ORIGINAL ARTICLE

Development, Usability, and Effect of a Hypertension Mobile Application on Knowledge and Guidelines Adherence among Family and Community Medicine Residents: A Before-and-After Educational Intervention Study

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ABSTRACT

Background and Objective. Mobile health applications have become integral in medical education and information access, yet their effectiveness varies, and barriers to engagement persist. This study aimed to develop and evaluate the usability and effectiveness of the Hypertension Now mHealth application in enhancing knowledge and guideline adherence among Family Medicine residents.

Methods. A before-and-after educational intervention study was conducted among residents of the Department of Family and Community Medicine (DFCM), Philippine General Hospital, from January to August 2023. The study involved the development of a mobile health application, Hypertension Now, designed to support clinicians on hypertension management. Usability, knowledge scores, and adherence to guidelines were assessed through questionnaires, pre- and post-interventions, and medical chart audits.

Results. All 32 DFCM residents participated. The app received high ratings for ease of use, interface, and overall satisfaction. It significantly increased residents' knowledge scores by 1.6 points (p=0.001). Adherence to proper physical examination (82% vs. 91%, p=0.024), diagnosis (80% vs. 90%, p=0.012), and pharmacologic treatment (53% vs. 83%, p=0.001) significantly improved. However, no significant increases were observed in adherence to risk assessment (83% vs. 78%, p=0.371), laboratory examination (35% vs. 40%, p=0.329), and non-pharmacologic treatment (77% vs. 81%, p=0.470).

Conclusion. This study showed the potential of mobile health tools to support medical education and enhance clinical practice in primary care settings. Integrating apps like Hypertension Now could improve management strategies and patient care outcomes.

Keywords: mobile health applications, medical education, usability

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INTRODUCTION

Mobile devices and apps are widely used for medical education, aiding communication, and offering portable access to medical information through mobile health applications (mHealth apps).[1] There are about 318,000 mHealth apps across different app stores, which serve as repositories for calculations, scoring tools, practice guidelines, and medications. These apps facilitate technology-enhanced

learning, especially relevant for time-constrained clinicians, and directly improve patient outcomes by reducing errors and hospital stays.[2–6]

The effectiveness of mHealth apps as a continuing medical education method has been discussed in several studies to explore more effective learning strategies. These studies had mixed outcomes with several reporting improvement in knowledge and performance while others found no significant change.[7–14]

Some studies have sought to gauge the impact of mHealth apps on physicians' adherence to clinical guidelines to optimize these apps' use in medical education. Specifically, mobile health apps have been shown to enhance adherence to pneumonia antibiotic guidelines and cardiac life support protocols.[15,16] Nonetheless, several barriers persist in the utilization of mHealth apps to increase guideline adherence.[17]

Mobile health app integration into medical practice has not progressed despite the continuing expansion and increasing availability. The limited number of apps that have undergone usability and effectiveness assessments further exacerbates this disparity.[18] Moreover, there exists a paucity of published data about mHealth app utilization in low-income nations where innovations in mHealth are sparse.[19] A scarcity of research also surrounds the effectiveness of mHealth apps in managing chronic diseases, such as hypertension, which continues to impose a substantial global, national, and local disease burden.[20–22] This research aimed to bridge these critical research gaps through the development and evaluation of 'Hypertension Now', a mobile health application featuring guideline-based content tailored for medical practitioners treating hypertension. The study sought to assess the usability and the effect of the app on the knowledge and adherence to practice guidelines among Family and Community Medicine resident physicians of the Philippine General Hospital.

METHODS

Study Design

This study used a before-and-after educational intervention design. It was conducted within the residency training program of the Department of Family and Community Medicine (DFCM), University of the Philippines-Philippine General Hospital (UP-PGH) from January 2023 to August 2023. This study also included a review of medical records of patients seen at the Family Practice Center (FPC), the outpatient clinic of DFCM.

Study Intervention

A mobile health application, HyperTension Now, was developed by a multidisciplinary team including content experts, software developers, and graphic designers. Phases of app development started with the selection of reference materials.[23] Hypertension guidelines by the International Hypertension Society and the Philippine Hypertension Society were used.[24–26] These guidelines were translated into bulleted summaries and flowcharts to enhance user understanding.

The selection of topics was based on their importance in hypertension management, as specified in the guidelines. Content experts reviewed the guidelines to identify critical areas for inclusion. The translation involved converting detailed guideline recommendations into simplified, actionable steps. Algorithms were crafted through collaboration between content experts, software developers, and graphic designers to ensure both clinical accuracy and user accessibility.

The app underwent multiple rounds of review and testing to ensure validity and effectiveness. Expert feedback was incorporated into the final design. Following testing for accuracy and usability, the app was launched on the Apple and Google app stores, available for free.

The app's content is organized into five main sections: (1) Diagnosis: includes definitions, classification of hypertension, proper BP measurement, and links to validated BP devices; (2) Risk Assessment: lists major risk factors and discusses organ damage detection; (3) Physical Examination: provides BMI calculation and physical findings by organ system; (4) Laboratory Examination: covers relevant blood, urine, ECG, and optional tests with cut-off values; and (5) Treatment Section further subdivided into: treatments goals, non-pharmacologic, and pharmacologic managements.

The app features BMI and eGFR calculators, a "Quiz of the Day" to reinforce knowledge, and educational illustrations to help clinicians motivate patients toward healthier behaviors. It also includes a list of drug prices in the Philippines to assist in selecting cost-effective treatments. Designed for ease of use, the app offers a main panel for each section, a bookmark function, and offline access to all content.

Study Population

All DFCM residents were invited and consented to participate in the study. Each resident was assigned a specific code to hide identity. Residents took a pre-intervention examination and attended a 15-minute presentation of the mHealth app. They were then instructed to download and use the app on their mobile phones. Afterward, the residents answered the post-intervention examination and the usability survey.

Guideline adherence was assessed by evaluation of electronic medical records of newly attended patients at the FPC. Charts with diagnosis of hypertension or hypertension-suspect were randomly selected and coded to de-identify the patients. A sample size of 268 charts (134 pre- and 134 post-intervention) was determined using GPower 3.1.9.4, assuming a 60% pre-intervention adherence rate and 75% post-intervention, with an alpha of 0.05 and 80% power.

Data Collection and Analysis

This study measured three outcomes: residents' perception of the usability of the app, change in knowledge score, and rate of adherence to practice guidelines. Data were

collected by two independent, trained data collectors to minimize observer bias. Statistical analyses were performed by an independent statistician using IBM SPSS Statistics version 29.0.1.0.

The mHealth App Usability Questionnaire (MAUQ) form was answered by the residents after a 2-month intervention period (April to May 2023).[27] The questionnaire used a 7-point Likert scale from strongly disagree (scored as 1) to strongly agree (scored as 7). Three parameters were rated: ease of use, interface and satisfaction, and usefulness. Responses were treated as ordinal data and results were analyzed descriptively using median scores. Frequency of use, comments, and suggestions were additional parameters gathered in the survey form to allow other insights about the use of the app.

A 20-item examination on hypertension was administered before the intervention in March 2023 and after the intervention in June 2023. The minimum passing level was set at 65% based on the Angoff method, wherein three experts estimated the probability that a minimally competent examinee would answer each test item correctly.[28] The raw and percentage exam scores were tested for normality using the Shapiro-Wilk test and were analyzed using the non-parametric Wilcoxon signed-rank test for paired samples.

A medical chart checklist based on hypertension clinical practice guidelines was developed and used for the app. The medical chart audit was divided into six categories: risk assessment, physical examination, diagnosis, laboratory examination, non-pharmacologic treatment, and pharmacologic treatment. Pre-intervention chart review was done from January to March 2023, while the post-intervention was done from June to August 2023. The target standard of care was set at 80%. The results were analyzed using the Z test for 2 independent proportions.

Ethical Considerations

The study protocol was approved by the University of the Philippines Manila Research Ethics Board (UPMREB code 2022-0405-01).

RESULTS

All 32 DFCM residents participated in the study. There were 7 third-year residents, 11 second-year residents, and 14 first-year residents, aged 26 to 34 years, with medical practice experiences ranging from 0 to 8 years.

Presentation of the Mobile Health Application

The mobile health application was introduced to participants through a 15-minute presentation covering its key features and functionalities. The interface features a landing page with a sign-up screen, leading to the homepage (Figure 1). From the homepage, users can choose to go to the "Quiz of the Day", lessons or resources, with a main navigation panel allowing easy access to any section at any time (Figure 2). The lessons page offers access to five primary topics and additional features designed for learning and managing hypertension.

Usability of the Application

There was high usability of the app among the residents. The mobile health app was perceived by the residents as easy to use (median score of 7, on a scale of 1-7). This rating considered factors like simplicity of learning the app, navigation consistency, and error recovery. Interface and overall satisfaction of the app were also rated high (median score 7). These covered factors such as app appearance, content organization, comfort of use in social settings, and likelihood of future use. Lastly, the usefulness of the app, based on access to healthcare delivery, patient management, expectations of functions and capabilities, offline use, and acceptability was also rated high (median score 7). The app also received positive feedback about the comprehensiveness of its contents. Suggestions about the app included incorporating other subject matters and CPGs into the app; and adding notifications to encourage daily quiz participation.

In terms of frequency of use, the mobile health app exhibited differences in usage patterns among the residents. The app was used once or twice per month by most of the residents (37.5%, 12 out of 32). It was used the highest number of times by 25% (8) of the residents at once a week. The lowest frequency of use was reported by 6% (2) of the residents at less than once a month.

Knowledge of Residents on Hypertension

There was an overall significant increase of 1.6 points in the mean knowledge scores of the residents after the intervention, p=0.0001. More than half of the residents (63%) had higher exam scores on the post-test than the pretest, with the highest change in score at 6 points and the lowest at 1 point. However, the remaining third of the residents (38%), had poorer scores (19%) or had no change in scores in the post-test (19%).

In terms of passing rate, the proportion of those who passed the exam significantly increased after the intervention (37.5% vs. 59.4%, p=0.035). (Table 1)

Adherence to Practice Guidelines Based on Medical Chart Audit

A total of 288 medical charts of new adult patients diagnosed with hypertension and hypertension-suspect in the DFCM outpatient clinic before and after the intervention were included in the study.

Pre-intervention chart review showed appropriate risk assessment based on age, sex, symptoms, past medical history, family medical history, and lifestyle habits (83%). This decreased to 78% post-intervention, although the difference was not significant (p=0.371).

Physical examination, based on documentation of height, weight, BMI, heart rate, chest PE, cardiac PE, and extremities

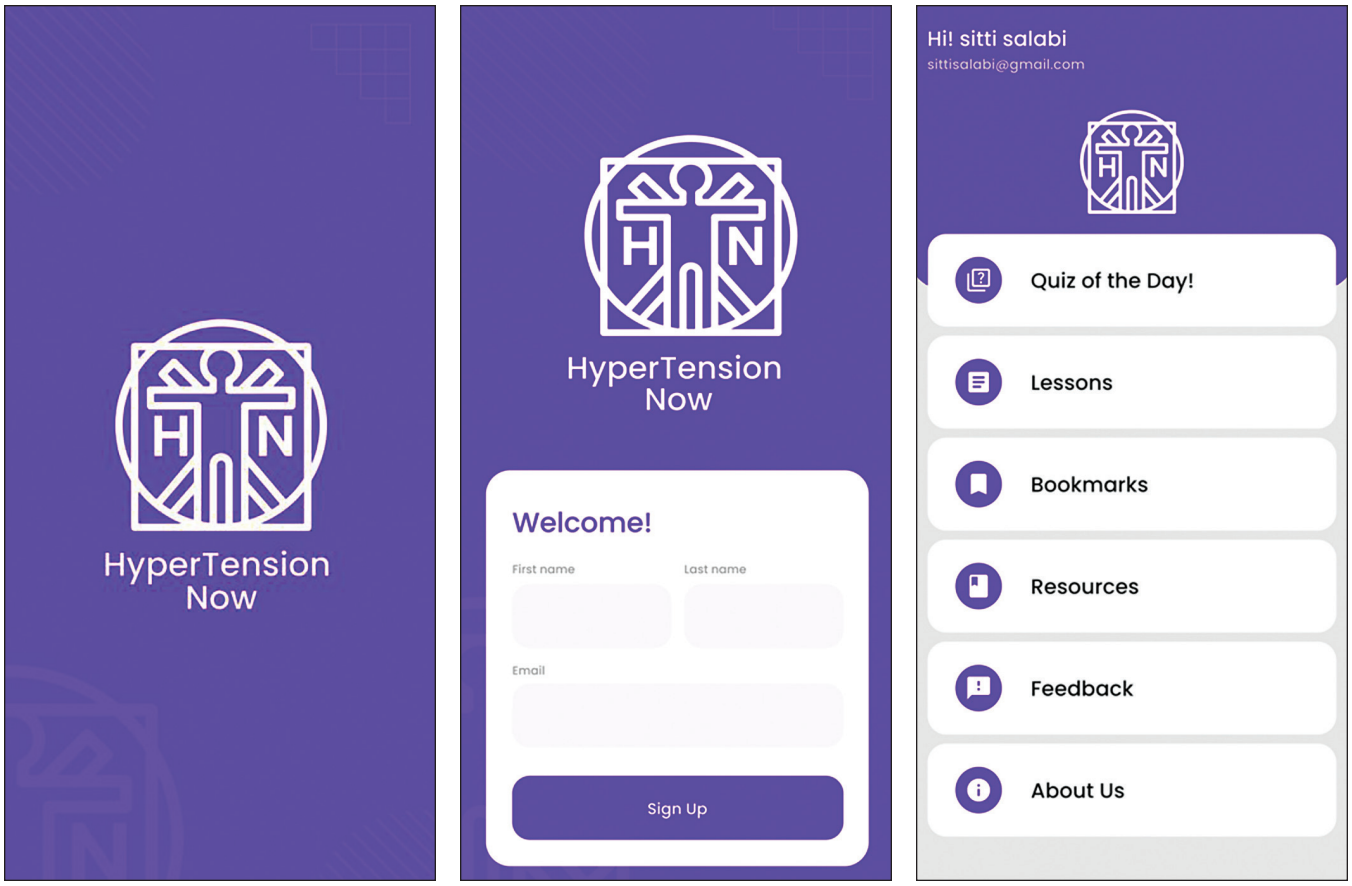

Figure 1. Sample frames of the Hypertension Now mHealth application showing the interfaces for **(A)** landing page, **(B)** sign-up screen, and **(C)** homepage.

Table 1. Knowledge Scores and Passing Rates in the Hypertension Exam before and after the Use of the Hypertension Now app among the PGH DFCM Residents

Parameters	Pre-test (N=32)	Post-test (N=32)	*p*-value*
Mean knowledge score (SD)	11.37 (±2.59)	12.97 (±2.58)	0.001
Number of residents who passed the exam (%)	12 (37.5%)	19 (59.4%)	0.035

**Computed using non-parametric Wilcoxon signed-rank test, significant at <0.05*

PE, was appropriately done at pre-intervention and post-intervention. The percentage of appropriate care significantly increased after intervention (82% vs. 91%, p=0.024).

Another statistically significant change was observed in adherence to proper diagnosis. The number of charts with appropriate guideline-based diagnoses before and after intervention significantly increased by 10% post-intervention (80% vs. 90%, p=0.012).

There were varying results in the treatment categories, which included completeness of laboratory examinations requested, non-pharmacologic advice, and pharmacologic treatment. The completeness of laboratory examinations, which included fasting blood sugar, lipid profile, 12-lead ECG, serum creatinine, and urinalysis, showed the lowest adherence rates among all tested categories. The laboratory workup adherence rates were considerably lower than the target standard of care set at 80%, both pre- and post-intervention (35% vs. 40%, p=0.329). Provision of guideline-adherent non-pharmacologic advice, which included dietary adjustments, exercise, smoking cessation, and alcohol moderation, reached the target standard of care after the intervention but the difference was not significant (77% vs. 81%, p=0.470). In contrast, the prescription of appropriate pharmacologic therapy increased significantly by 30% post-intervention (53% vs. 83%, p=0.001). (Table 2)

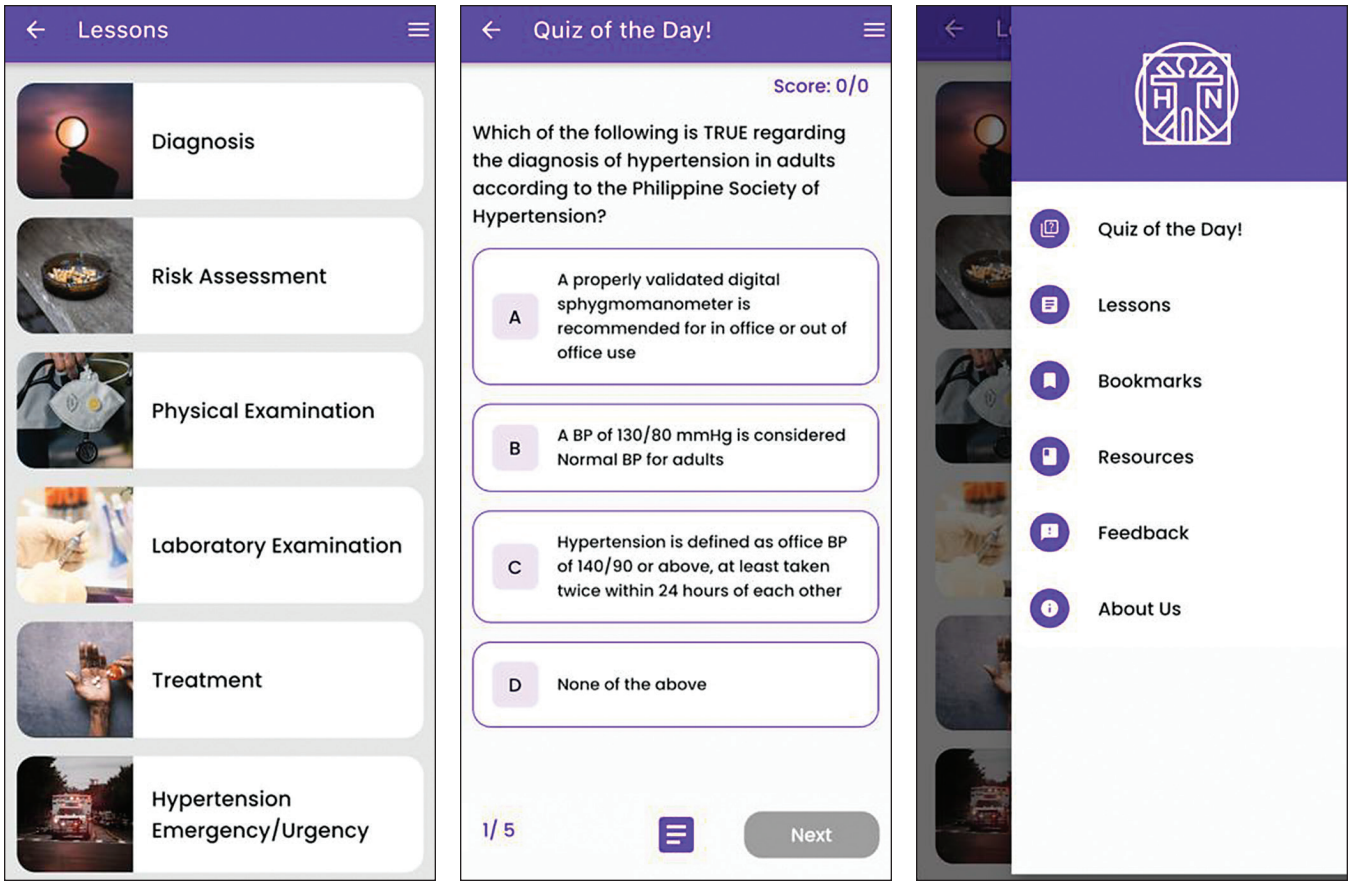

Figure 2. Sample frames of the Hypertension Now mHealth application showing **(A)** the interfaces for topics in the lessons tab, **(B)** a "Quiz of the Day" page, and **(C)** navigation panel.

Table 2. Number and Percentage of Charts Adherent to Practice Guidelines Based on Medical Chart Audit Criteria before and after the Use of the Hypertension Now app among the PGH DFCM Residents

Criteria	Pre-Intervention (N=144), (%)	Post-Intervention (N=144), (%)	*p*-value*
Risk assessment	119 (83)	113 (78)	0.371
Physical examination	118 (82)	131 (91)	0.024
Diagnosis	115 (80)	130 (90)	0.012
Laboratory examination	50 (35)	58 (40)	0.329
Non-pharmacologic treatment	111 (77)	116 (81)	0.470
Pharmacological treatment	76 (53)	119 (83)	0.001

**Computed using Z test for 2 independent proportions, significant at <0.05*

DISCUSSION

This study demonstrated that the mHealth app, Hypertension Now, had high usability for Family and Community Medicine residents. The app was effective in improving the knowledge of the residents on hypertension. It also effectively increased guideline adherence on proper physical examination, diagnosis, and pharmacologic treatment. However, it was not effective in increasing adherence to proper risk assessment, laboratory examination, and non-pharmacologic treatment. These findings aligned with the growing recognition of mobile health applications' potential in medical education and clinical practice.[7,8]

Previous studies have shown that the utility of mHealth apps has not been optimized due to various obstacles, including usability issues despite mHealth's increasing presence. These issues comprised diminished physician involvement, limited awareness, cost, and user interface design issues.[17,29,30] This study addressed these challenges by developing an app customized for hypertension management, adhering to

established practice guidelines, and integrating features to enhance usability. The results of these efforts were evident in the app's high ratings for usefulness in practice, ease of use, interface quality, and overall satisfaction among the resident users. These findings emphasized the effectiveness of tailored approaches in overcoming common usability challenges, thereby maximizing the impact of mobile health apps in healthcare.

The study's findings reflect the variability in user engagement seen in previous research regarding usage patterns.[31] Mobile health apps often exhibit different usage frequencies among users, with some users accessing the app more frequently than others. This variability underscores the importance of understanding and addressing user engagement patterns to enhance the use of mHealth apps.

Research investigating the effectiveness of mHealth applications as educational strategies yielded mixed findings. While certain studies have demonstrated enhancements in knowledge and adherence scores among participants exposed to mHealth interventions, others have reported no substantial influence on these metrics.[6,9–11,15,32] This study contributed to this ongoing discussion by demonstrating that the Hypertension Now app enhanced knowledge and guideline-adherent physical examinations, diagnostics, and pharmacological treatments for hypertension. However, it did not improve adherence to risk assessment, laboratory examination, and non-pharmacologic treatment. This could be due to the inadequacies of the app in these domains implying the need for app improvement. This also implies that the residency training program may need to evaluate how these domains are taught and practiced. Additionally, time constraints for comprehensive patient chart documentation might have influenced these clinical domains' lack of significant improvement.

The study had limitations. First, the enhanced knowledge and adherence observed among FCM residents during the 2-month intervention may be influenced by other educational activities and increased patient interaction, so the improvements may not be solely attributed to the mHealth app. Second, the absence of an experimental design featuring a control group may have affected the management of confounding variables and the study's internal validity. Finally, the assessment of adherence relied on medical chart audits, which may not capture the full spectrum of clinical practice due to missing data.

The Hypertension Now app must go beyond novelty by enhancing its maturity and technology readiness level, following the WHO and NASA criteria.[33] Currently, the app stands at prototype 1 maturity stage, tested by only 32 resident physicians. However, it has reached technology readiness level 5, signifying validation in a relevant environment, i.e., the outpatient clinic setting of DFCM. The app's usability and effectiveness shown in this study serve as foundations for potential larger-scale testing. Further research should explore its implementation among a broader group of physicians or medical students across diverse institutions. Additionally, conducting longer-term impact assessments could provide insights into sustained knowledge retention and potential effects on patient outcomes.

CONCLUSION

The mobile health application, Hypertension Now was usable and effective in increasing the knowledge and guideline-adherent practices of Family and Community Medicine residents in managing hypertension. While the app proved valuable in improving guideline-adherent physical examinations, diagnostics, and pharmacological treatments for hypertension, it did not improve adherence to risk assessment, laboratory examination, and non-pharmacologic treatment. These findings contribute to the expanding body of evidence regarding integrating mobile health applications into medical training programs and practice, potentially benefitting healthcare practitioners and patient outcomes.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

Co-author Sitti Khadija U. Salabi, is also a creator of the mobile health application evaluated in this study. To manage and mitigate any potential conflicts of interest, several measures were implemented. These included engaging independent data collectors and statistician to ensure objective data collection and analysis. Additionally, all authors disclosed their potential conflicts of interest, and no financial benefits or personal gains were associated with the research.

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REFERENCES

1. Abolfotouh MA, BaniMustafa A, Salam M, Al-Assiri M, Aldebasi B, Bushnak I. Use of smartphone and perception towards the usefulness and practicality of its medical applications among healthcare workers in Saudi Arabia. BMC Health Serv Res. 2019 Dec 12;19(1):826. doi: 10.1186/s12913-019-4523-1. PMID: 31718639; PMCID: PMC6849260.
2. Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. P T. 2014 May;39(5):356–64. PMID: 24883008; PMCID: PMC4029126.
3. Kyaw BM, Posadzki P, Paddock S, Car J, Campbell J, Tudor Car L. Effectiveness of digital education on communication skills among medical students: systematic review and meta-analysis by the Digital Health Education Collaboration. J Med Internet Res. 2019;21(8):e12967. doi: 10.2196/12967. PMID: 31456579; PMCID: PMC6764329.

4. George PP, Zhabenko O, Kyaw BM, Antoniou P, Posadzki P, Saxena N, et al. Online digital education for postregistration training of medical doctors: systematic review by the Digital Health Education Collaboration. J Med Internet Res. 2019 Feb 25;21(2):e13269. doi: 10.2196/13269. PMID: 30801252; PMCID: PMC6410118.
5. Lindquist AM, Johansson PE, Petersson GI, Saveman BI, Nilsson GC. The use of the Personal Digital Assistant (PDA) among personnel and students in health care: a review. J Med Internet Res. 2008 Oct 28;10(4):e31. doi: 10.2196/jmir.1038. PMID: 18957381; PMCID: PMC2629360.
6. Mickan S, Tilson JK, Atherton H, Roberts NW, Heneghan C. Evidence of effectiveness of health care professionals using handheld computers: a scoping review of systematic reviews. J Med Internet Res. 2013 Oct 28;15(10):e212. doi: 10.2196/jmir.2530. PMID: 24165786; PMCID: PMC3841346.
7. Gaglani SM, Topol EJ. iMedEd: the role of mobile health technologies in medical education. Acad Med. 2014 Sep;89(9):1207–9. doi:10.1097/ACM.0000000000000361. PMID: 24892404; PMCID: PMC4146691.
8. Chandran VP, Balakrishnan A, Rashid M, Pai Kulyadi G, Khan S, Devi ES, et al. Mobile applications in medical education: a systematic review and meta-analysis. Rahman MS, editor. PLoS One. 2022 Mar 24;17(3):e0265927. doi: 10.1371/journal.pone.0265927. PMID: 35324994; PMCID: PMC8947018.
9. Bonabi M, Mohebbi SZ, Martinez-Mier EA, Thyvalikakath TP, Khami MR. Effectiveness of smart phone application use as continuing medical education method in pediatric oral health care: a randomized trial. BMC Med Educ. 2019 Dec 21;19(1):431. doi: 10.1186/s12909-019-1852-z. PMID: 31752833; PMCID: PMC6873466.
10. Velasco HF, Cabral CZ, Pinheiro PP, Azambuja R de CS, Vitola LS, Costa MR da, et al. Use of digital media for the education of health professionals in the treatment of childhood asthma. J Pediatr (Rio J). 2015 Mar;91(2):183–8. doi: 10.1016/j.jped.2014.07.007. PMID: 25431855.
11. Samra S, Wu A, Redleaf M. Interactive iPhone/iPad app for increased tympanic membrane familiarity. Ann Otol Rhinol Laryngol. 2016 Dec 1;125(12):997–1000. doi: 10.1177/0003489416669952. PMID: 27670957.
12. Cook DA, Reed DA. Appraising the quality of medical education research methods. Acad Med. 2015 Aug;90(8):1067–76. doi: 10.1097/ACM.0000000000000786. PMID: 26107881.
13. Golshah A, Dehdar F, Imani MM, Nikkerdar N. Efficacy of smartphone-based mobile learning versus lecture-based learning for instruction of cephalometric landmark identification. BMC Med Educ. 2020 Dec 31;20(1):287. doi: 10.1186/s12909-020-02201-6. PMID: 32867758; PMCID: PMC7457473.
14. Chung H, Kallay T, Anas N, Bruno D, Decamps J, Evans D, et al. Using an audience response system smartphone app to improve resident education in the pediatric intensive care unit. J Med Educ Curric Dev. 2018 Jan 1;5:238212051877067. doi: 10.1177/2382120518770674. PMID: 29707650; PMCID: PMC5912270.
15. Yoon CH, Ritchie SR, Duffy EJ, Thomas MG, McBride S, Read K, et al. Impact of a smartphone app on prescriber adherence to antibiotic guidelines in adult patients with community acquired pneumonia or urinary tract infections. PLoS One. 2019 Jan 29;14(1):e0211157. doi: 10.1371/journal.pone.0211157. PMID: 30695078; PMCID: PMC6350960.
16. Field LC, McEvoy MD, Smalley JC, Clark CA, McEvoy MB, Rieke H, et al. Use of an electronic decision support tool improves management of simulated in-hospital cardiac arrest. Resuscitation. 2014 Jan;85(1):138–42. doi: 10.1016/j.resuscitation.2013.09.013. PMID: 24056391; PMCID: PMC4116642.
17. Boruff JT, Storie D. Mobile devices in medicine: a survey of how medical students, residents, and faculty use smartphones and other mobile devices to find information. J Med Libr Assoc. 2014 Jan; 102(1):22–30. doi: 10.3163/1536-5050.102.1.006. PMID: 24415916; PMCID: PMC3878932.
18. Larson RS. A Path to Better-Quality mHealth Apps. JMIR Mhealth Uhealth. 2018 Jul 30;6(7):e10414. doi: 10.2196/10414. PMID: 30061091; PMCID: PMC6090170.
19. McCool J, Dobson R, Whittaker R, Paton C. Mobile Health (mHealth) in low- and middle-income countries. Annu Rev Public Health. 2022 Apr 5;43(1):525–39. doi: 10.1146/annurev-publhealth-052620-093850. PMID: 34648368.
20. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020 Apr 5;16(4):223–37. doi: 10.1038/s41581-019-0244-2. PMID: 32024986; PMCID: PMC7998524.
21. Mercado-Asis L, Ona DI, Bonzon D, Vilela G, Diaz A, Balmores B, et al. Burden of disease of hypertension in the Philippines projected in 2050. J Hypertens. 2022 Jun;40(Suppl 1):e41. doi: 10.1038/s41440-022-01052-6. PMID: 36229530.
22. David-Ona D, De Castro DM, Baltazar AC. The distribution of hypertension in the Philippine General Hospital after 4 decades (a comparative study). Acta Med Philipp. 2013;47(3):49-52. doi: 10.47895/amp.v47i3.1315.
23. Bhatheja S, Fuster V, Chamaria S, Kakkar S, Zlatopolsky R, Rogers J, et al. Developing a mobile application for global cardiovascular education. J Am Coll Cardiol. 2018 Nov;72(20):2518–27. doi: 10.1016/j.jacc.2018.08.2183. PMID: 30442294.
24. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. 2020 International Society of Hypertension Global Hypertension Practice Guidelines. Hypertension. 2020 Jun;75(6):1334–57. doi: 10.1161/HYPERTENSIONAHA.120.15026. PMID: 32370572.
25. Ona DID, Jimeno CA, Jasul GV, Bunyi MLE, Oliva R, Gonzalez-Santos LE, et al. Executive summary of the 2020 clinical practice guidelines for the management of hypertension in the Philippines. The Journal of Clinical Hypertension. 2021 Sep 3;23(9):1637–50. doi: 10.1111/jch.14335. PMID: 34343391; PMCID: PMC8678709.
26. Department of Health P. DOH Approved Clinical Practice Guidelines. Department of Health, Philippines. 2022 [cited 2023 Aug 29]. Available from: https://doh.gov.ph/dpcb/doh-approved-cpg/
27. Zhou L, Bao J, Setiawan IMA, Saptono A, Parmanto B. The mHealth App Usability Questionnaire (MAUQ): development and validation study. JMIR Mhealth Uhealth. 2019 Apr 11;7(4):e11500. doi: 10.2196/11500. PMID: 30973342; PMCID: PMC6482399.
28. Mubuuke AG, Mwesigwa C, Kiguli S. Implementing the Angoff method of standard setting using postgraduate students: practical and affordable in resource-limited settings. Afr J Health Prof Educ. 2017;9(4):171–5. doi: 10.7196/AJHPE.2017.v9i4.631. PMID: 29291132; PMCID: PMC5745345.
29. Wu P, Zhang R, Luan J, Zhu M. Factors affecting physicians using mobile health applications: an empirical study. BMC Health Serv Res. 2022 Dec 4;22(1):24. doi: 10.1186/s12913-021-07339-7. PMID: 34983501; PMCID: PMC8729011.
30. Irfan ME, Ginige JA. Comparative study of medical reference and information mobile apps for healthcare professionals and students. Stud Health Technol Inform. 2018;254:43–52. doi: 10.3233/978-1-61499-914-0-43. PMID: 30306956.
31. Alessa T, S Hawley M, Alsulamy N, de Witte L. Using a commercially available app for the self-management of hypertension: acceptance and usability study in Saudi Arabia. JMIR Mhealth Uhealth. 2021 Feb 9;9(2):e24177. doi: 10.2196/24177. PMID: 33560237; PMCID: PMC7902196.
32. Teferi GH, Tilahun BC, Guadie HA, Amare AT. Smartphone medical app use and associated factors among physicians at referral hospitals in Amhara Region, North Ethiopia, in 2019: cross-sectional study. JMIR Mhealth Uhealth. 2021 Mar 26;9(3):e19310. doi: 10.2196/19310. PMID: 33769303; PMCID: PMC8096376.
33. Aksenova EI, Gorbatov SY, Pivovarova OA. Determining the level of technological readiness of developments in medicine based on the TRL methodology. Probl Soc Hyg Public Health Hist Med. 2021 Aug;29(Special Issue). doi: 10.32687/0869-866X-2021-29-s2-1395-1399. PMID: 34792895.