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Investigating the Design Practice in Mobile Health Application Development Process to Employ Stakeholders' Creativity

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Abstract

Stakeholders struggle to communicate with designers about mobile health app design. Thus, mHealth apps must be developed using a conceptual framework to engage stakeholders' co-creation and inventiveness. This study aims to (1) identify design difficulties in mHealth apps, (2) assess the optimal strategy for creating a mobile health app for pregnant women, and (3) evaluate a co-creation design that harnesses stakeholders' creativity. A systematic literature review synthesis involved 70 papers. Analyzing existing literature during early research conceptualization helps develop a theoretical framework. Visualization health records for pregnant women, mHealth app evidence-based information conceptual frameworks, and necessary visualization were significant findings. Final pregnant women health visualization conceptual framework.

This study proposes mHealth app design using evidence-based graphical data records for pregnant women to engage expert co-creativity. It encourages designers to use storyboarding to collaborate with stakeholders on mHealth app creation. Finally, this study suggests storyboarding for pregnant women's mHealth apps. Research is needed on storyboarding design methods for mHealth apps for pregnant women that employ experts' co-creativity.

Keywords: Mobile health application, Evidence-based, user centered design, pregnant women, visualization health

1. Introduction

With the development of 5G network, mobile health application (mHealth apps) is warmly welcomed by the users in China. At the same time, many internets company spend too much on the mHealth apps development. However, the quality of these apps is not always better, there exist many designs issue, such as copy, lack of end users and stakeholders be involved in the development process. The above issue caused the mHealth apps unreliable content and lack of users' adherence. Thus, much research talked about how to make the mHealth app contents evidenced and keep users' adherence. However, there are few research did on this in design perspective. Thus, our research uses systematic review approach to investigate the design practice of mHealth apps development. they are design issue, design practice, and design approach. Finally, it proposed three conceptual frameworks in design perspective for mHealth apps with pregnant women, it is "mHealth apps evidence-based information", "visualization health records for pregnant women", and "requirement visualization for evidence-based information". The main findings of our study suggest that integrating UCD (Empathies, Define, Ideate, Prototype, and Test) with storyboarding in UI design structure including (unborn child health, healthy diet, and self-care practice), through research to generate Electronic Medical, visualization health records to explore pregnant women and healthcare providers' requirements regarding increasing evidence-based information. Furthermore, storyboarding approach plays an important role in employ stakeholders creativity during the co-design workshop. Finally, the storyboarding oriented user centred design strategy give the chance for doctors and pregnant women to express their needs and wants towards visualize the medical data records to increase the evidence-based mHealth apps contents. This study contributes to the design aspect of mHealth apps, ensuring evidence-based information for pregnant women. It also give the chance for stakeholders to know how to get users' adherence for mHealth apps. It also provide the conceptual framework on how to visualize health data records of mHealth apps. The research outline consists of a literature review on the subtheme of design issue, design practice, and design approach. Figure 1 illustrates the research outline that guides this work, leading to the generation of thee conceptual frameworks: mHealth apps evidence-based information, Visualization health records for pregnant women, and Requirement visualization for evidence-based information. Lastly, we discussed the conceptual framework for pregnant women health visualization.

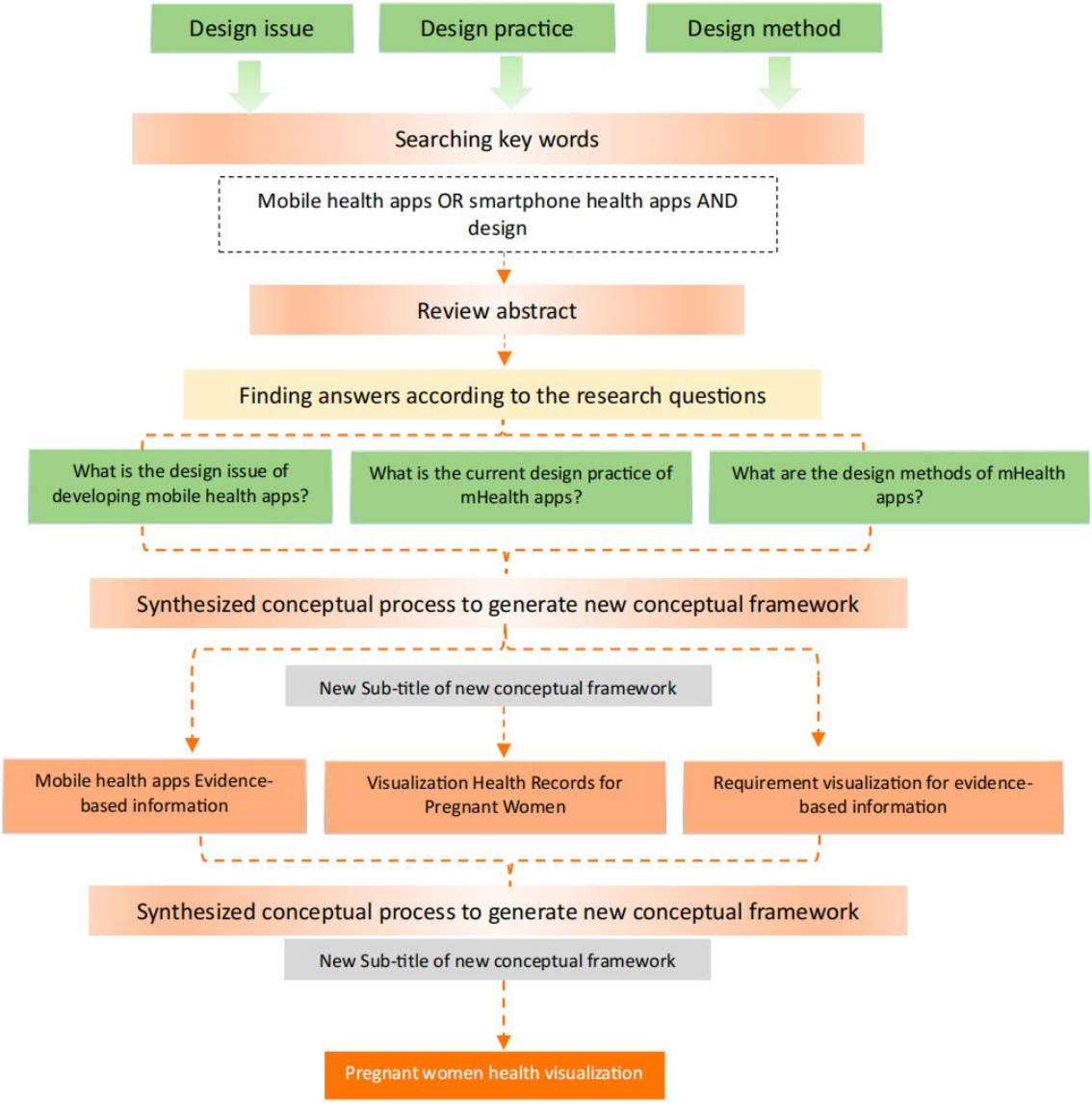

Figure 1: Outline of the research

2. Methods

This publication uses a "systematic literature review synthesis approach" to analyze the research that has come before it. This method is a special case of a literature review that serves to lay the groundwork for the study's theoretical framework by analyzing current literature on the topic. Three different types of research questions (RQs) were identified using Ibrahim's' method of categorizing RQ constructs. The following research questions are addressed in this study (1) What is the current design issue of mHealth apps development? (2) What is the design practice of mHealth apps? (3) What is the design approach of mHealth apps? Using the research questions and aims as keywords, a bibliographic search was cond ucted on "mHealth apps" OR "smartphone apps" and "design" in the WOS, SCOPUS, and Google Scholar databases. The key points and conclusions of the selected publications' abstracts, as well as the ways in which their work might further study in the future and any weakness, were later reviewed. The value of each of the 70 abstracts was determined before it was assigned to a particular subtheme and given

a thorough evaluation. The outcomes of this exercise produced synthesis summaries for each major theme, which were then crossed analysis to integrate potential solutions and priorities the synthesis summaries to analyze the strategy to employ doctor and pregnant women creativity. The main synthesis extracts were made according to the POD tree diagram's specifications, and the synthesis procedure was recorded using the EAGLE Navigator web-based system. Figure 2 of the report presents a flowchart of the literature review procedure.

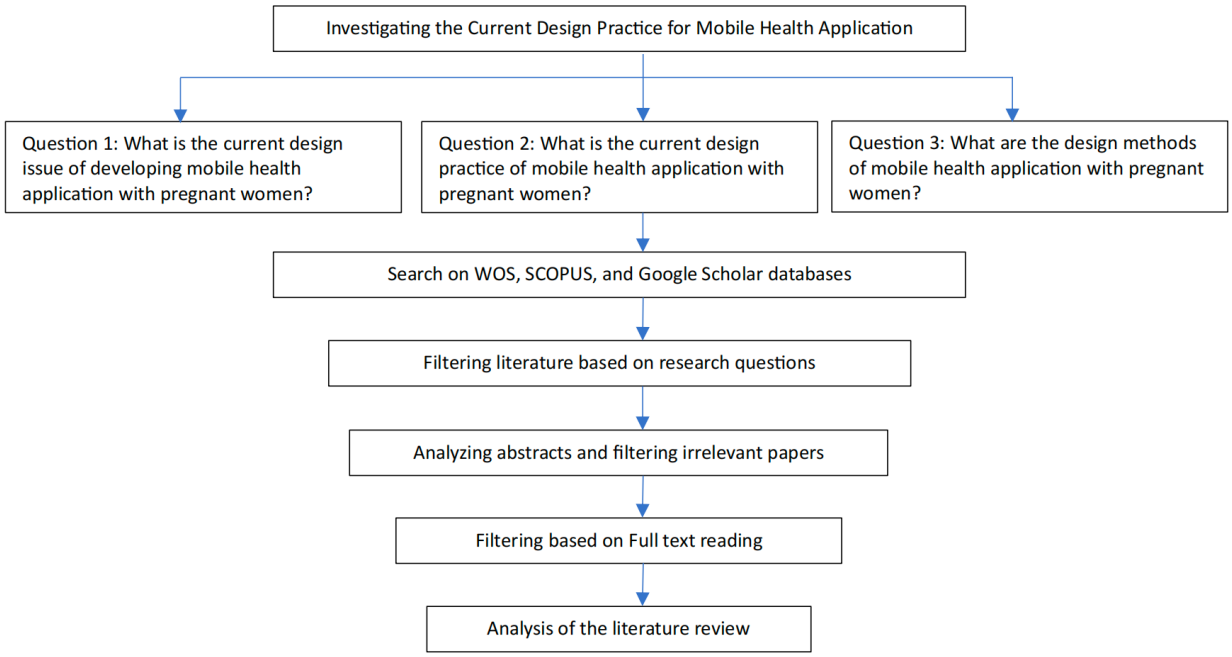

Figure 2: The Workflow of the Systematic Literature Synthesis Process Adapted with Permission.
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3. Results and Discussions

3.1 What is the design issue of developing mobile health application?

mHealth apps have helped ease the strain on healthcare systems during the pandemic. eHealth, or the enhancement of healthcare on a local, national, and international scale through the use of the Internet and other information and communication technologies, is an emerging field at the intersection of medical, public health, and business (Rybka et al., 2015).

Current mHealth applications are mainly used for patient self-management(Castensøe-Seidenfaden et al., 2017). Especially for patients with long-term chronic diseases, the current literature mainly revolves around: children's mental illness(Hill et al., 2022), obese patients(Thomas et al., 2021), Orthopedic diseases(Mrklas et al., 2020; Shewchuk et al., 2021). The majority of studies examining the topic of mHealth apps for expectant mothers focus on the following areas: Studies on Pregnancy, Exercise, and Diet(Green et al., 2022), overweight and obese pregnant women(Greene et al., 2021), sleep quality for pregnant women(L. Wang et al., 2020), breastfeeding(Park et al., 2022), pregnant women's use of meditation(Greenberg et al., 2012), self-care(Lee et al., 2022), health information needs, source of information, and barriers to accessing health information(Ghiasi, 2021), medical help-seeking

strategies(Sandborg, 2022), mental health for prenatal women with obstetric(Chung et al., 2020).

However, some scholars have different views on the role of mobile health applications in the use of these users. For example, according to Shewchuk (2021), the role of mHealth apps in improving outcomes can be achieved through patient activation and communication with healthcare providers(Shewchuk et al., 2021). Perkes (2022) highlights that co-design approaches may lead to mHealth interventions(Perkes et al., 2022). Greene (2011) shows that pregnant women, especially those from marginalised groups, are open to research treatments that involve the use of smartphone apps to help with things like fitness and nutrition planning(Greene et al., 2021).

Some scholars hold the contrary opinion, they are as below. Ogrin (2018) highlights that the use of co-designed applications is low and that aspects related to increased opportunities and motivation for behavior change need to be added(Ogrin et al., 2018). Zhang et al., (2022) stated that although many Chinese pregnant women use pregnancy apps, none have been linked to better birth outcomes (Zhang et al., 2022).

A literature review revealed the following: Wang (2020) highlights that continuous exercise instruction by health professionals via smartphones does make sense to improve sleep quality during pregnancy. Nordmann et al., 2022 emphasizes that mobile apps help broaden the knowledge and skills of pregnant women. Park (2022) held the point that designing application structures and user interfaces is based on user needs and selects applications by considering user needs. Greene's (2022) title "Calm", highlighted on the APP, is helpful for women who have sleep, anxiety, and stress issues during pregnancy. Lee (2022) highlighted the app they developed, which supports "healthy eating, physical activity, adequate rest and stress management" that enhances the practice of self-care at work for pregnant women and shows an adequate level of availability. Ghiasi (2021) highlighted that the most common information needs among pregnant women are information about the unborn child, nutrients, and childbirth, posting that some of the problems women have during pregnancy are: feelings of shame, waiting long times in clinics to see a healthcare provider, and lack of adequate information resources. Sandborg (2021) states that a trusted and appreciated and easy-to-use healthy pregnancy app can inspire a healthy lifestyle during pregnancy. Chung (2020) highlights the positive mediating role of perinatal women in improving health literacy, the importance of discussing the intention of discussing personal medical issues with health professionals based on online health information, and the strategies used are essential to understand the perinatal seeking of help and decision-making process. In addition to a short consultation to guide the patient’s actions quickly and authoritatively in choosing an obstetrician.

Therefore, mobile health applications have a positive effect on women's expansion of knowledge and skills during pregnancy and postpartum and self-management during pregnancy (sleep, nutrition, fetal information, exercise, maternity information consultation). However, these authors do not mention how to obtain evidence-based content on mHealth through a design perspective.

Therefore, our research focuses on the use of expert (healthcare provider) co-design (Shewchuk, 2021; Perkes, 2022) into the design and development of mHealth applications to obtain evidence-based content on mHealth and incorporate aspects related to increasing the chances and motivation for behaviour change (Ogrin, 2018).

Following a human-centred design process (empathy, definition, ideation, prototyping) (Chamberlain et al., 2022) analyses the interface design preferences of pregnant women for mHealth apps (Nordmann, 2022 and Wang, 2020).

At the same time, based on the above scholars' theme of using mobile health applications for pregnant women, my research focuses on the information needs of pregnant women who are most concerned about the unborn baby, nutrition, and childbirth (Ghiasi, 2021), providing pregnant women with an effective way to avoid the shame of waiting for information resources, with the aim of enabling women to maintain a healthy lifestyle during pregnancy Sandborg (2021), and be able to quickly and effectively find information online through the user interface (Chung, 2020).

In summary, the relevant literature of Design Issue of mHealth apps reviewed summarizes POD (Point of Depture). In a word, integrating user-centered design processes (Empathies, Define, Ideate, Prototype, Test) with pregnant women's seeking information needs (unborn child health, healthy diet, self-care practice, physical activity, and stress management) into mHealth apps content and structure can lead to evidence-based information**.** Figure 3 is the conceptual framework for the mHealth apps evidence-based information.

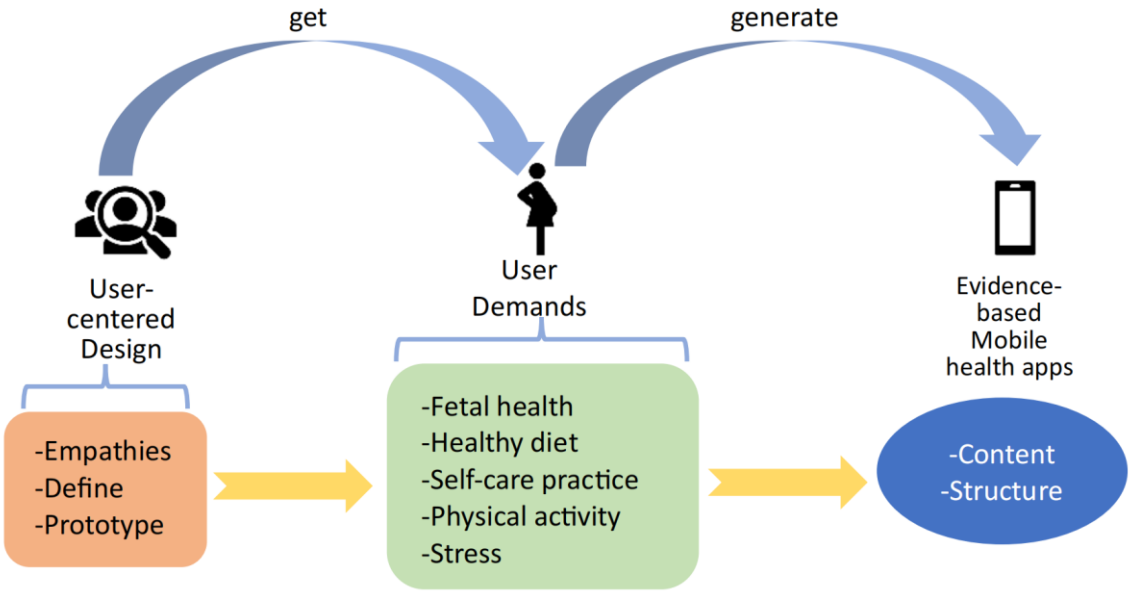

Figure 3: Proposed conceptual framework for mHealth apps evidence-based information

3.2 What is the current design practice of mobile health application?

At present, researchers mainly focus on the design practice of mobile health applications, including collaborative design, prototyping(Egan et al., 2021), evidence-based information (Wang, 2019), and story version(Blake et al., 2022). To encourage informal carers to engage in regular physical activity at home, Egan (2021) conducted a study on collaborative design and prototype of a new mobile application (called "CareFit") during and after Covid-19. To better understand how Chinese pregnant women utilise mHealth apps, Wang (2019) undertook a mixed-methods study. The utility of moHealth apps in mixed-lifestyle treatments for overweight and obese pregnant women was evaluated in a secondary analysis by Greene (2011), who examined the acceptability of pregnancy, exercise, and nutrition studies supported by

SMARTPHONE apps. According to Chung (2020), perinatal women with obstetric and mental health disorders face difficulties in medical decision-making as well as online health information-based tactics for seeking medical care.

Meanwhile, according to the above-mentioned scholars' research, the integration of expert opinions and tailored information of pregnant women into the content of smartphone applications through co-design strategies can improve the evidence and credibility of their content, which is conducive to improving the acceptance of pregnant women. For example: Egan (2021) emphasizes that it is feasible to integrate core physical activity guidelines into a co-designed smartphone app to provide users with functional and educational materials. Wang (2019) highlights that Chinese women use smartphone apps to monitor fetal development for dietary and physical activity information. He also said that Chinese pregnant women prefer apps that contain evidence-based information, expert opinions and tailored advice. Pregnant women, especially those from marginalized groups, are receptive to study interventions that involve the use of supportive smartphone apps for topics like exercise and nutrition, as highlighted by Greene (2011). In order to provide pregnant women with accurate and helpful information, Bland (2020) stresses the importance of incorporating evidence-based nutrition information into app development. Evidence from a study by Choi et al., 2016 shows that pregnant women who are motivated to increase their physical activity respond positively to mobile health treatments such as daily text messages and cell phone activity diaries with automated feedback and self-monitoring systems. Chung (2020) stresses the importance of discussing the intention of discussing personal medical issues with health professionals based on online health information and the strategies used to understand the perinatal seeking of help and decision-making process, as well as the positive mediating role of perinatal women in improving health literacy. In addition to a brief consultation, the patient's actions to choose an obstetrician can be quickly and authoritatively guided. However, few of the above-mentioned scholars mentioned how to use co-design strategies to design content for mobile health applications for pregnant women.

Therefore, based on this, the study will utilize co-design strategies to identify barriers and drivers for participants, working with experts to conduct needs to understand the core needs of users (Egan et al., 2021). At the same time, the study will focus on the availability variable of the Pregnant Woman's Mobile Health App to help pregnant women monitor fetal development and obtain dietary and physical activity information(N. Wang et al., 2019). This study will propose a design approach for mHealth apps based on Choi (2016) to motivate good behavior in pregnant women by optimizing user interface design elements and information structure to quickly and authoritatively guide patients to choose obstetrician actions (Chuang, 2020), leveraging story boards to co-construct content, sequencing, presentation, and interaction elements to increase participants with mobile health app user interfaces and healthcare evidence-based information(Blake et al., 2022).

To sum up, the researchers synthesized the above points of view to form the POD- of this sub-theme- Integrating storyboarding (co-construct the content, ordering, presentation, and interactive elements) into user interface design and information structure of mHealth apps for pregnant women to increase co-design participants'

knowledge relating to user interface design and healthcare evidence-based information (see Figure4).

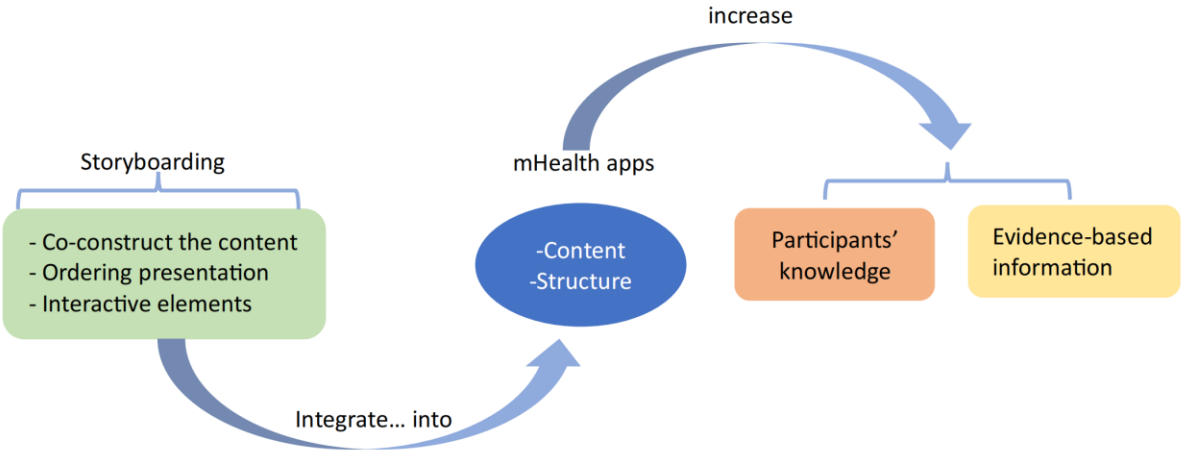

Figure 4. Proposed Conceptual Framework for Visualization Health Records for Pregnant Women

3.3 What are the design methods of mobile health application?

Some scholars have conducted research on co-design strategies for mobile health applications. For example, Mrklas et al., 2020 conducted a qualitative study on co-design to develop a mobile health app for patients and physicians managing knee osteoarthritis. Rau et al., 2020 conducted a study on designing tablet-based preterm education apps for parents hospitalized for premature birth. (Cunningham et al., 2019) conducted a study of mHealth 4 Afrika Beta v1 validation in rural and deep rural clinics in Ethiopia, Kenya, Malawi, and South Africa. Hill et al., (2022)conducted development and usability testing of online support and interventions for anxiety disorders in children. Wolstenholme et al., 2020 conducted a study on the use of co-manufacturing innovations to enter nurse-led hepatitis C clinics.

Thus, for the design approach of mobile health applications, most scholars have adopted a collaborative design strategy to develop and test the content and usability of the application. By co-designing strategies, stakeholders can maximize their creativity. For example, Chung (2010) highlights guidelines for using emotional storyboards designed with children: 1. Face-to-face crowdsourcing at children's events, 2. Make storyboards creative and active, 3. Engaging children one-on-one and giving them the confidence to express their story can provide meaningful design for children while providing children with a direct positive emotional experience. Wolstenholme et al., (2020) emphasizes that a creative approach to co-design can be used through a series of co-production workshops, and that it is a way to identify problems approached with clinics and co-develop potential solutions. Hill et al., (2022)highlighted that the needs and expectations of target users (parents, children, and clinicians) can be met through an iterative development approach to user-centered child anxiety app design. Mrklas (2020) emphasizes that it is feasible to maintain diversity of perspectives among patients, physicians, and researchers in terms of functional requirements for the mHealth app. Rau (2020) highlights that pregnancy apps, developed in collaboration with health professionals in multidisciplinary teams, can bring useful and reliable information to parents and pregnant women. Cunningham (2019) argues that better clinical care and decision-

making can be supported by co-designed primary maternal health service systems that integrate electronic medical records, medical sensors, visualisations, and the automatic generation of monthly health indicators.

However, the above articles are limited to focusing on children's emotional story version (Chuang, 2010), mHealth application co-design for managing knee arthritis(Mrklas, et al., 2020) and do not mention the method strategy of mobile health application collaborative design story version.

Therefore, this research will focus on design guidelines designed with experts using storyboards: 1. face-to-face crowdsourcing at expert events, 2. making storyboards creative and active, and 3. interacting with experts one-on-one to give them the confidence to express their stories, which can provide meaningful designs for experts while providing immediate positive emotional experiences for experts (Chuang, 2010). Barriers to contact arising during co-design sessions with experts will be addressed through creative co-design approaches (Wolstenholme, 2020). According to Hill, (2022), the study will use the workshop approach to explore the needs of experts and pregnant women for mHealth applications to obtain its holistic concept. In the second phase, prototypes of mHealth applications will be co-designed with expert documentation. Harnessing the creativity of expert users in multidisciplinary teams (Mrklas, 2020; Rau, 2020) to bring rich and reliable information to pregnant women, feedback will be generated by experts(Ramli, 2014), ultimately leading to the co-design of primary maternal health care delivery platforms that automatically generate monthly health indicators to support better clinical care and decision-making through the integration of electronic medical records, electronic medical records, medical sensors, and visualisations. so that more time can be devoted to patient care and continuing medical education (Cunningham et al., 2019).

According to the above author's opinion, the author summarizes the POD of the subtheme- Integrating crowdsource, storyboarding creative, and express stories into co-production workshops to gain pregnant women and healthcare providers' needs towards generating reliable information on mHealth apps including Electronic Medical, Health Records, visualization and monthly health indicators, decision making, and professional medical education(see Figure 5).

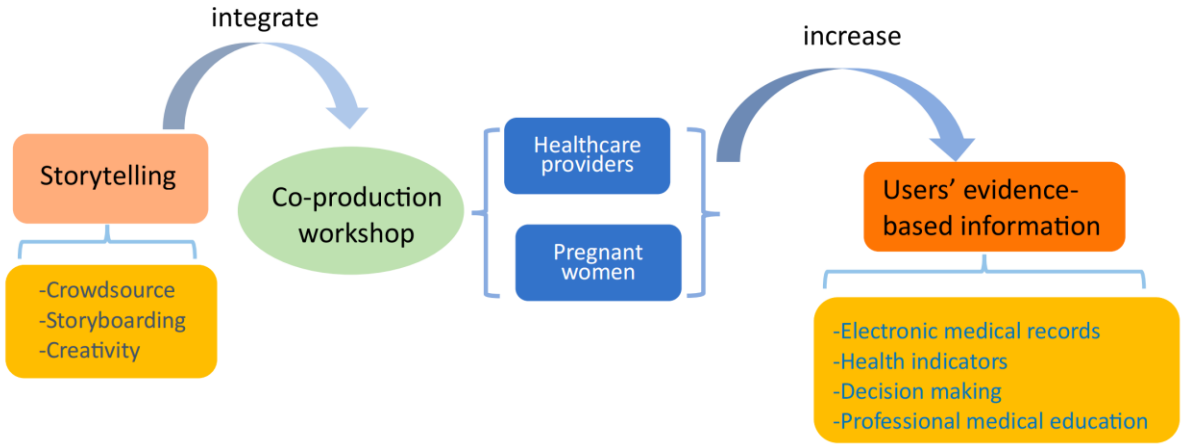

Figure 5. Proposed Conceptual Framework for Requirements Visualization for Evidence-based Information

4. Discussion on Synthesis Findings

Because of China's focus on pregnant women, the development of mobile health software for pregnant women has gradually increased, but the process is shaky, competing products copy one another, and users and stakeholders aren't involved, which leads to a lack of proof of mobile application content and a difficulty retaining users. Currently, the majority of the research focuses primarily on the technical and medical perspectives on the collaborative development process of such mobile apps. However, nothing is said from the standpoint of the designer on how to foster group creativity in the creation of mHealth apps so that those participating in collaborative design may interact freely throughout the design process.

The Chinese government is actively funding the creation of mobile health applications, however the majority of them are experiencing obstacles because of the unimpressive market and disinterested user base. This study examines, from a design viewpoint, the design issue, design practice, and design strategy of mHealth apps for expectant women. From the standpoint of user-centric methods, ways to boost engagement and preserve user loyalty in pregnant women are investigated. What's more, storyboarding as a co-design strategy can be used in the co-design workshop to get pregnant women's requirements to increase the evidence-based content of mHealth apps. All three sections including Electronic medical, health indicators, decision making, and professional medical education can be involved in the content. This co-design workshop style can get clinicians evidenced health information into the development phase of mHealth apps. Through this way not only improve the users' adherence of mHealth apps, but also can reduce the interdisciplinary cooperative barriers. Finally, to generate evidence-based visualization data records to help pregnant women to assess their physical health.

This study identifies the design issue of mHealth apps for pregnant women, investigate the design practice of mHealth apps, and document the design approach of mHealth apps. This study divided its analysis and discussion into six steps to better meet the demands of the research. The research sequence was created with the intention of evaluating the benefits and drawbacks of various perspective combinations and suggesting the best course of action for the bigger investigation. This section provides guidance on how to further integrate the preliminary data to develop a potential theoretical proposition for future research, with reference to the POD Tree Diagram presented in Figure 6.

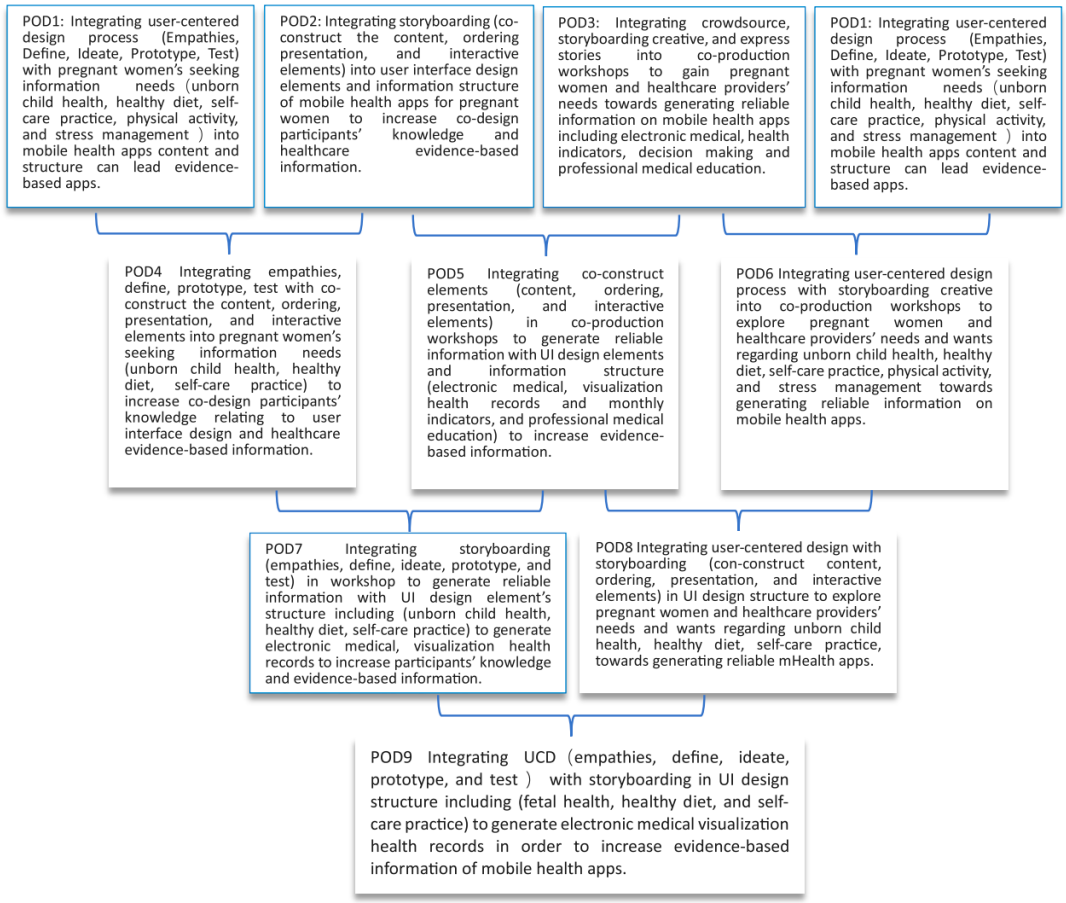

Figure 6: Point of departure (POD) Tree Diagram for "visualizing pregnant women health" Ibrahim, (2011) Copyright 2018, Ibrahim and Mustafa Kamal

Through the research and discussion in section 3.1 of the study, this study investigates the design issue of mHealth apps for pregnant women, such as lacking users' adherence, communication barriers among the co-design workshop, and lacking evidence-based information of mHealth apps. We propose the conceptual framework for the design issue to employ user-centered design process into the development of mHealth apps for pregnant women who are seeking health information, such as fetal health, healthy diet, self-care practice, physical activity, and stress management to lead evidence-based apps (see POD1). As we can see from the section 3.2, this research conducted that the in order to increase stakeholders' knowledge, the storyboarding design practice (including co-construct the content, ordering presentation, and interactive elements) into user interface design elements and information structure of mHealth apps for pregnant women (see POD2). The combination of POD1 and POD2 revealed that to increase participants' design knowledge, the user centered design process (including empathies, define, ideate, prototype and test) and storyboarding design practice (co-construct, ordering, presentation, and interactive elements) can be integrated into the co-design workshop (see POD 4).

In section 3.3, this study discovered that the co-design strategy including crowdsource, storyboarding creative, and express stories can be integrated into development mHealth apps to generate reliable information, such as electronic medical, health indicators, decision making and professional medical education (see POD 3). After combining POD2 and POD3, this study discovered that in co-design

workshop through co-construct the elements (including content, ordering, presentation, and interactive elements) to generate reliable information with user interface design elements and information structure (see POD 5). Following POD3 and POD1 synthesis, this study discovered that by integrating user centered design process with storyboarding into co-design workshop to meet their demands and needs (see POD 6)

Following the synthesis of POD4 and POD5, this study examined the POD Tree Diagram and discovered that integrate storyboarding design process into the co-design workshop to generate user interface design elements and reliable information towards the visualization health data records for pregnant women (see POD7). This study synthesized POD5 and POD6 and found that integrating user centered design with storyboarding design process to explore pregnant women's needs and wants to generate reliable mHealth apps contents (see POD8).

This study discovered that as the result of this synthesis between POD7 and POD8, by integrating UCD（empathies, define, ideate, prototype, and test ） with storyboarding in UI design structure including (fetal health, healthy diet, and self-care practice) to generate electronic medical visualization health records in order to increase evidence-based information of mHealth apps(see POD9). This study suggests that a viable solution might be possible based on POD9 through employing user centered design process into the user interface structure content (including fetal health, healthy diet, and self-care practice) towards generating electronic medical visualization health records to increase evidence-based information of mHealth apps (see Figure7).

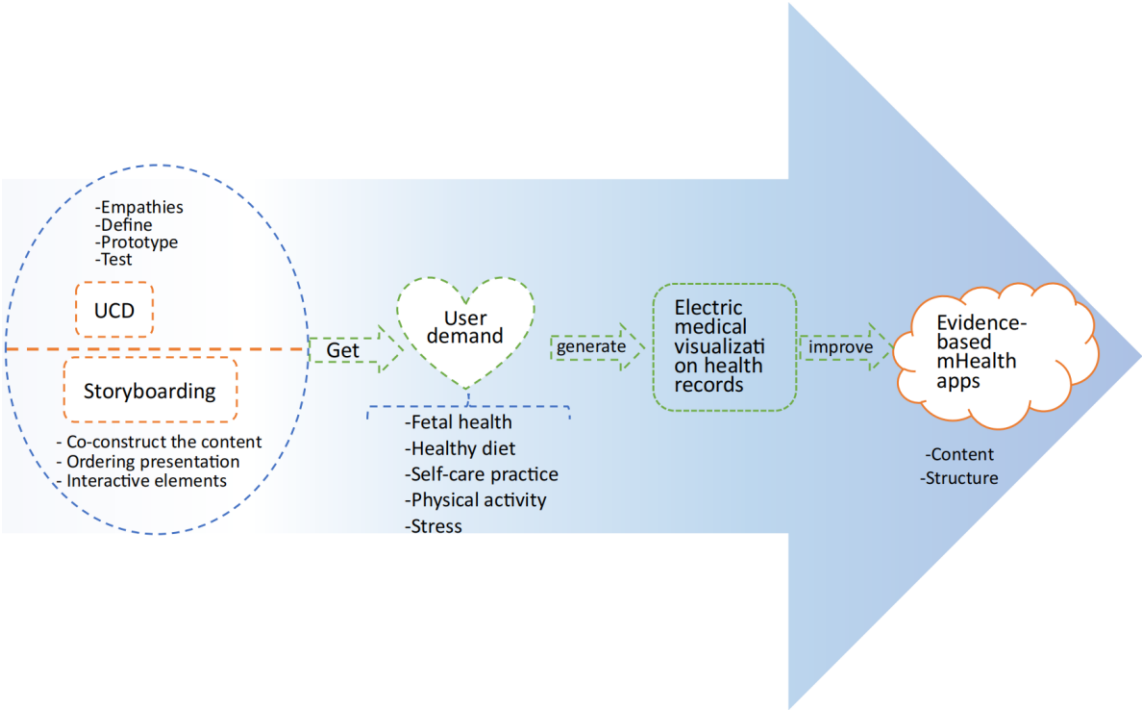

Figure 7. Proposed Conceptual Framework for pregnant women health visualization

5. Conclusion

This paper aims to investigate the current design practice of mHealth apps in China. The findings of this research are mHealth apps conceptual framework, visualization health records for pregnant women conceptual framework, and requirements

visualization for evidence-based information conceptual framework. Additionally, findings of the research also proposed the pregnant women health visualization conceptual framework, which is by integrating user centered design approach and storyboarding design practice to get pregnant women's demands to generate visualization health records can improve the evidence based mHealth apps. Visualization health data records on mHealth apps can help to establish antenatal attachment between pregnant women and their fetus(Yu et al., 2023). Additionally, the participation of user in the development of mHealth apps for pregnant female can improve the reliable content information structure. This study also found that the co-design storyboarding approach can give the chance to minus the communication barriers among the stakeholders. This study contributes to developing a framework for visualization pregnant women health in mHealth apps and give new horizon in design perspective of improve the evidence content of mHealth apps. What's more, the new sights on co-creative among stakeholders in developing mHealth apps will be potential creative. Further studies need to be done in terms of storyboarding design practice to generate co-creative for mHealth apps with pregnant women.

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