Promoting Wellbeing in Pregnancy: A Multi-component Positive Psychology and Mindfulness-Based Mobile App

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Abstract. Pregnancy involves important changes for women of all ages: it is a time of physical and psychological change. Women may experience anxiety and negative emotions, which can negatively influence their wellbeing and make difficult their adaptation to the new role of mothers. Furthermore, poor mental well-being and difficulties in emotion regulation can negatively affect obstetric outcomes, development of the child and neonatal adaptation. The aim of this work is to present a new self-applied multi-component positive psychology- and mindfulness-based intervention (MPPMI) supported by a mobile App addressed to pregnant women. The core of this MPPMI is to combine traditional positive psychology activities with mindfulness-based exercises. The purpose of this MPPMI App (available in both Android and IOS versions) is to increase positive feelings, behaviors and cognitions and to learn strategies to better cope with anxiety to get adaptively and positively through pregnancy.

The intervention is composed by five modules, for a total length of five weeks, and each module includes three activities.

The future steps will be to carry out a pilot study to examine the program implementation and preliminary evaluate the effectiveness of the intervention on women's mental well-being, both at the end of the intervention and after childbirth.

Keywords: Pregnancy · Positive psychology · Multi-component intervention · Mindfulness · Mobile app · Wellbeing

1 Introduction

Pregnancy is a psychologically complex period in women's lives, and every pregnancy could be a phase of potential vulnerability. During pregnancy women change their status from daughter to mother in just a few months and this change requires a profound reconstruction of self [1]. In addition to biological changes, pregnancy leads to a

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search for a new identity at the individual, couple and social levels [2, 3]. All these changes can challenge women emotional adjustment and can lead to negative thoughts and emotions such as anxiety, stress and depression.

Women who present more difficulties in regulating their emotional states, lower self-compassion and who feel more isolated seem to be at higher-risk of developing post-partum depressive symptoms [4]. Furthermore, a wide consensus exists about the role of maternal emotional state in influencing the development of the child and the course of the pregnancy: negative emotions are often associated with various complications, such as preterm childbirth, low baby weight and difficulties in the fetal neurocognitive development and further poor emotional regulation abilities of the baby during infancy and childhood [5–12]. In contrast, positive affect has been associated with longer length of gestation, with reduced risks of delivering preterm [13] and of pregnancy-specific psychological stress [14] and with more self-reported social support [15].

As well-being of the mother is critical for optimal pregnancy outcomes, it is important to support and enhance mental well-being in pregnant women and provide women with coping strategies to increase their quality of life and to maximize infant health and development. Thus, the promotion of women's self-regulatory skills may help them to face the changes and challenges they are experiencing, allowing them to be aware of- and non-judgmentally accept their negative parenting-related emotions, to have a more compassionate attitude towards their experiences and difficulties, and to actively promote a positive mother-child relationship [4].

To reach these objectives a wide range of interventions have been tested (e.g., relaxation, mindfulness meditation, yoga therapy, breathing instructions, guided imagery, etc.), showing promising results [16–19]. Among these, on the one hand it is recognized the effectiveness of mindfulness-based interventions on women's prenatal well-being: a recent systematic review indicated potential benefits of mindfulness interventions on maternal prenatal well-being, especially in terms of decreased levels of negative affect, depression, and anxiety during pregnancy [20, 21] and increased self-acceptance. On the other hand, Positive Psychology Interventions (PPIs), defined as programs "aimed at increasing positive feelings, positive behaviors, or positive cognitions as opposed to ameliorating pathology or fixing negative thoughts of maladaptive behavior patterns" [22] have been confirmed as interventions leading to reliable and sustainable boosts in well-being [23–26]. Recently, PPIs have been implemented and experimentally demonstrated their effectiveness in reducing women's prenatal stress [14].

In order to target multiple domains of positive functioning, here we propose a multi-component positive psychology- and mindfulness-based intervention (MPPMI) [27], that is an intervention composed of a minimum of three positive psychology activities combined with mindfulness-based exercises, which to a large extent overlaps with principles of positive psychology [28].

Today, new technologies are becoming emergent tools to support these interventions. Thanks to their ubiquity, multimodality, interactivity and easiness of use, new technologies allow pregnant women to develop personal skills to manage their affective states and better deal with impending childbirth and motherhood [29, 30]. Specifically, both web-based and mobile app seem to be feasible options for supporting interventions aimed to promote well-being and prevent anxiety and post-partum depression, and there is preliminary evidence of their efficacy [31–36].

Starting from these premises, the App SerenaMente Mamma was developed: it is a mobile App containing a multi-component positive psychology- and mindfulness-based program addressed to promoting and enhancing women's prenatal mental well-being and preventing post-natal depression. The present contribution aims at describing the app contents and structure that will be tested through a pilot study.

2 The App SerenaMente Mamma

The app SerenaMente Mamma has been released for both Android and iOS plat-forms and it is conceived to work on mobile devices like smartphones and tablets. After the App installation, the final user, namely the pregnant woman, is initially expected to fulfill a baseline self-assessment before starting to browse contents. A post-assessment step is also expected at the end of the user experience, when the App contents have been completely exploited. The App is configured to communicate with a server-side software component released as a Java servlet service joint with a PostgreSQL database system where the assessment results are stored for subsequent analysis. It is important to note that data anonymity is enforced on the server-side component to ensure privacy preservation of the involved users/women.

The App contents are based on a brief self-help protocol characterized by five modules including fifteen exercises. Thus, the entire intervention lasts thirty-five days (five weeks), with three exercises/tasks to be completed every week (see Fig. 1).

Fig. 1. Structure of *SerenaMente Mamma* App. After the baseline assessment, women can start the MPPMI: from the initial menu, they can have access to the first week module. At the end of each week, users are invited to rate the performed activities in order to unlock the contents of the following week. At the end of the intervention (after the fifth module) the final assessment is proposed. From that moment all contents are unlocked and freely re-usable.

Specifically, six of them are positive psychology-based exercises while the others are mindfulness-based guided meditation aimed to develop mindfulness abilities and self-awareness. It is also possible to replicate the exercises already completed following the five weeks, thus extending the duration of the intervention. Women can perform all the exercises on their own, wherever they want.

The App is available for Android and iOS devices. Users can install the app and use it after accepting the study conditions, presented after the first launch, and answering some questionnaires.

The modules are activated at a rate of one per week and after a week, the App automatically unlocks the next module, allowing users to complete the three weekly exercises proposed (see Fig. 2). To proceed to the next module, the app requests to rate user experience in terms of *perceived usefulness*, ("How much did you benefit from exercises practice?), *perceived ease of use* ("How difficult was the exercise?") and *pleasantness* ("How much did you like the exercise?") of the proposed activities.

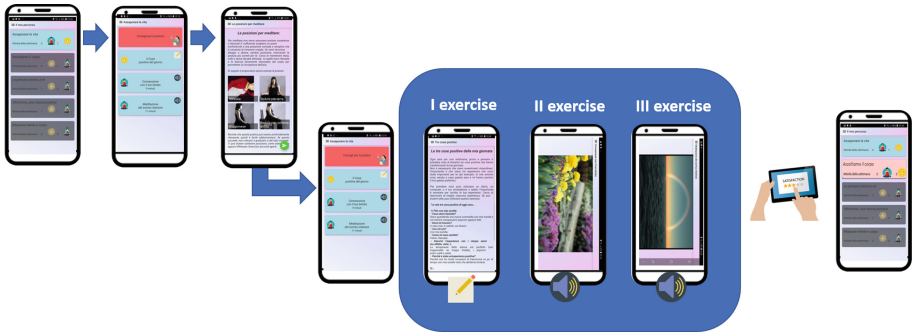

Fig. 2. First Week of SerenaMente Mamma App. After clicking on the first module, the App proposes a menu composed of four boxes. The first one contains some suggestions for a better practice. For example, the first module includes a description of the recommended positions of the body to favor meditation in pregnancy. Furthermore, the module proposes three exercises referred to mindfulness or positive psychology contents, which users have to rate to unlock and get access to the next module.

2.1 App Structure and Contents

Each module contains an introduction section ("Suggestions for practice" – "Consigli per la pratica") with text, images or audio which explains mindfulness or fundamental concept necessary for practice, with a simple language and images suitable for the specific users (see Table 1).

The first module is named **Savoring Life**: this module invites women to savor life, aiming to enhance and extend momentary pleasant experiences [37, 38]. This module aims to promote positive emotion and to decrease elements of negative affect [31], to enhance psychological wellbeing by engaging participants in three exercises: the "Three good things in life" [38], and "Inner connection" and "Inner meditation practice" [39].

The second module is named **Listen to your body**. This module provides a brief description of mindfulness and teaches participants to be connected to their body [40]. It proposes three exercises, to increased interoceptive awareness and acceptance [41] to better manage pain and discomfort. Three exercises are proposed: "Your body is changing", the "Body scan exercise" [40] and "You and your baby" in one body guided

Table 1. Modules structure and contents

Module	Name	Positive psychology-based exercises	Mindfulness-based exercises
1	Savouring life	*Three good things in life exercise*: participants identify three good things that went well each day and why	*Inner connection with you baby guided meditation*: mother to be are invited to think about their babies and to send loving thoughts to the unborn *Inner smile meditation*: mothers-to-be are requested form a smile on their own lips and then to extend it inwardly to all their body, to the unborn baby and to all the people in the world
2	Listen to your body	*Your body is changing:* women are invited to take a photo in front of a mirror every week or at the beginning of every month of pregnancy *Body scan exercise:* women are invited to focus the attention on their body, through the various regions of the body and to accept any discomfort or pain or any other bodily sensation. Body scan helps to understand the difference between thinking about a sensation and experiencing it [40]	*You and your baby in one body*. Mothers-to-be are requested to focus on bodily sensation of baby movements in the womb
3	People around you	*Connectedness exercise*: participants are asked to think about, identify and draw a graphic about their most important relationships and find an activity to do together *Gratitude exercise*: women are invited to write a letter or an email to a person they wanted to thank and to plan a visit to meet face to face this person	*Cuddling with my child in the womb and my partner:* women are invited to take a break of relaxing with their partner, to practice a guided meditation hugged
4	Optimism, a positive resource	*Best possible self-exercise*: participants visualize and write their ideal future life in as much detail as possible *Baby steps exercise*: participants write a list of goals and initial steps toward achieving their best possible self	*Inner smile*: see over

(*continued*)

Table 1. (*continued*)

Module	Name	Positive psychology-based exercises	Mindfulness-based exercises
5	Mind and body relax		*Breathing meditation* that invites to focus attention on breath and bodily movement (particularly of the chest and belly). When the mind wanders, the mother-to-be is invited to notice what distracted her and then return to observing her breathing. *Music relaxing exercise Rainbow guided imagery*: this exercise invites women to imagine herself in a quiet, peaceful and secure place to rest and to release anxieties, worries and thoughts, allowing her to come out of this imagery with a sense of comfort and refreshment; mothers-to-be are encouraged to imagine "a beautiful rainbow" and visualize the image's form, colour and flow, and to focus attention on how they are feeling. The voice guide suggested desired psychological states and emotions (e.g., "You feel calm, You feel relaxed, Your body is calm and relaxed, and also your baby is relaxed") to induce them

meditation. In particular, You and your baby in one body meditation is designed to create a state of direct connection with the baby to strengthen the relationship between mother and child in the womb, to prepare both for the childbirth [42].

Social support represents a protective factor against affective disorders during pregnancy [43]. Thus, the third module, **People around you**, encourages women to reflect on the relations with their loved ones and take steps to improve them. There are three simple exercises included: "Connectedness exercise", "Gratitude exercise" and "Cuddling with my child in the womb and my partner" [43].

The **Optimism** module is dedicated to developing and increasing a positive attitude toward the future. It includes "Best possible self-exercise" [44], "Inner smile meditation" and "Baby steps exercise" [44].

The fifth module, **Mind and Body Relax**, aims to teach relaxing and decentering technique to reduce reactivity and increase act with awareness [45]. Participants can learn how to manage their attention and to be more aware of the mind wandering; in terms of thought distancing, participants increase the ability to perceive thoughts as ''events'' in the minds, and simply observing the process of thought. Moreover, guided imagery is used to influence psychological and physiological states: the evoked images may mediate the communication between perception, emotion and physiological change and may induce a positive physiological process such as reducing the stress reaction and related stress symptoms (Schaub, 1995). This module proposes three practices: "Mindful breathing meditation" [42, 46], "Music relaxing exercise" [47, 48] and "Rainbow guided imagery" [49].

3 Method

3.1 Participants and Procedure

A pilot study will be performed to test the effectiveness of the SerenaMente Mamma app in promoting and enhancing women's prenatal well-being and preventing post-natal depression.

Women will be recruited from hospitals and perinatal services across Milan (Italy). Pregnant women up until gestational week 35, at least 18 years of age, able to read and write Italian, have access to the internet and have an electronic mailing account will be invited to participate to the study.

They can start the intervention from the second trimester of pregnancy. The reason for starting in the second trimester is that expectant mothers can be reached as early as possible, thus preventing prenatal depression and promoting a positive prenatal attachment to their baby [36].

3.2 Measures

In order to verify the effectiveness of the SerenaMente Mamma App in promoting and enhancing women's prenatal mental well-being and preventing post-natal depression, several questionnaires in App will be presented two times: (i) after acceptance of the study conditions (i.e., Baseline), (ii) at the end of the five-week intervention (i.e., Post Assessment). Finally, after the childbirth and within the first trimester of the child, the researchers will contact the new-mothers, that have voluntarily agreed to participate to the post-partum study, to propose to fill out a post-partum set of online questionnaires (i.e., Follow-up Assessment).

Firstly, a socio-demographic questionnaire aimed to assess women's age, nationality, marital status, education, current employment status and occupation, week of pregnancy and previous experience with relaxing or meditation techniques is proposed. Second, to investigate the MPPMI app effectiveness several validated self-report questionnaires (to be completed at Baseline, Post Assessment and Follow-up Assessment) are included.

The Flourishing Scale – FS [50, 51] consists in eight items on a 7-point Likert-type scale, which investigates the eudaimonic aspects of well-being (e.g., "I lead a

purposeful and meaningful life," "My social relationships are supportive and rewarding," "I am engaged and interested in my daily activities"). The total score is calculated by the sum of the item scores and can range from 8 to 56. Higher scores mean that the respondent rates herself as a very positive functioning individual.

Depression level is assessed using the Edinburgh Postnatal Depression Scale (EPDS) [52, 53], a widely used brief screening tool for depression. Participants are asked to think of their psychological conditions over the past seven days and to rate depressed mood, anhedonia, guilt, anxiety and suicidal ideation through 10 items on 4-point Likert scales (range 0–3). A sample item is 'I have blamed myself unnecessarily when things went wrong' with the following response format: 'yes, most of the time' (3), 'yes, some of the time' (2), 'not very often' (1), 'no, never' (0). The EPDS total score ranges from zero to 30, with higher values indicating more negative feelings.

Pregnancy-related anxiety (PRAS) [54] is a 10-item self-report scale that measures the frequency or extent to which pregnant women are worried or concerned about their health, their baby's health, labor and childbirth, and caring for a newborn. Responses are given on a four-point Likert scale ranging from 1 to 4, and the total scores range between 10 and 40.

The Maternity Social Support Scale (MSSS) [55] measures perceived social support in pregnancy (family support, friendship network, help from spouse/partner, conflict with spouse/partner, feeling controlled by spouse/partner and feeling loved by spouse/partner). It is a six-item questionnaire, on a five-point Likert scale. The total possible score for the scale is 30, with higher scores indicating increased support. A cut-off score of 24 has been recommended (Webster et al., 2000a).

Emotional well-being is assessed through the WHO-5[1] [56], a short instrument consisting of five positively formulated items: 'I have felt cheerful and in good spirits', 'I have felt calm and relaxed', 'I have felt active and vigorous', 'I woke up feeling fresh and rested' and 'My daily life has been filled with things that interest me'. The degree to which these feelings were present in the last 2 weeks is scored on a 6-point Likert-type, from 0 (not present) to 5 (constantly present). Item scores are summated and transformed to a 0–100 scale, with lower scores indicating poorer well-being. Based on previous studies, a cut-off <50 is recommended as threshold for further testing for depression [57, 58], while one study found a WHO-5 index score <28 to provide the best screening performance in terms of sensitivity and specificity WHO [59].

In addition to these instruments, during the Post Assessment, women are asked to fill out a qualitative questionnaire about their user experience with the App. To rate the perceived app quality,, an adapted version of the MARS [60, 61] is used. The MARS adapted version contains 28 items in 3 sections: classification, app quality, and satisfaction. Each MARS item uses a 5-point scale (1-Inadequate, 2-Poor, 3-Acceptable, 4-Good, 5-Excellent). The 28-item app quality section rates apps on four subscales: engagement, functionality, aesthetics, and information quality. The subjective quality section contains 4 items evaluating the user's overall satisfaction. The MARS is scored by calculating the mean scores of the app quality subscales and the total mean score.

[1] Italian versions available here: https://www.psykiatri-regionh.dk/who-5/Documents/WHO5_Italian.pdf.

4 Discussion

Pregnancy is a challenging time that can impact women's and children's well-being and development [62]. Although psychological research on pregnancy has mainly focused on detecting and treating disorders related to the perinatal period, an increasing number of studies have investigated positive aspects and protective factors of well-being during the prenatal period [4, 14]. Their results show the relevance and beneficial effects of cultivating maternal prenatal positive affect, positive life events, optimism, social support, and mindfulness on women's and infants' well-being. Therefore, to develop programs that promote and enhance women's prenatal well-being is a priority.

This work describes a novel, multi-component positive psychology and mindfulness-based intervention (MPPMI) for pregnant women – "SerenaMente Mamma"-, which has been developed in a mobile App format. The App "SerenaMente Mamma" presents different strengths. First, the intervention contents have a solid theoretical base. PPIs and mindfulness-based interventions have shown to be effective in maximizing well-being in general populations and an increasing number of studies have shown that PPIs and mindfulness-based interventions are valid tools in supporting pregnant women mental well-being [14, 20, 31, 63]. Second, the mobile App format offers different important advantages, as it reaches many people in a cost-effective manner, offering anonymity and allowing women to access the contents at the most convenient time and place for them. Third, the self-paced nature of the intervention has the advantage of empowering women, increasing their perception of being responsible for their own mental well-being and the health of the baby.

5 Future Directions

The future steps are to examine program implementation, including number of pregnant women registered for the program, potential barriers and women's user experiences, and to preliminary assess the effectiveness of the proposed intervention in a pilot study with a follow-up assessment in order to investigate whether the effects of the intervention on women's mental well-being can be maintained over time. In order to carry out the proposed pilot study, the collaboration with hospitals and perinatal clinics will be necessary.

6 Conclusion

Recently research on antenatal care has expanded to a new positive perspective, which examines the potential benefits of positive and protective factors that can influence the course of pregnancy, women's perinatal well-being and childbirth. In the wake of this positive perspective of prenatal care, the proposed work aims to present a novel mobile App-based MPPMI addressed to support women's perinatal mental well-being. If shown to be effective, this App could be an affordable and valid tool to promote and improve well-being pregnant women, and it could be translated in other languages in order to improve its accessibility. Finally, we believe that the present work will

contribute to bridging the research gap on promoting women's well-being during the prenatal period and provide a starting point for developing simple and cost-effective interventions for pregnant women around the world.

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