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A mobile application for early labour support -feasibility pilot study

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ABSTRACT

Background: Use of mobile applications (apps) are increasing during pregnancy but few of these are evidence-based or evaluated in research.
Aim: To examine the feasibility, including perceived usefulness and usability, and the preliminary effects of an app based on the *Confident birth* method.
Methods: A mixed-method approach, including 48 women, was used to evaluate acceptability, usability and to test study design and procedures. iPhone-users (n = 24) tested the app during pregnancy while the remaining (n = 24) formed a control group. Background characteristics and outcome measurements were collected from all women at baseline. Women in the app group received two follow-up phone calls from a midwife concerning usefulness and ease of use of the app. A follow-up questionnaire after birth were used to measure preliminary effects of the intervention as well as system usability of the app.
Results: Women using the app found the app exercises simple, understandable, and useful. System usability score showed a mean score of 85.3 indicating excellent system usability. Notes from phone calls resulted in four categories: positive feedback about the app, negative feedback about the app, partners involvement, and knowledge. Preliminary effects of labour experience showed no significant differences between the two groups, in terms of early labour or childbirth experience.
Conclusion: The app tested in this feasibility study, was perceived as useful and appreciated by women. Areas for improvement of the app were identified. The result shows promise for further efficacy testing in a forthcoming randomised controlled trial.

Statement of significance

Problem

Pregnancy apps are often used by women, but few are designed and tested in research.

What is already known

Primiparous women and their partners feel often left out from professional support during early labour. Several attempts to keep women at home longer in early labour have been tested, and technology-based approaches on women's self-management are needed.

1. Introduction

Early labour or the latent phase of labour is a part of childbirth when women more often feel insecure and stressed and feel excluded from care by professionals [1]. Previous research has shown that women and

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their partners often feel distressed and abandoned in early labour, and they need more support in the form of knowledge and pain management strategies. When compared to second-time mothers, first-time mothers are often more stressed during the early phases of labour [2] and for first-time mothers with a longer early labour, more information about the different phases is even more important, and they request more education during their pregnancy [3]. In a systematic review by Beake et al. (2018), it was stated that despite several attempts with standardised procedures aiming to keep women at home longer in early labour, none of these have solved the problem regarding some women's coping strategies [4]. The authors concluded that more knowledge about different interventions and support to improve women's confidence and self-efficacy to remain at home in early labour is needed [4]. The content of educational classes is most often dominated by information about pharmacological pain relief methods and parenthood issues [5]. Internationally, a systematic review concluded that structured antenatal education does not affect most birth outcomes except for the mode of birth [6]. Maternity and parental preparation for first-time parents have decreased in recent years, and even more during the Covid-19 pandemic. A literature review summarised that parental education during pregnancy may have a positive effect on the outcome of childbirth, but there may also be adverse effects, such as increased medical interventions, such as induction of labour and the use of epidural analgesia [7]. For men with a fear of childbirth, a parenting preparation course that includes the partner's role as a coach can contribute to a more positive childbirth experience [8]. A meta-synthesis of fathers' experiences showed that they wanted to be involved in the support of the woman giving birth, but they needed to be better prepared [9]. Furthermore, the important role of partners in the support of women giving birth has been demonstrated in several studies [10,11].

Measurements during pregnancy, such as blood pressure, fundal height, and laboratory studies, are standardised in many pregnancy guidelines. In contrast, the content, quality, and quantity of antenatal education vary greatly between clinics and even between individuals [12]. Antenatal education has been sensitive to opinions, and various trends and restrictions in group activities have accelerated the amount of various digital solutions with pre-recorded lectures, individual digital parenting courses, and digital group meetings [13]. There is a lot of information on the Internet, but it is difficult for women to navigate the massive amount of information, and the need for evidence-based information sources and digital applications (apps) is evident [14]. There are a hundred digital pregnancy apps available on the market on the most common smartphone devices, and today, young pregnant women expect more than just in-person prenatal education classes. Over the last ten years, smartphones have emerged as the primary means of accessing information, and in an effort to adapt this trend, even antenatal education has migrated to the Internet and digital apps [12]. A systematic review identifying several apps highlighted that more research is needed and that many apps lacked research references. The most common features in the apps were contraction timers, journaling/photo uploads, appointment trackers, checklists, and calendars, and the least common features were tools for obtaining safety information and health/fitness information [15]. A study that tested the use of an app to acquire knowledge discovered that knowledge of health care during pregnancy and the perinatal period, natural childbirth rate, prenatal examination compliance rate, and follow-up rate were significantly higher in the intervention group than in the control group [16]. It has also been discussed whether supporting user engagement and activity is a way forward to increase activity in apps. In a review, Hamari et al. stated that gamification (i.e., "the use of game design elements in non-game contexts") produces positive effects but is dependent on the context in which the intervention is implemented and also depends on the user [17].

Self-efficacy has a high impact on women's coping with and experiencing of childbirth. A previous study showed that women with low self-efficacy have higher levels of pain during childbirth [18]. Different methods for coping with pain, stress, and fear during labour have been proposed previously. A parental education method called *Confident Birth* was developed in the Swedish context and launched internationally. The purpose of this method is to strengthen the mother's inherent physical, emotional, and self-efficacy capacities to achieve a confident birth [19]. The *Confident Birth* method consists of four central tools: breathing, relaxation, vocalising, and the mind. The role of the partner accompanying the woman during labour and birth are emphasized in the method and the birth partner is a source of practical help and reassurance. The childbirth classes focus on giving hands-on skills, using the relationship and connection to provide support during the birth. The method itself contributes to calm and relaxation, leading to a sense of security. A study from Sweden explored the perceptions of midwives and first-line managers regarding the *Confident Birth* method and investigated opportunities and obstacles while implementing it. The study showed that the participants stated that the method was simple, logical, and built on physiology, and they perceived expectant parents as more confident after completing the course [20].

The mobile app tested in the current study, is based on *Confident Birth* method. The app contains two parts: one part for education and practical exercises, and one part for use during labour. It was developed to increase women's feelings of self-efficacy and contribute to a feeling of security and control. The partner or support person is an important person to be able to give the woman guidance, knowledge, reminders, and support, and the app was also created to increase the partner's involvement in the *Confident Birth* method. A special part in the app is created especially for the partner, and based on non-pharmacological pain-relief methods [21]. In the first information-part of the app, the partner gets information about how and why their support is valuable. In the training part, exercises about contraction signs, importance of closeness, instructions how to give pressure with firm hand, stroking and pressure, tickle the belly, give sacrum press and pelvic squeeze, and creating a stronger team together are added. The method provides a graph over the different phases of labour and suggested tools for the partner and the woman to use during the different phases of labour. Fig. 1.

To improve the effectiveness of the app, blended care (i.e., the combination of online therapy and in-person treatment [22]) was chosen as the delivery mode to ensure and strengthen self-management and compliance with using the mobile app during pregnancy. In a Norwegian study, participants described that app-based self-management support, in combination with face-to-face sessions, strengthened the intervention [23].

In order to successfully evaluate the effectiveness and feasibility of a complex intervention, the Medical Research Council framework recommends initial testing and refinement of interventions [24] therefore, we conducted a feasibility study that aimed to explore the usefulness, ease of use, and preliminary effects of the mobile app, preceding a larger research project [25]. The forthcoming project aims to investigate whether primiparous women who use the mobile app during pregnancy and childbirth experiences less distress and anxiety in early labour compared to women who have received the usual maternity care. Following this, the focus of the present study was to investigate the feasibility of the mobile app during pregnancy and childbirth. As suggested by Bowen et al., [26] feasibility conceptualizations was explored in following areas: *Acceptability*: To what extent the app is judged as suitable, satisfying, and attractive to participants. *Demand:* Exploration of the actual use of the *app* and it's modules. *Implementation*: To evaluate in small-scale whether the intervention can be deployed in the maternity care context. *Practicality:* Cost analyses and matching interviews with providers to identify potential areas during implementation. *Adaption*: To what extent the app is useful as described by the participants through blended care. *Limited efficacy testing*: To what extent the intervention show promise of being successful with the intended population.

This enables researchers to assess if the mobile app and the planned research are relevant, feasible, and sustainable [26]. The conceptual framework of usability covers the different lifecycle phases of a product,

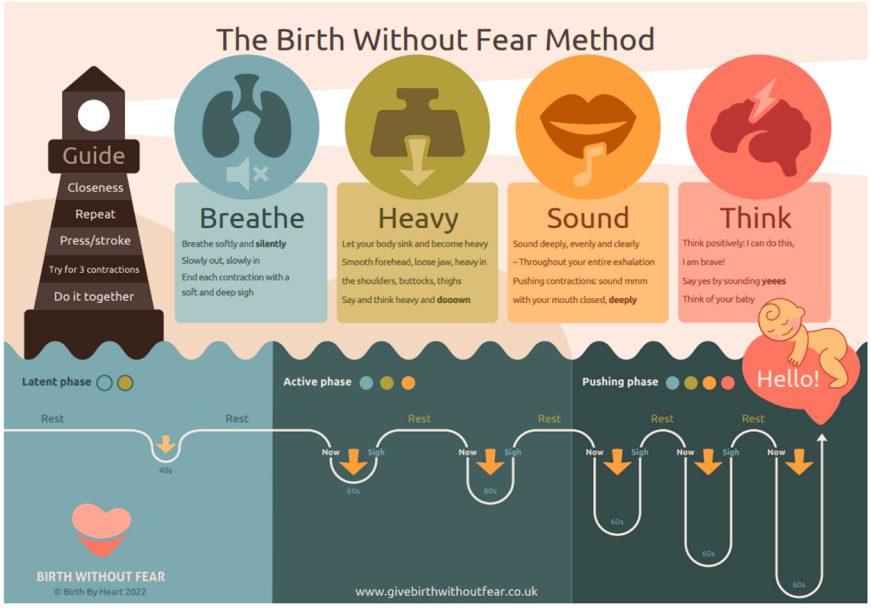

Fig. 1. Overview of the Birth Without Fear Method (published with authors permission).

as for highlight usability issues about a product before development, during the design phase and afterwards [27].

This pilot study aimed to examine the feasibility, including perceived usefulness and usability, and the preliminary effects of the app.

2. Method

2.1. Study design

This mixed method study was designed to assess the feasibility and acceptability of using an App for early labour. The study was looking at proof of concept and was conducted prior to research to assess the effectiveness of an App (through RCT). A mixed-methods approach allows for a more comprehensive account of the collected data and a broader picture can be achieved [28]. The trial was registered at ClinicalTrials.gov on July 26, 2022 (NCT05122390), and the first version of the protocol was uploaded on November 16, 2021.

2.2. Description of the app

The app was designed by a tech company, Birth by Heart ©, and was developed with input from key stakeholder groups representing health professionals, researchers, information technology experts, end-users, and executive managers. The research team consisted of seven multidisciplinary members: four midwives, one intensive care nurse, and two digital health nurses and researchers. The team expanded with additional researchers, including two experts in computer science and digital integrity. All project team members contributed to the overall design of the study and provided the tech company information when developing the app. Other key stakeholders, such as developers and end-users, played important roles at specific stages of the design and development process. Throughout the project, continuous interaction occurred between the project team and the tech company. Several meetings took place to discuss the possibility of displaying the product and obtaining feedback. Using collaborative virtual work as well as sharing platforms, the app was developed, tested, evaluated, and improved stepwise. The prototype was only developed for the iOS platform due to limitations in time and funding. The app contains two different parts: an overview of the *Confident Birth* method and a contraction part for use in actual labour. The first section explains the four different tools: breathing, relaxation, vocalising, and mind. Exercises built on these tools are provided to users and presented in chapters to make them easy to use. Users can read or listen to information according to their preference, but not simultaneously. In total, the app provides about six hours of material, most of which is within the education and exercise section. All parts can be used separately and are selected as standalone parts by users. Fig. 2.

2.3. Participants, recruitment, and study procedure

The research project "Digital Early Labour" was presented on a website, www.digi-el.se, created by the research group and used for information about the study as well as collecting informed consent from participants. Outcome measurements were collected using the REDCap-platform provided by Uppsala University. First-time mothers were recruited from an antenatal clinic in Sweden, with due dates in June and July 2022. In addition, recruitment took place digitally via Facebook groups aimed at pregnant women with estimated births from June to August 2022. A message was sent via the administrators of the Facebook groups containing information and a link to the website of the study, where the participants also registered their interest in testing the app and participating in the study.

Eligibility criteria: first pregnancy; planning to undergo a vaginal birth; pregnancy weeks 25–36 at the time of registration; ability to speak, read, and understand Swedish; and access to a smartphone or tablet. Fifty-seven participants consented to participate in this study. Of these, eight participants did not answer the questionnaire before labour and, therefore, were excluded. One participant withdrew, and the remaining 48 participants answered the first questionnaire in REDCap after providing informed consent. Fig. 3. Shortly after the recruitment of participants had started, it emerged that the first version of the app only was released for one operating system, iOS. Since the app only was compatible with an iPhone or iPad, two groups were natural formed. 24 women (i.e., iOS users) was given the app and 24 women (i.e., Android-users) formed a control group receiving only the usual antenatal follow-up. For participants with an iPhone or iPad, a link for downloading the app via TestFlight and a personal log on code were distributed. They received a message in the app that encouraged participants to start using the app right away and included information that a personal phone call with a midwife would take place in the coming weeks.

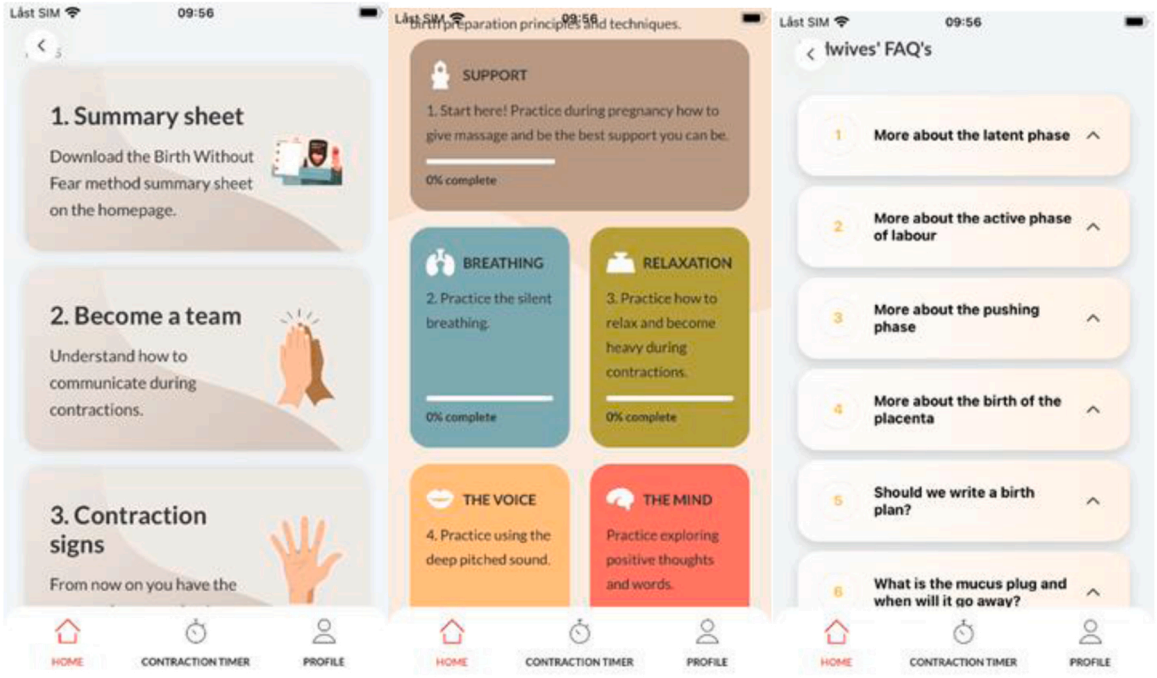

Fig. 2. Screenshots of the app.

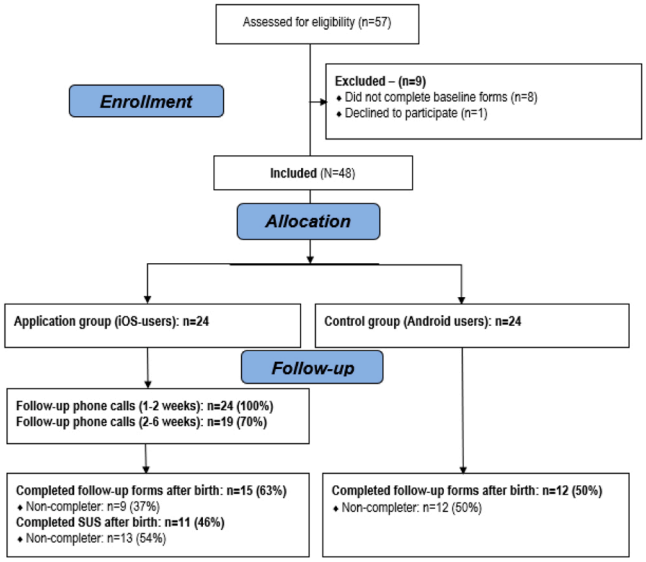

Fig. 3. Flowchart over participants according to CONSORT 10 flow diagram.

2.4. Background questionnaires and system use

The women answered questions about background characteristics such as age and marital status and completed the following validated questionnaires: Sense of Coherence-13 (SOC) [29], the Swedish Childbirth Self-Efficacy Inventory (Swe-CBSEI) [30], and the Fear of Birth-scale (FOBS) [31].

Data from app usage were provided by the tech company, and presented as log entries which indicated app activity measured as number of actions made by the user in the app.

2.5. Usefulness, usability, and ease of use

The participants in the app group (n = 24) were contacted by the first author by telephone after 1–2 weeks. The phone call was conducted with the aim of covering contingent questions from participants, evaluating the app's usability, and being able to answer other questions regarding the method or its use during pregnancy itself. A second follow-up call was performed 2–6 weeks after the first call with 19 women, five women did not respond to the second call, despite several attempts and text messages.

Both phone conversations were intended as a check-in to see if the app was still functioning properly and to tune in to any changed feelings and thoughts before birth, depending on the woman's due date. Phone calls were not recorded, but memory notes were taken to collect the qualitative data. Topics addressed during the conversations were the participants feelings before giving birth and how it had changed over time, if the woman and her partner had gone through the method in the app and if they had the intention to use it during pregnancy as well as during childbirth.

The 10-item System Usability Scale was used to assess app usability, with responses on a five-point Likert scale ranging from disagree to completely agree [32]. The SUS-scale was chosen due to its quickness and easiness for participants and administrators. It provides a single score on a scale ranging from 0 to 100, where higher scores indicate better usability [33]. In addition, two questions were asked about which part of the app they liked the best and the least in order to increase the aspects of usability from the participants.

2.6. Preliminary effect - methods/questionnaires

One month postpartum, the participants were emailed a link to a questionnaire with questions about childbirth, labour onset, birthing mode, pain relief used, gestational week at birth, and outcome for the baby in terms of need for neonatal care. Questions about hours in labour before admission were asked, and the validated outcome measures Sweden Early Labour Experience Questionnaire (SWE-ELEQ) [2] and Childbirth Experience Questionnaire (CEQ)[34] were used to measure the total childbirth experience. SWE-ELEQ measures experiences in early labour and contains three subscales: perceptions of midwifery care in early labour, emotional well-being, and emotional distress in early labour. The items were answered on a 5-point Likert scale. The CEQ was used to investigate the childbirth experience and covered four subscales:

own capacity, professional support, perceived safety, and participation. Most items are rated on a 4-point Likert scale, while items about pain, security, and control are rated on a visual analogue scale (VAS) from 0 to 100 mm [32].

2.7. Statistical analyses

Statistical analyses were performed using the Statistical Package for the Social Sciences (version 28; SPSS Inc., Chicago. IL) [35]. Descriptive statistics with background data were presented, and differences between groups were analysed using Pearson's chi-square test and Fisher's exact test. Non-parametric tests with Mann-Whitney U-tests were used to test the differences between the two groups. A standard alpha level of 0.05 was used for all analyses.

2.8. Qualitative analyses

The qualitative data were derived from blended care, and analysed with content analysis according to Elo and Kyngäs [36]. During blended care conversations, memory notes were collected and analysed. The extraction followed three steps: the lowest order in codes, sub-categories, and the next level; sub-categories were grouped together in four generic categories. All data from the phone call memory notes were highlighted in different colours, called open coding, and notes that described the highlighted text were taken in a mind map beside the text mass. These notes were concentrated to a few describing words and became sub-categories. Then the sub-categories were grouped to a higher level; generic categories, to retrieve overarching categories containing data that belonged to a particular group. Four generic categories were created from the data achieved from the phone calls and describes the blended care-intervention.

2.8.1. Ethical considerations

This study was approved by the Ethical Research Committee of Sweden (Dnr. 2021–03028). The participants were informed about the General Data Protection Regulation (GDPR) [37] and provided informed consent to participate in the study. All questionnaire data were collected electronically through the REDCap survey at Uppsala University, specifically geared toward supporting online and offline data capture for research studies. Participants were also able to withdraw their participation until publication.

3. Results

Table 1 shows an overview over the participants' background data when entering the study. The participants' mean age was similar in both groups (app-group 30.6, control group 30.5), and all women were living with a partner. Most participants had a university-level education for more than three years, and few were born outside Sweden. The participants' mean sense of coherence (SOC) score at admission to the study was similar in both groups (56.1/55.5). Self-efficacy (Swe-CBSEI) was also similar between the two groups (mean=169.7/172.5). Fear of childbirth, measured with the FOBS, showed mean values of 51.9 versus 50.1.

3.1. Perceived usefulness, usability and ease of use

The system usability scale (SUS) was provided to app users and responded to by 11 out of the 15 women responding to the questionnaires after birth. Responders to SUS did not use the app more compared to non-responders (Fig. 4). Most participants found the app easy to use, well-integrated, and functional, and they were eager to use it again. A few women thought there was too much inconsistency, did not feel confident using the app, and marked that they needed to learn many things before using it. Overall, the women found the exercises in the app to be simple and understandable, and the programme was useful. The

Table 1
Sociodemographic background, personal characteristics, and childbirth fear experience.

	Application group (n = 24)	**Control group** (n = 24)	***p*-value**
Age, mean (SD)	30.6 (2.9)	30.5 (4.0)	0.568
Marital status, n			
Living with partner	24	24	
Educational level, n			0.834
High school	3	4	
University level ≤3 years	7	8	
University level >3 years	14	12	
Country of birth, n			0.252
Sweden	21	23	
Outside Sweden	3	1	
SOC, mean (SD)	56.1 (5.0)	55.5 (6.7)	0.455
Swe-CBSEI, mean (SD)	169.7 (43.2)	172.5 (58.7)	0.725
FOBS- before, mean (SD)	51.9 (21.1)	50.1 (22.9)	0.842

Analysis with Pearson's chi-square and Mann-Whitney U-test.
SD: Standard Deviation; SOC: Sense of Coherence; Swe-CBSEI: the Swedish Childbirth Self-Efficacy Inventory; FOBS: Fear of Birth-scale

mean score for SUS was 85.3 (SD 11.3), indicating Grade A, which equals excellent system usability (i.e., score>80.3). Free text answers about what the participants liked best and least, showed that the exercises, information, and clarity of the application-layout was valued. Areas for improvement was mainly about the contraction-timer part; a more intuitive navigation, more clarity in how to use that part, and the large amount of text in the app.

One of the participants wrote a free text answer about how the app was considered better than the book:

> *"You feel safe and strengthened before the birth! I had read the book give birth without fear before, but in the app, you get the most important parts and that it becomes more visual!"*

Another participant wrote suggestions for improvement about design and layout of the app:

> *"I think what could be improved are pictures/animations showing how the partner should massage/stroke one. When you activate the labour mode, it would have been good if you had quicker access to the labour timer. Also, it would have been good if you could choose between the partner having access to the aids/exercises in text form, as you can sometimes feel that the narrator voice interferes with the work".*

Fig. 4 shows the activity in the app, counted in log entries of each user and is a sort of proxy of time spent in the app. Entries for each user varied between 3 and 180 times (mean 83.7 (SD 52.6)). Responders to the SUS-questionnaire made 66.2 (mean) entries, and the non-responders made 106.8 (mean) entries.

3.2. Blended care contacts

The first phone call with a midwife lasted 10–40 min, and the second phone call lasted 10–15 min. The first phone call was dominated by topics about the app itself, such as thoughts about and current experience of the method, but also discovered technical issues in the app. The phone call was also about both negative and positive expectations and feelings about giving birth. All women confirmed that the app was successfully downloaded, and they started to use it. The second phone call was revolving around continuously using the app and addressing the partners involvement. Twenty-four (100%) women responded to the first phone call and 19 (70%) responded to the second. A few women also gave an update by text message after birth where they confirmed that the app and the Confident Birth method had been useful. The qualitative analyses showed that the women gained knowledge about

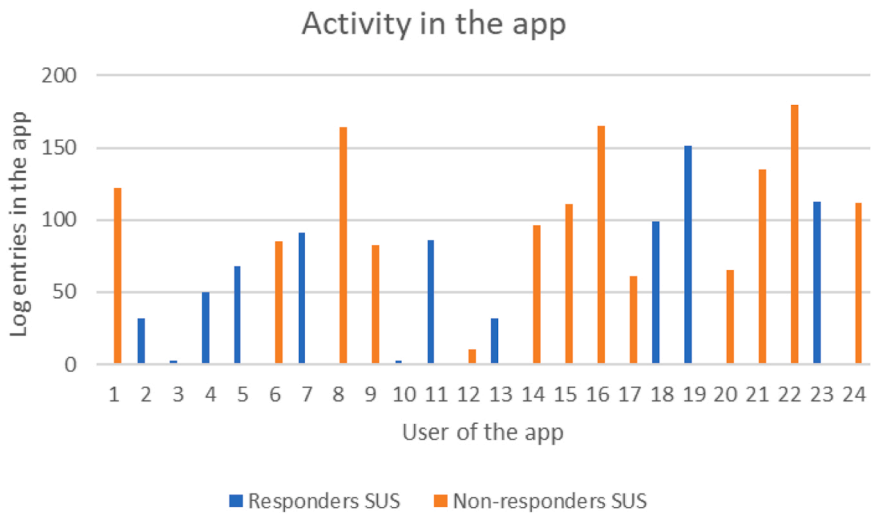

Fig. 4. Activity in the app shown by log entries from each user.

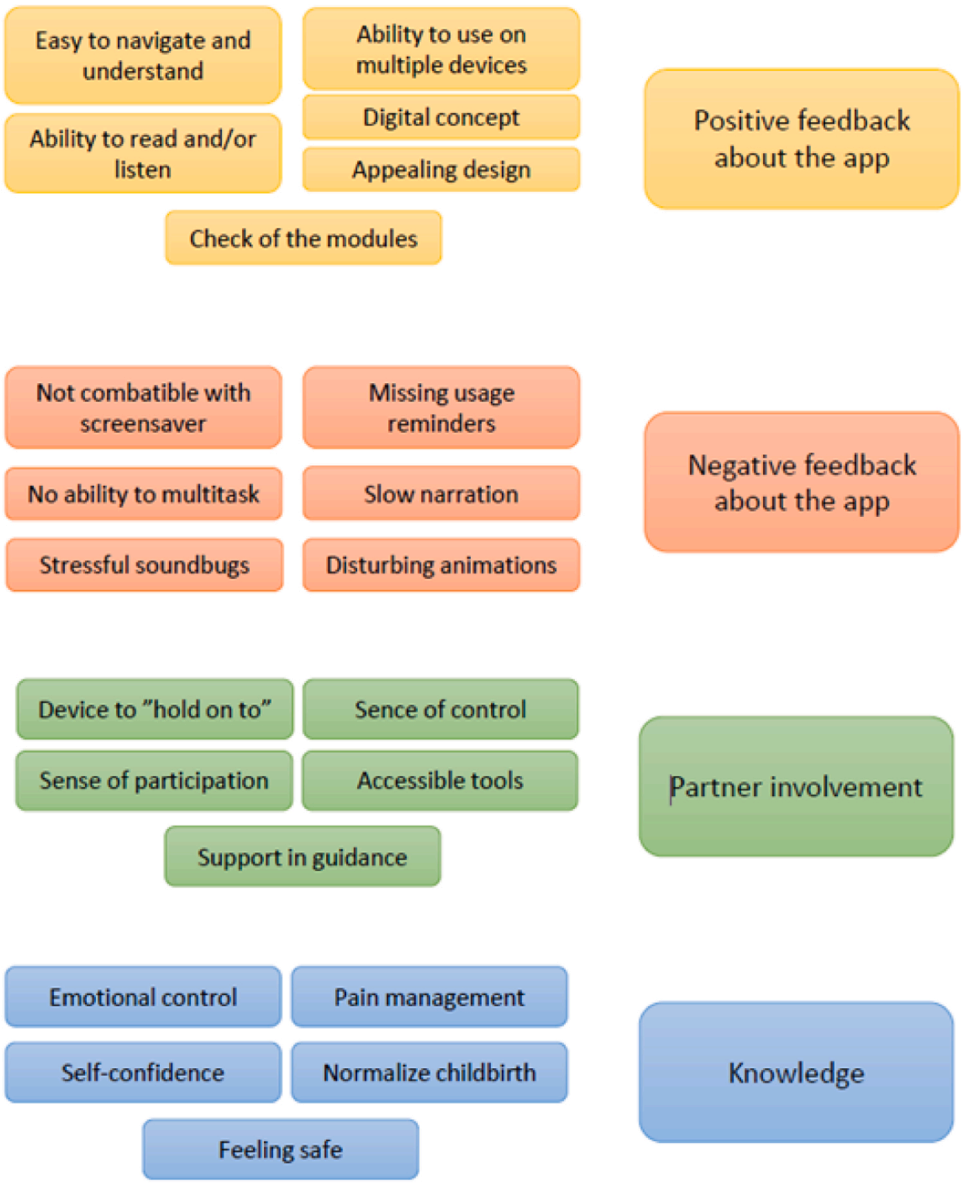

Fig. 5. Overview of blended care results.

the method by using the app and appreciated the digital concept. The data were analysed into four categories: positive feedback about the app, negative feedback about the app, partner involvement, and knowledge. Several positive quotes stated that the app was easy to use and that they needed no further guidance to use the app. They appreciated the design and could easily verify the modules used.

Negative experiences were mainly related to technical solutions. They mentioned problems with bugs in the app that caused irritation, and several women wanted to speed up the speaker. They also addressed the problem of not being able to multitask, that is, putting the phone aside and continuing to listen to the voice due to the saving mode. During these conversations, areas such as confirmation about usefulness were addressed, and some women stated that they used the app first but forgot to maintain the exercises in the app, and they suggested adding reminders to the app.

Most women also stated that their partners became more involved in preparing for birth while using the app together. Doing this together gave them a sense of participation and control, as well as the knowledge that the partner could easily guide the woman.

The knowledge provided in the app was described as leading to a feeling of safety and control, that is, how to manage labour pain and give self-confidence before birth. Several women appreciated that the interviewer was a midwife and wanted to share their thoughts about their pregnancies.

Fig. 5 provides an overview of codes and categories.

3.3. Preliminary effects

Outcome measurements after birth was reported by 29/48 (60%) women, and the response rate was similar in both groups, 15 women in the app group and 14 in the control group. No significant difference was found between the responders and non-responders regarding age, marital status, education or country of birth. Twelve women in the app group and ten women in the control group had a spontaneous onset of labour. Three women in both groups had induced labour, and one woman in the control group had a caesarean section before labour started. Most women in both groups had spontaneous vaginal births, and few new-born babies needed neonatal care. Women rated their time spent in labour before admission to the hospital, and the mean time was 17.0 h for the app-group and 17.6 h for the control group. Epidural anaesthesia was used by 10 of 15 women in the app group and 8 of 14 in the control group. Please see Table 2 for further details.

Early labour experience measured by SWE-ELEQ was not significantly different between the two groups, but a trend was observed for emotional well-being (app-group: mean 3.70; control group: mean 4.18). Childbirth experiences measured with the CEQ did not reveal a statistically significant difference between the two groups, but a trend was observed for professional support (mean=3.88/3.38). Please see Table 3 for further details.

Table 2
Labour outcome.

	Application group (n = 15)	Control group (n = 14)	*p*-value
Labour onset, n			0.563
Spontaneous	12	10	
Induction	3	3	
Caesarean section before labour, n		1	
Mode of birth, n			0.363
Vaginal	13	9	
Instrumental vaginal	1	3	
Acute caesarean section	1	2	
Neonatal care	1	3	0.330
Hours in early labour before admittance, mean (SD)	17.0 (16.6)	17.6 (25.7)	
Content with decision about leaving labour ward prior to admittance, n			*0.038*
Yes/Yes partly	6	3	
No	1	3	
Epidural anaesthesia, n			0.263
Yes	10	8	

Analysis with Pearson's chi-square or Fisher's exact test. Significance level at p-value < 0.05. SD: Standard Deviation.

4. Discussion

The aim of this study was to examine the feasibility, including system use, usefulness, ease of use, study design and procedures, and preliminary effects of the app. The result showed that recruitment of women via social media was straight forward, and also non-users of the app answered the questionnaire following birth. The results showed that the app is easy to use and useful. The results also indicate that the additional support provided in a blended healthcare model can improve app use. In addition, the study showed that the chosen outcome measures used during pregnancy and after childbirth were comprehensible for the participants and preliminary statistical testing showed promising results.

4.1. System use, usefulness, and users' feedback

According to the areas described by Bowen et al.,[26] the *acceptability* of the app was rated as useful, with simple and comprehensible exercises by a majority of the participants. In addition, the majority rated that most people would learn to use the app quickly. The SUS showed a high mean score, indicating excellent system usability. The development of the app in close collaboration with users, as recommended in research [38], and content based on the *Confident Birth* method [19] could have contributed to its high system usability and perceived usefulness.

The *demand* was tested by exploring participants activity in the app, and findings showing large variation of activities in the app suggests that the challenge of attrition can be improved. In a systematic review, Torous et al. (2020) showed that different strategies to improve the retention rate may include providing human feedback [39]. A few participants only opened the app, while some had many activities in the app. Some researchers suggest that gamification can be a possible solution to keep people using app-based programs by including elements that aim to increase motivation, engagement, and enjoyment [40].

Regarding *implementation,* the participants were easily included through the website created by the research group, and social media was a useful platform to recruit and include participating women. Although not all women had access to the app, the follow-up questionnaire had almost the same dropout rate regardless of the group. Blended care

Table 3
Early labour experience and childbirth experience.

	Application group (n = 15)	**Control Group** (n = 12)	**p-value**
	Mean (SD)	Mean (SD)	
SWE-ELEQ			
Emotional well-being	3.70 (0.73)	4.18 (0.53)	0.083
Emotional distress	2.34 (1.08)	2.38 (0.92)	0.781
Midwifery care	4.65 (0.39)	4.38 (0.60)	0.347
CEQ			
Own capacity	2.86 (0.31)	2.73 (0.61)	0.780
Professional support	3.88 (0.33)	3.38 (0.79)	0.051
Perceived safety	3.13 (0.48)	2.96 (0.55)	0.290
Participation	3.64 (0.56)	3.07 (1.13)	0.217

Analysis with Mann-Whitney U-test. Significance level at p-value < 0.05. Only complete responses in the subscales are included.
SD: Standard Deviation; SWE-ELEQ: Early Labour Experience Questionnaire; CEQ: Childbirth Experience Questionnaire

added an extended dimension, and the participants shared their experiences of usability and usefulness. Blended care delivered by a midwife was perceived positively, and questions about pregnancy itself could take place, leading to the app and blended care being strengthened, as stated in previous research [41]. Humanisation with personal contact and a technical solution can be applied to customary antenatal care. It is supposed that the app could be used by pregnant women with support from their antenatal midwives. This could benefit both the pregnant woman and the midwife, as the information can be individually adapted based on personal demands. A systematic review of mHealth stated that by using an integrated service combining appointments, self-monitoring activities, and mHealth, strong trust between the midwife and the woman was established [42].

The *Practicality* of the delivery of the intervention was assessed, and the content of support from blended care was reported. All twenty-four participants responded to the first phone call, a few participants were difficult to reach for the second follow-up call. The reason for dropping out by five women, despite several messages, cannot be fully explained, but it can be discussed in light of findings from a review of the usability and effectiveness of health technology and medical interventions during pregnancy, showing that the response rate decreased over time [43]. Women responding to the SUS questionnaire (n = 11) were not fully corresponding with the multiusers of the app, which needs further consideration in forthcoming research.

Adaptation of the study with a quasi-experimental design based on questionnaires was tested. Because the app was only available on iPhone smartphones and iPads, it provided a natural selection for two groups. The dropout rate in the web survey was equal in both groups, suggesting compliance despite future randomisation; likewise, there were comprehensible questions, and the answering pattern was as expected, showing sufficient face validity [44].

Limited efficacy showed that there were some small differences between the two groups, but these differences were not statistically significant. An interesting result of this pilot study was that significantly more women in the app-group were satisfied with leaving the labour ward in early labour compared to the control group. Ängeby et al. (2018) discovered that women who were dissatisfied with the decision to leave the labour ward in early labour scored significantly higher on the subscale of emotional distress than women who were satisfied with their decision [2]. No such differences in emotional distress were observed in the current pilot study even though the app-group were significantly more satisfied leaving the labour ward in early labour compared to the control-group.

4.2. Study limitations

This study had several limitations. First, the study was designed to assess feasibility of the app-based intervention for early labour management, and the non-randomised study design with a small sample size does not allow for statements of intervention efficacy. Therefore, results from outcome measures can only be regarded as indications. Second, the participants were recruited as convenience sample, through social media, and it may be assumed that the sample consists of highly motivated women. However, pregnant women often seek digital information and support, and as such, this recruitment method may probably appeal to this group. The participating women had a higher education level than average, which can indicate that more educated women are interested in using the app and interested in participating in research, which also are reported elsewhere [45]. Another limitation is that the test version was only available for the iOS operative system, leading to a possible bias of participants according to the findings from Shaw et al. (2016) suggesting that the choice of smartphone could be connected to the personality [46]. Additionally, the result from the usability of the app must be considered with precautions due to the limited response rate. However, many non-responders to SUS had high activity in the app, that could indicate that it was perceived positively. The decision of using the activity in the app instead of real time spent in app must be considered in the forthcoming trial. Some women may use just one part, i.e., contraction timer, however this is not mirrored in the actual productive activity.

5. Conclusion

This study established feasibility of an app-based intervention for early labour management. The app was perceived as useful and was appreciated by women. The study provides valuable input on areas for improvement of the app regarding technical solutions and areas for refinement of the app's usability. In addition, the study shows promise for further efficacy testing in a forthcoming randomised controlled trial with a larger sample size, allowing both iOS and Android operative system.

Ethical statement

Ethical Research Committee of Sweden (Dnr. 2021–03028).

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Author contributions

KÄ and AN was designing the whole project. All authors contributed to the design of the feasibility study. MF was conducting the feasibility study and KÄ, MF and AN did the first draft and preliminary analysis. All authors participated in the final version of the manuscript'.

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Conflict of interest

All authors statement no financial or other interest in the product or distributor of the product or any kinds of associations, such as consultancies, stock ownership, or other equity interests or patent licensing arrangements.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.wombi.2023.03.008.

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