

# Mindful Digital Program–based Interventions and their Role in Pregnancy and Fetal Outcomes

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## ABSTRACT

The joint family system provides a support system especially for children, young parents, and parents-to-be and is a major factor in their survival, health, education, development, and protection. It has the major potential to provide stability and support when there are problems. The joint family system even in India is on the decline, and nuclear families are on the rise both in urban and rural areas. This has left the pregnant woman with little or no family support to fall back on, which can be a cause of stress and thus affect the outcome of pregnancy. Moreover, during the COVID, the medical support was also limited, which has added to the distress.

Stress in the mother can result in hypertensive disorders of pregnancy with resultant low-birth-weight babies, preterm delivery, adverse neurodevelopmental outcomes for the child, and developmental delays in babies, and all these need to be avoided.

iMumz pregnancy, the baby care and parenting digital program, has sought to address these issues by partnering closely with pregnant women, offering a wide range of assistance and activities for maternal well-being in the comfort of their own homes. This study captures the responses and pregnancy outcomes of the women who have used the iMumz pregnancy digital program during pregnancy.

**Materials and methods:** This longitudinal study (panel study) was conducted on 512 primigravidas. The study group included 255 pregnant women who opted for a digital holistic health program: “Baby Care Program” (BCP), while the control group consisted of 257 pregnant women who received no such interventions.

The BCP included mindfulness meditation, 3 hours of yoga and breathing practices every week, 2 hours of harmonizing music every week, 1 hour of baby bonding activities every week, and 1 hour of personalized diet and pregnancy education each week. The data were collected at 15 and 35 weeks of pregnancy and then from 1 month until 6 months of postdelivery.

**Results:** The study showed a statistically significant improvement in sleep patterns and stress levels. It also showed a statistically significant decrease in the incidence of preterm delivery and low birth weight and a better maternal–fetal bonding or attachment (MFA) in the BCP study group compared to the control group. After initiation of BCP activities in the App, 88% of the patients reported a significant reduction in stress. The BCP study group also reported a higher sense of mastery in coping with postpartum blues. Eighty percent of the control group reported postpartum blues as compared to 19% of the BCP users. Moreover, 81.4% of the BCP study group reported more sense of control in managing their pregnancies, despite the stressful COVID environment.

**Conclusion:** The BCP activities, such as meditation, yoga and breathing exercise, harmonizing music, baby bonding activities and personalized diet, and pregnancy education, have helped pregnant women to reduce their stress levels with improvement in sleep quality, increased a sense of control over diet and nutrition, and educated about MFA.

The use of BCP has also positively correlated with better early childhood development and milestones.

**Keywords:** Baby Care Program, Baby blues, Fetal development, Mother–fetal attachment, Nuclear family, Pregnancy, Stressors.

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## INTRODUCTION

Traditionally, our social structure and culture supported the transition of women to motherhood. The pregnant women in the past with joint family system were surrounded by knowledgeable women, family, and close friends, who supported this transition with affirmation and great excitement. We also know that pregnant women were treated differently, given the best food, and protected from stress and hard physical work. The joint family system also played a major role in the survival, health, education, development, and protection of the children in the family and helped in providing expecting mothers with stability and support when they most needed it.<sup>1,2</sup> The current trend of changing family dynamics to a nuclear structure along with limited medical support during the COVID pandemic had led to more stress and anxiety during pregnancy. It has been observed that approximately 70% of women experience either prolonged depression or a phase of baby blues,<sup>3</sup> which can have an effect on the maternal–fetal bonding and also influence sleep patterns, ability to perform daily tasks, and quality of life in the pregnant women.

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It is a known fact that bonding with and shaping the baby's temperament, also known as maternal–fetal attachment (MFA), begins right from the time of conception.<sup>4</sup> The baby can hear and absorb mother's emotions and feelings in the womb. Mother is a powerful engineer in shaping the baby's traits and personality just with her state of mind, calmness, and mental stability. Her exposure to good nutrition, music, exercises, and meditation improves her coping up strategies and reduces stress.

Several studies have shown that educating mothers on MFA can enhance the mother's mental health and attachment to the infant.<sup>5</sup> During the past several decades, great strides have been made in improving the outcomes of pregnant women and their babies. The Baby Care Program (BCP) digital intervention was designed and developed to help mothers to improve MFA and help them to cope with stress. Thus, one can help pregnant women from all walks of life with the use of technology to experience the benefits of the age-old practices of maternal well-being.

Simple elements like “music” impacted a mother's state of mind and outcomes in pregnancy.<sup>6</sup> Chansoria, Konanki, and Tiwari in a single-center, randomized, open-label controlled trial of primigravida mothers aged 19–29 years concluded that prenatal music exposure of the mother significantly and favorably influenced neonatal behavior.<sup>7</sup>

The body of research on mindful interventions is the cornerstone of the BCP App, leading to its digital framework that involves the following:

- Meditation and sleep guidance
- Harmonizing music
- Talk to baby and storytelling (baby bonding activities)
- Yoga and breathing exercises
- Diet and pregnancy information

The vision of this app, which was established in July 2019, is to help the expectant mother develop and sustain a healthy, holistic lifestyle that begins in the preconception period and continues to the postpartum period. This app is a membership-based platform, which has a repository of 800 plus actionable activities under meditation, music, yoga, and unique baby bonding exercises for women to be physically and mentally healthy and connect with the baby.

The primary aim of this study was to test the efficacy of mindfulness activities and maternal bonding with the unborn baby with regard to postnatal outcomes in primigravidas. The secondary aim was to determine the influence of ongoing, real-time consultative mentoring for the primigravida on lowering the day-to-day maternal stress and other secondary effects.

## MATERIALS AND METHODS

This longitudinal study (panel study) was conducted on 512 primigravidas. The study group included 255 pregnant women who opted for a digital holistic health program: “Baby Care Program” (BCP), while the control group consisted of 257 pregnant women who received no such interventions. Table 1 shows the total number of women in the study and control groups in different age-groups.

The study group was offered the BCP that included the following:

- 8 minutes of daily guided mindfulness meditation.
- 3 hours of yoga and breathing practices every week.
- 2 hours of harmonizing music every week.
- 1 hour of baby bonding activities every week.
- 1 hour of personalized diet and pregnancy education every week.

**Table 1:** Subjects as per age-group

Age	Study group (n = 255)	Control group (n = 257)
20–30	158	135
30–35	62	78
35–40	23	43
>40	2	1

The data were collected at 15 and 35 weeks of pregnancy and then from 1 month until 6 months of postdelivery. Both quantitative and qualitative data were collected using a descriptive mixed-methods design. In the first data-gathering touchpoint, the primigravida milestones were collected from weeks 10–12.

In the 15th and 35th weeks, the maternal psychosocial indices were mapped on three scales, namely the Perceived Stress Reactivity Scale (PSRS), Pittsburgh Sleep Quality Index Scale (PSQI), and Cranley's Maternal–Fetal Attachment Scale (CMFAS).

Participants also responded to a 45-item self-reported questionnaire on their emotional state, postpartum blues, breastfeeding, sense of control, and their observations of the baby. This method of data collection was selected because it not only provides freedom for participants to express their views but also helps in validating results. Moreover, this method was the easiest to conduct during the COVID pandemic.

## RESULTS

This study to probe the role of the BCP mindful digital program-based interventions on pregnancy and fetal outcomes threw up interesting insights across several dimensions.

The mean gestational age at delivery and the weight of the baby was significantly more in the study group as compared to the control group (Table 2). The incidence of preterm deliveries was significantly lower in the study group as compared to the control group (Table 2). There was no statistical difference in the normal vaginal delivery or emergency cesarean section between the two groups, but the rate of elective cesarean section was much higher in the control group as compared to the study group though it did not reach statistical significance (Table 2). One must remember that there is still an 8% chance that the null hypothesis is true for the rate of elective cesarean section being more in the control group.

The data on the birth weight of the babies revealed that the BCP study group notched a mean of 3.1 kg as against the control group's 2.4 kg (Table 2). More than 86% of babies had a birth weight greater than 2500 g in the study group as against 67% in the control group (Fig. 1).

When the data were analyzed for preterm deliveries, it was observed that the incidence was much lower in the BCP group (12%) as compared to controls (32%) (Fig. 2).

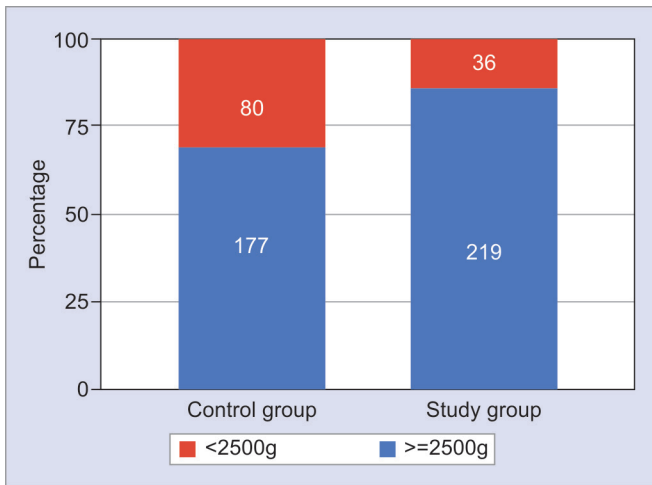
Eighty-two percent of mothers in the BCP group revealed that they were able to adopt diets with ideal nutrition, compared to 46% in the control group, based on the dietary information and recipes that were made available to them on the BCP.

The study group of BCP mothers reported better sleep during pregnancy. On the PSQI scale, there was a significant difference between mothers using the BCP activities vs those in the control group (Table 3). Patients reported better sleep (87%) as compared to their pre-BCP sleep, which was attributed to the in-App activities of BCP (Fig. 3).

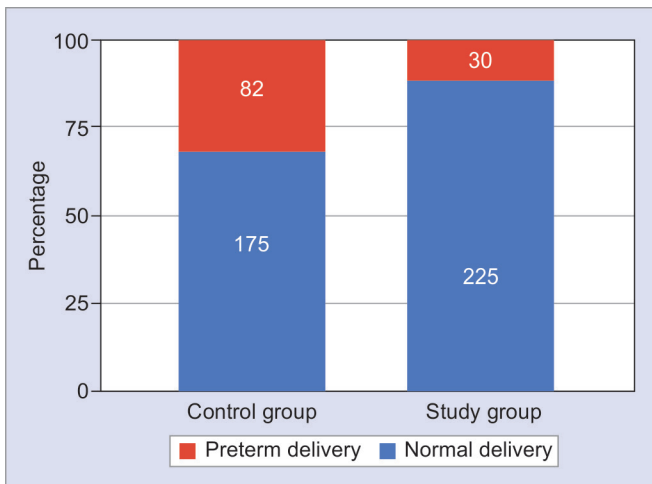
**Table 2:** Results of the pregnancy outcomes

	(Baby Care Program) Study group (n = 255)	Control group (n = 257)	p
Mean gestational age at delivery (weeks)	38.5	36	0.02
Mean birth weight (g)	3130	2490	0.004 (a)
Preterm delivery	30 (12%)	82 (32%)	0.0005 (a)
<b>Mode of delivery</b>			
Normal vaginal delivery	141 (55%)	129 (50%)	0.8
Elective cesarean section	40 (16%)	69 (27%)	0.08
Emergency cesarean section	74 (29%)	59 (23%)	0.4
<b>Birth weight</b>			
<2500 g	36 (14%)	80 (31%)	0.01 (a)
≥2500 g	219 (86%)	177 (67%)	0.01 (a)

<sup>a</sup>p <0.05 univariate analysis between groups; p value and significance



**Fig. 1:** Birth weights for control and study groups



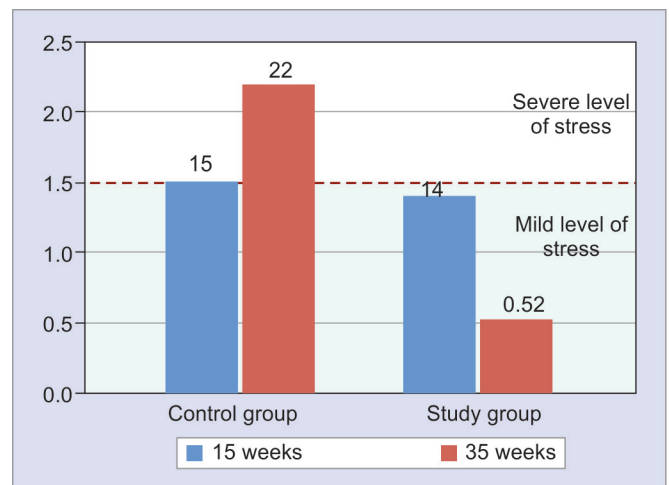
**Fig. 2:** Preterm delivery and normal delivery for control and study groups

A very important issue of maternal stress was also explored in this study using the PSRS. The BCP study group also self-reported significantly lower stress levels (14%) as compared to the control

**Table 3:** Responses on psychological scales: PSQI, PSRS, and Cranley's MFA scale

	Control group (n = 257)	Baby Care Program Group (n = 255)	p
<b>PSQI score</b>			
15th week	4.3	4.1	
35th week	5.1	2.8	0.018 (a)
<b>PSRS score</b>			
15 weeks	1.5	1.4	
35 weeks	2.2	0.52	0.032 (a)
<b>Cranley's MFA scale</b>			
15 weeks	76	74	
35 weeks	82	108	0.003 (a)

<sup>a</sup>p <0.05 univariate analysis between groups; p value and significance



**Fig. 3:** PSQI scale response for control and study group

group (79%). In the study group, 70% attributed to the reduction in stress levels to the activities they did under the BCP program.

The PSRS score was significantly higher (2.2) in the control group as compared to 0.52 noted in the BCP study group (Table 3). The study group performed better (Fig. 4) at 35 weeks of pregnancy.

This was further validated by the subjective self-reports. With regard to fears related to childbirth, BCP users reported significantly lower fear of labor (24%) as compared to the controls (12%).

The BCP study group also reported a higher sense of mastery in coping with postpartum blues. The control group reported significantly higher (80%) postpartum blues as compared to 19% of the BCP users. Moreover, 81.4% of the BCP study group reported that they felt a sense of control and confidence in managing their pregnancies, despite the stressful COVID environment.

In the current context of fast-paced urban lives, a raging pandemic, uncertainty of the future, has multiple stressors on expectant mothers. In the general population, mothers have reported that they spend an average of 17 minutes on themselves while the BCP reported a range of 2–4 hours. This, they said, was despite the increased workload and diminished support due to the lockdown. The question is how one can expand the use of scientifically proven mindfulness, relaxation, and planned activities for self-care to the entire pregnant population.

On the Cranley's MFA 24-item scale that has five subscales to measure the construct of MFA during pregnancy,<sup>8</sup> the Cranley's MFA scores positively correlated with the amount of available social support and negatively correlated with the amount of stress perceived. The BCP study group scored 108 as compared to the control, which scored 85 (Fig. 5).

The content analysis validated the above in which 97% of the BCP users reported higher levels of bonding and an understanding of their baby's needs compared to 19% in the control group. Ninety-three percent of BCP users reported a deep understanding of the importance of MFA compared to 34% of in the control group (the remaining did not have any knowledge of MFA). In addition, 93% of BCP users reported a marked increase in attachment with their babies after regularly practicing BCP baby bonding activities. Being informed and having easy access to query resolution led to expectant mothers reporting lower levels of anxiety.

Seventy-four percent of the study group also reported that the BCP in-App activities helped to stimulate baby's movements in the womb. The use of the BCP app resulted in a lower incidence of postpartum blues and depression and positively correlated with early childhood development—both mental (brain development, physiological) and physical (birth weight, motor skills, milestones). It also helped in improving baby–mother bonding.

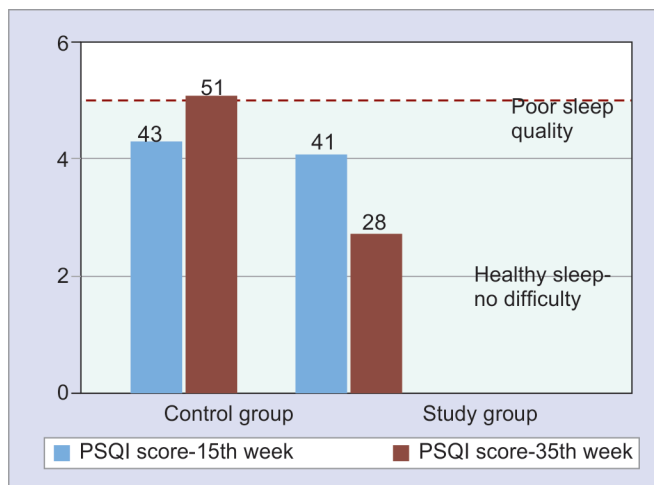


Fig. 4: PSRS scale response for control and study group

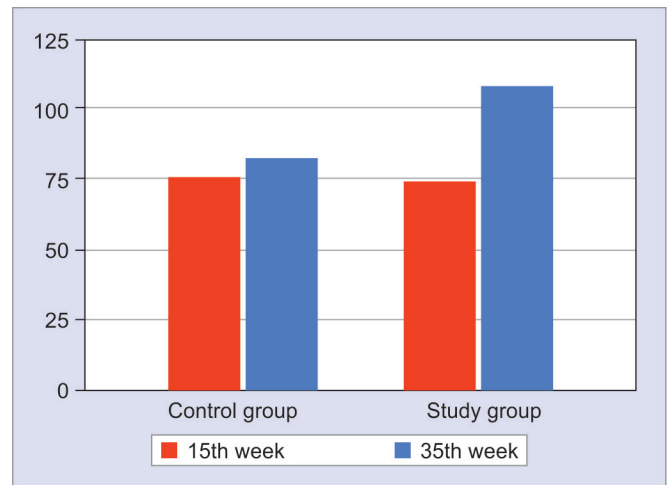


Fig. 5: Cranley's MFA score for control and study groups

Yoga, breathing exercises, and meditations helped in increasing lung capacity, controlling the breathing pattern, and alleviating labor fears. This helped the pregnant women in having a normal vaginal delivery and in accepting/tolerating pre- and postpartum symptoms and body changes.

Moreover, the real-time digital education on widespread pregnancy-related concerns, such as diet, fetal development, growth, symptoms, maternal bonding checkups, and scans, helped to reduce anxiety and manage nutrition especially during the pandemic, when access to healthcare is restricted. As the use of BCP increased the parental bonding with the baby, it led to exclusive breastfeeding that has several advantages.

## DISCUSSION

The iMumz pregnancy, a baby care and parenting app, has beautifully amalgamated the treasure of traditional methods of maternal and fetal wellness, runs past the stringent litmus of science, and is serving the same methods digitally, via activities easy for pregnant women to perform in their own comfort zone.

The objective of the digital app is to help the expectant mother to develop and sustain a healthy, holistic lifestyle right from the preconception period to postdelivery.

Sleep patterns, ability to perform daily tasks, and quality of life in the pregnant woman are affected by systematic variations caused by hormonal, emotional, mental, and physical factors.<sup>9</sup> Sleep deprivation leads to a decrease in the function of the immune system and functioning of the hypothalamus, pituitary, and adrenal glands.<sup>10</sup> Even as the pregnant woman tries to cope with this state during pregnancy, fears related to the upcoming childbirth add to her anxieties. In a study, 80% of pregnant women reported anxieties around the process of birth.<sup>11</sup>

The pregnant woman's state of mind affects the development of the unborn baby's cognitive and noncognitive skills: when she is calm and at peace, the baby reaps significant benefits and she experiences higher self-esteem and a sense of personal control.<sup>12</sup> The opposite leads to increased incidences of intrauterine growth retardation, preterm labor, prolonged labor, fetal heart rate decline, low birth weight, increased rate of cesarean section, postnatal neurobehavioral problems, and developmental disorder. Moreover, it was also observed that heightened maternal anxiety increased the

association between plasma and amniotic cortisol levels, suggesting that women's distress may affect children's outcomes via epigenetic regulation of glucocorticoid pathway genes in the placenta.<sup>13</sup>

A recent study found that pregnant women experience more anxiety antepartum as compared to postpartum.<sup>14</sup> A study based on the Avon Longitudinal Study of Parents and Children indicated that maternal prenatal anxiety predicted persistently higher behavioral and emotional symptoms across childhood with no decrease of effect into adolescence. Elevated prenatal anxiety (top 15%) was associated with a twofold increase in the risk of a probable mental disorder. Results were similar with prenatal depression that had a direct and persisting effect on the child's psychiatric symptoms and supported an in-utero programming hypothesis.<sup>14</sup>

Consistent with the Developmental Origins of Health and Disease model, prenatal distress was found to be associated with heightened psychiatric risk, suggesting a "third pathway" for the familial transmission of disease beyond shared genes and the postnatal effects of maternal psychopathology that influences fetal neurobehavioral development.

The woman needs to develop a strong attachment with her baby in natural and normal ways. She needs to be supported for this to alleviate her fears about the progress of pregnancy, labor, and birth so that she takes good care of herself and her baby.

The BCP has been seen to have a direct and indirect effect on the mother developing a closer connection with her baby. A milestone study by Tsao, Hsing, Wang, and Huey-Ming Guo established that there is a relationship between mindfulness and MFA during pregnancy.<sup>15</sup> A pregnant woman needs to be made aware of the need for her to connect to the fetus. Furthermore, cultivating an open and nonjudgmental attitude toward one's pregnancy stress is important in addressing the relationship between the mother and her baby.

A study on maternal bonding through pregnancy and postnatal life aimed to build a prognostic model of bonding quality based on sociodemographic factors and postnatal factors (e.g., weeks of gestation, breastfeeding problems, and crying behavior).<sup>16</sup> It was hypothesized that both the quality and intensity of maternal-antenatal bonding would increase through the course of pregnancy until the early postnatal period. Furthermore, it was expected that not only mother-fetal bonding in trimesters 1 through 3 would predict mother-infant bonding at 8 weeks postpartum.<sup>16</sup>

It is a known fact that preparation for a safe and easy birth is determined by what the mother does throughout pregnancy. Thus preparing for birth needs to start early in pregnancy and childbirth education plays a very important role in assisting the women on this journey. This education will help the women manage normal fears about pregnancy, labor, and childbirth, develop strong bonding with the baby, and also develop confidence in themselves about the process of birth. This also helps the women embrace the belief that she herself is responsible for the health and safety of herself and her baby.

During the COVID pandemic, it was difficult for face-to-face talks and counseling, which increased the stress in these pregnant women. The BCP app has helped these anxious mothers in changing their attitude, having a deeper understanding of pregnancy and childbirth, and becoming stress-free during their journey of becoming a mother. Moreover, calmness and peace do not emanate from outside and with momentary pleasures alone but it is influenced by the internal state of being. Yoga, music, meditation, breathing exercise, and counseling have been significantly effective

for reducing stress scores, coping with pregnancy, and the overall well-being of antenatal mothers.<sup>17</sup> All these were available in the interactive BCP app.

Bowlby's (1951) pivotal work on attachment suggested that the absence of a close and sustained bond with a mother (or mother figure) has irreversible mental health consequences on the child.<sup>18</sup> Fowles and Horowitz (2006) support this, describing infant development to be sensitive to the quality of mother-child interaction in the first postpartum year.<sup>19</sup>

Children of mothers with prenatal maternal depression (PMD) showed cortical thinning, particularly over the frontal lobes and this may be a risk marker for depression in the future. Another study found that the microstructure of the amygdala, indexed by fractional anisotropy, may be altered in newborns of mothers with PMD.<sup>18</sup> It was also observed that PMD-exposed infants had increased functional connectivity between the amygdala and several frontal regions.<sup>19</sup> Together these results suggest that exposure to PMD may influence the development of the frontal cortex and particularly, amygdala-prefrontal circuits, with implications for the future as altered amygdala-prefrontal connectivity has been implicated in pediatric depression.<sup>20-22</sup> Thus prenatal maternal mood and stress levels have a direct and persisting effect on her child's psychology and support an "in utero-programming" hypothesis for depression in childhood and adolescence.

Today, pregnancy and birth are treated as medical events rather than as normal life events and the woman is always under stress between her two prenatal visits that everything is "okay" in a nuclear family setup where the age-old culture of social and mental support of joint family is not there. Today with medicolegal issues, the obstetrician exaggerates the risks of pregnancy and birth and increases women's fears for themselves and their babies. This adds to the stress of the expectant mother that results in an exaggerated concern for safety, "intervention-intensive" pregnancy, as well as labor and childbirth. Moreover, the pandemic has increased the stress of the pregnant woman as her visits to the obstetrician have also decreased, which makes her worried about the well-being of her child.

A large number of studies have confirmed that a woman's active involvement with the fetus benefits both the woman and her unborn child.<sup>23,24</sup> We have explored how this attachment can be assisted and facilitated by providing her with well-researched activities that she can engage in through the BCP. The BCP not only provides activities but also sets up an engagement framework to intimate, involve, and continuously encourage the completion of the same. We must remember that everything that happens once a baby is born is the outcome of all that has happened during the pregnancy. One can help pregnant women with the use of technology to experience the benefits of the age-old practices of maternal well-being. The iMumz BCP App was designed and developed for precisely this purpose.

## CONCLUSION

The women's ability to negotiate this journey of pregnancy and the postpartum period will determine the well-being of the mother and child. The physical and emotional changes of pregnancy and then the experience of labor, birth, and breastfeeding play vital roles as women make the transition to motherhood. To make this journey of pregnancy and labor fruitful for the mother, both physical and psychological prenatal care systems contribute in a powerful

way and allow her to negotiate the pregnancy successfully and ultimately her transition to motherhood.

The BCP activities, such as *meditation, sleep guides, harmonizing music, talk to baby and baby bonding activities, yoga and breathing exercise, dietary, and pregnancy information*, have helped to reduce stress, educated about MFA, increased a sense of control over diet and nutrition, and improved the mother's quality of sleep, which ultimately has a bearing on the baby's temperament.

These results have important implications not only for pregnant women and their unborn children but also for healthcare professionals working in antenatal and postnatal services, technology visionaries and urban planners, and future generations. It also puts the spotlight on a return to traditions that were prevalent for ages. Their rediscovery with scientific validation and their brand-new method of digital delivery. In these times of social distancing, isolation, and stress during the pandemic, the BCP has helped in the remote assistance in pregnancy care. The BCP is one such contemporary prenatal care app that helps women to accomplish the tasks of pregnancy, labor, and birth and has the potential to help women's transition to motherhood.

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