Journal of Social & Health Sciences

Original Article

Assessing the effectiveness of digital media platforms on birth preparedness and complication readiness knowledge among healthcare professionals

Humaira Mahmood [a], Rubab Zulfiqar [a], Bibi Razia Bano [a], Seema Mohmand [a], Nazarul Islam [a], Seema Saifuddin [a], Hassan Mumtaz [b,*]

[a] National University of Medical Sciences, Pakistan
[c] BPP University, London, United Kingdom

* Correspondence: hassanmumtaz.dr@gmail.com; Telephone: +447506326264

Citation: Mahmood H, Zulfiqar R, Bano BR, Mohmand S, Islam N, Saifuddin S, et al. Assessing the effectiveness of digital media platforms on birth preparedness and complication readiness knowledge among healthcare professionals. J Soc Health Sci. 2023;2:17-24.

Received: 27 June 2023
Revised: 03 December 2023
Accepted: 07 December 2023
Published: 11 December 2023

Publisher's Note: Logixs Journals remains neutral concerning jurisdictional claims in its published subject matter, including maps and institutional affiliations.

Abstract

The integration of modern technology in healthcare education, mainly through digital media platforms, is pivotal for enhancing healthcare professionals' proficiency in birth preparedness and complication readiness (BP/CR). This study aimed to assess the effectiveness of digital media interventions on BP/CR knowledge among healthcare providers, reflecting on broader implications for global healthcare delivery and patient education. In this quasi-experimental study, 70 healthcare professionals were recruited using a nonprobability convenience sampling method. The training protocol was developed after an in-depth literature review, while the evaluation questionnaire incorporated provider-level index indicators aligned with Johns Hopkins University's BP/CR guidelines to ensure a comprehensive assessment framework. The intervention utilized widely accessible digital platforms, i.e., WhatsApp and email, aimed to deliver educational content, with its effectiveness gauged through pre- and postintervention assessments analyzed using SPSS 25.00. The study findings demonstrated significant improvements in BP/CR knowledge postintervention across various care domains. The results showed significant increases in BP/CR knowledge postintervention: focused antenatal care knowledge improved from 34.00% to 69.00% ($p < 0.001$), and knowledge of third-stage labor management increased from 21.00% to 56.00% ($p < 0.001$). Furthermore, significant improvements were also observed in neonatal care and emergency obstetric and neonatal care management knowledge ($p < 0.001$). These results affirm the role of digital media in improving healthcare education, suggesting its integration into healthcare policies to reduce maternal mortality and support professionals in resource-limited settings.

Keywords

Birth preparedness; Complication readiness; Digital media; Health personnel; Health knowledge

1. Introduction

In the constantly evolving landscape of global health, childbirth is a crucial event that affects both mothers and newborns, physically and emotionally [1,2]. This significant life event involves complex anatomical and physiological transformations, placing both the mother and the unborn child at considerable risk, particularly during labor and the immediate postpartum period. In low- and lower-middle-income countries (LMICs), maternal mortality remains a pressing concern, while maternal deaths worldwide are exceptionally high during the postpartum period, with noteworthy variations across regions [3]. This disparity highlights the differences in maternal health outcomes between

privileged communities and those with challenging conditions in underserved populations, emphasizing issues of limited healthcare access and awareness [4].

Several guidelines have been implemented to manage prenatal care and childbirth effectively. The World Health Organization (WHO) has developed labor management guidelines to promote well-being and reduce maternal mortality, especially in high-risk regions [5]. Despite several efforts, the quality of intrapartum care remains globally suboptimal, adversely affecting pregnant women [6,7]. Moreover, there are potential risk factors for maternal and neonatal mortality, including delays in accessing healthcare services and the absence of timely medical interventions [8,9,10].

It is evident from the literature that birth preparedness and complication readiness (BP/CR) is important in promoting skilled birth attendance and equipping families with essential planning tools, thus reducing maternal mortality [11]. In addition, the role of healthcare providers, including midwives, nurses, and doctors, is vital in delivering quality care, with digital tools increasingly being admired for their capacity to improve healthcare outcomes [12,13,14].

According to the WHO Quality of Care Framework, evidence-based practices for adopting effective interventions and preventing unsafe interventions are essential [15]. However, gaps persist between recommended practices and actual care, with deficiencies in monitoring, practice implementation, and infrastructure [16]. This issue is not isolated; for example, in Pakistan, despite a decrease in maternal mortality, significant challenges remain, highlighted by the high under 5 mortality rates [17,18].

The Agency for Healthcare Research and Quality (AHRQ) emphasizes the role of modern technology in enhancing health awareness and education [19]. The knowledge of healthcare professionals can be enhanced by using digital media, such as emails and messaging apps. The use of digital media is particularly relevant for overcoming the limitations of traditional training methods, especially during challenges such as the COVID-19 pandemic [20,21].

This study has additional relevance within the context of the Minimum Initial Service Package (MISP) for Sexual and Reproductive Health in disaster-affected areas. It recognizes that not only gynaecologists, but also general physicians are crucial in managing the health needs of disaster-impacted populations. Enhancing the knowledge of all health professionals regarding BP/CR is vital, especially when traditional educational sessions are impractical. In such contexts, digital media is an efficient tool for the rapid and broad dissemination of essential information, ensuring that healthcare providers are prepared even in challenging disaster scenarios.

This study aimed to assess the effectiveness of digital media platforms in enhancing knowledge regarding BP/CR among healthcare professionals, potentially transforming healthcare delivery and patient education.

2. Materials and methods

This quasi-experimental study, conducted over two months between January and February 2023 at the Armed Forces Post Graduate Medical Institute (AFPGMI), received its ethics approval from the AFPGMI's Ethical Review Committee in Rawalpindi (No. 258-AAA-ERC-AFPGMI).

Participants were recruited using a nonprobability convenience sampling method. The sample size, initially calculated at 53 based on a 1% significance level and 90% power with means of 9.5 and 11.0 [standard deviation of (SD) 2] as per Almerdhemah et al. (2021), was increased to 70 to enhance the study's validity [22].

The study recruited male and female public health practitioners who had or were pursuing a Master of Public Health (MPH), who were doctors with Bachelor of Medicine

and Bachelor of Surgery (MBBS) degrees, and who provided written consent to participate in the study. However, the study excluded those with less than one year of clinical or field experience to ensure that participants had a foundational level of professional expertise.

After an extensive literature review on birth preparedness and complication readiness, the principal and coprincipal investigators drafted the study protocol, including the training material. The corresponding evaluation questionnaire was developed using tools for provider-level index indicators detailed in a comprehensive document by Johns Hopkins University on birth preparedness and complication readiness [23]. This material was finalized in consultation with a panel of field experts.

The training manual underwent a pretest with five participants using digital media platforms, i.e., email and WhatsApp. During this pretest, participants completed an evaluation proforma before and after accessing the manual. The feedback acquired from this initial phase was instrumental in minor modifications to the training material, improving its understanding and clarity.

The final questionnaire was distributed among the study participants to gather preintervention responses. After receiving the responses, the training manual was distributed via digital media, followed by reminder messages to confirm participants' engagement with the material. After two weeks, the post-assessment questionnaire was redistributed among the participants. The participants' identities were kept confidential throughout the process.

In the study, the assessment comprised 20 questions categorized into four distinct sections: 1) antenatal care knowledge, encompassing four questions; 2) normal labor and childbirth, with five questions; 3) immediate newborn care, consisting of six questions; and 4) management of complications, also with five questions. Each question was formatted as multiple-choice with only one correct answer. For the evaluation, each correct response was awarded one mark. The participants' scores were then aggregated, and these cumulative scores served as the basis for comparative analysis, assessing the differences in knowledge before and after the intervention.

The data were analyzed using the Statistical Package for Social Sciences 25.00 (SPSS Inc., Chicago, IL, USA). The data are presented as frequencies, percentages, means, and SDs. In addition, the Shapiro–Wilk test was applied to test the normality of the data. Based on the data distribution, a paired sample t test was used to evaluate the differences in pre- and postintervention knowledge scores among healthcare practitioners, both overall and within each category.

3. Results

Out of the 75 questionnaires distributed, 70 participants, accounting for approximately 93%, returned the questionnaires. The findings of the study are summarized as follows:

3.1. Sociodemographic characteristics

Table 1 shows the sociodemographic characteristics of the participants. The intervention sample comprised mostly females (62.86%). The mean age of the participants was 29 ± 3.5 years. The study population was working in different public (68.57%) and private (31.43%) sector hospitals, with the majority having less than five years of experience (75.71%).

Table 1. Sociodemographic characteristics of the participants (n = 70).

Sociodemographics		No. (%)
Gender	Male	26 (37.14)
	Female	44 (62.86)
Age (in years)	< 25	13 (18.57)
	26 – 30	38 (54.29)
	31 – 35	18 (25.71)
	36 – 40	1 (1.43)
Years of experience (in years)	< 5	53 (75.71)
	6 – 10	14 (20.00)
	11 – 15	3 (4.29)
Place of work	Public	48 (68.57)
	Private	22 (31.43)

Table 2. Paired sample t-tests on pre- and posttest overall scores of the participants' knowledge.

	N	Mean ± SD	Standard Error Mean	95% CI (Difference)		t Value	Degree of Freedom	*p* Value **
				Lower	Upper			
Pretest score	70	9.03 ± 3.12	0.37	-	-	-	-	< 0.001 *
Posttest score	70	16.74 ± 4.09	0.49	-	-	-	-	
Pre and posttest	-	7.71 ± 4.87	0.58	6.55	8.88	13.25	69	

* Pre- and post-test scores compared using paired sample t-tests. ** A *p value* < 0.001 indicates significance.

Table 3. Comparative analysis of pre- and postintervention knowledge scores by category.

Variables	Pretest Score		Posttest Score		*p* value *
	Yes, N (%)	Yes, N (%)	Yes, N (%)	No, N (%)	
Prenatal education and care					
Educational messages for pregnant women	62 (88.57)	8 (11.43)	69 (98.57)	1 (1.43)	0.019 **
Focused antenatal care definition	64 (91.43)	6 (8.57)	69 (98.57)	1 (1.43)	0.058
Actions within focused antenatal care	34 (48.57)	36 (51.43)	69 (98.57)	1 (1.43)	< 0.001 **
Essential antenatal tests	25 (35.71)	45 (64.29)	37 (52.86)	33 (47.14)	0.064
Delivery and postpartum management					
Third-stage labor management	48 (68.57)	22 (31.43)	62 (88.57)	8 (11.43)	0.005 **
Steps in active management of third-stage labor	21 (30.00)	49 (70.00)	56 (80.00)	14 (20.00)	< 0.001 **
Post-placenta delivery bleeding management	11 (15.71)	59 (84.29)	54 (77.14)	16 (22.86)	< 0.001 **
Infection prevention during childbirth	26 (37.14)	44 (62.86)	60 (85.71)	10 (14.29)	< 0.001 **
Handling contaminated instruments	15 (21.43)	55 (78.57)	55 (78.57)	15 (21.43)	< 0.001 **
Neonatal care and protection					
Thermal protection for newborns	9 (12.86)	61 (87.14)	47 (67.14)	23 (32.86)	< 0.001 **
Immediate newborn care	24 (34.29)	46 (65.71)	55 (78.57)	15 (21.43)	< 0.001 **
Causes of newborn hypothermia	43 (61.43)	27 (38.57)	57 (81.43)	13 (18.57)	0.027 **
Maintaining newborn temperature	39 (55.71)	31 (44.29)	69 (98.57)	1 (1.43)	< 0.001 **
Umbilical cord care	17 (24.29)	53 (75.71)	58 (82.86)	12 (17.14)	< 0.001 **
Initiation of breastfeeding	43 (61.43)	27 (38.57)	60 (85.71)	10 (14.29)	< 0.001 **
Emergency obstetric and neonatal care					
Conducting rapid initial assessment	43 (61.43)	27 (38.57)	59 (84.29)	11 (15.71)	0.004 **
Causes of immediate postpartum hemorrhage	43 (61.43)	27 (38.57)	62 (88.57)	8 (11.43)	< 0.001 **
Newborn resuscitation procedures	9 (12.86)	61 (87.14)	56 (80.00)	14 (20.00)	< 0.001 **
Signs of a ruptured uterus	35 (50.00)	35 (50.00)	62 (88.57)	8 (11.43)	< 0.001 **
Managing eclamptic convulsions	21 (30.00)	49 (70.00)	57 (81.43)	13 (18.57)	< 0.001 **

* Knowledge-related variables were analyzed using the chi-square test. ** A *p* value less than 0.001 is considered significant.

3.2. Knowledge regarding BP/CR

All participants (n = 70) completed the pre- and postintervention assessments. The paired sample t tests comparing knowledge scores before and after the intervention are presented in Table 2. The results show a significant mean difference of 7.714 ± 4.87, with a *p* value of 0.001.

Table 3 shows the change in healthcare providers' knowledge postintervention. There were improvements in understanding focused antenatal care actions, with scores increasing from 34.00% to 69.00% ($p < 0.001$). Within the category of delivery and postpartum management, knowledge of active management in the third stage of labor increased from 21.00% to 56.00% ($p < 0.001$), and proficiency in post-placental bleeding management increased from 11.00% to 54.00% ($p < 0.001$). For neonatal care and protection, significant increases were observed in thermal protection, from 9.00% to 47.00% ($p < 0.001$), and in temperature maintenance, with scores increasing from 39.00% to 69.00% ($p < 0.001$). In emergency obstetric and neonatal care, knowledge of resuscitation procedures significantly improved from 9.00% to 56.00% ($p < 0.001$), and the ability to manage eclamptic convulsions increased from 21.00% to 57.00% ($p < 0.001$).

4. Discussion

The study's key findings underscore significant improvements in healthcare providers' knowledge following an educational intervention through digital media platforms, which is evident across various maternal and neonatal care domains. Notably, the intervention enhanced knowledge of focused antenatal care actions, management of the third stage of labor, post-placental bleeding, and crucial neonatal care aspects, including thermal protection and temperature regulation. There was also a significant increase in the participants' ability to manage critical obstetric and neonatal emergencies, including resuscitation procedures and eclamptic convulsion management. These outcomes affirm the role of digital media platforms in boosting healthcare providers' competencies in essential birth preparedness and pregnancy readiness areas, indicating a positive impact on their capacity to address and manage diverse conditions in maternal and neonatal health.

A study showed statistically significant improvements, with a mean increase in knowledge from 11.21 to 13.68 following a health education intervention focusing on noncommunicable diseases via digital media, i.e., WhatsApp [24]. The adoption of e-learning for training healthcare professionals has surged exponentially, with several studies affirming its effectiveness [25,26,27,28,29]. Furthermore, using social media and mHealth apps in pregnancy care has shown considerable effectiveness, yielding moderate to large effect sizes in enhancing maternal health and knowledge among healthcare professionals [30,31].

Another study conducted in Pakistan assessed the effect of web-based training on knowledge of preventive oral health and reported that healthcare professionals' knowledge improved after training from 69% to 81% (95% confidence interval [CI]: 9%-15%) [32]. Another study highlighted that during the COVID-19 pandemic, e-learning was adopted as a critical educational approach during lockdowns, aligning with learners' preferences for accessible and independent learning experiences [33]. This adaptation proved particularly effective for self-directed education among healthcare professionals in remote or underserved areas [34].

No such study has focused on using digital media interventions to improve the knowledge of healthcare professionals regarding birth preparedness and pregnancy readiness. This study highlights the critical role of healthcare professionals in mitigating

pregnancy-associated complications and reducing maternal mortality rates. Traditional onsite training, while valuable, demands substantial time, effort, and financial investment, often compounded by logistical challenges in scheduling. In contrast, e-media learning, mainly through assessment-centric methodologies, has emerged as an efficacious and resource-efficient alternative.

This study utilizes the digital media platforms WhatsApp and email, tools mostly used in both personal and professional circles; these tools are recognized for their efficiency and effectiveness in knowledge dissemination, facilitating far-reaching communication and education across diverse geographical locations. Despite its strengths, the study has significant limitations, including the absence of direct social interaction and the inability to assess skill improvement directly. The dependence on self-report questionnaires may lead to potential biases, as the data are based on participants' self-assessments rather than objective observations, possibly affecting the accuracy of the reported knowledge gains. The study's design, while innovative in its use of digital tools for educational purposes, points to the need for further research to explore the impact of such interventions on practical skills and direct patient care outcomes.

5. Conclusions

In conclusion, digital media interventions significantly enhance healthcare providers' knowledge, highlighting the educational potential of platforms traditionally used as social networking tools. The findings underline the need for future research to explore the effects of digital interventions on healthcare providers' practical skills across larger cohorts. Our findings also advocate for the formulation of digital patient education strategies and emphasize the necessity of integrating continuous digital training within health policies to reduce maternal mortality effectively.

Author contributions: Conceptualization, HM, RZ, BRB, SM, and SS; methodology, HM, RZ, NI, and SS; software, SM, and HM; validation, SM, and HM; formal analysis, SM, and HM; investigation, BRB, NI, SS, and HM; resources, HM, RZ, and BRB; data curation, HM; writing—original draft preparation, RZ, BRB, NI, SS, and HM; writing—review and editing, HM, RZ, and SM; visualization, SM, and HM; supervision, HM, and SM; project administration, BRB, and NI. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no specific grant from the public, commercial, or not-for-profit funding agencies.

Ethics statement: This study was approved by the Ethical Review Committee of the Armed Forces Post Graduate Medical Institute (AFPGMI), Rawalpindi (No. 258-AAA-ERC-AFPGMI).

Consent to participate: Informed consent was obtained from all participants involved in the study.

Data availability: The data supporting this study's findings are available from the corresponding author, Hassan, upon reasonable request.

Acknowledgments: None.

Conflicts of interest: The authors declare no conflicts of interest.

References

[1] Power C, Williams C, Brown A. Physical and psychological childbirth experiences and early infant temperament. Front Psychol. 2022;13:792392. https://doi.org/10.3389/fpsyg.2022.792392

[2] Olza I, Leahy-Warren P, Benyamini Y, Kazmierczak M, Karlsdottir SI, Spyridou A, et al. Women's psychological experiences of physiological childbirth: a meta-synthesis. BMJ Open. 2018;8(10):e020347. https://doi.org/10.1136/bmjopen-2017-020347

[3] Mzembe T, Chikwapulo V, Kamninga TM, Vellemu R, Mohamed S, Nthakomwa L, et al. Interventions to enhance healthcare utilisation among pregnant women to reduce maternal mortality in low- and middle-income countries: a review of systematic reviews. BMC Public Health. 2023;23:1734. https://doi.org/10.1186/s12889-023-16558-y

[4] Tesfay N, Tariku R, Zenebe A, Woldeyohannes F. Critical factors associated with postpartum maternal death in Ethiopia. PLoS One. 2022;17(6):e0270495. https://doi.org/10.1371/journal.pone.0270495
[5] WHO labour care guide: user's manual. Geneva (CH): World Health Organization; 2020.
[6] Ekblom A, Målqvist M, Gurung R, Rossley A, Basnet O, Bhattarai P, et al. Factors associated with poor adherence to intrapartum fetal heart monitoring in relationship to intrapartum related death: A prospective cohort study. PLOS Glob Public Health. 2022; 2(5):e0000289. https://doi.org/10.1371/journal.pgph.0000289
[7] Lama TP, Munos MK, Katz J, Khatry SK, LeClerq SC, Mullany LC. Assessment of facility and health worker readiness to provide quality antenatal, intrapartum and postpartum care in rural Southern Nepal. BMC Health Serv Res. 2020;20:16. https://doi.org/10.1186/s12913-019-4871-x
[8] Khaliq IH, Mahmood HZ, Sarfraz MD, Gondal KM, Zaman S. Pathways to care for patients in Pakistan experiencing signs or symptoms of breast cancer. Breast. 2019;46:40-7. https://doi.org/10.1016/j.breast.2019.04.005
[9] Ackers L, Ioannou E, Ackers-Johnson J. The impact of delays on maternal and neonatal outcomes in Ugandan public health facilities: the role of absenteeism. Health Policy Plann. 2016;31(9):1152-61. https://doi.org/10.1093/heapol/czw046
[10] Sumankuuro J, Crockett J, Wang S. Perceived barriers to maternal and newborn health services delivery: a qualitative study of health workers and community members in low and middle-income settings. BMJ Open. 2018;8(11):e021223. https://doi.org/10.1136/bmjopen-2017-021223
[11] Letose F, Admassu B, Tura G. Birth preparedness, complication readiness and associated factors among pregnant women in Agnuak zone, Southwest Ethiopia: a community based comparative cross-sectional study. BMC Pregnancy Childbirth. 2020;20: 72. https://doi.org/10.1186/s12884-020-2766-9
[12] Masuda C, Ferolin SK, Masuda K, Smith C, Matsui M. Evidence-based intrapartum practice and its associated factors at a tertiary teaching hospital in the Philippines, a descriptive mixed-methods study. BMC Pregnancy Childbirth. 2020;20:78. https://doi.org/10.1186/s12884-020-2778-5
[13] Orton M, Agarwal S, Muhoza P, Vasudevan L, Vu A. Strengthening delivery of health services using digital devices. Glob Health Sci Pract. 2018;6(Suppl 1):S61-71. https://doi.org/10.9745/GHSP-D-18-00229
[14] Naslund JA, Shidhaye R, Patel V. Digital technology for building capacity of nonspecialist health workers for task sharing and scaling up mental health care globally. Harv Rev Psychiatry. 2019;27(3):181-92.
[15] Tunçalp Ö, Were WM, MacLennan C, Oladapo OT, Gülmezoglu AM, Bahl R, et al. Quality of care for pregnant women and newborns—the WHO vision. BJOG. 2015;122(8):1045-9. https://doi.org/10.1111/1471-0528.13451
[16] Mgbekem MA, Nsemo AD, Daufa CF, Ojong IN, Nwakwue N, Andrew-Bassey P. Nurses' role in birth preparedness and complication readiness among pregnant women in University of Calabar Teaching Hospital, Calabar. Health. 2020;12(2):71–85. https://doi.org/10.4236/health.2020.122006
[17] UNICEF. UNICEF data: monitoring the situation of children and women. 2023 [cited 17 March 2023]. Available from: https://data.unicef.org/country/pak/.
[18] Bauserman M, Thorsten VR, Nolen TL, Patterson J, Lokangaka A, Tshefu A, et al. Maternal mortality in six low and lower-middle income countries from 2010 to 2018: risk factors and trends. Reprod Health. 2020;17(Suppl 3):173. https://doi.org/10.1186/s12978-020-00990-z
[19] Hailu M, Gebremariam A, Alemseged F, Deribe K. Birth preparedness and complication readiness among pregnant women in Southern Ethiopia. PLoS One. 2011;6(6):e21432. https://doi.org/10.1371/journal.pone.0021432
[20] Shukla M, Khan NZ, Agarwal A, Dwivedi AD, Singh JV, Alam S. Effect of focused birth preparedness and complication readiness counseling on pregnancy outcome among females attending tertiary care hospital in Barabanki district, Uttar Pradesh, India. J Educ Health Promot. 2019;8(1):p113. https://doi.org/10.4103/jehp.jehp_451_18
[21] Okoye K, Hussein H, Arrona-Palacios A, Quintero HN, Ortega LOP, Sanchez AL, et al. Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks. Educ Inf Technol. 2023;28:2291-360. https://doi.org/10.1007/s10639-022-11214-1
[22] Almerdhemah H, Mulla Z, Muamenah HM, Weber A, Boubakra T, Taha H, et al. Site-specific education using digital media to improve patient understanding of the radiotherapy trajectory: an interventional study. Adv Radiat Oncol. 2021;6(6):100742. https://doi.org/10.1016/j.adro.2021.100742
[23] Del Barco RC. Monitoring birth preparedness and complication readiness: tools and indicators for maternal and newborn health. Maryland (US): JHPIEGO;2004:1–338.
[24] Pereira AAC, Destro JR, Picinin Bernuci M, Garcia LF, Rodrigues Lucena TF. Effects of a WhatsApp-delivered education intervention to enhance breast cancer knowledge in women: mixed-methods study. JMIR Mhealth Uhealth. 2020;8(7):e17430. https://doi.org/10.2196%2F17430
[25] Paul P, Toon E, Hadadgar A, Jirwe M, Saxena N, Lim KTK, et al. Online- and local area network (LAN)-based eLearning interventions for medical doctors' education. Cochrane Database Syst Rev. 2018;10:CD012108. https://doi.org/10.1002/14651858.CD012108.pub2
[26] Bucher SL, Cardellichio P, Muinga N, Patterson JK, Thukral A, Deorari AK, et al. Digital health innovations, tools, and resources to support helping babies survive programs. Pediatrics. 2020;146(Suppl 2):S165-82. https://doi.org/10.1542/peds.2020-016915I
[27] Choi S, Yuen HM, Annan R, Monroy-Valle M, Pickup T, Aduku NEL, et al. Improved care and survival in severe malnutrition through eLearning. Arch Dis Child. 2020;105(1):32-9. https://doi.org/10.1136/archdischild-2018-316539

[28] Dzomeku VM, Mensah ABB, Nakua EK, Agbadi P, Okyere J, Kumah A, et al. Feasibility of the use of WhatsApp messaging technology to facilitate obstetric referrals in rural Ghana. BMC Digit Health. 2023;1:11. https://doi.org/10.1186/s44247-023-00012-5

[29] Owen MD, Ismail HM, Goodman D, Batakji M, Kim SM, Olufolabi A, et al. Use of WhatsApp messaging technology to strengthen obstetric referrals in the Greater Accra Region, Ghana: findings from a feasibility study. PLoS One. 2022;17(4):e0266932. https://doi.org/10.1371/journal.pone.0266932

[30] Chan KL, Chen M. Effects of social media and mobile health apps on pregnancy care: meta-analysis. JMIR Mhealth Uhealth. 2019;7(1):e11836. https://doi.org/10.2196/11836

[31] Weaver NS, Roy A, Martinez S, Gomanie NN, Mehta K. How WhatsApp is transforming healthcare services and empowering health workers in low-and middle-income countries. IEEE Global Humanitarian Technology Conference. IEEE GHTC 2022: Proceedings of the 12th IEEE Global Humanitarian Technology Conference; 2022 Sep 8-11; California, United States. New York: IEEE Xplore; 2022. p. 234-41.

[32] Talib N, Onikul R, Filardi D, Simon S, Sharma V. Effective educational instruction in preventive oral health: hands-on training versus web-based training. Pediatrics. 2010;125(3):547–53. https://doi.org/10.1542/peds.2009-0470

[33] Aristovnik A, Karampelas K, Umek L, Ravšelj D. Impact of the COVID-19 pandemic on online learning in higher education: a bibliometric analysis. Front Educ. 2023;8:225834. https://doi.org/10.3389/feduc.2023.1225834

[34] Mahdavi Ardestani SF, Adibi S, Golshan A, Sadeghian P. Factors influencing the effectiveness of e-learning in healthcare: a fuzzy ANP study. Healthcare. 2023;11(14):2023. https://doi.org/10.3390/healthcare11142035