. A five-point Likert scale was implemented as a questionnaire to assess the quality, efficiency, and ease of use of the application. The mean and Standard Deviation for each statement were collected on a scale of 1 to 5. Cronbach's Alpha was employed to measure the internal consistency of the questionnaire.

Results

A total of 96 Syrian community pharmacists participated in the study, comprising 22 men and 47 women. The participants' ages ranged between twenty-two and fifty years, with their years of experience spanning from one to thirty years. The majority of participants, totaling 72, graduated from public universities, while 24 graduated from private universities. A total of twenty-three participants (16 females, representing 69.6%, and seven males, representing 30.4%) met the criteria and were invited to voluntarily participate in this study. The results showed a significant improvement in participants' knowledge following the use of the Herbal Guide application. The average score in the pre-tests was 17.5, which significantly increased to an average of 22.04 in the post-tests, indicating a statistically significant improvement ($p = 0.002$). Furthermore, the standard deviation in pre-test scores was lower than that of the post-test scores. Detailed results can be found in (**Table 1**). Twenty-three participants completed the evaluation questionnaire. The majority of them described using the application in a positive manner. They mostly agreed with the positive statements that gauged the application's

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quality, efficiency, and ease of use. Overall satisfaction with both the application's content and design was high. All participants agreed on seven out of ten statements related to the content, with one participant suggesting a reminder feature for pharmacists who may overlook certain information. Over 85% of the participants agreed with the statements. Some participants felt that the scientific content could be presented in a more organized and clear manner or expressed a desire for more novel information rather than a summary of existing knowledge. Regarding the design evaluation, all participants agreed with six statements, with most also agreeing with the remaining ones. However, there were differing opinions on certain aspects, like potential additions to the application. Everyone found the Herbal Guide application simple and user-friendly. Many praised its simplicity, believing it to be accessible to all. Participants unanimously acknowledged the application's potential to improve pharmaceutical services and recommended it to their peers. They also recognized its practicality for daily practice. More than 90% of participants felt that the application adequately meets its intended purpose. Some participants, particularly those with extensive experience, noted areas for improvement, such as catering to less experienced pharmacists, incorporating more commonly used herbs, and providing information on herbal mixtures. Details of the analysis can be found in **Table 2.** The internal consistency of the questionnaire statements was evaluated using Cronbach's alpha coefficient, with scores of 0.81 for the first section, 0.69 for the second section, and 0.78 for the third section.

Table 1. Comparison of participants' scores before and after the intervention

Results of participants	n	Mean ± SD	Minimum	Maximum
Before the intervention	23	17.56 ± 1.22	15	20
After the intervention	23	22.04 ± 1.47	20	24
P-Value		0.002		

Note: A paired t-test was used to compare participants' scores before and after the intervention.
Abbreviations: n, number of participants; SD, standard deviation; p, probability-value.

Table 2. Participants' responses to statements assessing the application's content, design, efficiency, and ease of use

Statements	Agreement	Mean	SD
Application's content			
1. The content is relevant to the application's development objectives.	100%	4.17	0.38
2. The content is scientifically accurate and up-to-date.	100%	4.13	0.34
3. The content takes into account pharmacists' prior knowledge.	100%	4.26	0.44
4. The content is organized in a clear and logical manner.	91.31%	4.06	0.54
5. The language and terminology used are understandable and familiar.	100%	4.21	0.42
6. The content connects new information to existing knowledge.	91.3%	4	0.60
7. Pharmacists can independently access the information.	100%	4.26	0.44
8. The content is structured to facilitate knowledge acquisition.	86.9%	3.91	0.62
9. The content is comprehensive and directly relevant to commonly used natural herbs.	100%	4.30	0.47
10. The content is correct and based on approved scientific references.	100%	4.27	0.44
Application's design			
11. Navigation between the main and sub-pages is easy and intuitive.	100%	4.17	0.38
12. The main and sub-pages are visually appealing and consistent.	100%	4.26	0.44
13. The application's design facilitates content search and access.	91.3%	4	0.60
14. The application allows the developer to update and add new herbs.	86.9%	3.86	0.45
15. The information is presented in a way that supports quick access.	100%	4.26	0.44
16. The application includes instructions to help users access content.	100%	4.21	0.42
17. The content is presented in a way that considers prior knowledge.	95.6%	3.95	0.59
18. The content is clear, easy to read, and distinguishes between headings and subheadings.	100%	4.17	0.38
19. The application avoids oversized images or content.	86.9%	3.91	0.62
20. The colors and background used in the application are calm and suitable.	100%	4.26	0.44
Application's e efficiency and ease of use			
21. Navigation within the application is smooth and user-friendly.	100%	4.17	0.38
22. The interface design is appealing and consistent throughout.	100%	4.26	0.44
23. The structure facilitates easy search and access to the content.	91.3%	4	0.60
24. The app supports updates and additions by the developer.	86.9%	3.86	0.45
25. Information is displayed in a format that aids user navigation.	100%	4.26	0.44
26. The application provides clear guidance for content access.	100%	4.21	0.42
27. The presentation of content reflects users' existing knowledge.	95.6%	3.95	0.59
28. The text is easy to read and structured with clear headings.	100%	4.17	0.38
29. The app avoids large-sized visuals or unnecessary information.	86.9%	3.91	0.62
30. Background and color schemes are calming and appropriate.	100%	4.26	0.44

Note: Descriptive statistics were used to assess participants' agreement with each statement regarding the application's quality, content, and usability.
Abbreviations: SD, standard deviation; %, percentage.

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Discussion

The growing use of common natural herbs highlights the necessity for community pharmacists to possess knowledge about these herbs. They should also be equipped to offer effective guidance on their uses and potential risks. Additionally, the role of pharmacists has evolved from merely dispensing medications to providing advanced services [23]. This shift requires them to maintain professionalism, stay updated on the latest technologies and information, and deliver high-quality pharmaceutical services.

Mobile technologies have a significant impact on the delivery of healthcare services, enhancing the quality of health services [24]. Mobile applications serve as effective tools for enhancing knowledge and are valuable aids in education, characterized by their diverse nature, low development cost, ease of updates, and flexible learning features [22].

Utilization of mobile applications in medical education presents several opportunities that facilitate healthcare professionals in their educational endeavors. Furthermore, they can be regarded as a reliable and effective solution in crises with limited resources and unstable environments, such as in Syria [19, 20]. As stated earlier, the application was created to provide Syrian community pharmacists with a proper approach to expanding their knowledge of common natural herbs and their potential drug interactions and to serve as a reference tool when necessary.

Analysis of the study results revealed that the application effectively improved participants' knowledge of common natural herbs and their interactions with medications. There was a significant difference in the results of the participants before and after using the mobile application, with a statistically significant $p < 0.05$.

These findings align with the studies of Mikhael and colleagues [25] and Paydar and colleagues [26], who also found a positive impact of smartphone applications on enhancing community pharmacists' knowledge, improving pharmaceutical services, and enhancing their management of common minor diseases. Additional studies have also discussed the effectiveness of smartphone applications in enhancing the knowledge of health professionals.

Alsharif and colleagues [27] indicated that smartphone apps are accessible and effective educational tools for bridging the knowledge gap of MR radiographers and supporting them in recognizing and characterizing MR image quality errors.

This result also agrees with Smania [28], who addressed the positive impact of mobile learning applications on enhancing the knowledge and confidence of nurse practitioners regarding BReast CAncer gene 1 (BCRA) mutation, a risk factor for developing certain types of cancer in women. Similar findings were noted by Ponce and colleagues [29]. Researchers found that anatomic smartphone applications are effective in improving the knowledge and performance of participants.

The pre-test results of this study indicated that participants struggled with questions primarily focused on drug interactions, adverse effects, and precautions related to natural herbs, suggesting a lack of knowledge in this area. Similar findings were observed in studies conducted in Lebanon and Palestine [31, 32], where community pharmacists demonstrated knowledge of natural herb uses. Still, their understanding of side effects and drug interactions was limited. This underscores the importance of enhancing pharmacists ' knowledge concerning the side effects and interactions of common natural herbs.

Furthermore, there is a greater need for reliable sources of information on common natural herbs and the inclusion of pharmacy training programs in this domain; this was similarly reported by Carr and colleagues and Abahussain and colleagues [30, 31]. In contrast, participants excelled at answering questions related to the medicinal parts, properties, and uses of herbs. This proficiency can be attributed to recent graduates' familiarity with this information from their earlier years of study.

Additionally, experienced pharmacists likely acquired this knowledge through continuous education programs and seminars on common natural herbs provided by the Syrian Pharmacists' Association.

The study also explored the relationship between gender and the mean scaled scores before and after using the application but found no significant statistical difference (p-value = 0.34). Similarly, comparing participants ' years of experience (< 10 or > 10 years) did not result in increased mean scaled scores ($p > 0.05$). Nevertheless, the findings indicated that participants were satisfied with the scientific content, design, and user-friendliness of the application, demonstrating a clear preference for the mobile application. This agreed with the results of several studies [32, 33, 34], which reported that pharmacists exhibit a keen interest in leveraging information technology within their daily practices and prefer electronic applications over traditional paper references due to their quick access to information, ease of use, and regular updates.

However, upon further analysis of each section, it was observed that the design section received the lowest rating of 4.1 out of 5. Furthermore, the organization of the application content in the initial section of the evaluation questionnaire received the least satisfaction. This may be explained by the fact that the researcher heavily relies on the PDR reference for the preparation of the content, which serves as a primary resource for pharmacognosy and pharmacognosy chemistry courses in most Syrian pharmacy schools.

This reliance might have led participants to believe that the application did not offer new information. Moreover, the ability to update the application and include new

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herbs received the lowest satisfaction, likely because the researcher failed to inform participants about this feature. Additionally, the process of accessing the content, which involved several steps, received the lowest rating. Participants may have faced difficulties logging in and accessing the application's content, particularly since it required the installation of certain programs. The researcher did not clarify this detail, as the login process using email and the pre-test were intended solely for research purposes.

It should be emphasized that participants in this study were limited to those interested in enhancing their knowledge of common natural herbs and their interactions with drugs. Future studies should consider a larger sample size to confirm these findings.

Additionally, it is worth noting that this study has other limitations, including the limited timeframe within which it was conducted. The results for knowledge about common natural herbs and their drug interaction represent short-term knowledge gain rather than long-term retention.

Therefore, future work should consider long-term retention. Additionally, the selected herbs were the most popular in Syria, and it is possible that some participants were more knowledgeable about other herbs.

Conclusion

The findings of the present study demonstrated that the Herbal Guide application significantly improved community pharmacists' knowledge regarding common natural herbs and their potential drug interactions. They received it well.

Additionally, natural herbs should be incorporated into the application to enhance its effectiveness.

Ethical considerations

Ethical approval was obtained from the Ethical Research Committee of the Syrian Virtual University (SVU), under Number 4015\0, dated August 2, 2022.

Artificial intelligence utilization for article writing

No.

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Conflict of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

Author contributions

KA is the principal researcher who collected participants' groups and data, prepared the scientific content of the mobile application, and analyzed the results. Both MD and CK supervised the study and revised the scientific content of the mobile. Both KA and MD participated in choosing the idea for this study, as well as writing and revising the manuscript before submission. All authors read and approved the final manuscript.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, K. Alkurdi, upon reasonable request.

Appendixes

Appendix 1
https://drive.google.com/file/d/1GaGWqVUMq4g61haO_CtUdeE53r5GzBBM/view?usp=share_link
Appendix 2
https://drive.google.com/file/d/1QOiPzjbKHkchWN_Qi2XhNSW4OwwUaNg7/view?usp=share_link
Appendix 3
https://drive.google.com/file/d/1dWzRPpo_1SD58ZIJcyOu3AjLqRWk-iIM/view?usp=share_link

Supplementary material

Developing company: https://gulfdimension.com/

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