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Participation in an Online Prenatal Mindfulness- Relationship-Based (PMRB) Program: Outcomes for Maternal Mindfulness, Mental Health, Interoception, and Mother-Infant Relationship during Pregnancy and Post-Partum

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Abstract

This feasibility study sought to investigate the impact of an online 9-session Prenatal Mindfulness Relationship-Based (PMRB) group treatment program upon maternal mental health (depression, anxiety, and stress), interoception, and mother-infant relationship during pregnancy and post-partum. The study was designed in two parts 1) a quantitative examination of pre, post-treatment and 10-12 weeks post-partum measures targeting 13 pregnant women from a non-clinical population and 2) a qualitative exploration of the same pregnant women's experiences of the PMRB program reported during the sessions, including their birth stories. Responses to an open-ended question about how the program had supported them during pregnancy, labour/birth and the first post-partum trimester were summarised using thematic analysis. Women (N = 36) were recruited to the non-randomised feasibility study and 13 were allocated to the PMRB program. Women were excluded due to the online recruitment timeframe, missing baseline gestational age and unavailability for the proposed time. All the allocated women completed the program during pregnancy and the

baseline and post-treatment surveys. There were 12 women who completed the post-partum follow-up. Only one participant was lost to the follow up for unknown reasons. Results revealed an improvement in mindfulness, depression, interoception and mother-infant relationship post-treatment and at postpartum follow-up. The qualitative analysis led to the identification of 16 themes, which were organized in four categories describing the experience of participants. Findings provide preliminary support for the feasibility of the PMRB program to improve maternal mindfulness, interoception, mental wellbeing and mother-infant relationship during pregnancy and post-partum. The qualitative evaluation suggested the PMRB program may help women cope with emotional challenges and be more connected to their bodies and infant. The program may also help women become more aware of their unborn infant as a sentient being and the influence of their health and mental wellbeing on the infant development and health. Furthermore, it may be a facilitator of the mother-infant relationship during pregnancy and post-partum, promoting infant's healthy development.

Keywords
Maternal mindfulness; maternal interoception; pregnancy; maternal mental health; perinatal depression; perinatal anxiety; perinatal stress; mindfulness-based program; mother-infant relationship; unborn infant; birth stories

1. Introduction

Research conducted in recent years showed that depression affected seven to 25% of women during the prenatal period [1] and 10 to 30% during the postpartum period [2]. Furthermore, maternal anxiety during pregnancy has been estimated to range from 12 to 39% [1, 3], whereas postpartum anxiety estimates range between 11 and 20% [4, 5]. A global survey identified a substantial increase of maternal depression during the COVID-19 pandemic from 15% before the outbreak began to 41% [6]. In addition, the study found that the number of women reporting moderate to high anxiety symptoms rose from 29% prior to the pandemic to 72%. Perinatal mental health problems also have a considerable economic impact. The long-term cost of perinatal depression, anxiety, and psychosis in the UK is approximately £8.1 billion for each one-year cohort of births, and their adverse consequences on children £23 billion each year [7], with other countries facing similar challenges. Perinatal depression and anxiety (PNDA) costs Australia $877 millions annually, according to a 2019 PwC (Price Waterhouse & Co) Australia analysis prepared for Gidget Foundation Australia. The estimated cost of the lifetime adverse consequences of the increased risk of depression, anxiety, and ADHD on children of parents with PNDA is $5.2b (https://www.gidgetfoundation.org.au/wp-content/uploads/2019/11/Cost-of-PNDA-in-Australia_-Final-Report). It has been suggested that treating perinatal mental health problems effectively by promoting health-enhancement programs during pregnancy could save many of the serious long-term human and economic costs [7-9].

Reducing maternal distress during pregnancy and mitigating the risk for post-partum mental health disorders is a vital public health priority [7-10]. Maternal stress, anxiety, and depression during pregnancy and post-partum are reported to have short and long-term consequences for

women's health, impact on mother-baby/child interactions, and increase the risk of emotional, cognitive, behavioural, and social problems in children [11, 12]. Research has found that it is not only clinical levels of mental disorders in women during pregnancy which are associated with adverse outcomes for children, but also symptoms at sub-clinical levels related to a range of common objective stressors and subjective stresses [13]. Considerable evidence that a variety of ordinary issues in pregnancy - such as relationship difficulties [14], emotional or physical partner abuse [15], and even daily challenges [16] are associated with poorer outcomes for children, indicate that interventions targeting both clinical and universal pregnant populations are warranted.

It is well established that maternal mental health problems are key determinants of difficulties in the formation of the prenatal maternal-infant relationship [17, 18], bonding [19, 20], parental sensitivity and responsiveness [21] and maternal-infant relationship, particularly emotional availability [22]. The formation of a bonding relationship between a mother and her infant has been recognized as laying the foundation for later child development [22]. Associations between high levels of anxiety during pregnancy and poor quality of maternal bonding at 18 months postpartum have been found [23]. This is in line with findings showing an association between maternal anxiety and insecure attachment in young infants, as anxiety may hinder maternal sensitivity [24]. Maternal depression has been reported to influence a mother's sensitivity and responsiveness to her infant, with adverse consequences on the attachment relationship [25].

There is a need for research that provides important information regarding assessment and support strategies that may be developed during the prenatal period to facilitate optimal mother-infant relationships [26]. While links between maternal psychological distress in the post-partum period and difficulties in maternal-infant relationship have been well documented [5, 27], there is less research investigating the relationship between prenatal psychological distress and mother-infant relationship in the first post-partum trimester. A deeper understanding of the elements of interventions that may mitigate the risks of postnatal depression, anxiety and stress could help maternal health services provide prenatal support programs enabling mothers to cope with the challenges of the transition to childbirth and parenting. This would minimise the risk of mental health and mother-infant relationship issues postpartum.

Mindfulness-based programs are a relatively new approach to the prevention and treatment of mental health problems. Mindfulness is a quality of human consciousness that can be assessed and promoted. It allows us to witness sensations, feelings, and thoughts as they arise in our body and mind, as 'objects' which can be observed directly without cognitive evaluation or elaboration, thus enabling us not to feel overwhelmed by them. This compassionate awareness also reduces our automatic, habitual reactions to what is happening and allows for more space between the trigger and the response [28]. This non-reactivity fostered by mindfulness is a quality that enables people to 'let go' of the thoughts and emotions that would otherwise trouble the mind unnecessarily [29]. Mindfulness involves techniques that help cope with worry by helping an individual attend to the present rather than the past and the future [30]. For pregnant women and new mothers facing the challenges and stress of a significant period of transition, such skills may be of particular importance.

Many parents find themselves beset by everyday preoccupations and expectations, which generate stress and dissatisfaction with their lives. Parents' distress curtails parents' emotional availability towards their infants and relationship with them**,** which is supportive of infants' health and development [22]. By practicing present-moment awareness of both their child and their own thoughts and emotions without judgement and accepting them for what they "are", the parents

may develop protective psychological strategies [31, 32]. Contemplative traditions of mindfulness training have always focused upon the relational aspects of mindfulness (how people relate to others and themselves). Studies have shown that mindfulness training leads both to greater attention and increased self-compassion and empathy, and that these facets independently predict mental health outcomes [33, 34].

Mindfulness is a multi-dimensional concept that can be understood in a variety of ways and applied in a variety of contexts. In particular, it has been used for stress reduction [Mindfulness-Based Stress Reduction (MBSR)] [28], depression and relapse prevention [Mindfulness-Based Cognitive Therapy (MBCT)] [35], and in childbirth and parenting [36]. Support programs during pregnancy, such as mindfulness-based therapies, have shown positive outcomes, primarily in reducing parental stress, anxiety, and depression [3, 36-38]. Antenatal maternal mindfulness has been associated with better self-regulation and lower levels of negative affect in 10-month-old infants [39]. Associations between maternal mindfulness and response to infant stress with reduced reactivity have been identified [40, 41]. Furthermore, correlational longitudinal investigations spanning pregnancy and early childhood have provided evidence of the benefits of prenatal support programs on two generations [42]. In addition, higher levels of mother's self-reported use of mindfulness during pregnancy were found to be associated with maternal report of lower levels of infant self-regulation issues and negative affectivity [39].

Thus, these findings suggest that maternal prenatal mind state, mood, and behaviour are likely to influence infant stress physiology and behaviour. Therefore, participating in a mindfulness-based program that significantly reduces levels of stress, depression, and anxiety and improve maternal health and wellbeing could reduce the risk for psychological disorders and even health problems in the infant and child. A range of treatment programs [43] have revealed promising results in promoting maternal-infant attachment during pregnancy, including psychoeducation [44] and yoga sessions combined with mindfulness [45]. Mindfulness appears to be a protective factor fostering positive attachment and child development and behaviour outcomes [31, 41, 46].

There remains a need to consider the influence of antenatal mindfulness on mother-infant relationship during pregnancy and in the first post-partum trimester. Both maternal mental issues and mother-infant relationship difficulties post-partum could be addressed in the future by support strategies that target mindfulness during pregnancy [3].

Despite the growing interest in interoception for its significant relevance in the study of mind-body approaches and human health [47-49], little research has examined the influence of interoception in pregnant populations. Mothers' capacity to interocept and interpret has been associated with her capacity to respond to the infant's bodily cues, which is a requirement to meet the infant's developmental needs [50]. If pregnant mothers suffer from stress, depression and/or anxiety, this has been found to impact upon their interoceptive abilities [51], and thus their capacity to respond to their infant's need, affecting the future co-regulating processes within the mother-infant relationship [50, 52]. Based on this evidence, it may be necessary to investigate whether interoception can be an effective predictor tool for early detection of mental health disorders such as depression, anxiety, and stress during pregnancy and postpartum as well as mother-infant relationship difficulties.

Emotional availability has been considered a good postnatal indicator of a well-functioning mother-infant relationship [53]. Findings indicate the importance of emotional availability in the postpartum period and early parenthood as well as the need to support emotional availability in

parenthood [54]. Good emotional availability [53, 55] in the first year of life indicates well-attuned preverbal interactions between infant and parent; that is, a well-functioning parent-infant relationship [54]. These parental abilities and preverbal communications are key factors in parent-infant relationship and are essential contributors to infant development [56]. Mothers with depressive symptoms have been found to less likely verbally engage and attune with their infants and interpret their body cues, and more likely to manifest irritable behaviour with them [57]. Therefore, maternal mental health issues are reported to have an impact on maternal-infant emotional availability, which highlights the need for support during this crucial time for infant's development of a healthy relationship with the caregiver. Gaining an improved understanding of the effects of a mindfulness relationship-based program on post-partum emotional availability may highlight support strategies to promote better mother-infant relationship, potentially leading to more positive outcomes for children.

A qualitative exploration of participants' experiences is also needed to improve our understanding of pregnant women's experiences of prenatal mindfulness-based training. In previous qualitative research, women have reported the benefits they experienced from pausing and breathing, developing an attitude of acceptance, and being in the present moment and that these are all core aspects of mindfulness they have used to help them cope with pregnancy, childbirth, and parenting [58]. These identified themes are consistent with those of earlier qualitative analyses, especially acceptance [59, 60]. The value of having a supportive group experience has also been highlighted [60]. The qualitative component of another study also supported the quantitative findings, indicating the potential of mindfulness practices to significantly improve women's wellbeing during pregnancy [61]. It revealed that mindfulness can positively influence the lives of some pregnant women, that individuals engaged with the program in different ways, using different levels of meditation and different types of mindfulness practice. Changes attributed to mindfulness practice by the study participants included an improved ability to observe and make more considered responses to challenging situations rather than being caught in negative thoughts and emotions and escalating them with damaging consequences. Participants also reported improvements to interpersonal relationships, sleeping patterns, and mood and quality of life.

While these data are promising and improve our understanding of pregnant women's experiences of prenatal mindfulness training, there is a gap in the literature regarding pregnant women's experiences of their relationship and communication with their developing infant and the influence of this perception on birth, breastfeeding, and bonding in the first postpartum trimester. Gaining an understanding of the subjective experiences of pregnant women and factors that contribute to program adherence is important for designing effective programs to support maternal wellbeing and mother-infant relationship during pregnancy and post-partum. Therefore, a qualitative analysis has been helpful for further exploration of the PMRB program as a mental health and mother-infant relationship support strategy.

1.1 The Prenatal Mindfulness Relationship-Based (PMRB) Program

The current program [Prenatal Mindfulness Relationship-Based (PMRB)] was informed by the three key programs [28, 35, 36], the researcher's teaching training with *Youth Mindfulness* and recent findings of mindfulness and prenatal psychology, in particular evidence of the unborn infant

as a sentient being, capable of engaging in bidirectional interactions and communications with the mother [62-64]. Modifications were made to some components, such as the mindful movement component, and other elements were introduced, such as prenatal psychology education and awareness of the unborn infant's relational and communication abilities, to ensure they were appropriate for pregnant women. To our knowledge, there has been no previous program focused on the prenatal relationship and based on evidence of mindfulness and prenatal psychology. The PMRB program was the first to test the influence of maternal awareness of the unborn infant as a sentient being and mother-infant relationship during pregnancy on postnatal outcomes. The program was designed to test its feasibility and acceptability in a PhD project. It has been developed by the PhD researcher through her work with expectant parents and their infants and first described in her book [65].

The PMRB program is a 9-session mindfulness-based program focused on mother-infant embodied relationship and communication during pregnancy developed specifically for pregnant women. The sessions took place online, run for two hours and occurred weekly for eight weeks during pregnancy. There was one session 10-12 weeks post-partum. Participants were encouraged to attend all sessions and not miss more than two sessions if necessary. Most participants missed one or two sessions due to a meeting with the midwife or gynaecologist or family commitments. Everyone attended approximately 80% of the course. Participants were introduced to the mindfulness approach and strategies, including formal and informal mindfulness practices, prenatal and birth psychology, including consciousness of the unborn baby as a sentient being, and home practice.

The mindfulness facilitator was a female mental health professional (clinical psychologist specialized in the prenatal and perinatal field as well as PhD candidate conducting the current study) with specific training in the facilitation of mindfulness groups. Appropriate referral pathways where necessary were provided on the Participant's Information Sheet. No reports of adverse effects were received.

Key features of the program are described in the program manual which was developed as part of the PhD pilot study [66]. This outlines the main activities for each session, the time allocated for each activity and the purpose of each activity. Each session included a weekly discussion topic about mindfulness and prenatal and birth psychology, a discussion of home mindfulness and 'baby connect' practices, a space for breathing exercise, and formal meditation practice and feedback on the experience at the end of the session.

See Table 1 for a concise description of program content.

Table 1 Components of the Prenatal Mindfulness Relationship-Based (PMRB) program. Prenatal Psychology Education integrated with each session's topic.

Sessions number	Focus of session
1	Introduction to Prenatal Psychology and discovering the present moment
2	Everything is mindfulness
3	Discovering embodiment, stress and how it affects us
4	Learning acceptance and emotional availability
5	Self-compassion, self-love and intentionality

6	Cultivating nurturing emotions and conscious communication in the womb
7	Letting go
8	A mindful pregnancy, birth and life
9	Postpartum reunion and birth story

1.2 Current Study

The current study was designed to inform the development of a health-enhancement and clinical protocol and framework for an effective, enduring and low-cost prenatal program for improving maternal mental health (reducing depression, anxiety, and stress) and mother-infant relationship during pregnancy and post-birth among pregnant women of a non-clinical population. The current study aimed to assess whether pregnant women's mindfulness, mental health, interoception and the relationship with their infant during pregnancy and post-partum improved following completion of the 9-session PMRB program. The study also aimed to evaluate the impact of the PMRB program across time, including between pre-treatment, post-treatment during pregnancy, and 10-12 weeks post-partum follow-up. Finally, the study aimed to explore the participants' subjective experience of the program [67]. It was hypothesized that, at post-program the participants would report increased mindfulness and interception, reduced depression, anxiety, and stress, and improved mother-infant relationship during pregnancy and post-partum, indicated by increased emotional availability. Furthermore, it was hypothesized that these program effects would be maintained at 10-12 weeks post-partum follow-up and be consistent with the participants' reports of their experience of the PMRB program.

Qualitative information was collected from participants during the prenatal sessions and a 10-12-week postpartum reunion. The objectives of this qualitative investigation were: 1) To describe pregnant women's experiences in the PMRB program to mitigate the risk for psychological disorders during pregnancy, labour/birth and for mother-infant relationship difficulties; 2) To explore the influence of pregnant women's awareness of the unborn infant as a sentient being and connection with him/her.

An in-depth qualitative enquiry on the participants' subjective experiences may be beneficial in identifying elements of prenatal mindfulness training focused on mother-infant relationship that could be helpful or not helpful for mental health and mother-infant relationship post-partum. The use of the open-ended question, "How has the program supported (or not supported) you during pregnancy, labour/birth and the first post-partum trimester?", to elicit personal accounts of participants' experience of the program, aimed to provide insights into the possible mechanisms by which improvement occurred.

2. Methods

2.1 Procedure

Ethical approval of the study was provided by the Bond University Human Research Ethics Committee (BUHREC) in 2021 prior to commencement. Pregnant women were invited through advertisements on the social media to participate in an e-health feasibility study, including the participation in the PMRB program and completion of a self-report questionnaire package consisting of empirically established measures at three timepoints via an electronic link (Qualtrics). The

package consisted of a socio-demographic questionnaire and five questionnaires for the first survey at 20+ weeks gestation before the first session of the program (detailed below). Participants received requests for the completion of the same questionnaires at approximately 36 weeks' gestation after last session of the program via email. Participants would then be invited via email to complete a post-birth questionnaire package with the same questionnaires, excluding the Maternal-Fetal Attachment Scale (MFAS) and including the Emotional Availability Self-Report (EA-SR) at 10-12 weeks postpartum follow-up. If no response was received after three email communication attempts, follow-up was aborted. Participants were offered a $25 reward at the end of the study Figure 1 displays the time points (T1, T2, and T3) with baseline, post-program, and post-partum follow-up.

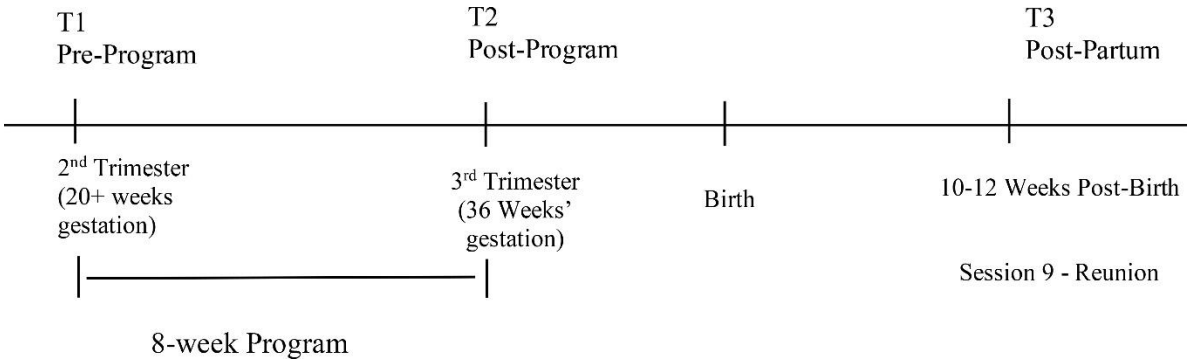

Figure 1 Time Points T1, T2, and T3.

2.2 Participants

Women were eligible to participate in the study if they were: (a) aged 18 or older; (b) 20+ weeks gestation and 26-weeks at onset of program; (c) had sufficient English and intellectual proficiency to understand and complete the questionnaires; (d) did not receive antenatal care from specialized clinics, irrespective of parity and ethnicity; (e) from Australia. Of 36 pregnant women who gave their consent to participation, only two groups of five (Group A) and eight participants (Group B) could be formed due to these participants' availability for the proposed weekday and gestational age required to commence the program. Thirteen pregnant women at 20+ weeks gestation completed all the surveys and participated in the PMRB program during pregnancy. Only one woman did not attend last session at 10-12 weeks post-partum and complete the follow-up. All the other twelve women provided their birth story and feedback on how the program had supported them during labour/birth and the first postnatal trimester. Demographic characteristics of the participants are described in Table 2.

Table 2 Demographic Profile of Participants (N = 13).

Individual-Level Variables	*n*	% (2 dp)
Age		
25-29	3	23.08
30-34	7	53.85
35-39	2	15.38
40-45	1	7.70

Marital Status		
Married	11	84.62
In a Relationship	2	15.38
No. of People in Household		
One	1	7.70
Two	9	69.23
Three	3	23.08
Highest Level of Education		
Vocational/Technical College	3	23.08
Bachelor's Degree	6	46.15
Master's Degree	2	15.38
Doctoral Degree	1	7.70
Other	1	7.70
Primary Area of Employment		
Full-Time	6	46.15
Part-Time	3	23.08
Casual	2	15.38
Hours Per Week		
10-20	1	50.00
20-13	1	50.00
Unemployed	1	7.70
Student	1	7.70
Household Total Annual Income		
0-40,000	1	7.70
60,001-80,000	1	7.70
80,001-100,000	4	30.77
100,001+	7	53.85
Level of Carer Responsibility		
Primary Carer	5	38.46
Equal Responsibility	8	51.54
Pregnancy Planned		
Yes	11	84.62
No	2	15.38
Pregnancy Wanted		
Yes	13	100.00
Undergone Fertility Treatment		
No	10	76.92
Yes	3	23.08
Current Number of Children		
One	13	100.00
Pregnancy Complications		
No	11	84.62
Yes	2	15.38

Gestational Diabetes	1	50.00
Placenta Cyst	1	50.00

Note. N = total number of participants, n = number of participants in the corresponding category, % = percentage of N in the corresponding category.

Participants' age ranged from 25 to 40 years (M = 32). The majority of women were primiparous, three having another child, married, from middle to upper class socioeconomic backgrounds (based on the IRSAD) and from vocational/technical college to doctoral degree educational level, with the majority holding a bachelor's degree. Nearly half of the women were in full-time employment, a quarter in part-time employment, two in casual employment, one was unemployed and one a PhD student. Eleven pregnancies had been planned, and two unplanned. All the pregnancies were wanted. Of thirteen participants, ten did not have fertility/infertility treatments and eleven did not have any pregnancy complication by the time of enrolment. Figure 2 describes the study recruitment and dropout from the enrolment phase through to the analysis.

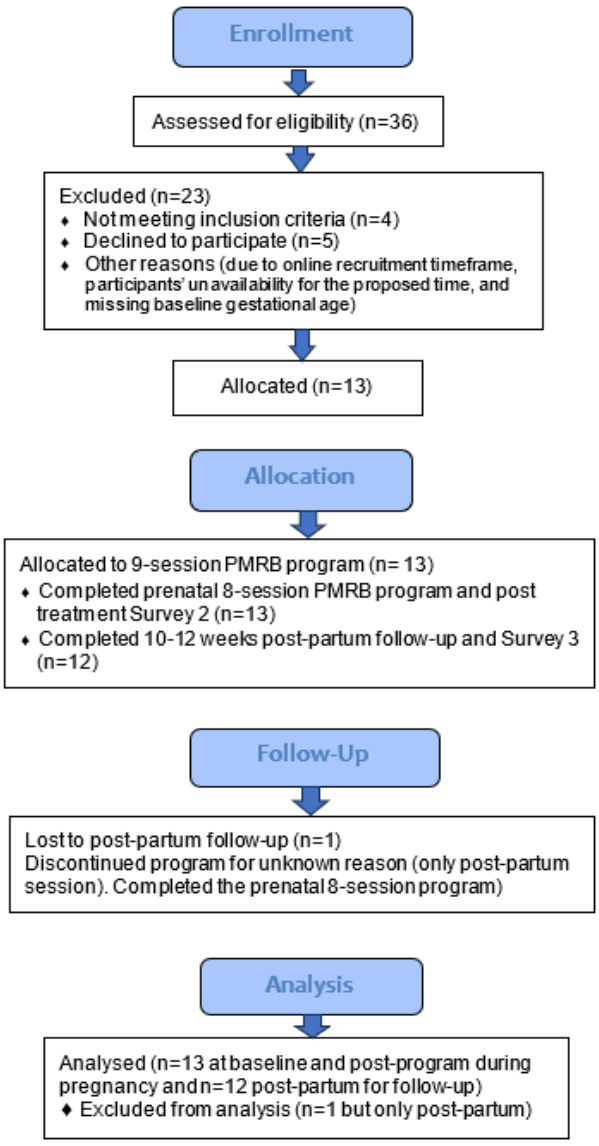

Figure 2 Consort participant flow diagram of PMRB program feasibility.

2.3 Measures

The outcome measures were divided into three categories: measures for mental health, measures for mother-infant relationship and measures for maternal personal development. The self-report questionnaire package is described below.

2.3.1 Socio-Demographic and Birth/Post Birth Questionnaires

Socio-demographic information (e.g., relationship status, number of children, and household income level) was collected from participants at baseline before the first survey at 20+ weeks gestation. Information surrounding type of birth, gestation length, birth weight, breastfeeding/feeding, pregnancy complications (e.g., pregnancy-induced hypertension, gestational diabetes, preterm labour) was collected at follow-up before the third survey at 10-12 weeks post-partum.

2.3.2 Maternal Mental Health Measures

Three different outcomes assessed mental health: depression, anxiety, and stress.

The *Edinburgh Postnatal Depression Scale* (EPDS) [68]. It is one of the most widely used self-report screening tools designed to detect depressive symptoms, particularly during the perinatal period, although it has also been widely used during pregnancy [69]. Pregnant women are required to select the statement which reflects how they have felt in the past 7 days, such as, "I have looked forward with enjoyment to things", As much as I always could; Rather less than I used to; Definitely less than I used to; Hardly at all. The scale consists of 10 Likert-type items scored from 0 to 3 on a 4-point Likert scale and scores are summed to get an overall score, with some items reversed scored [70], with a maximum score of 30. A higher EPDS score represents an increased risk of depressive symptoms. The scale has shown adequate internal consistency, test-retest reliability, and validity, in previous studies [70, 71].

The *Depression Anxiety Stress Scale-21* (DASS-21) [72]. The self-report DASS-21 was used to assess symptoms of depression, anxiety, and stress over the past week. DASS-21 contains seven items for each of the three subscales (total of 21 items), and items are rated on a four-point Likert scale ranging from 0 = never to 3 = almost always, with higher scores being indicative of higher levels of depression, anxiety, or stress [73]. DASS-21 has adequate reliability and validity, as evidenced in a number of outcomes studies [72, 74]. The DASS-21 has also been considered useful to evaluate psychological distress in the prenatal and perinatal period, as it showed adequate reliability and validity [75].

2.3.3 Maternal-Infant Relationship Measures

Two different measures assessed mother-infant relationship during pregnancy and post-birth: the Maternal-Foetal Attachment Scale (MFAS) [76] and the Emotional Availability Self-Report (EAS) (EA-SR) [77].

The *Maternal-Fetal Attachment Scale* (MFAS) [76]. The 24-item MFAS provided an assessment of pregnant women's engagement with behaviours indicative of an emotional connection and interaction with their unborn baby, such as talking to the baby and massaging the stomach where the baby is [76]. The MFAS comprises five subscales: role taking, differentiation of self from the

foetus, interaction with the foetus, attributing characteristics to the foetus, and giving of self. Each item is scored on a 5-point Likert-type scale with options ranging from 1 (strongly agree/definitely yes) to 5 (strongly agree/definitely no). The total scale score ranges from 24 to 120, with higher scores indicating more favourable maternal-foetal attachment. The MFAS is a frequently and internationally used instrument in prenatal studies [78]. The MFAS has been found to have good reliability [71, 76].

The *Emotional Availability Self-Report* (EA-SR) [53, 77]. The 36-item self-report was used to assess maternal emotional availability, a measure that is considered a good indicator of a favourable mother-infant relationship during the first year of a child's life [54]. The EA-SR comprises five subscales: Capacity to Involve the Parent, Mutual Attunement, Affect Quality, Intrusiveness, and Hostility. Each scale is rated on a 5-point Likert scale: (0) Not agree at all, (1) Rather not agree, (2) Neutral (3) Rather agree (4) Totally agree. Two scales, Intrusiveness and Hostility, refer to the parent contribution to the relationship as perceived by the parent. One scale, Capacity to Involve the Parent, refers to the child's contribution to the relationship as perceived by the parent. Two other scales, Mutual Attunement and Affect Quality, refer to both parent and child's contribution to the relationship. An example of the included items is, "I do understand my child, when he or she cries" (Mutual Attunement). The EA-SR is a psychometrically sound measure, with good reliability and convergent validity [54, 77].

2.3.4 Maternal Personal Development Outcome Measures

Two different outcomes assessed maternal personal development during pregnancy and post-birth: the Five Facets Mindfulness Questionnaire (FFMQ; [79, 80]) exploring the level of maternal mindfulness and the Multidimensional Assessment of Interoceptive Awareness, Version 2 (MAYA-2; [81]), measuring maternal interoception (or interoceptive awareness).

The *Five Facets Mindfulness Questionnaire* (FFMQ) [79]. The FFMQ contains 39 items, scored on a Likert-scale of 1 (Never or very rarely true) to 5 (Very often or always true), with higher scores indicating greater mindfulness. These items capture five facets of mindfulness: observing, describing, acting with awareness, nonjudgment of inner experience, and nonreactivity to inner experience. An example question from the Acting with Awareness subscale is "It seems I am 'running on automatic' without much awareness of what I am doing". The measure, widely used in diverse populations, has shown high levels of internal consistency and convergency and discriminant validity when used in nonclinical samples [80]. The FFMQ has showed good reliability and validity in a number of outcome studies of pregnant women [23, 81].

The *Multidimensional Assessment of Interoceptive Awareness, Version 2* (MAYA) [81]. The new version 37-item MAIA-2 consists of eight scales corresponding to its 8-factor structure. These are labelled Noticing, Not-distracting, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body Listening, and Trust. The two items were added to improve internal consistency and make it a valid measure of interoception [82]. MAYA has been widely used in research and clinical contexts and is the mostly widely used self-report measure of interoceptive bodily awareness. Despite the growing interest in interoception for its significant relevance in the study of mind-body approaches and human health [47, 49], little research has examined the psychometric properties of interoception in pregnant populations. A pilot study found significant correlations between interoceptive awareness and anxiety [51], showing good validity of this instrument.

3. Results

3.1 Quantitative Analysis and Results

Statistical data analysis was performed using Statistical Package for Social Sciences (SPSS) version 28 [83]. An alpha coefficient of 0.05 (*$p < 0.05$) was used to assess the significance. Four one-way repeated measures ANOVAs were conducted on 12 participants who completed all the three surveys to determine the presence of statistically significant differences between the dependent variable mean scores across three points time. Additionally, a one-way repeated measures MANOVA was conducted on 13 participants to compare dependent variable mean scores across T1 and T2.

Prior to conducting the main analyses, the data was visually screened for any missing variables, or data entry errors, which was corrected. In circumstances where there was more than 5% of the data missing for a participant, the participant was excluded from the dataset [84]. One participant was excluded from the three-time point ANOVA analysis dataset due to insufficient information provided at T3, however, this participant was utilized in a MANOVA analysis between T1 and T2. Table 3 displays the means and standard deviations for the dependent variables at Baseline (T1), Post-Program (T2) and Follow-up (3). Figure 3 displays the image on Scatter Plot of the mean scores measured on FFMQ, EPDS, DASS-21 and MAIA-2 from Time 1 to Time 2 to Time 3 (N = 12).

Table 3 Means and standard deviations for the dependent variables at Baseline (T1), Post-Program (T2) and Follow-up (T3).

	ANOVA (n = 12)			MANOVA (n = 13)	
Scale	Time 1 M (SD)	Time 2 M (SD)	Time 3 M (SD)	Time 1 M (SD)	Time 2 M (SD)
FFMQ	120.83 (20.06)	143.25 (21.16)	138.58 (21.74)	121.46 (19.34)	142.92 (20.30)
EPDS	19.25 (2.93)	16.33 (3.94)	17.08 (4.87)	19.23 (2.80)	17.31 (5.15)
DASS-21	36.00 (9.76)	30.33 (7.19)	30.50 (7.78)	35.62 (9.45)	30.62 (6.96)
MAIA-2	112.58 (33.46)	135.25 (25.32)	127.58 (22.83)	112.62 (32.04)	134.31 (24.48)
MFAS	-	-	-	89.38 (14.15)	101.23 (11.88)

Note. FFMQ = Five Facet Mindfulness Questionnaire; EPDS = Edinburgh Postnatal Depression Scale; DASS-21 = Depression Anxiety Stress Scale-21 Short Form; MAIA-2 = The Multidimensional Assessment of Interoceptive Awareness, Version 2; MFAS = The Maternal-Foetal Attachment Scale.

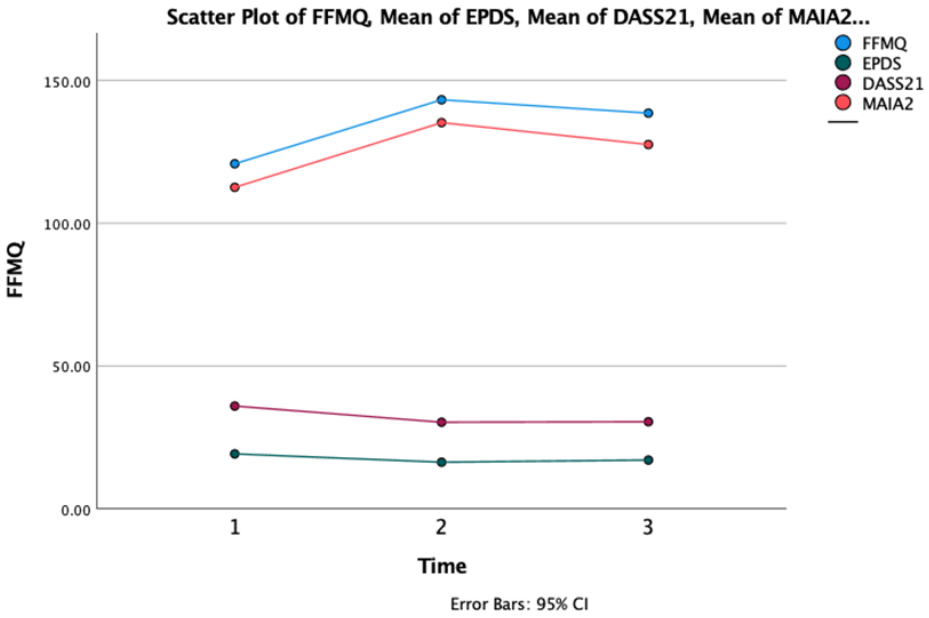

Figure 3 Mean Scores Measured on FFMQ, EPDS, DASS-21 and MAIA-2 from Time 1 to Time 2 to Time 3 (N = 12).

Four within-subjects ANOVAs were run between T1, T2, T3 to explore the effects that the Prenatal Mindfulness- Relationship-Based (PMRB) program had on maternal mindfulness, mental health, in particular depression, anxiety, and stress, and interoception during pregnancy and post-partum. Univariate analysis on FFMQ indicated a significant difference in mindfulness scores F (2, 11) = 7.97, p = 0.009, partial η^2 = 0.615. Univariate analysis on EPDS indicated a significant difference in depressive scores F (2, 11) = 11.91, p = 0.002, partial η^2 = 0.704. Univariate analysis on DASS-21 did not indicate a significant difference in depressive, anxiety, and dress scores F (2, 11) = 2.62, p = 0.121, partial η^2 = 0.344. Univariate analysis on MAIA-2 indicated a significant difference in interoceptive awareness scores F (2, 11) = 10.67, p = 0.003, partial η^2 = 0.681. These results indicated that mindfulness and interoception scores significantly increased ($p < 0.05$) from pre-treatment to immediately following treatment and 10-12 weeks post-partum follow-up. No significant differences were found between post-treatment and follow-up (the p values were on the threshold of significance), suggesting mindfulness and interoceptive scores increased and remained stable over time. Results suggest a similar pattern for depressive scores (EPDS), with pre-treatment scores significantly higher than immediately post-treatment and post-partum follow-up, and no significance difference between post-treatment and follow-up; depressive symptoms reduced and maintained consistent over time.

A within-subjects MANOVA was run between T1 and T2 to explore the effects that the PMRB program had on maternal mindfulness, mental health, interoception, and mother-infant relationship during pregnancy, referred to as maternal-foetal attachment by the MFAS. Using Wilk's λ, the MANOVA demonstrated a significant multivariate main effect F (1, 12) = 5.19, p = 0.020, partial η^2 = 0.764, indicating that there was a significant difference in participants' overall scores T1 and T2. Univariate follow ups on FFMQ indicated a significant difference in mindfulness scores F (1, 12) = 17.32, p = 0.001, partial η^2 = 0.591. Univariate follow up on EPDS did not indicate a significant difference in depressive scores F (1, 12) = 2.64, p = 0.130, partial η^2 = 0.180. Univariate follow up on DASS-21 did not indicate a significant difference in depressive, anxiety, and stress scores F (1, 12) =

4.63, $p = 0.052$, partial $\eta^2 = 0.278$. Univariate follow up on MAIA-2 indicated a significant difference in interoceptive awareness scores F (1, 12) = 14.34, $p = 0.003$ partial $\eta^2 = 0.554$. Univariate follow up on MFAS indicated a significant difference in maternal-foetus attachment F (1, 12) = 26.84, $p = < 0.001$, partial $\eta^2 = 0.691$.

Using Wilk's λ, univariate analysis on the subscales on the DASS indicated a difference in depression scores F (2, 11) = 3.49, $p = 0.071$, partial $\eta^2 = 0.411$, but this was not significant. Univariate analysis on the anxiety subscale scores indicated a significant difference F (2, 11) = 7.48, $p = 0.010$, partial $\eta^2 = 0.599$. Lastly, univariate analysis on the stress subscale did not reveal a significant change across time F (2, 11) = 3.06, $p = 0.092$, partial $\eta^2 = 0.380$. Results indicated that participants' anxiety (as subscale) significantly decreased from pre-treatment to immediately after the treatment and follow-up. Table 4 displays the means and standard deviations for T1 T2 and T3 for the DASS subscales.

Table 4 Means and standard deviations for T1 T2 and T3 for the DASS subscales.

DASS-21 Subscales	M (SD)
T1. Depression SS	10.58 (3.15)
T2. Depression SS	8.50 (1.62)
T3. Depression SS	9.42 (2.91)
T1. Anxiety SS	10.83 (3.10)
T2. Anxiety SS	9.58 (2.31)
T3. Anxiety SS	8.58 (1.44)
T1. Stress SS	14.58 (4.60)
T2. Stress SS	12.25 (4.14)
T3. Stress SS	12.50 (4.34)

Note. DASS-21 = Depression Anxiety Stress Scale – 21; SS = Subscale

An individual analysis was performed on participants' mean scores of maternal emotional availability, as the measure can only be used in the postnatal period. Therefore, a comparison between the MFAS and EA-SR could not be performed. The individual results of EA-SR indicated that participants reported mean score of maternal emotional availability post-partum close to the Non-Depressed Sample mean score. Specifically, the mean scores of the subscales Mutual Attunement, Child Involvement, and Affect Quality were all higher than those of a depressed sample and close to the mean scores of a non-depressed sample. Intrusiveness mean score was lower than in a depressed sample and non-depressed sample. Table 5 displays EA-SR score means comparing to sample mean to Depressed and Non-Depressed Clinical Sample Means.

Table 5 EA-SR Comparing to Sample Mean to Depressed and Non-Depressed Clinical Sample Means.

Subscale	Study M	Depressed Sample M	Non-Depressed Sample M
Mutual Attunement	38.92	31.52	40.41
Child Involvement	38.50	32.36	35.85
Affect Quality	22.33	21.32	23.86
Intrusiveness	18.58	22.32	21.06

Hostility	11.33	4.98	5.06

Compared to data extracted from Nicole Vliegen, Patrick Luyten & Zeynep Biringen (2009) A Multimethod Perspective on Emotional Availability in the Postpartum Period, Parenting: Science and Practice, 9:3-4, 228-243, DOI: 10.1080/15295190902844514.

3.2 Qualitative Results

This study also conducted an in-depth exploration of pregnant women's experiences of the 9-session prenatal mindfulness relationship-based (PMRB) program. Information about pregnant women's experiences of the PMRB program was collected during the sessions, including their birth stories. Responses to an open-ended question about how the program had supported them during pregnancy, labor/birth and the first post-partum trimester were summarised using a thematic analysis. A thematic analysis involves developing themes and categories from transcripts [85]. Sixteen themes were identified and organised in four categories: 1) Expectations and motivations (healthy pregnancy and mental health, non-medicalised birth, contribution to the field); 2) Experiences of the PMRB program (positive experiences, shared experience, engagement with mindfulness practices, pain, stress, and anxiety relief); 3) Changes attributed to the mindfulness practice (increased mindfulness/self-awareness, stop look listen, embracing the moment, acceptance); 4) Changes attributed to the PMRB program (a new way of responding to stressors, trusting the process, connecting to body, breath, and unborn infant, awareness of the unborn infant as a sentient being). Table 6 displays the identified categories and themes.

Table 6 Categories, themes, and examples.

Category/theme and description	Examples
Expectations and motivation (healthy pregnancy and mental health, non-medicalized birth, contribution to field). Women frequently talked about the desire for a healthy pregnancy as motivation to attend class as they believed the PMRB program would help them cope with challenges and be good for their health as well as the baby. Knowledge about the baby as a sentient being provided by the course also increased their motivation to complete the course. Most women reported having signed up to the program as they wanted an intervention-free birth and four reported to be willing to contribute to research that is much needed to improve pregnancy and birth care.	"Just thinking of my baby's well-being as affected by my health has motivated me to persevere with the course attendance and home practice, despite working late and being tired". "I had no idea what to expect and was unsure whether enrolling but just wanted to learn a new way of dealing with things and be better prepared for my second birth than last time when I had a caesarean. "My joy would be having a home birth and my fear is being transferred to a hospital and having my birth disturbed". "Lots of hard work is going into this study, but it could help to empower women to take responsibility for their birth and not to be afraid of it but to trust in its perfect design".
Experiences of the PMRB program (positive experiences, shared experience, engagement with mindfulness practices, pain, stress, and	"During the program I took all the information and used it during labour and birth. Baby was very calm when he came. It was amazing!".

anxiety relief). All women reported participating in the PMRB program was a positive experience and enjoyed the course. Most participants reported a sense of unease to share their stories during the first two sessions when the group was forming. One of the reported benefits of sharing time and stories with the group was to feel their own experience and challenges were common. Participants reported different ways of engaging with the mindfulness practice. Some mentioned they were finding it a bit challenging to focus attention on the breath and body sensations for an extended time, calm their mind and stop thinking during the first two sessions. However, they could see the benefits of practising regularly. The variety of exercises and practices during the course and at home, including those fostering the connection with the baby, was considered a strength of the program, as it allowed participants to have different experiences with the mind, body, and developing baby. Women generally felt it was easier to use mindfulness in daily activities and in group than formally practicing it.	"It was good to listen to other women's experiences and feel in a safe place where you could feel comfortable to talk about your feelings". "I really enjoy the meditation baby/connect practice at the end of each session because I can be guided and more easily focused and find a holding space". "Becoming aware it is not easy to love yourself and we can practice it to learn not to be harsh to ourselves, for instance, by feeling angry, guilty, self-judgmental, has been a revelation". "I like practising any time of the day. I particularly like the Baby Connect practice, as I can always connect with my baby in many ways, for instance talk to him while driving". "Breastfeeding was a bit painful at the beginning but then settled and became enjoyable thank to the mindfulness practice and belief in giving health foundations to the baby".
attributed to mindfulness practice (increased mindfulness/self-awareness, stop look listen, embracing the present moment, acceptance). Women mentioned mindfulness practice increased 'mindfulness' or bodyself awareness, which helped them pay attention to what was going on in their body and mind, including their developing baby. They referred to their ability to stop and notice sensations, feelings, thoughts, and consciously respond rather than reacting impulsively, which is one of the core abilities learnt with mindfulness practice. Being connected to the present moment is one of the core qualities of mindfulness practice, and in fact this theme emerged with consistency from the data. Participants described how present moment awareness gad helped them in everyday life during pregnancy, labour/birth and in the interactions with the baby. They	"The mindfulness abilities learnt during the course helped me deal with the baby's challenges with calm and acceptance". "The mindfulness practice, both formal meditation and informal practice, taught me the importance and benefits of being mindful, both in pregnancy and everyday life, and how the increased mindfulness helps me connect with my body and baby". "I have learnt to pause and not react immediately when my child has a tantrum but to create a space to listen to his emotion. I can now understand him better and connect". "When the baby cries, rather than being annoyed and questioning what I have done wrong or is wrong with him, being triggered or trying to fix it, I take a breath and calm down, thinking nothing is wrong, it is what it is and just being with the baby:"

mentioned that not being distracted but being present in their bodies during pregnancy helped them connect with the baby and stay calm, and during labour helped them go through every contraction rather than resisting. The idea of acceptance or 'surrender' emerged particularly strongly from participants' reports that they felt more able to accept things as they were rather than struggling with how they would like things to be.	"Mindfulness practice helped me feel the arising emotion, let it happen, be present with what was arising in my body without holding back, fighting or regretting having had an emergency caesarean because of the fear that the scar from my previous caesarean would rupture".
Changes attributed to the PMRB program (a new way of responding to stressors, trusting the process, connecting to body, breath, and unborn infant, awareness of the unborn infant as a sentient being). Women reported to have learnt to be with the challenging thoughts, emotions, and behavioural patterns. Rather than being overwhelmed by negative thoughts and emotions and letting them escalate to destructive levels by reacting impulsively, women were able to step back, take a breath, observe, and consciously choose a more considered response. Women frequently spoke about how knowing that the baby is responsive to their mental states was a strong motivation to reduce their overthinking and worries. Participants spoke about how the PMRB program taught them to trust the process of pregnancy, labour/birth, breastfeeding and bonding. They frequently talked about how coming back to their body, breath, and connection with their baby helped them deal with challenging emotions or situations. Becoming aware of the unborn baby as active agent, participant in the communication with the mother and responsive to her emotional states is one of the core concepts of the PMRB program. Therefore, it is not surprising that this theme emerged particularly strongly from the data.	"I used to let my thoughts and worries take over and expect the worse. But the practice of mindfulness and awareness of my baby as a sentient being have taught me not to worry about things that might not even happen and are only in my mind and can potentially upset the baby. This has allowed me to just be present...If I am sad, I just accept and savour my sadness". "The moment we stopped doing what they had been taught about baby sleep during a course, her baby started to sleep well. She ascribed this to having learnt the importance of relying on the baby's bodily cues and going with the flow to reduce the anxiety and connect with the baby". "When I was 38-week pregnant, the doctor proposed the induction because of the risks of gestational diabetes. He said that 50% of still births are unexplained and diabetes could be a cause. But the course helped me to trust my body and the process of labour, and I had a complication-free home water birth". "I'm really enjoying the increased awareness of my baby and love the empowered feelings I get from actively building a connection with him. Just last night, I asked my husband to spend some time with the baby by rubbing my belly and listening to his movements. After a short while the baby started kicking where hubby had his hand, where they'd poke and prod at each other - it was quite special. It then became a game that went on for a good 5-10 minutes".

	"The chapter of the book I am reading as part of my home practice has given me examples of how to expand the communication with the baby, allowing me to understand I am 'We' not 'I' anymore".

4. Discussion

The current study sought to examine the feasibility of the PMRB program delivered in an online format on pregnant women to enhance mindfulness, mental health, and mother-infant relationship during pregnancy and at 10-12 weeks post-birth follow-up. Following the prenatal PMRB eight-week program, participants' mindfulness, interoception, mental health, and prenatal relationship had significantly improved. Furthermore, these improvements were maintained over time. However, although a statistic analysis between post-treatment and post-partum (T2) follow-up (T3) was not performed, it was noted that results revealed a drop in mean score between T2 and T3 for all the maternal variables, which brough the difference between T2 and T3 on the threshold of significance.

Results indicated the PMRB program significantly increased mindfulness in pregnant women from pre- to immediately post-treatment and follow-up. The current finding is consistent with previous studies demonstrating significant increases in mindfulness scores following a mindfulness-based program [33, 86]. The follow-up, however, indicated that the improvement from post-treatment to follow-up was smaller than from baseline to post-treatment, with the difference on the cut-off value of significance.

Participants also revealed significant decreases in depressive scores as measured with the EPDS post-program. This finding is consistent with previous research [3, 37, 87], which indicates that mindfulness-based treatments have the potential to improve maternal mental health during pregnancy and the post-partum period. The follow-up of the current study, however, did not indicate further significant improvements from immediately post-treatment to the follow-up time point. The reduction in depression from post-treatment was smaller than from baseline to post-treatment.

In terms of depression, anxiety, and stress as measured with the DASS-21, the study findings did not indicate a significant impact of the PMRB program post-treatment and at follow-up on the overall score. The DASS-21 significant level was 0.054, so just on the cusp, which may be attributed to the small size. This is inconsistent with previous studies [87-89] revealing significant decreases in anxiety and stress scores following a mindfulness-based program. However, an analysis on the DASS-21 subscales revealed a significant reduction in anxiety mean score from baseline to post-program and follow-up, which is consistent with the cited previous studies. One reason for this inconsistency of findings may be the low levels of depression, anxiety, and stress of most participants at baseline. Mean baseline scores for depression were in the low mild range and baseline stress scores were in the normal range, which may have limited the amount of change. Additionally, the sample was small.

With respect to interoception, as measured with MAIA, study findings demonstrated significantly higher interoception scores from pre- to post-treatment, with this effect maintained at follow-up, although the increase was smaller than from baseline to post-treatment. This is consistent with previous studies demonstrating significant increases in interoception scores post-treatment during

pregnancy and post-partum of mothers who had received mindfulness-based childbirth preparation training [90]. This may further suggest that interoception can be enhanced through practice, which is of high relevance to early parenting, as parents' interoception can be recognized as an important contributor to supporting their ability to understand and thus respond to the infants' body signals and emotion states [52]. This is important finding, as, although in recent years there has been increasing interest in research on the mind-body correlation or 'interoception', interoception in pregnant women and early parenting has attracted little attention.

In terms of mother-infant relationship during pregnancy, as measured with the MFAS, results indicated significantly higher levels of maternal-foetal attachment from pre- to post-treatment. This finding is consistent with previous research indicating that mindfulness appears to be a protective factor fostering positive attachment and child development and behaviour outcomes [31, 41, 42]. However, the finding of the current study indicates the need to consider the influence of an antenatal mindfulness-based program on mother-infant relationship during pregnancy and in the first post-partum trimester.

In terms of maternal post-partum emotional availability, measured with the EA-SR, participants reported mean scores close to the Non-Depressed Sample mean score. Specifically, the mean scores of the subscales Mutual Attunement, Child Involvement, and Affect Quality were all higher than those of a depressed sample and close to the mean scores of a non-depressed sample. The Intrusiveness mean score was lower than in a depressed sample and non-depressed sample. This may be an effect of the PMRB program. Emotional availability has been studied in observed and self-reported clinically depressed and non-depressed mother-baby pairs [54]. Findings indicated that post-partum depressed mothers had significantly lower scores on most dimensions of emotional availability, both as observed by clinicians during 30-min free play mother-baby interaction and on the self-report measure of emotional availability, except for hostility and intrusiveness during the first year of life [54]. Participants of the current study, however, revealed a total higher score on hostility**,** compared to both a depressed and non-depressed sample. Findings revealed that only two participants showed higher scores on hostility, which, being the sample small, brought up the overall score quite substantially. In fact, small samples can inflate the means from those higher scores. It was hypothesised that the hostility of these pregnant women may have been potentially related to their birth intervention experience and likely the result of the short period from the follow-up time point.

One reason for the drop in mindfulness and interoception scores in the difference between post-treatment and postpartum follow-up may be that approx. 50% of the new mothers gave birth at the hospital and experienced birth with intervention (one with forceps, one planned caesarean and four emergency caesarean), whereas the other 50% who gave birth at home had intervention-free birth. This may also explain the similar pattern in depressive scores. Hence, the new mothers may have been still affected by the birth outcome and the ordinary challenges of having a newborn baby, although most participants reported in the qualitative arm having learnt from the course the tools to deal with these challenges. The small sample size may have also affected the study results. Furthermore, it is possible the new mothers who completed the eight-week program and home practice during their pregnancy, did not engage in the home practices or not as consistently as during the program, which would help explain the no significant differences between post-treatment and follow-up scores. While participants were advised to continue using the techniques and practices in the perinatal period, the physical and emotional involvement in the care of a new

baby may have prevented the new mothers from using the techniques. However, results indicated that improvements remained stable over time.

Although the eight-week duration of the PMRB program in the current study led to positive outcomes, future research designs could assess whether a longer program duration extending to the postpartum period would produce better effects. Notwithstanding the smaller improvements at postpartum follow up compared to immediately post-treatment significant effects, the qualitative arm of the current study supported the program benefits sustained over time. For example, mothers reported that the program had provided the tools to positively cope with the birth unexpected complications and the challenges of having a baby and connect and bond with the baby straight after birth. All mothers were breastfeeding and expressed their intention to continue it for a long period. Most of them were not concerned about their baby's crying or sleeping patterns and attributed this to the PMRB program. Overall, present quantitative and qualitative results together support the notion that the changes that occurred within the eight-week program were sufficient to positively influence maternal mindfulness, interoception, wellbeing and the relationship with the infant during pregnancy and in the first postpartum trimester.

These quantitative limited findings were supported by the qualitative component of this feasibility trial [67], indicating the potential of mindfulness practices focused on the prenatal mother-infant relationship and maternal interoception, and integrated with prenatal psychology education, to significantly improve women's mindfulness, wellbeing, and relationship with their infant during pregnancy and post-partum.

Participants reported that stopping, breathing, and noticing, developing an attitude of acceptance and connecting with the present moment, which are core aspects of mindfulness, helped them cope with pregnancy, childbirth and early parenting challenges. The main themes identified in the current analysis, especially regarding the changes attributed to the practice of mindfulness, are consistent with those of earlier qualitative analysis, especially the concept of acceptance [59-61]. Improved ability to cope with challenging emotions and pain also emerged as a main theme among participants and may have contributed to program adherence. Connecting to body, breath, and baby inside was another important theme emerging from the data. Women reported that they were able to "get more in touch with their bodies" and that they learned how to be present in their body and listen to it, an ability that is related to interoception. Mothers' capacity to interocept has been associated with the capacity to respond to the infant's bodily signals and meet the infant's developmental needs [50]. Embodied awareness may broaden mothers' repertoire of body sensations and experiences, allowing them to have a better understanding of their child's experience [91]. Another major theme that emerged among participants in relation to mental health and mother-infant relationship was the increased mindfulness/awareness that women experienced during and after participation in the PMRB program. Awareness of the infant inside as a sentient being capable of bidirectional communication also emerged as a main theme among participants and may have contributed to program adherence. Women talked about how communicating with their unborn baby gave them a great motivation to overcome challenging moments. They described the wonderful feeling to perceive the baby's movements and knowing their communicative meaning. One woman reported a sense of "being We and not I anymore", another of having a partner to talk with while driving and doing house chores. So, feeling connected to the baby revealed to be a strong facilitator of engagement with the course. Women also noted a greater sense of wellbeing and that this also motivated them to attend class. Eight mothers,

including all those who gave birth at home, used natural pain management strategies, such as showering, water immersion, breathing, mobilising, meditation, and visualisation. They reported that these choices had been influenced by the abilities learnt during the course. All women who experienced unexpected complications during labour at the hospital, emphasised how the PMRB program helped them accept the unexpected intervention and the consequent challenging emotions and bond with the baby. All women expressed their intention to breastfeed during the course and successfully did and intended to continue extendedly. Most women reported not to be concerned or be somewhat concerned about their baby's crying and sleeping and attributed this to their ability to cope with challenges, be present and tune into the infant, which they had learnt during the course.

4.1 Limitations and Implications for Future Research

The present study had several limitations that could be addressed in future research. Although the findings of both quantitative and qualitative results of the current study are promising, the small sample size is likely to affect the generalizability of research findings. Although there is no need to calculate G Power for feasibility studies with small samples, future replication studies may seek to examine the effectiveness of the PMRB program with larger sample sizes and a control group, in order to ensure power of study conclusions. An analysis for a MANOVA indicated that to achieve a power level of 0.80, when setting the level of significance $\alpha = 0.05$, at least 32 participants per group would be needed to detect significant change on primary and secondary outcome measures and to achieve a medium effect size.

Another limitation was that there was no non-intervention control group to compare the PMRB program outcomes to and no active intervention comparison group. Future studies could compare the efficacy of online delivery of the PMRB program with a waitlist control group and a gold-standard therapeutic intervention [e.g., online delivery of Cognitive-Based Therapy (CBT) or Mindfulness-Based-Stress-Reduction (MBSR), which does not include prenatal psychology and focus on the communication with the unborn baby].

Moreover, an accurate program evaluation may be needed to more specifically assess how program materials are implemented or practiced by participants. A further limitation of the current study was the use of self-report thus subjective measures and lack of an objective/physiological assessment, which is a common methodological issue within psychological research. It is important to consider whether the study findings may have been affected by bias such as social desirability. Therefore, future research may also benefit from assessing physiological measures in order to investigate the mechanisms by which the PMRB program impact these measures.

Finally, while the other maternal measures could be repeatedly administered prenatally and postnatally, a comparison between mother-infant relationship during pregnancy and post-partum could not be performed, since they were assessed with different questionnaires. Hence, two different analyses had to be performed and emotional availability was assessed individually through each EA-SR subscale, with the mean scores referring to clinical and non-clinical sample means. This highlights the need to develop a single measure to assess mother-infant relationship during pregnancy and postpartum, which would be in line with the theoretical framework that there is a continuum in human development from pregnancy to the postnatal period.

The qualitative findings presented here provide important insights related to pregnant women's experience in a PMRB program to improve maternal mental health and mother-infant relationship during pregnancy and in the first postpartum trimester. However, important limitations should be acknowledged. Qualitative research has inherent limitations as these analyses generate rather than confirming hypothesis but can be used to understand human experience as compared to quantitative research [92]. Qualitative research can assist in the collection of both quantitative and qualitative data to assess feasibility and acceptability of recruitment, follow-up methods and the program.

Qualitative research (compared to quantitative) may be more easily influenced by the researcher's bias. Finally, the nature of recruitment in this study implied self-selection bias, and as such, the sample may not well represent the target population and the experiences of participants in the PMRB program cannot be generalized. Participants were all Australian and from middle to upper socioeconomic levels, therefore a larger study may include a lower class and diverse nationalities.

Nonetheless, the high adherence to the program and retention of participants completing all the three surveys in the quantitative study, sharing of their experience of the PMRB program and reported positive experiences of the course are strengths of the current study. There was only one participant out of 13 who did not complete the post-partum follow-up of the study, although she did complete the eight-week program and two baseline and post-treatment surveys and showed her interest in completing last follow-up survey. The high adherence and collection of both current quantitative and qualitative data [67] to assess feasibility and acceptability of the PMRB program may warrant the integration of this program into a variety of settings that provide care for pregnant women.

Notwithstanding the limitations, the current study has provided preliminary evidence for the utility of the online PMRB program as a support tool to help address the worldwide increase of perinatal mental health disorders and their impact on infant/child development and health. It is suggested that future research validate the efficacy of PMRB program for reducing a variety of psychological symptoms such as depression, anxiety, and stress and improving mother-infant relationship during pregnancy and in the early postnatal period by conducting replication longitudinal follow-up studies. These improvements are likely to positively impact the developmental trajectory of infants. Future research is also urged to investigate how an online PMRB program can be made accessible to pregnant women worldwide and how it can be included in the healthcare services for pregnant women, couples, and infants.

4.2 Implications for Practice and Policy

The current study has a number of strengths, including having expanded on the limited research examining the impact of a mindfulness-based program on maternal wellbeing, interoception, and mother-infant relationship during pregnancy and the first postnatal trimester. Furthermore, this study provided preliminary evidence for the effectiveness of adopting a more holistic mind-body approach that examines not only mindfulness and mental health, but also other psychological variables such as interoception and mother-infant relationship from before birth.

The findings from the thematic analysis provide support for the feasibility of the PMRB program to enhance maternal wellbeing and facilitate mother-infant relationship during pregnancy and

postpartum, which has been widely recognised as laying the foundation for later child development [22, 93, 94]. Future researchers or clinicians aiming to test or use a prenatal mindfulness relationship-based program as a tool to improve maternal wellbeing and mother-infant relationship, thus potentially improve infant's development and health, may consider the following:

- Ensure that prenatal mindfulness-based classes focus on implementing body and breath awareness and mindfulness to help women develop a deeper connection with their body or interoception, and potentially increase awareness of the influence of health choices and health behaviours on the infant's development and health.
- Ensure that prenatal mindfulness-based classes incorporate foundations of prenatal psychology education and cultivation of mother/father-baby relational engagement and communication.
- Examine the impact of a MPRB program in an in-real-life setting instead of online to look at barriers and facilitators, having the online program had very high adherence.
- Explore both qualitatively and quantitatively the potential mechanisms through which a PMRB program may affect maternal mental health and mother-infant relationship during pregnancy and postpartum.
- Include fathers to maximise their involvement in prenatal care, the relationship with the infant, with potential enrichment and improvement in the relationship with their partner.
- Examine the impact of the PMRB program on maternal mental health and mother-infant relationship in at-risk populations, including severely depressed, anxious, and distressed women and women with all kinds of psychological disorders.
- Integrate the PMRB program into a variety of settings that provide care and/or services for pregnant women, including clinics, prenatal care programs, other healthcare facilities, and online programs, and investigate the perception of pregnant women participating in the program in various settings and differences in outcomes in various settings.

5. Conclusions

The current study represented the first feasibility study designed to assess the effectiveness of online delivery of a mindfulness-based program integrating prenatal psychology in improving maternal wellbeing and mother-infant relationship from before birth. In the absence of a clear holistic pathway to pregnancy and perinatal healthcare, the PMRB program may provide an opportunity to facilitate maternal emotional availability and thus mother-infant earliest relationship, which has been widely recognized as foundational for later child development. Participants' subjective accounts of their experience provide some insights into the possible mechanisms by which mindfulness combined with prenatal psychology education and the cultivation of mother-infant communication work to produce improvements in maternal well-being and mother-infant relationship during pregnancy and the first post-partum trimester. This has potential to improve the developmental trajectory of parents and infant. Pregnancy is a window of opportunity for parents and their infants, a significant time in a woman's life when she is open to receive new information and develop a new repertoire of skills to cope with pregnancy, birth, and parenting challenges. It follows that childbirth and parenting preparation classes can benefit from incorporating some training in mindfulness as well as in prenatal psychology and embodied dialogic communication with the infant, thus providing becoming parents the opportunity to learn important abilities. Future

research should focus on expanding alternative mind-body health enhancement approaches that are readily available to pregnant women, in order to reduce the international perinatal mental health pandemic.

Acknowledgments

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Author Contributions

The first author conceived and designed the Prenatal Mindfulness- Relationship-Based (PMRB) program that was piloted in her PhD, supervised by Peta Stapleton and Alan Patching.

Competing Interests

The authors declare no competing interests. The first author may derive income from keynote speeches and trainings related to the topic explored because of her relevant expertise. There are no other conflicts that exist.

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