ORIGINAL RESEARCH ARTICLE

The role of digital health in early detection and treatment of pre-eclampsia in the prenatal period at primary healthcare facilities, South Africa: Pregnant women's perspective

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Abstract

An average of 76 000 maternal deaths and 500 000 neonatal deaths are reported globally yearly as a result of pre-eclampsia. To deal with this major concern, digital health initiatives are being increasingly used especially in maternal health, as it shows potential to improve the maternal health gap in reaching and achieving the Sustainable Development goals targets 3.1 and 3.2. Surprisingly, little is known about its use and role in early detection and treatment of pre-eclampsia among women in their prenatal period in a South African context. Therefore, this poses an inquiry of "What role digital health might possible play in early detection and treatment of pre-eclampsia?" Thus, this study intends to explore the digital health use in early detection and treatment of pre-eclampsia by pregnant women at primary healthcare facilities. A qualitative exploratory and descriptive design were used for the understanding of participants' knowledge and barriers to digital health utilization. The study adopted a purposive sampling method to select participants for interviews and data saturation was reached with the 10th participant. Data was collected using semi-structured interviews and was analyzed using an open Tesch's coding. Data quality was enhanced by applying four elements recommended by Lincoln and Guba. The study revealed that there's knowledge inconsistencies on digital health use among women with pre-eclampsia. Despite the knowledge inconsistencies factors such as poor socio-economic status, lack of trust and validation of digital health initiatives, and poor network connectivity prevented the women in using digital health effectively. Nonetheless the study also revealed that families, friends and midwives play an imperative role as a source of support and knowledge on early detection and treatment of pre-eclampsia. Therefore, the study recommends that measures to ensure enhanced access to digital health information should be adopted. Moreover, more efforts should be made towards improving the accessibility of the digital health; this includes provision of infrastructure. *(Afr J Reprod Health 2025; 29 [9]: 18-29).*

Keywords: Pre-eclampsia; early detection; treatment; digital health; prenatal

Résumé

En moyenne, 76 000 décès maternels et 500 000 décès néonatals sont signalés chaque année dans le monde en raison de la prééclampsie. Pour répondre à cette préoccupation majeure, les initiatives de santé numérique sont de plus en plus utilisées, notamment en santé maternelle, car elles présentent le potentiel de combler les lacunes en matière de santé maternelle et d'atteindre les cibles 3.1 et 3.2 des Objectifs de développement durable. Étonnamment, on sait peu de choses sur son utilisation et son rôle dans la détection et le traitement précoces de la prééclampsie chez les femmes en période prénatale en Afrique du Sud. Par conséquent, la question se pose de savoir quel rôle la santé numérique pourrait jouer dans la détection et le traitement précoces de la prééclampsie. Cette étude vise donc à explorer l'utilisation de la santé numérique dans la détection et le traitement précoces de la prééclampsie par les femmes enceintes dans les établissements de soins de santé primaires. Une approche qualitative exploratoire et descriptive a été utilisée pour comprendre les connaissances des participantes et les obstacles à l'utilisation de la santé numérique. L'étude a adopté une méthode d'échantillonnage raisonné pour sélectionner les participants aux entretiens, et la saturation des données a été atteinte avec le dixième participant. Les données ont été collectées au moyen d'entretiens semi-structurés et analysées à l'aide d'un codage Tesch ouvert. La qualité des données a été améliorée grâce à l'application de quatre éléments recommandés par Lincoln et Guba. L'étude a révélé des divergences de connaissances sur l'utilisation de la santé numérique chez les femmes atteintes de prééclampsie. Malgré ces divergences, des facteurs tels qu'un statut socio-économique défavorable, le manque de confiance et de validation des initiatives de santé numérique, ainsi qu'une mauvaise connectivité réseau, ont empêché les femmes d'utiliser efficacement la santé numérique. Néanmoins, l'étude a également révélé que les familles, les amis et les sages-femmes jouent un rôle essentiel en tant que source de soutien et d'informations sur la détection précoce et le traitement de la prééclampsie. Par conséquent, l'étude recommande l'adoption de mesures visant à garantir un meilleur accès aux informations de santé numérique. De plus, des efforts accrus devraient être déployés pour améliorer l'accessibilité de la santé numérique, notamment en fournissant des infrastructures. *(Afr J Reprod Health 2025; 29 [9]: 18-29).*

Mots-clés: : Prééclampsie ; détection précoce ; traitement ; santé numérique ; prénatal

Introduction

Pre-eclampsia affects 2%-8% of pregnant women and influences maternal and fetal well- being, subsequently leading to catastrophic outcomes. An average of 76 000 maternal deaths and 500 000 neonatal deaths are reported globally yearly as a result of pre-eclampsia, the majority of the deaths are from low-income and middle-income countries[1,2,3]. The majority of the pregnant women affected by pre-eclampsia often lack knowledge about pre-eclampsia therefore unable to take preventive measures[4].Through early detection and treatment perinatal complications resulting from pre-eclampsia can be advertently reduced. To deal with this major concern, digital health initiatives are being increasingly used especially in maternal health, as it shows potential to improve the maternal health gap in reaching and achieving the Sustainable Development goals targets 3.1 and 3.2, of reducing maternal and child mortality to less than 70 per 100 000 by 2030[5,6]. Nonetheless, digital health is relatively a new emerging field in the healthcare industry. It involves the use of technology such as mobile phones (i.e., Apps), wearable devices, telehealth and telemedicine to improve quality care and health. Some scholars iterated that the use technology in digital health is a key to healthcare improvements as it reduces costs, improves patient safety and satisfaction; and reduces potential errors. For this effect, over the past five years remarkable progress had been made in defining digital health and technology use in the healthcare sector, particularly in the maternal and child healthcare. Evolving of the healthcare system has meticulously improved patient care. In effect, pregnant women are able to access information about nutrition, complications and fetal development as well as information about emerging risk[6,7].

In maternal health, use of digital health engages women in their care and supports them and their families during pregnancy. It promotes good maternal health practices and promotes facilitated communication with healthcare professionals. The use of digital health is seen as the most promising instrument to optimize the quality of healthcare and has great potential to strengthen and transform the healthcare system[8,9]. Different scholars at the Sub-Saharan Context, reported that digital health innovation has become essential in Sub-Saharan Africa for the reinforcement of healthcare[10]. In Tanzania, Wazazi Nipendeni digital health initiative was designed to improve maternal health through maternal morbidity and mortality ratio reduction. Meanwhile a tele-monitoring digital health initiative was applied in Parkinstan to support women at risk of developing pre-eclampsia by close monitoring of blood pressure at home for earliest signs[11,12]. The study of Feroz *et al*[12] further stated that the use of tele-monitoring could possibly lead to early detection of pre-eclampsia and the required need for treatment and admission of women with pre-eclampsia.

On the other hand, in South Africa, various digital health initiatives were developed and implemented to combat mortalities among pregnant women and children. An example of digital health initiative in South Africa is momConnect which was established in 2014 to assist women with their pregnancies by providing them with the health information required by them[13]. MomConnect is a Short Message Service (SMS) mobile health initiative with access to a help desk for questions and feedback. The help desk has impacted positively on optimizing quality of maternal healthcare[13]. Such initiatives can easily be used by patients in the comfort of their own homes[7]. Although digital health utilization is gradually increasing and transforming the healthcare system globally. Surprisingly, little is known about its use and role in early detection and treatment of pre-eclampsia among women in their prenatal period in a South African context. This presents a substantial research gap of what role digital health play in early detection and treatment of pre-eclampsia among pregnant women in rural South African context. Thus, this study intends to explore the utilization of digital health in the early detection and treatment of pre-eclampsia by pregnant women at Emalahleni local municipality of Mpumalanga province, South Africa.

Methods

The study was conducted in Primary Healthcare (PHC) facilities at Emalahleni local municipality of Nkangala District in Mpumalanga. Nkangala District is comprised of a total population of 1 357 744 and 50.6% were females; Midyear estimates 2013[15]. Emalahleni local municipality is one of the six municipalities in Nkangala district with a total of

15 PHCs rendering maternal care services to population within the municipality[16]. The Emalahleni local Municipality forms part of the western regions of Mpumalanga Province and borders onto Gauteng Province. The Thembisile Hani, Victor Khanye and the City of Tshwane Metro in Gauteng border the Municipality to the north and Steve Tshwete borders to it east; and the Gert Sibande borders to it south. The area of Emalahleni is approximately 2 678 kilometres square, known for its mining industries and transport network connecting to Johannesburg and Pretoria in Gauteng Province through N12 and N4 respectively[17.]

Nonetheless, a qualitative, exploratory, descriptive, research design underpinned this study. The adoption of these designs allowed the authors to gain insight on the knowledge of the pregnant women concerning the utilization of digital health during pregnancy. Authors probed the pregnant women regarding their knowledge, opinions and how they perceive utilization of digital health for early detection of pre-eclampsia as a way to gain understanding of the problem under study[14]. Pregnant women with pre-eclampsia attending Antenatal Care (ANC) within Emalahleni local municipality PHCs were recruited to participate in the study. Purposive sampling method was used to select the pregnant women based on their medical diagnosis and the clinic where they were attending ANC[18]. The study only included pregnant women with pre-eclampsia as conventional pregnant women don't share the same medical burden faced by women diagnosed pre-eclampsia. Therefore, their perspective was essential to investigate in-depth their knowledge and barriers in digital use in terms of their experiences living with pre-eclampsia. Purposive sampling assisted the researcher to select participants who were diagnosed with Pre-Eclampsia since they had lived experiences and knowledge about their condition[19]. The sample size was directed by data saturation. Following vigorous probing and prolonged engagement with participants the data saturation was reached with the 10th participant and there were no new codes emerging from the analysis. This was concluded when similar information was disclosed during the one-on-one interviews with the participants. Nonetheless, the sample size was considered adequate as the purpose of the study wasn't to quantify the findings but to explore in-depth and provide a nuanced understanding of the use of digital health among pre-eclampsia women[20,21]. In addition, through member checking the researchers were able to check the accuracy of the data and whether the data resonance and reflects the participants true experiences which enhanced the credibility of the data.

The data was collected by the primary author using semi-structured one-on-one interviews. Prior to data collection, the author conducted meetings telephonically with the operational managers, and the means of conducting the study was explained taking into consideration the research problem, aim, objectives, and benefits of the study. The days when pregnant women come to the facilities for ANC were discussed and, on those days, the operational managers introduced the authors to the women present at that time. The operational managers orientated the authors to the facility sphere and the room available for the data collection on that day. The qualitative data was then collected. During that collection, the author adhered to the rules and regulations of covid-19. Furthermore, the chairs during the interview were placed in a way that a social distance of 1.5 meters was always maintained and the participants were encouraged to wear their masks at all times. The interviews took approximately 40 to 60 minutes and were conducted in a private space with minimal disturbances. Furthermore, the interview session was audiotaped for data analysis upon consent request from the participants. The data collection process took a period of two months. The authors adhered to the sampling techniques in selecting the participants and bias was minimized. All the interviews were conducted in a language of preference by the participants. The interviews were transcribed verbatim and all the transcripts were kept under lock and key only accessed by the first author and corresponding author. The semi-structured interviews allowed the authors to get in-depth knowledge of the participant regarding digital health utilization[14]. Semi-structured interviews are utilized when the authors pose broad questions that must be addressed in an interview; to ensure all the questions relevant to the topic are broadly covered the interviewers use an interview guide[22]. The authors conducted semi-structured one-on-one interviews with each participant at a time, an interview guide was used to guide the authors in covering all the basics of the topic. This assisted the authors in

gathering the relative knowledge and barriers to digital health. All the answers were recorded following consent from the participant. The interviews were transcribed while the author can still recall the interviews proceedings.

Tesch's open coding approach was used to thoroughly read and understand the transcribed data, and further categorize and cluster the data in themes and subthemes. Tesch open coding is a qualitative data analysis method focusing on accurate naming and categorization of the situation by close examination of the gathered data. The first author first read all the transcripts to get meaning and make sense of the data. Secondly, following vigorous transcripts analysis the data was clustered into comparable and unique topics, in which they were reduced into codes to identify any new categories. Thereafter the codes were clustered into categories and any categories interrelated or similar were categorized together. According to the analysis only two themes with a total of nine subthemes[23,14]. Qualitative research experts were consulted to assist with transcribing, coding, and categorization. Transcribed data and recordings were verified by the last three authors who are experienced in qualitative research analysis authors. Thereafter a meeting was held to discuss and agree on the themes and sub-themes which emerged.

- Lastly, ethical approval for this study was obtained from the Turfloop Research Ethics Committee (TREC) of the University of Limpopo (TREC/81/2022: PG). Each participant signed a written informed consent form approving their participation in the study and the audio recording of their interviews. All participants were above the age of 18 years. All participants with no educational background, the researcher explained the detailed consent form in language of preference and guardians and spouses were consulted to co-sign the consent forms as witnesses. The study was conducted following the Declaration of Helsinki guidelines

Results

The results presented below reflect the responses of pregnant women regarding the utilization of digital health in the early detection and treatment of pre-eclampsia. Table 1 depicts the themes and sub-themes that emerged from the study.

Theme 1: The role of knowledge about digital health in its utilizations

Patient centred care involves knowledge management to improve quality care. However, the pregnant women with pre-eclampsia shared their views on their knowledge of digital health use in early detection and treatment[24]. The study revealed that there are significant roles of knowledge in utilization of digital health and there mode of delivery of such knowledge the pregnant women have. The participants expressed their significant knowledge of pre-eclampsia and sources of such information. The sub-themes and extracts below reflect the significant roles of knowledge and made of delivery about digital health utilization in early detection and treatment of pre-eclampsia outlined.

Sub-theme 1.1: Digital health as a tool to enhance access to information.

As digital technology transforms the healthcare industry, it has been said that digital health has a potential to reshape the traditional healthcare delivery. This includes the strengthening of the maternal healthcare delivery system[25]. Some highlighted their views and knowledge on the significance of usage of digital health initiatives to access information. The participants described digital health as being helpful and beneficial to them in terms of nutritional and informational support. This includes instances where the use of digital health informed them on the variety of kinds of food they should eat, being reminded of antenatal visits and it also gave them an insight of what pre-eclampsia is. The following extracts show the participants' views on the significant roles played by digital health utilization in their lives.

One participant said*: "The use of digital health was informing me about the things I should eat since I had high blood pressure. Now since this is my third pregnancy am using the same information I have learned from my previous pregnancy. The time I was using MomConnect, it was helpful because it used to remind me about my antenatal visits. And also, the foods I should eat."* (Participant 007)

Another participant said: *"...using digital health, I got to learn a lot about the symptoms of high blood pressure. I became aware of how to care for myself and my baby. I usually come across a lot of information."* (Participant 009)

Table 1: Themes and subthemes.

THEMES	SUB-THEMES
1. The role of knowledge about digital health in its utilizations	1.1. Digital health as a tool to enhance access to information. 1.2. Low awareness of the availability of digital health services and alternative sources of information. 1.3. Knowledge versus lack of knowledge of digital health use and alternative sources of information. 1.4. Other non-digital sources of information. 1.5. The role of family and friends in supplementing the information from PHC
2. Barriers for digital health use	2.1. The challenge of poor network connectivity and lack of technological knowledge 2.2. Lack of trust and validation of digital health initiatives is a concern 2.3. Poor socio-economic status and access to digital health 2.4. Lack of support in the use available digital health services.

This was supported by another participant by saying: *"My experience in using digital health was helpful because I was diagnosed with high blood pressure around 26 weeks of my pregnancy. From there I was concerned about my pregnancy and started to research high blood in pregnancy. It kept me informed and I learned about the foods am supposed to eat and avoid oil foods and salty foods. It helps to check whether my baby is growing well"* (Participant 008).

"Digital health guides me on the foods that am supposed to eat. Give me access to information that I never knew of before. I think the reason my blood pressure right now because I watch what I eat." (Participant 009).

Another participant said that: *"When I used digital health, I learnt that I should take care of my baby and attended antenatal visits on time. It further helped to accept my pregnancy and learn how to care for myself and my baby since I have pre-eclampsia."* (Participant 004)

One participant said that: *"The significant thing that I have noted is that as women we won't always have money to go to the doctor, but then the use of digital health gave access to more information about the kind of foods I am supposed to eat and what's important such as sleeping positions and well-being of my baby."* (Participant 001).

S*ub-theme 1.2: Low awareness of the availability of digital health services and alternative sources of information*

Although some of the pregnant women shared their views and Knowledge on the importance and usage of digital health initiatives to access information on pre-eclampsia, however their knowledge on the availability of digital health initiatives is insufficient and limited. Most of the participants mentioned the use of the internet, MomConnect and Facebook. This is supported by the following quotes.

"…So this time I used the internet to check the weight and foetal movements as well as signs of pre-eclampsia. Digital health was helpful to me to know about my condition." (Participant 001)

A probing question was asked as follows: *Could you kindly share your knowledge on the digital health apps you used?*

The participant answered and said; *"There was no apps I used instead, I googled the website pages called babies mommy and etc. you know when you go to google and search that specific content you want, it shows you variety of options. Then I'd choose flow and also mom n' baby, calendar, I visit those a lot."* (Participant 001)

Another participant said: *"I only found out that I have high blood pressure around last week, so when I read on the internet, I found out that it is really dangerous and I didn't know about it. The information I accessed was relevant because the signs and symptoms they mentioned I also experienced them. Some information I just googled myself from the internet after opening my file and checked what I was diagnosed with."* (Participant 005)

In addition, other participants said: *"I am using MomConnect and it is alright, because it guides me on the type of foods I should eat and that I should be*

in a clean environment. And also eat fruits, milk it could be Nkomati or fresh milk." (Participant 003)

However, only one of the participants expressed their knowledge in another different digital health app from others, even though the knowledge of other digital health initiatives is insufficient and the information provided was not of relevance to the study topic, but it shows that the participant has significant knowledge about digital health even before pregnancy and pre-eclampsia. This was supported by the following extract;

"So most of the things I had to learn from the internet… I also used a digital calendar to inform me of my menstrual cycle before pregnancy." (Participant 008)

Sub-theme 1.3: knowledge versus lack of knowledge of digital health use and alternative sources of information

Although majority of participants lacked the knowledge of the digital health use to inform them about pre-eclampsia, fair number of pregnant women expressed their knowledge of digital health in early detection and treatment of pre- eclampsia. They described that some of their knowledge to digital health initiatives were due to their previous experiences with pre-eclampsia, meanwhile others reported that they taught and registered to momConnect by some of the midwives where they were attending their prenatal care. This was supported by the following quotes,

"The last pregnancy I didn't know that I had pre-eclampsia. I experienced blurred vision. This time when I came to the clinic I found out that I have pre-eclampsia again. This time there were no signs and symptoms as before. So I googled about my baby foetal movements at each and every trimester. Check the estimated weight at each every trimester because last pregnancy my baby was not properly growing in the uterus, I was informed that it was due to the elevated blood pressure" (Participant 001)

In addition another participant said that: *"I used my phone to check the signs and symptoms of high blood in pregnancy. Although I forgot some of the things. I have learnt things like that you take care of the baby." (Participant 004) "The midwives taught me about digital health they even registered me to Mom Connect…"* (Participant 003)

However, the study further revealed the majority of the participants lack the knowledge of digital health use in the early detection and treatment of pre-eclampsia. As the participants describe that they never used digital health initiatives.

Nonetheless this appeared to be linked into poor socio-economic status to some of the participants as they reported they don't even have phones. Hence they reported they never used it before. This is supported by the following quotes;

"I have never used a phone or any kinds of digital health initiatives to inform myself about my condition." (Participant 006)

This was followed by a probing question structured like; *"Could you kindly share your reasons of not utilizing digital health?"*

The participant answered and said; *"It's because I didn't download it and I don't even have a smart phone"* (Participant 006)

Second participant said that*; "The problem is that I don't have a phone that am currently using. Therefore, I don't use digital health initiatives."* (Participant 002)

The probing question was asked as; *"Could you kindly share the reasons why you don't have a phone?"*

The participant answered and said; *"Eish, I don't see the need for the use of a cell phone."* (Participant 002)

Furthermore, this could be also due to the failure of midwifery practitioner to assume their health promotion and preventive roles during practice. This was supported by the following quote;

"So far the midwifery practitioners haven't taught me about digital health and its use in pregnancy and in informing about my condition"(Participant 001)

Sub-theme 1.4: Other non-digital sources of information

The pregnant women described their alternative sources of information used to keep their self-informed about the pre-eclampsia. This includes information from midwives and pamphlets from primary healthcare facilities. This was supported by the following quotes;

"… The midwives also taught me how I should care for myself and not to lift up heavy stuff. And that I should avoid stressful events. (Participant 003).
"I was never taught about digital health however, I was informed about what pre-eclampsia is and how to care for myself from the clinic. They also taught me I should eat healthy and drink a lot of water."(Participant 004).
"I was only reading magazines and the pamphlets from the clinic on how to care from myself and the baby." (Participant 006).
Although some of the participants expressed that they were taught by midwifery practitioners about Pre-Eclampsia. Others stated that they were not informed nor taught about pre-eclampsia and the utilization of digital health. If they happen to be taught about it; it's because they asked about it from the midwives. This is supported by the following quotes;*"Nurses never taught me anything about the*

use of the phones in pregnancy. Most of the time I have to ask them about the information so that they can tell me. That's how I learnt about MomConnect, because in my first pregnancy I wasn't told about MomConnect. So with this second pregnancy that's when I started to consult the internet because I didn't want to go through what I went through the first pregnancy." (Participant 009)
"Ah, I was never taught about high blood pressure in pregnancy. I was referred to high risk clinic at general hospital." (Participant 008)
"No, I have never been informed about digital health initiatives. Maybe it's because this is my second visit. (Participant 001)

A probing question was asked as follows; *Since this is your second pregnancy, could you kindly explain your experience in your first pregnancy about digital health?*

The participant answered;*"Even on my first pregnancy when I was attending my visits, the time I got here when they detected the high blood pressure they referred me straight to the hospital. So I was attending my clinic there."* (Participant 001)

Sub-theme 1.5: The role of family and friends in supplementing the information from PHC

The study revealed that the reason some of the pregnant women are knowledgeable of Pre-Eclampsia is because they used alternative sources of information to keep themselves informed about pre-eclampsia. This includes the consultation of family and friends. The participants expressed the reasons they prefer consultation of friends and family than digital health; it's because they want to avoid confusion and that they don't really trust some of the information. This was supported by the following quotations;
"I never used digital health because at home there's someone who has high blood pressure and been living with it for some time. So also the sisters at the clinic taught me about my condition. So I used the information from my relative with high blood pressure and the one from the nurses. I watched what I should eat and what I should avoid eating." (Participant 010)
"So most of the things I had to learn from the internet and from my mother as well." (Participant 008)
Another participant said;
"I usually talk to other pregnant women at the clinic about pre-eclampsia." (Participant 008)

Theme 2: Barriers for digital health use

Despite some of the participants' familiarity with the digital health utilization in early detection and treatment of pre-eclampsia, some expressed their challenges that led them not to use digital health as much as they like.

Sub-theme 2.1: The challenge of poor network connectivity and lack of technological knowledge

Although the some of the participants have significant knowledge of digital health and the availability of digital health initiatives, they expressed their challenges in accessing the information they need related to their pregnancy and Pre-Eclampsia. This includes challenges such as Wi-Fi and poor network connection. This was supported by the following quotes;
"Ah, from my side I won't lie and say I experienced a lot of difficulties because I know how to google search especially because am young so what if someone else whose old whom don't have the knowledge to use phones and those who don't have smart phones. They weren't going to be able to google…However poor network connections is also the challenge I usually face most of the time and I

*don't have Wi-Fi at home, I mostly use the Wi-Fi at work access information about my pregnancy and pre-eclampsia."(*Participant 001)

This was supported by another participant who said; *"Sometimes I'd face network connectivity problems when trying to access information about my pregnancy and pre-eclampsia especially during load shedding."* (Participant 008)

Sub-theme 2.2: Lack of trust and validation of digital health initiatives

In contrast to the knowledge of digital health utilization in early detection and treatment of pre-eclampsia by pregnant women. Some participants expressed their fears about the use of digital health information. Some mentioned a lack of trust in the information access because they don't know whether such information is true and validated. This is supported by the following extracts;*"The thing is that for me is that I was never sure which website to use and to trust, because I was never taught about it at the clinic. Nowadays people can write on the about their experiences about pre-eclampsia and most of their information is not validated… "*(Participant 008)

"I usually come across a lot of information, sometimes I get confused on which one to trust, especially on Facebook because a lot of women there have a lot share, so I end up not knowing whether to trust the information." (Participant 009)

Sub-theme 2.3: Poor socio-economic status and access to digital health

Most of the participants are from rural areas with poor socio-economic factors. Most of the participants expressed their concerns with regards to the utilization of digital health in the early detection and treatment of pre-eclampsia. The participants further stated the factors impending them from the use and access of digital health were socio-economic mainly affordability of smartphones and data, and unemployment. This is supported by the following extracts;

"And nowadays data is expensive, even myself I usually google a lot when am at work and save data. I can say that my challenge is whenever am at home, I can't google more because I don't have enough data…" (Participant 001)

"Another challenge, data was the problem most, because am unemployed and a student I can't afford to buy data all the time to google, still have to rely on my boyfriend and my parents…" (Participant 008)

"Sister, I don't have a smart phone. So, the information I have about the high blood pressure is because of my previous pregnancy because this registered me to what you call mom- connect. So, it was informing me about the things I should eat since I had high blood pressure. Now since this is my third pregnancy, I am using the same information I have learnt from my previous pregnancy." (Participant 007)

A probing question was asked as follows; *Could you kindly elaborate more on the challenges and barriers to utilization of digital health?*

The participant answered and said; *"As I have already said I don't have a smart phone and I don't know much about the use of cell phones and computers. My last standard 4, so am uneducated and I don't think I even afford to buy one."* (Participant 007)

Sub-theme 2.4: Lack of support in the use available digital health initiatives.

Most of the participants expressed that they receive no support on the use of digital health in pregnancy. Moreover, they shared that they were never taught about the available digital health initiatives. This was supported by the following quotes;

"I just googled myself from the internet after opening my file and checked what I was diagnosed with. So I didn't receive any support from the midwives." (Participant 005)

Another participant said;

"I have never received any support with regards to the use of digital health initiatives. They never taught me anything about digital health initiatives that may assist me with my pregnancy." (Participant 004).

Discussion

The World Health Organisation declared that improvements to maternal healthcare services delivered requires deliberate focus on the quality of services rendered[24]. The quality of services should

involve providing services that are effective, patient centred, integrated, efficient, safe, timely and equitable. Introduction of digital health in health system was meant to improve and strengthen the quality of maternal healthcare and prevent maternal mortalities and morbidities[24,26]. Hence the current study aim was to explore on the utilization of digital health in early detection and treatment of pre-eclampsia by pregnant women at primary healthcare facilities. The following two major themes emerged in this study: the role of knowledge about digital health in its utilizations and barriers for digital health use.

The role of knowledge about digital health in its utilizations

The current study revealed that some of the participants had knowledge of pre-eclampsia, treatment and prevention. For example, the participants expressed that they aware of pre-eclampsia and the kinds of food they are supposed to eat. Moreover, the knowledge was from the previous pregnancies, pamphlets and magazines. More importantly families, friends and midwives were described as major source of knowledge and support during pregnancy. Other scholars affirms that past life experiences or behaviour often have influence and impact on the current experiences and also have influence on decision making[27]. It seems like the negative experiences that pregnant women had on their previous pregnancies; motivated them to learn more about pre-eclampsia on google to avoid such experiences again.

However, knowledge gap was identified on the use of digital health for early detection of pre-eclampsia. This concur with the results of Burke, Nahin and Stussman on limited knowledge as a reason for non-use of four common complementarily practices that found out that lack of knowledge is a common impediment on use of complementarily practices in health and it's mostly likely as a result of lowered attained educational level and other sociodemographic factors[28]. From the study results seems like lack of knowledge among pre-eclampsia is still a major problem for management of pre-eclampsia as some of the women were not able to take preventing measures of pre-eclampsia predisposing them to complications associated with pre-eclampsia. Moreover, some instances the lack of knowledge amongst pregnant women often leads to negative outcomes such as perinatal and maternal morbidities, consequently result to failure to achieve the Sustainable Development Goal and the UN target of reduction of deaths by 70 per 100 000[5,29]. Therefore health literacy is a need among pregnant women as accessing information in the digital platform requires literacy, for instance accessing information from a call centre (i.e. MomConnect) with regards to your enquiries one is required to press specific numbers in response to questions or directions. Alternatively browsing the internet needs English literacy for one to be able to use it[30.]

Barriers for digital health use

Despite the knowledge of digital health inconsistencies amongst the pregnant women, the study revealed that there are barriers that impended the women from utilization of digital health. This included barriers such as poor network connectivity (i.e. lack of access to Wi-Fi connection, poor network connection); which is sometimes associated with power outages as stated by the participants. Similarly, other scholars affirmed that access to the internet still remains a major concern in low- and middle-income countries especially in rural areas. Most people experience slow or intermittent internet and inequalities access to electricity. Moreover, poor infrastructures such as poor network connectivity and unstable power supply influences the use of digital health[10,31,32]. The aforementioned barriers results in unsuccessful use of digital health and further impact the maternal and perinatal being as it impedes them from receiving essential information of self-care during pregnancy particular when diagnosed with complicated conditions such as pre-eclampsia.The study highlighted that accessibility to digital health is the leading concern as it is negatively impacted by number of barriers. For example, the participants in this study reported that they can't afford smartphones and data. It seems like that poor socioeconomic status leads to unsuccessful utilization of digital health by pregnant women; as most highlighted the matters of affordability. This findings are consistent with results of study of Goggin[33] and other scholars that affirmed that affordability is a recurrent issue on the use and access of digital health; people with low and no income tend to have limited availability and

access to internet or digital healthcare services[33,34]. Watkins *et al*[35] concurred with the study findings and other scholars that financial instability influences the utilization of digital health and as a result of in financial instability patients couldn't afford airtime consequently reducing the use of digital health platforms. The study findings highlight the need of offline and SMS based digital health initiatives to combat the barriers related to poor socioeconomic status.

On the other hand, the study findings suggest that lack of trust and technology validation of digital health is a concern and challenge when it comes to digital health utilization. For instance, the participants that they were mostly not sure which website to trust and there's a lot of information online, this sometimes leads to them being confused. Similarly, a study by Ahmed et al[30] found that most participants don't trust the truthfulness and quality of the digital health information. Instead, they prefer direct interactions with the person providing the information and advice. The findings of the study are in agreement with the study of Kaihlanen et al[36] and Caballero-Uribe that revealed that fears, lack of reliability and lack of trust of digital health impedes the use of digital health platforms. Other scholars work is in support of the study findings, they reported that although digital health is envisioned to improve access and quality of healthcare; and reduce any inefficiencies in the healthcare systems[36,37]. However most digital health interventions are not validated and the internet is overflowing with thousands of websites providing treatment option and advice; this poses a risk of misinformation likely to endanger lives of the patients[26]. From the study findings, it is necessitated that the legislative and regulatory frameworks should be provided to support the digital health interventions implementation and validate its use in the clinical practice by both patients and healthcare professionals. This is in support with Cabuka's suggestion in the seminar on prioritizing research and evaluation of digital health in South Africa; that there's a dire need of regulatory frameworks and policies to support the development and implementation of digital health, as it enhances the validation of the digital health intervention[38].

In addition, the findings revealed that there's lack of support and poor implementation of available digital health initiatives by midwifery practitioners in clinical practice. This shows that the lack of knowledge digital health and available digital health apps among pregnant women could be associated with lack of support and poor implementation by midwives; hence the pregnant women lack skills and knowledge of digital health. Similarly, a study by Kaihlanen et al[36] affirmed that weak skills are often linked to another common problem to access digital health such inadequate experience and difficulty in finding support for digital health services use. Moreover, the lack of guidance and support from practitioners is a concern in implementation of digital health services[39]. Thus, midwives should take it upon themselves to counsel and guide pregnant women on the use of digital health[40].

Limitations

The study was conducted only at primary healthcare facilities of Mpumalanga province in Emalahleni local Municipality. Therefore, the results should not be subjected to generalization to other regions and provinces. The study only used a qualitative research approach, meaning the results were drawn from a small sample size; therefore, cannot be generalized to the whole population. The population of the study were women diagnosed with pre-eclampsia, meaning that the results cannot be generalized to women living with other obstetric medical conditions or to non-gravid women. Nonetheless, it shed light on the phenomenon of inquiry of this study.

Conclusion

In conclusion, inaccessibility to digital health information by pregnant women with pre-eclampsia impedes them from receiving holistic optimal care in terms of early detection and treatment possibly predisposing them to catastrophic pregnancy outcomes. Therefore, to achieve the Universal Health Coverage goals of improving accessibility of healthcare services to all and SDG target 3.1 and 3.2 in terms of reduction of maternal and child mortalities. The study recommends that measures to ensure enhanced accessibility to digital health information should be adopted. Moreover, the department of health along with healthcare stakeholders should put more efforts towards

improving the accessibility of the digital health; this includes provision of infrastructure

Authors' contribution

M.W.N, L.M, T.M.M conceptualized the study. L.M, T.M.M and M.O.M analyzed the findings. Original draft preparation was done by M.W.N, L.M and review and editing was done by T.M.M and M.O.M. All authors read and agreed on the published version of the manuscript.

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